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TOWARDS AN ONLINE ATLAS OF THE FLORA OF THE ALPS: FIRST YEAR OF THE PILOT PHASE AND NEXT STEPS)

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Abstract - BRIGITTE MARAZZI, SYLVAIN ABDULHAK, SEBASTIANO ANDREATTA, ALESSIO BERTOLLI, ROBERTO DELLAVEDOVA, WOLFGANG DIEWALD, PHILIPPE JUILLERAT, MICHAEL KLEIH, ANDREA MAINETTI, KONRAD PAGITZ, GILBERTO PAROLO, FILIPPO PROSSER, LUISE SCHRATT-EHRENDORFER, ALBERTO SELVAGGI, GIULIA TOMASI, BRANKO VREŠ, JULIA WELLSOW, THOMAS WILHALM & STEFAN EGGENBERG - Towards an online atlas of the flora of the Alps: first year of the pilot phase and next steps).

Efforts are ongoing towards a first update of the comprehensive floristic knowledge since 'Flora Alpina' was published by Aeschimann and co-workers two decades ago. After the kick-off meeting in March 2023, the transnational collaborative project for an online atlas of the flora of the Alps, the so-called 'Atlas Flora Alpina' (AFA) project, has been progressing thanks to four working groups that were set up with specific tasks each. Over a dozen institutions and floristic data centers from across the entire Alpine arc (Austria, France, Germany, Italy, Slovenia and Switzerland) supported the start of phase 1 of the project, and 25 participants from these six countries attended the second meeting on April 12-13, 2024, at the Museo Civico di Rovereto in Trentino (Italy). In this paper, we

provide a summary of the four workshops lead by the respective working groups: ‘Pilot map’, ‘Perimeter Delimitation’, ‘Funding’, and ‘Taxonomy’. For each of them, we first present the starting situation from the kick-off meeting in 2023, then the workshop results in terms of preliminary work discussed, suggestions made, decisions taken, and finally, the next steps to undertake. In conclusion, few open issues are listed that will have to be addressed in the future, possibly at the next AFA project meeting in 2025.

Keywords: Alpine plants, Data network, Ehrendorfer grid, Flora Alpina, Species distribution.

Riassunto - BRIGITTE MARAZZI, SYLVAIN ABDULHAK, SEBASTIANO ANDREATTA, ALESSIO BERTOLLI, ROBERTO DELLAVEDOVA, WOLFGANG DIEWALD, PHILIPPE JUILLERAT, MICHAEL KLEIH, ANDREA MAINETTI, KONRAD PAGITZ, GILBERTO PAROLO, FILIPPO PROSSER, LUISE SCHRATT-EHRENDORFER, ALBERTO SELVAGGI, GIULIA TOMASI, BRANKO VREŠ, JULIA WELLSOW, THOMAS WILHALM & STEFAN EGGENBERG - Verso un atlante online della flora delle Alpi: primo anno della fase pilota e prossimi passi.

Sono in corso gli sforzi per un primo aggiornamento completo delle conoscenze floristiche dell’arco alpino a quasi 20 anni dalla pubblicazione di ‘Flora Alpina’ da parte di Aeschmann e collaboratori. Dopo il kick-off meeting nel marzo 2023, il progetto di collaborazione transnazionale per un atlante online della flora delle Alpi, il cosiddetto progetto “Atlas Flora Alpina” (AFA), è proseguito grazie a quattro gruppi di lavoro istituiti con compiti specifici. Più di una dozzina di istituzioni e centri di dati floristici di tutto l’arco alpino (Austria, Francia, Germania, Italia, Slovenia e Svizzera) hanno aderito all’avvio della prima fase del progetto e 25 partecipanti provenienti da questi sei Paesi hanno partecipato al secondo incontro del 12-13 aprile 2024, presso il Museo Civico di Rovereto in Trentino (Italia). In questo documento, forniamo una sintesi dei quattro workshop condotti dai rispettivi gruppi di lavoro: “Mappa pilota”, “Delimitazione del perimetro”, “Finanziamento” e “Tassonomia”. Per ciascuno di essi, presentiamo prima la situazione di partenza dall’incontro di avvio del 2023, poi i risultati del workshop in termini di lavoro preliminare discusso, suggerimenti avanzati, decisioni prese e, infine, i prossimi passi da intraprendere. In conclusione, vengono elencate alcune questioni aperte che dovranno essere affrontate in futuro, possibilmente in occasione del prossimo incontro del progetto AFA nel 2025.

Parole chiave: rete di dati, Distribuzione di dati, Flora alpina, Griglia Ehrendorfer, Piante alpine.

1. INTRODUCTION

Great efforts have been made during the last thirty years to build up regional and national databases of floristic records in Europe and publish them on web atlas interfaces as online distribution maps. However, those covering a biogeographical unit across national borders of two or more countries remain exceptional. In 2018, the online atlas dealing with the flora of the Jura Mountains went online on www.florajurana.net as the result of the international cooperation between the flora data centers of Switzerland and the neighboring region in France. This success was inspirational to officially start in 2023 an ambitious cross-border project of an online and freely consultable atlas of the flora of the Alps, called the “Atlas Flora Alpina project”, or more simply the “AFA project” (EGGENBERG *et al.*, 2022; MARAZZI *et al.*, 2023). The AFA project represents the first update of the comprehensive floristic knowledge of the Alps since the publication of ‘Flora Alpina’ two decades ago

(AESCHMANN *et al.*, 2004). The relevance of the AFA project goes far beyond that: the publication of the data in the form of species distribution maps on the web will make it possible to reach a wider audience resulting in increased knowledge and, above all, awareness of Alpine floristic biodiversity. The maps would highlight which species are the rarest in an area, an essential prerequisite for protecting the flora. They would also indicate the most common species and those that are experiencing range erosion, point out alien entities that are spreading, and essentially show floristic patterns of an area over a period of time, which is a prerequisite to assess any future (negative or positive) changes as a result of land use changes and/or global climate warming. To start the project, a kick-off meeting was organized on March 10-11, 2023, at the Natural History Museum of Canton Ticino in Lugano (Switzerland). Twenty-six participants from at least 17 institutions and 6 countries (Austria, France, Germany, Italy, Slovenia and Switzerland) were invited to represent the many floristic



Fig. 1 - Participants at the 2nd meeting of the Atlas Flora Alpina project, 12-13.04.2024, Rovereto, Italy. The meeting took place at the Museo Civico di Rovereto. Line in the back, from left: Filippo Prosser, Alberto Selvaggi, Wolfgang Diewald, Gilberto Parolo, Maurizio Bovio, Andrea Mainetti, Markus Hofbauer, Luise Schratt-Ehrendorfer, Konrad Pagitz, Bertrand Lienard, Fridtjof Gilck, Julia Wellsow, Brigitte Marazzi, Sebastiano Andreatta, Jérémie van Es. Line in front, from left: Silvain Abdulhak, Branko Vreš, Alessio Bertolli, Michael Kleih, Giulia Tomasi, Roberto Dellavedova, Paolo Majorano, Stefan Eggenberg, Philippe Juillerat, Thomas Wilhelm.

regions across the Alps (see Fig. 1 in MARAZZI *et al.*, 2023). In that meeting, phase 1 of the project, aiming at a first version of the atlas going online within two years, was proposed; questions on fundamental topics, such as taxonomy, grid system, symbols, atlas perimeter, data export and data policy, were addressed; the next steps until the next meeting of the AFA project consortium were outlined (MARAZZI *et al.*, 2023) and, finally, four working groups were created: 'Pilot Map', 'Perimeter Delimitation', 'Funding', and 'Taxonomy'. A total of 25 participants from six countries attended the second meeting on the AFA project, held on Friday and Saturday, 12-13 of April 2024, at the Museo Civico di Rovereto (TN, Italy; Fig. 1) and organized by the Botany Department of the Museo. The meeting started with presentations of the progress made in the first year of phase 1, and subsequent workshops of about an hour focused on the topics of the four working groups. In the present paper, we present the results of these workshops, including first an overview of the starting situation from the Lugano meeting (cfr. MARAZZI *et al.*, 2023), then a summary of work in progress discussed, and, finally, the next steps outlined by the workshop participants.

2. PILOT MAP

2.1 Starting Situation

The focus of this working group based on results from discussions on all four fundamental topics addressed in Lugano in 2023: 'Grid and symbols', 'Perimeter delimitation', 'Taxonomy', and 'Data exchange and policy'. The discussion about the grid immediately converged to the conclusion that the Ehrendorfer grid (EHRENDORFER & HAMANN, 1965) should be used as a grid system in the AFA project, like in most of the atlases, such as in Italy, Austria and Germany. In addition, a grid based on the WGS 84 / ETRS 89 coordinate system appeared as the best solution. In addition to displaying the presence of taxa across the Alps, it was agreed that symbols of data points on the map should convey a certain amount of information on these taxa, such as: the degree of establishment (i.e., the origin – if natural or alien – of a population), the age of an observation (or the age of the last observation in a grid cell), the type of source of an information (e.g., literature, herbarium specimen, or field mapping) and data validation. The first perimeter to be used in phase 1 would be the geographic delimitation of the Alps as proposed by the Flora Alpina (AES-

CHIMANN *et al.*, 2004). AESCHIMANN *et al.*'s taxonomic concepts, but with an updated nomenclature, should be used as a backbone list, and the GBIF tools should be used to offer a "translation" from this backbone list to the checklists used by the data centers. Finally, the minimum information for each taxon should consist of the common taxon ID, the grid ID, and the year of the last verified observation.

2.2 Preliminary Work: Pilot Maps of 100 Species

In view of the Rovereto meeting, the working group compiled a list of 100 taxa to be used in the pilot project. The respective data were assembled to provide display tests on an unpublished online web page of the AFA Project hosted on the pilot map server at InfoFlora. As the floristic data evidently cover the entire Alpine arc quite uniformly, the distribution maps of these selected taxa are of striking quality, as shown by the example of *Gentiana clusii* in figure 2.

The need to provide distribution data for 100 species, based on a predefined list, required all partners to verify the nomenclatures and to make a preliminary validation of the data provided for the AFA project. This allowed us to evaluate the difficulties and the work necessary for this phase of the project. The visualization of the alpine maps, as a result of the aggregation of the data provided by all partners, is an important result not only for the purposes of delimiting the range of the species, but also for verifying inconsistencies due to the differences in taxonomic concepts used in the different countries, localization errors, etc. The creation of online maps requires a validation effort that does not stop at the aggregation of already validated data supplies from different partners, but requires overall and subsequent validation phases that will require an organization.

2.3 Next Steps of the Working Group

Workshop participants discussed to have a "public" and a "private" website of the atlas. On the public one there should be only a limited amount of information available and only the distribution of the following five species (four natives and one alien): *Carex microglochin* (representative of humid habitats), *Gentiana brentae* (a narrow endemic), *Homogyne alpina* (representative of siliceous habitats), *Primula auricula* (of calcareous habitats), and *Senecio inaequidens* (an invasive alien species). It was agreed to let thoroughly check the distribution of these five species by the AFA project members. Further desired features on this public website included the possibility to click on single points in the map. A list of

the participating institutions should be provided, along with suggestions on how to cite the project. A formal project name was discussed and proposed to stay in line with the name so far used informally: Atlas Flora Alpina Project (AFAP).

The "private" website with more information would be accessible to AFAP members through a login and a personal account. Members would be able to examine all maps of the first 100 species selected for the pilot project and edit the data shown in a window that would open when clicking on a given point on the map. It was also suggested that in a future development phase of the project, more data fields could be added to the contributions of each AFAP member, along with optional fields such as, in particular, a list of the names of all observers providing data in a given quadrant and (if applicable) the institutions to which they belong. The main reason for wanting optional fields is that not all participants have the same information in their data collections.

Other two discussed topics dealt with the status of non-native species and occurrences and how to deal with occurrences proven to be erroneous. In the first discussion, it was proposed to have three statuses for point data: the two already considered, 'autochthonous' (i.e., native) and 'introduced', and 'synanthropic' as an additional status meaning that the plant is either not persistent or it is not known if it is. Participants agreed that, if a map quadrant would include occurrences classified as both native and nonnative, only the symbol for native presence should be shown. On the other topic, the majority of participants agreed, that incorrect occurrences should also be included in the shared database and shown on the map, e.g., with a minus sign.

3. PERIMETER DELIMITATION

3.1 Starting Situation

The question of the geographical delimitation of the Alpine arc is not an easy one, due to the many questions that arise when going into details. Many partners of the AFA project wished for a better delimitation of the Alps than it is proposed by the Flora Alpina (AESCHIMANN *et al.*, 2004) and was chosen for phase 1 of the project (cfr. EGGENBERG *et al.*, 2022). Local groups would decide on the final boundaries of the Alps, and it was agreed that at least 20% of a grid cell should lie within the delimitation of the Alpine arc in order to be displayed in the atlas. Eventually, the best way to adapt the exact border

of the atlas appeared to be a QGIS project in which the exact borders could be redefined at least during the first phase of the AFA project until a final perimeter could be found.

3.2 Preliminary Work: SOIUSA Perimeter and Coastal Species

In the workshop held in the Rovereto meeting, results of the Lugano workshop were repeated, confirmed and supplemented by the Perimeter Delimitation Working Group: (1) The boundaries of the Flora Alpina (AESCHIMANN *et al.*, 2004) must be revised; (2) wherever possible, the revision should be carried out by regional experts; and (3) guidelines would be helpful to ensure that the revision is carried out in a homogeneous way. The boundary line from Sergio Marazzi's atlas (MARAZZI, 2005) of the SOIUSA classification of the Alps was presented, and participants agreed that this is a much better starting boundary line than AESCHIMANN *et al.* (2004). On the northern and eastern borders of the Alps, the line seems to be quite accurate and probably requires only minor corrections. Branko Vreš and Boštjan Surina (representing Slovenia in the AFA project) shall carry out an analysis of the most delicate delimitation across Slovenia and eventually present a proposal for improvement. The SOIUSA delimitation in the western and southwestern Alps was not discussed; therefore, participants suggested that it shall be evaluated in a subsequent meeting by the experts from France (CBNA, CBNMED) and Italy (Gabriele Casazza, Simonetta Peccenini, Alberto Selvaggi).

The problem of the coastline and the question of excluding coastal species was another important topic addressed in the workshop. In contrast to AESCHIMANN *et al.* (2004), the SOIUSA delimitation in the Maritimes Alps (*Alpes maritimes*, *Alpi marittime*) proposes a demarcation along the coastline of the Gulf of Genova and would thus meet requests made in Lugano. A brief discussion followed about the consequences and the question, if this would mean that the Mediterranean seaside flora should also be included in the AFA project. It was finally suggested that taxa might be excluded (or weakly prioritized), if their distribution is of no relevance for the flora of the Alpine arc.

3.3 Next Steps of the Working Group

The following next steps were proposed: (1) compilation of guidelines, (2) allocation of the boundary line sections to experts, and (3) initial proposals for corrections. Participants decided that Boštjan Surina would

be asked to take over the leadership of the Perimeter Delimitation Working Group. The central question as to what resolution or precision the corrections to the SOIUSA line should be made, remained unanswered. In fact, there was no conclusive opinion on whether species should be recorded along a line based on SOIUSA or whether, somewhat less precisely, all species from a grid cell (quadrants) on the edge of the Alps should either be included or omitted completely. The decisions of the 2023 Lugano workshop on this topic were not considered. However, it will be important for all experts to work at roughly the same resolution, which is why recommendations should be provided in form of guidelines. The working group will have to meet soon to reach some consensus and provide the requested guidelines.

4. FUNDING

4.1 Starting Situation

Participants of the kick-off meeting in Lugano listed sufficient funding as one of the main prerequisites for their involvement and contribution to the project. They welcomed it, that web hosting and maintenance of the atlas would be granted by InfoFlora in Switzerland. Based on their experience with European projects, participants from France suggested to consider the Interreg Alpine Space program as a possible funding source for much of the work to be done in the first years of the AFA project.

4.2 Preliminary Work: Exploring Suitability of the Alpine Space Program

A first draft of the project lines that could be submitted to the Interreg Alpine Space program was presented during the Rovereto meeting. In general, a so-called 'classic' project must have some fundamental elements (see <https://www.alpine-space.eu/>). To be in time to organize the contents and actions to be carried out, the third call of the Interreg Alpine Space program could be the most appropriate in terms of timing. To move in this direction there are two main steps and associated timings. In first place, it is necessary to identify the partners involved in the project, establish a budget and contents of the various work packages, draft and submit a proposal in early 2025. Second, if this pre-project is accepted, a proposal for the Detailed Project could be submitted afterwards, i.e., mid-late 2025.

A preliminary project (or pre-project) has been developed before the Rovereto meeting by the *Conservatoire*

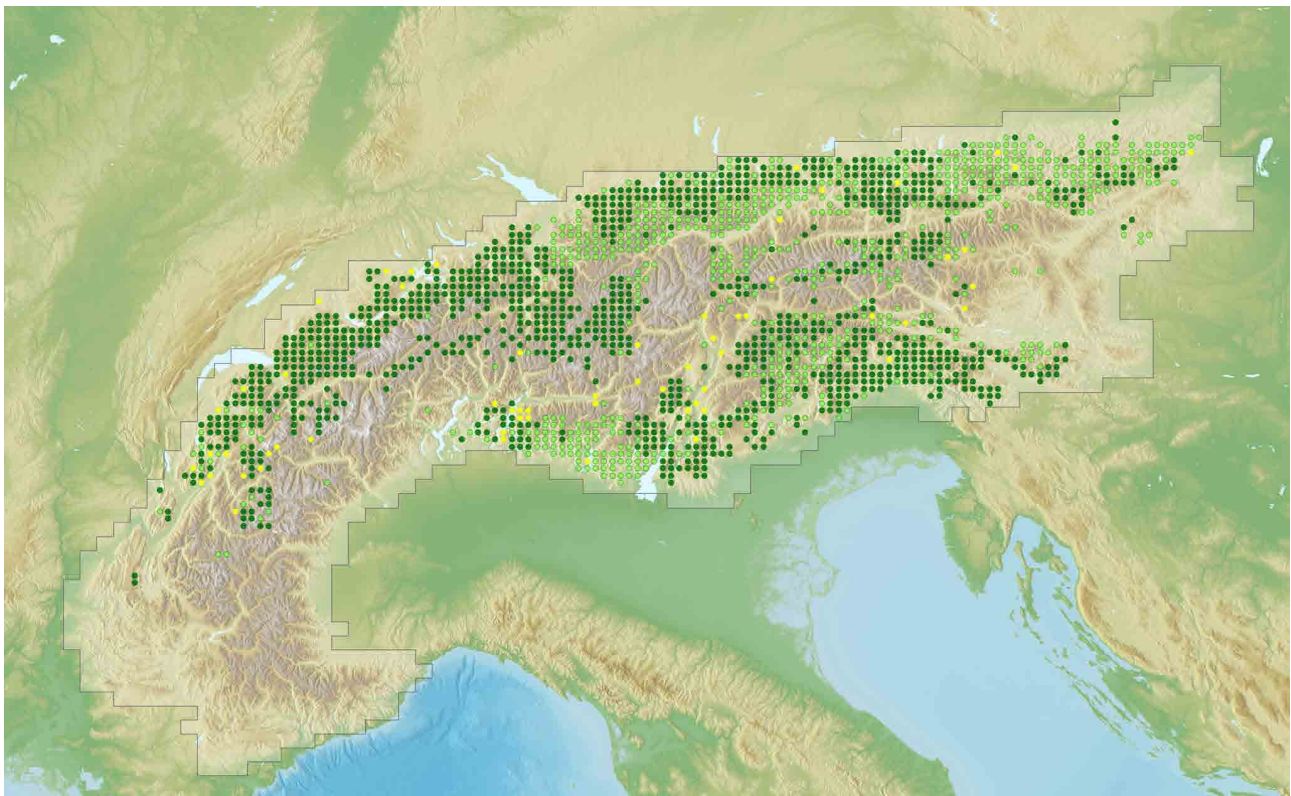


Fig. 2 - Example of taxon distributions displayed on the online atlas of the flora of the Alps. Ehrendorfer grid (EHRENDORFER & HAMANN, 1965) spanning the geographic delimitation of the Alps inferred from Flora Alpina (AESCHIMANN *et al.*, 2004). The markings show the distribution of *Gentiana clusii* E.P. Perrier & Songeon. Colors of dots indicate the age of the most recent observation within each grid cell: dark green: ≥ 2000 ; light green: 1950-1999; yellow: <1950 . Background map by ALOS World 3D-30m.

Botanique National Alpin (CBNA) in Gap according to the national requirement model of France, which was then submitted to the national contact point for the Alpine region and received a positive recension. This pre-project was ascribed to Priority 1 (Climate resilient and green Alpine region) in the Objective 1.2 (Enhancing protection and preservation of nature, biodiversity and green infrastructure, including urban areas, and reducing all forms of pollution). The main objectives listed in this preliminary project are to monitor and document the flora diversity in the Alpine region, gain a better understanding of biodiversity, assess threats it faces, and promote its conservation. Other specific objectives are: a) to update a current Alpine flora inventory from collection, compilation, and harmonization of dataset on Alpine flora from multiple sources; b) to develop an online biodiversity portal accessible to all, to effectively monitor and manage Alpine flora diversity; and c) to raise awareness and education among the public, researchers, and policy makers of the importance of Alpine flora biodiversity and its conservation; d) to draw up periodic reports on the status of Alpine flora

diversity; e) to promote international cooperation, with scientific experts and institutions and on transnational scale for a global understanding of Alpine flora diversity. The preliminary project includes also a list of technical or scientific activities, such as the collection, structuring and quality control of data, the creation of a shared taxonomic archiving system, and field sessions on the inventory of Alpine species. Other activities relate more broadly to the overall operation of the project, its governance, administrative management, and communication through awareness-raising initiatives and the creation of events and conferences. These require a strong commitment from the lead partner.

4.3 Next Steps of the Working Group

In the Rovereto workshop, the discussion first aimed at identifying who among the participants could be interested to participate in the Alpine Space program. In general, participants expressed a desire to explore in depth at individual institutions what the single contribution could be. The partnership could be composed of

at least seven members from France, Germany, Italy and Austria with different institutions, with the possibility of expanding participation to other countries. In particular, in a next step, participants would like to define who participates in the project entry as 'lead partner', 'partner' or 'observer'.

A suitable name of the specific project to be submitted for the Alpine Space program was discussed and debated; finally, it was suggested to go more broadly and use a name like a biodiversity observatory. Ultimately, the following steps were defined: i) identify the lead partner, with a view to involving a regional institutional partner, and ii) plan a future meeting to discuss in depth the list of project activities to be shared with potential partners in the respective countries, in order to define the size of the project budget.

5. TAXONOMY

5.1 Starting Situation

Since the beginning of the AFA project, taxonomy was recognized as one of the biggest challenges for a common data aggregation, because of differences in national checklists and divergences in the way national checklists are applied at the regional scale and in the way some taxa are interpreted by the regional data centers. The two difficult questions addressed were solved as follows. The first was about what taxonomy shall be applied in phase 1 to allow a first online version to be available in the short term. Participants agreed that it seemed reasonable to apply the taxonomic concepts of AESCHIMANN *et al.* (2004, but with an updated nomenclature) for a first version of the atlas, using it as a backbone and offer a "translation" from this backbone list to the checklists used by the data centers by means of the GBIF tools. The second question addressed was about taxonomically problematic taxa in the AFA-project. However, it was agreed to treat these taxa very pragmatically in a first phase, possibly by creating new (intermediate) aggregates, and to find a taxonomic consensus for these taxa in later phases.

5.2 Preliminary Work

During preparations for the Rovereto meeting, the working group compiled the first distribution maps with a test set of 100 selected species (see Chapter 2.2). The set included some problematic taxa, e.g., subspecies of *Anthyllis vulneraria* or some *Hieracium* species that are difficult to translate in regional taxonomical

concepts. Through these preliminary compilations, the working group could highlight the taxonomic difficulties involved. It could be shown that implausible distribution patterns can arise like distribution areas that are delimited along national borders. Therefore, preliminary distribution maps may be used when translating different taxonomic concepts and when discussing the definition of a common taxonomic backbone.

5.3 Next Steps of the Working Group

The working group considered the elaboration of a taxonomic reference list to be a fundamental and mandatory basis for compiling all distributional data of the single Alpine regions. The species list presented by AESCHIMANN *et al.* (2004) was recognized by the group as a backbone and thus as a starting point, because it is the only checklist available to date for the area and, above all, because it provides the taxonomic concept of the individual taxa treated and shows deviations from concepts given by other authors. The latter in particular is an enormous tool for combining the regional checklists. The fact that the species list in AESCHIMANN *et al.* (l.s.) is incomplete and the nomenclature partly outdated does not play a role in the choice insofar as missing taxa can easily be added and an updated nomenclature can be applied at the very end after the taxonomic checklist has been compiled and completed.

By the next AFA meeting in 2025, it is planned that all regional reference persons will work on a common table containing the species list of AESCHIMANN *et al.* (2004) as a reference. Each person who provides data for the AFA project (privately or on behalf of an institution) will have to check for each individual taxon whether there is an equivalent in their own region or only a partial equivalent. At this stage of the process, it is not decisive or not always possible to specify the nature of a mismatch (e.g., completely different species concept, *pro parte* problem, etc.). It will be the task of the working group to find solutions to this problem as soon as the rough version of the checklist has been completed. The table should contain the following (exclusive) information per taxon line and per region: 1) taxon is missing in the region (-), or 2) taxon occurs in the region and corresponds 1:1 to the Aeschimann taxon (+!) (additional note in case of a different nomenclature), or 3) taxon occurs in the region, but concept differs from the reference (+ ?) (additional note in case the matching problem can be named exactly).

The aim is to be able to present a checklist at the next AFA meeting that clearly shows which taxa of all regional

checklists of the Alpine region match perfectly and can therefore be shown on an AFA distribution map without any problems, and which taxa have matching problems.

6. OPEN ISSUES AND PERSPECTIVES

A number of topics from the Lugano 2023 meeting remained unaddressed in Rovereto, mainly because not directly addressed during the phase 1 of the AFA project. For instance, in the 'Data Exchange and Policy' workshop held in Lugano it was agreed that, in addition to the minimum information provided for each taxon (i.e., common taxon ID, grid ID, and year of the last verified observation), all other information (i.e., the number of observations per grid ID, status regarding the degree of establishment, etc.) had to be discussed in detail and agreed upon in future workshops. A download tool of atlas data that enables to "control" the download and facilitates local data retrieval was also recommended to be implemented in a second development phase of the project. Such a tool could then be used to declare the terms and conditions, define the citations, and generate specific DOIs (digital object identifiers).

Furthermore, the consortium still needs to be formalized in some way, so that all participants, including providers of large data sets as well, can officially be recognized as members. One way could be at the level of the publications produced: when results of the consortium are published in the form of papers or other products, the name of the Consortium is used as the only author for the citation, and the names of the contributors are listed separately within the publication. Examples come from other existing botanical scientific consortia, such as the well-known Angiosperm Phylogeny Group, where papers are published and cited with the group name (e.g., APG IV, 2016), and names of all contributing authors are listed separately in the paper.

In conclusion, the Rovereto AFA meeting gave renewed *momentum* to phase 1 of this ambitious atlas project. In order to take advantage of pivotal European financial support, the most urgent next steps are those concerning the project submission outlined above. Each working group has identified its next steps and will work to meet at least some of these steps by the next meeting that will be organized by the French AFAP members.

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