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Checklist

Towards an online checklist of the vascular plants of Georgia (the Caucasus)

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Abstract

Georgia is a floristically diverse and biogeographically complex country within the Caucasus region. It has a long history of botanical exploration, resulting in a substantial body of floristic literature. Nevertheless, taxonomic knowledge remains uneven, and many existing floristic works are partly or largely outdated, and therefore of limited use for biodiversity research and conservation. We present the concept, scope, and editorial framework for an ongoing project to develop a new, modern, dynamic online checklist of the vascular plants of Georgia. The checklist will compile available floristic and taxonomic literature and include native and naturalised taxa at the family, genus, species, and subspecies ranks. Particular attention will be given to a conservative treatment of endemics and range-restricted species, as well as the transparent documentation of taxonomic uncertainty. The checklist is intended to serve as a modern, foundational taxonomic baseline rather than a full-scale revision, and will be continuously expanded and updated.

Key words: Biodiversity informatics, cybertaxonomy, floristic inventory, taxonomic backbone

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Introduction

The Caucasus region is a mountainous area located between the Black Sea and the Caspian Sea, covering a territory of about 500,000 km^2. The North Caucasus is for the most part located in Russia and ranges from the Black Sea coast of the Krasnodar Krai eastwards to Dagestan. The South Caucasus spans the countries of Armenia, Azerbaijan, and Georgia, as well as a part of north-eastern Türkiye in the west and a part of north-western Iran in the south-east. The topography of the Caucasus is characterized by several mountain ranges: the Greater Caucasus extending over a distance of about 1,100 km across the entire region from the Black Sea to the Caspian Sea, and the Lesser Caucasus, the Armenian highlands, and the Talysh Mountains in the south.

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The highest mountains of the region are located in the Greater Caucasus; the highest peak is Mount Elbrus at 5,642 m, located in Kabardino-Balkaria, in the Russian Federation, making it the highest peak in Europe in the wider geographical sense.

The Caucasus harbours a diverse and unique flora and vegetation, making it one of the most species-rich temperate areas in the northern hemisphere (Barthlott et al. 2007). Its vascular flora is estimated to comprise 6,300–6,500 species, of which about 1,600 are endemic (https://www.binran.ru/resursy/informatsionnyye-resursy/tekuschie-proekty/caucasian-flora/contentkav/vvod.php). This high diversity is a result of the many climate types and geological substrates, the high topographic relief, and a complex, diverse biogeographic history. In terms of its floristic composition, the Caucasus is a crossroads between the Euro-Siberian, Mediterranean, Irano-Turanian, and Central Asian floristic regions, making it a melting pot of different floristic elements. Typical Caucasian ecosystems encompass a wide range of habitat types, including moist coastal forests along the Black and Caspian Seas, open and xerophytic woodlands, steppes, semi-deserts, and various mountain habitat types with semiarid and humid zonation patterns, as well as anthropogenic habitats, such as traditionally managed agricultural lands.

Georgia is the second-largest of the South Caucasian countries. It spans about 69,700 km^2, with approximately two-thirds covered by mountainous terrain. Georgia contains a variety of ecosystems, ranging from high mountain habitats of the Greater Caucasus to humid Colchic forests. The total diversity of vascular plants in Georgia is estimated at approximately 4,300–4,400 species, with some 300 endemics to the country (Ketskhoveli and Sosnovsky 1941–1952; Ketskhoveli et al. 1971–2011; Davlianidze et al. 2018).

Most Caucasian ecosystems are currently severely affected by accelerating shifts in land use patterns, fragmentation, and degradation. The Caucasus is therefore classified as one of the global biodiversity hotspots with high priority for conservation (Myers et al. 2000). In response, several regional conservation initiatives have been established, including the Red List of the Endemic Plants of the Caucasus (Solomon et al. 2014) and the Caucasus Plant Initiative (CPI), a Regional Plant Conservation Strategy (Batsatsashvili et al. 2013). The targets of the CPI correspond to the overarching targets of the Global Strategy for Plant Conservation, adapted specifically for the Caucasus region. Target 1 of the CPI is an online Flora of the Caucasus intended to serve as a reference for conservation status assessments and conservation planning, provide a consistent taxonomic backbone for biodiversity research, and support taxonomic and phylogenetic studies. To date, however, no online taxonomic resource specifically tailored to the Caucasus has been realized, despite the availability of the necessary technical framework.

Developing a harmonised taxonomic resource for the Caucasus depends on well-curated national-level resources that can be integrated into a single comprehensive framework. Focusing initially on individual countries therefore offers a scalable and pragmatic approach.

The specific objective of this paper is to present the development of a new national checklist for Georgia. The methods and overall approach are applicable to other Caucasian countries, as well as to similar national checklist projects elsewhere.

Historical background and state of floristic knowledge in Georgia

Historical background and institutional foundations

Early botanical exploration

The botanical exploration of Georgia has a long and well-documented history, reflecting both the country's biogeographic significance within the Caucasus and the establishment of major scientific institutions in the region. The earliest botanical expeditions date back to the early 18th century, with pioneering work by Joseph Pitton de Tournefort (Tournefort 1717; Guiral 1957) and Friedrich August Marschall von Bieberstein, whose Flora Taurico-Caucasica covered the Caucasus and Crimea, documenting 2,322 vascular plant species (Marschall von Bieberstein 1808–1819). Until the early 19th century, the botanical exploration of Georgia was conducted primarily by individual scientists from the Russian Empire, Germany, and other European countries; the earliest major plant collections and species descriptions date to this period. By the end of the 19th century, approximately 4,000 species had already been documented from the Caucasus, as summarized by Lipsky (1899).

Establishment of botanical institutions in Georgia

Alongside these exploratory efforts, key scientific institutions were established in Georgia during the mid-to-late 19th century, most notably the Tbilisi Botanical Garden (founded in 1845) and the Museum Caucasicum (founded in 1852 and opened to the public in 1856). The museum has maintained herbarium collections since 1867, when it was reorganized by its director, the prominent German botanist, zoologist, geographer, and ethnographer Gustav Radde, who lived and worked in the Russian Empire during the second half of the 19th century. Radde was a member of the St. Petersburg Academy of Sciences and was awarded the Gold Medal of the Royal Geographical Society.

The Tbilisi Botanical Garden and the Museum Caucasicum became focal points for floristic research and the documentation of the Georgian flora. From 1888 onwards, extensive collecting activities were undertaken across Georgia and the Caucasus, laying the foundation for substantial herbarium collections. From 1911 onwards, the first female Georgian botanists, Lyubov Kemularia-Nathadze (Fig. 1) and Elisabed Kikodze, became actively involved in floristic research as staff members of the Tbilisi Botanical Garden, paving the way for many other female Georgian researchers during the mid-20th century.

Two other important botanical institutions in Georgia are the Sukhumi Botanical Garden (founded in 1840), which focuses on studying the botanical diversity of Abkhazia and Colchis, and the Batumi Botanical Garden (founded in 1912), which has played a key role in the exploration of the diverse flora and vegetation of Adjara.

The Department of Botany at Tbilisi State University (now Ivane Javakhishvili Tbilisi State University) was established in 1918, shortly after the university was founded. From 1922 to 1932, the department was headed by the prominent Georgian botanist Zakaria Kanchaveli (Fig. 1), who played a key role in advancing botanical science and education in Georgia.

Figure 1. Some prominent Georgian botanists of the 20th century. **A:** Lyubov Kemularia-Nathadze (1960s); **B:** from left to right: Nikoloz (Niko) Ketskhoveli, Zakaria Kanchaveli, Pavle Tsagareli and Elisabed (Liza) Kikodze, photo from the late 1920s or early 1930s; **C:** Nikoloz Ketskhoveli (1970s). **D:** Aleksandre (Sasha) Makashvili, eminent Georgian botanist, Head of the Department of Botany at the Tbilisi Pedagogical Institute from 1953 to 1962, and author of the renowned Botanical Dictionary (first edition published in 1949) right, with the well-known Georgian ornamental gardener Mikheil Mamulashvili (left, photo late 1950s).

Consolidation during the Soviet era

During the Soviet period, institutional restructuring further consolidated botanical research in the region. The herbarium and scientific departments originally established at the Tbilisi Botanical Garden in 1894 formed the basis for the Institute of Botany of the Transcaucasian Branch of the Academy of Sciences of the USSR, established in 1933. In 1935, independent branches of the USSR Academy of Sciences were established in all three South Caucasian republics. They formed the basis for the creation of the Academy of Sciences of Georgia (1941), the Academy of Sciences of Armenia (1943), and the Academy of Sciences of Azerbaijan (1945). The Institute of Botany became part of the Acad-

emy of Sciences of the Georgian SSR in 1941 and emerged as the leading botanical institution in Georgia. Among the most important projects carried out primarily by its staff were the two editions of the Flora of Georgia (1941–1952; 1971–present) and others. Leading Georgian botanists of that time included Niko Ketskhoveli ((1897–1982) the key figure in the development and organization of botanical science in Georgia. In addition to his fundamental contributions to the study of the country's vegetation and geobotany, he played a major organizational role in coordinating botanical research and in the preparation of the first edition of the multi-volume Flora of Georgia. His scientific and institutional legacy also provided an important foundation for the subsequent second edition of the Flora of Georgia.), Aleksandre Makashvili, Anna Kharadze, Mikheil Sakhokia, Armen Dolukhanov, Ida Mandenova, Olga Kapeller, Shushana Kutateladze, Ioseb Lachashvili, Leonida Khintibidze, Revaz Gagnidze, Zaira Ghvinianidze, and Marine Ivanishvili, among others.

Current situation and major collections

Today, the National Herbarium of Georgia (TBI) holds the most comprehensive botanical collection in Georgia, with approximately one million specimens, including around 1,500 type specimens (Fig. 2), representing all major groups of plants, fungi, and lichens (Table 1). This herbarium has undergone several institutional transformations: from 1933 to 1980, it functioned within the Department of Plant Systematics and Geography, and since 1980, it has operated as an independent unit. In 2009, it was granted the status of the National Herbarium of Georgia and is now housed in a modern building (Fig. 3) as part of the Niko Ketskhoveli Institute of Botany at Ilia State University. Niko Ketskhoveli (Fig. 1) was a prominent Georgian botanist and public figure who served as director of the Institute of Botany from 1963 to 1982. The second-largest herbarium in Georgia (200,000 specimens) is the Herbarium of the Georgian National Museum (TGM), which is the oldest herbarium in the Caucasus region. Additional significant collections are housed at the Sokhumi Botanical Garden (SUCH), the Batumi Botanical Garden (BATU), and Ivane Javakhishvili Tbilisi State University (TB) (see Table 1 for an overview). In addition to their physical holdings, parts of the collections at TBI, TGM, and BATU are digitized (Fig. 4) and accessible through JACQ (https://jacq.org/); type specimens from TBI are accessible through JSTOR. Together, these collections document the floristic diversity of Georgia spanning nearly two centuries of sustained collecting activity and provide the foundation for taxonomic syntheses in Georgia and the wider Caucasus.

Floristic and taxonomic synthesis of the Caucasus and Georgia

The flora of Georgia is documented in several major supra-regional, national, and regional floristic works. One of the key supra-regional works is the Flora of the USSR (Komarov 1934–1964), which, while taxonomically largely outdated, remains an important historical reference. The Flora of the Caucasus (Grossheim 1928–1967) was the first modern taxonomic framework dedicated to the entire Caucasus, and although some treatments are outdated, it still forms a major source of Caucasian plant taxonomy. The Caucasian Flora Conspectus

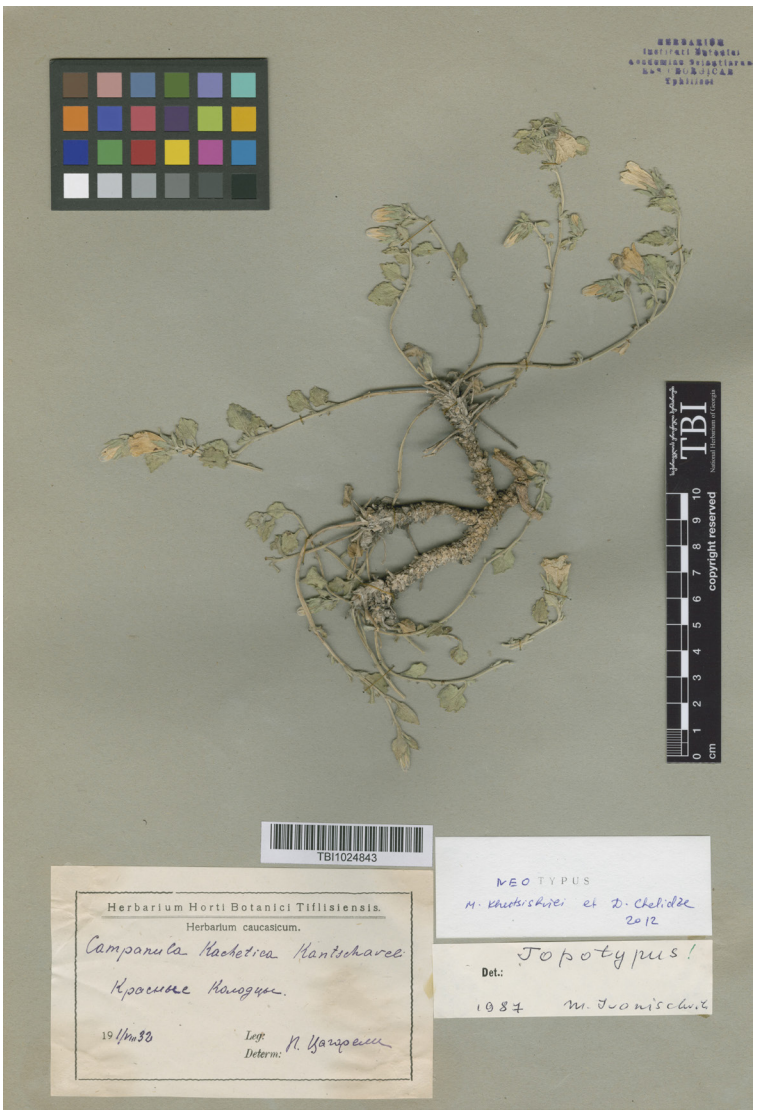

Figure 2. Neotype of *Campanula kachetica* Kantsch. (TBI1024843), a rare ornamental species described by Georgian botanist Zakaria Kanchaveli in 1931 from the environs of Dedoplistskaro (then Tsiteli Tskaro) in Eastern Georgia.

Figure 3. Building of the Niko Ketskhoveli Institute of Botany, Ilia State University (opened in 2011), housing, among other collections, the National Herbarium of Georgia (Photo: Shalva Sikharulidze).

Table 1. Major botanical institutions and herbaria in Georgia.

Institution	Herbarium code	Founded	Collection size	Geographic focus	Key role	Important collectors
National Herbarium of Georgia	TBI	1894 / 1933	c. 1 million specimens, c. 1,500 type specimens	Caucasus	National reference collection, Floras, Red Lists	N. Albov, N. and E., Bush, Z. Kanchaveli, L. Kemularia-Natadze, O. Kapeller, M. Sakhokia, R. Gagnidze
Herbarium of the National Museum of Georgia	TGM	1867	c. 200,000 specimens, c. 250 type specimens	Caucasus, Georgia, environs of Tbilisi	Historical collections from early botanical exploration periods	R. Hohenacker, S. Sommier and E. Levier, F. Bieberstein, Ch. Steven, N. Albov, G. Radde, N. Kuznetsov, B. Shishkin, A. Grossheim, K. Kimeridze, D. Ochiauri
Ivane Javakhishvili Tbilisi State University	TB	1918	c. 70,000 specimens	Caucasus, Georgia	Botanical education and research	A. Grossheim, N. Ketskhoveli, A. Makashvili, M. Sakhokia, Sh. Shetekauri
Herbarium of the Batumi Botanical Garden	BATU	1924	c. 70,000 specimens	Adjara and wider South Colchis	Regional floristics	N. Albov, A. Grossheim, A. Dmitrieva, V. Memiadze, M. Davitadze, M. Mazurenko
Herbarium of the Sokhumi Botanical Garden	SUCH	1934	c. 40,000 specimens	Abkhazia, Colchis	Regional floristics, Colchic flora	Y. Voronov, V. Lipsky, P. Panutin, V. Maleev, A. Kolakovsky, V. Iabrova-Kolakovskaya, Z. Adzinba

(Takhtajan 2003–2012) is the most up-to-date synthesis of the vascular plant flora of the Caucasus, aiming for nomenclatural stability and a harmonized taxonomy across the Caucasus, but it unfortunately remains incomplete.

At the national level, the Flora of Georgia (1st edition 1941–1952, 2nd edition 1971–present) has been the key floristic work for the country, providing substantially advanced knowledge of species diversity, endemism, and distribution. The second edition of the Flora of Georgia covers about 3,800 species in 16 volumes (Ketskhoveli et al. 1971–2011) and is almost complete, except for volume 17 covering Poaceae Barnhart. Additions and updates were made for individual families in subsequent years, as summarized by Cherepanov (1973; 1995). There are also two checklists of the vascular plants of Georgia. The first edition (Gagnidze et al. 2005) was largely based on the Flora of Georgia in terms of the classification system and accepted species. The second edition (Davlianidze et al. 2018) includes 4,275 accepted species, with taxon concepts adjusted primarily to align with the Flora of Georgia and, to some extent, with the Caucasian Flora Conspectus.

At a finer scale, numerous regional floristic studies have contributed to the documentation of Georgia's plant diversity, particularly since the second half of the 20th century and continuing to the present day (Kolakovsky 1938–1949; Dmitrieva 1960; 1990; Sakhokia and Khutzishvili 1975; Gagnidze and Kemularia-Natadze 1985; Lachashvili and Mamukelashvili 1986; Lachashvili et al. 2007; Shetekauri and Chelidze 2016; Shetekauri 2017). In parallel, considerable attention has been devoted to the study of Georgia's vegetation and ecosystems. These studies typically include comprehensive species inventories, systematic–floristic analyses, and assessments of floristic affinities and the origins of regional floras (Sokhadze 1968; Ivanishvili 1973; Gagnidze 1974; Lachashvili and Khachidze 2010). Research on the vegetation of Georgia remains active (Lachashvili et al. 2020a,b; Lachashvili et al. 2023; Tedoradze et al. 2023).

Plant systematics and taxonomy have historically represented one of the primary foundational pillars of botanical research in Georgia. Studies addressing various genera and families are documented in monographs, doctoral dissertations, and numerous scientific articles (Kemularia-Natadze 1966; Davlianidze 1976; Gviniashvili 1976; Kutateladze 1978; Gagnidze et al. 2010), collectively forming a cornerstone of the Flora of Georgia.

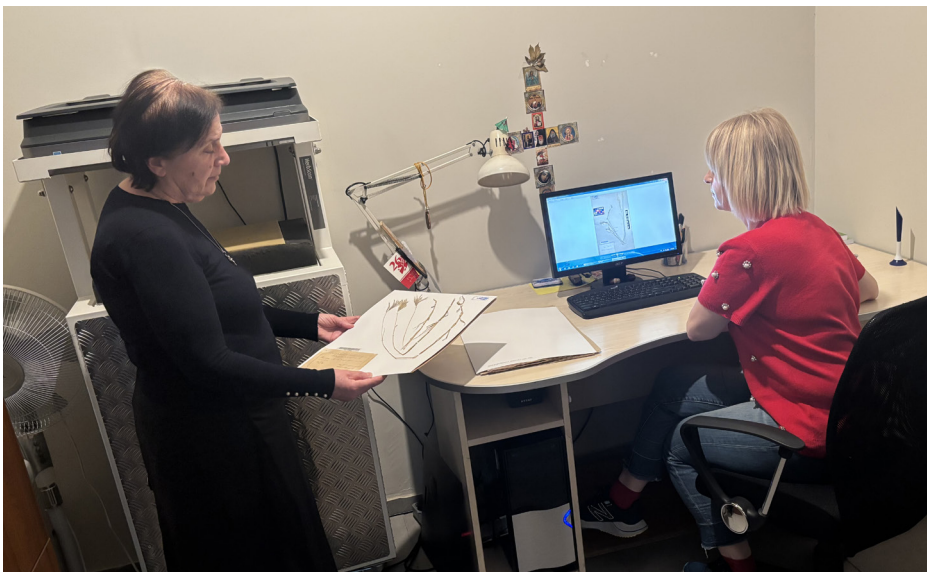

Figure 4. Manana Khutsishvili (left, Head of the National Herbarium of Georgia) and Patman Murtskhvaladze (right, imaging and data entry technician) digitising and databasing herbarium specimens (Photo: Shalva Sikharulidze).

Conservation frameworks were developed through the preparation of the Red Data Book of the Georgian SSR (Kacharava 1982) and subsequently the Red List of Georgia, which served as the basis for governmental resolutions approving the national Red Lists (Government of Georgia 2006; 2014). Research on rare and endangered plant species and their conservation—often conducted within the framework of international projects—remains ongoing.

Several illustrated field guides for the flora of Georgia and the Caucasus have also been published, aimed at a wider audience, including non-specialists (Fischer et al. 2018; Shetekauri et al. 2018; Sukhitashvili 2022; Gabrielian et al. 2023). The Georgian Biodiversity Database (GBD, Tarkhnishvili et al. 2025) is an online biodiversity portal for Georgia that also presents information on plants, primarily observational distribution data, photographs, and conservation status. It is therefore another valuable source for the floristic inventory of Georgia.

In recent years, collaborative phylogenetic research on Caucasian plant genera has expanded across the region, aiming to integrate molecular, morphological, and geographical data to achieve more robust species delimitations. So far, work has focused on *Jurinea* Cass., Asteraceae Bercht. & J.Presl (Szukala et al. 2019), *Campanula* L., Campanulaceae Juss. (Silakadze et al. 2019; Silakadze et al. 2024), *Dianthus* L., Caryophyllaceae Lam. & DC. (Fassou et al. 2022), *Scutellaria* L., Lamiaceae Martinov (Salimov et al. 2021), and *Pyrus* L., Rosaceae Juss. (Korotkova et al. 2018).

In addition to floristic and taxonomic studies, phytosociological, ecological, ethnobotanical, and related research fields have long held, and continue to hold, an important place in botanical science in Georgia. Collectively, all the aforementioned studies demonstrate a long tradition of botanical research in Georgia, forming the basis for biodiversity documentation and synthesis.

Yet, while these works represent a major achievement in documenting the flora of Georgia, they all share important limitations. They were developed over long time periods using different taxonomic frameworks; as a result, species

concepts are not harmonized across works, and taxonomic treatments vary in depth and quality. While the Caucasian Flora Conspectus remains the most up-to-date regional synthesis, it does not yet cover several major families, including Lamiaceae, Fabaceae, and Rosaceae. The second edition of the Flora of Georgia is incomplete, pending the final volume covering Poaceae Barnhart, one of the most taxonomically complex and ecologically and economically important families. The latest national checklist does not include comprehensive synonymy, partly uses illegitimate or otherwise incorrect names, does not distinguish between native and introduced or naturalised species, and does not cite voucher specimens to confirm species occurrences. Moreover, all sources contain outdated generic concepts, as updated classifications based on phylogenetic studies have not yet been fully integrated into the regional taxonomic literature. In addition, many Caucasian species—particularly local endemics—have not been included in phylogenetic analyses, making it unclear how unsampled Caucasian species should be assigned to newly circumscribed genera.

As a result, current floristic and taxonomic knowledge in Georgia remains uneven, and no fully up-to-date taxonomic baseline exists for floristic inventories, ecological studies, conservation planning, or further taxonomic research. More specifically, several major gaps in the knowledge of the Georgian flora remain to be addressed:

1. Many plant groups have not been revised using modern taxonomic approaches, and existing treatments are often outdated, based solely on comparative morphology, or inconsistent across regions. For numerous taxa—particularly endemic or narrowly distributed species—molecular phylogenetic data are lacking, limiting understanding of species boundaries and evolutionary relationships. Additionally, closely related species complexes with high morphological variability or frequent hybridization remain poorly resolved, resulting in taxonomic uncertainty and inconsistent species concepts;
2. Endemic, rare, or geographically restricted species are often insufficiently collected and studied, leading to unclear taxonomic status or doubtful species validity;
3. Several regions of Georgia remain poorly explored botanically, and herbarium collections are spatially biased toward accessible or historically well-studied areas;
4. Historical misidentifications, misapplied names, and unclear synonymy resulting from incomplete typification persist in the majority of floristic accounts;
5. The declining number of trained taxonomists, coupled with limited institutional support, constrains the revision of taxonomically complex or species-rich groups.

Online taxonomy resources

Many of the limitations described above are difficult to address within the framework of static Floras and checklists. In particular, the continuous revision of taxonomic concepts, the integration of phylogenetic evidence, the documentation of vouchers, the addition of newly described species, and nomenclatur-

al updates require dynamic information systems. These needs are universal across regional taxonomic syntheses; as a result, the field of biodiversity informatics has developed approaches and tools for digital taxonomic work, including internationally recognized data standards, data exchange formats, and access protocols (Godfray 2002; Mallet and Willmott 2003; Godfray et al. 2007; Mayo et al. 2008).

Online taxonomic resources, such as online Floras or checklists, have consequently become increasingly available and invaluable over recent decades, as they offer numerous advantages over traditional print publications. They are freely accessible online and can be updated in real time, ensuring that they reflect the most current information, up-to-date nomenclature, newly described species, and any new data that become available. Using online tools, treatments can be published as soon as they are complete, eliminating the need to await the completion of a print publication. Online resources allow for expanded functionality, such as search capabilities, literature links, multimedia integration, links to specimen scans, cross-linking with other platforms, and much more. As there are no physical space constraints, online resources can be expanded as needed and store a much larger amount of information than print publications.

Perhaps even more importantly, e-taxonomy has allowed taxonomic syntheses to become more collaborative and community-driven. Prominent examples include the World Flora Online (WFO, http://www.worldfloraonline.org), a global source of information on the world's plant diversity that is curated by Taxonomic Expert Networks (Borsch et al. 2020). Other resources have been developed at continental scales, including the Flora e Funga do Brasil (https://floradobrasil.jbrj.gov.br), the online Flora of Australia (https://profiles.ala.org.au/opus/foa), the African Plant Database (https://africanplantdatabase.ch/), and the Euro+Med PlantBase (https://europlusmed.org/) for the Euro-Mediterranean region. At the country level, many online checklists also exist, for example for Greece (https://portal.cybertaxonomy.org/flora-greece/intro), Israel (https://flora.org.il/en/plants/), Cyprus (https://www.flora-of-cyprus.eu/), Croatia (https://hirc.botanic.hr/fcd/), Italy (https://dryades.units.it/floritaly/), and more.

An online checklist for the vascular plants of Georgia

As a product of a long-standing collaboration among the Niko Ketskhoveli Institute of Botany of Ilia State University (Tbilisi), the Simon Janashia Museum of Georgia (Tbilisi), the Batumi Botanical Garden, and the Botanic Garden and Botanical Museum Berlin, we are developing a dynamic online checklist of the vascular plants of Georgia as a digital infrastructure (Fig. 5). It is not a new edition of the 2005 and 2018 checklists, but rather a completely new resource in digital format.

The checklist is intended to serve as a baseline for the vascular plant diversity of Georgia, not as a definitive taxonomic treatment or a large-scale revision of the Georgian flora. It is rather a modern, transparent, and continuously updatable synthesis of the available taxonomic and floristic evidence, compiled in a cautious and conservative manner. Uncertainty regarding taxon circumscription or conflicting taxonomic views is explicitly documented rather than pre-

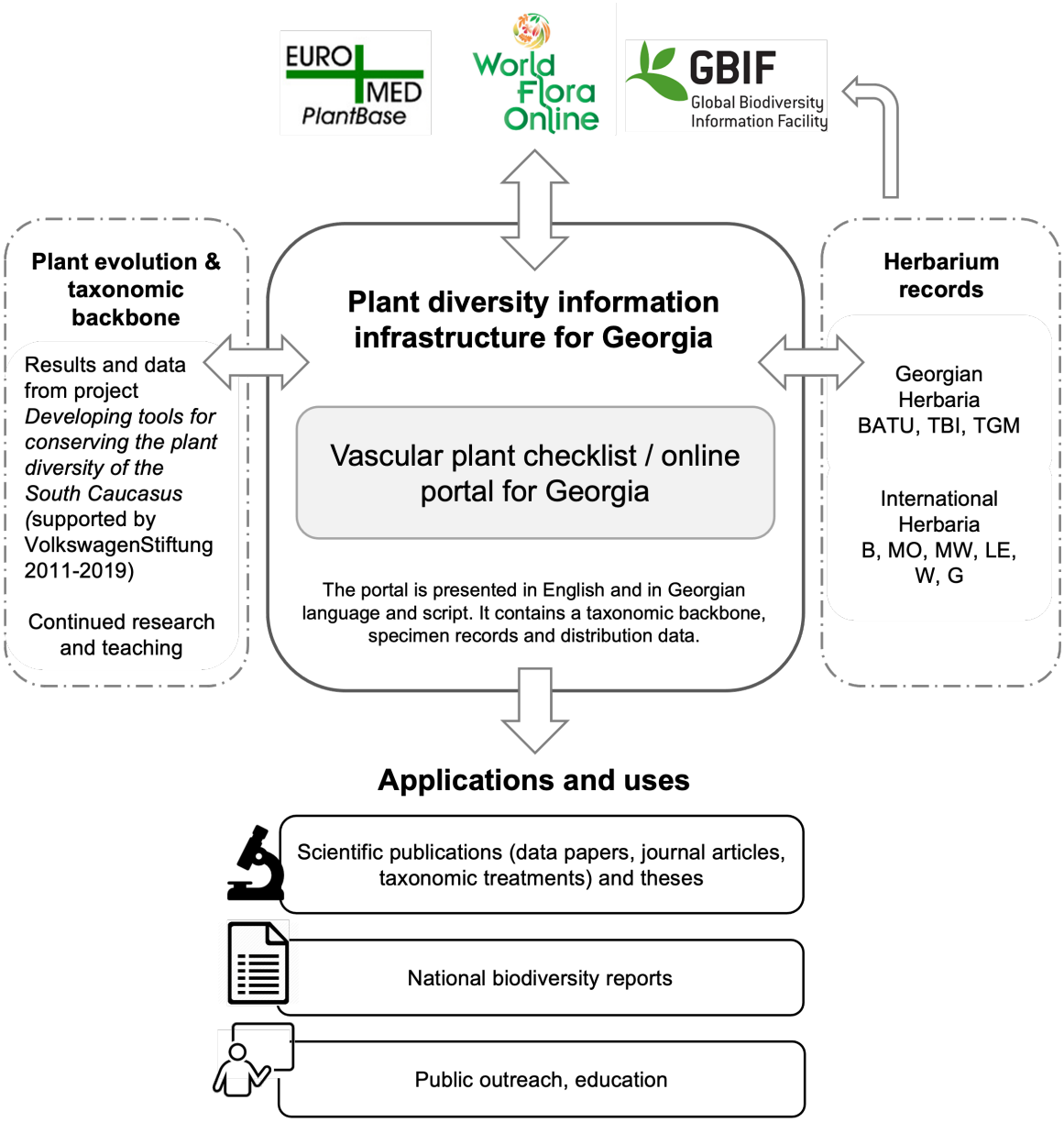

Figure 5. The plant diversity information infrastructure for Georgia and its interaction with other taxonomic information systems, as well as its potential uses.

maturely resolved. In this way, the checklist provides both a practical reference and a foundation for future taxonomic and floristic research.

The first version of the checklist will include: (1) a taxonomic backbone comprising accepted families, genera, species, and subspecies; (2) synonyms relevant to the Georgian or Caucasian context; (3) area-based distribution maps showing occurrences across the Flora of Georgia subdivisions; and (4) taxonomic notes commenting on species status in cases of conflicting views or uncertainty, along with literature references used to justify adopted taxon concepts.

Taxonomic scope: The checklist includes vascular plants, i.e., ferns, fern allies, gymnosperms, and angiosperms. Taxa are accepted at the ranks of family, genus, species, and subspecies. Taxa below the rank of subspecies are omitted or relegated to synonymy. Hybrids and nothotaxa are not included. The check-

list covers and distinguishes native and naturalised species, but excludes (1) plant taxa known only from cultivation, and (2) taxa that do not fulfill the criteria for naturalisation, i.e., neophytes that are not represented by at least one established population over approximately 25 years that reproduces locally. The naturalisation status of taxa is inferred from the relevant literature (e.g., Kikodze et al. 2010; Aleksidze et al. 2021). Where the available evidence is inconclusive, the status 'naturalisation uncertain' will be recorded instead of 'naturalised'.

Doubtful taxa: A taxon can be regarded as doubtful for two main reasons: (1) it is taxonomically doubtful, or (2) its presence in Georgia cannot be confirmed, e.g., due to misidentification, ambiguous literature data, imprecise locality data, or otherwise doubtful occurrence records. Taxonomically doubtful taxa will be flagged as such. The occurrence status will be recorded using categories such as 'doubtfully native', 'reported in error', or 'extinct'. If no published record is at hand, the criterion for inclusion in the checklist is the citable existence of at least one voucher specimen deposited in a public herbarium, preferably available through GBIF.org. In this case, a linked digitized specimen may serve as the citable reference. Taxa that have been reported and are plausible in terms of their overall distribution, but currently lack verified herbarium material, will be listed separately as 'expected species' in an appendix accompanying the main checklist publication, so that their occurrence can be verified in the future. Taxa reported in error will be recorded as well and listed separately from expected or unverified taxa. Taxa confirmed as extinct in the wild are only included if their historical presence is supported by voucher specimens.

Platform and technical implementation

The Georgian checklist is created and maintained using the EDIT Platform for Cybertaxonomy (https://cybertaxonomy.eu/), an open-source software package that covers the curation, editing, and publication of taxonomic information (Ciardelli et al. 2009). Key platform components are (1) a server serving as a central data repository, (2) a desktop editing application (the TaxEditor), and (3) web portals for publishing and querying data. The platform is based on the Common Data Model (CDM, https://cybertaxonomy.eu/cdm-uml/latest/), which provides a structured representation of taxon names, classifications, nomenclature, media, distribution data, literature, specimen data, and more (Müller et al. 2017). The platform supports collaborative editing through role-based user management. All information can be linked to literature references, other sources, or contributor credits, providing context and maintaining a high level of accuracy by making every piece of information traceable. Data can be exported in various formats (CSV, Darwin Core), facilitating data sharing and integration with other resources. The EDIT Platform supports multiple languages and scripts, which is particularly important for this project, as relevant literature is in Latin, Cyrillic, and Georgian scripts, and the portal is intended to be bilingual (English and Georgian).

The EDIT Platform is a well-established tool used for more than 20 taxonomic databases with a regional focus (Euro+Med PlantBase, Flora of Greece Web, Flora of Cyprus) or with a taxonomic focus (Cichorieae, PalmWEB); https://cybertaxonomy.org/references. It is continuously developed, ensuring sustainability and support.

A major reason for selecting the EDIT platform for this project is its full compatibility with the Euro+Med PlantBase, which is also maintained using the EDIT Platform and editorially managed at the Botanic Garden Berlin. Euro+Med PlantBase is a dynamic, curated, and critical inventory of vascular plants of the wider Euro-Mediterranean area based on published sources and contributions from taxonomic and regional experts. The Euro+Med PlantBase covers the Caucasus and currently contains data for about 6,200 Caucasian species across five areas: the North Caucasus, Armenia, Azerbaijan, Nakhchivan, and Georgia. Using the same system thus allows data to be re-used and re-integrated. Furthermore, the main literature sources are already included in the Euro+Med PlantBase. It already contains data for Georgia and covers at least 90% of the species and relevant names along with their nomenclatural references, fully curated and standardized. The work on the Georgian checklist will thus also contribute to the ongoing improvement and updating of the Euro+Med PlantBase.

Initial data compilation

A Georgia-specific database was created for this project using an export from the Euro+Med PlantBase. For the initial import, an existing import function for direct transfers from one CDM database to another was used and adapted for the Georgian data. The import was run as a taxon-centric import, meaning that only data that occurred in the taxonomic tree and were directly or indirectly referenced by it were imported. The tree was also filtered to include all taxa with at least one distribution record in Georgia, even if, in exceptional cases, the occurrence status indicated absence, such as 'reported in error,' as this status is also relevant to the Georgia-specific database. If Georgian distribution data existed for a species or subspecies, the corresponding higher taxa were also imported, even if no explicit distribution data were recorded for them.

Taxa from families not yet fully revised in the Euro+Med PlantBase were also imported, provided that a distribution in Georgia had already been recorded for them. However, the World Checklist of Vascular Plants (WCVP) data for Lamiaceae, Orchidaceae Juss., Amaryllidaceae J.-St.-Hil., Euphorbiaceae Juss., Iridaceae Juss., Fagaceae Dumort., Betulaceae Gray, and Juncaceae Juss., as well as the ILDIS data for Fabaceae Lindl., were not imported. These datasets are only displayed temporarily in the Euro+Med PlantBase, pending the release of revised original Euro+Med treatments for these families, and distributions in WCVP are not recorded at the country level, but only for the entire Caucasus or the South Caucasus.

Particular emphasis was placed on the import of endemism data. Georgian endemism was inferred from endemism status and distribution within the Euro+Med area. If a taxon was recorded as 'non-endemic' in the Euro+Med PlantBase or was indicated as 'native' to another geographical unit in the Euro+Med area, it was also imported into the Georgian database as 'non-endemic'. If it was listed as 'endemic' in the Euro+Med area and 'native' to Georgia, it was recorded as endemic to Georgia only if it was not native to any other area. In all other cases, its endemism status was recorded as unknown.

Another focus was placed on the adoption of synonyms. Generally, all synonyms homotypic to the accepted name were adopted. Heterotypic synonyms

were only adopted if the use of the name in a source for Georgia was documented in the Euro+Med PlantBase. This avoided including names in the synonymy that had never been used in the context of Georgia.

As the next step, all names treated in the Flora of Georgia that were not included in the Euro+Med PlantBase were manually entered into the Georgian database to ensure complete coverage of all relevant names.

An internal web portal has been established and currently serves as an editorial working environment. It will be made publicly available once the taxonomic revision has reached a sufficiently mature stage.

The imported dataset forms the initial taxonomic backbone of the Georgian checklist. Rather than being adopted uncritically, this backbone serves as the starting point for an ongoing editorial revision. During this process, generic and species concepts are evaluated against Georgian and Caucasian literature, taxonomic revisions, and phylogenetic studies.

Editorial revision of the taxonomic backbone

The editorial revision of the imported taxonomic backbone from the Euro+Med PlantBase proceeds at two levels: (1) evaluation of generic concepts, and (2) evaluation of species concepts. Taxon concepts are evaluated on a case-by-case basis using the most relevant and up-to-date evidence available for each taxonomic group, and the revision is carried out collaboratively by the project team alongside specialists for selected taxonomic groups. The available knowledge differs considerably among taxonomic groups; while some have been recently revised or included in phylogenetic studies, others are still only treated in older floristic works. Consequently, taxonomic decisions rely on different combinations of evidence, depending on the group under consideration.

The principal works that are used throughout the revision are the previous editions of the national checklist, the Caucasian Flora Conspectus, the second edition of the Flora of Georgia, and the standard Floras of adjacent countries. The Flora of Turkey (Davis 1965–1985; Davis et al. 1988; Güner et al. 2000) is an important additional source for distributional information, as the descriptions of many taxa from north-eastern Anatolia refer to Georgian material as well. The Flora Iranica (Rechinger 1963–2015) is a further complementary resource for Irano-Turanian taxa, xerophytic and steppe taxa, or south-west Asian genera. Depending on the group, additional literature can include regional Floras, recent and older taxonomic revisions, monographs, phylogenetic studies, World Flora Online, protologues, and, where appropriate, consultation with specialists.

Because these sources differ in their treatment of many Caucasian taxa, no single source is followed consistently across all taxonomic groups. Rather, the available evidence is critically evaluated with the aim of adopting taxonomic concepts that are scientifically well supported and appropriate for the Georgian checklist, and the respective source of each taxon concept is cited.

At the time of writing, generic concepts have already been reviewed for a portion of the genera, and revision of species circumscriptions has begun. The editorial framework is summarized in Table 2.

Table 2. Editorial framework used for revising the Georgian checklist.

Editorial aspect	Starting point	Further evidence considered	General approach
Accepted families	APG IV	WFO	APG IV followed except Chenopodiaceae
Accepted genera	Euro+Med PlantBase	WFO, phylogenetic studies, taxonomic revisions	Evaluated case by case; stable, well-supported concepts favoured
Accepted species	Euro+Med PlantBase	Floristic literature covering Georgia or the Caucasus, revisions, monographs, expert opinion	Evaluated case by case, best evidence favoured, conservative treatment of unresolved endemics
Synonymy	Euro+Med PlantBase, Flora of Georgia	Floristic literature, revisions, monographs, expert opinion	Include names relevant for Georgia and used in the context of Georgia
Doubtful taxa	Published records	Voucher specimens, GBIF	Include separately and annotate uncertainty
Naturalisation	Floristic literature	Voucher specimens	Include only naturalised taxa, document uncertainty
Endemism	Distribution data	Regional evidence	Record when evidence supports Georgian endemism

Family-level classification

Family circumscriptions follow APG IV (2016), except that Chenopodiaceae Vent. is retained as separate from Amaranthaceae Juss. This follows World Flora Online and the recommendation of the Caryophyllales Taxonomic Expert Network, which continues to recognize Chenopodiaceae as a distinct family (https://wfoplantlist.org/taxon/wfo-7000000655-2026-06, https://caryophyllales.org/cdm_dataportal/taxon/ba469aa3-cf23-4565-ab46-24f0c6e314cd). This solution is also more practical for Georgia, where Amaranthaceae s. str. is represented only by a few, mostly non-native species, while Chenopodiaceae comprises a native and diverse element of the vegetation.

Generic concepts

As a practical solution, accepted genera are primarily adopted from the Euro+Med PlantBase and World Flora Online, where curated by Taxonomic Expert Networks. Because neither source is fully up-to-date, relevant phylogenetic literature is screened for this checklist to determine the most appropriate generic concept, while also prioritizing nomenclatural stability and usability. Where studies are inconclusive or sampling is insufficient, the most stable, broadly accepted generic concepts are retained. Newly segregated, established, or recircumscribed genera are adopted where phylogenetic evidence is robust, and where such changes are already widely adopted in the Euro+Med area. For genera with unresolved or conflicting interpretations, discussion notes document the current state of knowledge, alternative views, and the rationale for the adopted concept.

Species concepts

Accepted species are initially adopted from the Euro+Med PlantBase, but with caution. In the Caucasus, there are well-established and widely accepted 'classical' species, usually described in the 19th century, as well as many local endemics described in the 1950s–1980s, often reflecting fine-scale morphological variation and local differentiation. These taxa are often accepted in local Floras, but have never been critically evaluated as part of broader taxonomic revisions or using modern approaches to species delimitation. Their status is

therefore often uncertain: some may be genuinely range-restricted endemics, while others may represent only morphotypes or ecotypes of more widespread species. Broader regional and global treatments or databases, including the Euro+Med PlantBase, may synonymize them, potentially obscuring unresolved local diversity. Revision therefore focuses specifically on endemics, and we adopt a conservative approach, retaining Georgian and Caucasian endemics when there is insufficient evidence to justify synonymy. Retention of such taxa should therefore be understood not as a definitive taxonomic judgment, but as a conservative documentation strategy that preserves significant taxonomic and biogeographic information until a comprehensive revision covering these taxa becomes available.

The checklist will include accepted names as well as homotypic and heterotypic synonyms. Among the homotypic synonyms, the basionym will always be provided; additional homotypic synonyms will be included only if they have been widely used. Heterotypic synonyms will be listed if relevant and used in Caucasian literature or in Floras of adjacent countries (Iran, Russia, Turkey); the checklist will not provide a complete synonymy for every name, as those are resolved in World Flora Online. Names below the rank of subspecies will be included only when they are basionyms of either accepted names or synonyms, or are used in recent key works to facilitate cross-referencing. Invalid names will be included only when relevant. Misapplied names will be recorded, as they may become increasingly important if taxonomic or phylogenetic research results in changing species concepts.

Geographic scope and endemism

Georgia is treated within the geographic circumscription of the Flora of Georgia. The distribution data are given according to the Flora of Georgia subdivisions. Even if these are not well-supported phytogeographic divisions, but rather large, partly ill-defined historical, political, and natural units, they represent a practical solution for incorporating distribution data from the Flora. It is assumed that the territorial division of Georgia proposed for use in both editions of the Flora of Georgia was intended to preserve the historical names of Georgian regions. These regions, however, do not represent biogeographical or botanical units, nor do they reflect the administrative divisions of Georgia at the time. The system can therefore be regarded as a hybrid division, in which most historical regions are combined with regional names adopted during the Soviet period (e.g., South Ossetia).

For endemism, only ‘endemic to Georgia’ is indicated, rather than whether a taxon is also endemic to the Caucasus. For Georgian endemics, three categories are available: endemic, not endemic, or endemism unresolved. In the case of narrowly distributed endemics whose ranges are divided by political borders (sub-endemics), e.g., *Seseli foliosum* (Sommier & Levier) Manden., with one locality in Adjara and another in adjacent Anatolia, an explanatory comment is given. Given the currently incomplete data and the varying geographic interpretations of ‘Caucasus’ and ‘Caucasian’ in the botanical literature, endemism in the Caucasus is not easily inferred. If the Caucasus is understood in a narrower sense—restricted to the Euro-Siberian territories of the North and South Caucasus—then potential endemics of the ecoregion sensu WWF (Zazanashvili et al.

Figure 6. An example of a genus page in the online checklist portal, showing the treatment of *Phedimus* (Crassulaceae).

2020), including parts of north-eastern Anatolia and north-western Iran, or the dry foothills in Georgia, would not be included. Conversely, if a broader view of the Caucasus sensu the Caucasus ecoregion is adopted, the data on which the reliability of an 'endemic to ...' status depends are more limited. The Euro+Med PlantBase does not cover Iran, and for Turkey, only country-wide presence or absence is indicated. Endemism in the Caucasus is therefore generally not indicated, but may be included in notes, if relevant, and if taxa have a known narrow Caucasian distribution (e.g., only occurring in the Greater Caucasus).

The online portal: example pages

Two sample pages (Figs. 6 and 7) illustrate the overall structure and functionality of the online portal interface. The portal contains navigation tools, search functions, and links to taxa. Taxon pages provide an overview of the nomenclature, distribution, and relevant literature for each taxon. Each page includes the classification and breadcrumb navigation, the accepted scientific name

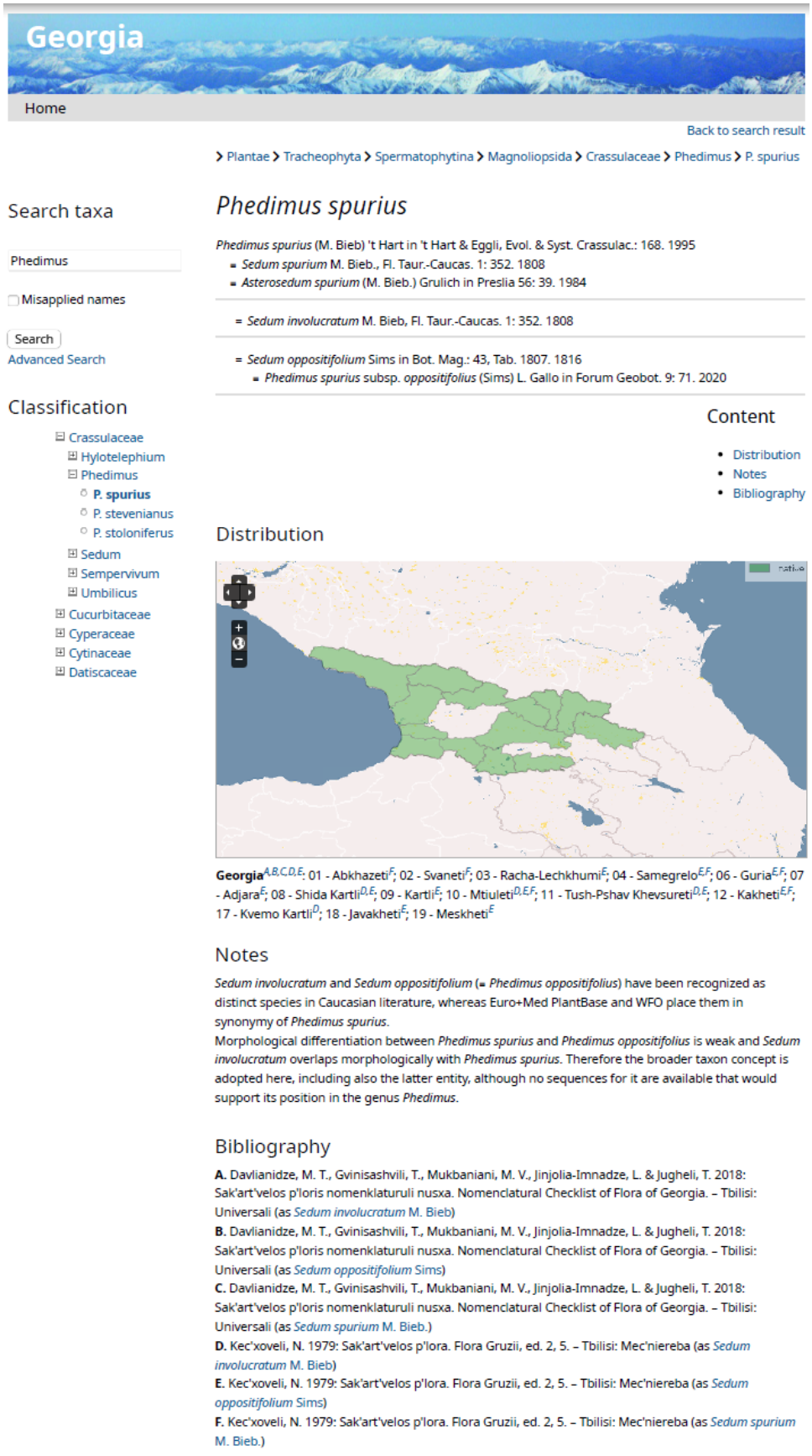

Figure 7. An example of a species in the checklist online portal, showing the treatment of *Phedimus spurius* (Crassulaceae).

with full nomenclatural citation, and a synonymy section listing homotypic and heterotypic synonyms with their nomenclatural references. The distribution section shows occurrence within subdivisions and links records to underlying literature sources through reference annotations. Notes provide additional taxonomic or nomenclatural comments, such as differing taxonomic concepts or the rationale for the accepted circumscription, and a bibliography section compiles all references listed on the page.

Potential uses

Such a resource has multiple potential future uses. First, our initiative will support existing and future national biodiversity strategies and action plans, as well as biodiversity reporting obligations. One concrete example is Georgia's National Biodiversity Strategy and Action Plan (NBSAP) 2014–2020, along with its future updates. This relates to a broader set of national biodiversity targets (targets C1 and C2: inventory and assessment of biodiversity, including plants, to determine the status of species and habitats, and the improvement of scientific knowledge and monitoring systems for species and habitats).

The checklist can be used to support university and school curricula in teaching botany, ecology, and biodiversity. It will also provide verified species data for taxonomic studies, ecological surveys, and biodiversity assessments. It will help environmental organizations in Georgia align with internationally recognized conservation standards and inform environmental policies. Additionally, the checklist will be a useful tool for horticulturists, naturalists, citizen scientists, and platforms such as iNaturalist, by encouraging field surveys to fill existing gaps in plant geography, mapping, and new inventories.

Future developments and applications

The checklist is designed to accommodate additional information that can be incorporated in future updates, expanding both its scientific value and practical applications. One long-term goal is to include nomenclatural type information for accepted species, together with links to digitized specimen images where available, initially focusing on species described from Georgia. The checklist could also incorporate information relevant to conservation, such as IUCN Red List categories, national Red List assessments, legal protection status, or CITES listings. This will help environmental organizations in Georgia align with internationally recognized conservation standards and inform environmental policies. It could also enable authorities, plant traders, customs officers, or CITES Management Authorities to identify protected species and help prevent illegal trade. A next step could be to include well-curated and documented photographs of individual species. Another long-term goal is to include common names and vernacular names in the Georgian language and script—potentially also in Georgian regional languages—based on the botanical dictionary of Makashvili (1991).

Together with photographs, common names would make the checklist more accessible to educators, students, local communities, conservation practitioners, and the general public, facilitating identification, communication, and engagement with the Georgian flora.

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

Artificial Intelligence (AI) use

The authors accept full responsibility for the content of the manuscript, including the disclosure of any use of AI. No AI tools were used in the preparation of this manuscript.

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Author contributions

Manuscript conceptualization and writing – DK, NK (equal contribution), NL, SS, DK, E von RS, GP, AM, TB; Checklist and database conceptualization – E von RS, MM, NK, MM, MK, KK, DK, NM; Technical implementation – AM; Example of Crassulaceae – NK, GP.

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Data availability

All of the data that support the findings of this study are available in the main text or Supplementary Information.

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