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LONG DATABASE REPORT ECOINFORMATICS

Transcaucasian Vegetation Database – a phytosociological database of the Southern Caucasus

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Abstract

The Caucasus is a hotspot of global biodiversity. However, even in the era of big data, this region remains underrepresented in public vegetation-plot databases. The Transcaucasian Vegetation Database (GIVD code AS-00-005) is a novel dataset which primarily aims to compile, store and share vegetation-plot records sampled by the Braun-Blanquet approach and originating from Transcaucasia (the Southern Caucasus), i.e. the countries of Armenia, Azerbaijan and Georgia. The database currently contains 2,882 vegetation plots. The oldest plots originate from 1929, the newest from 2022, and their collection is ongoing. The data include mesophilous forests (phytosociological class *Carpino-Fagetea*) and various alpine and subalpine communities (e.g. *Carici-Kobresietea*, *Loiseleurio-Vaccinietea*) – selected other habitats are also represented. Most of the plots (84%) are georeferenced, 36% with high precision of 25 m or less. The database includes 2,500 taxon names; *Asteraceae*, *Poaceae*, *Fabaceae* and *Rosaceae* represent the most common families. Vascular plants are recorded in all plots, while data on species composition of bryophytes are available for 11% of plots. The database intends to contribute to the complex biodiversity research of this biologically unique territory. The data might be used in diverse projects in botany, biogeography, ecology and nature protection.

Taxonomic reference: The Plant List (http://www.theplantlist.org/ [Accessed 10 Jan 2023]).

Syntaxonomic reference: Mucina et al. (2016).

Abbreviations: TVD = Transcaucasian Vegetation Database.

Keywords

biodiversity hotspot, Caucasus, database, European Vegetation Archive, Global Index of Vegetation-Plot Databases, phytosociology, southwestern Eurasia, vegetation survey

GIVD Fact Sheet: Transcaucasian Vegetation Database

GIVD Database ID: AS-00-005			**Last update:** 2023-04-19
Transcaucasian Vegetation Database		**Web address:**	
Database manager(s): Pavel Novák (pavenow@seznam.cz); Veronika Kalníková (V.Kalnikova@seznam.cz); Daniel Szokala (512772@muni.cz)			
Owner: Masaryk University			
Scope: The database stores original and published phytosociological plots sampled mainly in Transcaucasia (S Caucasus), i.e. Armenia, Azerbaijan and Georgia. Currently, it contains 2882 plots, mostly of forest vegetation and subalpine and alpine communities. The scope of the database is to compile vegetation plot-records from the whole target region, both zonal and azonal vegetation types, and provide them for a wide variety of scientific projects.			
Abstract: The database compiles vegetation plot-records from Transcaucasia (S Caucasus). They all include vascular plant species composition in a plot, cover of species in a defined scale and basic data on their geographical position and environmental conditions (e.g. elevation, inclination and aspect of slope, soil pH).			
Availability: according to a specific agreement		**Online upload:** no	**Online search:** no
Database format(s): TURBOVEG		**Export format(s):** TURBOVEG, Excel	
Plot type(s): normal plots		**Plot-size range (m^2):** 0.25 to 2500	
Non-overlapping plots: 2882	**Estimate of existing plots:** 2882	**Completeness:** 100%	**Status:** ongoing capture
Total no. of plot observations: 2882	**Number of sources (biblioreferences, data collectors):** 45		**Valid taxa:** 2502
Countries (%): GE: 80; AM: 1; AZ: 15; RU: 4			
Formations: Forest: 39% = Terrestrial: 39% // Non Forest: 61% = Aquatic: 6% (Fresh water: 6%); Terrestrial: 55% (Arctic-alpin: 41%; Non arctic-alpin: 14%)			
Guilds: all vascular plants: 100%; bryophytes (terricolous or aquatic): 11%			
Environmental data (%): altitude: 93; soil pH: 26; soil depth: 1			
Performance measure(s): presence/absence only: 0%; cover: 100%; number of individuals: 0%; biomass: 0%; other: 0%			
Geographic localisation: GPS coordinates (precision 25 m or less): 36%; point coordinates less precise than GPS, up to 1 km: 27%; small grid (not coarser than 10 km): 21%; political units or only on a coarser scale (above 10 km): 16%			
Sampling periods: 1920-1929: 1%; 1930-1939: 2%; 1970-1979: 0.5%; 1990-1999: 0.5%; 2000-2009: 5%; 2010-2019: 16%; after 2020: 22%; unknown: 53%			
Information as of 2023-04-26; further details and future updates available from http://www.givd.info/ID/AS-00-005			

Introduction

The databases collecting, storing and sharing georeferenced vegetation-plot records are among the significant data sources in the ongoing rapid emergence of ecoinformatics. However, the Caucasus is one of the areas of Europe and its adjacent territories still poorly represented in existing vegetation databases (Chytrý et al. 2016; Bruelheide et al. 2019; Preislerová et al. 2022).

The Caucasus is a mountainous region situated in the middle sector of the Alpine–Himalayan orogenic belt, on the borderline of Europe and Asia. The so-called Caucasian isthmus stretches between the Black and Caspian Seas. The area spans a broad elevation gradient from -29 m (Caspian Sea shore) to 5,642 m (Mount Elbrus), making it the broadest in western Eurasia. The region is mainly characterized by rugged topography and offers a wide range of geological bedrock, including limestone karst areas, extensive neovolcanic zones with both extrusive bodies and lava plateaus, clay and saline Tertiary sediments or ophiolite outcrops. The climatic gradients are also significant. In terms of annual precipitation, the highly humid Colchic mountains in western Georgia receive 4,500 mm of precipitation yearly and represent one of the wettest areas in western Eurasia. Contrary, the arid climate of the Azerbaijan lowlands is characterized only by 200 mm per year. Mean annual temperatures in vegetated areas span from -9 °C (Elbrus Mt.) to 14 °C (Black and Caspian Sea coasts). The climatic continentality gradient is also remarkable (Volodicheva 2002; Nakhutsrishvili et al. 2011; Bondyrev et al. 2015). This considerable variety of environmental conditions, the specific history of local biota and its position on a biogeographic crossroad of the Circumboreal and Irano–Turanian Floristic Regions support extraordinarily high biodiversity (Takhtajan 1986; Gegechkori 2020). The Caucasus is listed among the top 34 world biodiversity hotspots, along with the Mediterranean Basin, the only two remaining partly in Europe (Mittermeier et al. 2005). It harbours exceptionally high vascular plant species diversity, one of the highest in certain latitudes (Barthlott et al. 2005). This taxonomic group shows a considerable species endemism rate of ~25% out of 6,400 species in total (Mittermeier et al. 2005; Kier et al. 2009). Moreover, the territory includes two essential Tertiary flora refugia of temperate and subtropic Northern Hemisphere, Colchic in W Georgia and NE Turkey and Hyrcanian in SE Azerbaijan and NW Iran (Milne and Abbott 2002; Nakhutsrishvili et al. 2011, 2015). They harbour numerous ancient relicts, including many evergreen shrubs, and their forests are classified as temperate rainforests (Nakhutsrishvili et al. 2011, 2015; Nakhutsrishvili 2013). Vegetation and habitat richness is, therefore, also comparably high (Nakhutsrishvili 2013; Jiménez-Alfaro et al. 2014; Fayvush and Aleksanyan 2016).

The Caucasus might be divided according to the main ridge of the Greater Caucasus, which shows a general west–east orientation. The northern slopes of the Greater Caucasus and adjoining hilly and undulated landscape are called Ciscaucasia (or Northern Caucasus). Contrary, Transcaucasia (or the Southern Caucasus) lies southwards from the main ridge. Its vegetation cover is the main subject of the AS-00-005 - Transcaucasian Vegetation Database (TVD) presented here, which is included in the Global Index of Vegetation-Plot Databases (GIVD) and the European Vegetation Archive (EVA; Chytrý et al. 2016).

Transcaucasia, with its unique nature, attracted generations of naturalists. The history of research on local vegetation dates back to the 19th century, when the German botanist Karl Koch twice visited the Caucasus and Transcaucasia. After his journeys, he published the first map of Caucasian vegetation (Koch 1850; Lack 1978). He was succeeded by the German universal naturalist Gustav Radde and the Russian botanist Jakob Sergejevitsch Medwedew who published a series of articles describing fundamental vegetation characteristics of specific regions of the Southern Caucasus (e.g. Radde 1866; Medwedew 1869). These investigations accelerated in the early decades of the 20th century when the first pioneering overviews of vegetation formations in specific areas appeared (e.g. Rubel 1914; Troitsky 1930). However, during the century, a vegetation classification approach based on the dominant species strongly prevailed in the region (e.g. Magakyan 1941; Takhtajan 1941; Grossheim 1948; Makhatadze 1958; Prilipko 1970; Gulisashvili et al. 1975) while studies carried out following the protocols of the Braun-Blanquet's Zürich–Montpellier school were scarce (e.g. Bush and Bush 1936). In the 1980s, many phytosociological studies applying the Braun-Blanquet approach were published, especially those focusing on subalpine and alpine plant communities or forest vegetation of the Greater Caucasus (e.g. Passarge 1981a, 1981b; Guinochet 1984; Bedoshvili 1985). After the dissolution of the Soviet Union in the early 1990s, armed conflicts slowed the research of Caucasian vegetation. Later, the research accelerated again, and many studies focusing mainly on Georgian territory were published, both dominant-based (Nakhutsrishvili 1999, 2013; Huseynova 2021; Ibadullayeva and Huseynova 2021) and Braun-Blanquet-based (e.g. Filibeck et al. 2004; Kaffke 2008). In the last decade, more Braun-Blanquetian studies appeared, both local (e.g. Novák et al. 2020, 2021; Goginashvili et al. 2021) or focusing on large areas or whole national territories (e.g. Jabbarov et al. 2020; Kalníková et al. 2020; Nakhutsrishvili et al. 2022). A field workshop by the Eurasian Dry Grassland Group in Armenia in 2019 (Aleksanyan et al. 2020; Biurrun et al. 2021) brought a considerable step forward in the knowledge of the Transcaucasian grassland vegetation. The first modern comprehensive habitat overviews of the Transcaucasian countries were published after 2010, serving as an essential reference for vegetation research (e.g. Akhalkatsi and Tarkhnishvili 2012; Fayvush and Aleksanyan 2016). Despite this persistent effort, Transcaucasian vegetation diversity belongs among the less phytosociologically explored within Europe and adjacent areas (Preislerová et al. 2022). Existing vegetation-plot databases from Transcaucasia within GIVD (Dengler et al. 2011) primarily focus on relatively small fractions of the region or specific habitats. They correspond to five databases originating from Azerbaijan (EU-AZ-001–005) and storing plots recorded for purposes of specific grants and theses in the 2000s. Additionally, the Caucasus Vegetation Database Georgia (AS-GE-001) includes plots of subalpine and alpine formations in two distinct mountainous areas of Georgia (Bakuriani, Kazbegi). However, these databases are not included among the EVA core databases (Chytrý et al. 2016) and thus accessibility of Caucasian vegetation data for EVA projects has been seriously limited to date. Aiming to fill geographical and ecological gaps in the vegetation-plot records from Transcaucasia, we established a novel database intending to encompass the entire territory and all vegetation types.

Many anthropogenic factors cause the current deterioration of Transcaucasian biodiversity. They include, for instance, extensive legal and illegal logging to obtain firewood or timber, overgrazing of alpine grasslands, environmental pollution, slope erosion, construction activities including building of new water reservoirs, forest fires, outbreaks of tree pathogens and invasions of alien species. Ongoing climate change will presumably bring new threats, including more frequent drought periods, desertification or shifts of the upper treeline (Zazanashvili and Mallon 2009; Akhalkatsi 2015; Slodowicz et al. 2018; Fayvush and Aleksanyan 2020). Within Europe and adjoining areas, Transcaucasian countries are among the states with the highest need for effective nature conservation (Giam et al. 2010).

Data collection

The field data collection started in the summer of 2015; during the first vegetation expedition of the botanists from the Masaryk University (Brno, Czech Republic) to Georgia led by V. K. and P. N. Thenceforth, regular fieldwork with intensive vegetation sampling leading to the Southern Caucasus started. Plots sampled during these expeditions served as a basis for the database. Additionally, we digitized vegetation plots from numerous literature sources, including papers, vegetation overviews and monographs, and unpublished sources (i.e. "grey literature" like project reports and theses). All plots in the database were sampled using the Braun-Blanquet phytosociological approach (Dengler et al. 2008). They are currently stored in the TURBOVEG (version 2.159, Hennekens and Schaminée 2001).

All plots contain information on vascular plant species assemblages. Species covers were visually assessed in percentages or in grades of Braun-Blanquet (Dengler et al. 2008) or specific *ad hoc* cover scales, depending on their author. A fraction of plots from the aforementioned expeditions also include bryophytes, determined by experienced bryologists (see Acknowledgments). Data on the species composition and covers in the bryophyte layer are additionally available from a few literature sources.

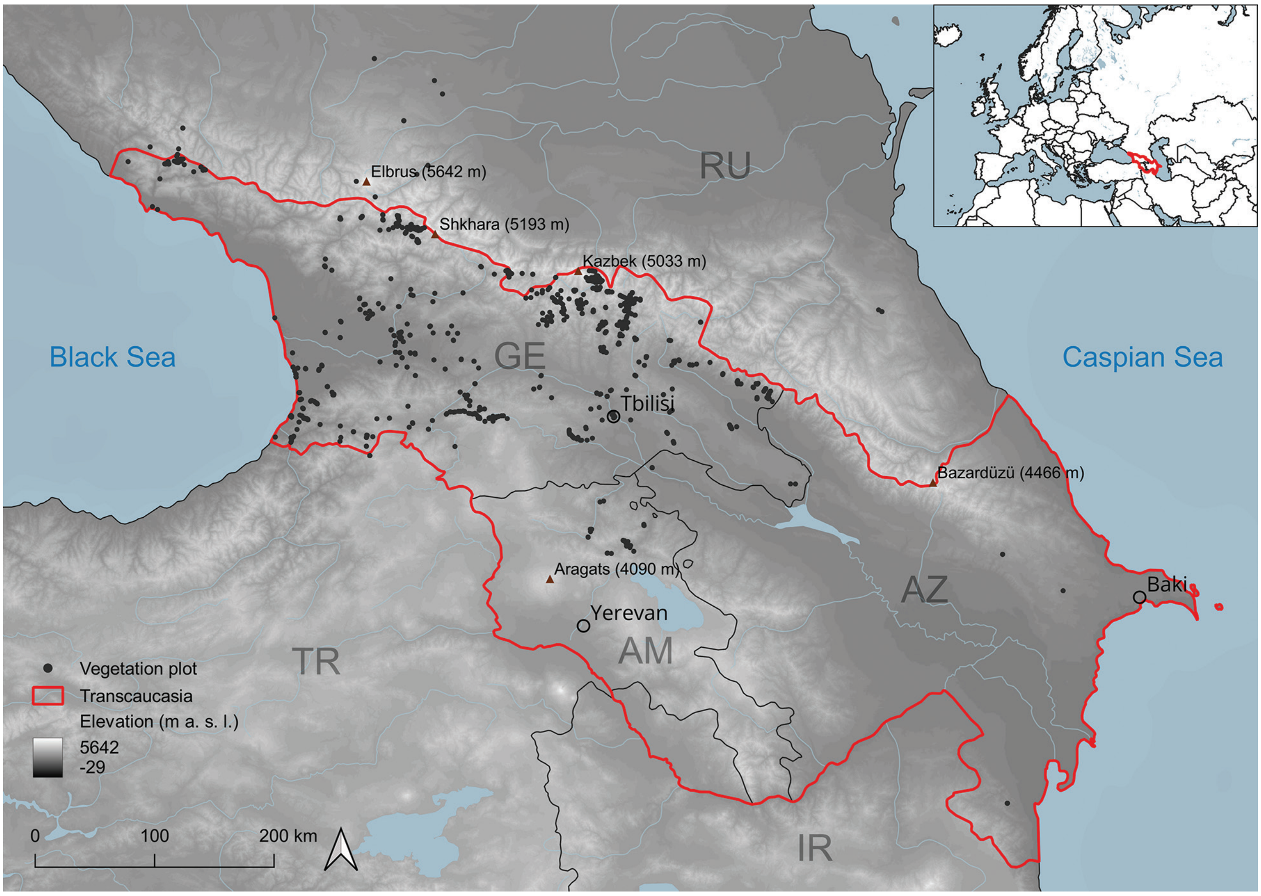

Figure 1. Geographic distribution of georeferenced plots stored in the Transcaucasian Vegetation Database (to 2023-04-26).

Header data from the original sources accompany the stored plots. As the geographic location is among the principal attributes of the plots, we paid particular attention to their georeferencing (WGS84). Plots with missing coordinates, thus especially those digitized from older literature before the 2000s, were georeferenced with appropriate accuracy, as far as possible, according to their site descriptions. The geographic coordinates' precision is provided for most georeferenced plots. When achievable, the localization of plots from the literature was additionally consulted with their authors.

Plots from the literature that could be localized only roughly (e.g. region, state) were also digitized as they may serve specific purposes like national vegetation and flora overviews. Further environmental data acquired during the field sampling or digitized from literature include elevation (m a. s. l.), slope inclination (°) and aspect (°). For a high portion of plots from our field research, we measured soil pH in a suspension (2:5) of a soil sample (uppermost 15 cm of soil surface) and deionized water by portable devices (e.g. GMH 3530, Hach HQ40d). The sampling date (at least the year) from the literature was also extracted. Full citations of the source literature of the digitized plots are provided (Suppl. material 1).

Database content

The TVD is the largest vegetation-plot database in the Caucasus in terms of the number of stored plots as well as geographic scope (39°–44°N, 40°–49°E). Currently, the collection encompasses 2,882 plots recorded using the Braun-Blanquet method (Figure 1).

The database comprises unpublished plots from the authors' field research (30%) and plots (70%) from 45 literature sources. Their header data show various completeness (Figure 2). The oldest plots were sampled in 1929 (Bush and Bush 1936), the newest in 2022 (unpublished to date). Thus, the database covers almost a century of phytosociological research in Transcaucasia. The number of plots per decade steadily increases from the 1990s on (Table 1). The geographic coordinates are available for 84% of plots. The remaining plots (typically ones located at the country level only) were impossible to georeference even in a very rough grid. 36% of plots are precisely located (GPS coordinates with an accuracy of up to 25 m) while 27% show an accuracy of up to 1 km and 21% an accuracy between 1 and 10 km. Plots originate from four countries, comprising 2,295 plots (80%) recorded in Georgia, 433 in Azerbaijan (15%), 124 (4%)

in Russia and 30 (1%) in Armenia. Georgian plots were sampled primarily in the Central Greater Caucasus and at lower elevations. Armenia is represented mainly by forest plots sampled in the northern part of the country. A higher number of plots cover Azerbaijan. However, they generally lack geographic coordinates due to missing localization in their source literature. Moreover, the database stores plots from selected studies from the main Greater Caucasus range and the Caucasian promontories in Russia.

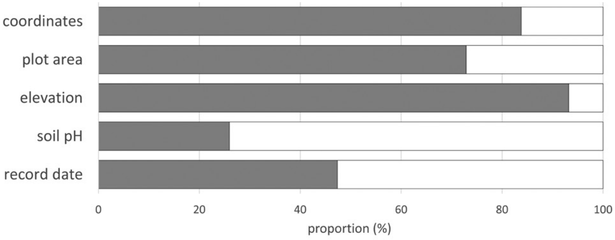

Figure 2. Completeness of main header data for the plots stored in the Transcaucasian Vegetation Database. Grey areas show the proportion of plots containing data for the given variables.

Table 1. Numbers of plots in the Transcaucasian Vegetation Database recorded per decade. Decades with no plots available were omitted.

Decade	Number of plots
1921–1930	31
1931–1940	62
1971–1980	18
1991–2000	13
2001–2010	143
2011–2020	451
2021–2030	646
not indicated	1518
Total number	2882

The database utilizes the TURBOVEG species list Russia with plant species nomenclature following Czerepanov (1995) supplemented by several taxa described after this source was published. Regarding taxonomical composition, the database encompasses 2,500 taxon names. Out of this number, it contains 2,305 species of vascular plants from 139 families and 195 species of bryophytes from 39 families. The most frequent families of vascular plants include *Asteraceae*, *Poaceae*, *Fabaceae* and *Rosaceae* while *Brachytheciaceae*, *Amblystegiaceae*, *Mniaceae* and *Pottiaceae* represent the most common bryophyte families (Figure 3). All plots contain vascular plants accompanied by their cover values, while data on species composition of the bryophyte layer is available for 11% of plots.

As the database contains a large number of mesophilous forest plots, the most common trees across the dataset are: *Carpinus betulus* (present in 20% of all plots), *Fagus orientalis* (20%), *Fraxinus excelsior* (11%), *Quercus petraea* subsp. *iberica* (11%) and *Tilia begoniifolia* (9%). The most frequent herbs and shrubs encompass *Galium odoratum* (16%), *Ranunculus oreophilus* (16%), *Leontodon hispidus* (15%), *Trifolium ambiguum* (15%), *Corylus avellana* (15%), *Bromus variegatus* (14%), *Veronica gentianoides* (14%), *Brachypodium sylvaticum* (13%), *Geranium robertianum* (12%) and *Campanula rapunculoides* (12%). Aliens originating outside western Eurasia (sensu Kikodze et al. 2010) are relatively scarce in the dataset. The most common ones include the Asian herbs *Oplismenus undulatifolius* (6%) and *Duchesnea indica* (2%), and the North American tree *Robinia pseudoacacia* (1%). All chiefly occur in forest vegetation across low and warm parts of Transcaucasia.

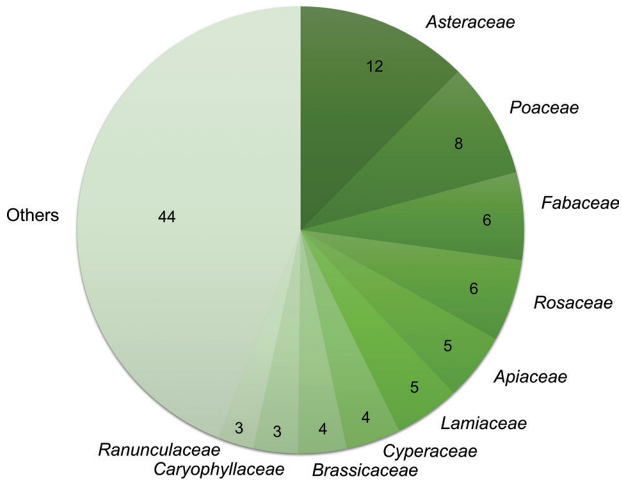

Figure 3. Relative contribution (%) of the ten most frequent families in the Transcaucasian Vegetation Database.

The plot area varies (Figure 4), including plots of < 1 m^2 (0.5% of plots), 1–25 m^2 (23%), 26–100 m^2 (32%), 101–400 m^2 (17%) and > 400 m^2 (0.5%). For 27% of plots, the area is unknown. The elevation of plots ranges between 0 and 3,600 m (1,465 m on average). It shows a bimodal distribution (Figure 5) with maxima in lower elevations (lower forest belt) and subalpine and alpine zones. As basic soil properties are among the key environmental variables driving vegetation diversity, we provide measured soil pH for most plots recorded during the field expeditions (26%). It spans from 3.8 to 8.0 (6.3 on average).

The dominant vegetation formations of the database include deciduous broad-leaved forests, subalpine tallforb vegetation, shrub and elfin forests, and alpine grasslands and heathlands. They all represent the region's key natural vegetation (Bohn et al. 2000–2003). Many other habitats are also present in the database (Figure 6). Moreover, plots from the Caucasian gravel river bars are stored in a separate database (Kalníková and Kudrnovsky 2017).

The current version of the TVD is available upon request via GIVD (Dengler et al. 2011) and EVA (Chytrý et al. 2016).

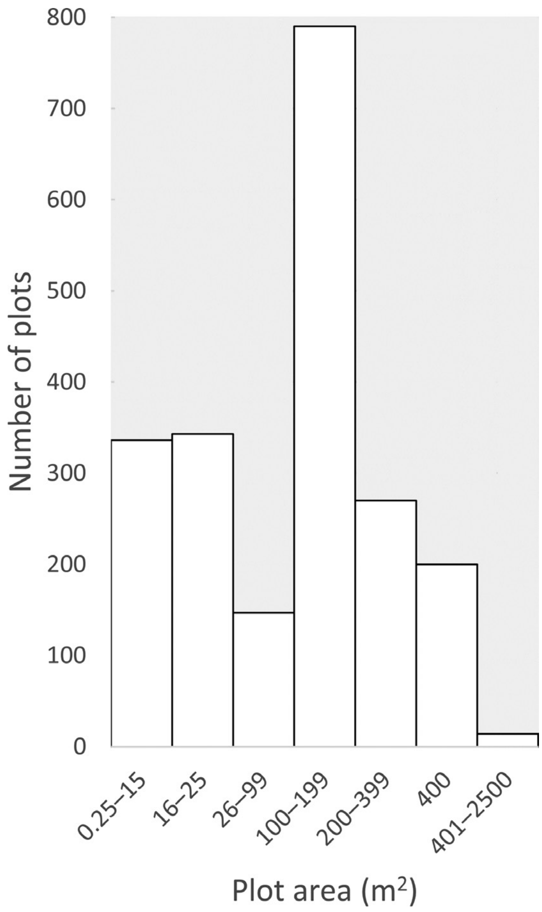

Figure 4. Size (area) of plots stored in the Transcaucasian Vegetation Database.

Future perspectives

The TVD represents a developing vegetation database focusing on a global biodiversity hotspot where a comparable dataset has not been available to date.

Plots from the TVD are currently being analyzed and have been used in numerous international EVA projects, particularly those focusing on various aspects of the botanical, functional or ecological diversity of Europe and adjacent areas.

Data collection and storage in the TVD is an ongoing process. The number of stored plots is continuously growing by both the own field research of the authors and the digitization of newly published data. The field expeditions aiming at plot recording are led yearly and focused on various areas of the Southern Caucasus and diverse vegetation types. We plan to sample especially in poorly represented areas and vegetation types, both zonal (e.g. beech and coniferous forests, steppes) and azonal (e.g. wetlands, rocks and screes). Therefore, the geographic and ecological scope of the TVD is regularly extending. Consequently, the database might serve a wider variety of thematic projects dealing with, for instance, large-scale vegetation classifications, alien species monitoring, biodiversity assessments and the potential impact of climate change. Moreover, it provides data applicable to nature protection, including habitat mapping, environmental management planning, restoration projects, and vegetation monitoring. The plots with high precision of coordinates might be used as a baseline for a future resurvey that would detect eventual changes in vegetation structure and plant species assemblages.

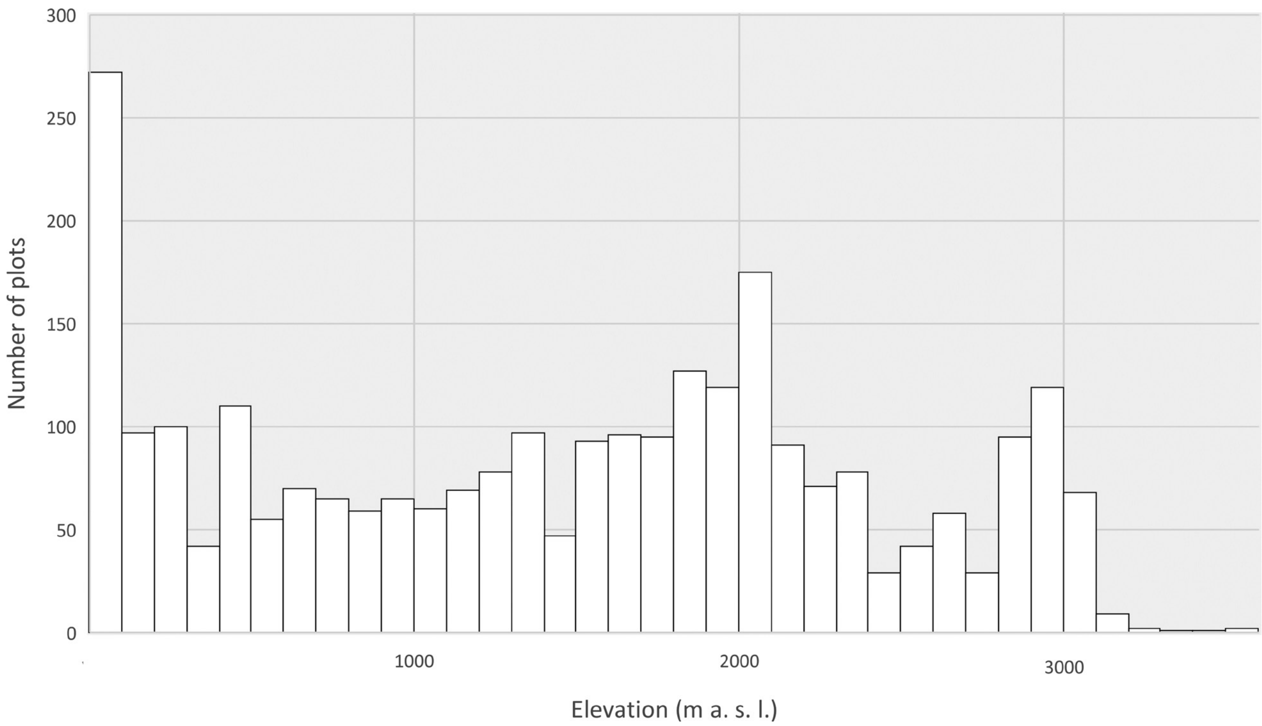

Figure 5. Elevation distribution of plots stored in the Transcaucasian Vegetation Database.

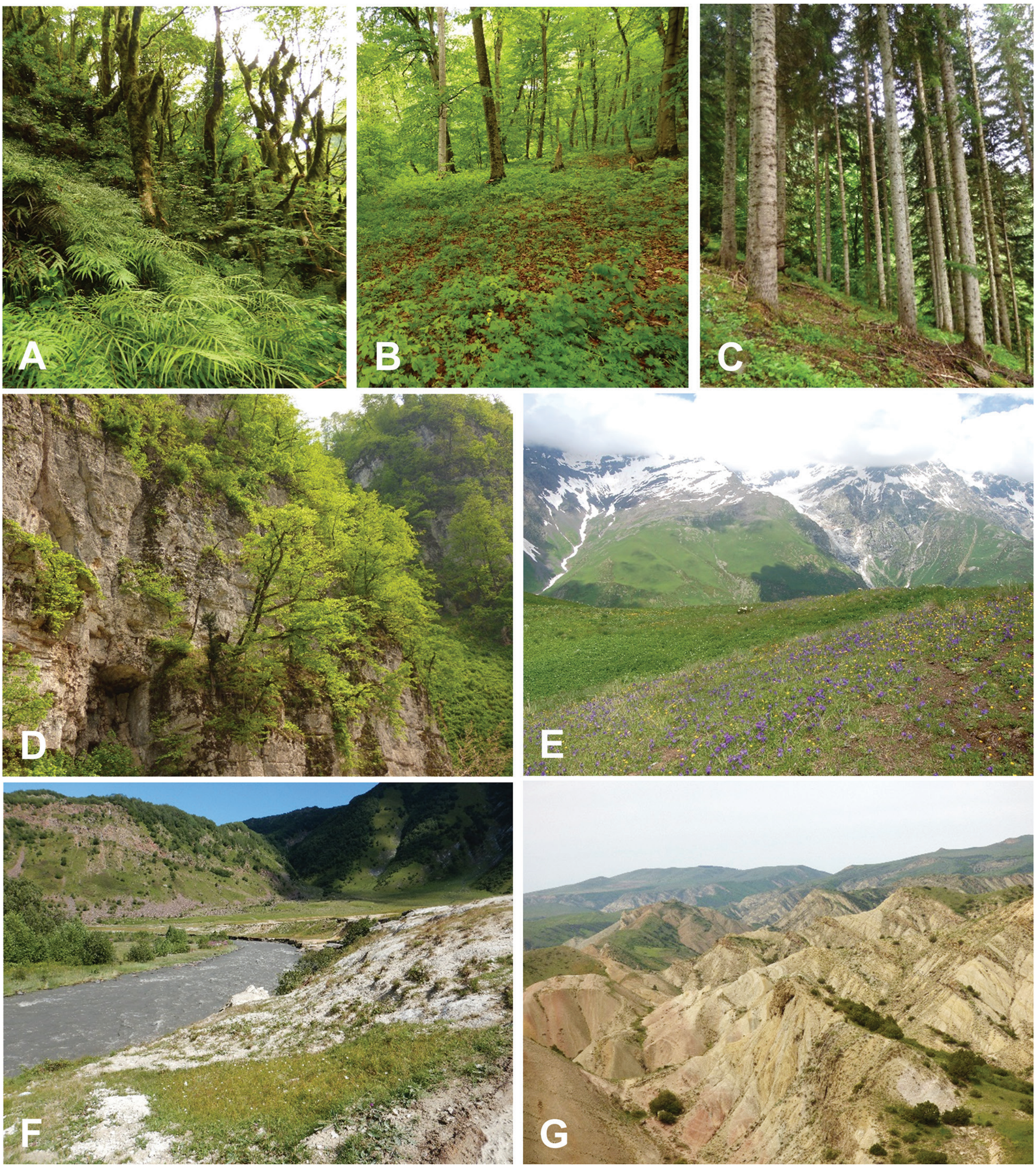

Figure 6. Examples of vegetation types and complexes included in the Transcaucasian Vegetation Database. A) Colchic temperate rainforest with understory rich in ferns, Samegrelo Region, W Georgia; B) Mesophilous *Fagus orientalis* forest, Ijevan Region, N Armenia; C) Western Caucasian *Abies nordmanniana* forest, Racha Region, W Georgia; D) Complex of rock and forest vegetation in deeply incised valleys, Ijevan Region, N Armenia; E) Grazed alpine grassland in the Central Greater Caucasus, Racha Region, W Georgia; F) A diverse landscape of the intermontane Greater Caucasian basin, a mosaic of semi-natural and natural habitats including subhalophilous grasslands on travertine deposits, Khevi Region, N Georgia; G) Semi-desert in the arid parts of central Transcaucasia, Kartli Region, E Georgia.

The database intends not only to help fill the gaps in our knowledge of this key biodiversity area but also to provide an opportunity for international collaboration among vegetation scientists from various countries.

Author contributions

PN and VK conceived the idea of the database. PN built the database, elaborated data and led the writing. DS prepared the map. All authors provided vegetation plot data to the database, revised the manuscript and approved its final version.

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References

Akhalkatsi M (2015) Forest habitat restoration in Georgia, Caucasus ecoregion. Mtsignobari, Tbilisi, GE, 102 pp.

Akhalkatsi M, Tarkhnishvili D (2012) Habitats of Georgia. GTZ, Tbilisi, GE, 118 pp.

Aleksanyan A, Biurrun I, Belonovskaya E, Cykowska-Marzencka B, Berastegi A, Hilpold K, Kirschner P, Mayrhofer H, Shyriaieva D, … Dengler J (2020) Biodiversity of dry grasslands in Armenia: first results from the 13th EDGG Field Workshop in Armenia. Palaearctic Grasslands 46: 12–51. https://doi.org/10.21570/EDGG.PG.46.12-51

Barthlott W, Mutke J, Rafiqpoor MD, Kier G, Kreft H (2005) Global centres of vascular plant diversity. Nova Acta Leopoldina 92: 61–83.

Bedoshvili DO (1985) Opyt klassifikacii alpiiskikh lugov Kavkaza s ispolzovaniem grupp sopriazhennykh vidov (na primere raiona Kazbegi) [An attempt to classification of the alpine meadow vegetation of the Caucasus using the groups of associated species (as exemplified by the Kazbegi Region)]. Botanicheskii zhurnal 70: 1605–1613. [in Russian]

Biurrun I, Pielech R, Dembicz I, Gillet F, Kozub Ł, Marcenò C, Reitalu T, Van Meerbeek K, Guarino R, … Dengler J (2021) Benchmarking plant diversity of Palaearctic grasslands and other open habitats. Journal of Vegetation Science 32: e13050. https://doi.org/10.1111/jvs.13050

Bohn U, Neuhäusl R, Gollub G, Hettwer C, Neuhäuslová Z, Raus T, Schlüter H, Weber HE [Eds] (2000–2003) Karte der natürlichen Vegetation Europas / Map of the natural vegetation of Europe. Maßstab / Scale 1: 2 500 000. Landwirtschaftsverlag, Münster, DE.

Bondyrev IV, Davitashvili ZV, Singh VP (2015) The geography of Georgia: problems and perspectives. Springer International Publishing, Cham, CH; Heidelberg, DE; New York, US; Dordrecht, NL; London, UK, 228 pp. https://doi.org/10.1007/978-3-319-05413-1

Bruelheide H, Dengler J, Jiménez-Alfaro B, Purschke O, Hennekens SM, Chytrý M, Pillar VD, Jansen F, Kattge J, … Tang Z (2019) sPlot–A new tool for global vegetation analyses. Journal of Vegetation Science 30: 161–186. https://doi.org/10.1111/jvs.12710

Bush NA, Bush EA (1936) Rastitelnyi pokrov vostochnoi Jugo-Osetii i ego dynamika [Vegetation cover of eastern South Ossetia and its dynamics]. Proizvoditelnyye sily Yugo-Osetii, V, AN SSSR, SSPS, seria Zakavkazskaya, Vol. 18. Moskva-Leningrad, RU, 263 pp. [in Russian]

Chytrý M, Hennekens SM, Jiménez-Alfaro B, Knollová I, Dengler J, Jansen F, Landucci F, Schaminée JHJ, Aćić S, … Yamalov S (2016) European Vegetation Archive (EVA) an integrated database of European vegetation plots. Applied Vegetation Science 19: 173–180. https://doi.org/10.1111/avsc.12191

Czerepanov SK (1995) Vascular plants of Russia and adjacent states (the former USSR). Cambridge University Press, Cambridge, UK; New York, US; Melbourne, AU, 516 pp..

Dengler J, Chytrý M, Ewald J (2008) Phytosociology. In: Jørgensen SE, Fath BD (Eds) Encyclopedia of Ecology, Vol. 4. Elsevier, Oxford, UK, 2767–2779. https://doi.org/10.1016/B978-008045405-4.00533-4

Dengler J, Jansen F, Glöckler F, Peet RK, De Cáceres M, Chytrý M, Ewald J, Oldeland J, Finckh M, … Spencer N (2011) The Global Index of Vegetation-Plot Databases (GIVD): a new resource for vegetation science. Journal of Vegetation Science 22: 582–597. https://doi.org/10.1111/j.1654-1103.2011.01265.x

Fayvush GM, Aleksanyan AS (2016) Habitats of Armenia. National Academy of Sciences of the Republic of Armenia, Institute of Botany, Yerevan, AR, 358 pp.

Fayvush GM, Aleksanyan AS (2020) The Transcaucasian Highlands. In: Noroozi J (Ed.) Plant biogeography and vegetation of high mountains of Central and South-West Asia. Springer Nature Switzerland AG, Cham, CH, 287–313. https://doi.org/10.1007/978-3-030-45212-4_8

Filibeck G, Arrigoni PV, Blasi C (2004) Some phytogeographical remarks on the forest vegetation of Colchis (Western Georgia). Webbia 59: 189–214. https://doi.org/10.1080/00837792.2004.10670768

Gegechkori A (2020) Biomes of the Caucasus: A comprehensive review. Nova Science Publisher, New York, US, 502 pp. https://doi.org/10.52305/LKTA3424

Giam X, Bradshaw CJ, Tan HT, Sodhi NS (2010) Future habitat loss and the conservation of plant biodiversity. Biological Conservation 143: 1594–1602. https://doi.org/10.1016/j.biocon.2010.04.019

Goginashvili N, Togonidze N, Tvauri I, Manvelidze Z, Memiadze N, Zerbe S, Asanidze Z (2021) Diversity and degradation of the vegetation of mountain belt forests of central Adjara (the Lesser Caucasus), Georgia. Journal of Forest Science 67(5): 219–241. https://doi.org/10.17221/80/2020-JFS

Grossheim AA (1948) Rastitelnyi pokrov Kavkaza [Vegetational cover of the Caucasus]. MOIP, Moskva, RU, 268 pp. [in Russian]

Guinochet M (1984) Sur quelques relevés de phytosociologie sigmatiste pris au Tadjikistan et au Caucase. Botanica Helvetica 94: 339–354.

Gulisashvili VZ, Makhatadze LB, Prilipko LI (1975) Rastitelnost Kavkaza [Vegetation of the Caucasus]. Nauka, Moskva, RU, 232 pp. [in Russian]

Hennekens SM, Schaminée JHJ (2001) TURBOVEG, a comprehensive database management system for vegetation data. Journal of Vegetation Science 12: 589–591. https://doi.org/10.2307/3237010

Huseynova IM (2021) The classification of desert and semi-desert vegetation of the Caspian coast (Azerbaijan). Bulletin of Science and Practise 7/11: 43–50. https://doi.org/10.33619/2414-2948/72/05

Ibadullayeva SJ, Huseynova IM (2021) An overview of the plant diversity of Azerbaijan. In: Öztürk A, Altay V, Efe R (Eds) Biodiversity, Conservation and Sustainability in Asia. Volume 1. Prospects and Challenges in West Asia and Caucasus. Springer, Cham, CH, 431–478. https://doi.org/10.1007/978-3-030-59928-7_17

Jabbarov MT, Ibragimov AS, Nabieva FH, Atamov VV, Karaman Erkul S (2020) Phytosociological features of frigana vegetation of Nakhchivan, Azerbaijan. Bangladesh Journal of Botany 49(2): 273–286. https://doi.org/10.3329/bjb.v49i2.49300

Jiménez-Alfaro B, Chytrý M, Rejmánek M, Mucina L (2014) The number of vegetation types in European countries: major determinants and extrapolation to other regions. Journal of Vegetation Science 25: 863–872. https://doi.org/10.1111/jvs.12145

Kaffke A (2008) Vegetation and site conditions of a Sphagnum percolation bog in the Kolkheti Lowlands (Georgia, Transcaucasia). Phytocoenologia 38: 161–176. https://doi.org/10.1127/0340-269X/2008/0038-0161

Kalníková V, Kudrnovsky H (2017) Gravel bar vegetation database. Phytocoenologia 47: 109–110. https://doi.org/10.1127/phyto/2017/0177

Kalníková V, Chytrý K, Novák P, Zukal D, Chytrý M (2020) Natural habitat and vegetation types of river gravel bars in the Caucasus Mountains, Georgia. Folia Geobotanica 55: 41–62. https://doi.org/10.1007/s12224-020-09364-6

Kier G, Kreft H, Lee TM, Jetz W, Ibisch PL, Nowicki C, Mutke J, Barthlott W (2009) A global assessment of endemism and species richness across island and mainland regions. Proceedings of the National Academy of Sciences of the United States of America 106: 9322–9327. https://doi.org/10.1073/pnas.081030610

Kikodze D, Memiadze N, Kharazishvili D, Manvelidze Z, Müller-Schärer H (2010) The alien flora of Georgia. 2nd edn. Joint SNSF SCOPES and FOEN publication, Ascona, CH; Tbilisi, GE, 36 pp.

Koch K (1850) Karte von dem Kaukasischen Isthmus und von Armenien. Reimer, Berlin, DE.

Lack HW (1978) The Turkish and Caucasian collections of C. Koch. Notes from the Royal Botanic Garden Edinburgh 37(1): 79–94.

Magakyan AK (1941) Rastitelnost Armianskoj SSR [Vegetation of Armenian SSR]. Nauka, Moskva-Leningrad, RU, 274 pp. [in Russian]

Makhatadze LB (1958) Dubravy Armenii [Oak forests of Armenia]. Izdatelstvo Akademii Nauk Armiianskoi SSR, Yerevan, AR, 327 pp. [in Russian]

Medwedew JS (1869) Lesa yuzhnoy chasti Shoropanskiygo rayonu Kutaisskogo distrikta [Forests of the southern part of Shoropani Region of Kutaisi District]. Notulae of the Caucasian Agricultural Society 15: 1–74. [in Russian]

Milne RI, Abbott RJ (2002) The origin and evolution of tertiary relict floras. Advances in Botanical Research 38: 281–314. https://doi.org/10.1016/S0065-2296(02)38033-9

Mittermeier RA, Gil PR, Hoffmann M, Pilgrim J, Brooks T, Mittermeier CG, Lamoreux J, Da Fonseca GAB (2005) Hotspots revisited: Earth's biologically richest and most endangered terrestrial ecoregions. Cemex, Mexico City, MX, 390 pp.

Mucina L, Bültmann H, Dierßen K, Theurillat J-P, Raus T, Čarni A, Šumberová K, Willner W, Dengler J, … Tichý L (2016) Vegetation of Europe: hierarchical floristic classification system of vascular plant, bryophyte, lichen, and algal communities. Applied Vegetation Science 19(suppl. 1): 3–264. https://doi.org/10.1111/avsc.12257

Nakhutsrishvili G (1999) The vegetation of Georgia (Caucasus). Braun-Blanquetia 15: 1–74.

Nakhutsrishvili G (2013) The Vegetation of Georgia (South Caucasus). Springer, Berlin, DE, 235 pp. https://doi.org/10.1007/978-3-642-29915-5

Nakhutsrishvili G, Zazaznashvili N, Batsatsashvili K (2011) Regional profile: Colchic and Hyrcanian temperate rainforest of the Western Eurasian Caucasus. In: DellaSala DA (Ed.) Temperate and boreal rainforests of the world: ecology and conservation. Island Press, Washington DC, US, 212–221.

Nakhutsrishvili G, Zazanashvili N, Batsatsashvili K, Montalvo Mancheno CS (2015) Colchic and Hyrcanian forests of the Caucasus: similarities, differences and conservation status. Flora Mediterranea 25: 185–192. https://doi.org/10.7320/FlMedit25SI.185

Nakhutsrishvili G, Batsatsashvili K, Bussmann RW, Rahman IU, Hart RE, Haq SM (2022) The subalpine and alpine vegetation of the Georgian Caucasus - a first ethnobotanical and phytosociological synopsis. Ethnobotany Research and Applications 23: 1–60. https://doi.org/10.32859/era.23.12.1-60

Novák P, Zukal D, Harásek M, Vlčková P, Abdaladze O, Willner W (2020) Ecology and vegetation types of oak-hornbeam and ravine forests of the Eastern Greater Caucasus, Georgia. Folia Geobotanica 55: 333–349. https://doi.org/10.1007/s12224-020-09386-0

Novák P, Stupar V, Kalníková V (2021) *Carpinus orientalis* forests in Georgian Colchis: first insights. Tuexenia 41: 37–51. https://doi.org/10.14471/2021.41.012

Passarge H (1981a) Carpineta in kartalinischen Kaukasus. Phytocoenologia 9: 533–545. https://doi.org/10.1127/phyto/9/1981/533

Passarge H (1981b) Über *Fagetea* im kartalinischen Kaukasus. Feddes Repertorium 92: 413–431. https://doi.org/10.1002/fedr.19810920507

Preislerová Z, Jiménez-Alfaro B, Mucina L, Berg C, Bonari G, Kuzemko A, Landucci F, Marcenò C, Monteiro-Henriques T, … Chytrý M (2022) Distribution maps of vegetation alliances in Europe. Applied Vegetation Science 25: e12642. https://doi.org/10.1111/avsc.12642

Prilipko LI (1970) Rastitelnyi pokrov Azerbaidjana [Vegetation cover of Azerbaijan]. Elm, Baku, AZ, 168 pp. [in Russian]

Radde G (1866) Berichte über die biologisch-geographischen Untersuchungen in den Kaukasusländern: Reisen im Mingrelischen Hochgebirge und in seinen drei Längenhochthälern (Rion, Tskenis-Tsquali und Ingur). Tbilisi, GE, 225 pp.

Rubel E (1914) The forest vegetation of the Western Caucasus. Journal of Ecology 2: 39–42. https://doi.org/10.2307/2255372

Slodowicz D, Descombes P, Kikodze D, Broennimann O, Müller-Schärer H (2018) Areas of high conservation value at risk by plant invaders in Georgia under climate change. Ecology and Evolution 8: 4431–4442. https://doi.org/10.1002/ece3.4005

Takhtajan AL (1941) Botanico-geographicheskii ocherk Armenii [Phyto-geographical essay of Armenia]. Proceedings of the Institute of Botany of Armenian Branch of Academy of Sciences of the USSR 2: 3–156. [in Russian]

Takhtajan AL (1986) Floristic regions of the world. University of California Press, Berkeley, US; Los Angeles, US; London, UK, 522 pp.

Troitsky NA (1930) Ocherk Rastitelnosti Garedzhiiskoi stepi [Study on vegetation of the Garedjian steppe]. Prikladnoy otdelov Tbiliskogo botanichskogo sada 7: 1–92. [in Russian]

Volodicheva N (2002) The Caucasus. In: Shahgedanova M (Ed.) The physical geography of Northern Eurasia. Oxford University Press, New York, US, 350–376.

Zazanashvili N, Mallon D (Eds) (2009) Status and protection of globally threatened species in the Caucasus. CEPF and WWF, Tbilisi, GE, 232 pp.

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Supplementary material

Supplementary material 1
Complete list of the sources of the plots acquired from the literature
Link: https://doi.org/10.3897/VCS.105521.suppl1