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Crossing the Caucasus hunting for plants: the collection itinerary of the botanists Stéphen Sommier and Émile Levier in the summer of 1890

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ABSTRACT

Stéphen Sommier and Émile Levier were eminent botanists and plant collectors (but also ethno-anthropologists, geographers and photographers), best known for their scientific travels in Italy and abroad. This study accurately reconstructs the travel and collection itineraries of a trip through the Caucasus in 1890. The botanical importance of this journey is significant, with over 10,000 specimens collected, more than 1600 taxa identified, and over 250 newly described taxa based on the collected samples. The locations visited are placed in a time sequence on up-to-date georeferenced topographic maps. Furthermore, using dedicated heatmaps, we show the sites where the two explorers collected specimens that were later identified as taxa new to science. These maps will also be useful to botanists, historians, scholars and curators of natural history museums, who work with Caucasian flora and vegetation, ethno-anthropology, history of photography, and landscape.

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Botanic explorations; conservation; ethno-anthropology; geography; natural history

1. Introduction

Stéphen Sommier (1848–1922) was an Italian botanist, geographer and ethno-anthropologist born in Florence to French parents. He is renowned for his scientific travels to Italy, Scandinavia and Russia, as well as for his important botanical collections. He had contact with illustrious scientists of his time, including Aleksandr Herzen, Paolo Mantegazza, Enrico Giglioli, Odoardo Beccari, Filippo Parlatore and Émile Levier. With the latter, he embarked on a journey through the Caucasus which is the subject of this work. Despite their contrasting personalities, they were able to collaborate effectively. Sommier was an active botanist, founding members and president of the Italian Botanical Society. He authored numerous publications, primarily focused on botany, but also covering geography and ethno-anthropology (Pampanini, 1922). Levier (1839–1911), was a Swiss-born doctor who settled in Florence. He had a great passion for botany, was a keen collector, and was a skilled botanical designer. He was an expert in bryophytes but was rather reluctant to publish the data of his research under his own name. Instead, he often preferred to collaborate disinterestedly with other colleagues, including Sommier, to whom he was bound by a deep friendship, consolidated through many collection campaigns in Italian territories (Levier, 1894; Sommier, 1912). Sommier's herbarium was donated to the Herbarium Centrale Italicum (now belonging to the Botanical Collections of the Natural History Museum of the University of Florence) in May 1922. It consisted of 475 packages of plants, which were added to the 7729 specimens donated to the Herbarium between 1872 and 1915 (Cuccuini & Nepi, 1999). Levier's herbaria consisted of about 30,000 specimens of vascular plants and 150,000 cryptogams (see Cuccuini, 2009), which are preserved in the Herbarium of Florence.

The Botanical Collections of the Natural History Museum of the University of Florence have a rich history intertwined with naturalistic explorations in distant and lesser-known countries, particularly from a botanical perspective. This connection dates back to before the establishment of the Central Italian Herbarium in 1842. It is sufficient to note, that during his trip to Brazil (1817–1818), Giuseppe Raddi (1770–1829), one of the greatest botanists of his time contributed to the pre-existing naturalistic collections of the Grand Duke of Tuscany (Moggi, 1994, 2009). However, during the second half of the nineteenth century, Florentine botanists, whether by birth or adoption, embarked on extraordinary journeys, which allowed for a large number of type specimens to reach the Central Herbarium. These specimens are the original samples on which species were described for the first

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time, together with a vast quantity of plant samples from areas not previously represented within the existing collections. For instance, Odoardo Beccari (1843–1920), one of the greatest Florentine botanical explorers, authored three extraordinary journeys that covered Malaysia, New Guinea, Australia and New Zealand (Cecchi et al., 2022; Nepi, 2009; Viciani et al., 2021). Equally important are the explorations undertaken by Sommier in the territories of the Ob River in Siberia, Lapland, and the Caucasus region (Pampanini, 1922). This final journey is notable for passing through little-known and, at the time, difficult to explore territories, bringing back a notable number of plant samples of great interest, some of which were previously unknown to science. The aim of this work is to accurately reconstruct Sommier and Levier's travel itineraries to the Caucasus, linking the site names they used to the current ones, and placing them in a temporal sequence on updated georeferenced maps. We also aim to show the sites on the trip where the collected samples were richest in plant species later described as new to science.

2. Methods

2.1. The map

The map was created using ESRI ArcGIS 10.8.1 for all data processing, mapping and design. The cartographic background intentionally omits infrastructure to highlight the morphology and orography, which were derived from SRTM images (Shuttle Radar Topography Mission) that were merged, cropped and reclassified (Jarvis et al., 2008).

The itinerary lines were faithfully drawn based on Levier's indications (1894). This text contains details on their journey, therefore several toponyms have been identified to accurately reconstruct the route. In addition, a map that completes the list of illustrations and the list of new detected species is also appended.

During his journey, Levier shared his impressions with his family through letters which were published between 1890 and 1893 (Biagioli, 2005; 2006; Cheishvili, 2021; Levier, 1890, 1891, 1892, 1893). We consulted these letters to reconstruct the names of places and the chronology of the trip. Old maps and works were consulted, including Douglas Freshfield's Caucasus maps with peaks, passes and glaciers of the Central Caucasus (Freshfield, 1888; Freshfield & Reeves, 1889) as well as the two volumes of 'The Exploration of the Caucasus' (Freshfield, 1902).

The explorer's arrival and collection locations have been listed chronologically. Every point has been identified on current maps by comparing them with numerous geographic service websites [https://earth.google.com/; https://www.google.it/maps/; https://mapcarta.com/; https://www.oldmapsonline.org/; http://www.etomesto.com/map-atlas_topo-russia/]. Each point was georeferenced using WGS84 (EPSG4326) geographical coordinates system and labelled with a current topographic site name. The accuracy of each location was assessed, indicating a distance radius of 5000 m. The tolerance range accounts for the uncertainty value in identifying the position of an ancient place name on modern maps, considering that authors have sometimes provided inadequate description of the location reached. Furthermore, according to the authors' reports (Levier, 1891, 1892, 1894; Sommier, 1892), they frequently travelled a few kilometres around the indicated locations to explore the area and collect specimens.

Sommier and Levier's travel destinations, including the locations where they collected samples, were topographically recorded to accurately recontruct their itinerary. Additionally, a subset of points was selected to highlight the places where the largest number of taxa were collected. This subset only includes the sites where Sommier and Levier collected specimens on which new taxa were described. This work has also been helpful in understanding Georgian toponyms because the authors studied the Russian orthography of site names and adapted it to Latin spelling.

Some sub-maps have been produced as 'heatmaps', which are a useful visualisation method for displaying event density or occurrence. The heatmaps show the estimated density of the phenomenon 'new taxa collected' and create hotspots. The free licensed QGIS software, includes a processing algorithm called 'Heatmap (Kernel Density Estimation)'. This algorithm was used to create a regular raster grid from a point layer. To run the algorithm, the layer was reprojected to EPSG 32638 (UTM38N-WGS84). The radius parameter must be set to determine the circular neighbourhood around each point where that point will have an influence. For our data, we assume that the sum of collected species will have an influence up to 5 km from the site, taking into account positional error and the fact that the botanists moved around the site for several kilometres. Finally, we set the minimum output pixel size at 50 m to create a smoother cartographic representation.

2.2. The considered taxa new to science

Regarding the newly described plants, it is important to note that in the study conducted by Sommier and Levier (1900), the new taxa, incuding new species, varieties and forms, described for the Caucasus are categorised in the following ways:

(1) new taxa described by Sommier & Levier in their work based on their field collections;

(2) new taxa already described by the two authors in previous publications (e.g. *Acta Horti Petropolitani, Nuovo Giornale Botanico Italiano*, etc.), based on their own material collected during the travel;
(3) new taxa described by other botanical specialists to whom Sommier and Levier sent specimens belonging to critical groups, coming from the material collected during their journey (e.g. J.F. Freyn, R. Keller and H. Siegfried, P.W. Magnus, etc.);
(4) new taxa identified based on collections carried out by other botanists who explored the Caucasian territory, regardless of Sommier and Levier's collected material (e.g. V.F. Brotherus, H. Lojka, N.K. de Seidlitz, G.F.R.von Radde).

However, since the present paper focuses on Sommier and Levier's travel, only the first three cases were included in the dataset. It is important to note that this work does not address taxonomic or nomenclatural issues, such as verifying materials' types or current synonymies.

3. Results and discussion

3.1. The map

Sommier and Levier's travel itinerary is available in Supplement 1, including a list of all visited places with coordinates, site names, and original and current names of the region/country and was used to create the map. The Main Map consisted of several submaps. The top left map covers the entire route from Livorno (Leghorn) (28 May 1890) to Florence (10 October 1890). The top right map shows the general itinerary taken by Sommier & Levier as they crossed the Caucasus, along with the location diagram of the following five maps. These five maps display heatmaps of the routes travelled and sites explored by the two botanist at different scales and in chronological order. They also show hotspots with high density of newly described taxa.

Heatmap no. 1 highlights hotspots of new taxa described by the authors, with the main hotspots located in the Khanli-Perival range. On this site, the two botanists herbalized in just a few hours before having to return to the road to Khulo (Levier, 1894). Among the collected specimens, several species were previously unknown and were then described as new taxa.

Heatmap no. 2 shows few hotspots, but the richer one includes a large urban centre, namely the Georgian capital Tbilisi, where the herbalisations were profitable.

On the other hand, heatmaps no. 3 and 4 are found in many areas with high concentrations of collection sites for newly described taxa. These hotspots are mainly located in mountainous areas, often at very high altitudes and practically unexplored from a botanical point of view, such as Latpari Pass (m 2764 a.s.l.), Mt. Tekali (m 2877 a.s.l.), Klukhori Pass (m 2480 a.s.l.), Epchik Pass (m 2989 a.s.l.) and Mt. Elbrus (m 3674 a.s.l.). These areas are considered the heartland of the Caucasian region. In their works (Levier, 1894; Sommier, 1892) the two botanists often describe the botanical aspect and richness of their collection, as well as their adventures in search of plants in the wild ravines among the snow-capped mountains. They also express their wonder at the incredible landscapes and infinite horizons. Figure 1 highlights the close positive relationship between altitude and the number of newly described taxa.

Heatmap no. 5, which relates to the final part of the return journey, shows few collection points and a low number of newly described taxa.

3.2. The trip and the features of the travelled territories

The travel to the Caucasus was conceived by Sommier, who invited Levier to participate and assured him that he would cover all the expenses. Evidence of this can be found in a letter sent in May 1889, which is preserved in the Levier Fund of the Science Library (Botany section) at the University of Florence (https://www.sba.unifi.it/p1335.html). The two botanists were accompanied by 'Gosto' (Costantino Vannucchi), a peasant who assisted them in their collection and who had previously collaborated with Sommier. He began his journey with them from Livorno on 28 May 1890. They landed in *Batum* (today Batumi, Georgia) on 15 June, and travelled approximately 600 km through the various regions of the Caucasus before embarking for Odessa on 30 September. In summary (Main Map, Travel itinerary), they traversed the lower region before heading towards the ridges of the Greater Caucasus. They reached the highest mountain in the Caucasus (Mt. Elbrus), where they encountered perennial snow at an altitude of over 3500 m a.s.l. They then descended and continued through the Cossack and Kabardian steppes before returning to the Georgian capital, passing through uninhabited and inhospitable areas. The itinerary took place mainly in an area that belonged to or was under the influence of the Russian Empire, which includes present-day Georgia and the Russian Federation. The climate in the country varied greatly depending on the region. The high and mountainous areas were cold and harsh but without the presence of endemic diseases. The lower territories, particularly in the west near the Black Sea, were hot and humid, with a high risk of contracting malarial fever due to the presence of swamps and marshes. The easternmost part of

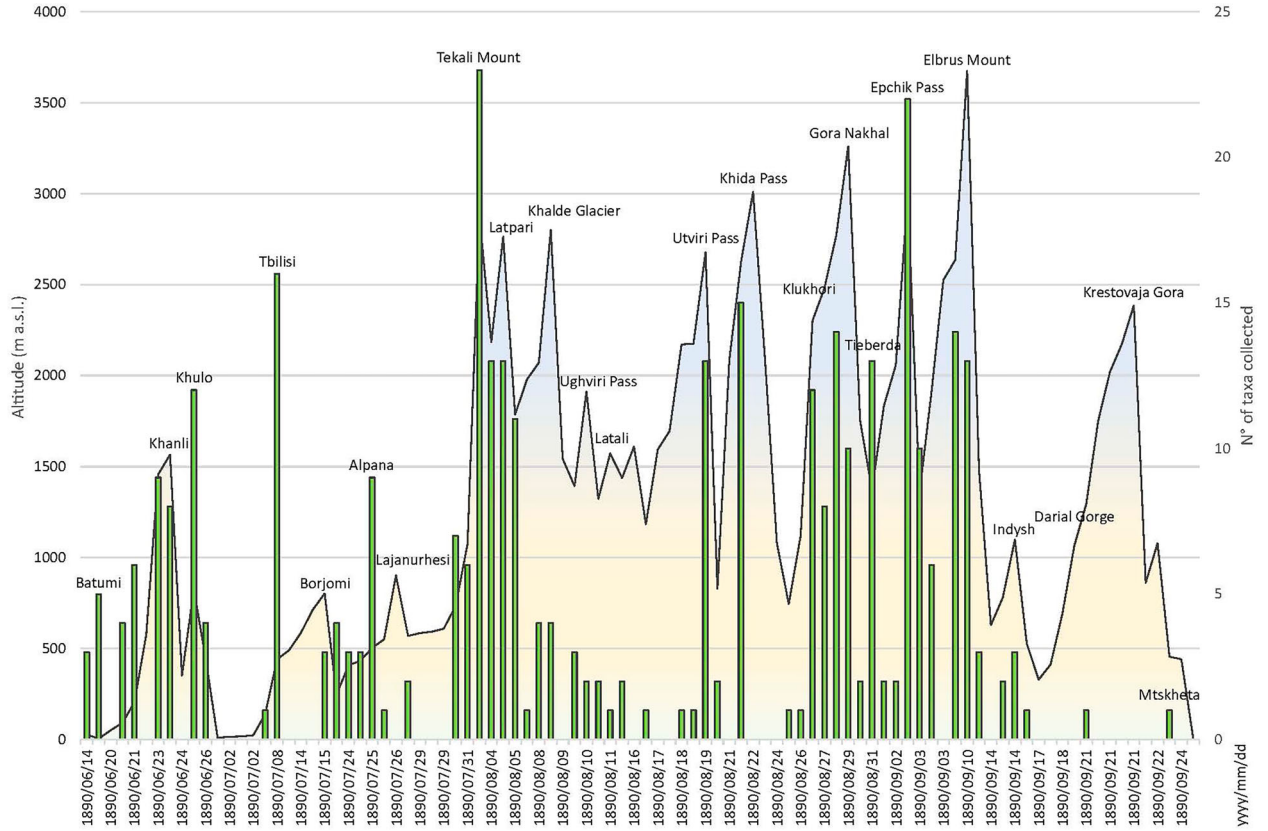

Figure 1. Chart in order of time and location, also showing site altitudes, of specimen collections that have been described as new taxa.

the territories was more arid. Due to the wide range of geological substrates present in the area (Adamia et al., 2011; Gamkrelidze et al., 2021) and the significant altitudinal range they covered, the botanists encountered a highly diverse plant landscape ranging from coastal, low altitude and temperate rainforests of Colchis in the western areas closer to the Black Sea, to the hilly and mountain vegetation belts, to the subalpine, alpine and nival vegetation of the highest altitudes. The easternmost part of their itinerary also includes semi-deserts, dry steppes and arid open forests. For more details on the plant communities of the area, refer to Nakhutsrishvili (1999, 2013), Nakhutsrishvili et al. (2015), and Novák et al. (2020, 2021, 2023). By superimposing the itinerary on the current vegetation, which is more anthropized than that encountered by the two explorers, one can appreciate the great variety of environments (see Figure 2). This variety results in a high level of biological diversity, making the area one of the most botanically diverse regions on Earth and a global hotspot for biodiversity conservation (Brooks et al., 2006; Dinerstein et al., 2017; Kier et al., 2005; Mittermeier et al., 2011; Myers et al., 2000; Zazanashvili et al., 2020). Figure 3 shows Sommier and Levier's itinerary superimposed on the current regional division of the territories. Supplement 1 provides a list of the original names of the regions used by the explorers as they not entirely correspond and only partially overlap with current ones. The list includes toponyms used by them, derived from transliteration, along with their probable current name. The report of the journey describes in great detail the people encountered, divided by origin and race, and observed with curiosity by Sommier, an expert photographer. The two explorers, as true gourmets, enthusiastically describe the sumptuous dinners consumed together with local guests, as well as the makeshift meals put together on the spot with locally hunted animals and fish. Sommier was able to communicate with the locals as he knew Russian. He introduces his friend Levier who, being a doctor, had a field pharmacy with him and was consulted by the locals to diagnose and treat malarial fevers with quinine.

The means of transport used on the journey were varied. They arrived on the ship 'Azof' and travelled along the valley of the Acharistskali River in a horse-drawn carriage. The botanists used saddled horses and mules to traverse the forests and follow the steep paths along the internal gorges (Main Map, heatmap 1). The stretch from Batumi to Tbilisi was covered by train with an oil-fueled locomotive (Main Map, heatmap 2). However, to reach Svanetia, they had to rely on the 'telega', a wooden box mounted on four wheels without shock absorbers, to cross streams and tackle climbs and wild and picturesque descents. Subsequently, near the Lajanuri Gorge, a team of oxen with a man accompanying them on foot was necessary (Main Map, heatmap 3).

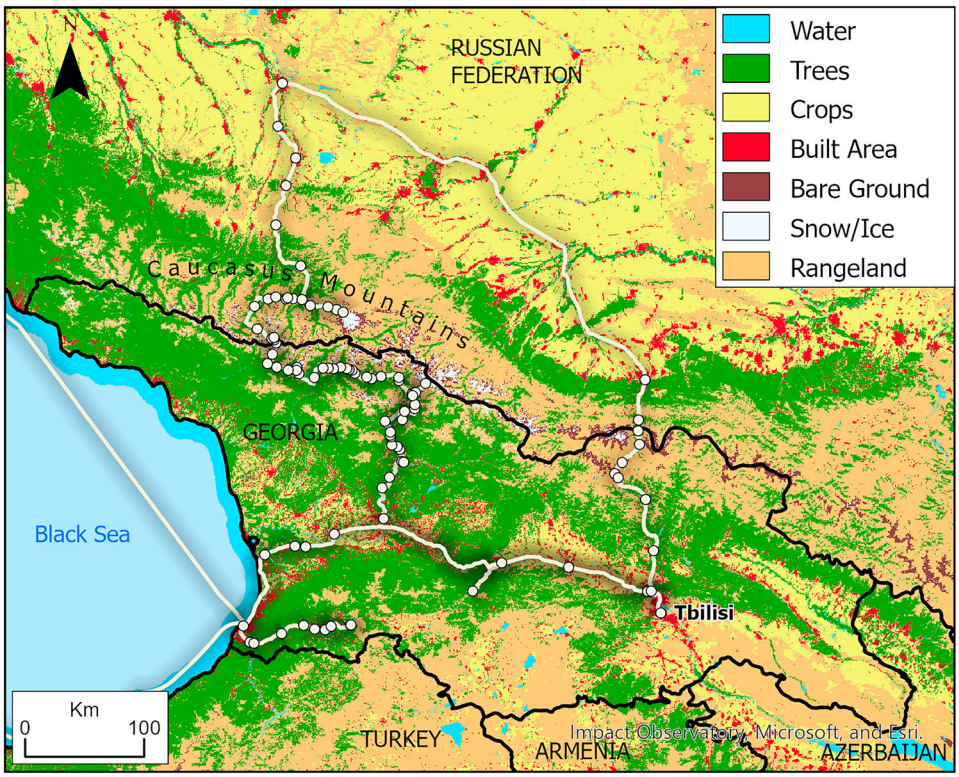

Figure 2. The routes travelled by Sommier & Levier superimposed on the current land use and physiognomic vegetation map, concerning the simple plant formations (data retrieved from Karra et al., 2021, modified).

Figure 3. The routes travelled by Sommier & Levier superimposed on the current regional division of the territories.

Throughout the journey, the two explorers were always under the protection of local government officials and accompanied by four or seven natives, including a 'dragoman' as an interpreter. The section known as the ' Caucasus heartland' was traversed on horseback and mostly on foot to reach snow-capped peaks and gravelly slopes, or to collect at high altitudes (Main Map, heatmap 4). The group walked up to 20 or 30 km per day and in the absence of a covered shelter, set up bivouacs at the end of the day in clearings along the paths. They wrapped up for the cold using the 'bachelik' and the 'bourka', which are respectively a turban and a Caucasian coat. Their objective was to reach Mt. Elbrus, the highest peak of the Caucasus. After crossing Abkhazia, they attempted the most challenging route, but the adverse weather conditions prevented them from reaching the summit. They used a Swiss-made aneroid barometer to measure altitude, which indicated 3700 m as the highest point they reached, beyond which it was not possible to continue (Main Map, heatmap 4). The two explorers crossed the Caucasus range and traversed the vast plain of the Kuban River to reach the Nevinnomyssk station, from where they returned by train to Vladikavkaz (North Ossetia). The journey continued with a stage-coach ride through the narrow mountain Darial Gorge, which serves as a border pass between present-day Russia and Georgia. The destination was Tbilisi, as indicated on the Main Map, heatmap 5. The final stop was Batumi, a coastal city where, after gathering all the collections, they departed with the steamer 'Olga' towards Odessa. The two friends will

Figure 4. Émile Levier in August 1899, near a plant of *Heracleum mantegazzianum* Sommier & Levier cultivated at Bagni Nuovi in Bormio (Lombardy, Italy) (photo published for the first time in Sommier & Levier, 1900).

part ways in Odessa, a Black Sea port city, biffing their final farewell. Sommier returned to Europe via the Danube, while Levier boarded a train and arrived in Florence on 10 October 1890, after six days of travel (Main Map, Travel itinerary).

3.3. Notes on the botanical importance of the travel

The botanical collections resulting from the trip were of great significance. They were published starting from 1892 mainly in the Russian journal *Acta Horti Petropolitani*, as well as in other scientific journals. Short contributions were written on new plants discovered during the journey. The expedition's success from a botanical perspective can be summarised in the subsequent publication of Sommier and Levier (1900). Over 10,000 specimens were collected, with over 1600 taxa identified. Additionally, more than 250 newly described species and infraspecific taxa were based on the collected samples (Pampanini, 1922). Among the many new species described on samples collected during the journey, *Heracleum mantegazzianum* Sommier & Levier (Figure 4), of the Apiaceae family, undoubtedly stands out. The botanists collected it on the banks of the Seken River in Abkhazia. This species is characterised by its enormous size and high toxicity when in contact with sunlight-exposed skin. This plant was previously used for ornamental purposes in the West. However, it has now escaped cultivation and spread to natural environments, making it a dangerous invasive alien species in many parts of Europe and the world (Pyšek et al., 2008).

3.4. Notes on the importance of travel for the history of photography and ethno-anthropology

The journey of Sommier & Levier is noteworthy for its original scientific photographic contribution. Sommier carried with him his cutting-edge photographic equipment and was a founding member of the Italian Photographic Society. He is well-known for his botanical studies, but his ethno-anthropological studies are lesser known. During his trip to the Caucasus, he collected a significant amount of anthropometric data which he published separately (Sommier, 1901). Additionally, his photographs contributed to the development of visual ethno-anthropological research. The entire Sommier's photographic collection is now kept in the Anthropological Collections of the Natural History Museum of Florence (see Chiozzi, 2014). At the same time, another person was exploring the remote region of Svanetia, although Sommier was unaware of this. He was Vittorio Sella, a world-famous mountaineer and photographer known for his expertise in mountain photography. Together with Sommier, he published a collection of images that were of high aesthetic, documentary, and mountaineering value (Fiory Ceccopieri, 1981; Levier, 1894; Sella, 1889, 1890).

4. Conclusions

The maps we produced have significant historical and botanical value and will benefit botanists, ethno-anthropologists, historians of photography and curators of natural history museums studying specimens collected by Sommier & Levier during their voyage to the Caucasus or working with Caucasian flora, vegetation, ethno-anthropology, history of photography and landscape. We believe that this type of study can also be useful for updated nature conservation purposes. During the past century, various anthropogenic threats and pressures such as agriculture, industry and urban expansion, have led to habitat loss, the introduction of invasive alien species, and climate change. These factors have a significant impact on biodiversity, particularly in the most biodiverse region, including the Caucasus (Brooks et al., 2006; Dinerstein et al., 2017; Mittermeier et al., 2011; Zazanashvili et al., 2020). The accurate geolocalisation of Sommier & Levier's routes, combined with their detailed description of the natural surroundings, (and accompanying photographs) can offer valuable insights into the original wilderness of these areas. This information can be used to compare current conditions and make predictions about future implications for wildlife and conservation.

Software

The maps were created and edited using the software ESRI ArcGIS 10.8.1. and Q.GIS 3.34

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Data availability statement

The data that supports the results of this study is mostly available in Supplement 1 and in the vector layers of the Main Map. Additional data can be obtained by contacting the corresponding author.

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