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Research Article

Berat County's Limestone Secrets: Exploring Rare Terrestrial Mollusks and Their Habitats

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Abstract – Biodiversity conservation remains a cornerstone of ecological research, particularly in the face of climate change and increasing human pressures. This study evaluates the alignment of the Natura 2000 network with the distribution of rare and endemic terrestrial mollusks in Berat County, Albania. Focusing on selected protected areas, including Tomorr Mountain National Park, the research assesses the effectiveness of existing conservation efforts while identifying significant gaps in biodiversity protection. Extensive field expeditions were conducted during the spring and summer months 2024, targeting diverse habitats within and outside proposed Natura 2000 sites. Collected specimens were analyzed in the laboratory for species identification based on morphological characteristics. Results revealed that several endemic and rare mollusk species inhabit calcareous rocky slopes with sparse vegetation, including *Montenegrina tomorosi*, *Cochlostoma elegans*, and *Monacha emigrata sattmanni*. Mapping analyses indicated that a significant proportion of these species occur outside the current conservation boundaries, highlighting critical gaps in biodiversity protection. The findings emphasize the ecological importance of Berat County as a biodiversity hotspot and underline the need to expand protected areas to align with EU conservation directives. Recommendations include expanding the proposed Natura 2000 network (or existing protected areas), establishing clear site boundaries, and implementing regular monitoring programs. By providing a detailed understanding of species distribution and conservation gaps, this research offers practical insights to guide national biodiversity policies and enhance Albania's integration with EU environmental standards.

Keywords –Natura 2000, Protected Areas, Terrestrial Mollusks, Berat County, Conservation Policy.

I. INTRODUCTION

Biodiversity represents one of the planet's most valuable natural assets, ensuring the proper functioning of ecosystems and their essential services for human well-being [1]. The conservation of biodiversity and ecosystem integrity has become a crucial objective in ecological research, particularly in response to the dual threats of anthropogenic activities and climate change [2]. The European Union's Natura 2000 network is the largest coordinated conservation initiative worldwide, established to safeguard areas of

high ecological significance [3]. It focuses on Special Protection Areas (SPAs) for birds and Special Areas of Conservation (SACs) for habitats and species, ensuring long-term biodiversity preservation [4].

As part of its EU accession process, Albania has undertaken efforts to align its environmental policies with EU directives, including the identification of 43 potential Natura 2000 sites [5]. However, the absence of clearly defined boundaries and inadequate implementation frameworks present major obstacles to effective biodiversity management [6].

Berat County, located in southern Albania, is widely recognized for its remarkable biodiversity, hosting a variety of endemic and rare species [7]. Among these, terrestrial mollusks serve as valuable bioindicators due to their sensitivity to environmental changes and habitat degradation [8]. Despite their ecological significance, these species remain largely unprotected, facing mounting pressures from human activities, habitat fragmentation, and climate change [9]. Given the vulnerability of these organisms, the study of their distribution and conservation status is imperative to inform evidence-based policy decisions and conservation initiatives.

This research aims to evaluate the alignment between Albania's proposed Natura 2000 network and the distribution of terrestrial mollusks in Berat County. Through extensive field surveys, laboratory analysis, and spatial mapping, this study identifies key conservation gaps and proposes recommendations for strengthening biodiversity protection in the region. By integrating ecological data with conservation planning, the findings of this study offer critical insights that can support Albania's compliance with EU environmental standards and contribute to the sustainable management of its natural heritage.

II. MATERIALS AND METHOD

A. Study Area

Research was conducted in Berat County, with a particular focus on the Tomorr Mountain National Park and other proposed conservation sites. The area's unique environmental conditions, including calcareous rocky slopes classified under Habitat Code 8210 of the Habitats Directive [10], provide a crucial habitat for numerous terrestrial mollusk species.

B. Literature Review

Extensive literature was reviewed to gather information on the current status of Natura 2000 sites, terrestrial mollusk species distribution, and conservation efforts in Albania. Sources included previous field studies, taxonomic literature, and conservation reports [11].

C. Field Expeditions

Expeditions were carried out during the spring and summer months, focusing on habitats both inside and outside the proposed Natura 2000 sites. Mollusk specimens were manually collected using tools such as tweezers and brushes, with precise GPS coordinates recorded for each sampling location.

Fig 1. Work during expeditions.

D. Laboratory Analysis

Specimens were preserved in 70% ethanol to maintain morphological integrity. Identification was performed based on physical characteristics such as shell shape, size, and coloration, referencing established taxonomic literature.

Fig. 2. Laboratory work identifying mollusk species.

E. Data Analysis

Species distribution data were mapped using GIS software to assess the overlap between mollusk habitats and proposed protected areas.

III. RESULTS

A. Habitat Characteristics and Species Distribution

Field observations revealed that terrestrial mollusks predominantly inhabit calcareous rocky slopes with sparse vegetation. The Tomorr Mountain National Park was identified as a biodiversity hotspot due to its favorable microclimatic conditions.

Fig. 3. Limestone slopes in Tomorr Mountain, Berat County.

B. Species Identified

Several endemic and rare mollusk species were documented, including:

- *Montenegrina tomorosi* (endemic to Tomorr Mountain);
- *Cochlostoma (Pomatias) elegans*;
- *Monacha emigrata sattmanni*;
- *Cochlostoma tessellatum*;

These findings underscore Berat County's ecological importance and the need for targeted conservation efforts.

Fig. 4. Montenegrina tomorosi.

Tab. 1. Datas about the species collected.

Endemic/ Subendemic	IUCN Red List Global	IUCN Red List Europe	IUCN Red List Mediterranean	Albania Red List 2020	Family	Species	Coordinates	Locality	Date of collecting	Collector
	LC	LC	-	+	Clausiliidae	Agathylla neutra	40° 31'22.48"N, 20°15'26.82"E	Skrapari District, Pirrogoshi Cave	12.05.2024	A. Cobanaj
	LC	LC	-	+	Clausiliidae	Agathylla neutra	40° 32'30.31"N, 20°16'9.74"E	Skrapari District, Qafa e Devrise	12.05.2024	A. Cobanaj
End.	NT	NT	-	+	Zonitidae	Allaegopis amphikypellon/scenderbegas	40°41'50.06"N, 20° 8'55.05"E	Tomorr Mts., eastern slopes, above Rroms, 21780 m	12.05.2024	A. Cobanaj
	-	-	-	+	Zonitidae	Allaegopis sp.	40° 37'25.29"N, 20°11'17.92"E	Skrapari District, Tomorri Mts. Teqe of Abaz-Ali	12.05.2024	A. Cobanaj
	-	LC	-		Chondrinidae	Chondrina arcadica	N 40° 40. 279' E 020° 07.924'	Tomorr Mts., Mbi Lybeshë, 886 m	18.06.2024	L. Shuka
	-	LC	-		Chondrinidae	Chondrina arcadica	40°42'21.07"N, 20° 6'46.55"E	Tomorr Mts., Kala, 3932	19.06.2024	L. Shuka
	-	LC	-		Chondrinidae	Chondrina arcadica	40° 37'25.29"N, 20°11'17.92"E	Skrapari District, Tomorri Mts. Teqe of Abaz-Ali	12.05.2024	A. Paparisto
	-	LC	-		Chondrinidae	Chondrina arcadica	40° 39'12.37"N, 20°8'20.21"E	Berat District, Kapinovw, Western side of Tomorri Mts.	13.05.2024	A. Cobanaj
	-	LC	-		Chondrinidae	Chondrina arcadica	40° 35'46.60"N, 20°12'4.86"E	Skrapari District, Tomorri Mts, Qafa e Kulmakut	12.05.2024	L. Shuka
	-	-	-		Cochlostomatidae	Cochlostoma (Pomatias) elegans	40° 39'12.37"N, 20°8'20.21"E	Berat District, Kapinovw, Western side of Tomorri Mts.	13.05.2024	L. Shuka
	-	-	-		Cochlostomatidae	Cochlostoma (Pomatias) elegans	40° 27'45.51"N, 20°15'55.65"E	Skrapari District, Kanjonet e Osumit	19.06.2024	A. Cobanaj
	-	-	-		Cochlostomatidae	Cochlostoma tessellatum excisum	40° 27'45.51"N, 20°15'55.65"E	Skrapari District, Kanjonet e Osumit	19.06.2024	A. Cobanaj
	-	-	-		Cochlostomatidae	Cochlostoma tessellatum excisum	40° 31'22.48"N, 20°15'26.82"E	Skrapari District, Pirrogoshi Cave	20.01.2024	A. Cobanaj
	LC	LC	-		Chondrinidae	Granaria frumentum subaii	40° 32'30.31"N, 20°16'9.74"E	Skrapari District, Qafa e Devrise	13.05.2024	A. Cobanaj
	LC	LC	-		Chondrinidae	Granaria frumentum subaii	40° 31'22.48"N, 20°15'26.82"E	Skrapari District, Pirrogoshi Cave	20.01.2024	L. Shuka
	LC	LC	-		Chondrinidae	Granaria frumentum subaii (transitional form)	40°42'18.85"N, 20° 6'43.08"E	Tomorr Mts., Kala 3997	19.06.2024	A. Paparisto
	-	-	-		Helicidae	Helix schlaeflii	40° 40'1.37"N, 20°9'57.96"E	Skrapari District, Tomorri Mts, Eastern slopes	13.05.2024	A. Paparisto
	LC	LC	-		Helicidae	Helix vladika	40°37'48.13"N, 20° 9'56.01"E	Nën, Maja Abaz-Ali, 2252 m	17.06.2024	L. Shuka
	LC	LC	LC		Helicidae	Josephinella byshekensis	40°42'1779" N, 20° 6'39.02"E	Tomorr Mts., Kala, 4042	19.06.2024	A. Cobanaj
	LC	LC	LC		Hygromiidae	Josephinella byshekensis	41° 27'45.51"N, 20°15'55.65"E	Skrapari District, Kanjonet e Osumit	19.06.2024	A. Paparisto
	LC	LC	LC		Hygromiidae	Josephinella byshekensis	40° 40'1.37"N, 20°9'57.96"E	Skrapari District, Tomorri Mts, Eastern slopes	13.05.2024	L. Shuka
	LC	LC	LC	+	Helicidae	Liburnica (Superba) skipetarica asketa	N 40° 38. 219' E 020° 09.735'	Tomorr Mts., Nën (below) Maja Abaz-Ali, 2348 m	17.06.2024	L. Shuka
	LC	LC	LC	+	Helicidae	Liburnica (Superba) skipetarica asketa	N 40° 40. 567' E 020° 07.974'	Tomorr Mts., Mbi Lybeshë, 1060 m	18.06.2024	A. Cobanaj
	LC	LC	LC	+	Helicidae	Liburnica (Superba) skipetarica skipetarica	40°43'9.59"N, 20° 9'17.12"E	Tomorr Mts., Sterrat e Trovës, 1875 m	23.07.2024	A. Cobanaj
	LC	LC	LC	+	Helicidae	Liburnica (Superba) skipetarica skipetarica	40°40'31.30"N, 20° 9'49.38"E	Tomorr Mts., eastern slope, 2035 m	20-21.07.2024	A. Cobanaj
	LC	LC	LC	+	Helicidae	Liburnica (Superba) skipetarica skipetarica	40°41'50.06"N, 20° 8'55.05"E	Tomorr Mts., eastern slopes, above Rroms, 21780 m	21.07.2024	A. Cobanaj
	LC	LC	LC	+	Helicidae	Liburnica (Superba) skipetarica skipetarica	40° 43'9.48"N, 20°8'47.32"E	Berati District, Tomorr Mt, North-Western peak	23.07.2024	A. Paparisto
	LC	LC	LC	+	Helicidae	Liburnica (Superba) skipetarica skipetarica	42° 39'51.16"N, 20°8'25.27"E	Berati District, above Lybesha village	01.07.2024	L. Shuka
	LC	LC	-		Helicodontidae	Lindholmiola corcyrensis	40°43'9.59"N, 20° 9'17.12"E	Tomorr Mts., Sterrat e Trovës, 1875 m	23.07.2024	A. Paparisto
	LC	LC	-		Helicodontidae	Lindholmiola corcyrensis	40°43'22.58"N, 20° 8'42.19"E	Tomorr Mts., Northern (veri) slopes of Tomorr, 1450 m	13.05.2024	L. Shuka
Subend.	LC	LC	LC		Hygromiidae	Monacha emigrata sattmanni	N 40° 38. 219' E 020° 09.735'	Tomorr Mts., Nën (below) Maja Abaz-Ali, 2348 m	17.06.2024	A. Cobanaj
Subend.	LC	LC	LC		Hygromiidae	Monacha emigrata sattmanni	40°42'1779" N, 20° 6'39.02"E	Tomorr Mts., Kala, 4042	19.06.2024	A. Paparisto
End.	LC	LC	LC	+	Clausiliidae	Montenegrina tomorosi	40° 35'46.60"N, 20°12'4.86"E	Skrapari District, Tomorri Mts. Qafa e Kulmakut	12.05.2024	A. Cobanaj
End.	LC	LC	LC	+	Clausiliidae	Montenegrina tomorosi	40°43'9.59"N, 20° 9'17.12"E	Tomorr Mts., Sterrat e Trovës, 1875 m	23.07.2024	A. Paparisto
End.	LC	LC	LC	+	Clausiliidae	Montenegrina tomorosi	40°40'1.90"N, 20° 9'57.37"E	Tomorr Mts., eastern slope 1800 m	20-21.07.2024	L. Shuka
End.	LC	LC	LC	+	Clausiliidae	Montenegrina tomorosi	40°41'50.06"N, 20° 8'55.05"E	Tomorr Mts., eastern slopes, above Rroms, 21780 m	21.07.2024	L. Shuka
End.	LC	LC	LC	+	Clausiliidae	Montenegrina tomorosi	N 40° 38. 219' E 020° 09.735'	Tomorr Mts., Nën (below) Maja Abaz-Ali, 2348 m	17.06.2024	A. Cobanaj
End.	LC	LC	LC	+	Clausiliidae	Montenegrina tomorosi	40°43'22.58"N, 20° 8'42.19"E	Tomorr Mts., Northern (veri) slopes of Tomorr, 1450 m	13.05.2024	L. Shuka
End.	LC	LC	LC	+	Clausiliidae	Montenegrina tomorosi coerulescens (typical)	40° 43'9.48"N, 20°8'47.32"E	Berati District, Tomorr Mt, North-Western peak	30.06.2024	A. Paparisto
End.	LC	LC	LC	+	Clausiliidae	Montenegrina tomorosi muranyii	N 40° 40. 567' E 020° 07.974'	Tomorr Mts., Mbi Lybeshë, 1060 m	18.06.2024	L. Shuka
End.	LC	LC	LC	+	Clausiliidae	Montenegrina tomorosi muranyii	N 40° 40. 279' E 020° 07.924'	Tomorr Mts., Mbi Lybeshë, 886 m	18.06.2024	A. Cobanaj
End.	LC	LC	LC	+	Clausiliidae	Montenegrina tomorosi muranyii	40°42'21.07"N, 20° 6'46.55"E	Tomorr Mts., Kala, 3932	19.06.2024	A. Cobanaj
End.	LC	LC	LC	+	Clausiliidae	Montenegrina tomorosi muranyii	40°42'18.85"N, 20° 6'43.08"E	Tomorr Mts., Kala 3997	19.06.2024	A. Paparisto
End.	LC	LC	LC	+	Clausiliidae	Montenegrina tomorosi muranyii	40°42'18.85"N, 20° 6'43.08"E	Tomorr Mts., Kala 3997	19.06.2024	A. Paparisto
End.	LC	LC	LC	+	Clausiliidae	Montenegrina tomorosi muranyii	40° 39'51.16"N, 20°8'25.27"E	Berati District, above Lybesha village	01.07.2024	A. Paparisto
End.	LC	LC	LC	+	Clausiliidae	Montenegrina tomorosi ssp.	40° 37'25.29"N, 20°11'17.92"E	Skrapari District, Tomorri Mts. Teqe of Abaz-Ali	12.05.2024	A. Cobanaj
End.	LC	LC	LC	+	Clausiliidae	Montenegrina tomorosi ssp.	40° 40'1.37"N, 20°9'57.96"E	Skrapari District, Tomorri Mts, Eastern slopes	13.05.2024	A. Cobanaj
End.	LC	LC	LC	+	Clausiliidae	Montenegrina tomorosi ssp.	40° 39'12.37"N, 20°8'20.21"E	Berat District, Kapinovw, Western side of Tomorri Mts.	13.05.2024	L. Shuka
	-	-	-		Oxychilidae	Morlina (Oxychilus) glaber	40° 27'45.51"N, 20°15'55.65"E	Skrapari District, Kanjonet e Osumit	29.06.2024	A. Cobanaj
	LC	LC	-		Spiraxidae	Poiretia cornea	40°43'22.58"N, 20° 8'42.19"E	Tomorr Mts., Northern (veri) slopes of Tomorr, 1450 m	13.05.2024	A. Paparisto
Subend.	LC	LC	-		Spiraxidae	Poiretia delesserti	40° 27'45.51"N, 20°15'55.65"E	Skrapari District, Kanjonet e Osumit	29.06.2024	L. Shuka
	-	LC	-		Pyramidulidae	Pyramidula cephalonica	40° 39'12.37"N, 20°8'20.21"E	Berat District, Kapinovw, Western side of Tomorri Mts.	13.05.2024	A. Cobanaj
	LC	LC	-		Clausiliidae	Strigilodelima conspersa	40°43'15.92"N, 20° 8'42.51"E	Northern (veri) slopes of Tomorr, 1653 m	13.05.2024	L. Shuka
	LC	LC	-		Clausiliidae	Strigilodelima conspersa	40° 27'45.51"N, 20°15'55.65"E	Skrapari District, Kanjonet e Osumit	29.06.2024	A. Paparisto
	LC	LC	-		Clausiliidae	Strigilodelima conspersa	40° 34'19.89"N, 40°34'19.89"E	Skrapari District, Bogove	12.05.2024	L. Shuka
	LC	LC	-		Clausiliidae	Strigilodelima conspersa (dwarf morph)	40° 35'46.60"N, 20°12'4.86"E	Skrapari District, Tomorri Mts, Qafa e Kulmakut	12.05.2024	L. Shuka
	LC	LC	-		Clausiliidae	Strigilodelima conspersa giant morph	40° 31'22.48"N, 20°15'26.82"E	Skrapari District, Pirrogoshi Cave	20.01.2024	L. Shuka
Subend.	LC	LC	LC		Hygromiidae	Xeromunda vulgarissima	40°37'48.13"N, 20° 9'56.01"E	Tomorr Mts., Nën (below) Maja Abaz-Ali, 2252 m	30.08.2024	L. Shuka
Subend.	LC	LC	LC		Hygromiidae	Xeromunda vulgarissima	40°37'48.13"N, 20° 9'56.01"E	Nën (below) Maja Abaz-Ali, 2252 m	17.06.2024	A. Cobanaj
Subend.	LC	LC	LC		Hygromiidae	Xeromunda vulgarissima	40° 37'25.29"N, 20°11'17.92"E	Skrapari District, Tomorri Mts. Teqe of Abaz-Ali	12.05.2024	L. Shuka
	-	-	-		Enidae	Zebrina detrita	40°40'1.63"N, 20° 9'57.22"E	Tomorr Mts., eastern slope 1754 m	21.07.2024	L. Shuka
	-	-	-	+	Enidae	Zebrina detrita	40°43'15.92"N, 20° 8'42.51"E	Northern (veri) slopes of Tomorr, 1653 m	13.05.2024	A. Cobanaj
	-	-	-	+	Enidae	Zebrina detrita	40°42'1779" N, 20° 6'39.02"E	Tomorr Mts., Kala, 4042	19.06.2024	L. Shuka

C. Conservation Gaps

Mapping results revealed that a significant proportion of mollusk populations occur outside the boundaries of the proposed Natura 2000 sites. These highlights significant gaps in current conservation coverage.

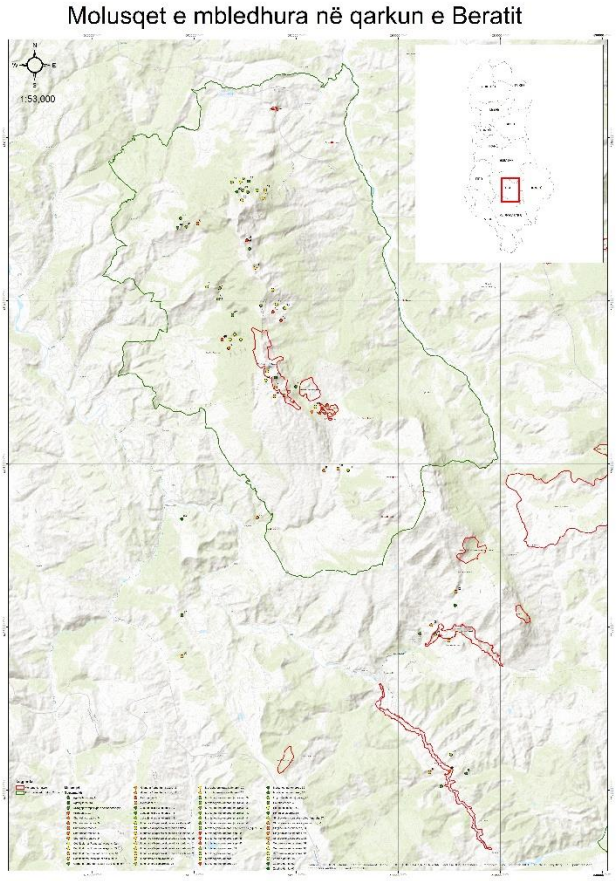

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Fig. 5. Map showing mollusk distribution and conservation gaps in Berat County

The map identifies the species found outside the boundaries of protected areas as shown below:

Tab 2. Species found in the Berat region outside protected areas.

Endemic/ Subendemic	IUCN Red List Global	IUCN Red List Europe	IUCN Red List Mediterranean	Red List of Albania 2020	Species	Locality
	LC	LC	-	+	Agathylla neutra	Skrapari District, Pirrogoshi Cave
	LC	LC	-	+	Agathylla neutra	Skrapari District, Qafa e Devrisë
Suben.	-	-	-		Cochlostoma (Pomatias) elegans	Berat District, Kapinovë, Western side of Tomorri Mts.
	-	-	-		Cochlostoma tessellatum excisum	Skrapari District, Kanionet e Osumit
	-	-	-		Cochlostoma tessellatum excisum	Skrapari District, Pirrogoshi Cave
	LC	LC	-		Granaria frumentum subaii	Skrapari District, Qafa e Devrisë
	LC	LC	-		Granaria frumentum subaii	Skrapari District, Pirrogoshi Cave
	LC	LC	LC		Josephinella byshekensis	Tomorr Mts., Kala, 4042
End.	LC	LC	LC		Monacha emigrata sattmanni	Tomorr Mts., Kala, 4042
	-	-	-		Morlina (Oxychilus) glaber	Skrapari District, Kanionet e Osumit
	LC	LC	-		Poiretia cornea	Tomorr Mts., Northern (veri) slopes of Tomorr, 1450 m
	LC	LC	-		Strigilodelima conspersa	Skrapari District, Bogovë
	-	-	-	+	Zebrina detrita	Tomorr Mts., Kala, 4042

IV. DISCUSSION

The findings emphasize the critical ecological role of Berat County and the pressing need to enhance Albania's conservation framework. The identification of rare mollusk species outside protected areas suggests that the current Natura 2000 network proposal does not adequately encompass vital habitats. Expanding the network to include these areas is imperative to ensure biodiversity preservation.

The absence of clearly defined boundaries for proposed Natura 2000 sites further complicates conservation management and enforcement. Establishing precise borders and integrating these areas into national planning strategies is essential.

Regular monitoring and targeted conservation actions are recommended to mitigate the impacts of climate change and human activities on terrestrial mollusk populations. Collaborative efforts involving researchers, policymakers, and local communities will be crucial.

V. CONCLUSION

This study provides valuable insights into the distribution of terrestrial mollusks in Berat County and the limitations of the proposed Natura 2000 network. Key conclusions include:

1. Berat County hosts a diverse range of endemic and rare mollusk species, many of which are inadequately protected under current conservation policies.

2. Expanding the Natura 2000 network to incorporate unprotected habitats is essential.

3. Establishing clear boundaries and implementing regular monitoring programs will enhance conservation efforts.

These findings offer a scientific basis for improving biodiversity conservation in Albania and aligning it with EU standards. By addressing the identified conservation gaps and fostering sustainable management practices, Albania can contribute to the preservation of its unique biodiversity.

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