

Lagomorphs of Mali: taxonomic uncertainty, biogeography, and conservation perspectives

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Abstract. The lagomorph fauna of Mali remains poorly documented, and its taxonomic composition, geographic distribution, and conservation status are insufficiently resolved. Recent molecular and phylogeographic studies have revealed substantial genetic structuring within African hares (*Lepus* spp.), challenging traditional classifications that grouped geographically widespread populations within broad species concepts, particularly *Lepus capensis* sensu lato. This mini-review synthesizes available evidence on the taxonomic history, biogeographic context, habitat associations, anthropogenic pressures, and conservation implications of lagomorphs in Mali. Particular attention is given to the limitations of historical morphology-based identifications, the potential occurrence of cryptic evolutionary lineages, and the scarcity of voucher-supported records and country-specific ecological studies. Evidence from neighboring regions and broader African lagomorph research provides a comparative framework for interpreting the distribution of hares across the Saharan, Sahelian, and Sudanian ecological zones. However, regional findings cannot substitute for verified records from Mali, and apparent distributional gaps may reflect inadequate sampling rather than genuine absence. The available literature also suggests that habitat modification, hunting, climatic variability, and constraints on biodiversity monitoring may complicate conservation assessments. Three priorities emerge: reassessing historical specimens under current taxonomic frameworks, conducting geographically representative surveys that integrate morphological and molecular identification, and establishing systematic monitoring of habitat associations and anthropogenic pressures. Improved taxonomic resolution and occurrence data are essential for determining the composition of Mali's lagomorph fauna and developing evidence-based conservation measures. This review highlights substantial knowledge gaps and provides a framework for future research on these understudied mammals in West Africa.

Keywords: African hares, *Lepus* spp., phylogeography, cryptic diversity, molecular systematics, Sahelian ecosystems, habitat fragmentation, biodiversity monitoring, wildlife management, West Africa.

Introduction. Mali's lagomorph fauna appears to be taxonomically simpler in the historical record than in the modern literature, because older West African records often treated widespread African hares under broad, unstable names, whereas recent molecular work shows that African *Lepus* contains deeply structured lineages and likely cryptic taxa (Lado et al., 2016; Lado et al., 2019). A cautious review for Mali therefore has to distinguish between what has been recorded in the country and what can currently be assigned with confidence under updated taxonomy (Lado et al., 2016; Musila et al., 2018).

The aim of this mini-review is to critically synthesize the available evidence on the taxonomic identity, biogeographic distribution, ecological context, and conservation challenges of lagomorphs in Mali. By integrating regional phylogeographic findings with

broader research on lagomorph ecology and conservation, the review evaluates the reliability of existing species records, identifies major geographic and methodological knowledge gaps, and proposes research priorities for improving national occurrence data, taxonomic assessments, and conservation planning.

Taxonomy and Record History. The historical literature on African hares was dominated by morphology and palaeontology, but those approaches are limited because characters overlap broadly among species, producing persistent disagreement over species limits, subspecies, and mapped ranges across the continent (Slimen et al., 2006; Lado et al., 2016). This problem is especially acute for the Cape hare complex, traditionally treated as *Lepus capensis* sensu lato across much of Africa and Asia, yet now recognized as a heterogeneous evolutionary entity with strong geographic structuring and probable cryptic species (Lado et al., 2016; Lado et al., 2019).

Recent phylogeographic work is more conservative than older broad classifications and provides the best basis for interpreting Malian material. Northwest African *Lepus* shows at least five major geographic genetic groups at continental scale, including a distinct northwestern African lineage, while fine-scale mtDNA structure within the western Sahara–Sahel indicates additional fragmentation not reflected in traditional taxonomy (Lado et al., 2016; Lado et al., 2019). A separate study of hares from northwest Africa went further, arguing that morphologically similar populations in the region actually include three species distinct from both *L. capensis* and *L. victoriae*, with partially overlapping ranges (Soria-Boix et al., 2019). By contrast, earlier genetic work did not reject a very broad concept of *L. capensis*, illustrating that the taxonomic shift has been recent and evidence-driven rather than merely nomenclatural (Slimen et al., 2006).

For Mali itself, the evidence assembled here is striking for how little direct lagomorph documentation it contains. A survey of southern Mali recorded 46 mammal species, but the indexed summary does not mention any lagomorph among its notable records, which implies that country-level lagomorph documentation remains scattered and weakly synthesized rather than absent from the fauna (Meinig, 1998). That pattern is consistent with broader African checklist work showing that national mammal lists are often updated by combining historical records, museum material, and modern surveys, and that taxonomy continues to change as recent literature is incorporated (Musila et al., 2018; Neves et al., 2018).

A practical taxonomic interpretation for Mali is therefore provisional. The older assumption that Malian hares can simply be filed under *L. capensis* is no longer the most credible default, because modern studies show that North and Northwest African hares are genetically structured, that mtDNA and nuclear markers can tell different stories, and that species boundaries remain unresolved without integrative sampling of morphology, genomes, and geography (Lado et al., 2016; Lado et al., 2019).

A map of mammal observations from neighboring Mauritania illustrates how strongly records cluster in accessible regions and how sparse the eastern borderlands near Mali remain, which is directly relevant to interpreting the historical incompleteness of Malian lagomorph records (Figure 1). Taxonomic interpretations relevant to Mali are summarized in Table 1.

Table 1

Taxonomic interpretations for Malian lagomorph records

<i>Historical name in regional use</i>	<i>Current interpretation for Mali</i>	<i>Main basis</i>
<i>Lepus capensis</i> sensu lato	Best treated as a provisional complex, not a secure single species	Deep geographic structure and likely cryptic taxa in Africa (Lado et al., 2016)
Northwest African hare records	May represent distinct regional lineages or species rather than one widespread form	Three northwest African species proposed from mtDNA and morphology (Soria-Boix et al. 2019)

<i>Historical name in regional use</i>	<i>Current interpretation for Mali</i>	<i>Main basis</i>
Older morphology-based records	Useful historically, but often taxonomically outdated	Morphological overlap obscures species limits (Lado et al., 2016; Soria-Boix et al. 2019)
Country checklist records without genetics	Presence evidence is stronger than species assignment	Recent checklist practice prioritizes updated literature and curated occurrence data (Musila et al., 2018; Neves et al., 2018).

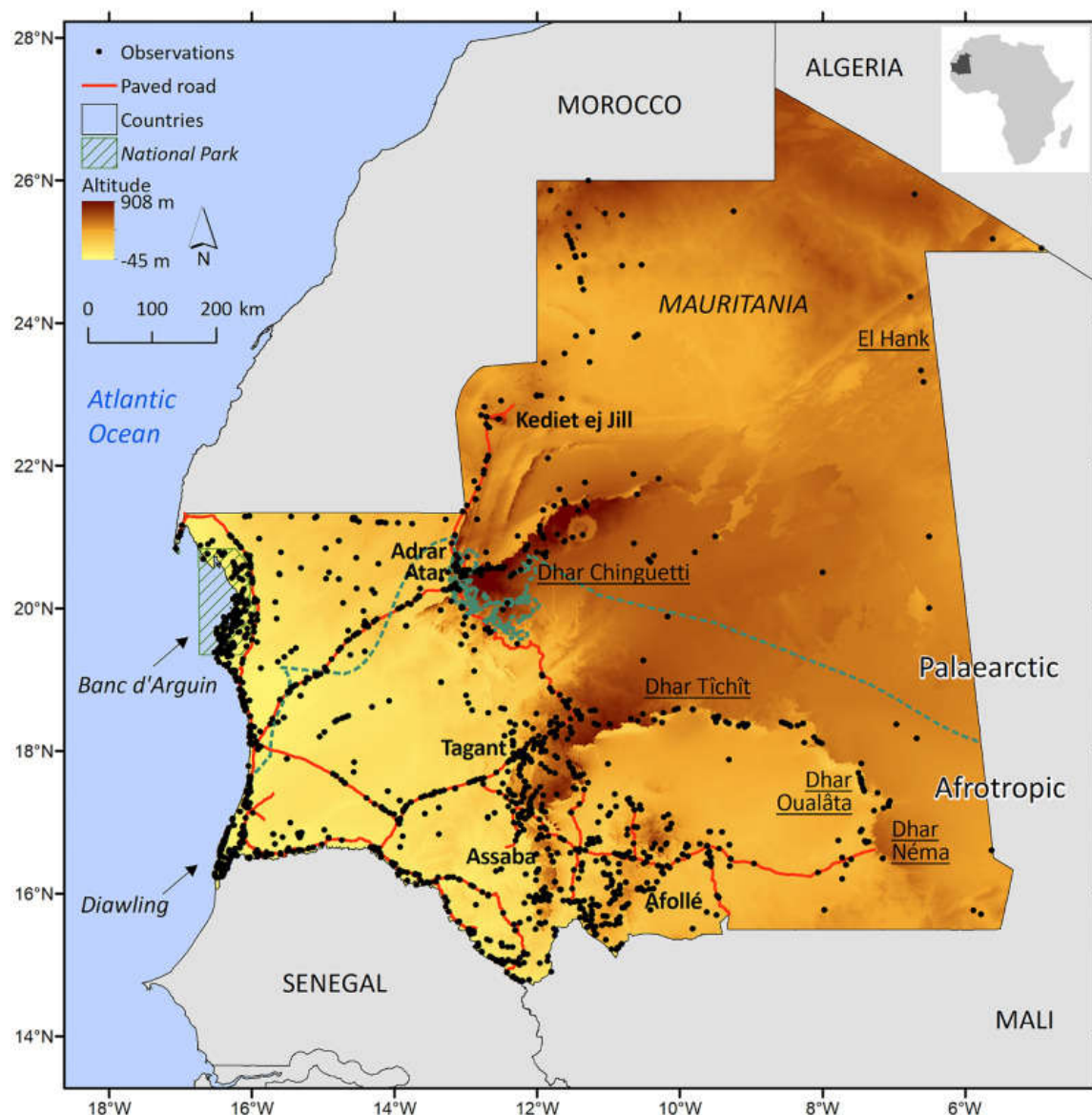


Figure 1. Neighboring Mauritania mammal records show major sampling gaps (Brito et al., 2022).

Geographic Distribution and Habitat Associations. Mali sits at the intersection of Saharan, Sahelian, and Sudanian environments, so any lagomorph distribution in the country should be expected to reflect large-scale biome transitions rather than a single continuous habitat block (Lado et al., 2016; Lado et al., 2019). Across African hares, climatic oscillations, vegetation shifts, and barriers to gene flow have been central to present-day distribution patterns, with the Sahara–Sahel system acting both as a corridor and as a fragmentation zone depending on period and taxon (Lado et al., 2016; Lado et al., 2019).

The closest well-resolved regional evidence comes from Northwest Africa. One mtDNA haplogroup of the Cape hare complex spans most of the Maghreb, whereas another appears endemic to the Atlantic Coastal Sahara and reaches as far south as Mauritania, indicating that arid landscapes that seem continuous can still harbor distinct hare lineages (Lado et al., 2019). This matters for Mali because neighboring Mauritania includes unsampled inland sectors along the Mali border, so the apparent absence or simplicity of mapped hare distributions there likely reflects poor field coverage as much as biology (Brito et al., 2022).

At broader scale, biogeographic work on *Lepus* supports an African radiation shaped by dispersal followed by regional speciation and later introgression, rather than a set of easily delimited static species (Wu et al., 2005; Tolesa et al., 2017). Even within Africa, some lineages are ancient and reticulate, and North African cape hares show close but not taxonomically simple relationships to South African populations and other African taxa (Tolesa et al., 2017). For Mali, that argues against inferring species identity solely from geography or pelage in transitional Sahelian landscapes.

Habitat association is also likely to be broader than older “desert hare” or “savannah hare” labels imply. Comparative work elsewhere shows that lagomorph occurrence can shift across mosaics of scrub, marsh, riparian, and open habitats under competition, predation, flooding, or population decline (Woodgate et al., 2021; Beltrán et al., 2022). In Togo, modern camera trapping in a forest-savannah mosaic recovered mammal inventories and habitat-use information while simultaneously detecting poaching pressure, illustrating the value of site-based survey designs in West African heterogeneous landscapes (Assou et al., 2021).

The strongest distributional inference for Mali is therefore cautious: lagomorphs probably occur across multiple ecological belts, but the exact boundaries among Saharan, Sahelian, and southern populations remain unresolved because modern occurrence records, habitat-linked detections, and voucher-backed identifications are still too sparse (Brito et al., 2022).

Ecology, Anthropogenic Pressures, and Conservation. No paper in the retrieved set provides a dedicated field ecology study of Malian lagomorphs, so ecology has to be inferred from African and general lagomorph literature while keeping the country-specific evidence narrow. At order level, lagomorphs are ecologically important and globally conservation-relevant, with roughly one quarter of species under some conservation concern (Arregoitia et al., 2015; Smith et al., 2018). At the same time, extinction risk in lagomorphs is associated more strongly with human population pressure and habitat modification than with body size alone, and habitat generalists tend to be less threatened (Arregoitia et al., 2015).

For Mali, the likely pressure set is familiar for Sahelian mammals: land-use change, hunting pressure, insecurity-linked monitoring gaps, and climate variability. Regional syntheses from arid West Africa show that biodiversity knowledge gaps persist where remoteness and insecurity constrain surveys, and that long-term conservation is embedded in socioeconomic and environmental pressures rather than biology alone (Brito et al., 2022). In Togo’s protected landscapes, camera traps documented poachers directly, while in broader lagomorph conservation reviews the dominant threats to restricted or declining species include habitat loss, productive land conversion, poaching, fire regimes linked to livestock management, predators, feral dogs, and climate change (Lorenzo et al., 2015; Assou et al., 2021).

Ecological interactions may also matter more than country checklists suggest. Multispecies occupancy modelling in South Africa showed that one endangered rabbit’s occurrence was conditional on hare absence, indicating that competition can structure local lagomorph distributions and should not be ignored in habitat-based inference (Woodgate et al., 2021). Work in Doñana similarly showed that disease-driven declines in rabbits reshaped habitat use by hares and altered predator communities, demonstrating how disease, competition, and predation can cascade through lagomorph systems (Beltrán et al., 2022).

Conservation planning for Mali therefore has to proceed under uncertainty. Global and species-focused syntheses emphasize that lagomorph conservation depends on

species-level taxonomic clarity, area prioritization from a biogeographic perspective, and incorporation of under-represented taxa into protected-area planning (Alves et al., 2008; Lorenzo et al., 2015). This is especially pertinent in arid West Africa, where species richness and threat assessments are distorted by sparse observations and where protected-area representation can be poor even when checklists improve (Brito et al., 2022). A concise pressure-and-response framework relevant to Mali is presented in Table 2.

Table 2

Conservation pressures and management implications for Malian lagomorphs

<i>Conservation dimension</i>	<i>Evidence relevant to Mali</i>	<i>Implication</i>
Taxonomic uncertainty	African hare taxonomy remains unstable and not fully reflected by traditional names (Lado et al., 2016; Lado et al., 2019)	Species-specific status assessment is currently provisional
Survey limitation	Arid-region mammal data are spatially biased and often preliminary (Brito et al., 2022)	Apparent rarity may partly reflect non-detection
Anthropogenic pressure	Human population pressure, habitat modification, and poaching elevate lagomorph risk (Arregoitia et al., 2015; Lorenzo et al., 2015; Assou et al., 2021)	Monitoring should be paired with threat surveillance
Ecological complexity	Competition, disease, and predator responses can reshape habitat use (Woodgate et al., 2021; Beltrán et al., 2022)	Management should avoid single-factor habitat models
Conservation design	Biogeographic prioritization and protected-area integration are needed (Lorenzo et al., 2015)	Range mapping should guide site selection.

Knowledge Gaps and Future Priorities. The largest gap is basic evidence on which lagomorph taxa actually occur in Mali. Modern African hare systematics shows that morphology alone is not enough, that the Cape hare complex likely masks multiple evolutionary units, and that even well-sampled regions still require genomic, morphological, and ecological integration before species boundaries can be considered stable (Lado et al., 2016; Lado et al., 2019). For Mali, this means voucher-based reassessment of museum specimens and new tissue-backed field collections should be the first research priority. Evidence coverage across Malian lagomorph research is presented in Table 3.

Table 3

Evidence coverage across Malian lagomorph research

<i>Item</i>	<i>Genetics</i>	<i>Occurrences</i>	<i>Ecology</i>	<i>Geography</i>	<i>Conservation</i>
<i>Taxonomy</i>	Wu et al., 2005; Slimen et al., 2006; Alves et al., 2008; Arregoitia et al., 2015; Lado et al., 2016; Tolesa et al., 2017; Lado et al., 2019; Soria-Boix et al., 2019;	Meining, 1998; Alves et al., 2008; Moores et al., 2012; Lorenzo et al., 2015; Musila et al., 2018; Assou et al., 2021; Woodgate et al., 2021; Brito et al., 2022	Alves et al., 2008; Lorenzo et al., 2015; Arregoitia et al., 2015; Smith et al., 2018; Hema et al., 2023	Meining, 1998; Wu et al., 2005; Alves et al., 2008; Moores et al., 2012; Lorenzo et al., 2015; Arregoitia et al., 2015; Lado et al., 2016; Smith et al., 2018; Soria-Boix et al., 2019; Lado et al., 2019; Brito et al., 2022	Flux & Chapman, 1991; Alves et al., 2008; Lorenzo et al., 2015; Smith et al., 2018 Brito et al., 2022
<i>Country records</i>	No papers	Meining, 1998; Alves et al., 2008; Neves et al., 2018;	No papers	Alves et al., 2008; Assou et	Brito et al., 2022

<i>Item</i>	<i>Genetics</i>	<i>Occurrences</i>	<i>Ecology</i>	<i>Geography</i>	<i>Conservation</i>
		Musila et al., 2018; Assou et al., 2021; Brito et al., 2022		al., 2021; Brito et al., 2022	
<i>Habitat use</i>	No papers	Musila et al., 2018; Assou et al., 2021; Woodgate et al., 2021; Brito et al., 2022; Beltran et al., 2022	Alves et al., 2008; Arregoitia et al., 2015; Smith et al., 2018; Assou et al., 2021; Woodgate et al., 2021; Beltran et al., 2022; Hema et al., 2023	Alves et al., 2008; Smith et al., 2018; Brito et al., 2022	Brito et al., 2022
<i>Threats</i>	No papers	Assou et al., 2021; Brito et al., 2022	Alves et al., 2008; Arregoitia et al., 2015; Lorenzo et al., 2015;	Alves et al., 2008; Brito et al., 2022; Arregoitia et al., 2015;	Assou et al., 2021; Alves et al., 2008; Smith et al., 2018; Lorenzo et al., 2015
<i>Monitoring</i>	No papers	Alves et al., 2008; Smith et al., 2018; Brito et al., 2022; Hema et al., 2023	No papers	Smith et al., 2018; Brito et al., 2022	Brito et al., 2022.

The second major gap is geographic coverage. Neighboring Mauritania still contains large unsampled sectors, especially toward the Mali border, and its national assessments remain preliminary because key parameters such as population trends, fragmentation, and temporal dynamics are poorly known (Brito et al., 2022). Comparable checklist efforts in Mozambique and Kenya show that integrating museum collections, literature, and curated occurrence databases can substantially improve national faunas, but they also show that species numbers remain underestimated until additional surveys and taxonomic revision are completed (Neves et al., 2018; Musila et al., 2018).

The third gap is ecological process. Across lagomorphs, competition, disease, habitat change, and anthropogenic disturbance can alter occupancy, activity, and conservation outlook, yet none of the retrieved Mali-focused sources provides equivalent field evidence for the country (Woodgate et al., 2021; Beltrán et al., 2022). The most useful future design for Mali would combine camera trapping, line transects, habitat covariates, and noninvasive genetics across Saharan, Sahelian, and Sudanian sites, because regional work shows that field surveys remain indispensable even when ecological modelling is planned (Brito et al., 2022).

Finally, conservation research should not wait for perfect taxonomy. Global lagomorph reviews show that threatened species are often studied unevenly, with conservation and ecology lagging behind phylogeny and taxonomy for some groups, and that long-term, collaborative, field-based research is needed to generate management-relevant evidence (Lorenzo et al., 2015). For Mali, the immediate agenda is clear even under uncertainty: update the national lagomorph checklist using recent systematics, map verified records across ecological zones, quantify habitat associations and threats, and build long-term monitoring that can support future Red List assessments and protected-area planning (Flux & Chapman, 1991; Brito et al., 2022).

Conclusions. The lagomorph fauna of Mali remains insufficiently characterized, particularly regarding species-level identification, geographic distribution, and ecological requirements. Molecular studies of African hares demonstrate that traditional taxonomic assignments, especially those based on broad interpretations of *Lepus capensis*, may conceal substantial evolutionary diversity. Nevertheless, regional phylogeographic patterns

cannot independently establish the identity or distribution of particular taxa within Mali. The scarcity of country-specific records and ecological investigations therefore remains a fundamental limitation for assessing species occurrence and conservation status.

Future research should prioritize the reassessment of museum specimens, the collection of voucher-supported field records, and the integration of morphological, molecular, and geographic evidence. Standardized surveys across Saharan, Sahelian, and Sudanian environments are also needed to establish distribution patterns, characterize habitat associations, and evaluate anthropogenic pressures. These efforts should be complemented by long-term monitoring and improved integration of verified occurrence data into national biodiversity assessments. Resolving these uncertainties is a prerequisite for reliable conservation planning and for understanding the biogeographic position of Mali within the broader evolutionary history of African lagomorphs.

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