

Temporal changes in barn owl (*Tyto alba*) diet at a palm grove oasis in Southeastern Algeria

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Abstract

The barn owl, *Tyto alba* (Scopoli, 1769), is an opportunistic nocturnal predator which diet tracks ecological changes in its habitat. To assess temporal dietary changes in a Saharan palm grove ecosystem, 402 pellets were collected between July 2022 and August 2023 in the Ranou palm grove (Touggourt, Southeastern Algeria) and compared with baseline data from 2009–2010 published by Hadjoudj et al. (2020). A total of 1353 prey items belonging to 29 species across four taxonomic classes were identified. Mammals dominated the diet in terms of relative abundance and estimated biomass. Commensal rodents increased markedly over the study period, particularly *Mus musculus* (Linnaeus, 1758) and *Rattus rattus* (Linnaeus, 1758), with the latter accounting for 47.7 % of the total biomass. Conversely, desert-adapted species of *Gerbillus* (Desmarest, 1804) declined significantly, while bird prey increased markedly, with Palaearctic migrants recorded for the first time. The reptilian component shifted from Lacertidae to Gekkonidae. Predation on the cricket *Brachytrupes megacephalus* (Lefebvre, 1827), a major agricultural pest in Saharan environments (Gryllidae), suggests a potential contribution of *T. alba* to regulating agricultural pest populations. These findings highlight the value of temporal dietary monitoring in assessing ecological changes and biodiversity dynamics in arid environments.

Key words: bioindicator, desert agroecosystems, Saharan biodiversity, owl pellets, prey dynamics, trophic ecology.

Introduction

The barn owl, *Tyto alba* (Scopoli, 1769), is a nocturnal raptor of the family Tytonidae. Recent taxonomic revisions have divided the previously cosmopolitan barn owl complex into three distinct species: Western barn Owl *T. alba*, restricted to Europe, Africa (including Madagascar), and Middle East; American barn Owl *T. furcata*; and Eastern barn Owl *T. javanica* (Marti et al. 2024a,b; Debus et al. 2024). Western barn Owl plays a significant role in regulating small mammal populations. Its diet is mainly composed of micromammals but also includes insects, lizards, small birds, bats and occasionally amphibians (Roulin 2020; Milchev et al. 2004, 2006). Prey composition varies according to land use, agricultural intensification, and landscape structure, favouring commensal species such as mice and rats in anthropogenic environments (Horváth et al. 2018, Achille et al. 2024). Therefore, the diet of this species constitutes a reliable indicator of rodent abundance and diversity, supporting its potential role in agricultural biological control (Kross et al. 2016).

In arid and semi-arid environments, prey composition is strongly influenced by habitat structure and anthropogenic influence. Desert-adapted rodents generally dominate prey spectra in relatively undisturbed habitats (Leonardi and Dell'Arte 2006, Obuch and Benda 2009), while studies have reported variations in prey assemblages in urbanised and agriculturally modified habitats (Al-Ghamdi et al. 2025). Similar patterns occur in Algerian Saharan environments, where rodents predominate in several agricultural oases such as Biskra, Touggourt, and the Souf region (Farhi et al. 2016, Hadjoudj et al. 2020, Alia et al. 2024), while avian prey, particularly *Streptopelia* sp. and *Passer*

sp., are more prevalent in urbanised habitats such as Ouargla (Benamane et al. 2019) and Ghardaïa (Souilem et al. 2018). However, no study has yet examined temporal dietary changes within a single Saharan oasis under increasing anthropogenic influence. Building on a baseline dataset collected in 2009–2010 (Hadjoudj et al. 2020), the present study aimed to evaluate temporal changes in the diet of *T. alba* in the Ranou palm grove oasis and to assess whether these changes reflect ongoing modifications in local prey communities. The study also examined the potential of the barn owl as a bioindicator of ecological change in Saharan oasis ecosystems.

Materials and Methods

Study area

The study was conducted in the Ranou palm grove, an oasis ecosystem extending over 103 ha in the Oued Righ region of Southeastern Algeria (33°03'32.81" N; 6°03'01.09" E), located approximately 6 km south of Touggourt at an altitude of 75 m a.s.l. (Fig. 1). The surrounding region is characterised by oasis habitats bordered by dunes of the Grand Erg Oriental (Dubost 2002). Vegetation exhibits a characteristic three-tiered organisation dominated by date palms (*Phoenix dactylifera* L.), associated with cultivated shrubs such as olive trees (*Olea europaea* L.) and grapevines (*Vitis vinifera* L.), as well as spontaneous and cultivated herbaceous vegetation (Hadjoudj et al. 2018). The climate is hyper-arid, with marked seasonal thermal contrasts and very low precipitation. Mean monthly temperatures ranged from 9.6–9.9 °C in January to 35.5–37.8 °C in July during 2022–

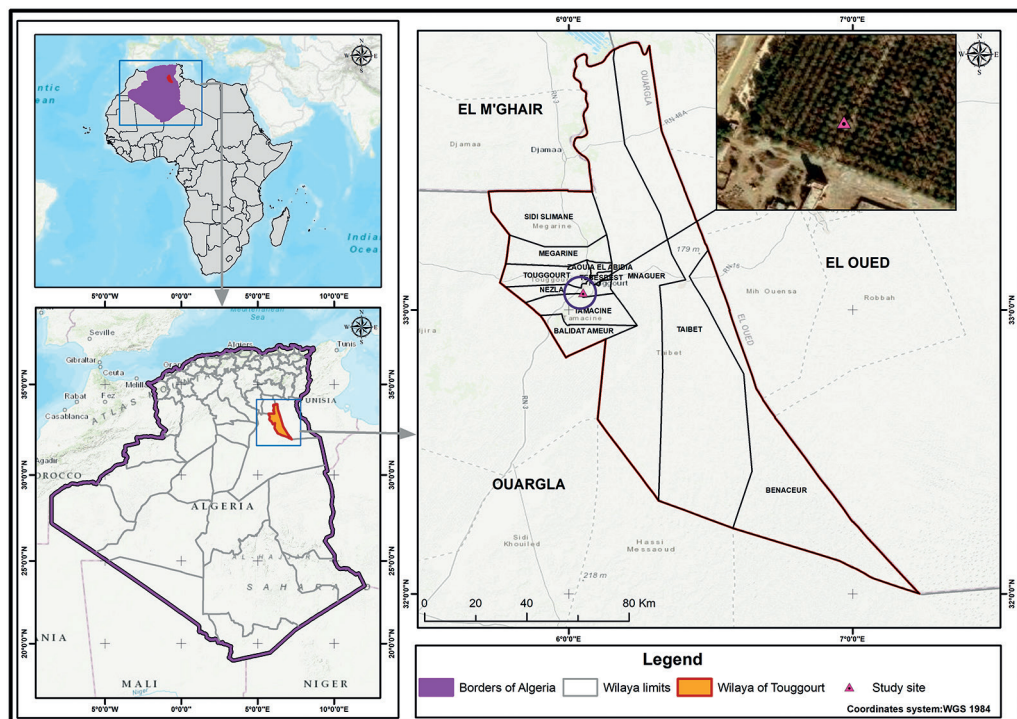


Fig. 1. Location of the Ranou palm grove, Touggourt, Southeastern Algeria.

2023, while annual precipitation totalled 9.15 mm in 2022 and 24.14 mm in 2023 (ONM 2022–2023).

Pellet collection and analysis

Pellets were collected every two weeks from 4 July 2022 to 28 August 2023 beneath a *Washingtonia robusta* H.Wendl. (Mexican fan palm) used as a nesting and roosting site by the barn owl. Repeated observations of fledglings at the same nest (Fig. 2) confirmed local breeding by a single pair at the collection site throughout the study period. Only fresh and intact pellets entered the analysis, and removal followed each visit to prevent repeated prey accumulation.

Pellet dissection followed the protocol described by Sekour et al. (2014).

Minimum number of individuals (MNI) estimation relied on the most abundant paired skeletal elements for each taxon. Mammal identification used cranio-dental characteristics (mandibles and skulls) following Barreau et al. (2017). Bird identification relied on diagnostic skeletal elements (beaks, humeri, femora, tibiotarsi, and feathers) following Cuisin (1989) for passerine skulls, and by comparison with the ENSA (El Harrach) reference collection for non-passerine birds. Reptile remains were assigned to family level (Gekkonidae, Lacertidae) on diagnostic cranial and osteodermal characters following Schleich et al. (1996) and Le Berre (1989). Arthropod identification used sclerotised structures (heads, mandibles, antennae, legs, and elytra) following Hacini and Doumandji (1998) and Souttou et al. (2004),



Fig. 2. Fledgling barn owls (*Tyto alba* (Scololi, 1769)) at the nest in a *Washingtonia robusta* H. Wendl., Ranou palm grove, Touggourt, Algeria (June 2023).

with reference to dichotomous keys and collections of the Department of Agricultural and Forest Zoology, National School of Agronomy, El Harrach, Algiers. Identification proceeded to the lowest taxonomic level the available material allowed: to genus where diagnostic elements remained (e.g. *Gerbillus* sp., *Streptopelia* sp., *Passer* sp.), and to family for fragmentary remains without diagnostic features.

Data analysis

Diet composition analyses included prey species richness (S), relative abundance (RA, %), and biomass (B, %) following Marti et al. (2007). Relative abundance represented the proportion of individuals of each taxon among all identified prey items. Biomass combined the MNI of each taxon with mean body masses from Dunning (2008) for birds, Le Berre

(1990) and Kowalski and Rzebiak-Kowalska (1991) for mammals, and published sources or representative specimens for reptiles and arthropods, and expressed results as percentages of total biomass. When identification reached only genus or family level, average values for the corresponding group were applied. Pearson's chi-square tests were applied only to count data (number of individuals per taxon), comparing the two periods in 2×2 contingency tables; biomass was expressed as a proportion of total prey mass and is reported descriptively, without statistical testing. All analyses were performed in R version 4.4.0 (R Core Team 2024).

Results

Diet composition at the class level

Analysis of 402 pellets yielded 1353 prey items across four taxonomic classes (figs 3 and 4). Mammals constituted the dominant class both numerically ($n = 730$, RA = 54.0 %) and in terms of estimated biomass ($B = 67.9$ %), comprising at least 13 species. Birds were the second most represented class ($n = 305$, RA = 22.5 %; $B = 30.8$ %), followed by insects ($n = 298$, RA = 22.0 %; $B = 1.2$ %) and reptiles ($n = 20$, RA = 1.5 %; $B = 0.1$ %). Compared with the 2009–2010 baseline, mammals increased in relative abundance from 43.6 % to 54.0 % ($\chi^2 = 7.28$, $df = 1$, $p < 0.01$) and estimated biomass from 51.0 % to 67.9 %. The relative abundance of birds increased from 10.7 % to 22.5 % ($\chi^2 = 25.09$, $df = 1$, $p < 0.001$), while their estimated biomass changed from 34.3 % to 30.8 %. Reptiles decreased from 9.6 % to 1.5 % ($\chi^2 = 64.51$, $df = 1$, $p < 0.001$), while insects decreased from 35.3 % to

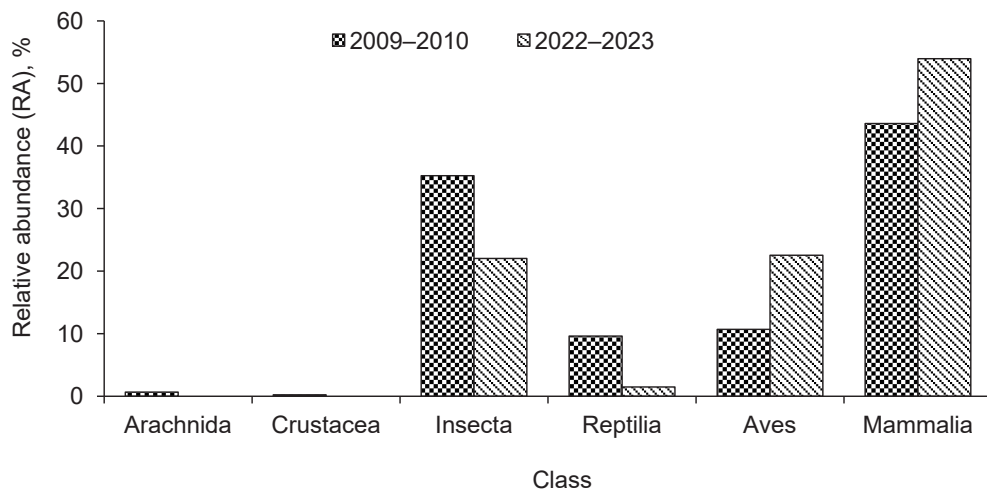


Fig. 3. Comparison of relative abundance of prey classes between the two study periods: 2009–2010 (Hadjoudj et al. 2020), 2022–2023 (present study).

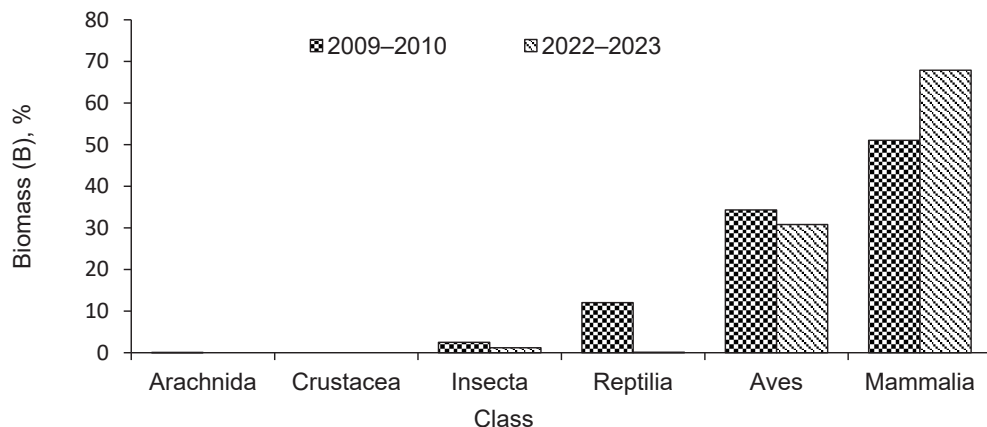


Fig. 4. Comparison of biomass contribution of prey classes between the two study periods: 2009–2010 (Hadjoudj et al. 2020), 2022–2023 (present study).

22.0 % ($\chi^2 = 23.74$, $df = 1$, $p < 0.001$). Arachnids and crustaceans, which represented less than 1 % of prey items in 2009–2010, were not recorded in the 2022–2023 samples. Overall, diet composition at the class level differed markedly between the two periods in both relative abundance (Fig. 3) and estimated biomass (Fig. 4).

Changes in prey species and family composition

The most abundant prey taxa were *Mus musculus*, *Rattus rattus*, Gryllidae and *Passer* sp., while *R. rattus* also dominated in terms of estimated biomass, followed by *Columba livia* (J.F. Gmelin, 1789), *M. musculus* and *Streptopelia* sp. (Table 1).

Table 1. Prey spectrum of *Tyto alba* in the Ranou palm grove (Touggourt, Southeastern Algeria) during two yearly sampling periods (February 2009 – January 2010 and July 2022 – August 2023).

Class /Order	Family / Species	2009–2010			2022–2023		
		<i>n</i>	RA, %	B, %	<i>n</i>	RA, %	B, %
Arachnida	Galeodidae	3	0.64	0.08	-	-	-
Crustacea	Oniscidae	1	0.21	0.00	-	-	-
Insecta	Mantidae	1	0.21	0.00	-	-	-
Blattodea	Hodotermitidae	1	0.21	0.00	-	-	-
Orthoptera	Tettigoniidae	1	0.21	0.00	-	-	-
	Acrididae	2	0.43	0.03	39	2.88	0.02
	Gryllidae	103	22.01	2.37	197	14.56	0.96
	Gryllotalpidae	2	0.43	0.05	36	2.66	0.20
Dermaptera	Labiduridae	1	0.21	0.00	-	-	-
Hemiptera	Scutelleridae	1	0.21	0.00	-	-	-
Coleoptera	Scarabaeidae	4	0.85	0.04	26	1.92	0.02
	Cicindelidae	2	0.43	0.00	-	-	-
	Hydrophilidae	1	0.21	0.00	-	-	-
	Tenebrionidae	8	1.71	0.02	-	-	-
	Curculionidae	6	1.28	0.00	-	-	-
	Cerambycidae	2	0.43	0.00	-	-	-
	Scoliididae	1	0.21	0.00	-	-	-
	Formicidae	29	6.20	0.00	-	-	-
Reptilia	Lacertidae	43	9.19	11.82	-	-	-
	Agamidae	2	0.43	0.24	-	-	-
	Gekkonidae	-	-	-	20	1.48	0.13
Aves	<i>Columba livia</i> (J.F. Gmelin, 1789)	10	2.14	10.21	26	1.92	12.46
	<i>Streptopelia</i> sp.	16	3.42	15.71	45	3.33	10.56
	Columbidae indet.	1	0.21	1.02	-	-	-
	<i>Merops persicus</i> Pallas, 1773	-	-	-	4	0.30	0.33
	<i>Apus apus</i> (Linnaeus, 1758)	-	-	-	2	0.15	0.14
	<i>Passer</i> sp.	5	1.07	0.16	99	7.32	3.58
	<i>Hirundo rustica</i> (Linnaeus, 1758)	1	0.21	0.00	26	1.92	0.93
	<i>Delichon urbicum</i> Linnaeus, 1758	-	-	-	31	2.29	0.89
	Sylviidae indet.	7	1.50	0.99	-	-	-
	<i>Lanius excubitor</i> (Linnaeus, 1758)	6	1.28	3.30	-	-	-
	<i>Muscicapa striata</i> Pallas, 1764	-	-	-	4	0.30	0.11
	<i>Phylloscopus</i> sp.	-	-	-	18	1.33	0.27
	<i>Oenanthe</i> sp.	-	-	-	19	1.40	0.56
	Passeriformes indet.	2	0.43	1.35	31	2.29	0.97
	Aves indet.	2	0.43	1.57	-	-	-

Class /Order	Family / Species	2009–2010			2022–2023		
		<i>n</i>	RA, %	B, %	<i>n</i>	RA, %	B, %
Mammalia	<i>Suncus etruscus</i> (Savi, 1822)	1	0.21	0.02	1	0.07	0.00
	Rhinolophidae	1	0.21	0.24	-	-	-
	Chiroptera indet.	34	7.26	6.14	24	1.77	0.21
	Dipodidae	7	1.50	3.02	10	0.74	1.13
	Gliridae	2	0.43	0.82	12	0.89	1.53
	<i>Gerbillus</i> sp.	3	0.64	0.60	21	1.55	1.05
	<i>Gerbillus campestris</i> (Lichtenstein, 1823)	5	1.07	0.90	19	1.40	0.85
	<i>Gerbillus gerbillus</i> (Olivier, 1801)	31	6.62	7.13	36	2.66	2.06
	<i>Gerbillus nanus</i> Blanford, 1875	41	8.76	5.41	21	1.55	0.61
	<i>Gerbillus tarabuli</i> Thomas, 1902	3	0.64	0.80	8	0.59	0.53
	<i>Gerbillus henleyi</i> Thomas, 1919	-	-	-	5	0.37	0.11
	<i>Mus musculus</i> (Linnaeus, 1758)	17	3.63	2.54	298	22.03	11.07
	<i>Mus spretus</i> (Lataste, 1883)	36	7.69	5.37	31	2.29	1.00
	<i>Rattus</i> sp.	5	1.07	3.93	-	-	-
	<i>Rattus rattus</i> (Linnaeus, 1758)	18	3.85	14.14	244	18.03	47.72

Note: *n* – number of individuals; RA – relative abundance, %; B – estimated biomass proportion, %; indet. – identified to the indicated taxonomic level only; - – absent from samples.

Compared with 2009–2010, the relative abundance of Gryllotalpidae and Acrididae increased ($\chi^2 = 9.31$, $p < 0.001$; and $\chi^2 = 8.31$, $p < 0.01$), whereas Formicidae and Tenebrionidae were no longer recorded. Gekkonidae were recorded only in 2022–2023 and Lacertidae only in 2009–2010. *Passer* sp. increased markedly (0.6 % to 7.3 %, $\chi^2 = 23.77$, $p < 0.001$), and several Palaearctic migrants were recorded for the first time in 2022–2023 (*Hirundo rustica* (Linnaeus, 1758), *Delichon urbicum* Linnaeus, 1758, *Merops persicus* Pallas, 1773, *Apus apus* (Linnaeus, 1758), *Phylloscopus* sp., *Oenanthe* sp. and *Muscicapa striata* Pallas, 1764), while *Lanius excubitor* (Linnaeus, 1758) was recorded only in 2009–2010.

Among mammals, *Mus musculus* and *Rattus rattus* increased strongly (from 3.6 % to 22.0 %, $\chi^2 = 68.00$; and from 3.9 % to 18.0 %, $\chi^2 = 48.65$; both $p < 0.001$), whereas *Gerbillus nanus* Blan-

ford, 1875 and *Gerbillus gerbillus* (Olivier, 1801) decreased ($\chi^2 = 53.07$ and 14.84, $p < 0.001$), as did *Mus spretus* (Lataste, 1883). Chiropterans declined in both relative abundance and estimated biomass.

Discussion

The diet of *T. alba* in the Ranou palm grove (Touggourt region) in 2022–2023 was dominated by rodents (RA = 54.0 %), with *Mus musculus* and *Rattus rattus* as the principal prey, followed by birds (RA = 22.5 %). Similar patterns occur elsewhere in the Algerian Sahara, in the agricultural oasis of Biskra (Farhi et al. 2016) and the agricultural oases of the Souf region (Alia et al. 2024), whereas birds dominate in the urban oasis of Ghardaïa (Souilem et al. 2018), the oasis of Ouargla (Benamane et al. 2019), and the coastal oasis of Al Qatif, eastern Saudi Arabia (Al-Ghamdi et

al. 2025). This geographical variation reflects the opportunistic foraging behaviour of *T. alba*, whose diet closely tracks local prey availability (Taylor 1994, Aulagnier et al. 1999).

Interpreting these temporal changes requires distinguishing genuine ecological shifts from sampling effects. The 2022–2023 dataset comprised more pellets than the 2009–2010 baseline, 402 vs 153 as reported by Hadjoudj et al. (2020), and larger samples tend to increase the detection of occasional prey (Heisler et al. 2016); the first records of Palaearctic migrants and the higher species richness may therefore partly reflect this greater effort. Nevertheless, both surveys covered a full annual cycle at the same site with comparable methods, and the major shifts in commensal rodents and desert gerbils involve abundant, robustly identified prey that sampling effort alone cannot explain. More fragile prey categories, such as invertebrates and bats, warrant additional caution, as their changes may reflect both a genuine ecological trend consistent with declines documented over the past 150 years in European barn owls (Roulin 2016a,b; Roulin and Christe 2013) and a methodological effect arising from the analysis of intact pellets only.

The marked increase in *Mus musculus* and *Rattus rattus* coincided with a decline in *Gerbillus* spp. In the Touggourt region, *Gerbillus* species favour natural sandy habitats, whereas murine rodents concentrate in palm groves and agricultural environments (Hadjoudj et al. 2020). The expansion of *R. rattus* is particularly notable: this anthropophilic species has recently colonised Saharan oases and human-modified habitats across the region

(M'lik 2019, M'lik et al. 2022), and its low occurrence in 2009–2010 likely reflects an early stage of establishment. The progressive replacement of desert-adapted gerbils by commensal rodents points to the ongoing anthropogenic transformation of the oasis environment.

Bird prey increased markedly, and several Palaearctic migrants (*Hirundo rustica*, *Delichon urbicum*, *Phylloscopus* sp., *Oenanthe* sp., *Merops persicus* and *Muscicapa striata*) appeared in the diet for the first time in 2022–2023, although the larger sample size may have contributed to their detection. Desert oases serve as essential stopover sites for trans-Saharan migrants (Isenmann and Moali 2000), and the presence of these species in the pellets underlines the role of the Ranou oasis along migration routes and points to a seasonal use of the site by *T. alba*.

The reptilian component also shifted, with Lacertidae present only in 2009–2010 and Gekkonidae only in 2022–2023. Many gecko species are nocturnal and readily occupy human-modified environments (Martín et al. 2023), suggesting that this turnover reflects both changing prey availability and a shift in the temporal activity window of prey accessible to *T. alba*; this interpretation nonetheless requires caution, as squamate remains could only be assigned to family level. Finally, predation on *Brachytrupes megacephalus* (Lefebvre, 1827), a major pest of date-palm agroecosystems (Lakhdari et al. 2015), points to a potential contribution of *T. alba* to agricultural pest regulation, an ecological service also documented for *Bubo ascalaphus* (Savigny, 1809) in the saline wetland of El Menia (Lakhdari et al. 2026).

Conclusions

Over the 13-year interval between the two surveys, the diet of *Tyto alba* in the Ranou oasis showed notable changes in prey composition. Commensal rodents, particularly *Mus musculus* and *Rattus rattus*, increased markedly, while several desert-associated prey taxa declined and Palaearctic migrant birds appeared in the recent diet. These shifts are consistent with the progressive transformation of Saharan oases under increasing agricultural and urban pressure, which favours commensal, anthropophilic species at the expense of desert specialists, although differences in sampling effort between periods warrant some caution in their interpretation. These patterns also emphasise the ecological importance of Saharan oases for both resident and migratory fauna. Therefore, pellet-based dietary monitoring provides a valuable and non-invasive approach for monitoring the biological responses of arid ecosystems to environmental and anthropogenic change.

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Ethics Statement

Pellets were collected non-invasively beneath natural roost sites in accordance with Algerian wildlife protection legislation. The study did not involve the capture, handling, or disturbance of animals, and no specific permits were required.

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