

Dietary composition of the Pharaoh Eagle-Owl (*Bubo ascalaphus*) in the Northern Algerian Sahara

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Abstract

This study evaluates the trophic spectrum of the Pharaoh Eagle-Owl (*Bubo ascalaphus* Savigny, 1809), a nocturnal raptor, in the Northern Algerian Sahara (El Menia region) to assess its ecological role in arid ecosystems. Analysis of 92 pellets collected between June and December 2018 revealed dietary composition and seasonal trophic dynamics. A total of 586 prey items representing 36 species across five taxonomic classes were identified. Mammals dominated the diet (69.6 %), followed by birds (10.9 %), insects (10.4 %), arachnids (5.0 %), and reptiles (4.1 %). Desert-adapted rodents formed the principal prey base, with *Gerbillus nanus* Blanford, 1875, *Mus musculus* Linnaeus, 1758, and *Rattus rattus* Linnaeus, 1758 being the most abundant species. Rodents contributed 72.8 % of total biomass, whilst dietary diversity showed marked seasonal variation, peaking during summer months. These findings demonstrate a generalist trophic strategy with pronounced seasonal plasticity, confirming the species' role as a top predator in Saharan food webs. This baseline supports future biodiversity monitoring and conservation planning in arid ecosystems.

Key words: diet composition, pellet analysis, prey diversity, Saharan ecosystems, seasonal dynamics, trophic ecology.

Introduction

The Pharaoh Eagle-Owl (*Bubo ascalaphus* Savigny, 1809) is a medium-sized

nocturnal raptor widely distributed across the arid and semi-arid regions of the Afro-Arabian belt, primarily inhabiting rocky escarpments, mountainous areas, dry sa-

vannahs, and steppes (Mohedano et al. 2014, Benamor et al. 2021). Pellet analysis represents the primary method for investigating the trophic strategy and prey community structure of *B. ascalaphus*, revealing a dietary spectrum that typically includes small mammals, birds, reptiles, and large-bodied arthropods depending on local resource availability (Mikkola 2013), and providing fundamental insights into population dynamics and ecological interactions in fragile Saharan ecosystems (Todorova et al. 2025).

Extensive research across the Afro-Arabian range has revealed marked geographical variation in the dietary composition of *B. ascalaphus*. In the Arabian Peninsula, studies demonstrate distinct spatial dietary patterns across northern and eastern Saudi Arabia (Abi-Said et al. 2020; Al-Ghamdi et al. 2023a,b) and southern Qatar (Mohedano et al. 2014). In Jordan, dietary data are available across several sites (Amr et al. 1997, Rifai et al. 2000, Shehab and Ciach 2008). North African records include Egypt (Moldován and Sándor 2009), Morocco (Bergier et al. 2014, Kayser et al. 2023), and Mauritania (Kayser et al. 2025), collectively revealing strong trophic plasticity in the species in response to habitat structure and local prey community composition.

In Algeria, available research primarily concerns semi-arid steppe zones and certain protected areas (Boukhamza et al. 1994, Sekour et al. 2010, Djilali et al. 2011, Bounaceur et al. 2016, Benamor et al. 2021), whilst the northern Saharan zone remains insufficiently documented. This study provides the first data on the trophic structure of *B. ascalaphus* in the El Menia region of the Northern Algerian Sahara, to better understand its trophic ecology under arid conditions and to contribute to biodiversity conservation in Sa-

haran ecosystems.

Materials and Methods

Study area

The study site is located at Sebkhet El Melah, a shallow saline wetland situated 12 km south of El Menia in the Northern Algerian Sahara (30°28'06" N, 2°55'35" E; 370 m a.s.l.) (Fig. 1). This site lies within the administrative boundaries of El Menia municipality, Ghardaïa Province, Algeria. The endorheic depression covers approximately 800 ha and is surrounded by sand dunes, rocky formations, and a southern escarpment that provides perching habitat for raptors (Fig. 2). The region experiences a hyper-arid climate characterised by mean annual rainfall of 30–50 mm and temperature ranges from 5 °C to 44 °C (Bouam et al. 2024). Halophytic vegetation includes *Phragmites communis* Trin., *Limoniastrum guyonianum* Boiss., and *Juncus acutus* L. The wetland holds Ramsar Site status (RIS 1429) owing to its ecological significance for Saharan biodiversity, especially waterbirds (Bouzid et al. 2019, Chedad et al. 2021).

Pellet collection and analysis

A total of 92 pellets from *B. ascalaphus* were collected monthly between June and December 2018 beneath cliff roosting sites (30°27'57.85" N, 2°56'7.94" E). Prior to dissection, pellet length, maximum diameter, and weight were recorded for morphometric characterisation. Each pellet was then moistened and manually dissected using fine forceps to extract skeletal remains, fur, feathers, and arthropod fragments. Prey items were identified following Orsini et al. (1982) and Barreau et

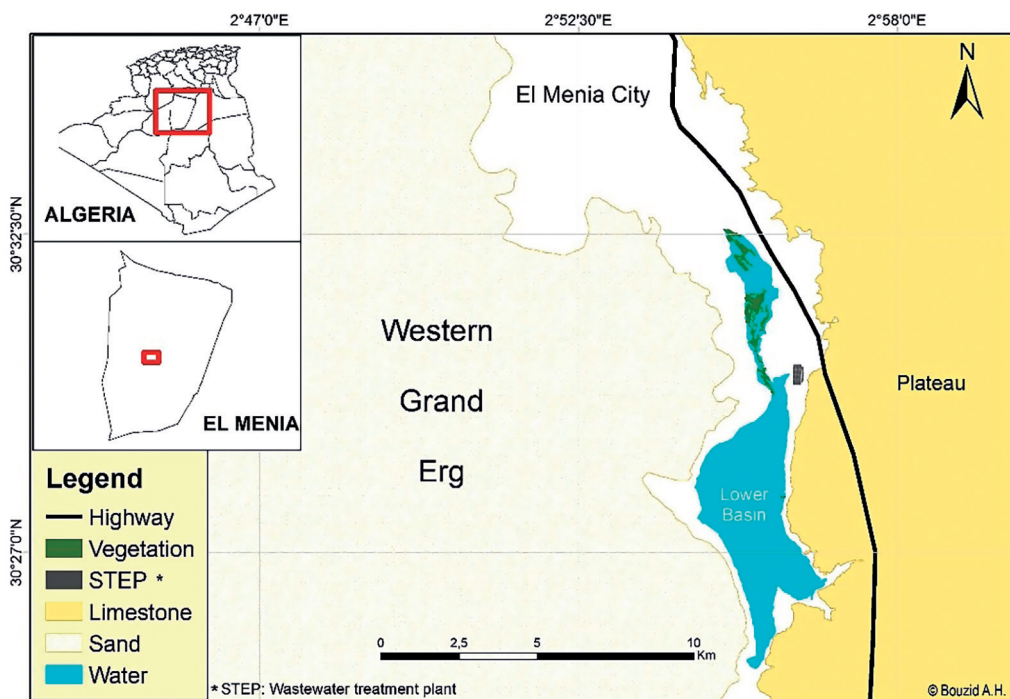


Fig. 1. Map of the study area (Sebkhet El Melah, Northern Algerian Sahara).



Fig. 2. Adult *Bubo ascalaphus* at the study site, Sebkhet El Melah (June 2018).

al. (1991) for mammals, Cuisin (1989) for birds, and Heim de Balsac and Bourlière (1955) for arthropods.

Dietary composition was quantified using relative abundance (RA%), biomass contribution (B%), and species richness (Blondel 1975, Ramade 1984, Zaime and Gautier 1989). Descriptive statistics are presented as mean $\pm$ standard deviation (SD), whilst median values are reported for non-parametric analyses. Trophic diversity was evaluated by calculating the Shannon–Weaver diversity (H') and Pielou's evenness coefficient (J). Data analyses were carried out in R software (version 4.4.0, R Core Team 2024), and graphical outputs were generated using the ggplot2 package (Wickham 2016, Patil 2021).

Results

Pellet morphology

The pellets of *B. ascalaphus* were characterised by colours ranging from light grey to greyish beige, with some showing a sandy tint. They exhibited a cylindrical shape with rounded ends and were gen-

erally solid. Pellet length varied from 21 to 98 mm (mean $\pm$ SD = 50.84 ± 15.04 mm), maximum diameter ranged between 15 and 47 mm (25.21 ± 5.34 mm), and weight fluctuated from 1.6 to 21.17 g (6.83 ± 3.61 g).

Dietary composition

Each pellet contained between 1 and 14 prey items (mean $\pm$ SD = 6.4 ± 2.76 prey per pellet). Pellets containing six prey items were the most frequent (20.7 %), followed by those with eight prey (15.2 %), four prey (12 %), and three or five prey items (11 %). The ones containing between six and eight prey items accounted for 47.8 % of the sample, whereas pellets with 9–14 prey items were relatively rare ($1.1 \% \leq \text{RA}\% \leq 7.6 \%$).

A total of 586 prey items belonging to 36 species were identified from 92 pellets and assigned to five taxonomic classes: Mammalia (14 species, 69.6 %), Aves (9 species, 10.9 %), Insecta (11 species, 10.4 %), Arachnida (2 species, 5.0 %), and Reptilia (2 species, 4.1 %) (Table 1, Fig. 3). Mammals clearly dominated the diet numerically. *Gerbillus nanus* Blanford,

Table 1. Diet composition of *Bubo ascalaphus* at Sebkhet El Melah, Northern Algerian Sahara (June–December 2018, $n = 92$ pellets).

Class	Family	Prey species	<i>n</i>	RA%	FO%	B%
Arachnida			29	4.95		0.39
	Buthidae	Buthidae spp.	24	4.10	20.65	0.35
	Galeodidae	<i>Galeodes</i> spp.	5	0.85	5.43	0.04
Insecta			61	10.41		0.72
	Mantidae	Mantidae spp.	2	0.34	2.17	0.04
	Gryllotalpidae	<i>Gryllotalpa gryllotalpa</i> Linnaeus, 1758	9	1.54	7.61	0.15
	Gryllidae	<i>Brachytrypes megacephalus</i> Fieber, 1853	13	2.22	7.61	0.19
	Labiduridae	<i>Labidura</i> spp.	10	1.71	7.61	0.04
	Carabidae	<i>Anthia sexmaculata</i> Fabricius, 1781	5	0.85	5.43	0.04
	Scarabaeidae	<i>Phyllognatus</i> spp.	3	0.51	3.26	0.01

Class	Family	Prey species	n	RA%	FO%	B%
	Tenebrionidae	<i>Pachychilus sevilla</i> Bourguignat, 1864	9	1.54	9.78	0.18
		<i>Pimelia</i> spp.	3	0.51	3.26	0.08
	Formicidae	Formicidae spp.	7	1.19	6.52	0.00
	Reptilia		24	4.10		0.76
	Gekkonidae	Gekkonidae spp.	19	3.24	16.30	0.58
	Agamidae	Agamidae spp.	5	0.85	4.35	0.18
	Aves		64	10.92		13.82
	Alaudidae	Alaudidae spp.	1	0.17	1.09	0.12
	Passeridae	<i>Passer</i> spp.	32	5.46	22.83	3.50
	Hirundinidae	<i>Hirundo rustica</i> Linnaeus, 1758	1	0.17	1.09	0.11
		<i>Delichon urbicum</i> Linnaeus, 1758	3	0.51	3.26	0.26
	Phylloscopidae	<i>Phylloscopus</i> spp.	2	0.34	2.17	0.09
	Turdidae	<i>Oenanthe</i> spp.	1	0.17	1.09	0.09
	Columbidae	<i>Columba livia</i> Gmelin, 1789	3	0.51	2.17	4.34
		<i>Streptopelia turtur</i> Linnaeus, 1758	6	1.02	6.52	5.32
		<i>Streptopelia</i> spp.	15	2.56	14.13	11.52
	Mammalia		408	69.62		72.78
	Vespertilionidae	Chiroptera spp.	39	6.66	20.65	1.04
	Muridae	<i>Mus</i> spp.	3	0.51	2.17	0.35
		<i>Mus musculus</i> Linnaeus, 1758	53	9.04	35.87	5.95
		<i>Mus spretus</i> Lataste, 1883	12	2.05	8.70	1.17
		<i>Rattus rattus</i> Linnaeus, 1758	26	4.44	23.91	15.36
		<i>Rattus</i> spp.	4	0.68	4.35	0.61
	Gerbillidae	<i>Gerbillus</i> spp.	3	0.51	3.26	0.21
		<i>Gerbillus henleyi</i> Thomas, 1919	3	0.51	3.26	0.21
		<i>Gerbillus nanus</i> Blanford, 1875	130	22.18	54.35	11.37
		<i>Gerbillus gerbillus</i> É. Geoffroy, 1803	36	6.14	21.74	6.23
		<i>Gerbillus campestris</i> (Lichtenstein, 1823)	11	1.88	11.96	1.48
		<i>Gerbillus tarabuli</i> Thomas, 1902	32	5.46	20.65	6.39
		<i>Pachyuromys duprasi</i> (Duvernoy, 1842)	13	2.22	10.87	3.07
		<i>Meriones</i> spp.	20	3.41	13.04	10.64
	Dipodidae	<i>Jaculus jaculus</i> Linnaeus, 1758	26	4.44	19.57	8.91

Note: RA% = relative abundance, FO% = frequency of occurrence, B% = biomass contribution, n = number of individuals.

1875 was the most abundant prey species ($n = 130$, RA% = 22.2 %), followed by *Mus musculus* Linnaeus, 1758 ($n = 53$, RA% = 9.0 %) and *Chiroptera* spp. ($n = 39$, RA%

= 6.7 %). Among birds, *Passer* spp. was the most frequently recorded taxon ($n = 32$, RA% = 5.5 %).

In terms of biomass, mammals ac-

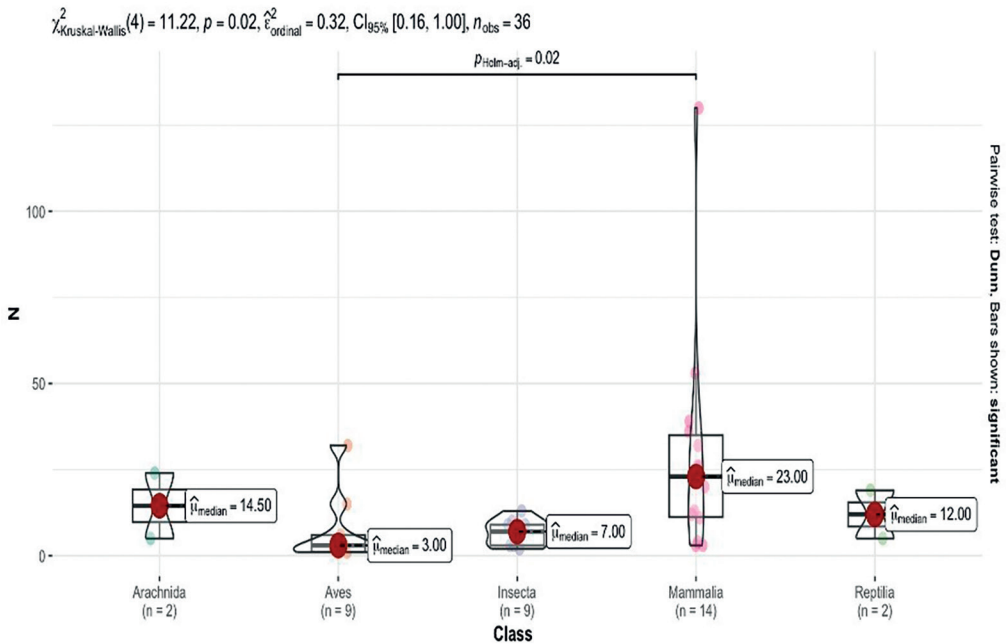


Fig. 3. Number of prey distribution across taxonomic classes in the diet of *Bubo ascalaphus* at Sebkhet El Melah (June–December 2018).

Note: Boxes represent interquartile ranges, horizontal lines indicate median values. Significant differences were detected among classes (Kruskal–Wallis: $\chi^2 = 11.22$, $df = 4$, $p = 0.02$).

counted for 72.8 % of the total biomass consumed. *Rattus rattus* (Linnaeus, 1758) contributed the highest proportion (15.4 %), followed by *Streptopelia* spp. (11.5 %), *Gerbillus nanus* (11.4 %), *Meriones* spp. (10.6 %), *Jaculus jaculus* (Linnaeus, 1758) (8.9 %), and *Gerbillus tarabuli* Thomas, 1902 (6.4 %) of the total biomass (Table 1).

Taxonomic and temporal variation

Kruskal–Wallis test indicated significant differences in prey abundance among classes ($\chi^2 = 11.22$, $df = 4$, $p = 0.02$). The effect size was moderate ($\epsilon^2_{\text{ordinal}} = 0.32$). Mammals exhibited the highest median abundance (median = 23 prey items), followed by arachnids (14.5) and reptiles (12), whereas birds (3) and

insects (7) showed lower median values (Fig. 3). Species richness differed significantly among prey classes ($\chi^2 = 10.33$, $df = 4$, $p = 0.04$), with a moderate effect size ($\epsilon^2_{\text{ordinal}} = 0.30$). Mammals displayed the highest median species richness (median = 15), whereas birds showed the lowest median value (median = 2) (Fig. 4).

Dietary diversity indices showed marked seasonal variation (Fig. 5). Higher values of species richness, Shannon diversity (H') and Pielou's evenness (J) were observed during the early summer period (June–August). From September onwards, richness and Shannon diversity tended to decrease, with lower values recorded in October and November, whilst Pielou's evenness remained relatively high before declining in December.

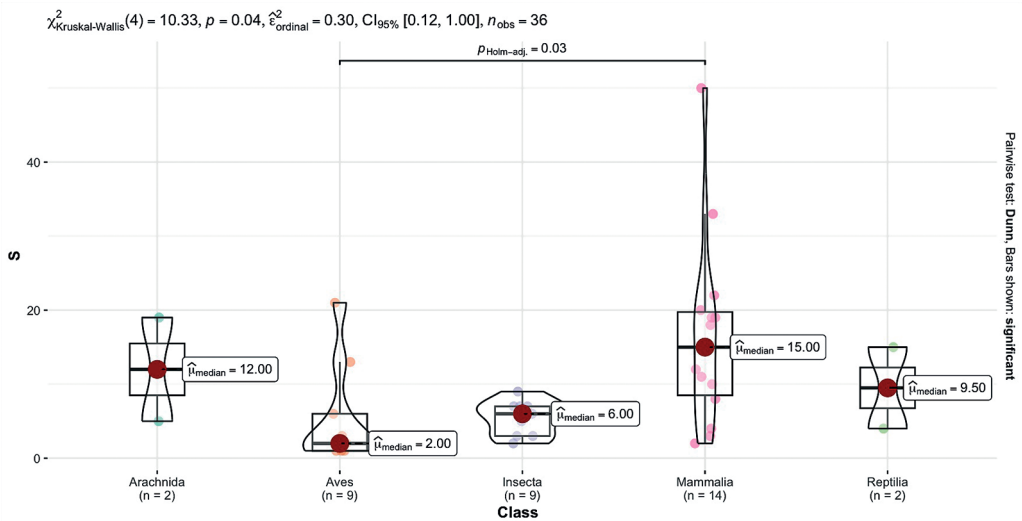


Fig. 4. Species richness across prey taxonomic classes in the diet of *Bubo ascalaphus* at Sebket El Melah, Northern Algerian Sahara (June–December 2018).

Note: Boxes represent interquartile ranges, horizontal lines indicate median values (Kruskal–Wallis test: $\chi^2 = 10.33$, $df = 4$, $p = 0.04$).

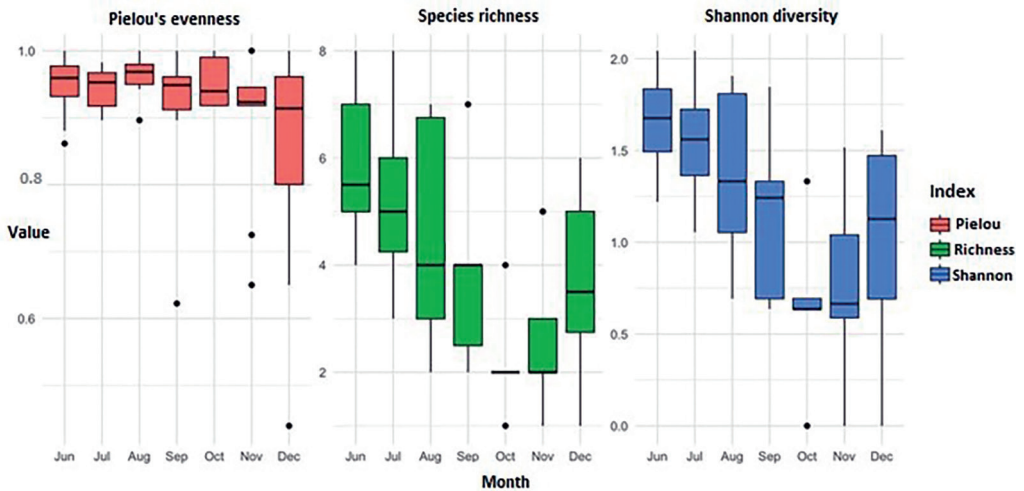


Fig. 5. Monthly variation in prey diversity metrics (Pielou's evenness J , species richness, Shannon index H') in the diet of *Bubo ascalaphus* (June–December 2018).

Discussion

The size of the regurgitated pellets of *B. ascalaphus* is closely related to the mor-

phology of the predator, particularly the width of the beak, the diameter of the oesophagus, and the size of the gizzard (Sekour et al. 2010, Tobajas et al. 2021).

The dimensions obtained in our study are comparable to those reported by Sekour et al. (2010) in Mergueb, Algeria ($57.2 \pm 16 \text{ mm} \times 27.1 \pm 3.7 \text{ mm}$), and by Abi-Said et al. (2020) in Riyadh, Saudi Arabia ($52.2 \pm 6.8 \text{ mm} \times 22.84 \pm 3.5 \text{ mm}$). The high number of prey items per pellet (6.4 ± 2.76) reflects the dominance of small to medium-sized prey, consistent with the inverse relationship between prey size and number of individuals per pellet (Al-Ghamdi et al. 2023a).

Mammals constituted 69.6 % of the diet, consistent with other Algerian populations, where reported proportions range from 88.8 % to 95.4 % (Boukhamza et al. 1994, Biche et al. 2001), as well as with Arabian populations, where values vary from 75.75 % to 91.0 % (Abi-Said et al. 2020, Al-Ghamdi et al. 2023b). In contrast, avian prey dominated in Mauritanian coastal habitats with 71 % (Kayser et al. 2025), whilst arthropods prevailed in Jordan with 50.8 % (Rifai et al. 2000) underscoring the opportunistic foraging strategy of *B. ascalaphus* across its Afro-Arabian range. Secondary components included birds (10.9 %), reptiles (4.1 %), insects (10.4 %), arachnids (5.0 %), and Chiroptera (6.7 %). The higher prey diversity (36 species) reflects the habitat mosaic of dunes, salt flats, and oases at Sebkhet El Melah.

The prey spectrum recorded at Sebkhet El Melah reflects a clear ecological partitioning among the dominant rodent species. *Gerbillus nanus* (22.2% RA) and *G. gerbillus* É. Geoffroy, 1803 (6.1 %), characteristic of sandy Saharan substrates and well documented in the Northern and Central Algerian Sahara (Beddiaf et al. 2013, Hadjoudj et al. 2015), are strictly nocturnal and thus particularly accessible to the predation strategy of the owl. The commensal species *Mus muscu-*

lus (9.0 %) and *Rattus rattus* (4.4 %) constitute the second most important group, reflecting the capacity of this raptor to exploit agricultural environments near El Menia. Despite its moderate numerical occurrence, *R. rattus* contributed disproportionately to total biomass (15.4 %), suggesting the exploitation of energetically profitable prey, consistent with findings from urban Hurghada, Egypt (Sándor and Moldován 2010), and highlighting the potential role of *B. ascalaphus* as a biological control agent against pest rodents in Saharan agroecosystems (Moldován and Sándor 2009, Al-Ghamdi et al. 2023b).

Furthermore, *Meriones* spp. (10.6 % biomass) and *Pachyuromys duprasi* (Duvernoy, 1842) (2.2% RA) constitute an ecologically significant specialist component. The remains assigned to *Meriones* most likely correspond to *M. crassus* Sundevall, 1842 and/or *M. libycus* Lichtenstein, 1823, both recorded in the Ouargla and El Menia regions (Chaworth-Musters and Ellerman 1947, Kowalski and Rzebik-Kowalska 1991). *M. crassus* exhibits crepuscular activity, making it particularly vulnerable to nocturnal predation, whilst the presence of the partially diurnal *M. libycus* suggests occasional crepuscular hunting by this owl (Rifai et al. 2000). In contrast, *M. shawi* (Duvernoy, 1842), closely associated with cultivated areas and northern steppes (Le Berre 1990), is unlikely to occur at El Menia. The significant biomass contribution of *Meriones* spp. supports the opportunistic foraging strategy of *B. ascalaphus*, driven by local prey availability rather than fixed dietary preferences.

Diversity indices showed marked seasonal variation (Fig. 5), with higher values recorded during summer (June–August) and declining towards autumn–winter (September–December), reflecting fluc-

tuations in prey availability under desert conditions. Outside the breeding period, the diet relies primarily on medium-sized rodents, consistent with the observations of Sekour (2010). During the breeding season, larger and more energetically profitable prey may be exploited: at Mergueb, *Paraechinus aethiopicus* (Ehrenberg, 1832) represented 69 % of nest biomass (Sekour 2010), while at Relizane, Algeria, *Meriones shawi* was reported as the principal prey delivered to nestlings during the breeding period, which begins in February with laying in early March (Aroudj and Ouaraab 2021). The absence of such prey from our pellets, collected entirely outside the breeding period (June–December), supports the hypothesis of a seasonally flexible foraging strategy shaped by prey availability and the energetic demands of the biological cycle.

Conclusions

This study provides the first dietary baseline for *Bubo ascalaphus* in the Northern Algerian Sahara and highlights its opportunistic nature, closely linked to local prey availability. Mammals, particularly desert-adapted rodents, dominate the diet, whilst birds, reptiles, insects, and arachnids constitute secondary components. The dietary composition suggests an adaptive trophic strategy in which desert specialist rodents, notably *Gerbillus nanus* form the primary prey base in sandy Saharan habitats, whereas commensal rodents such as *Mus musculus* and *Rattus rattus*, favoured by proximity to agricultural areas, represent an important alternative resource. These findings underline the species' capacity to exploit both natural and anthropised environments, as well as its potential role in

regulating rodent pests within Saharan agroecosystems. Seasonal variation in diversity indices highlights the influence of temporal dynamics of trophic resources under desert conditions. Overall, these results contribute to a better understanding of predator–prey relationships in poorly documented Saharan ecosystems and confirm the ecological value of this raptor for biodiversity monitoring and biological regulation in arid environments.

Acknowledgements

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Ethics Statement

This study was based entirely on non-invasive methods (pellet collection beneath natural roosting sites). No animals were captured, handled, or harmed during this research. The study complied with national regulations for wildlife research in Algeria and ethical guidelines for ornithological studies.

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