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DIETARY COMPOSITION OF THE GREAT GREY SHRIKE *LANIUS EXCUBITOR ELEGANS* IN AN ARID REGION FROM SOUTHERN ALGERIA

Mohamed Belkacem[a, f]*, Faiza Marniche[b], Noureddine Menzer[a], Belkacem Aimene Boulaouad[c, f], Farah Hamici[d], Samia Daoudi-Hacini[e], Salaheddine Doumandji[e]

[a]Biotechnologies and Protection of Agricultural and Natural Ecosystems Laboratory, Faculty of Nature, Life and Earth Sciences, University of Bouira, 10000 Bouira, Algeria;
[b]National Veterinary School, El Alia, 16000 Algiers, Algeria;
[c]Department of Agronomy, SNV-TU Faculty, Mohamed El Bachir El Ibrahimi Bordj Bou Arreridj University, 34000 Bordj Bou Arreridj, Algeria;
[d]Management and Valorization of Natural Resources and Quality Assurance Laboratory, Faculty of Nature, Life and Earth Sciences, University of Bouira, 10000 Bouira, Algeria;
[e]Department of Agricultural and Forestry Zoology, National School of Agronomy, El Harrach, 16000 Algiers, Algeria;
[f]Algerian Wildlife Watchers Association, Hassi-Bahbah 17002, Djelfa, Algeria

*Corresponding author. Email: m.belkacem@univ-bouira.dz

Mohamed Belkacem: https://orcid.org/0000-0001-6151-0758
Faiza Marniche: https://orcid.org/0000-0002-3309-4811
Belkacem Aimene Boulaouad: https://orcid.org/0000-0002-4573-9031
Farah Hamici: https://orcid.org/0009-0002-2761-3571

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Abstract. This study investigates the diet of the Great Grey Shrike (*Lanius excubitor elegans*) in the Adrar region by comparing food availability and analysing 110 pellets collected across different seasons. A total of 194 prey species representing 7 classes and 21 orders were identified. Insects overwhelmingly dominated the diet, comprising 97.8% of the prey, with Coleoptera being the most consumed order (34.2%), followed by Hymenoptera (29.2%), and other orders making up the remaining 36%. The two most frequently eaten insect species were *Messor* sp. (9.61%) and *Cataglyphis* sp. (6.41%) from the Hymenoptera order (Formicidae) and a coleopteran species, *Cicindela flexuosa* (5.84%) (Cicindelidae). Additionally, the diet included notable pest species such as *Gerbillus* sp. (0.14%) and some grasshoppers like *Eyprepocnemis plorans* (1.28%). Statistical analyses indicated no significant seasonal differences in the distribution of prey classes, highlighting the consistently high presence of insects throughout the year. However, significant variations were observed within the Insecta class, particularly among the Coleoptera and Orthoptera orders. These findings suggest that the Great Grey Shrike plays a beneficial role in biocontrol and contributes to environmental balance.

INTRODUCTION

Birds provide significant ecological services to agriculture by serving as natural predators of insect and rodent pests that threaten crops, assisting in the dispersal of seeds, and contributing to the cross-pollination of flowers in numerous plant species (Whelan et al. 2008; Kaur and Dhanju 2013). Global populations of shrikes, including the Great Grey Shrike, are experiencing a significant decline due to habitat destruction and transformation (BirdLife International 2024).

Agricultural intensification, characterized by the excessive use of pesticides that directly poison prey or indirectly affect birds, including shrikes, is a key contributing factor (Lefranc and Worfolk 2022; Heath et al. 2008; Sun et al. 2012; Peng et al. 2015). The resulting low availability of prey in agricultural environments further exacerbates the decline of this bird (Lepley et al. 2000; Moreno-Rueda et al. 2016). Additional factors, such as anthropogenic disturbance, play a role in the decline of shrike populations. Even outside the nesting period, human-induced disturbances induce stress and contribute to a decline in shrike numbers (Sfougaris et al. 2014).

The Great Grey Shrike (*Lanius excubitor*) belongs to the family Laniidae and the genus *Lanius*, which contains 23 species (Lefranc and Worfolk 2022). The taxonomy of shrikes remains complex and unresolved, it has undergone revisions using genetic studies, with the current classification distinguished *Lanius meridionalis* exclusively in the Iberian Peninsula and southern France, while *Lanius excubitor elegans* is found in Africa (Olsson et al. 2010; Lefranc and Worfolk 2022). The Great Grey Shrike (*Lanius excubitor*), which has several subspecies is distributed both north and south of the Iberian range, as well as across Asia. In Africa, the elegans group, consisting of four subspecies of *Lanius excubitor*, is considered by some to represent a distinct species, the Desert Grey Shrike (*Lanius elegans*). Two subspecies of this group, *algeriensis* and *elegans*, breed in the Maghreb region. *Algeriensis* occupies the more northern and western parts of the Maghreb, while *elegans* is primarily found in the southern Saharan habitats (Yosef et al. 2020; Garcia 2024; Gill et al. 2024). In Algeria, formerly, three subspecies were recognized: *Lanius meridionalis algeriensis* in the central and eastern Tell, *Lanius meridionalis dodsoni* in the Oranie, and *Lanius meridionalis elegans* in the Saharan Atlas (Isenmann and Moali 2000), but in the recent works of Boulaouad et al. (2021, 2022, 2024) the species found in the southern part of the country is considered as *Lanius excubitor*.

Furthermore, the shrike consistently seeks elevated observation posts to spot its prey (Lefranc and Worfolk 2022). This behaviour has been corroborated by Taibi and Doumandji (2014), who confirmed these observations on date palms and electric poles. However, the reliance on electric poles can pose a risk to the birds (Belkacem et al. 2024). Ababsa et al. (2015) added that the predator often builds its nests on date palms and jujube trees in the Dayas. Notably, these plants, with their thorns, serve as larders where the shrike impales its prey.

Shrikes resemble falconiform raptors in their hunting techniques (Yosef 2008). However, they differ by having relatively strong talons and fragile claws, allowing them to capture and kill prey with their beaks. Additionally, shrikes have the ability to ingest large prey in a single meal (Lefranc and Worfolk 2022).

The objective of this study is to provide insights into the diet of a species highly threatened by human activities and to examine its role in biological balance by comparing food availability assessed using pitfall traps, with dietary composition analysed from pellet contents. Additionally, we aim to assess the species' ability to adapt and thrive in harsh climate conditions and modified agricultural areas by observing changes in its dietary preferences across different seasons according to food availability.

MATERIALS AND METHODS

Study area

The research was conducted in the Touat region in the southwest of Algeria, situated at the heart of the Algerian Sahara. This area, covering over two million square kilometres, ranks among the hottest and driest regions globally. Situated in the central part of the country, it is delineated by distinct geographical features. To the north, it is bordered by the Saharan Atlas Mountain range, while to the south lies the vast expanse of the Sahara Desert. The eastern boundary is marked by the Tademait Plateau, while to the west, it extends to the Tindouf Province. The central coordinates of the Adrar region are approximately 27.8675° N latitude and 0.2842° W longitude, capturing the heart of this arid yet geographically diverse region (Sekkoum et al. 2012).

Characterized by a hot desert climate (Köppen climate classification BWh) (Peel et al. 2007), the Touat region experiences extremely long and hot summers, coupled with short yet very warm winters. The average annual rainfall is a mere 16 mm, and summer temperatures consistently soar to extreme highs, often reaching 50 °C. This hyper-arid landscape is marked by sparse vegetation, primarily composed of sand dunes, stone plateaus, gravel plains, dry valleys, and salt flats.

Due to the minimal precipitation, the region relies heavily on groundwater from the continental intercalary, an area spanning parts of Algeria, Libya, and Tunisia (Sokona and Diallo 2008). This dependence underscores the vital role of groundwater in sustaining both the region and its agricultural activities.

In this study, pellets were collected from different sites (Figure1):

Site A: Near the city of Adrar, specifically at the experimental exploitation of the INRAA (National Institute of Agronomic Research of Algeria) of Adrar (27° 50' N, 0° 18' W; Elevation: 243 m). This regional experimental station of the research institute is established for the purpose of conducting experiments and tests on various crop varieties. Its vegetal stratum is characterized by the dominance of date palms, surrounded by windbreak trees, such as *Tamarix* sp., with underlying crops (vegetables, fodder) in greenhouses and open fields, including lucerne and wheat. Concurrently, it also engages in livestock farming and beekeeping.

Site B: Close to Telouline village between Zaouiet Kounta and Reggan (27° 03' N, 0° 08' W; Elevation: 210 m). This is a family farm characterized by various types of crops, primarily by the ubiquitous presence of date palms and tiered crops, including arboriculture, cereal cultivation, vegetable farming, as well as non-food

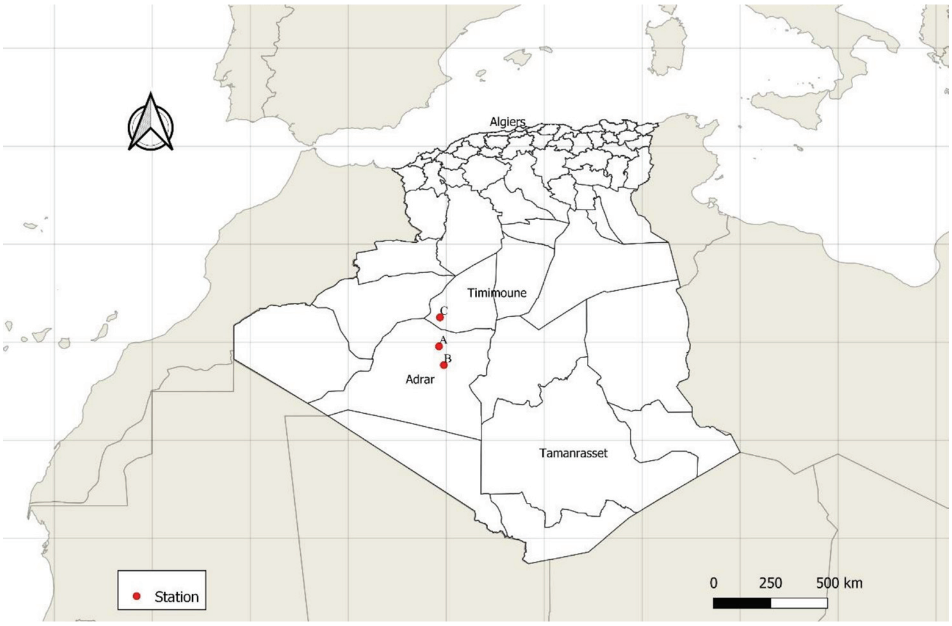

Figure 1. Study sites of food of the Great Grey Shrike (A: INRAA of Adrar; B: Telouline village; C: ITMAS of Timimoune).

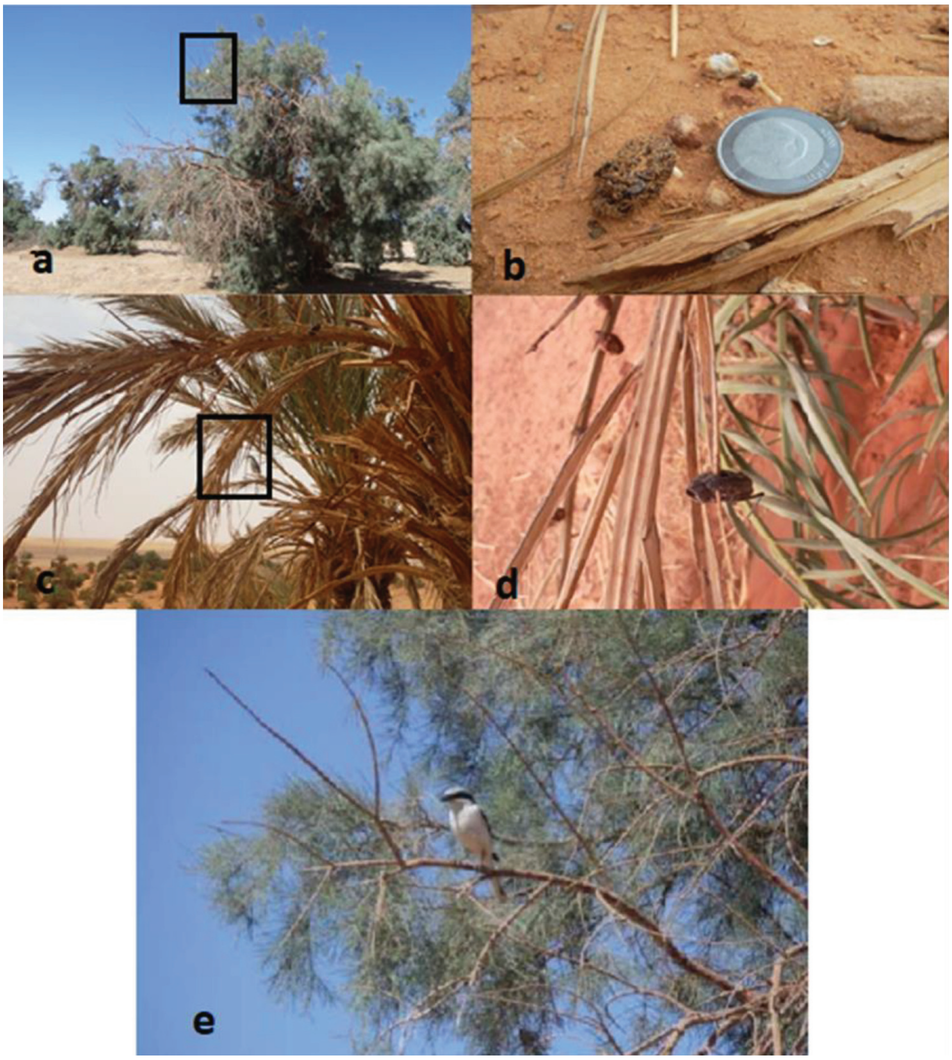

Figure 2. The preferred habitats of the Great Grey Shrike and its features: a – Windbreaks of *Tamarix* sp.; b – Pellets of the Great Grey Shrike; c – Roosting on date palm; d – Impaled species on a palm thorn (*Adesmia* sp.); e – *Lanius excubitor elegans* perches.

plants such as tobacco and henna, and the breeding of broiler chickens (Figure 1). The farmers on this farm use the traditional irrigation system (Foggara).

Site C: Located in ITMAS (The Institute of Specialized Medium Agricultural Technology) of Timimoune: located in the municipality of Timimoune on the edge of National Road No. 51, linking Ghardaïa to Adrar (29° 15'N, 0° 14' W; Elevation: 287 m). Situated in the southern part of the city of Timimoune, it covers an area of about 10 ha and contains various types of crops used for training specialized technicians in agriculture, such as date palm cultivation, arboriculture, forage crops, and vegetable cultivation, including lucerne, wheat, tomatoes, and tobacco.

Data collection and diet analysis

Observations and data collection in the field were conducted between January 2014 and April 2015, covering all seasons. The primary method employed was the analysis of 110 pellets, a technique proven effective in understanding the shrike's diet (Berger 2005; Wang et al. 2009). As per Mebs (1994), regurgitated pellets were collected beneath the perches during the bird's rest periods at the various sites mentioned in Figure 2. Three study sites are located in the same province and share similar habitat characteristics, so differences between sites were not considered. A total of 55 pellets were collected across 5 periods at the INRAA station (A), 44 pellets across 4 periods at the Telouline station (B), and 11 pellets were collected during a single season at the ITMAS station (C).

In the laboratory, after measuring the dimensions of the pellets to confirm their belonging to the relevant species (Table 1), the pellets underwent analysis using a humid technique involving the addition of ethanol. Each pellet was placed in an individual glass or plastic Petri dish. After a brief maceration period, typically lasting a few minutes, the pellets were ready for further examination. This method, particularly effective for pellets with a high insect content, facilitated the handling of fragments.

Diagnostic remains of insects, including heads, mandibles, elytra, and legs, were counted to estimate the number of prey items. For legs, the count was divided by six unless they formed a specialized pair (e.g., the forelegs of crickets or the hind legs of grasshoppers and locusts), in which case they were divided by two. Each head capsule and distal segment of the abdomen (i.e., telson) was regarded as representing a single individual. The obtained values were compared, and the highest count was taken as the estimate of the number of insects consumed (Calver and Wooller 1982). Vertebrates were identified through the analysis of bones, hairs, fur, and feathers. Prey items were classified using reference collections and manual identification guides. The identification of prey species present in the regurgitated pellets and those captured, which were likely to be prey at each instance, relied on dichotomous keys and collections from the Agricultural and Forest Zoology Department (ENSA, Algiers).

Table 1. Measurements of pellets of the Great Grey Shrike in Central Algerian Sahara: arithmetic mean ± standard deviation; minimal – maximal values.

Measurement	Spring	Summer	Autumn	Winter
Length (mm)	19 ± 5.8 (14–31)	16.93 ± 4.2 (9–23)	15.47 ± 3.3 (9–21)	18.4 ± 4.6 (9–26)
Width (mm)	9.29 ± 2.5 (8–17)	9.43 ± 1.8 (7–13)	9.68 ± 1.6 (7–13)	9.9 ± 1.1 (8–11)
Weight (g)	0.22 ± 0.1 (0.1–0.47)	0.23 ± 0.1 (0.06–0.4)	0.24 ± 0.1 (0.06–0.46)	0.34 ± 0.2 (0.06–0.66)

Data analysis

We utilized the Relative Abundance Index (*AR*%) to assess the proportion of each prey species in the bird's diet relative to all prey species consumed. The Relative Abundance Index helps identify the most abundant prey species in the bird's diet relative to others, providing valuable insights into the frequency of prey consumption by the predator. This index is calculated using the formula:

$$AR\% = (N_i / N) * 100$$

N_i – number of individuals of prey species

N – total number of prey individuals consumed

Additionally, we employed the Biomass Index (*B*%) to evaluate the percentage contribution of each prey species to the total biomass of prey consumed by the bird. The Biomass Index assists in determining the importance of different prey species in the shrike's diet based on their biomass contributions. This index is calculated using the formula:

$$B\% = (P_i / P) * 100$$

P_i – biomass of prey species

P – total biomass of all prey species consumed

We also used the Total Richness Index as a measure that represents the total number of different prey species found in the bird's diet. It is a simple count of the distinct species identified from the analysis of the bird pellets. Total Richness is important because it gives a snapshot of the dietary breadth of the bird. A higher richness indicates a more diverse diet, which may reflect the shrike's adaptability to different prey availability or environmental conditions.

Statistical analyses

To assess the significance of differences in the consumption of various animal classes across different seasons, we employed the Chi-square test for independence. This test was chosen due to its suitability for categorical data analysis. The Chi-square test enabled us to determine whether there were statistically significant differences in the consumption patterns of different animal classes across the seasons. A *p*-value of less than 0.05 was considered indicative of a significant difference. The results of this analysis provided valuable insights into the dietary habits of the species under study and the influence of seasonal variations.

The Chi-square test was performed using the scipy.stats module in Python, executed in a Google Colab environment for ease of computation and reproducibility.

RESULTS

This study offers insights into the composition of the regurgitation pellets of this bird, along with the identification of the most consumed species and plied the different indices (AR% and B%).

Diet composition

The analysis of the shrike's pellets reveals 194 animal species belonging to 68 families. Altogether, 1389 food items are found. Ants of the genera *Messor* and *Cataglyphis* are the most abundant prey of this predator. Beetles are the most represented with more than 70 species, among which *Cicindela flexuosa* is the most ingested species with a rate exceeding 5% (Table 3).

In the diet spectrum of the Great Grey Shrike, seven animal classes are identified, with insects being the most dominant, accounting for an abundance approaching 95%, across all seasons and stations. Insects are represented by 175 species belonging to 12 orders (Figure 3). The other classes are noted with values not exceeding 2%, and their presence is irregular across seasons and stations. An exception is made for arachnids, which are found in all four seasons, and reptiles observed in all three study stations (Table 2).

The Chi-square test was applied to evaluate whether the distribution of different prey classes (Insecta, Aves, and Mammalia) varied significantly across seasons (winter, spring, summer, and autumn). The results showed no significant differences in the distribution of prey classes between the seasons. Specifically, for Insecta (p = 0.618), Arachnida (p = 0.916), Aves (p = 0.108), and Mammalia (p = 0.288), the *p*-values were all greater than the significance threshold of 0.05, indicating that the distribution of these prey classes across seasons is independent and does not differ significantly. However, at the order level within the Insecta class, significant differences were observed, particularly for the orders Coleoptera (p = 0.0008) and Orthoptera ($p < 0.0001$), while no significant difference was found for the Hymenoptera order (p = 7.417).

The total richness of prey species found in the pellets of the Great Grey Shrike during a year and a half across three stations is 200 species, including 5 plant species. In the Telouline station, a traditional palm grove, we counted 136 animal species and 4 plant species over 4 seasons. Over five seasons at the INRAA station, we recorded 132 species and two plant species. At ITMAS, there were 40 species for one season (spring). In terms of seasons, the highest values coincide with the spring season for all three stations (between 40 and 63 species). The autumn period had the lowest species richness (37 species at INRAA and 42 at Telouline).

Biomass index

Insects remain the primary food source for the Great Grey Shrike throughout the year, with their abundance peaking at over 65% in autumn and winter. During spring, birds and mammals contribute significantly, accounting for 29% and 21% of the biomass consumed, respectively. Arachnids serve as a potential substitute for insects, making up 14.82% in summer and 12.05%

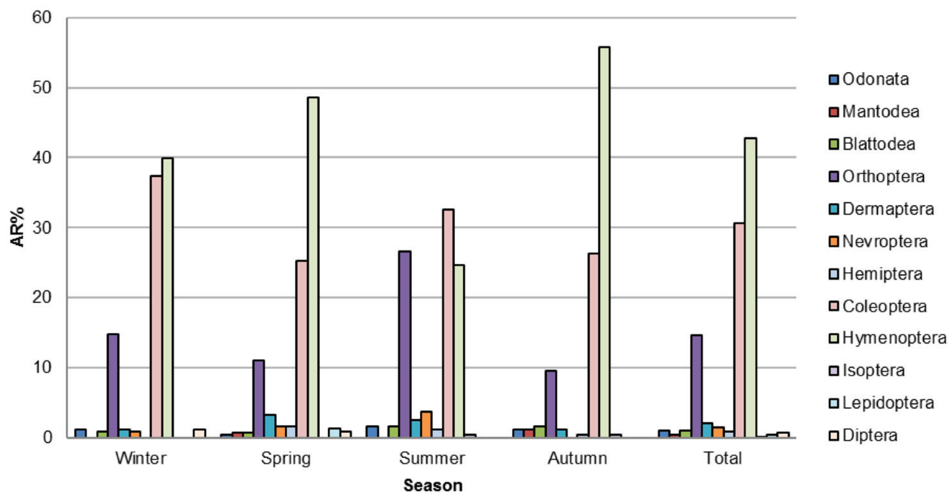

Figure 3. Relative Abundance Index (*AR*%) of the main insect orders consumed by the Great Grey Shrike in each season.

Table 2. The relative abundances, biomass and total richness of the classes of prey species of the Great Grey Shrike in relation to seasons (AR% – Relative Abundance Index; B% – Biomass Index; O. ind. – order unidentified).

Prey taxa	Index	Season				Total
		Winter	Spring	Summer	Autumn	
Arachnida	AR%	1.56	1.32	2.02	1.59	1.57
	B%	7.04	3.68	14.82	12.05	7.85
Insecta	AR%	97.10	95.16	94.76	97.61	96.01
	B%	65.41	37.44	49.98	67.98	49.83
Aves	AR%	0.00	0.88	0.40	0.00	0.36
	B%	0.00	29.01	14.82	0.00	16.22
Mammalia	AR%	0.22	0.66	0.00	0.00	0.28
	B%	14.54	21.76	0.00	0.00	12.81
Reptilia	AR%	0.22	0.44	0.81	0.80	0.50
	B%	2.68	2.28	5.19	9.32	3.86
Amphibia	AR%	0.00	0.00	0.41	0.00	0.07
	B%	0.00	0.00	3.33	0.00	0.73
Vertebrata O. ind.	AR%	0.22	0.00	0.00	0.00	0.07
	B%	3.83	0.00	0.00	0.00	0.81
Plants	AR%	0.67	1.54	1.61	0.00	1.14
	B%	6.50	5.82	11.86	10.65	7.88

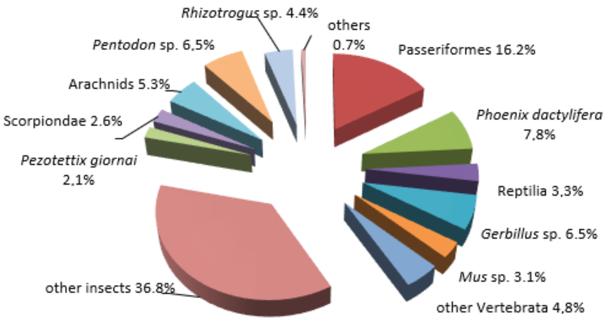

Figure 4. The relative biomasses of the main species ingested by the Great Grey Shrike in the study region.

in autumn. The inclusion of plants, especially dates, in the diet is notable, particularly during fruit maturation, constituting 11.86% in summer and 10.65% in autumn (Table 2). The comprehensive analysis includes all elements found in the pellets.

In terms of relative biomass, insects dominate, comprising 49.83%, followed by birds, predominantly a Passeriformes species unidentified, contributing 9.73%. Mammals, represented by the genera *Gerbillus* and *Mus*, make up 6.49% and 3.08% of the biomass consumed, respectively. Arachnids and plants collectively contribute over 7%.

The Great Grey Shrike shows dietary preferences with passerines constituting 9.7%, dates 7.8%, *Gerbillus* sp. and *Pentodon* sp. 6.5%, and notable pests like *Rhizotrogus* sp. beetles 4.4%. Orthopterans, specifically *Pezotettix giornai*, contribute 2.1%. A scorpion, a favoured prey, is present at a rate of 2.6%. Spring emerges as a season with the highest biomass of prey for the Great Grey Shrike (Figure 4).

DISCUSSION

Diet composition

During the spring and summer seasons, both bird and amphibian prey species were observed. Similar findings were reported in a Saharan area, specifically Ouargla, showing comparable results to those recorded in the current study (Ababsa et al. 2012). According to the same authors, Rodentia contribute only 2.9% to the diet. Similarly, Taibi et al. (2018) note that the diet of the grey shrike is primarily insectivorous. In the Biskra region, insects account for 91.6%, while vertebrates contribute 6.2% (Ababsa et al. 2005) in two palm groves (*Phoenix dactylifera*). These results revealed that the diet of the subspecies *Lanius excubitor elegans* consists mostly of prey belonging to the class Insecta, with a frequency of 87.5%, followed by the class Arachnida (9.6%) and Rodentia (2.9%). Our observations align with those of Hódar (2006), as he emphasizes that in two Spanish zones, beetles predominate in the diet with a rate of 75% of prey in April, followed by orthopterans. The menu is enriched with lizards during the breeding period. Birds and small mammals are found accidentally in the diet of the shrike.

The lack of significant differences in prey class distribution across seasons, as observed in the Chi-square test, could be attributed to the specific environmental conditions of the study area. This study was conducted in a desert region, where extreme temperatures and limited precipitation create relatively stable ecological conditions. Unlike more temperate regions where seasonal variations may significantly affect prey availability and abundance, desert ecosystems tend to exhibit a more constant pattern of resource availability year-round. The seasonal fluctuations that typically influence prey populations in other ecosystems may be less pronounced in such harsh environments, leading to relatively uniform distribution patterns throughout the year. However, within the Insecta class, significant differences were observed, particularly in the orders Coleoptera and Orthoptera, while no significant differences were found in the Hymenoptera order. This suggests that the Great Grey Shrike shows a preference for insects and actively seeks substitutes among different orders within this class, reflecting the observed variation in this taxa level (order).

In Poland, *Lanius collurio* primarily consumes beetles, hymenopterans, and orthopterans, accounting for a rate of 98.9% (Tryjanowski et al. 2003). The same trophic behaviour is noted for the grey shrike in another study by Antczak et al. (2005). These authors emphasize that the role of amphibians is marginal in the trophic menu of the species. On the contrary, Hromada et al. (2002) studied the effect of the grey shrike on the reproductive success of small passerines due to its significant predation power over this group of prey. While during the non-breeding season, Paczuska et al. (2021) observed that the ratio of vertebrates to invertebrates was 64.6 : 35.4, with Rodentia and Coleoptera being the most abundant orders. Hymenopteran species are prey that occupy the first position with a proportion of 40 to 55% from autumn to winter. They are in the third position in terms of abundance, after beetles and orthopterans.

Throughout the study period, the trophic menu of the grey shrike is composed of 42.8% of hymenopterans, followed by beetles with 30.6% and orthopterans with 14.7%. In Europe, hymenopterans are less consumed in the meals of juveniles, representing a rate of 11.5% (Budden and Wright 2000). They constitute 17% of the total prey of the Red-backed Shrike (Tryjanowski et al. 2003). Finally, in the trophic menu of *Lanius collurio*, the abundance of hymenopterans is around 8.0% and comes in second place after beetles (Golawski 2006).

The same observations are recorded in the north of Algeria. Taibi et al. (2011) identified a total of 258 prey species distributed among 25 systematic categories. Hymenoptera dominate in terms of the number of individuals both in Ramdhania (35.9%) and Baraki (41.9%).

In the Canary Islands, the study of the spring diet of *Lanius meridionalis* shows that in both the north and south of Tenerife, beetles dominate with 70.9% and 87.2%, respectively. They are followed by lizards with 9.4%, as well as hymenopterans with 5.0%, respectively in north and south Tenerife (Padilla et al. 2009). The prey differs according to the region and the period, and this predator shows adaptability with the lack of preferred prey.

Hymenopteran prey belong to 68 families, with the family Formicidae being the most abundant with a percentage exceeding 35%. Other Hymenoptera such as Scoliidae, Pompilidae, and Sphecidae are used with very low values. Tenebrionidae, Scarabeidae, and Cicindellidae are the preferred beetle prey for the grey shrike. Acrididae also count among the most chosen families with a rate exceeding 12% in the summer menu of the grey shrike. Padilla et al. (2005) counted a percentage exceeding 85% for beetles, primarily represented by Curculionidae (49.5%) and Tenebrionidae (34.5%), the rest consisting of other arthropods such as Hymenoptera, Orthoptera, Hemiptera, Odonata, Dictyoptera, as well as the family Araneae and vertebrates including reptiles and micromammals.

In terms of species, ants of the genera *Messor*, *Cataglyphis*, and *Componotus* are the most abundant in the trophic menu of this predator, with percentages of 12.6%, 9.55%, and 7.61%, respectively. In the region of Ouargla, although the grey shrike prefers orthopterans such as *Gryllotalpa vulgaris* with a rate of 12.5% and a Caelifer (undetermined species) with an abundance of 10.6%, ants are found with interesting relative frequencies, such as *Camponotus* sp. (11.5%) and *Tapinoma* sp. (5.8%) (Ababsa and Doumandji 2006).

The order of beetles is the most represented in terms of species, with more than 70 species. Among them, *Cicindela flexuosa* is the most chosen with an abundance exceeding 5.8% possibly due to its attractive colour. In Romania, the diet of *Lanius senator* is dominated by *Cicindela lunulata* with a rate of 74.7% (Sandor et al. 2004).

A similar scenario is observed in Mitidja region by Taibi et al. (2009), where an unspecified Gryllidae species constitutes the most preferred item in the grey shrike's menu, accounting for rates between 12.6% and 15.6% in two Algiers stations. Vertebrates are included in the bird's diet, with abundances not surpassing 0.28%. Furthermore, they report the presence of a urodele amphibian, *Discoglossus pictus* (0.6% of the diet), along with an undetermined lacertilian reptile, birds such as *Phylloscopus* sp. and *Passer* sp., and mammals like *Mus spretus, Crocidurarussula,* and Chiroptera sp. ind. According to these authors, shrike primarily preys on organisms with substantial biomass, typically featuring soft bodies and easy catchability. In Ouargla, two mammals are present in the regurgitates, *Mus musculus* and *Gerbillus gerbillus*, with respective frequencies of 1.9% and 1.0% (Ababsa et al. 2012). Bats are also mentioned in the diet of *Lanius excubitor*, such as the species *Pipistrellus pipistrellus* in Germany (Grimm 2020). While in Poland, Paczuska and Golawski (2021) observed the presence of amphibian species (*Lissotriton vulgaris*) during the winter season.

The highest values of total richness corresponded with the spring season for all three stations (between 40 and 63 species). The autumn period had the lowest species richness (37 species at INRAA and 42 at Telouline). Similar data were collected at Sidi Okba by Taibi and Doumandji (2014), who recorded a total richness of 135 species with 40 species during spring and 70 species in autumn. Taibi et al. (2009) counted 194 prey species for the Mitidja region for all the study period.

Biomass index

Plants, mainly dates, are present in the predator's diet, especially during the fruit maturation period (summer and autumn). According to previous studies, plants are not typically part of the grey shrike's trophic menu. The presence of some vegetation such as *Phoenix dactylifera*, Asteracae or Poaceae species in the diet might be considered as a secondary effect of predation on insects located on these plants, representing unintentional ingestion. In this investigation, we took into account all components identified in the pellets, similar to previous studies like by Belkacem et al. (2017).

Throughout the sampling period, half of the relative biomass corresponds to that of insects, followed by birds, mainly represented by a Passeriformes species unidentified. Finally, the genera *Gerbillus* and *Mus*, which are mammals, represent only 6.49% and 3.08%, respectively. Arachnids and plants are present with rates exceeding 7%. Isenmann et al. (2000), studying the ingested biomass by *Lanius minor* near Montpellier, report that beetles contribute the most to the biomass (77.2%) in both 1997 and 1998. In Spain, the study on *Lanius meridionalis koenigi* shows that vertebrates provide the largest share of relative biomass (87.6%), where lizards represent a rate of 64%, compared to arthropods, which only occupy 12.4%, mainly composed of beetles (9.2%) and orthopterans (2.3%) (Padilla et al. 2005). In Spain, vertebrates represent more than 40% of the biomass 8 months out of 11 in Baza and 5 months out of 6 in Grao (Hódar 2006). In winter, it consists of birds and mammals, while during the breeding season, reptiles are more prominent. In addition to vertebrates, orthopterans and beetles are present with very low biomass throughout the year. They consist of arachnids, spiders, or myriapods with a value that reaches 5% of the total biomass. According to Didier (2007), although the grey shrike rarely captures small vertebrates, they constitute 50% of the food biomass, which is a very important part of the energy intake.

Among the most ingested species in terms of biomass, passerines species unidentified constitute 9.7%, dates come in second place with 7.8%, followed by *Gerbillus* sp. and *Pentodon* sp., contributing with a biomass of 6.5%. Beetles characterized by a significant pest, notably *Rhizotrogus* sp., form a biomass of 4.4%. Orthopterans, particularly *Pezotettix giornai*, participate with 2.1%. It's worth noting a scorpion, which is one of the preferred preys of the Great Grey Shrike, with a rate of 2.6%. Padilla et al. (2009) indicate that the house mouse presents a seasonal biomass ranging between 22.9% and 30% in different seasons. According to Taibi et al. (2011), *Discoglos suspictus* constitutes the highest biomass of 11.9% (in winter) in the Ramdhania station. While in Baraki, the same species holds the highest rate in spring (16.1%). Although *Messor barbarus* is more abundant than other species, it makes up only a very small part of the ingested biomass, not exceeding 0.7%, all seasons and stations combined, due to its small size compared to other prey. The species *Macrothorax morbillosus* also forms a relatively modest biomass with 4.3% (in winter in the Ramdhania station) and 3.6% (in spring in Baraki). *Rhizotrogus* sp. represents 1.2% of the biomass in winter in Ramdh ania and 0.8% in Baraki. Beetles, despite being rich in species, represent a relatively low biomass in the menu of the Northern Algerian Grey Shrike.

CONCLUSION

The feeding habits of the Great Grey Shrike show clear seasonal variations, though no significant differences were observed at the taxonomic class level. Insects remain the predominant food source throughout the year. At the taxonomic order level, a high significant difference was observed. During the summer months, its diet is mainly composed of orthopterans and beetles, potentially reflecting a decrease in ant predation. In the breeding season, covering both spring and summer, the shrike preys on nestlings, capitalizing on their limited mobility. In autumn and winter, the focus shifts towards rodents. This ability to adjust prey preferences based on seasonal availability underscores the remarkable adaptability of the Great Grey Shrike. Furthermore, the species plays a crucial role in regulating insect populations, particularly in environments where it serves as a top predator. By feeding on insects such as grasshoppers, beetles, and ants, the shrike helps control the numbers of these pests, reducing the potential damage to crops and native vegetation. Its predatory behaviour contributes to maintaining ecological balance, supporting natural biological control, and reducing the need for chemical pest control. This underscores the ecological significance of the Great Grey Shrike in promoting biodiversity and sustaining healthy ecosystems.

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Appendix - Table 3.

Inventory, counts, and relative abundances of species ingested by *Lanius excubitor elegans* in the study stations combined (AR% – Relative Abundance Index; Ni – individuals number; C. ind. – class unidentified; O. ind. – order unidentified; F. ind. – family unidentified; Sp. ind. – species unidentified).

Class	Order	Family	Species	AR% Winter	AR% Spring	AR% Summer	AR% Autumn	Ni	AR%
Arachnida	Araneae	Araneae F. ind.	Araneae sp. ind. 1	0.45	0.44	0.00	0.40	5	0.36
			Araneae sp. ind. 2	0.22	0.00	0.00	0.00	1	0.07
			Araneae sp. ind. 3	0.22	0.22	0.00	0.00	2	0.14
	Solifugae	Galeodidae	Galeodes sp.	0.00	0.22	0.00	1.20	4	0.28
		Solifugae F. ind.	Solifugae sp. ind.	0.00	0.22	0.00	0.00	1	0.07
	Scorpiones	Buthidae	*Androctonus* sp.	0.00	0.22	0.40	0.00	2	0.14
			Buthidae sp. ind.	0.22	0.00	0.40	0.00	2	0.14
		Scorpiones F. Ind.	Scorpiones sp. ind.	0.22	0.00	1.21	0.00	4	0.28
	Arachnida O. Ind.	Arachnida F. ind.	Arachnida sp. ind.	0.22	0.00	0.00	0.00	1	0.07
Insecta	Odonata	Libelluliddae	Libellulidae sp. ind.	0.22	0.44	0.00	0.40	4	0.28
		Odonata F. ind.	Odonata sp. ind.	0.89	0.00	1.61	0.40	9	0.64
		Lestidae	Lestidae sp. ind.	0.00	0.00	0.00	0.40	1	0.07
	Mantodea	Empusidae	*Blepharopsis mendica*	0.00	0..00	0.00	1.20	3	0.21
		Mantidae	Mantidae sp. ind.	0.00	0.66	0.00	0.00	3	0.21
	Blattodea	Blattidae	*Periplaneta americana* (L., 1758)	0.22	0.22	1.21	0.00	5	0.36
			Blattidae sp. ind.	0.22	0.00	0.40	1.20	5	0.36
		Blattodea F. ind.	Blattodea sp. ind.	0.45	0.44	0.00	0.40	5	0.36
		Gryllidae	Gryllidae sp. ind.	0.22	0.22	0.40	0.00	3	0.21
	Orthoptera	Ensifera F. ind.	Ensifera sp. ind.	0.00	0.22	0.40	0.00	2	0.14
		Pyrgomorphidae	*Pyrgomorpha cognata*	0.00	0.00	2.02	0.00	5	0.36
			Pyrgomorpha sp.	1.34	1.32	1.61	0.00	16	1.14
		Acrididae	*Thisoicetrus* sp.	0.45	1.10	1.61	0.00	11	0.78
			Acrotylus sp.	0.89	0.88	4.44	4.78	31	2.21
			Aiolopus sp.	0.22	0.00	0.00	0.00	1	0.07
			Pezotettix giornai	2.00	0.44	4.44	1.59	26	1.85
			Ochrilidia sp.	0.00	0.00	2.42	0.00	6	0.43
			Locusta migratoria	0.00	0.00	0.40	0.00	1	0.07
			Omocestus sp.	0.00	0.00	0.40	0.00	1	0.07
			Anacridium aegyptium	0.00	0.00	0.00	0.80	2	0.14
			Eyprepocnemis plorans	1.34	0.00	3.23	1.59	18	1.28
			Calliptamus sp.	3.79	0.00	0.40	0.00	18	1.28
			Calliptaminae sp. ind.	0.00	0.44	0.00	0.00	2	0.14
			Oedipoda sp.	2.23	0.00	0.00	0.00	10	0.71
			Acrididae sp. ind.	1.34	0.88	0.81	0.00	12	0.85
			Acrididae sp. ind. 1	0.22	1.76	0.81	0.00	11	0.78
			Acrididae sp. ind. 2	0.22	1.32	1.21	0.40	11	0.78
			Acrididae sp. ind. 3	0.45	0.66	0.00	0.00	5	0.36
			Acrididae sp. ind. 4	0.00	1.76	0.40	0.00	9	0.64
			Acrididae sp. ind. 5	0.00	0.00	0.81	0.40	3	0.21
			Acrididae sp. ind. 6	0.00	0.00	0.81	0.00	2	0.14
	Dermaptera	Labiduridae	*Labidura riparia*	0.22	0.22	1.21	0.00	5	0.36
			Anisolabis mauritanicus	0.45	0.66	0.81	0.00	7	0.50
		Forficulidae	*Forficula auricularia*	0.45	1.32	0.40	0.40	10	0.71
			Forficula sp.	0.00	0.66	0.00	0.00	3	0.21
		Dermaptera F. ind.	Dermaptera sp. ind.	0.00	0.22	0.00	0.40	2	0.14

Class	Order	Family	Species	AR% Winter	AR% Spring	AR% Summer	AR% Autumn	Ni	AR%
			Dermaptera sp. ind. 2	0.00	0.22	0.00	0.00	1	0.07
			Dermaptera sp. ind. 3	0.00	0.00	0.00	0.40	1	0.07
	Nevroptera	Myrmeleontidae	Myrmeleontidae sp. ind. 1	0.89	0.66	0.40	0.00	8	0.57
			Myrmeleontidae sp. ind. 2	0.00	0.44	2.02	0.00	7	0.50
			Myrmeleontidae sp. ind. 3	0.00	0.22	1.21	0.00	4	0.28
		Chrysopidae	*Chrysoperla* sp.	0.00	0.22	0.00	0.00	1	0.07
	Hemiptera	Reduviidae	*Reduvius* sp.	0.00	0.22	0.40	0.00	2	0.14
			Reduviidae sp. ind.	0.00	0.00	0.40	0.00	1	0.07
		Pentatomidae	Pentatominae sp. ind.	0.00	0.44	0.40	0.00	3	0.21
		Nabidae	Nabidae sp. ind.	0.00	0.44	0.00	0.00	2	0.14
		Lygaeidae	Lygaeidae sp. ind.	0.00	0.44	0.00	0.00	2	0.14
		Heteroptera F. ind.	Heteroptera sp. ind.	0.00	0.00	0.00	0.40	1	0.07
	Coleoptera	Pterostichidae	Pterostichidae sp. ind.	0.45	1.10	0.00	0.00	7	0.50
			Pterostichidae sp. ind. 1	0.00	0.22	0.00	0.00	1	0.07
			Platysma sp.	0.00	0,66	1.61	0.00	7	0.50
		Scarabeidae	*Harpalus* sp. 1	1.56	0.00	0.00	0.00	7	0.50
			Harpalus sp. 2	0.45	0.00	0.00	0.00	2	0.14
			Harpalinae sp. ind.	0.22	0.22	0.00	0.00	2	0.14
			Pentodon sp.	0.45	3.30	3.63	5.58	40	2.85
			Rhizotrogus sp.	0.00	3,30	0.40	0.00	16	1.14
			Dynastinae sp. ind.	0.00	0.00	0.00	0.80	2	0.14
			Onthophagus sp.	0.00	0.00	1.61	0.00	4	0.28
			Rutelinae sp. ind.	0.00	0.00	0.00	0.40	1	0.07
			Anomalacra sp.	0.00	0.00	0.00	0.40	1	0.07
			Scarabeidae sp. ind. 1	0.00	0.44	0.40	0.00	3	0.21
			Phyllognathus sp.	0.00	0.22	0.00	0.00	1	0.07
			Scarabeidae sp. ind. 2	0.00	0.44	0.81	0.40	5	0.36
			Scarabeidae sp. ind. 3	0.67	0,22	0.00	0,00	4	0.28
			Scarabeidae sp. ind. 4	0.22	0.00	0.00	0.00	1	0.07
			Scarabeidae sp. ind. 5	0.22	0.00	0.00	0.00	1	0.07
		Cetoniidae	Cetoniidae sp. ind.	0.22	0.00	0.00	0.00	1	0.07
		Aphodiidae	*Aphodius* sp.	0.45	0.00	0.81	0.00	4	0.28
		Carabidae	*Acinopus* sp.	0.22	0.22	2.02	0.00	7	0.50
			Percus sp.	0.22	0.00	0.00	0.80	3	0.21
			Poecilus purpurascens	0.67	0.22	0.00	0.80	6	0.43
			Scarites sp.	0.00	0.00	0.40	0.00	1	0.07
			Carterus sp.	0.89	0.22	0.00	0.00	5	0.36
			Bembidion sp.	0.00	0.22	0.00	0.00	1	0.07
			Carabidae sp. ind.	0.22	0.22	0.00	0.40	3	0.21
		Caraboidea F. ind.	Caraboidea sp. ind. 1	0.45	0.22	0.00	0.00	3	0.21
			Caraboidea sp. ind. 2	0.00	0.00	0.81	0.00	2	0.14
		Cicindellidae	*Cicindela flexuosa*	6.90	3.08	7.26	7.57	82	5.84
		Tenebrionidae	*Litoborus* sp.	4.23	1.76	1.61	0.00	31	2.21
			Asida sp.	0.22	0.00	0.00	0.00	1	0.07
			Nalassus sp.	0.00	0.22	0.00	0.00	1	0.07
			Neoisocerus tunisiensis	0.67	0.22	0.81	0.00	6	0.43
			Mesostena angustata	0.67	0.00	0.00	0.40	4	0.28
			Opatroides sp.	0.00	1.32	0.00	0.00	6	0.43
			Erodius zophosoideus	1.11	0.22	0.00	0.00	6	0.43
			Erodius sp.	0.45	3.74	0.00	0.00	19	1.35

Class	Order	Family	Species	AR% Winter	AR% Spring	AR% Summer	AR% Autumn	Ni	AR%
			Zophosis punctata	0.45	0.00	0.00	0.00	2	0.14
			Zophosis plana	3.12	0.22	0.40	0.00	16	1.14
			Trachyderma hispida	0.00	0.00	0.40	2.39	7	0.50
			Crypticus sp.	0.22	0.00	0.40	0.00	2	0.14
			Pachychila sp.	0.45	0.00	0.00	0.00	2	0.14
			Opatrum sp.	0.00	0.22	0.00	0.40	2	0.14
			Pimelia sp.	0.45	0.00	0.00	1.20	5	0.36
			Adesmia metallica faremonti	0.00	0.22	0.00	0.00	1	0.07
			Tentyria sp.	0.67	0.00	0.00	0.00	3	0.21
			Alleculinae sp. ind.	0.45	0.22	0.81	0.00	5	0.36
			Tentyrini sp. ind. 1	1.11	0.22	0.00	0.00	6	0.43
			Tentyrini sp. ind. 2	0.67	0.00	0.00	0.00	3	0.21
			Tenebrionidae sp. ind.	0.45	0.66	2.02	0.40	11	0.78
			Tenebrionidae sp. ind. 2	2.00	0.44	0.40	0.40	13	0.93
			Tenebrionidae sp. ind. 3	0.67	0.22	0.81	0.00	6	0.43
			Tenebrionidae sp. ind. 4	0.89	0.00	0.00	0.00	4	0.28
		Dermestidae	Dermestidae sp. ind.	0.45	0.00	0.00	0.00	2	0.14
		Silphidae	Silphidae sp. ind.	0.45	0.00	0.00	0.00	2	0.14
		Buprestidae	*Sphenopterus* sp.	0.22	0.00	0.00	0.00	1	0.07
		Elateridae	*Cryptohypnus* sp.	0.00	0.00	2.42	0.00	6	0.43
			Elateridae sp. ind.	0,00	0.22	2.02	0.00	6	0.43
		Curculionidae	*Sitona* sp.	0.22	0.00	0.00	0.00	1	0.07
			Lixus sp.	0.22	0.00	0.00	0.40	2	0.14
			Otiorhynchus sp.	0.00	0.00	0.00	0.80	2	0.14
			Coniocleonus sp.	0.00	0.22	0.00	0.00	1	0,07
			Hypera sp.	0.45	0.00	0.00	0.00	2	0.14
			Coccotrypes dactyliperda	0.22	0.00	0.00	0.40	2	0.14
			Curculionidae sp. ind. 1	0.45	0.22	0.00	0.80	5	0.36
			Curculionidae sp. ind. 2	0.22	0.00	0.00	0.80	3	0.21
		Apionidae	Apionidae sp. ind.	0.45	0.00	0.40	0.40	4	0.28
		Staphylinidae	Staphylinidae sp. ind.	0.22	0.00	0.00	0.00	1	0.07
		Coleoptera F. ind.	Coleoptera sp. ind. 1	0.00	0.22	0.40	0.40	3	0.21
			Coleoptera sp. ind. 2	0.45	0,00	0.00	0.00	2	0.14
	Hymenoptera	Apidae	*Apis mellifera*	0.45	0.44	0.00	0.40	5	0.36
			Apidae sp. ind.	0.22	0.00	0.00	0.00	1	0,07
			Xylocopinae sp. ind.	0.45	0.00	0.00	0.40	3	0.21
		Apoidea F. ind.	Apoidea sp. ind.	0.89	0.00	0.40	0.00	5	0.36
			Apoidea sp. ind. 2	0.00	0.00	0.40	0.00	1	0.07
		Formicidae	*Monomorium* sp.	0.00	1,32	0.40	1,99	12	0.85
			Monomorium salomonis	0.00	2.42	3.23	0.00	19	1.35
			Monomorium monomorium	0.00	0.44	0.00	0.00	2	0,14
			Pheidole pallidula	0.00	0.44	0.81	0.00	4	0.28
			Cataglyphis savignyi	0.00	1.32	0.00	0.00	6	0.43
			Cataglyphis bombycina	1.34	2.86	0.81	1.59	25	1.78
			Cataglyphis bicolor	0.00	2.86	0.00	0.00	13	0.93
			Cataglyphis sp.	8.91	6,37	3.23	5.18	90	6.41
			Tetrmorium sp.	0.00	0.22	0.40	0.00	2	0.14
			Tapinoma nigerrimum	2.00	0.88	0.00	0.00	13	0.93
			Tapinoma sp.	0.45	0.00	0.00	1.59	6	0.43

Class	Order	Family	Species	AR% Winter	AR% Spring	AR% Summer	AR% Autumn	Ni	AR%
			Componotus xanthomelas	0.22	0.22	0.00	0.00	2	0.14
			Componotus thoracicus	0.22	3.30	3.63	0.00	25	1.78
			Componotus sp.	9.80	2.20	0.81	9.56	80	5.69
			Messorforeli	2.45	0.44	0.00	7.57	32	2.28
			Messora egyptiacus	0.00	0.22	0.00	3.59	10	0.71
			Messor sp.	9.13	13.19	0.81	12.75	135	9.61
			Crematogaster sp.	0.00	0.22	0.00	2.39	7	0.50
			Plagiolepis sp.	0.00	0.22	0.00	0.00	1	0.07
			Formicidae sp. ind. 1	0.00	0.00	0.00	0.80	2	0,14
			Formicidae sp. ind. 2	0.22	0.00	0.00	0.00	1	0.07
		Ichneumonidae	Ichneumonidae sp. ind. 1	0.22	0.00	0.40	0.00	2	0.14
			Ichneumonidae sp. ind. 2	0.00	0.00	0.00	1.20	3	0.21
		Sphecidae	Sphecidae sp. ind. 1	0.22	0.22	0.81	0.00	4	0.28
			Sphecidae sp. ind. 2	0.22	0.44	0.00	0.00	3	0.21
		Andrenidae	Andrenidae sp. ind.	0.22	0.66	0.00	0.00	4	0.28
		Pompilidae	Pompilidae sp. ind.	0.22	0.00	0.40	0.00	2	0.14
		Scoliidae	*Elis* sp.	0.00	0.66	0.00	1.20	6	0.43
			Scolia sp.	0.22	0.66	0.81	0.40	7	0.50
			Scoliidae sp. ind.	0.89	1.10	0,40	0.80	12	0.85
			Scoliidae sp. ind. 2	0.22	0.22	0.00	0.00	2	0.14
			Scoliidae sp. ind. 3	0.45	0.00	0.40	0.00	3	0.21
		Anthophoridae	Anthophoridae sp. ind.	0.22	0.22	0.00	0.00	2	0.14
		Eumenidae	Eumenidae sp. ind.	0.00	0.44	0.00	0.40	3	0.21
		Vespoidea F. ind.	Vespoidea sp. ind.	0.00	0.88	0.40	0.40	6	0.43
			Vespoidea sp. ind. 1	0.00	0.44	0.81	0.80	6	0.43
			Vespoidea sp. ind. 3	0.00	0.22	0.00	0.80	3	0.21
			Vespoidea sp. ind. 4	0.00	0.22	0.00	0.80	3	0.21
		Ophionidae	Ophionidae sp. ind.	0.00	0.00	0.00	0.80	2	0.14
		Tiphiidae	Tiphiidae sp. ind.	0.00	1.76	0.40	0.00	9	0.64
			Tiphiidae sp. ind. 2	0.00	0.66	0.40	0.00	4	0.28
			Tiphiidae sp. ind. 3	0.00	0.00	0.40	0.00	1	0.07
		Halictidae	*Halictus* sp.	0.00	0.00	3.23	0.00	8	0.57
			Lasioglossum sp.	0.00	0.00	0.81	0.40	3	0.21
			Halictidae sp. ind.	0.00	0.22	0.00	0.00	1	0.07
	Isoptera	Isoptera F. ind.	Isoptera sp. ind.	0.00	0.00	0.40	0.40	2	0.14
	Lepidoptera	Lepidoptera F. ind.	Lepidoptera sp. ind.	0.00	1.32	0.00	0.00	6	0.43
	Diptera	Calliphoridae	*Lucilia* sp.	1.11	0.22	0.00	0.00	6	0.43
		F. ind.	Cyclorapha sp. ind.	0.00	0.66	0.00	0.00	3	0.21
Aves	Passeriformes	Passeriformes F. ind.	Passeriformes sp. ind. 1	0.00	0.66	0.00	0.00	3	0.21
			Passeriformes sp. ind. 2	0.00	0.22	0.40	0.00	2	0.14
Mammalia	Rodentia	Muridae	*Gerbillus* sp.	0.00	0.44	0.00	0.00	2	0.14
			Mus sp.	0.22	0.00	0.00	0.00	1	0.07
		Rodentia F. ind.	Muridae sp. ind.	0.00	0.22	0.00	0.00	1	0.07
Reptilia	Squamata	Lacertidae	Lacertidae sp. ind.	0.00	0.22	0.00	0.00	1	0.07
		Scincidae	*Chalcides* sp.	0.00	0.22	0.00	0.00	1	0.07
		Squamata F. ind.	Squamata sp. ind.	0.00	0.00	0.40	0.00	1	0.07
	Reptilia O. ind.	Reptilia F. ind.	Reptilia sp. ind.	0.22	0.00	0.40	0.80	4	0.28
Amphibia	Amphibia O. ind	Amphibia F. ind.	Amphibia sp. ind.	0.00	0.00	0.40	0.00	1	0.07
Vertebrata C. ind.	Vertebrata O. ind.	Vertebrata F. ind.	Vertebrata sp. ind.	0.22	0.00	0.00	0.00	1	0.07