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Diet composition of the Atlas Flycatcher *Ficedula speculigera* in Northeastern Algeria

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Abstract The diet of the Atlas Flycatcher, an endemic bird species of North Africa is studied in Northeastern Algeria in the forest of Guerrouch in the Taza National Park. The diet analysis was based on the examination of the faecal sacs of the nestlings (n=150) collected in nest boxes installed in a mixed formation of Algerian oak and African oak *(Quercus canariensis* and *Quercus afares)*. A total of 854 food items were identified, representing 49 prey taxa. The analysis of centesimal frequencies by class revealed the clear dominance of Insecta with 85.12%, followed by Arachnida 13.34%, Gastropoda 1.28% and Malacostraca 0.23%. Regarding orders, the diet was constituted mainly of Coleoptera 44.37%, followed by Hemiptera 21.89% and Araneae 13.34%. The size of the prey taxa varied between 3 and 14 mm with an average of 7.11±3.14 mm. The best represented size class was that which varies between 3 and 4.37 mm. To test the homogeneity between the 4 nest boxes sampled, an *ANOVA test* was applied. The results show the presence of 2 distinct groups of nesting boxes concerning the variable number of families / faecal sacs.

Keywords: diet, Guerrouch, prey taxa, oak forest

Összefoglalás Az Észak-Afrikában endemikus Atlasz-légykapó táplálékösszetételét vizsgálták a Taza Nemzeti Park tölgyeseiben (Guerrouch, Északkelet-Algéria). A Kanári-tölgy és az afrikai tölgy kevert állományába kihelyezett négy fészekodú fiókáitól összesen 150 ürülékmintát gyűjtöttek. Az ürülékből 854 táplálékmaradványt azonosítottak, amelyeket 49 taxonba soroltak. A maradványok százalékos megoszlása alapján a rovarok (85,12%) domináltak, amelyeket a pókok (13,34%), a csigák (1,28%) és a szárazföldi rákok (0,23%) követtek. A rovarok többsége a bogarakhoz (44,37%) és a poloskákhoz (21,89%) tartozott. A táplálékdarabok mérete átlagosan 7,11±3,14 mm-esnek (3–14 mm közötti intervallumban) adódott. A tápláléktípusok (családok) előfordulási gyakorisága alapján a négy fészekalj két elkülönülő csoportot alkotott.

Kulcsszavak: táplálék, Guerrouch, zsákmány összetétel, tölgyerdő

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Introduction

The Atlas Flycatcher *(Ficedula speculigera)* is an endemic bird of the Atlas Mountains in North Africa. Few studies have been devoted to this species, probably because it was considered a subspecies of the Pied Flycatcher (*F. hypoleuca)*. Saetre *et al.* (2001) were the first to suggest, mainly based on molecular genetic data, that the Atlas Flycatcher should be elevated to full species status. They compare mitochondrial DNA sequences within the black and white *Ficedula* species complex. As a result, they found that this species complex contains one more species than previously recognised, which originated from the Atlas Mountains of Morocco. They found that this latter was genetically as distinct from the Pied Flycatcher as from the Collared Flycatcher *(F. albicolis)*. However, since Saetre *et al.* (2001) did not compare *F. h. speculigera* with the morphologically and geographically intermediate form *F. h. iberiae*, their assessment has been widely rejected (e.g. Dickinson 2003, del Hoyo *et al*. 2006, Taylor & Christie 2013), and just a few works have accepted it (e.g. Clements *et al*. 2015). More recently Corso *et al*. (2015) and Robb andThe Sound Approach (2015) analysed plumage and song variation, which clearly showed that *F. speculigera* is different from the designated *F. hypoleuca* but not systematically with the form *F. h. iberiae*. Since then Potti *et al*. (2016) have reanalyzed morphological characters, which led them to conclude that the form *F. h. speculigera* is specifically distinct from the form *F. h. iberiae*.

The Atlas Flycatcher is distributed across Morocco (south to the Middle Atlas Mountains), northern Algeria and northern Tunisia, and winters in West Africa (del Hoyo *et al*. 2006, Clements *et al*. 2015). There are also unconfirmed sightings in Italy and Malta (Corso *et al*. 2015).

Aspects of the biology and ecology of this species still poorly understood in North Africa. In this context, only the work of Boudeffa (2014) can be mentioned, who was interested in the breeding biology and trophic ecology of this species in a cork oak forest *(Quercus suber)* in the region of El Kala in the extreme Northeast Algeria. The diet composition was studied by analyzing the food bolus of the chicks using the collar method.

Our contribution aims to better understand the trophic ecology of this bird, in a humid deciduous oaks forest in the Taza National Park, in North Algeria.

Material and Methods

Study area

The study was carried out in the National forest of Guerrouch inside the Taza National Park (Jijel, Algeria). The Guerrouch forest is located in the northeastern part of Algeria, 30 km southwest of Jijel province (36°41’39.10’’ N 5°38’55.37’’ E). It covers an area of nearly 10,860 hectares, from the gorges of the Taza River in the north to the Selma pass in the south. It is 19 km long from east to west and 13 km wide from north to south. Its highest point is the summit of M’cid-Echta at 1,543 m (a.s.l). The Guerrouch forest is characterized

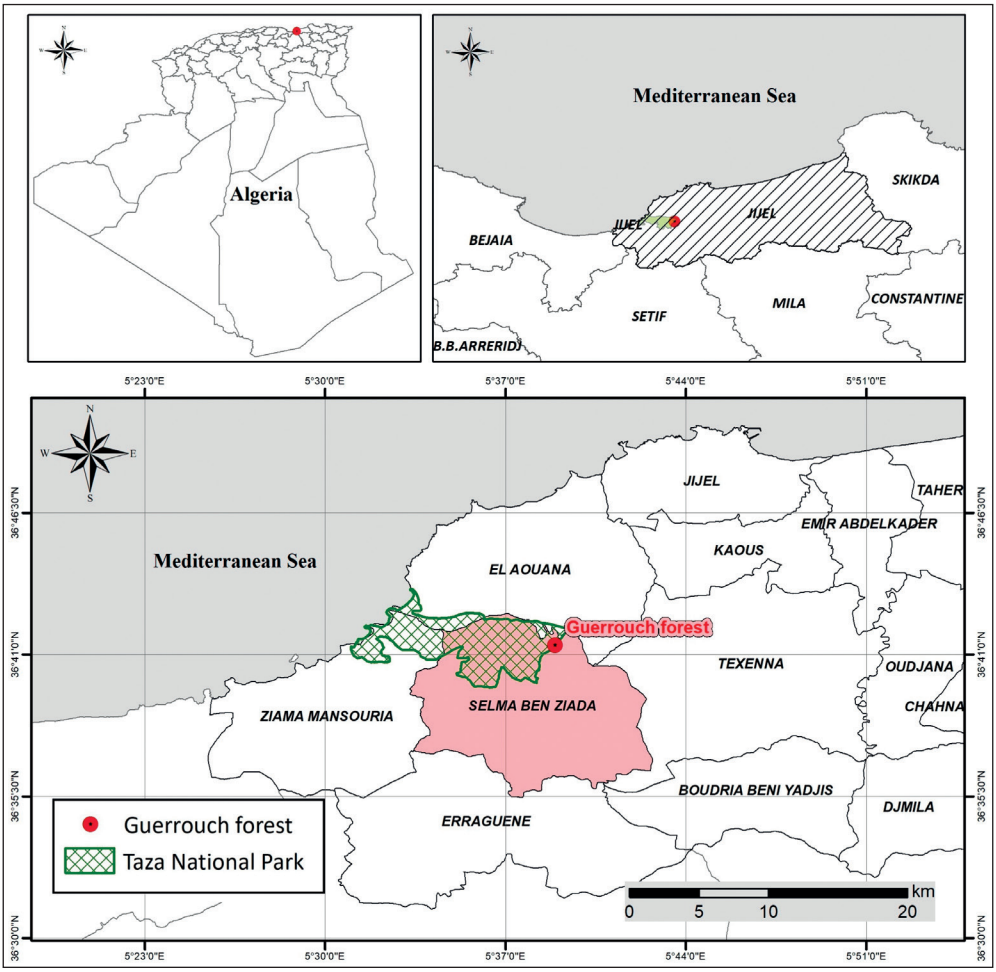

Figure 1. The geographic location of the study area
1. ábra A vizsgálati terület elhelyezkedése Algériában

by the best preserved oak forests in the country, with the presence of the Algerian oak *(Quercus canariensis)* widely distributed from low altitudes up to about 700 m (a.s.l). The African oak *(Quercus afares)* from 900 m (a.s.l), and the cork oak *(Quercus suber)* in low and medium altitudes *(Figure 1)*.

Data collection

The diet of the Atlas Flycatcher was studied by analyzing the content of the faecal sacs of nestlings during the breeding season of 2017. The faecal sacs were recovered directly from nest boxes at the end of the breeding period, towards the end of June. The samples come from four nest boxes (4 locations) installed in the mixed oak forest located at 900 meters (a.s.l).

Data analysis

A total of 150 faecal sacs were collected. The faecal sacs were placed separately in numbered pill boxes and marked with information such as date and place of collection. Before the examination of each faecal sac, the sample was placed inside a Petri dish containing 70° alcohol, which made it possible to easily separate the different fragments found in the faecal sac.

Using entomological forceps and under a binocular magnifying glass (total magnification: 7–10×40), we proceeded to dissect and sort all the fragments contained in the triturated faecal sac (heads, elytra, mandibles, thorax, abdominal segments pronotums and sometimes even complete individuals). These fragments were then arranged by category in another Petri dish lined with blotting paper divided into 6 to 8 boxes.

Prey fragments were determined by referring to various identification guides (Helgrad 1984, DuChatenet 1986, Zahradnik 1988, Leraut 2003), collections of the Department of Applied Zoology, University of Bejaia. Prey taxa were counted and their sizes were estimated either using a strip of graph paper and/or using reference guides.

Ecological indices and statistical methods have been applied to study diet composition and diversity. The total species richness *(S)* is represented by the total number of taxa found in all analyzed faecal sacs. The average specific richness *(s),* which is the average number of species present per sample, was calculated by the ratio between the total number of species identified during each survey and the total number of surveys carried out.

The composition of the diet was expressed as a percentage of centesimal frequency *(cF%)*, which is the ratio between the number of individuals of a given category of prey *(n_i)* and the total number of prey (*N*), the frequency of occurrence *(Fo%)*, which is the ratio of the number of faecal sacs containing the taxon *i* to the total number of faecal sacs. The frequencies of each taxon were represented in a single graph (Costello 1990), to provide description of the frequency of preys (dominant or rare), the feeding strategy of the predator (specialist or generalist) and the degree of homogeneity of the diet. Thus, prey points that are positioned near 100% occurrence and 100% abundance were considered as dominant prey taxa. A prey group positioned near to 100% of occurrence and 1% of abundance indicated that the predator hunts several prey taxa in low abundance (a generalized diet). Points that are close to 1% occurrence and 100% abundance indicated the specialization on certain taxa by certain predators (Costello 1990).

The Shannon index (Shannon & Weaver 1948) was applied to assess the diversity of the Atlas Flycatcher's diet generally, which was calculated as $H' = -\Sigma\, p_i \ln p_i$, p_i is the probability of encountering taxon prey *i*, which is given by the following formula $p_i = n_i/N$, where n_i is the number of individuals of taxon prey *i*, and *N* is the total number of individuals.

The equitable or equal distribution index (E) is the ratio between the calculated diversity (H) and the maximum theoretical diversity (H_{max}) which is represented by the log 2 of the total richness (S) (Blondel 1975).

$E = H'/H_{max}$

H': is the index of Shannon

$H_{max} = \log_2 S$

This index vary from 0 to 1:

When it tends towards 0 (E<0.5), it means that almost the entire population tends to be concentrated on a single species. It is equal to 1 when all species have the same abundance (Barbault 1981).

The size classes of the different prey were determined by applying Sturge's rule, and the number of individuals in each class was expressed in centesimal frequency.

To test the homogeneity of the faecal sacs sampled from the 4 nesting boxes, an ANOVA test was performed taking the number of families per faecal sac as a variable. This analysis was performed by the software SPSS.

Results

Diet composition of the Atlas Flycatcher

The number of individuals (N_i), the centesimal frequency (*cF%*) and the occurrence of each species (*Fo%*) are summarized in *Table 1*. The analysis of 150 faecal sacs of young Atlas Flycatchers, collected in the forest of Guerrouch, enabled us to count a total of 854 individuals, divided into 4 classes, 8 orders, 17 families, and 49 species.

Centesimal frequency per class

The class with the largest number of individuals was that of Insecta with 727 individuals (85.12%). The dominant insect groups were: Issidae sp. with 111 individuals, Lepidoptera sp. with 87 individuals and *Otiorhynchus* sp. 3 with 73 individuals. The second largest class was Arachnida with 114 individuals (13.34%) represented exclusively by Araneidae sp. In the third and fourth positions, we found the class of Gastropoda with 11 individuals 1.28% and the class of Malacostraca with 2 individuals only 0.23% *(Figure 2)*. We can note the clear dominance of Insecta (85.12%), which is probably linked to their great availability in this forest.

Centesimal frequency by order

The results of the centesimal frequencies by order of the prey consumed by the Atlas Flycatcher in the forest of Guerrouch are indicated in *Figure 3*.

The order Coleoptera seems to be the most dominant among the 8 identified orders with a centesimal frequency of 44.37%, followed by the order Hemiptera with 21.89%, and Araneae with 13.34%. Then we have 2 orders with similar occurrences: Lepidoptera with 10.18% and Hymenoptera with 8.31%. The three remaining orders are captured with low frequencies, they are: Stylommatophora, Orthoptera and Isopoda with frequencies of 1.28%, 0.35%, and 0.23% respectively.

Table 1. Diet composition of the Atlas Flycatcher *(Ficedula speculigera)* in the forest of Guerrouch (Jijel, Algeria) (*ni:* number of individuals*; cF%:* centesimal frequency*; Fo%:* frequency of occurrence)

1. táblázat Az Atlasz-légykapó *(Ficedula speculigera)* fiókák táplálékösszetétele a Guerrouch erdőben (Jijel), Algériában (*ni:* az *i* tápláléktípus egyedszáma; *cF%: i* tápláléktípus egyedszámának százalékos aránya az össztáplálékban; *Fo%: i* tápláléktípust tartalmazó ürülékminták százalékos aránya az összes ürülékmintához képest)

Classes	Orders	Families	Prey-taxa	*ni*	*cF* (%)	*Fo* (%)
Gastropoda	Stylommatophora	Helicidae	Helicidae sp.	11	1.28	7.33
Arachnida	Araneae	Araneidae	Araneidae sp.	114	13.34	76.0
Malacostraca	Isopoda	Oniscidae	Oniscidae sp.	2	0.23	1.33
Insecta	Orthoptera	Gryllidae	*Gryllus* sp.	3	0.35	2.0
	Hemiptera	Issidae	Issidae sp.	111	12.99	74.0
		Coreidae	Coreidae sp.	51	5.97	34.0
		Acanthosomatidae	*Acanthosoma* sp.	25	2.92	16.6
	Coleoptera	Curculionidae	*Otiorhynchus* sp.1	18	2.1	12.0
			Otiorhynchus sp.2	4	0.46	2.66
			Otiorhynchus sp.3	73	8-54	48.66
			Curculionidae sp.1	38	4.44	25.33
			Curculionidae sp.2	34	3.98	22.66
			Curculionidae sp.3	1	0.11	0.66
			Curculionidae sp.4	11	1.28	7.33
			Curculio sp.	15	1.75	10.0
			Pissodes sp.	1	0,66	0,66
		Chrysomelidae	Chrysomelidae sp.1	71	8.31	47.33
			Chrysomelidae sp.2	21	2.45	14.0
			Chrysomelidae sp.3	20	2.34	13.33
		Cerambycidae	Cerambycidae sp.1	1	0.11	0.66
			Cerambycidae sp.2	16	1.87	10.66
			Cerambycidae sp.3	9	1.05	6.0
			Cerambycidae sp.4	3	0,35	2.0
		Carabidae	Pterostichinae sp.1	9	1,05	6.0
			Pterostichinae sp.2	2	0.23	1.33
			Pterostichinae sp.3	1	0.11	0.66
			Carabinae sp.	2	0.23	1.33
			Carabidae sp.	3	0.35	2.0
			Cicindelinae sp.	18	2,1	12.0
		Scarabaeidae	*Onthophagus* sp.	1	0.11	0.66
		Nitidulidae	Nitidulidae sp.	3	0.35	2.0
		Buprestidae	Buprestidae sp.	4	0.46	2.66
	Hymenoptera	Formicidae	*Monomorium salomonis*	11	1.28	7.33
			Camponotus sp.	8	0.93	5.33
			Camponotus laurenti	1	0.11	0.66
			Camponotus truncatus	1	0.11	0.66
			Cataglyphis bicolor	11	1.28	7.33
			Messor sp. 1	5	0.58	3.33
			Messor sp. 2	1	0.11	0.66
			Messor sp. 3	1	0.11	0.66
			Lasius sp.	1	0.11	0.66
			Formica sp.	1	0.11	0.66
			Crematogaster scutellaris	1	0.11	0.66
			Aphaenogaster testaceopilosa	4	0.46	2.66
		Apidae	Apidae sp.	1	0.11	0.66
		/	Apoidea sp.	17	1.99	11.33
		Sphecidae	Sphecidae sp.	5	0.57	3.32
		Pompilidae	Pompilinae sp.	2	0.23	1.33
	Lepidoptera	/	Lepidoptera sp.	87	10.18	58.0
Total 4	**8**	**17**	**49**	**854**	**100**	

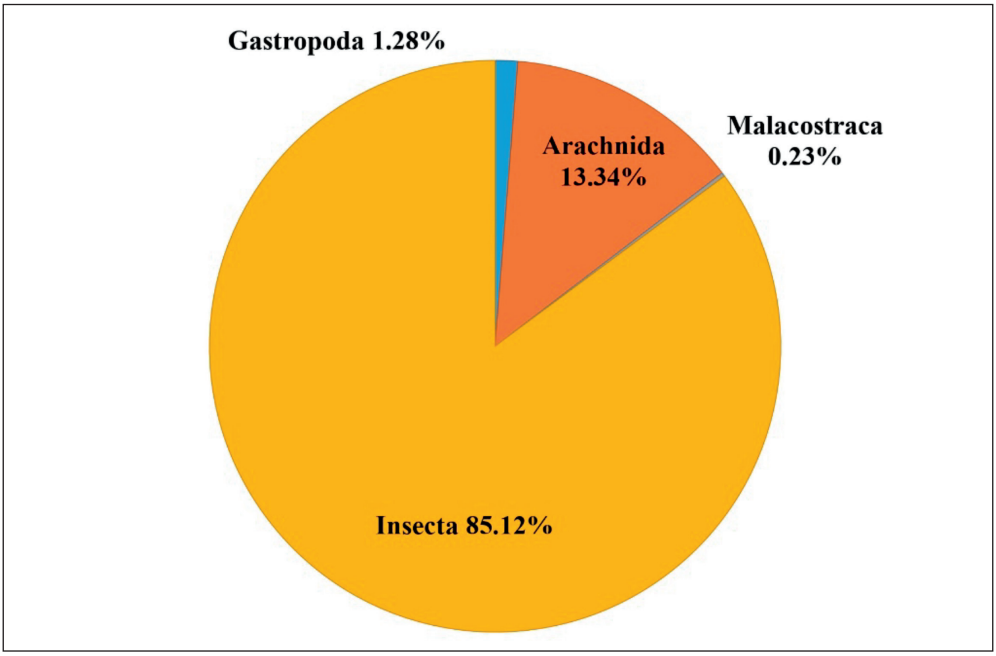

Figure 2. Distribution of the sampled preys by class
2. ábra A tápláléktípusok osztályok szerinti megoszlása

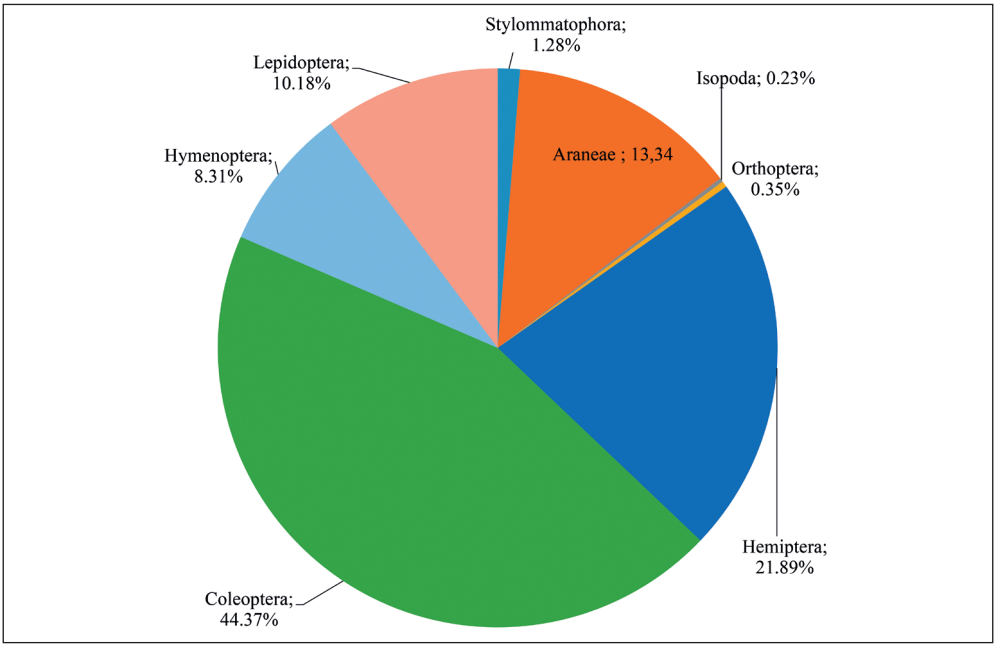

Figure 3. Orders constituting the diet of Atlas Flycatcher in northeastern Algeria
3. ábra A tápláléktípusok rendek szerinti megoszlása az Atlasz-légykapó fészkeknél gyűjtött táplálékban

Prey size

The size of the prey found in the faecal sacs of the Atlas Flycatcher varied between 3 mm (Curculionidae sp 2) and 14 mm (Sphecidae sp.), with an average of 7.11±3.14 mm. The size and the number of prey taxa of the Atlas Flycatcher by class are given in *Table 2*.

Table 2. Distribution of prey numbers among the prey size classes in Atlas Flycatcher (*Ni*: Total number of individuals, c*F%*: centesimal frequency)

2. táblázat A táplálékegyedek eloszlása a táplálékméret kategóriák között (*Ni*: táplálékegyedek száma, c*F%*: százalékos eloszlási arány)

Prey's size (mm)	*Ni*	*cF(%)*
3–4.37	273	31.96
4.37–5.75	6	0.70
5.75–7.12	178	20.84
7.12–8.5	167	19.55
8.5–9.87	4	0.46
9.87–11.25	99	11.59
11.25–12.62	122	14.28
12.62–14.0	5	0.58
Total	**854**	**100**

After applying Sturge's rule, 8 groups were obtained, the first [3–4.37 mm] was the most represented in number of individuals (31.96%). We noted that *Otiorhynchus* sp. 3, Chrysomelidae sp. 1, Curculionidae sp. 1 and Curculionidae sp. 2 were the most present in this group. In the second position, we have the group [5.75–7.12 mm] with a frequency of 20.84%, mainly represented by Issidae sp., Chrysomelidae sp. 3, *Curculio* sp. and Apoidea sp. Then we have the group [7.12–8.5 mm] (19.55%) mainly represented by Araneidae sp., Chrysomelidae sp. 2 and Curculionidae sp. 4. After that we have the group [11. 25–12,62 mm] (14.28%), composed essentially of Coreidae sp., *Acanthosoma* sp., and Cicindelinae sp. Groups [4.37–5.75 mm] [8.5–9.87 mm] and [12.62–14 mm] are represented by a relatively small number of individuals.

Food preference of the Atlas Flycatcher

By using the centesimal frequencies and the frequencies of occurrence of the taxa consumed by the Atlas Flycatcher, we obtained a graphical representation, following Costello (1990) *(Figure 4)*.

This representation shows dominant species such as Araneidae sp. (*Fo*=76%; *cF*= 13.34%), Issidae sp. (*Fo*=74%; *cF*=2.99%) and Lepidoptera sp. (*Fo*= 58%; *cF*=10.18%), rare species such as: Apidae sp. *(Fo*= 0.66%, *cF*= 0.11%), *Gryllu*s sp. (*Fo*=2%, *cF*=0.35%) and Helicidae sp. (*Fo*=7.33%; *cF*=1.28%) and other more or less consumed species such as *Otiorhynchus* sp. 3 (*Fo*=48.66%, *cF*=8.54%), Chrysomelidae sp. 1 (*Fo*=47.33%; *cF*=8.31%) and Coreidae sp. (*Fo*=34%; *cF*=5.97%)

Comparison of the sampled nest boxes

To evaluate the existing differences between the 4 nest boxes studied, the total richness (*S*), the average richness (*s*), the Shannon index (*H'*) and the equitability (*E*) were calculated *(Table 3)*.

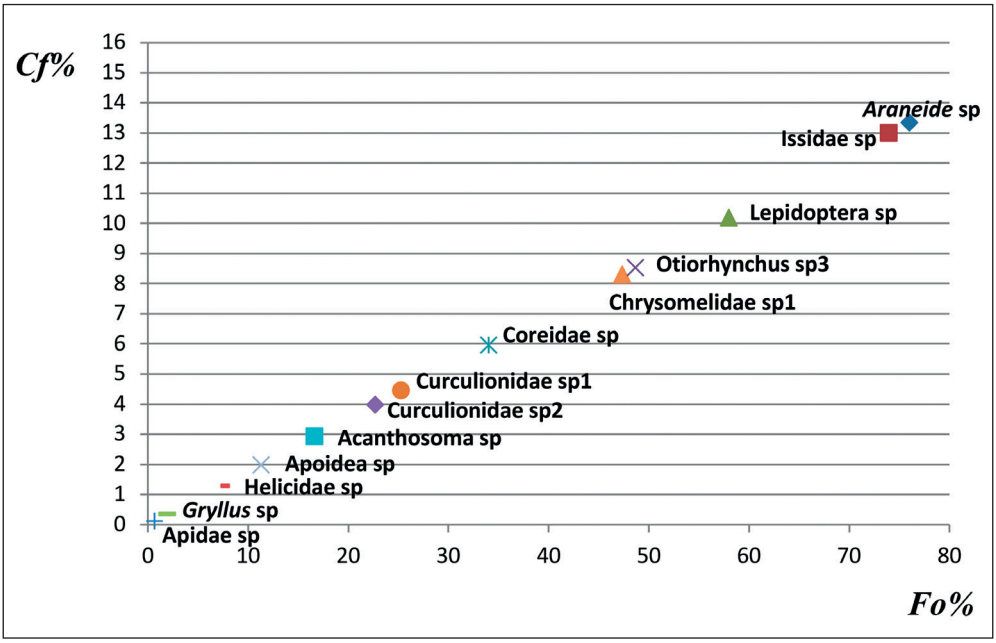

Figure 4. Graphical representation of the potential preys of the Atlas Flycatcher based on Costello's method (*Fo%*= frequency of occurrence; *cF%*= centesimal frequency).

4. ábra Az Atlasz-légykapó táplálékában azonosított főbb tápláléktípusok eloszlása Costello-módszer szerint (*Fo%: i* tápláléktípust tartalmazó ürülékminták százalékos aránya az összes ürülékmintához képest, *cF%: i* tápláléktípus egyedszámának százalékos aránya az össztáplálékban)

The total richness of the 4 nest boxes combined is 49 prey taxa, and in one next box. we recorded 43 species.

The mean richness in nest box 1 is 5.07±1.82, in the nest box 2 is 6.15±1.1; in the nest box3 is 6.15±1.1 and in the nest box 4 is 6.68±2.13.

The value of the Shannon index in nest box 1 is 3.28, in the nest boxe 2 is 2.52 in the nest box 3 is 2.80 and in the nest box 4 is 2.85.

The comparison of the values of each parameter between the 4 nest boxes reveals the existence of 2 distinct groups:

– Group 1: represented by nest box 1

– Group 2: represented by nest boxes 2, 3, and 4.

Table 3. Diet characteristics of the nestling food collected from 4 nest boxes.

3. táblázat Négy Atlasz-légykapó fészkeknél gyűjtött táplálék összetételének jellemzői

Parameters	Nest box 1 n=54	Nest box 2 n=20	Nest box 3 n=44	Nest box 4 n=32
Total richness (S)	43	20	29	23
Average richness (s) (M±SD)	5.07±1.82	6.15±1.1	6.59±1.57	6.68±2.13
Shannon index (H')(Bits)	3.28	2.52	2.80	2.85
Equitability (E)	0.25	0.41	0.32	0.41

Table 4. The result of the ANOVA test applied to the variable: number of prey families/faecal sacs of the 4 sampled nest boxes

4. táblázat Az Atlasz-légykapó négy vizsgált fészkénél gyűjtött táplálék különbözőségére végzett ANOVA teszt eredménye (a vizsgált változó az ürülékmintánkénti táplálékcsaládok száma)

	Sum of squares	Degree of freedom	Mean square	*F*	*p*<
Between-groups (combined)	56.341	3	18.780	9.473	0.000
Unweighted linear term	38.227	1	38.227	19.282	0.000
Weighted	49.620	1	49.620	25.028	0.000
Deviation	6.721	2	3.361	1.695	0.187
Within-groups	289.452	146	1.983		
Total	345.793	149			

To test the homogeneity of the preys sampled from the faecal sacs of the 4 nest boxes (sites), a statistical test of ANOVA was carried out concerning the 3 variables: Total richness/ faecal sac, number of families /faecal sac and number of orders/ faecal sac. Before this test, we performed a Principal Component Analysis (PCA), to choose the most appropriate variables. According to the PCA, the number of families / faecal sac had the highest contribution (95.5%) to the information on our 4 nest boxes, therfroe, we used it in the ANOVA analysis. According to Levene's statistics, there is no significant difference between the variables of the four nest boxes (P=0.654) so, homoscedasticity is respected and an ANOVA test can be performed because the data follow normal distribution.

According to the ANOVA *(Table 4)* there is a significant difference between the nest boxes (F= 9.473 and P=0.000), so a post-hoc test must be done to find out which nests differ between them and those which are homogeneous; this is the Newman and Keuls test. According to this test, there are two homogeneous groups:

– Nest-box 1 highly differed from the others, with a mean of 4.48 against 5.35, 5.81 and 5.82 which are the means of nest box 2, nest box 3 and nest box 4 respectively, (P= 1.000).

Discussion

The main purpose of the paper was to draw attention to the trophic ecology of the Atlas Flycatcher, a species endemic to North Africa by analyzing nestling's faecal sacs. To our best knowledge, only one study has reported the diet of the Atlas Flycatcher in Algeria, done by Boudeffa (2014) in a cork oak forest in eastern Algeria, using the neck-collar method on nestlings.

Flycatcher faecal samples originated from the forest of Guerrouch during the breeding season of 2017, allowing us to count a total of 854 food items, belonging to 49 prey taxa and distributed between 17 families, 8 orders and 4 classes. Among the 49 prey taxa identified, 3 are consumed with high frequencies: Araneidae sp., Issidae sp. and Lepidoptera sp.

The dietary profile of flycatcher nestlings in our study showed great diversity in the choice and consumption of prey available in the environment. It seems that insects are the most

available prey in the environment followed by: Arachnida, Gastropoda and Malacostraca. Researches undertaken on the Pied Flycatcher, a closely-realted species to ours in interest suggest that nestlings are supplied with more digestible invertebrates than those consumed by adults, consisting mainly of Aranea, Lepidoptera, Diptera, Hymenoptera and Coleoptera (Mansfeld 1942, Creutz 1953, Von Haartman 1954, Meidell 1961, Bösenberg 1964, Dornbusch 1981, Silverin & Andersson 1984, Lifjeld & Slagsvold 1988, Lundberg & Alatalo 1992).

In our study, the diet consists mainly of Coleoptera, Hemiptera, Araneae, Lepidoptera and Hymenoptera.

Boudeffa (2014) collected 804 food items, mainly composed of lepidopteran larvae (23.4%) and Hemiptera (17.9%), represented mainly by wood bugs. Diptera occupy the third rank in the composition of the diet with a percentage of 16.5% among the prey brought. The rest of the diet consists of Hymenoptera, Arachnida, and Coleoptera in various stages of development.

We found only fragments of adult butterflies in faecal sacs, which is not the case for the food items collected with the collar method from Atlas Flycatcher nestlings, analyzed by Boudeffa (2014) where he found that caterpillars represent more than 23% of consumed items. The absence of caterpillar traces in the faecal sacs can be linked to two factors: The first relates to digestion because the caterpillars are soft and not very chitinous, so they leave no visible trace after passing through the digestive tract of the chicks. The second is related to the age of the chicks and the phenology of reproduction. Our faecal sacs are certainly from chicks aged between 11 and 13 days. At this time (end of June) there are few caterpillars available in the foliage of trees, most having undergone their metamorphoses (Mayeche *et al*. 2020). Perrins (1979) reports that sometimes an obstacle to the analysis of faecal sacs can occur, in the case of unpleasant or dangerous preys, such as certain caterpillars or the larvae of Hymenoptera, the parents are known to prepare particular elements by decapitating them, it results that the mandibles which are from a diagnostic point of view very important part of the body, are absent in the food brought by the parents and, consequently, absent in the faecal sacs. In addition, Boudeffa (2014), point out that the proportion of caterpillars decreases along the season to the benefit of other prey groups. This decline causes an increase in the size of preys, a diversification of the diet and a reduction in its digestibility.

In our case the Hemiptera occupy the second place with 21.89%, it's also the case of the results of Boudeffa (2014) obtained thanks to the collar method with 17.9%. Diptera seems to be absent from the faecal sacs of the Atlas Flycatcher of the Guerrouch forest, while they occupy the third place (17%) in the constitution of the diet of the Atlas Flycatcher in cork oak forests in eastern Algeria (Boudeffa 2014). This is certainly linked to the difficulty of detecting the remains of Diptera in faecal sacs. In this sense, small Diptera are systematically under-represented in faecal sacs compared to the collar method (Kleintjes & Dahlsten 1992, Moreby & Stoate 2000). The activity rate of prey during the day can also explain the existing differences between food profiles; some birds have adapted their hunting techniques to the activity rate of their prey. For example, the Spotted Flycatcher *(Muscicapa striata)* looks for aphids (Aphidoidea) in the foliage, during the hot hours of

the day when Diptera and other winged insects are inactive. Thus, some differences in diets may be due to the time of day when birds are actively foraging (Davies 1977). Spiders seem to be well represented in the trophic menu from the faecal sacs of *F. speculigera* nestlings. This result is in agreement with that of Silverin and Andersson (1984), who found a higher proportion of spider remains in the stomachs of *F. hypoleuca* nestlings than in adults. In general, the differences observed in the food composition of flycatchers are related to the nature of the habitat, the food availability, the phenology of reproduction, in particular the age of the nestlings and the methodology of sampling.

From the research that has been conducted, it is possible to conclude that the Atlas Flycatcher is a species that has a diversified diet, so we think that it can be adapted to different environmental conditions.

The disadvantage of studying bird's diet by analyzing faecal sacs is the advanced state of degradation of prey, only the chitinous parts of the insects remain there, so winged insects and the caterpillars are underestimated in the samples. But this method has the advantage of being non-stressful for the brood and the parents because no individual is taken or touched. As far as possible, it is therefore preferable to combine this method with the neck-collar method to get as close as possible to the food spectrum of this species. The other disadvantage is that sometimes we cannot reach the species level when analyzing certain prey, so it is recommended to use more sensitive methods such as DNA barcoding, which consists of identifying the fragments of degraded DNA that remain in the faecal sacs of birds, to recognise the species that have been consumed (Hebert & Gregory 2005). In perspective to this research, it would be interesting to undertake similar studies on the diet of the Atlas Flycatcher in other humid forests of Algeria, in particular that of Akfadou or Babor which have different habitat characteristics to assess the adaptation of this species to various environmental conditions in North Africa.

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