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Nestling Diet of Common Blackbird *(Turdus merula mauritanicus)* in Algeria

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ABSTRACT

In this study we focused on the feeding ecology of the urban Blackbird (*Turdus merula mauritanicus*) in the north-eastern of Algeria, in the city of Annaba during the year 2006, The diet composition of the nestling Blackbird, was studied from regular monitoring of nests, choosing the neck collar method. The second phase of this study was to determine the protein value of the food brought to nestlings by their parents, by the Bradford method. The results concluded that in terms of number, the animal food was about 80% and plant food just 20%, but in terms of biomass, the percentages are 51% for plant food and 49% animal food. Furthermore, it was concluded that early nestling (Post-hatching) are fed only with animal items (gastropods, earthworms). Intermediate stage are fed with animal prey and started feeding with plants (Blackberries, dates) and at the end of hatching (a few days before the flight), nestlings are mostly fed with plant items. The protein value shows a higher level in animal food than in plant food.

Keywords Blackbird (*Turdus merula mauritanicus*), Nestling diet, Urban ecology, Algeria.

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INTRODUCTION

Works on urban ornithology in the world and later in Algeria (Belabed *et al.* 2012, 2013, 2014) show that the increase of avian richness in urban areas is a general phenomenon that is ongoing. However, at a given time, species richness decreases with increasing degree of urbanization (Mahler *et al.* 2010).

It turns out then that the species richness and changes of birds in urban areas are not due to chance but are due to the active and passive urbanization (Dinetti and Fraissinet 2001). Passive urbanization concerns birds that occupied environments that have found themselves embedded in the city: Some species resist, others disappear. It causes a decrease in species richness. Active urbanization concerns species that have come to colonize the already established urban environment (mainly parks). This phenomenon therefore results in an increase in specific richness. The Blackbird *Turdus merula mauritanicus* could be part of the two cases. Indeed, his former forest character, would have allowed him to stay in areas that were included in the urban environments and its ability to migrate and occupy new territories would allow it to colonize them, becoming, one of the most common birds in most cities and urban parks of the Western Palearctic.

The extremely complex active urbanization, can explain the colonization of urban areas by avian species and the extent of adaptive changes (Isaksson 2018).

The urban environment has characteristics (temperature, lighting, noise) that explain the need for a number of adaptations for urban species such as: Nest site, diet, lifestyle, distrust of human being. Then we call it, Birds Urbanity (Malher and Magne 2010).

The city becomes a fabulous laboratory for studying biodiversity and evolution because of very high stresses exerted on the species, which will face new factors of brightness, dispersion of food, predation.... (Clergeau 2007).

Trophic relationships are an essential part of the organization of an ecosystem and one of major adaptations, which urban species will face. Duffy (2002) indicated that changes in biodiversity at a given trophic level may affect biodiversity in adjacent trophic levels and the next ones, the dynamics of the ecosystem will be fully affected (Villanueva 2002).

Diet is an important part of the role of a species in the ecosystem, to understand habitat selection and aspects of population dynamics (Ginane *et al.* 2008).

Some bird species are limited by trophic resources. Indeed, the densities are higher in areas where food is abundant than in areas where food is rare. Densities are higher in good years than in famine years. Sudden changes in short or long term densities are due to sudden changes in short or long term of food resources (Belabed 2013).

Correlations between the number of birds and the amount of food in different environments have been noted in several groups of birds and through those studies it was concluded that each bird or pair of territorial birds keeps a territory whose size depends on its food availability, and therefore the density of birds can be related to food resources.

In this context of studying of the urban environment and its pressures on wild species, we are interested in the adaptability of the urban Common Blackbird in Algeria, by studying its diet strategies. This work will be in two parts:

1 - The Blackbird nestlings' diet taxonomic characterization in urban areas.
2 - The Blackbird nestlings' diet protein value characterization in urban areas.

MATERIALS AND METHODS

Study site

This study was carried out in the city of Annaba, which is the fourth most populated city in Algeria (Belabed *et al.* 2017), located in the extreme north-east to latitude 36° 54′ 15″ north, 7° 45′ 07″ east. The study site is the Christian cemetery of Annaba with an area of 6.2 ha. This site hosts a highly species richness which is representative of different microhabitats "open or closed environments", including diverse vegetation species that creates an environment with forest characteristics and a rich biodiversity (Fig. 1) (Belabed *et al.* 2013).

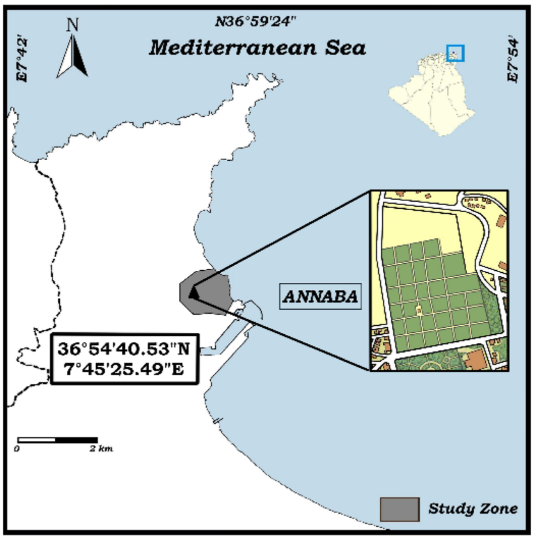

Fig. 1. The study site map, the Christian cemetery of Annaba.

Biological model

The Blackbird is the most abundant species of the Turdidae family in urban areas in Algeria. Its binomial name is *Turdus merula* and the North African subspecies is *T. m. mauritanicus.* It is, moreover, the only species of this family to be found in extremely anthropized North African ecosystems. Today the habitat of the Blackbird is very diverse, including almost any range of forest and pseudo-forest habitats to highly anthropized urban habitats.

Our model is an omnivorous species, with preferences for animal prey in all seasons. Earthworms are often the staple food, most of the year and specifically during the breeding season (Török 1981, 1985). Animal prey consumed are mainly: Various species of adult insects such as larvae, gastropods, spiders, myriapods and, rarely, small vertebrates: Lizards (Bell 1996), fish (Raes *et al.* 2008) and mice.

Its plant component is also well diversified and consumed especially by migrants during the period preceding migration (Vauk and Wittig 1971). A multitude of berries are then appreciated by the Blackbird during the winter season, in particular the Common Hawthorn (*Crataegus monogyna*), the Common Juniper (*Juniperus communis*), the grape (*Vitis* sp.), the Common ivy (*Hedera helix*) and the Common Buckthorn (*Rhamnus alaternus*), blackberries (*Rubus* sp.), olives (*Olea europaea*) and partially ripe dates (*Phoenix dactylifera*).

METHODS

The study and the diet determination of the urban Blackbird was conducted in 2006 and is made on 10 nests whether 30 nestlings. The monitoring was daily for 05 nests and we chose to follow the diet for the others 05 nests, just for the third (D03), the sixth (D06) and the ninth day (D09).

Food samples were collected using the neck collar method (Tanneberger *et al*. 2017). It consists on collaring a wrapped wire of 0.5 mm diameter around the neck of nestlings to prevent prey being swallowed (Koródi Gál 1967, Dyrcz 1969, Török 1981, 1985, 1988, Bouslama 2003). The collar was carefully laid around the neck of the nestling, which could still breathe unhindered, but was unable to swallow food (Tanneberger *et al.* 2017).

The food composition of the nestlings from the age of 3 days (before this age necklaces can't be placed as nestlings are too young, fragile and difficult to handle) until the time of leaving the nests (14-15 days), was monitoring with this method.

Sampling took place daily, for 2 to 3 hours in the early morning. Once fitted, we left the nests for an hour. On returning to the nest, the food accumulated was collected from the throats of the nestlings using round-tipped tweezers. After the neck-collar was taken off the nestlings was fed with boiled eggs of an approximately identical quantity with that taken away (Török 1981).

We repeatedly gathered prey with the same method after one hour without neck-collars (Tanneberger *et al.* 2017). Thus, in hourly turns, we obtained the food samples 2 to 3 hours per day.

Food items collected from nestlings were pooled for each nest (n=10 nests), and stored at 4°C until determination.

Prey items in neck collar samples were identified at species level if possible, otherwise at genus or family level. Then, items were classified among two classes: animal food and plant food. All diet items were weighed (wet weight) using a precision balance (±0.1 mg) and stored in 90% alcohol.

Characterization of collected items groups (Niche metrics)

The collected group of items is characterized by analyzng the following structural parameters:

-Species richness "S"; Abundance "N"; Species Diversity "H":

We calculated food niche width using the Shannon formula,

$$H' = -\sum_{t=1}^{n} P_i \log_2 P_i$$

Table 1. Food composition of nestling Blackbirds in the study site.

Class	Order	Genus	Species	Common name	Nb	Weight
01 Gastropods	Stylommatophora	*Cepaea*	*Cepaea* sp.	Fields snail	42	12.9189 g
02 Blackberry	Urticales	*Morus*	*Morus nigra*	Blackberry	12	15.4555 g
03 Lumbricidae	Haplotaxida	*Lumbricus*	*Lumbricus terrestris*	Earthworm	8	1.9472 g
04 Dates	Arecales	*Phoenix*	*Phoenix dactylifera*	Dates	5	8.2775 g
05 Larvae of Coleoptera	Coleoptera	*Melolontha*	*Melolontha melolontha*	Cockchafer	3	5.7187 g
		Agriotes	*Agriotes* sp.	Agriotes	2	0.7578 g
06 Larvae of Lepidoptera	Lepidoptera	*Biston*	*Biston betularia*	Peppered moth	3	1.0528 g
		Noctua	*Noctua pronuba*	Large Yellow Underwing	3	0.6999 g
07 Adults of Coleoptera	Coleoptera	*Geotrupes*	*Geotrupes* sp.	Earth-boring scarab	3	1.2067 g
		Cynthia	*Cynthia cardui*	The painted lady	3	0.3384 g
08 Adults of Lepidoptera	Lepidoptera	*Coenonympha*	*Coenonympha tullia*	Common Ringlet	2	0.4059 g
09 Centipedes	Geophilomorpha	*Geophilus*	*Geophilus* sp.	/	3	0.9229 g
10 Olives	Lamiales	*Olea*	*Olea europaea*	Olive	3	2.6772 g
11 Unidentified items	/	/	/	/	6	0.5615 g
12 Egg pouches	/	/	/	/	2	0.4876 g
Total					100	53.4285 g

Evenness was computed using the formula $J = H / H_{max}$ where $H_{max} = \log_2 S$.

In the above formula n_1 is the number of prey items belonging to the i^{th} prey or category, N is the total number of prey specimens and sis the number of prey categories.

- The maximum diversity of a settlement H'_{Max} is calculated as follows:

$$H'_{Max} = \log_2 S$$

S: *Total wealth of the settlement.*
H'_{Max}: *The maximum theoretical diversity.*

- Pielou evenness index (J'):

The evenness is the ratio of the observed diversity to maximum diversity. It measures the degree of balance and complexity of a settlement by the standard of H' versus H'_{max}.

$$J' = H' / H'_{max}$$

The change in composition of the nestlings' diet during the brood period

In our study, we found that the diet, which is supposed to vary from year to year or season to season due to climatic and spatial constraints, ultimately varied during the two weeks of the brood period. For this, it was proposed to merge the successive days that are similar in food taxonomic richness, to group or stage and using this method we have reached 04 stages which are:

1. Stage 01: 4 days (D03 – D04 – D05 – D06),
2 Stage 02: 3 days (D07 – D08 – D09),
3. Stage 03: 3 days (D10 – D11 – D12),
4. Stage 04: 3 days (D13 – D14 – D15)

Extraction and determination of protein values of food items in the Blackbird nestlings diet

The samples to be evaluated for their protein value were collected in food pools depending on the age of nestlings. This assembly assumes that the protein undergoes changes due to many factors like the type of prey and its stage of development. Samples that will be used for the determination of protein value are weighed and store in the trichloroacetic acid (TCA 20%) at 4°C until biochemical assay. The amount of protein of each prey was determined after extraction and by spectrophotometric methods of Bradford (1976).

Statistical Analysis

The mean and standard deviation of each parameter

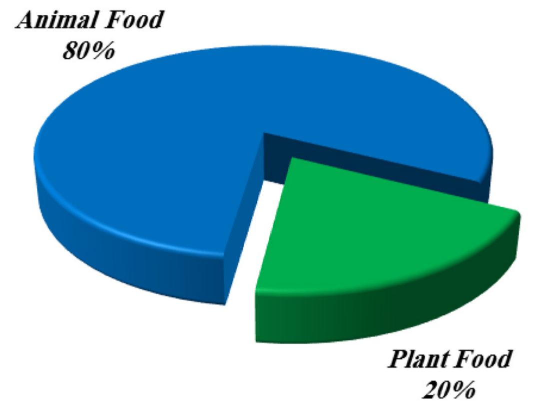

Fig. 2. The amount percentage of the plant and animal food.

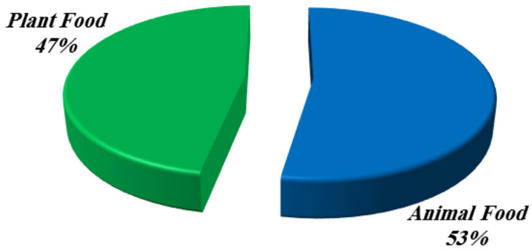

Fig. 3. The biomass percentage of plant and animal food.

were calculated using *Microsoft Excel* 2019.

RESULTS

Biomass and number of preys brought to nestlings

The number of preys collected during our study is 100, belonging to 15 categories including two unidentified, this gives us 13 species belonging to 8 orders. The total mass of prey was 53,4285 g, with an average weight of 0,5343±0,5258 g per prey. (Table 1) shows the different groups and their respective weights and numbers.

Diet structure of Blackbird nestlings

After collecting and analysing prey, we were able to determine the composition of plant and animal material in the nestlings diet. The amount of animal food represents 80% of the total amount while that of plant food is 20% (Fig. 2).

Even if the number of animal prey is very much higher than the number of plant food, in terms of biomass, the animal and plant fractions are approximately equilibrate (Fig. 3).

Diet composition of Blackbird nestlings

The analysis of the proportion of the preys according to their stage of development reveals that adults constitute almost the entire diet of nestlings (61%), plants (20%), larvae represent 11% of the prey, while the egg pouches constitute only 02% and the rest is unidentified prey (Fig. 4).

Diet specific structure of Blackbird nestlings

The analysis of the results shows that the diet is composed of 13 species which four belong to Lepidoptera order, three to Coleoptera order and a single species for Stylommatophora, Urticales, Haplotaxida, Arecales, Geophilomorpha and Lamiales.

The animal food mainly consists of invertebrate organisms from at least five orders, with the exception of egg pouches and indeterminate prey. Stylommatophora (Gastropods) are the main prey (42%), Lepidoptera represent 11%, Coleoptera 08%, Haplotaxida 08%. The rest of the diet consists of: Geophilomorpha 03%, egg pouches 02% and unidentified prey 06%.

The plant food belongs to three orders; Urticales represent 12% of all collected items, Arecales

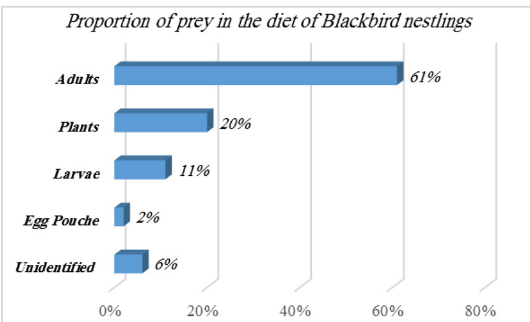

Fig. 4. Proportion of prey in the diet of Blackbird nestlings.

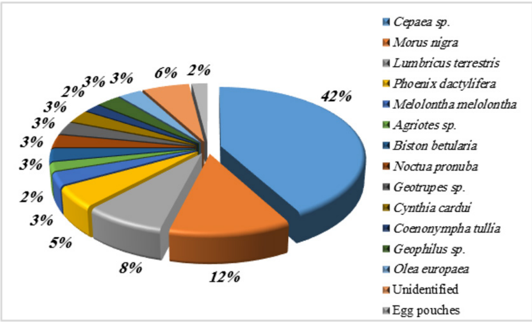

Fig. 5. Diet specific structure of Blackbird nestlings.

represent 05% and finally Lamiales represent only 03% (Fig. 5).

The classification of the different prey according to their number shows that some species are more abundant than others. Gastropods (*Stylommatophora*) are the most abundant prey species with *Cepaea* sp. (42 items), Urticales were represented by 12 items of Blackberry (*Morus nigra*), the order of Haplotaxida contained 08 individuals of the common earthworm (*Lumbricus terrestris*). The rest of the diet is composed of the following species: Dates (*Phoenix dactylifera*) with 05 items, Cockchafer (*Melolontha melolontha*) with 03 items, Peppered moth (*Biston betularia*) with 03 items, Large Yellow Underwing (*Noctua pronuba*) with 03 items, The Painted Lady (*Cynthia cardui*) with 03 items, *Geophilus* sp. with 03 items, Olives (*Olea europaea*) with 03 items, Geotrupes sp. with 03 items, Agriotes (*Agriotes* sp.) with 02 items Common Ringlet (*Coenonympha tullia*) with 02 items, 02 egg pouches and 6 unidentified items (Fig. 6).

Table 2. Characterization of the collected items.

	Items group
H’	3.0448
H'_{max}	3.9069
J’	0.7793
S	15
N	100

Table 3. Protein values of food items in the Blackbird nestlings diet.

	Species	Protein values (µg/g)
01	*Egg pouche*	10,49 µg/g
02	*Noctua pronuba*	9,13 µg/g
03	*Biston betularia*	8,93 µg/g
04	*Agriotes* sp.	7,41 µg/g
05	*Olea europaea*	6,74 µg/g
06	*Melolontha melolontha*	6,61 µg/g
07	*Coenonympha tullia*	4,05 µg/g
08	*Hamearis lucina*	3,98 µg/g
09	*Cepaea* sp.	3,97 µg/g
10	*Geophilus* sp.	3,73 µg/g
11	*Lumbricus terrestris*	3,49 µg/g
12	*Agriotes* sp.	3,04 µg/g
13	*Phoenix dactylifera*	1,05 µg/g
14	*Morus nigra*	0,97 µg/g
15	*Geotrupes* sp.	0,58 µg/g

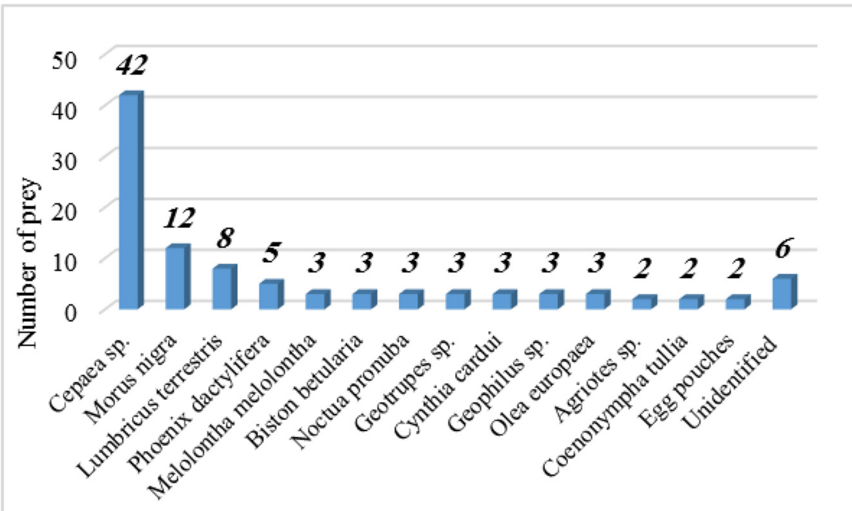

Fig. 6. The diet specific structure and composition.

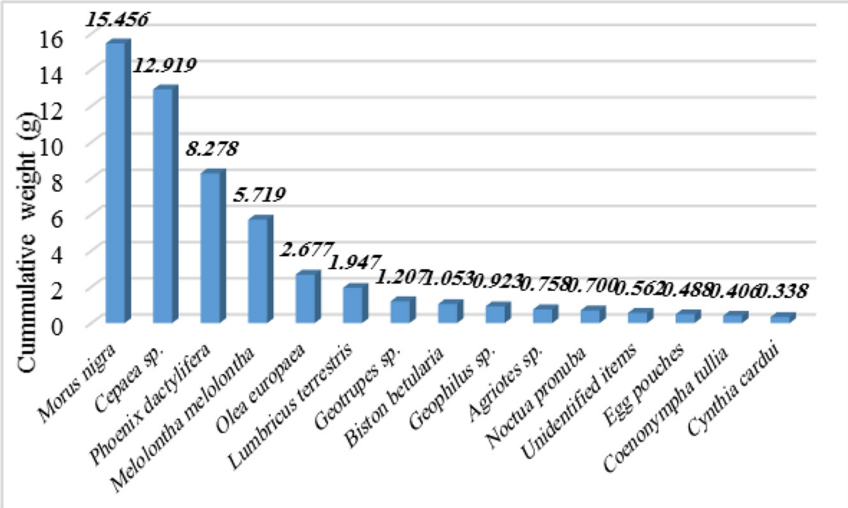

Fig. 7. The diet specific structure and composition (According to cumulative weight of species).

Rating species according to their weight shows that the species having the largest cumulative biomass is *Morus nigra* with 15.455 g (Fig. 7). However, the most important average biomass per item is for *Melolontha melolontha* with 1.906±0.133 g/item, followed by plant items such as *Phoenix dactylifera* 1.655±0.123 g/item and *Morus nigra* 1.288±0.309 g/item (Fig. 8).

Characterization of collected items groups (Niche metrics)

The review of (Table 2) shows a total richness of 15 species for the group of collected items. The total diversity is equal to 3.0448. The evenness is (0.7793) which indicates an imbalance in the distribution of species abundance for the benefit of one or two spe-

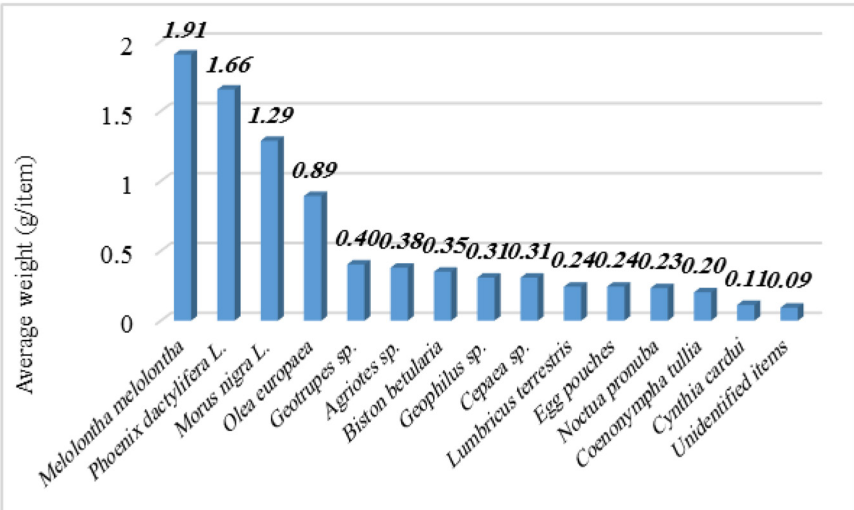

Fig. 8. The diet specific structure and composition (According to average weight of species).

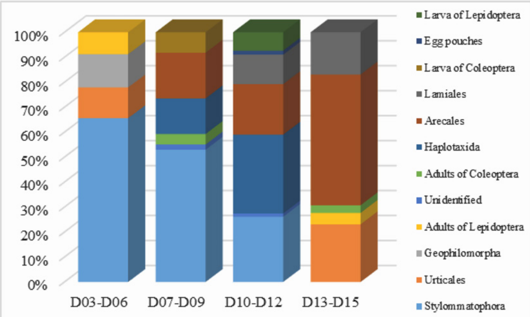

Fig. 9. Diet structure of Blackbird nestlings at four stages of the nestlings.

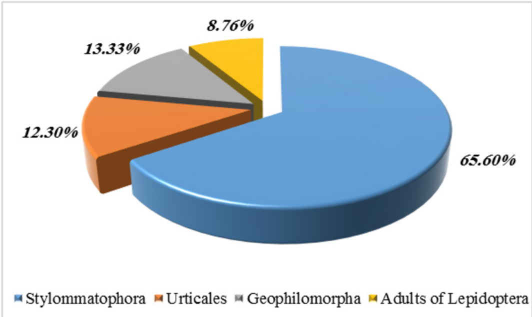

Fig. 11. Taxonomic composition of Blackbird nestlings diet during the first stage (D03-D06).

cies in particular.

The change in composition of the nestlings' diet during the brood period

The diagram of our four stages is shown in the (Fig. 9).

During the first stage, there were only animal food, it begins to change during the second and the third stages. To arrive at a nutrition to over 80% of plants during the last stage (Fig. 10).

First stage (D03 - D06)

We note during the first stage the total absence of plants in the food given to the nestlings and a predominance of gastropods (Stylommatophora) represented by *Cepaea* sp. at a rate of 65.60%, followed by *Geophilus* sp. at a rate of 13.33%, the Haplotaxida represented by *Lumbricus terrestris* at 12.30% and finally adults Lepidoptera at 08.76% (Fig. 11).

Second stage (D07 - D09)

During the second stage the main food still gastropods (Stylommatophora) represented by *Cepaea* sp. at a rate of 52,94%, followed by 14,27% of Haplotaxida, 08,18% of Coleoptera Larvae, 04,19% of Coleoptera adults and finally 2,11% of unidentified items. We note the first appearance of plant food, represented by 18,27% of Arecales (*Phoenix dactylifera*) (Fig.12).

Third Stage (D10 - D12)

During the third stage food animal food begins to decrease and plant food takes over the percentage, indeed noticed a predominance of Haplotaxida at 31.55%, followed by Stylommatophora at 26.11%, then Lepidoptera larvae at 07.36% and only 01.58%

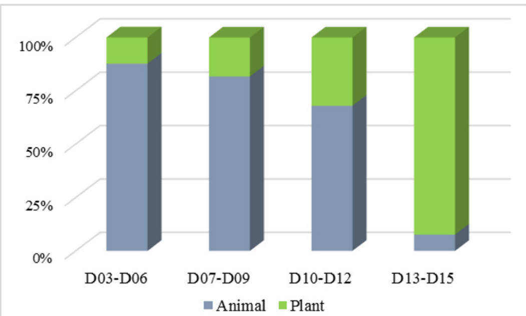

Fig. 10. Diet structure of Blackbird nestlings at four stages of the nestlings (Plant and Animal food).

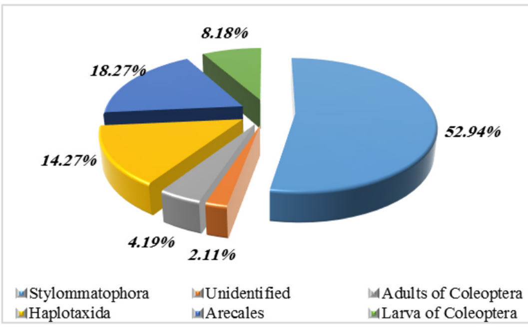

Fig. 12. Taxonomic composition of Blackbird nestlings diet during the second stage (D07-D09).

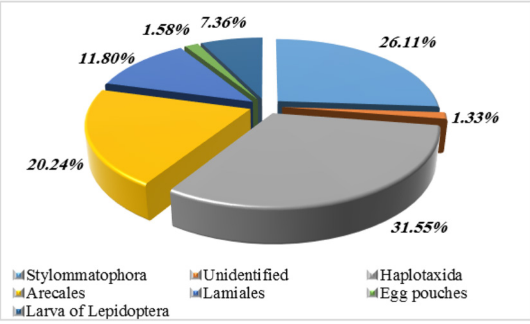

Fig. 13. Taxonomic composition of Blackbird nestlings diet during the third stage (D10-D12).

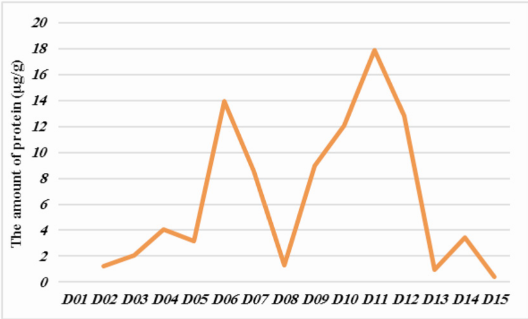

Fig. 15. Daily protein values of food items in the Blackbird nestlings diet.

of egg pouches. Plant food is represented by Arecales (*Phoenix dactylifera*) at 20.24% and Lamiales (*Olea europaea*) at 11.80% and finally 01.33% of unidentified items (Fig. 13).

Fourth Stage (D13 - D15)

The fourth stage reflects the changing trend in the nestlings diet. Indeed, the most abundant food is Arecales accounted for 52.33%, followed by Urticales at 23.08%, 16.93% of Lamiales, 03.07% of Coleoptera adults and finally 04.57% of Lepidoptera adults (Fig. 14).

Determination of protein values of food items in the Blackbird nestlings diet

We calculated the protein value of each food item over one gram of tissue sampled. The protein values vary between different items. However, animal food is much richer in protein than plant food. The largest rate of protein is for the egg pouches with 10.49 µg/g, followed by *Noctua pronuba* with 9.13 µg/g, *Biston betularia* with 8.93 µg/g and *Agriotes* sp. with 7.41 µg/ (Table 3).

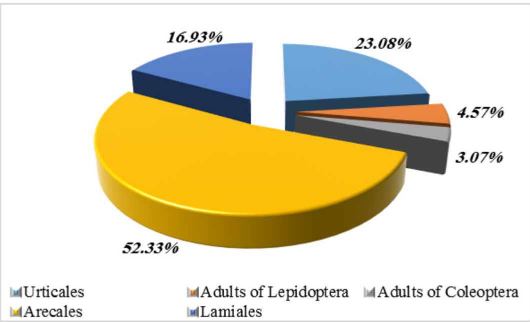

Fig. 14. Taxonomic composition of Blackbird nestlings diet during the fourth stage (D13-D15).

Daily protein values of food items in the Blackbird nestlings diet

Daily values of protein in the prey vary during the brood period (Fig. 15). The maximum is observed on the eleventh day, followed by the sixth day. Meanwhile, the minimum values are the eighth and the thirteenth day.

DISCUSSION

The floristic composition is a major factor in maintaining bird populations. The natural cycle occurring in urban ecosystems is different from forest ecosystems, because the landscapes typically selected by birds within cities are the places where the vegetation is more developed. The tree-lined neighbourhoods, parks, gardens and then cemeteries are crowded with birds especially for nesting (Belabed *et al.* 2012). The Blackbird is one of those nesting species it is common in many habitats (Isenmann 2000). Many studies have been published on this species in the ornithological literature among those publications, Koródi Gál (1967), Berthold (1976), Vauk and Witting (1971), Török (1981, 1985, 1988), Sorensen (1981, 1984), Théry (1989), Saxton *et al.* (2004), Post and Götmark (2006) Fritsch *et al*. (2012) examined the diet behavior of the Blackbird.

The comparative study of Havlin (1977) was used to analyze the stomach contents of hundreds of starlings and Blackbirds. Using the same method Eble (1963) was able to determine the compozition of the diet of Blackbird in several habitats. The study of Dyrcz (1969) was very thorough in discussing the distribution, habitat selection, determining the diet and breeding ecology of this species. The study Smith (1973), was based on the behavior of foraging.

Török (1981, 1985, 1988) tried to achieve an ecological review of the breeding species and the compozition of the nestlings' diet in urban and agricultural areas.

Comparing our results with those of Vauk and Witting (1971) on Blackbirds' nutrition in migration periods, we find significant differences. In fact, the stomach contents of Blackbirds in migration periods consisted of 40% of plant food and earthworms were missing. So it was concluded that the bird food was determined by the supply of food in different regions and seasons (seasonal migration or reproduction).

There are also differences concerning the composition of arthropods in the food. In the study of Vauk and Witting (1971), the food of migrating Blackbirds contained many snails (*Oxychilus* sp. and *Littorina* sp.), weevils (*Otiorhynchus ovatus*) and ants (*Formica* sp.). However, nothing of all that was found by Török (1981) or by almost insignificant amount. Our study shows that the main ingredient feeder of young Blackbirds is gastropods Stylommatophora (*Cepaea* sp.) at a rate of 42%. Chamberlain *et al.* (1999), the seasonal pattern of the prey compozition of nestling diet in each year shown that Earthworms contributed most to energy intake, followed by caterpillars in rural habitats. Other items, including other insect larvae (especially tipulids), adult insects, spiders, slugs and berries, were present throughout the season in small amounts, except in 1992 when these prey types predominated towards the end of the breeding season.

According to Eble (1963), animal and plant percentage in the food of the Blackbirds nestlings was 48.7 % and 51.3% respectively, what we find in our results of 49% of plant material 51% of animal material for biomass. However, if we count the numbers of items, we have another result of 80% for animal food and 20% for plant food. For Havlin (1977), it was about 10 % of plants and 90% animals for the adults. In two different Oakwoods, neither Dyrcz (1969) nor Török (1981) have found plant food in the diet of nestlings.

This could be due either to age or to the study site, in fact, Eble (1963) did not work in an Oakwood and he only sampled adults. However, Dyrcz (1969), Török (1981) and our study are focused in nestlings.

According to Török (1981) an important part of the food consisted in earthworms and insects easily digestible and low in chitin (Diptera, Hymenoptera, Lepidoptera: larvae, pupae and adults), during the first stage (between the 1st and the 3rd day). The proportion of beetles increases particularly in the final stages of growth of the nestlings (10-12 days).

Our results differ than those of Török(1981), in fact, during the first stage (1-4 days) the proportion of animal food was 100%, but it decreases with age, replaced by plant food. This could be explained by the physiological status of nestlings. Being vulnerable during the early growth, they need animal protein to ensure the development of their immune system, reproductive, and improve their fitness.

The comparison of the two studies of Koródi Gál (1967), Török (1981), shows that there is a common fact about the increase in the rate of Coleoptera and a decrease in the rate of Arachnids throughout the brood period.

Török (1981), with the exception of a single slug, no snail was found among 292 prey collected. This is probably due to the lack of snails in the environment of this study (an Oakwood), or it is due to the dry climate, that does not allow the spread of snails. In addition, it was found that the low presence of earthworms might be due to the same reasons mentioned above.

In the study by Eble (1963), Coleoptera was predominant, but the proportions of Gastropods, Lepidoptera, Diptera were also high. Török (1981), there has been the same results except Gastropods and in the study of Dyrcz (1969), the same results were found except that the proportion of adult Lepidoptera was very high.

The caterpillars have been reported to be the most important prey item among passerines during the breeding season to feed their nestlings, because they are seasonal and most abundant in spring and summer (Greenberg 1995).

Other theories to explain the differences in diet composition between different species are:

The height of the foraging site. The difference between the plant species used by birds. Habitat selection. Competition (Perrins and Birkhead 1983).

The change in the food distribution to the nestlings may be influenced by changes in the quality of food, which could influence the effect of the potential value of this food on the growth and survival of nestlings. Both possibilities should be investigated in further studies that examine the variation in reproductive success of this species in urban areas.

Most omnivorus birds feed on invertebrates throughout the season and Berthold (1976) found that plants constitute a reserve of food which can be exploited when invertebrates are not available.

The nutrient provided by invertebrates is the animal protein and its lack in the food leads to weight loss and death (Berthold 1976). Only specialized herbivorus birds such as pigeons are able to survive without this animal protein. In experimental study with captive birds, Berthold (1976), found that they do not prefer plant food at any season; birds fed all-fruit diet lost weight and died, but addition of 2-3 g of beetle larvae per day was sufficient to maintain weight (Berthold 1976).

During the last decades, much attention has been paid to the interactions between fruit trees (with fleshy fruit) and frugivorus birds (Herrera 1995). A number of field studies and anecdotal reports have demonstrated the importance of fruit in the diet of many species of birds (Jordano 1995). Many studies have reported striking differences in the quantities of different species of fruit consumed by birds (Jordano and Herrera 1981, Sorensen 1981). The reasons for these different patterns of fruit consumption are often unknown. In some cases, preference has been linked to the abundance, nutritional value of fruits (Jordano and Herrera 1981) or the growth form of fruit-bearing plants. However, other studies have reported a lack of relationship between fruit consumption and fruit abundance, nutritional values (Sorensen 1981), or fruit search/handling times (Sorensen 1981). Some experimental works suggest that taste may cause birds to avoid some species of fruit. However, the order of taste preferences does not always correspond completely with the consumption of different fruit species in the field, suggesting that additional factors are important in determining preference (Sorensen 1984).

While feeding birds with fruit during migration and wintering have been extensively studied (Herrera 1995), much less attention has been paid to its role during the breeding season (Snow and Snow 1988, Widmer 1996). This is surprising especially in moderate southern latitudes where many fleshy fruits ripen during the summer months: Debussche *et al.* (1987) identified 25 species of fruits that ripen in the summer in a region of southern France and Herrera (1982) found the same number for two locations in southern Spain.

The frugivorus birds usually move in a constant and well-defined territory during the breeding season, where fruit trees are a large, predictable and accessible food source. Therefore, the fruit can be used by adults to systematically feed the nestlings (Widmer 1996).

The Blackbird seems to act as an opportunist because it does not change its model space activity during the ripening season. The importance of summer frugivority for Blackbirds seems to vary among populations, because it depends on the supply of fruit during the autumn and winter (Berthold 1976, Snow and Snow 1988, Jordano 1995).

The adults Blackbirds spend most of their time foraging in grasslands during the year. During the breeding season, especially when it comes to feeding young in May and June, their diet consists of invertebrates obtained almost all from the floor or surface fields. If this food source were to disappear for some reason, for example, during a particularly dry season, the chances of survival of nestlings are much reduced when they are given to alternatives such as: Bread, cereal, or the livestock feed. In addition to a food with just plant protein that are less assimilated than animal protein, the absence of invertebrates in the diet can deprive late nestlings from their only source of water. Efficient digestion of low quality food, may require much more time to retain in the gut (Hilton *et al.* 2000), and potentially impose a constraint on the growth of nestlings.

During the breeding season fleshy fruits can play a significant role in the nestlings nutrition, even if there was some exceptions (Widmer 1996), they appear to be an emergency food during periods where the availability of invertebrates is very low (Berthold 1976, 1984, Snow and Snow 1988). Young Blackbirds (yearlings) have a rather high proportion of frugivory compared to nestlings of other species because they feed directly on fruit trees (Glutz von Blotzheim and Bauer 1997).

These observations clearly support the hypothesis that the easily accessible fruit trees are important for the nutrition of novices and immature birds of a first brood (Desrochers 1992).

The quality of food, especially protein content, can influence the growth and survival of nestlings (Birkhead *et al.* 1999). Observations on many occasions showed that parents fed the young with human food. An experimental work suggests that the Blackbirds show a preference for Lepidoptera larvae when they feed their nestlings, but if the energy costs associated to the search and capture of Lepidoptera larvae are raised, their preference changes to the more available food and easier to find: Human food (Shawkey *et al.* 2004).

Therefore, if the search and the supply costs of urban arthropods are high because of their low abundance, parents may prefer to feed nestlings easier, with available foods, even if it is low quality aliments. In addition, the effectiveness of the assimilation of proteins in these foods may be much lower than the high-level protein food.

First, the proteins are very important for the normal growth of the birds. Protein from animal sources provide more amino acids and are called the "complete protein". Proteins that lack some essential amino acids are called the "incomplete proteins" and these incomplete proteins comes from mostly plant sources.

This confirms our results because the values of protein found in animal food are much higher than in plant food, but that plant food compensate their low protein levels by a much larger biomass than animal food.

Most passerines feed their nestlings in the nest with an insect-based food and only after, they add other foods. Even adults Blackbirds eat a diet rich in insects and with fruit, depending on the season. The Blackbirds are omnivores, though because they eat a large amount of insects that most omnivorous birds, they are very close of being insectivorus. Their dietary needs include animal protein, vitamins (especially vitamin A) and minerals such as calcium.

CONCLUSION

The diet of urban Blackbird nestlings consists of animal food to 51 % and 49% of plant food in terms of biomass and respectively 80% and 20% in terms of numbers.

This difference comes from the significant biomass of the plant food brought to the nestlings to overcome the low protein level of this food. Also, animal food is very difficult to find and requires effort from parents. These efforts are necessary at the beginning of the brood because the nestlings have huge energy needs, but the demand decreases with the weight gain and nestlings' age. This creates a nutritional change; in fact, it is the plant food, which replaces the animal food.

In conclusion, the Blackbird *Turdus merula mau-*

ritanicus, is acclimated to urban areas by adopting specific strategies for nutrition (as a balance between animal and plant food and research efforts).

Knowing that the Blackbird is now part of the landscape and urban ecosystems, the study and monitoring of its populations are of capital importance in this ecological dynamic. The processes associated with urbanization are events that control the change of landscape and represent a major threat to biodiversity. Urban planners need a better understanding of factors affecting the distribution of species and community structure in order to create or maintain biodiversity in urban areas.

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