THE FOOD PROFILE OF THE GREAT SPOTTED WOODPECKER (*Dendrocopos major*) IN THE TIKJDA FOREST OF NORTH AFRICA

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Abstract. The study of the diet of the Great Spotted Woodpecker (*Dendrocopos major*) was undertaken the Tikjda forest which lies north of Bouira (Algeria). We identified, thanks to Barber pots, food availability of up to 1094 individuals during 3 months of study in 2018, the highest number of which is recorded in Hymenoptera order with 63.62%. Similarly, we have collected 52 droppings of *Dendrocopos major* in the same period. The analysis of droppings allowed us to enumerate a set of 8066 food items. These items belong to 100 different prey taxa grouped in 6 classes, 21 orders and 55 families. The insect class is the most represented with 7820 individuals. One finds the greatest number of individuals in Hymenoptera and in particular in ants with 7576 individuals (93.93%). *Messor picturatus* with 5185 individuals is 64.28% of the total number of individuals in this family, followed by *Camponotus micans* with a rate of 13.66% (1102 individuals). The other classes are poorly represented ranging from 0.07% to 1.35%.

Keywords: Tikjda (Algiers), Great Spotted Woodpecker, *Dendrocopos major*, food availability, diet, Formicidae.

Rezumat. Profilul alimentar al ciocănitoarei pestriţe mari (*Dendrocopos major*), în pădurea Tikjda din Africa de Nord. Studiul dietei la ciocănitoarea pestriță mare (*Dendrocopos major*) a avut loc în pădurea Tikjda, situată la nord de Bouira (Algeria). Am determinat cu ajutorul vaselor Barber un spectru trofic ajungând la 1094 de exemplare pe parcursul a 3 luni de studiu din anul 2018, dintre care predominant fiind ordinul Hymenoptera cu 63,62%. Totodată, am colectat 52 de excremente de *Dendrocopos major* în aceeași perioadă. Analiza excrementelor ne-a permis să numărăm un set de 8066 elemente (ingluvii). Acestea aparțin la 100 de taxoni diferiti de pradă, grupați în 6 clase, 21 de ordine și 53 de familii. Clasa de insecte este cea mai reprezentată, cu 7820 de indivizi. Cel mai mare număr de taxoni se încadrează în ordinul Hymenoptera, dintre care Formicidae, cu 7576 indivizi (93,93%). *Messor picturatus*, cu 5185 de exemplare, reprezintă 64,28% din numărul total din această familie, urmată de *Camponotus micans* cu o rată de 13,66% (1102 indivizi). Celelalte clase sunt slab reprezentate, variind de la 0,07% la 1,35%.

Cuvinte cheie: Tikjda (Algeria), ciocănitoare pestriță mare, *Dendrocopos major*, disponibilitate alimentară, dieta, Formicidae.

INTRODUCTION

According to agriculture professionals, predation is defined as an essential ecological process in controlling populations and evolution of prey (RAMADE, 1984). The Picidae family includes some 200 worldwide distributed species, having the size of a blackbird (*Turdus merula*), and weighing between 70 and 100 g. Furthermore, the Great Spotted Woodpecker is, indeed the European woodpecker species with the widest distribution, as documented mainly for insectivorous birds (ants, larvae, beetles, caterpillars, flies), and more occasionally for gastropods, earthworms, seeds, conifer cones, fruits, buds, sap (BAVOUX & LEMARCHAND, 2015). Since forestry biodiversity is a very wide topic, our study was devoted on investigating the diet of the Insectivore Picidae Great spotted woodpecker (*Dendrocopos major*) around the forest of Tikjda (Bouiracity, Algeria) (Fig. 1). This region is well-known by its marked richness and originality of flora and fauna, and forestry environments, mainly plant formations which are more or less conserved and are located on top of mountain massifs. The great spotted woodpecker is a species of woodpecker, most widely and commonly found in Asia (up to Japan), Asia Minor, North West Africa and Europe (GEROUDET, 1980), since the great spotted woodpecker (*Dendrocopos major numidus*) found in Algeria and Tunisia has black and red chest, and the red of the lower abdomen part extends to the abdomen (GORMAN, 2014), and due to its unremitting activity, it plays an important role in forestry ecology. Moreover, this bird species also promotes the colonization of dead trees by fungi and xylophagous insects (Coleoptera), indicative of forest richness, and whose effect leads to wood breakdown (OOSNECK-DALIGAULT, 2015). Woodpeckers (Picidae) are the world scientific topic for several studies, such as those of MEYLAN (1931), HENRY (1998), BOCCA (1999) and ISENMANN et al. (2005). Interestingly, the great spotted woodpecker lives in the forests of Algeria, especially those of oak trees (*Quercus* spp.), but not those composed of Aleppo pine, and also in the maritime pines near to Oubeira Lake (ISENMANN & MOALI, 2000). Similarly, GACEM (1997) has found this species in olive groves of the Mâatkas region in the Tizi-Ouzou city (North Algeria). Unexpectedly, the works of BENDJOUDI & DOUMANDJI (1997) have investigated the diet of the great spotted woodpecker living in Mitidja plain (North Algeria). Despite the generalization of this study, overall and punctual data are provided in general books, like those of HEIM & MAYAUD (1962), ETCHECOPAR & HUE (1964), LEDANT et al. (1981), ISENMANN & MOALI (2000) and MAOUCHE-HENINE (2016). So far, very limited works have been conducted on the relationship between the trophic availability present in the field and the prey actually eaten by Great Spotted Woodpecker in the study region. Hence, this contribution comes on the one hand, to enhance the data that have been already collected, and at the other hand to determine the diet profile of the Great Spotted Woodpecker species in the Tikdjda region (northern Algeria) characterized by a humid climate in cool winter.

Figure 1. The Great Spotted Woodpecker *Dendrocopos major* (Linnaeus. 1758) in the Tikjda Forest (Bouira) (original picture by Aimene Boulaouad, 2018).

MATERIAL AND METHODS

Study site

The study was performed in the Tikjda region, located at the foot of the Akouker Massif, one major region of the Bouira city (northern Algeria), the southern slope of Djurdjura in the Great Kabylie region, and the administrative headquarters of the Djurdjura National Park and UNESCO Biosphere. This experimental area is located at 1478 m of altitude and geographic coordination 36°15'53" N, 4°04'26" E, and the Tikjda massif includes red sandstone (Triassic) (FLANDRIN, 1952). Amazingly, the study site is mainly exposed to snow accumulation for the Mediterranean region (comparable to the Mercantour region) resulting from the ferruginous minerality of the subsoil, and the proximity of the Mediterranean Sea (Fig. 2).

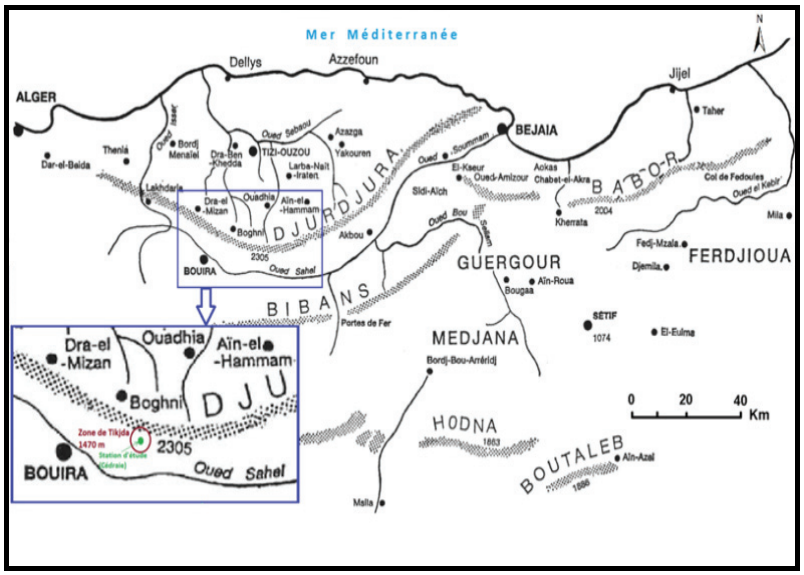

Figure 2. Geographical location of the three sampled station (PND. 2012, modified).

Also, the site is located in the humid bioclimatic level in cool winters. This study area is rich in endemic flora and fauna, and hence the different plant formations of Djurdjura have been described by several authors (LAPIE, 1909; MAIRE, 1926; QUEZEL, 1957; BARBERO et al., 1990). In this regard, MENARD & VALLET (1988) have identified five types of vegetation in the Tikjda area, namely Cedar forest (*Cedrus atlantica*), evergreen oak (*Quercus rotundifolia* L.), Matorral of cedar and holm oak forests, shrubby and lawn formations with Chamaephyte.

Wildlife availability, diet study and dropping analyses

The sampling of the prey species of *Dendrocopos major* and its droppings in the study site took lplace during the period of juvenile feeding, i.e the period between early April and late June. Here, eight Barber pots were placed in the habitats of the Great Spotted Woodpecker, which are separated from each other by a space of about 4 cm. Each pot was filled with water and vinegar at a third of its depth, and then the mixture was sprinkled with a pinch of domestic detergent as a powder in order to slow down the breakdown of the prey. Lastly, the flasks were covered by a stone so that the attention of those passing by would not be called. During the whole 72 hours, the pot contents were collected by a small mesh strainer and the traps were then put in place. The contents of all the pots were transferred into a Petri dish, and transported to the laboratory for being sorted using a binocular loupe (10x / 20). The prey species collected in the Barber pots were largely confirmed by PhD. Marniche Faiza (Zoology laboratory, National Veterinary School of El Alia, Algiers, Algeria), in addition to the supporting dichotomous keys and books, including taxonomic order of Myriapods (PERRIER & DELPHY, 1932), Orthoptera (CHOPARD, 1943), Coleoptera (DUCHATENET, 1986; MCGAVIN,2005), Heteroptera (VILLIERS, 1977), Hymenoptera (BERNARD, 1968; CAGNIANT, 1968, 1969, 1970) and consulted sites for identification of the species (www.antarea.com.; www.antweb.com; www.myrmecofourmis.com.; www.keibtier). The study of the diet of the great spotted woodpecker requires an actual field exploration. In this context, we have performed 11 regular spacewalks during a monthly cycle, from April to June, 2018 throughout all the study areas, along with all their droppings (slopes, dense forests and walkways). During these spacewalks, we have collected 52 of *D. major* droppings found under the Cedar trees, and then samples were labelled with the date and place of collection, and safely kept until the day of the analysis (Fig. 3).

Figure 3. Collection of field samples (Original).
Pots Berber; **b.** droppings of Great Spotted Woodpecker; **c.** measurement.

The analysis of great spotted woodpecker droppings was performed at the laboratory of zoology of the higher national veterinary school of El-Alia (Algiers, Algeria). First of all, the contents of each dropping was mixed in ethanol 70°, and then poured into Petri dishes. All of the fragments contained in triturated droppings (heads, elytra, mandibles, thoraxes, abdominal segments, pronotum (dorsal) and sometimes complete body) were dehusked and sorted by using forceps and a binocular microscope (total magnification: 10×20). These fragments were thereafter arranged in groups in another Petri dish for being measured.

Measurement of prey taxa fragments and data analysis

When the prey taxa fragments are sorted, determined and counted, they can be measured by using strips of graph paper to estimate the prey size of the prey taxon consumed by great spotted woodpecker. The size estimation of the designed prey was extrapolated from a fragment. Overall, the heads corresponds to 1/6, thorax 1/3, elytra ½ of the total length of the insect body (BENABBAS, 2014). This estimation is justified and completed by the reference guides (GRENHALGH & OVEDEN, 2009; TACHET et al., 2000) (Fig. 3). The results of Barber pots were efficiently used to evaluate the species abundance and the diversity in the study site. These data were analysed using Paleontological Statistics software package version 2.17 (HAMMER et al., 2001), and consequently the prey species consumed by this woodpecker is evidenced by some ecological indices as follow: the centesimal frequency (Fc %) (DAJOZ, 1975) the frequency of occurrence (Fo %) (DAJOZ, 1982); COSTELLO (1990); the interval of size classes of preys are estimated according to Stürge (SCHERRER, 1984); the diversity indices of Shannon and Equitability indices (E) (RAMADE, 1984); the length of the diet niche (B) (PIELOU, 1969), the biomass (B %) (VIVIEN, 1973) and the indices of Ivlev (FARHI et al., 2003).

Figure 4. Some fragments consumed by the Great Spotted Woodpecker at the edge of the Tikjda forest (Bouira) under a binocular loupe 20x (Original).

a. Head *Messor* sp.; b. Head *Tapinoma* sp.; c. Head *Pheidole* sp.; d. Head *Camponotus* sp.; e. Head Halctidae sp.; f. Head *Forficula* sp.; g. Head *Eupelix* sp.; h. Head *Sisyphus* sp.; i. Thorax *Crematogaster* sp.; j. Thorax *Messor* sp.; k. Thorax *Pheidole* sp.; l. Thorax *Tetramorium* sp.; m. Elytre of *Onthophagus* sp.; n. Elytre *Curculionidae*; o. Elytre *Apionidae*; p. Complete ants *Lasius* sp.

RESULTS

Wildlife availabilities

The analysis of samples through the Barber pots during the three months of study leads to count a set of 1094 species items, belonging to 73 different taxa grouped into six classes, namely Arachnids, including 153 prey taxa, Myriapods, Iules and Crustaceans (2 prey taxa each), Chilopoda (1 prey taxa), and Insects (831 taxa) (Appendix 1, Table 2). The insect is the highly represented class with 831 individuals (Fc% = 71.96 %), since the higher individual number was noticed in Hymenoptera (696 taxa), and mainly in Formicidae including 657 individuals (Fc% = 60.05 %) followed by Apidae, Halictidae and Apoidea having one individual each. In the same class, the Coleoptera occupies the second position with 58 individuals (Fc % = 5.30%) and Diptera the third position with 28 individuals (2.56%), in addition to Orthoptera including 20 individuals (Fc% = 1.83%). The second class is that of Arachnids, the most important class, containing 153 individuals (Fc% = 13.99%), while the third class is that of Opiliones with 99 individuals (9.05%), and the last classes are those of Crustaceans, Diplopods, Myriapods and Chilopods with 2 and 1 individuals, respectively and a frequency of 0.18% and 0.09% (Table 1). Formicidae hves been reported by several authors. Elsewhere close to El-Kseur region (north Algeria), SALMI et al. (2002) have reported the relative importance of the trapped ants in the Barber pots, like *Aphaenogaster testaceo-pilosa* (A.R. % = 14.9 %), *Tapinoma nigerrimum* (A.R. %= 7.1 %), *Cataglyphis bicolor* (A.R.%= 6.8 %) and *Messor barbara* (A.R.% = 6.3 %).

Table 1. The number of species trapped in Barber pots in the three-month study in the vicinity of forests Tikjda (Djudjura National Park).

Orders	April	May	June	ni	Fc (%)
Opiliones	29	12	58	99	9.05
Aranea	64	29	60	153	13.99
Acari	0	2	2	4	0.37
Myriapoda	0	1	1	2	0.18
Scolopendrida	0	1	0	1	0.09
Julida	0	0	2	2	0.18
Zygentoma	1	0	4	5	0.46
Dictyoptera	2	2	2	6	0.55
Orthoptera	7	11	2	20	1.83
Dermaptera	5	2	1	8	0.73
Hemipera	2	2	1	5	0.46
Homoptera	1	1	0	2	0.18
Coleoptera	30	13	15	58	5.30
Hymenoptera	**189**	**346**	**161**	**696**	**63.62**
Diptera	5	13	10	28	2.56
Lepidoptera	0	1	2	3	0.27
Malacostraca	1	1	0	2	0.18
Total (N)	**336**	**437**	**321**	**1094**	**100.00**

On top of that, the diversity indices of Shannon during the three study months are weak, and ranged from 0.93 bits to 1.49 bits (Table 3).

Table 3. Indices of ecological species trapped in Barber pots in the three months of study around the forests of Tikjda (Djudjura National Park).

Month	April	May	June
Taxa S	12	15	14
Individuals	336	437	321
Dominance D	0.37	0.64	0.32
Simpson1-D	0.63	0.37	0.65
Shannon H'(bits)	1.39	0.93	1.49
Evenness (e^H/S)	0.33	0.17	0.32
Equitability (E)	0.39	0.24	0.39

This index shows a strong emphasis of the rare species (FAURIE et al., 2003). In this study, Simpson's diversity index was found to be between 0.63 and 0.68, respectively for April and June. Unlike the diversity indices of Shannon, the Simpson index provides higher importance to abundant species than those of rare species, although it is less sensible to species diversity (MAGURRAN, 1988) except during May, when the species become less abundant in the study site. Maximum diversity is revealed by the value 1.49, since the minimum diversity is presented by the value 0.93. Moreover, the recorded index of equitability varies from 0.24 to 0.39, and hence this value seems to tend toward 0 which seems to appear as an imbalance between the numbers of species trapped by Barber pots. This imbalance is due to the dominance of the order Hymenoptera with the species *Messor picturatus* within the ant population.

Diet study

All insect fragments identified at the level of 52 droppings recovered from the Great Spotted Woodpecker were represented as spectra for food category groups. Figure 5 shows that the 6 classes have an average centesimal frequency ranging from 0.07% to 96.95%. Indeed, the analysis of the food diet of this species demonstrated the predominance of insects with 7820 individuals (Fc% = 96.95%). The Diplopoda, the Malacostraca, arachnids, centipedes and gastropods supplement the diet with converging frequencies Fc – 1.37%, 0.92%, 0.60%, 0.11% and 0.07% (Fig. 5).

The high impact on insects is due to the abundance of this group, generally much higher than that of other class categories (Table 2, Appendix 1).

The Picidae have been considered almost exclusively insectivore birds in some works (ZAKARIA et al. 1999; SAZIMA et al. 2001).

Here, the insect dominance in *Dendrocopos major* is most actually related to the fact that the individuals of this class are the most abundant animal in the environment. The works of MIRANDA & BÜRGI (2005) conducted in Switzerland have shown that the Great Spotted Woodpecker has a clear preference for insects and their larvae living not only in the woods, but also spiders, caterpillars, seeds and nuts rich in fat.

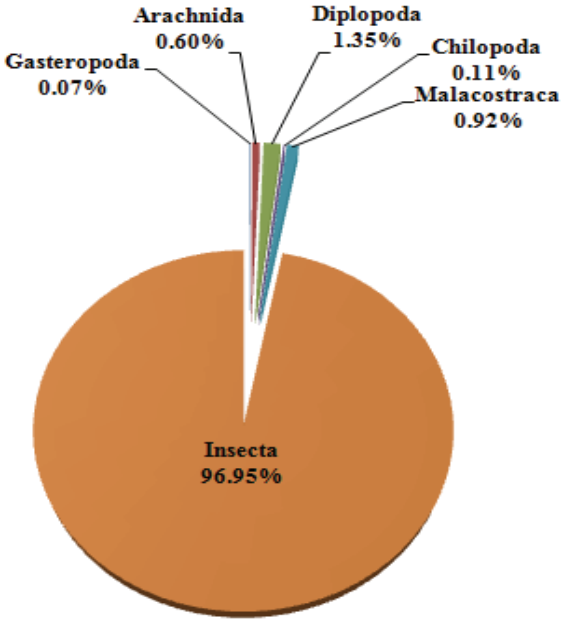

Figure 5. Different classes found in the droppings of the Great Spotted Woodpecker in the Tikjda Forest (Bouira).

Centesimal frequencies of species-prey, *Dendrocopos major* grouped according to the Formicidae species

The Formicidae family is ranked first in terms of prey species consumed by Great Spotted Woodpecker, and hence the 7576 prey-species identified in 52 droppings are mainly ants exhibiting a high rate (93.93%) (Table 4).

Table 4. Centesimal frequencies of the species of Ants within the Formicidae in the menu of the Great Spotted Woodpecker.

Species	ni	Fc (%)
Camponotus micans	1102	14.55
Camponotus creuntatus	149	1.97
Camponotus erigens	74	0.98
Camponotus barbaricus xanthomelas	3	0.04
Crematogaster scutellaris	374	4.94
Cataglyphis viatica	12	0.16
Pheidole pallidula	77	1.02
Tapinoma magnum	27	0.36
Tetramorium biskrens	69	0.91
Plagiolepis barbara	49	0.65
Aphaenogastertestaceo-pilosa	455	6.01
Messor picturatus	5185	68.44
N	**7576**	**100.00**

Within this same family, there is a dominant species (*Messor picturatus)* whose individual numbers found in droppings are estimated at 5185, and also reveals 64.28% of the prey species consumed by *D. major*, in addition respectively, to *Camponotus micans* (13.66%), *Aphaenogaster testaceo pilosa* (5.64%), *Crematogaster scutellaris* (4.94%) and *Camponotus creuntatus* (1.97%), *Pheidole pallidula* (0.95%) and *Camponotus erigens* (0.92%). The other species, namely *Camponotus barbaricus xanthomelas*, *Cataglyphis viatica, Tapinoma magnum* and *Plagiolepis barbara* present rates varying between 0.04 % and 0.91% of Formicidae found in the trophic diet of *D. major*, suggesting therefore that this species is predominantly myrmecophagous (Fig. 4). Also, the Great Spotted Woodpecker may be considered as a very useful predator limiting species populations of pest ants, like *Tapinoma magnum* which raise, protect and promote the multiplication of aphids and mealy bugs or *Crematogaster scutellaris* that perforate the bark of cork oaks and pines (BERNARD, 1968).

Centesimal frequencies (FC %) and the occurrence frequency (FO %)

The trophic diet of Great Spotted Woodpecker in the Tikjda forest includes 100 prey taxa, and is mainly composed of insects. As indicated in Table. 2, the higher value of the centesimal frequency was noticed for *Messor picturatus* (64.28 %), followed by *Camponotus micans* in second position (13.66 %), since the following positions are occupied by *Aphaenogaster testaceo pilosa* (5.64 %), *Crematogaster scutellaris* (4.64 %), *Camponotus creuntatus* (1.85%) and *Pheidole pallidula* (0.95 %). The remaining prey taxa are found very weak in droppings of *Dendrocopos major*. The occurrence frequency is defined as the ratio expressed as the percentage of the dropping numbers where the prey taxa are related to the total analysed droppings. Hence, the different prey taxa groups are grouped into three categories (privileged, secondary and accidental) of six prey taxa each (SORBE, 1972), and also the diet of *D. major* is presented by three occurrence classes (Table. 5).

Table 5. Classification of *Dendrocopos major* prey taxa by occurrence classes in the Tikjda Forest (Bouira).

Occurrence Classes	Preferred	Secondary	Accidental
Number of prey taxa	09	18	73
Parentage (%)	09.00	18.00	73.00

The privileged prey taxa class includes two orders, the Formicidae family, sub-families of Coleoptera order, and the sub-family Harpalinae which was found in the 52 analysed droppings. The second prey taxa class includes 18 species (18.00 %), 5 orders, 9 families, and lastly, the accidental species (73.00%) include 12 orders and 40 families (Table2). Noteworthy, the three occurrence classes are not similar, and thus this is proved by applying the Kruskaland Wallis ($\chi 2$ ddl=1, obs. = 13.29) test. The Costello graph can be performed focusing on the centesimal and occurrence frequencies of the most common prey taxa for the Great Spotted Woodpecker, and on those presented by the privileged species (Fig. 6).

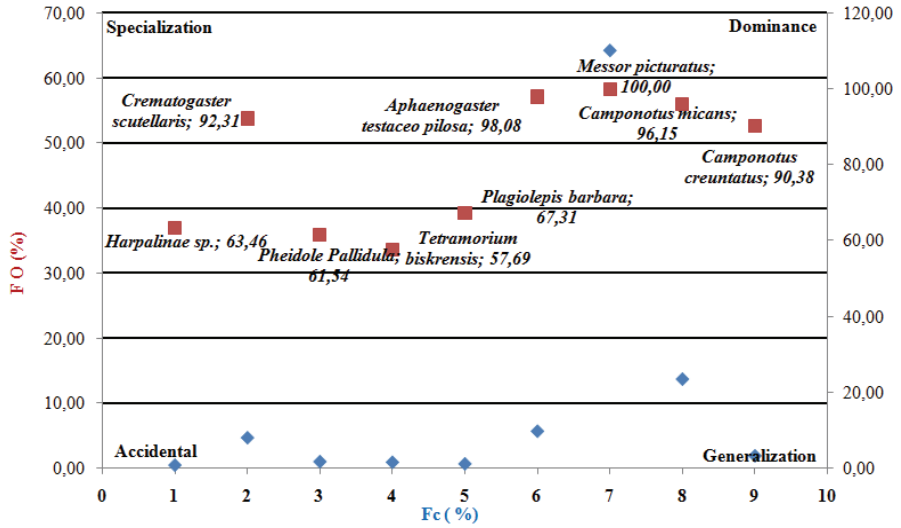

Figure 6. Potential prey taxa of Great Spotted Woodpecker in the Tikjda Forest (Bouira).

These various species are considered to be the potential prey taxa of *Dendrocopos major* in the Tikjda forest. On the other hand, the ant *Messor picturatus* (64.28 %, 100 %) is the only potential prey taxon of the Great Spotted Woodpecker. Additionally, other prey taxa are considered important in the species diet, including *Aphaenogaster testaceo-pilosa* (5.64%, 98.08%), *Camponotus micans* (13.66%, 96.15%), *Crematogaster scutellaris* (4.64%, 92.31%), *Camponotus creuntatus* (1.85%, 90.38 %), *Plagiolepis barbara* (0.61%, 67.31%), *Harpalinae* sp. (0.41%, 63.46 %), *Pheidole pallidula* (0,95 %, 61.54 %) and or *Tetramorium biskrensis* (0.86 %, 57.69 %). Despite their weak abundance (in occurrence and in number) in the analysed droppings, some species exhibit are quite significant in the diet of the spotted woodpecker, such as *Armadillidium* sp. (0.33%, 48.08 %), *Anisolabis mauritanicus* (0.17%, 23.08 %), *Ectobius* sp. (0.14 %, 19.23 %), *Dysdera* sp. (0.20 %, 17.31%), *Pentatomidae* sp. (0.04%, 5.77 %), *Theba pisana* (0.02%, 3.85 %) and *Eobania* sp. (0.01%, 1.92 %) (Appendix1, Table 2).

Shannon's index of diversity, equidistribution and width of the food niche

The diversity of diet of *D. major* is, overall, about 2.20 bits, while the maximum value H'max. reaches 4.46 bits. This indicates that the diet of this insectivore is less diversified, in terms of prey taxa, but it is compensated by the important number of prey consumed by the Picidae with an average of 159.72 items per droppings. The equidistribution index (E) gives the value 0.33and 9.03 for diet niche, indicating thus that the numbers of prey taxa consumed by Great Spotted Woodpecker tend to be in disequilibrium with each other, due to reason of diet preferences of *D. major* whose trophic profile is composed of 64.28 % of ant *Messor picturatus,* since the other species are low presented, and this subsequently proves that the species selects these preys to feed oneself. The abundance of Formicidae in the trophic diet of *D. major* can be justified by the wealth and accessibility of this family (exclusively social insects) in the environment.

Classification of prey taxa consumed by Great Spotted Woodpecker as a function of their sizes

The sizes of prey taxa consumed by *D. major* vary from 0.9 mm for *Acari* sp. and from 1 to 41 mm for *Cylindroiulus* sp. The average size of prey taxa per droppings is 10.39 ± 0.05 mm, in addition that eleven classes of the species were identified following the Sturge's Rule (NC = 1 + (3.3 Log10 N). The results of the centesimal frequencies of size classes of prey taxa consumed by Great Spotted Woodpeckerare displayed if Fig.7, from which we noticed that the first size class expressed in mm [6.62 – 9.48[includes high individual numbers with a frequency of 66.28%. Furthermore, *Messor picturatusis* identified as the dominant species in this class, followed by the class [12.34-15.20[(Fc % = 20.07%) including only 1619 individuals, in addition to the families; Oniscidae, Glomeridae, Polydesmie, Lithobiidae and Porcelionidae. The third class [3.76-6.62[having frequency of 5,43% includes only 438 individuals, and is represented by *Camponotus micans*, *Aphaenogaster testaceo-pilosa* et *Crematogaster scutellaris,* since the other

classes are, [15.20-18.06[including 251 individuals (F% = 3.11%) and represented by Geotrupidae, Scarabaeidae and Cetonidae, class of [0.9-3.76[including 129 individuals (Fc %= 1.60%) and represented by Acari, Linyphiidae, *Atheta* sp, *Tapinoma magnum* and *Pheidole pallidula*, and the last classes are those of the interval [29.2-23.78[including 11 individuals exhibiting only a cumulated frequency as 0.14 %, such as the families, namely Blattidae, Blatellidae, Gryllidae, Forficulidae and Carcinophoriudae.

As a result, the species *D. major* shows a clear preference for the small sized preys, and this is largely compensated by the number of individuals of an anthill, and hence a nest of *Pheidole pallidula* may be counted up to 100.0000 individuals (BERNARD, 1968).

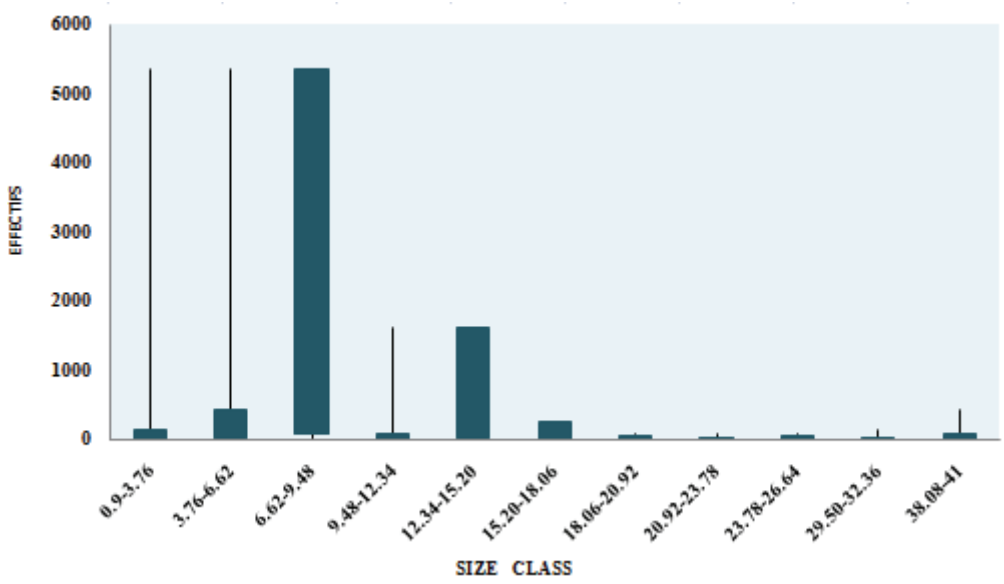

Figure 7. Effective of estimated size classes the Great Spotted Woodpecker's prey during 3 month of study.

Prey taxa biomass of *Dendrocopos major* in Tikjda forest (Bouira, North Algeria) and index of Ivlev Li

In term of biomass, among the highly consumed order by Great Spotted Woodpecker is that of Hymenoptera whose Formicidae family dominates with the species *Camponotus micans* (44.20 %), followed by the species *Messor picturatus* (34.66 %), *Camponotus creuntatus* (5.98 %), and *Aphaenogaster testaceo pilosa* (4.56 %). Regarding the other families, their biomass oscillates ranged from 0.07 % to 0.33 % are weakly represented (Table 6).

Table 6. Biomass *Dendrocopos major* taxa of prey in the forest of Tikjda (Bouira).

Ordres	Families	Prey taxa	pi	B (%)
Hymenoptera	Formicidae	*Camponotus micans*	13.22	44.20
		Camponotus creuntatus	1.79	5.98
		Camponotus erigens	0.89	2.97
		Camponotus barbaricus xanthomelas	0.04	0.12
		Crematogaster scutellaris	0.75	2.50
		Cataglyphis bicolor	0.14	0.48
		Pheidole pallidula	0.08	0.26
		Tapinoma magnum	0.02	0.07
		Tetramorium biskrens	0.14	0.46
		Plagiolepis barbara	0.15	0.49
		Aphaenogaster testaceo-pilosa	1.37	4.56
		Messor barbara	10.37	34.66
	Apidae	Apidae sp.	0.02	0.08
		Apis sp.	0.08	0.27
	Apoidea	Apoidea sp1	0.60	2.01
		Apoidea sp2	0.15	0.50
	Ichneumonidae	Ichneumonidae sp.	0.10	0.33
	Chalcidae	Chalcidae sp.	0.02	0.07
		N	**29.92**	**100.00**

To establish the relationship between the availability and the diet of Great Spotted Woodpecker, we have used the Ivlev's index, promoting to compare the abundance of available preys in the environment and the selection of consumed preys by *D. major.* On other words, this index is applied to highlight the prey- species preferential to Great Spotted Woodpecker in Tikjda forest. In Table 7, the values of Ivlev index in *D. major* at the site of cedar forests of Tikjda vary from 0.31 for *Tapinoma magnum* to 0.72 for *Aphaenogaster testaceo- pilosa*. Also, the species whose Ivlev

Li value is negative are less consumed though, they are widely found in the environment including *Tapinoma magnum* (Li = - 0.13) or Ichneumonidae sp. (Li = - 0.98), since the species whose Ivlev Li value is positive, they appeared to be highly sought by the predator, ie species is weakly abundant species in the environment, but it has high frequencies in the trophic profile, eg the species, *Pheidole pallidula, Armadillidium* sp., *Messor picturatus* or Tenebrionidae sp. These four species are well represented in D. major's trophic menu. This is probably due to their average size (3 to 12 mm) and their anthills that house thousands of individuals (CAGNIANT, 1997).

Table 7. IVLEV index of prey of *Dendrocopos major* in Tikjda cedar (Bouira) (FR: the abundance of an item i in the diet of the Great Spotted Woodpecker FD: the abundance of an item i in the medium considered: Li: IVLEV Li).

Categories	Species	FD	FR	Li
Aranea	*Dysdera* sp.	152	16	-1
Malacostraca	*Armadillidium* sp.	2	27	0
Hymenoptera	*Messor picturatus*	390	5185	0
	Tapinoma magnium	7	27	0
	Aphaenogaster testaceo- pilosa	10	455	1
	Pheidole pallidula	8	77	0
	Cataglyphis viatica	99	12	-1
	Ichneumonidae sp.	14	1	-1
	Apoidea sp.	1	3	0
Coleoptera	*Carabus morbillosus*	2	2	-1
	Onthophagus taurus	1	1	-1
	Onthophagus sp.	2	1	-1
	Ocypus olens	6	8	-1
	Tenebrionidae sp.	1	12	0

The species found in the soil-terrain, and present in the trophic diet of *D. major* arecounted as 63 species (Li = -1), and among them, all species of the classes, Arachnids, Collemboles and Crustaceans, as well as the species of the orders; Hemiptera, Diptera, Orthoptera, Cockroaches and Coleoptera. In Formicidae, we noticed the following species; *Cataglyphis viatica, Tapinoma magnum, Messor structor, Monomorium salomonis* or again *Monomorium* sp. Also, the species found in the trophic diet, but not in the study environment and exhibiting Ivlev Li value equals to +1 are counted as 96 species. These results are in line with those previously reported on other Picidae by BENABBAS (2014), who proved that within the species well-noted in the trophic diet of Wryneck Wren, the ants were found to be widely abundant in the diet as in the environment, and this is the case of *Pheidole pallidula* (Ii. = + 0.79), *Tapinoma nigerrimum* (Ii. = + 0.98) and *Tetramorium biskrens* (Ii. = + 0.72). The value of Ivlev Li index of the species namely, *Crematogaster scutellaris, Camponotus barbaricus xanthomelas* and *Plagiolepis barbara* is +1 (Li = +1)(Table 7). Moreover, the species spotted woodpecker proved to be selective in its search for food, i.e. it chooses the place of its nest as a function to its feeding habitats. The work of TOUIHRI et al. (2015) carried out in Tunisia proved that the nesting and feeding sites are overall associated for the species *P. vaillantii,* and similarly to those carried out in Great-Bretain for the species *Picus viridis* (ALDER & MARSDEN, 2010). Conclusively, the Great Spotted Woodpeckeris a very helpful predator limiting the populations of insect species; in particular ants, and thus *Dendrocopos major* can be used as a model to study the myrmecofauna of an environment.

DISCUSSION AND CONCLUSION

Up to now, no research work has been conducted on the ecological trophic of *Dendrocopos major* in north-Africa and particularly in Algeria. Therefore, the present work was designed to study the trophic profile during breeding period. In this study, the diet of Great Spotted Woodpecker has been studied through the analysis of 52 faeces collected in period of three months (early April, May and late June, 2018), by which 8066 food items were counted, and they are belonged to 100 prey taxa distributed into six classes; Gastropods, Arachnids, Crustaceans, Myriapods, Diplopods and Insectes. This dominance of insects in the trophic profile of *D. major* is, surely related to the fact that the preys of this class are highly abundant in the environment. In Tikjda forest, the nesting spotted woodpeckers are real opportunists, and whose trophic profile are mainly composed of Hymenoptera, especially Formicidae and Coleoptera, in particular Carabidae, as well as they select less of other taxonomic groups, such as Diptera. Additionally, Coleoptera and Hymenoptera are omnipresent preys in their respective diet, which is considered as the general characteristic property of the ecology and trophic biology of this species in Algeria. Ants are a good food for the youngsters because of their thin *chitinous cuticula*, they are also relatively easy to capture because of their slow-moving speed (ant colonies), and are generally in sufficient size. All these characteristics make ants an energy-efficient prey. Since the spotted is almost exclusively insectivore, the dominance of insects in the trophic menu of Great Spotted Woodpecker becomes related to the fact that the individuals of this class are the most abundant in the environment. The other woodpeckers are also insectivores and differ from one another by their searching mode for food as the Great Woodpecker, such as green and ash woodpeckers are usually found in soil and feed almost exclusively on ants (LEGRAND & BARTOLI, 2005). The diet of *D. major* is mainly insectivore (larvae, dipterans, spiders and especially beetles, like Capricorns) confirms that this class is identified as “helpful insectivore” following the convention for the protection of birds useful for agriculture

of March 19, 1902 (SIRIEZ, 1966). In similar, one author has shown that the diet of Great Spotted Woodpecker is highly varied than in other species of woodpecker. Importantly, high insectivore diets during breeding period make the species feed on insect xylophages, ants, spiders, larvae on or under bark, in cracks but also in the woods of trees (LANG, 2012). The food-at the base, must be essentially composed of larvae of phytophage insects searched in the wood that dig for all. Nevertheless, several species are also specialised in the searching of ants found in soil (Torch, green and ash peaks). Some other woodpecker species, like black woodpecker search for ants in soil rather than in trees. As for the colourful woodpecker, they are purely arboreal and more obviously omnivorous (frugivorous, granivorous, and insectivorous). Furthermore, the Great Spotted Woodpecker may have a meat diet, but it feeds willingly on eggs and chicks and does not hesitate to widen the cavities and nest boxes as predator (CLERGEAU & CHEFSON, 1988). In fact, the *D. major* feeds on insects throughout the year, grains in winter as well as eggs and chicks. Also, the species probes the slits, digs the bark and notches the hard wood through its powerful beak, and subsequently extracts the food by its elongated, flexible, sticky and hairy tongue (HAYMAN & HUME, 2003; CHANTELAT, 2001). Interestingly, the diet of this woodpecker species is a very eclectic spectrum, including mainly larvae of Coleoptera and butterflies, but also all types of insects (from ants to grasshoppers, including wasps), in addition to eggs and chicks of various passerines. Indeed, the available data regarding the role of these diets in the food chain highlight the importance of their involving in the trophic networks. Besides, the species find their main food in the insect groups, causing serious hazards to cultivated plants at one hand, and serving as a prey for other animals at the other hand. The established relationships between the plants and ants may be harmful to the human economy, indicating that some species of Formicidae (eg, *Plagiolepis* sp, and especially *Tapinoma* sp.) that can damage the agriculture protect and promote the multiplication of aphids and mealybugs to benefit from their sweet secretions (MAOUCHE-HENINE, 2016). In this context, DOUMANDJI & DOUMANDJI-MITICHE, 1992 have reported that the high significant losses of cereal grains in the highlands of Algeria are related to *Messor barbara.* It must not overlook, also, the damages due to *Crematogaster scutellaris* on the olive trees, and the cork forests, leading subsequently to the diminution of the market value of the forest product. Alike to the agricultural environment, this ant species affects, as well the wood dead than the living wood, and they make their colonies into various tree bark (BERNARD, 1968). The rapid growth of ants can be restrained by some vertebrate animals, involved in the limitation of these insects and contributed at a large extent to safeguard the ecosystem equilibrium. Among the ant enemies, the insectivorous birds, mammals, amphibians, including especially the spotted woodpecker species, feeding on 93% of ants, and consequently is considered as an efficient animal for the agricultural activities. In conclusion, the Great Spotted Woodpecker is selective in its search for food, and places its nest close to its feeding habitat, as well as it acts in the regulation of insect populations, in particular Formicidae family, and thus the species woodpecker proved to be an efficient animal model to study the myrmecofauna of an environment.

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APPENDIX. 1. Table 2. Inventory of prey taxa consumed by the Great Spotted Woodpecker during three months of study in the vicinity of the Tikjda Cedars (Djudjura National Park) and frequency of occurrence (FO%).

Classes	Orders	Families	Prey -Taxon	ni	Fc (%)	FO (%)	Occurrence classes
Gasteropoda	Pulmonae	Helicidae	*Eobania* sp.	1	0.01	1.92	Accidental
			Helicidae sp1	1	0.01	1.92	Accidental
			Helicidae sp2	2	0.02	1.92	Accidental
			Theba pisana	2	0.02	3.85	Accidental
Arachnida	Araneae	F.ind.	Araneae sp.	1	0.01	1.92	Accidental
		Dictynidae	Dictynidae sp1	3	0.04	1.92	Accidental
			Dictynidae sp2	1	0.01	1.92	Accidental
		Dysderidae	*Dysdera* sp.	16	0.20	17.31	Secondary
		Scytodidae	Scytodidae sp.	9	0.11	9.62	Accidental
		Lycosidae	Lycosidae sp.	2	0.02	1.92	Accidental
		Linyphiidae	Linyphiidae sp	2	0.02	3.85	Accidental
		Gnaphosidae	Gnaphosidae sp1	4	0.05	5.77	Accidental
			Gnaphosidae sp2	2	0.02	1.92	Accidental
		Salticidae	Salticidae sp.	1	0.01	1.92	Accidental
		Theridiidae	Theridiidae sp.	3	0.04	5.77	Accidental
	Acari	Acari	Acari sp1	1	0.01	1.92	Accidental
			Acari sp2	1	0.01	1.92	Accidental
	Ixodida	Ixodidae	Ixodidae sp1	1	0.01	1.92	Accidental
	Mesostigmata	Parasitidae	*Pergamasus* sp.	1	0.01	1.92	Accidental
Diplopoda	Julida	Julidae	*Cylindroiulus* sp.	68	0.84	30.77	Secondary
	Glomerida	Glomeridae	*Glomeris* sp	8	0.10	15.38	Secondary
	Polydesmida	Polydesmidae	*Polydesmus* sp1	12	0.15	9.62	Accidental
Diplopoda			*Polydesmus* sp2	21	0.26	5.77	Accidental
Chilopoda	Lithobiomorpha	Lithobiidae	Lithobiidae sp1	4	0.05	7.69	Accidental
			Lithobiidae sp2	3	0.04	5.77	Accidental
	Scolopendromorpha	Cryptopidae	*Cryptops* sp	2	0.02	1.92	Accidental
Malacostraca	Isopoda	Oniscidae	*Oniscus* sp.	33	0.41	36.54	Secondary
		Armadillidiidae	*Armadillidium* sp.	27	0.33	48.08	Secondary
		Porcellionidae	*Porcellio* sp.	14	0.17	7.69	Accidental
Insecta	Dictyoptera	Blattidae	*Blatta orientalis*	7	0.09	11.54	Secondary
		Blattellidae	Ectobiinae sp.	4	0.05	3.85	Accidental
			Ectobius sp.	11	0.14	19.23	Secondary
	Orthoptera	Tettigoniidae	Tettigoniidae sp.	2	0.02	3.85	Accidental
		Gryllidae	*Nemobius sylvestris*	12	0.15	23.08	Secondary
		F.ind.	Orthoptera sp.	6	0.07	11.54	Secondary
	Dermaptera	Forficulidae	*Forficula auricularia*	9	0.11	11.54	Secondary
		Carcinophoridae	*Anisolabis mauritanicus*	14	0.17	23.08	Secondary
	Coleoptera	Geotrupidae	*Geotrupes* sp.	2	0.02	1.92	Accidental
	Coleoptera	Scarabaeidae Scarabaeidae	*Rhizotrogus* sp.	2	0.02	1.92	Accidental
			Pentodon sp.	2	0.02	3.85	Accidental
			Sisyphus sp.	1	0.01	1.92	Accidental
			Onthophagus taurus	1	0.01	1.92	Accidental
			Onthophagus sp.	1	0.01	1.92	Accidental
		Staphylinidae	*Ocypus olens*	8	0.10	15.38	Secondary
			Staphylininae sp.	2	0.02	3.85	Accidental
			Atheta sp.	5	0.06	9.62	Accidental
			Othius sp.	5	0.06	5.77	Accidental
		Cetoniidae	Oxythelinae sp.	2	0.02	3.85	Accidental
			Oxythyrea funesta	2	0.02	3.85	Accidental
Insecta		Cetoniidae	*Potosia* sp.	2	0.02	1.92	Accidental
		Elateridae	*Athous* sp1	4	0.05	3.85	Accidental
			Athous sp2	1	0.01	1.92	Accidental
			Elateridae sp.	1	0.01	1.92	Accidental
		Oedemeridae	*Oedemera* sp.	1	0.01	1.92	Accidental
		Tenebrionidae	Tenebrionidae sp.	12	0.15	17.31	Secondary
			Opatrum sp.	12	0.15	15.38	Secondary
			Tribolium sp.	9	0.11	3.85	Accidental
			Tenebrio sp.	3	0.04	5.77	Accidental
		Carabidae	Carabidae sp.	1	0.01	1.92	Accidental
			Pterostichinae sp.	2	0.02	3.85	Accidental
			Nebria sp.	1	0.01	1.92	Accidental
			Harpalinae sp.	33	0.41	63.46	Privileged
			Poecilus sp.	1	0.01	1.92	Accidental
			Carabus morbillosus	2	0.02	3.85	Accidental
			Chlaenius sp.	4	0.05	7.69	Accidental

		Curculionidae	*Otiorhynchus* sp.1	3	0.04	3.85	Accidental
			Otiorhynchus sp.2	6	0.07	5.77	Accidental
			Hylobius sp.	1	0.01	1.92	Accidental
		Meloidae	*Meloe* sp.	11	0.14	15.38	Secondary
		Chrysomelidae	Chrysomelidae sp.	1	0.01	1.92	Accidental
			Halticinae sp.	7	0.09	9.62	Accidental
		Histeridae	*Saprinus* sp.	2	0.02	3.85	Accidental
		Cerambycidae	*Agapanthia* sp.	1	0.01	1.92	Accidental
	Hymenoptera	Formicidae	*Camponotus micans*	1102	13.66	96.15	Privileged
			Camponotus creuntatus	149	1.85	90.38	Privileged
			Camponotus erigens	74	0.92	42.31	Secondary
Insecta			*Camponotus barbaricus xanthomelas*	3	0.04	3.85	Accidental
			Crematogaster scutellaris	374	4.64	92.31	Privileged
			Cataglyphis viatica	12	0.15	11.54	Secondary
			Pheidole pallidula	77	0.95	61.54	Privileged
			Tapinoma magnum	27	0.33	23.08	Secondary
			Tetramorium biskrens	69	0.86	57.69	Privileged
			Plagiolepis barbara	49	0.61	67.31	Privileged
			Aphaenogaster testaceo pilosa	455	5.64	98.08	Privileged
			Messor picturatus	5185	64.28	100.00	Privileged
	Hymenoptera	Apidae	Apidae sp.	3	0.04	5.77	Accidental
			Apis sp.	1	0.01	1.92	Accidental
		Apoidea	Apoidea sp1	2	0.02	3.85	Accidental
			Apoidea sp2	1	0.01	1.92	Accidental
		Ichneumonidae	Ichneumonidae sp.	1	0.01	1.92	Accidental
		Chalcidae	Chalcidae sp.	1	0.01	1.92	Accidental
	Hemiptera	Pyrrhocoridae	*Pyrrhocoris apterus*	2	0.02	3.85	Accidental
		Coreidae	Coreidae sp.	3	0.04	5.77	Accidental
		Reduviidae	Reduviidae sp.	1	0.01	1.92	Accidental
			Rhinocoris sp.	1	0.01	1.92	Accidental
		Acanthosomatidae	*Elasmucha* sp.	2	0.02	3.85	Accidental
		Lygaeidae	Lygaeidae sp.	2	0.02	3.85	Accidental
		Pentatomidae	Pentatomidae sp.	3	0.04	5.77	Accidental
	Trichoptera	Leptoceridae	Leptoceridae sp.	1	0.01	1.92	Accidental
	Diptera	Stratiomyidae	Stratiomyidae sp.	1	0.01	1.92	Accidental
N = 6	**N = 19**	**N = 55**	**100 Species**	**8066**	**100.00**		