Available online freely at www.isisn.org

Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2021 18(2): 1397-1404. **OPEN ACCESS**

Relationship between food stocks and ant composition of the trophic regime of the Anteater Torcol (*Jynx torquilla mauretanica* Rothschild 1909) in agroecosystems of northern Algeria

Ilham Benabbas- Sahki[1], Kamel Hamadi[1,2] and Salaheddine Doumandji[3]

[1]Dynamic and Biodiversity Laboratory, Faculty of Biological Sciences, Houari Boumediene University of Sciences and Technology, Bab Ezzouar, Algiers, **Algeria**
[2]National Institute of Higher Training for Youth Executives, Algiers, **Algeria**
[3]Department of Agricultural and Forestry Zoology, Higher National Agronomic School, El-Harrach, Algiers, **Algeria**

***Correspondence:** sahki_ilham@hotmail.fr, hamadikamel@yahoo.fr **Received 13-02-2021, Revised: 24-04-2021, Accepted: 30-04-2021 e-Published: 02-05-2021**

A study of the diet of the Torcol anteater *Jynx torquilla mauretanica* was carried out in the north of Algeria and more specifically in the region of Baraki. Analysis of the contents of 109 droppings identified 21638 prey belonging, mostly taxa, to the Formicidae family. The species consumed the most by torcol are *Tapinoma nigerrimu*m (AR% = 76.6%), *Pheidole pallidula* (AR% = 16.8%) and *Tetramorium biskrense* (AR% = 2.4%), the other species of ants are represented marginally. The prey most sought after by the Anteater Torcol are *Pheidole pallidula* (Ii = 0.95) and *Tapinoma nigerrimum* (Ii = 0.92). The results obtained thus confirm that the Torcol has a strictly myrmecophagous diet since its trophic menu is composed of 90% ants, and has a great capacity of adaptation on the trophic level.

Keywords: Anteater Torcol, diet, prey, myrmecophagus, Algeria

INTRODUCTION

The North African subspecies of the Anteater Torcol, *Jynx torquilla mauretanica* Rothschild 1909, is reported to be sedentary in northern Algeria by several authors (Heim de Balsac and Mayaud, 1962; Ledant et al.1981; Cramp et al.1985; FRY et al. 1988; Isenmann and MOALI, 2000). At most, Moulaï (1997) looked at the trophic menu of this species, but in a highly anthropized urban environment. But in rural areas no in-depth study has been devoted to it. It is also possible to cite some works carried out in urban or suburban environments within the framework of the preparation of dissertations of engineers and magisters in Zoology at the National Agronomic School of Algiers in particular by Benabbas (1995), Benabbas et al. (2004, 2006, 2010), Moulaï and Doumandji (1996), Bakiri (1998) and by Sahki et al. 2007. However, several works in Europe have been devoted especially to the trophic regime of the young at the nest of *Jynx torquilla torquilla* Linnaeus 1758; nevertheless the data concerning the adults are very rare and not very precise. The most detailed information was provided by Madon (1930) who analyzed the contents of the digestive tracts of 42 dead torcols from various European countries and by Freitag (1998) who identified the contents of the 86 droppings of *Jynx torquilla torquilla* in Switzerland. The aim of this study is to provide more precision on the composition of the trophic menu of Torcol compared to the availability of ants, potential prey present in the field. Its originality lies in the fact that no work has been published so far on the

relationship between the prey content of *Jynx torquilla mauretanica* droppings and the food availability present in the field.

MATERIALS AND METHODS

The study environment covering an area of 20 ha. It is for agricultural purposes located in the region of Baraki in north central Algeria (36 ° 41 'N.; 3 ° 08' E.), characterized by the presence of plots of cereals, vegetable crops and soils fallow. These plots are delimited by hedges of reeds (*Arundo donax*) and Acacia (*Acacia retinoides*) and by windbreaks made up mainly of olive trees (*Olea europaea*), and casuarinas (*Casuarina torulosa*) (Fig. 1). The climate of the study environment is Mediterranean, belonging to the subhumid bioclimatic stage with mild winter with an average annual precipitation of 750 mm.

The trophic availability study was carried out using the Barber jar sampling technique. Eight (8) buried traps were set up around the 15th of each month. The interval distance between the pots is 5 m, and the trapping time is 24 hours. The content of each trap is recovered for sorting and identification in the laboratory, by examination under a binocular magnifying glass using dichotomous reference keys (Perrier, 1940; Bernard, 1968 and Cagniant, 1968, 1973).

Collecting the droppings of adult Torcols in the field is one of the techniques most practiced in ornithology because it does not cause any disturbance to the individuals studied. Samples can be collected at any time of the year.

In the laboratory, the droppings are placed one by one separately, each in a Petri dish containing ethanol at a third of its height. Once soaked in ethanol, the excrement is triturated with two fine points in order to disperse the various fragments contained. The sclerotinized pieces are collected by systematic affinity in order to be able to estimate the number of individuals consumed per species-prey. These pieces are measured using a strip of graph paper to estimate the size of the entire prey. The determinations are made using dichotomous keys, insect collections from the insectarium and reference fragments.

The results obtained are exploited by ecological indices of composition, such as total richness, specific average and centesimal frequency, and by structure indices such as the Shannon diversity index which makes it possible to assess the real diversity of a stand, $H' = -\sum pi.Log_2 pi$, knowing that pi corresponds to the probability of finding species i, with pi = ni/N, ni being the number of individuals of species i and N the total number of individuals all species combined (Blondel, 1979). The balance between the numbers of the species present is approached by means of the distribution index E represented by the ratio between the observed diversity H' and the maximum diversity H' max., that is E = H'/ H'max. Equitability varies between 0 and 1. It tends towards 0 when almost all of the numbers correspond to a single species, and tends towards 1 when each species is represented by the same number of individuals. The Ivlev selection index is taken into account in this study in order to compare the potential prey species available with those actually ingested by the Anteater Torcol. According to Johnson (1980), Ii = (Na - Nb) / (Na + Nb), Na being the abundance of an item i in the diet of the Anteater Torcol and Nb the abundance of an item i in the environment took into consideration. The raw biomass consumed is calculated for each species using the average weights obtained after weighing individuals sampled in the study environment.

Figure 1: Collection station for anteater Torcol droppings in Baraki (Algiers)

RESULTS

A total of 109 droppings rejected by adult Torcols was collected between January 2016 and February 2017 in an agricultural environment in Baraki in Algeria. Almost all of the remains present in the droppings are fragments of ants. The number of individuals consumed is 21638 belonging to 11 species of the family Formicidae (Tab. I). The study of the trophic regime of Torcol shows that Formicidae dominate. *Tapinoma nigerrimum* alone revealed a relative abundance of 76.6%, followed by *Pheidole pallidula* (16.8%) and *Plagiolepis barbara* (3.4%).

Table 1: Relative abundances (A.R. %) and biomass (B. %) of formicidae species recorded in the diet of *Jynx torquilla mauretanica.*

Species	ni.	A.R. %	B %
Tapinoma nigerrimum	16566	76.56	72.44
Pheidole pallidula	3630	16.78	15.87
Tetramorium biskrense	526	2.43	2.30
Plagiolepis barbara	728	3.36	3.18
Crematogaster scutellaris.	153	0.71	1.34
Aphaenogaster testaceo-pilosa	18	0.08	0.24
Crematogaster sp .	2	0.01	0.20
Messor barbarus	12	0.06	4.20
Camponotus barbaricus xanthomelas	1	0.01	0.09
Cataglyphis bicolor	1	0.01	0.26
Cataglyphis sp.	1	0.01	0.26
Totals	21638	100	100

ni: Number of individuals.

The other species intervene only slightly in the trophic menu of this species, this is the case of *Crematogaster scutellaris* (0.7%), *Aphaenogaster testaceo-pilosa* (0.1%), *Messor barbarus* (0.1%) and *Camponotus barbaricus* (0.0%). It should be noted that the droppings do not contain any trace of brood. However, they contain adult ants, either soldiers like those of *Pheidole pallidula*, or workers of other species. The biomass calculation (B %) shows that *Tapinoma nigerrimum* remains the most dominant ant (B% = 72.4%), followed by *Pheidole pallidula* (B% = 15.9%), *Plagiolepis barbara* (B% = 3.2%) and *Tetramorium biskrense* (B% = 2.3%) (Tab. I). In Baraki station, the total richness (S) fluctuated between 6 species in March and 9 species in February 2007 (Tab.2), with an average richness (Sm) in ant prey equal to 7.8.

Table 2: Relative abundances (A.R. %) and biomass (B. %) of formicidae species recorded in the diet of *Jynx torquilla mauretanica.*

Species	ni.	A.R. %	B %
Tapinoma nigerrimum	16566	76.56	72.44
Pheidole pallidula	3630	16.78	15.87
Tetramorium biskrense	526	2.43	2.30
Plagiolepis barbara	728	3.36	3.18
Crematogaster scutellaris.	153	0.71	1.34
Aphaenogaster testaceo-pilosa	18	0.08	0.24
Crematogaster sp .	2	0.01	0.20
Messor barbarus	12	0.06	4.20
Camponotus barbaricus xanthomelas	1	0.01	0.09
Cataglyphis bicolor	1	0.01	0.26
Cataglyphis sp.	1	0.01	0.26
Totals	21638	100	100

S: Total richness; Sm: Average richness; H ': Shannon-Weaver Diversity

H 'max: Maximum diversity; E: Equitability index, (-): absence of droppings

The Shannon-Weaver H'diversity index value is 0.4 bits, with an E value of less than 0.5 suggesting that there is a weak tendency towards imbalance in the numbers of ingested species. This imbalance is due to the dominance of the prey species *Tapinoma nigerrimum* in numbers. It can be seen that the size classes of the prey consumed by the Anteater Torcol are between 2 and 9 mm (Tab. 3).

Table 3: Size **classes of species consumed by *Jynx torquilla mauretanica* in Baraki station**

Size classes in mm	ni.	A.R.%
2	3451	15.95
3	13265	61.30
4	4799	22.18
5	108	0.50
6	1	0.01
7	12	0.06
8	1	0.01
9	1	0.01
Totals	21638	100

ni.: Number of individuals by size class.
A.R.%: Relative abundances.

The most ingested preys measure 3 mm with a percentage of 61.3% corresponding to *Tapinoma nigerrimum* and *Pheidole pallidula*. The class with 4mm prey is in second place with a rate of 22.2%, represented by two species of *Crematogaster* and two more of *Aphenogaster*. The prey class measuring 2 mm with a rate of 16% includes *Plagiolepis barbara* and *Tetramorium biskrensis*. The 7 mm class contains 12 individuals (0.1%), comprising the genera Camponotus and Cataglyphis. The other classes are represented by low rates (0.01% <AR% <0.5%). The study of the availability of prey in the study environment allowed us to sample 1230 individuals distributed in 10 orders, 28 families and 49 species (Tab 4). The relationship between diet and prey availability expressed using the Ivlev index (Ii) shows that there are species that are little consumed but present in large numbers in the field. They correspond to negative values of Ii. This is the case of *Aphenogaster testaceo-pilosa* (A.R. % = 42.1%; Ii = - 0.99) and *Messor barbarus* (A.R. % = 15.9%; Ii = - 0.99). Other species are better represented in the Torcol diet than in the field, corresponding to positive values.

Table 4: Numbers of species caught by the pot-trap method in the station study and the Ivlev index of anteater Torcol prey in Baraki station level.

Orders	Families	Species	ni.	A.R. %(Nb)	A.R.% (Na)	Ii
		Helicella sp. 1	110	9.27	-	-1
		Helicella virgata	114	9.27	-	-1
		Helicella sp. 2	93	7.57	-	-1
	Helicidae	Helicidae *sp*.	1	0.08	-	-1
		Helix aspersa	1	0.08	-	-1
Aranea	undetermined	*Aranea* sp. 1	6	0.49	-	-1
		Aranea sp. 2	2	0.16	-	-1
		Aranea sp. 3	6	0.49	-	-1
	Dysderidae	*Dysdera* sp. 1	3	0.24	-	-1
		Dysdera sp. 2	10	0.81	-	-1
	Lycosidae	*Lycosidae* sp.	7	0.57	-	-1
Isopoda	Oniscidae	*Oniscidae* sp.	1	0.08	-	-1
Orthoptera	undetermined	*Ensifera* sp.	1	0.08	-	-1
	Tettigoniidae	*Odontura algerica*	1	0.08	-	-1
		Platycleis tesselata	1	0.08	-	-1
		Gryllulus sp.	9	0.73	-	-1
	Acrididae	*Dociostaurus jagoi jagoi*	5	0.41	-	-1
		Pezotettix giornai	5	0.41	-	-1
Dermaptera	Forficulidae	*Forficula auricularia*	1	0.08	-	-1
Embioptera	undetermined	*Embioptera* sp.	2	0.16	-	-1
Heteroptera	undetermined	*Heteroptera* sp.	1	0.08	-	-1
	Pentatomidae	*Pentatoma* sp.	2	0.16	-	-1
Coleoptera	undetermined	Coleoptera sp.	3	0.24	-	-1
	Lebiidae	*Tachyta nana*	3	0.24	-	-1
	Harpalidae	*Ophonus* sp.	1	0.08	-	-1
	Staphylinidae	Staphylinidae sp. 1	2	0.16	-	-1
		Staphylinidae sp. 2	1	0.08	-	-1
	Chrysomelidae	*Pachnephorus corinthi.*	5	0.41	-	-1
		Pachnephorus sp.	5	0.41	-	-1
Hymenoptera	Ichneumonidae	Ichneumonidae sp.	3	0.24	-	-1
	Formicidae	*Aphaenogaster testaceo-pilosa.*	517	42.03	0.08	-0.99
		Aphaenogaster sardoa	1	0.08	-	-1
		Tapinoma nigerrimum	39	3.17	76.56	0.92
		Messor barbarus	195	15.85	0.06	-0.99
		Pheidole pallidula	5	0.41	16.78	0.95
		Cataglyphis bicolor	23	1.87	0.01	-0.99
		Tetramorium biskrense	-	-	2.43	+1
		Plagiolepis barbara	-	-	3.36	+1
		Crematogaster scutelaris	-	-	0.71	+1
		Crematogaster sp.	-	-	0.01	+1
		Cataglyphis sp.	-	-	0.01	+1
		Camponotus.barbaricus xanthomelas	-	-	0.01	+1
	Vespidae	*Polistes gallicus*	1	0.08	-	-1
	Pompilidae	Pompilidae sp.	1	0.08	-	-1
Diptera	Tipulidae	Tipulidae sp.	13	1.06	-	-1
	Sciaridae	Sciaridae sp. 1	1	0.08	-	-1
		Sciaridae sp. 2	1	0.08	-	-1
	Muscidae	Muscidae sp.	1	0.08	-	-1
	Dolichopodidae	Dolichopodidae *sp*.	1	0.08	-	-1
	undetermined	Cyclorrhapha *sp*. 1	13	1.06	-	-1
		Cyclorrhapha *sp*. 2	6	0.49	-	-1
	Sarcophagidae	Sarcophagidae *sp*. 1	1	0.08	-	-1
		Sarcophagidae *sp*. 2	1	0.08	-	-1
	Drosophilidae	Drosophilidae sp.	6	0.49	-	-1
	Totals		1230	100		

ni. : Number of individuals of species i.

A.R. %: Relative abundances in percentage.
Na: Abundance of item i in the diet of *Jynx torquilla mauretanica.*
Nb: Abundance of an item i in the environment taken into consideration of *Jynx torquilla mauretanica.*
Ii: Ivlev index.

This is the case with *Tapinoma nigerrimum* (A.R. % = 76.6%; Ii = + 0.92) and *Pheidole pallidula* (A.R. % = 16.8%; Ii = + 0.95) (Tab.4).

DISCUSSION

The study of the diet of the Anteater Torcol in an agricultural environment in northern Algeria shows that it is mainly composed of Formicidae, which testifies to the myrmecophagy of this species. The results obtained in the gardens of the National Agronomic School of Algiers revealed that the Torcol menu is made up of 95% Formicidae (Doumandji and Doumandji-Mitiche, 1992; Benabbas and Doumandji, 1995). The present study shows that the ants mostly consumed by *Jynx torquilla* are *Tapinoma nigerrimum*, *Pheidole pallidula* and *Plagiolepis barbara*. The Tapinoma and Pheidole are among the most frequent ants (Taibi et al. 2010). In sub-urban areas, Bakiri (1998) underlines a high consumption of *Tapinoma simrothi* in summer with 34.1%, while *Pheidole pallidula* presented a percentage of 20.7% in spring. However, the study of the trophic regime carried out in an urban environment on 232 Torcol droppings collected in the Hamma trial garden in Algiers shows that the latter is dominated by *Tapinoma simrothi* with 64.5% and *Pheidole pallidula* with 25.7% (Moulai, 1997). In contrast, in Valais in Switzerland, the genus Tapinoma is reported as occasional prey for Torcol, both in its droppings and in the faecal sacs of its chicks (Freitag, 1998). In Europe, the most dominant ants on the Anteater Torcol's menu are *Lasius niger*, *Lasius flavus*, *Tetramorium caespitum* and *Formica rufa* (Madon, 1930; Niethammer, 1938; King and Speight, 1974). The latter are often captured during the reproduction period of *Jynx torquila* (Bussmann, 1941; Klaver, 1964; Bitz and Rohe, 1993; Jobges et al. 1998; Geiser et al. 2008, Coudrain et al. 2010). In Japan, Yoshimura et al. (2003) underline at the level of 4 nests of the subspecies *Jynx torquilla* japonica the presence of 13 species of ants of which the most frequent is *Lasius japonicus* followed by *Formica japonica*. In Baraki, *Tapinoma nigerrimum* is best represented (B% = 72.4%), followed by Pheidole pallidula (B% = 15.9%). Klaver (1964) in Holland underlines the ingestion of the *Lasius niger* ant with a high biomass rate (B% = 100%). In Germany, Bitz and Rohe (1993) draw attention to the highest rate of relative biomass (B% = 90%) recorded for the species *Lasius alienus*. The Shannon-Weaver Diversity Index found that *Jynx torquilla mauretanica*'s diet is quite diverse. In the gardens of the National Agronomic School of Algiers, the values of H' are between 0 and 3.3 bits (Doumandji and Doumandji-Mitiche, 1992). Similarly, Benabbas (1995) shows for the same species and in the same environment that the values found are very close to the previous ones (0.7 bits <H'<2.4 bits), and the same observation was made by Bakiri (1998) in a suburban area (0.7 bits <H'<2.3 bits). In the present study, the noted values of E are less than 0.5, probably due to the two dominant species in the droppings, *Tapinoma nigerrimum* (AR% = 76.6%) and *Pheidole pallidula* (AR% = 16.8%) . The Anteater Torcol has a great ability to adapt to different environments and seasons. Indeed, *Messor sp.* and *Cataglyphis bicolor* are interesting ants for Torcol compared to *Tapinoma sp.* and *Pheidole sp.*, this may be due to the size of the species, a criterion determining the hunting effort of this predator. The ants hunted by the Torcol are often small to medium sizes which can be between 2 mm and 3 mm (Bakiri 1998; Sahki et al. 2007) and 3 mm and 4 mm (Freitag, 1996). We have found that the Torcol does not dig to access its prey. It is often in search of abundant food (Freitag, 2000) and is content to collect its ant prey directly from the nests thanks to its long sticky tongue (Doumandji and Doumandji-Mitiche, 1994). The Ivlev Selection Index provides information on the use of different prey present in the hunting grounds. But the comparison between the prey ingested by the Anteater Torcol and the potential prey present in the environment is still imprecise and only gives a very fragmentary overview of this relationship. Selection index (I.i.) values range from -1 to +1. In Baraki station, 8 species have a positive value. These are species ingested by the anteater but which are not present in the trophic availability. These species are in particular *Tetramorium biskrense* (Ii = +1), *Plagiolepis barbara* (Ii = +1), *Crematogaster scutellaris* (Ii = +1), *Crematogaster sp.* (Ii = +1), *Pheidole pallidula* (Ii = +1) and *Monomorium sp.* (Ii = +1). It should be noted that *Tapinoma nigerrimum* (Ii = + 0.92) has a very high value of Ii. These prey are abundant in the diet but rare in the trophic

availability. On the contrary, the ants *Aphaenogaster testaceo-pilosa*, *Messor barbarus* and *Cataglyphis bicolor* are rare in the trophic diet but abundant in the environment. This can be explained in various ways. None of the authors who have worked on the diet of the *Jynx torquilla* have investigated the choice of prey by this woodpecker using selection cues. It is possible that the Torcol preferably chooses one abundant and available prey species over another, as it is also likely that small to medium-sized species of less than 4 mm are chosen by this predator. Analysis of the diet of *Jynx torquilla mauritanica* in an agricultural environment and study of the available prey revealed that this species is strictly myrmecophagous. It gets its supplies while collecting several hundred individuals from the most populous and abundant anthills, especially during the feeding period of the young. This hunting behavior is particularly advantageous when it comes to collecting as much food as possible in the shortest time to maximize net energy gain.

CONCLUSION

The results obtained reveal that the diet of this Picidae is insectivorous, consisting mainly of ants. The present work agrees with the opinion of Freitag (1998), who underlined, that the died of anteater Wryrneck consist only of the ants. It is a myrmecophagus feeding mainly on *Tapinoma*, *Pheidole* and *Tetramorium.* These ants are sought after by the Wryneck both at the nest and at the column level.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT

We extend our warn thanks to Mrs. A. Freitag for the documentation and the scientific criticisms of this work

AUTHOR CONTRIBUTIONS

IBS designed the theme, analyzed the results, produced and examined the manuscript.
KH participated in the analysis of the results and carried out the insect.SD determined the species and examined the manuscript. All authors have read and approved the final version.

REFERENCES

Bakiri, A., 1998. *Relation entre les disponibilités trophiques et le régime alimentaire du torcol fourmilier Jynx torquilla mauretanica Rothschild, 1909 (Aves, Picidae) en milieu suburbain près d'Alger*. Thèse Magister, Inst. nati. agro. El Harrach, 166p.

Benabbas, I., 1995. *La myrmécophagie chez le Torcol fourmilier Jynx torquilla mauretanica Rothschild* 1909 *(Aves, Picidae) dans un parc d'El Harrach.* Thèse Magister, Inst. nati. agro. El Harrach, 190.p.

Benabbas, I., Bakiri A., Doumandji, S., 2010. Analyse des contenus de 648 fientes du Torcol fourmilier *Jynx torquilla mauretanica* dans une aire de 10 ha (Littoral algérois). *Journées nationales sur la Zoologie Agricole et Forestière* 19,20 et 21 avril *Inst. nati. agro. El Harrach*, p.185.

Benabbas, I., Bakiri, A., Doumandji, S., 2004. Tailles des fourmis-proies consommées par le Torcol fourmilier *Jynx torquilla mauretanica* Rothschild, 1909 (Aves, Picidae) dans les jardins de L'I.N.A. 2ème*Journée de protection des végétaux, 15 mars 2004, Inst. nati. agro. El Harrach*, p.28.

Benabbas, I., Doumandji, S., 1995. Place des Formicidae dans le régime alimentaire du Torcol fourmilier *Jynx torquilla mauretanica* dans un milieu suburbain El Harrach. 2èmes*journées nati. entomol. Constantine*, 29 - 30 *mai* 1995

Benabbas-Sahki, I., Bakiri, A., Doumandji, S., 2006. Variation des tailles des proies consommées par le Torcol fourmilier *Jynx torquilla mauretanica* Rothschild, 1909 (Aves, Picidae) en milieu suburbain près d'Alger. *Colloque International : l'Ornithologie à l'Aube du* 3*éme Millénaire,* 11- 13 *novembre* 2006, *Dép. sci. biol., Univ., El-Hadj Lakhdar, Batna, p.*70.

BERNARD, F., 1968 - *Les fourmis (Hymenoptera, Formicidae) d'Europe occidentale et septentrionale*. Ed. Masson et Cie, Paris, 3, Coll. ''Faune d'Europe et du

bassin méditerranéen'',441 p.

Bitz, A., Rohe, W., 1993. Nahrungsokologische Untersuchungen am Wendehals (*Jynx torquilla*) in Rheinland-Pfalz. *Beih Veroff Naturschutz Landschaftspflege Bad-Wurtt,* 67: 83-100.

Blondel, J., 1979*. Biogéographie et écologie*, Ed. Masson, Paris, 173p.

Bussmann, J., 1941. Beitrag zur kenntnis der brutbiologie des wendehalses (*Jynx torquilla)*. Arch*.* Suisses *Ornith.,* 1 : 467-480.

Cagniant H., 1973. *Les peuplements de fourmis des forêts algériennes. Ecologie, Biologie, Essai biologique.* Thèse Doctorat es-sci. natu., Univ. Paul Sabatier, Toulouse, 464 p.

Cagniant, H., 1969. Deuxième liste de fourmis d'Algérie, récoltées principalement en forêt (1er partie). *Bull. Soc. Hist. Nat., Toulouse*, T.105 : 405 – 430

Coudrain, V., Arlettaz, R., Schaub, M., 2010. Food or nesting place ? Identifying factors limiting Wryneck populations *Journal of ornithology* (sous press).

Cramp, S., Brooks, D.,J., Dunn, E., Gillmor, R., Hall-Craggs, I., Hollom, P.A.D., Nholsonic, E.M., Ogilvie, M. A., Roselarr, C.S., Sellar, P.J., Simmons, K.E.L., Voous, K.H., Wallace, D.I.M., 1993. *Handbook of the Birds Europe, the Middle-East and North Africa.*Ed. Univ. Presse, Oxford, Vol. VII, 1063 p.

Doumandji, S., Doumandji-Mitiche, B., 1992. Relations trophiques insectes / oiseaux dans un parc du Littoral algérois (Algérie). *Alauda*, 60, (4): 274-275

Doumandji, S., Doumandji-Mitiche, B., 1994*. Ornithologie appliquée à l'agronomie et à la sylviculture.* Ed. Office Publ. Univ., Alger, 124 p.

Freitag, A., 1996. Le régime alimentaire du Torcol fourmilier (*Jynx torquilla)* en Valais (Suisse). *Nos Oiseaux,* 43: 497-512

Freitag, A., 1998*. Analyse de la disponibilité spatio-temporelle des fourmis et des stratégies de fourragement du Torcol fourmilier (Jynx torquilla L.)*. Thèse Doctorat, Musée Zool., Institut Ecol., Fac. Sci., Univ. Lausanne, 213p.

Freitag, A., 2000. La photographie des nourrissages : une technique originale d'étude du régime alimentaire des jeunes torcols fourmiliers *Jynx torquilla*. *Alauda*, 68, (2): 81-93.

Fry, C.H., Keith, S., Urban, E.K., 1988. The Birds of Africa. Ed. Academic, press. Santiago, 3, 611p.

Geiser, S., Arlettaz, R., Schaub, M., 2008. Impact of weather variation on feeding behaviour, nestling growth and brood survival in Wrynecks *Jynx torquilla Journal of ornithology* Vol.149 n° 4 p. 597-606

Heim de Balsac, H., Mayaud, N., 1962*. Les 0iseaux du Nord-Ouest de l'Afrique*. Ed. P. Lechevalier, Paris, Encyclopédie ornithologique, X, 486 p.

Isenmann, P., Moali, A., 2000. *Oiseaux d'Algérie/Birds of Algeria*. Ed. Société d'Etudes Ornithologiques de France (S.E.O.F.), Paris, 332 p.

Jöbges, M.,Selle, R., Wegge, J., 1998. Zum vorkommen und bestand des Wendehals (*Jynx torquilla*) in Nordrhein-Westfalen *Charadrius* 34, Heft 3-4, p.126-135.

Johnson, D.H., 1980. The comparison of usage and availability measurements for evaluating resource preference, *Ecology*, 61 (1): 65-71.

King, B., Speight, M.C.D., 1974. Anting-like behavior and food of Wryneck. *Brit. Birds*, 67: 388-389.

KLAVER, A., 1964. Waarnemingen over de biologie van de Draaihals. *Limosa,* 37: 221 - 231.

Ledant, J.P., Jacob, J.P., Jacob, P., Malher, F., Ochando, B., Roché, J., 1981. Mise à jour de l'avifaune algérienne. *Le Gerfault / de Giervalk,* 71: 295 - 389.

Madon, P.,1930. Pics, grimpereaux, sitelles,huppes, leurs régimes. *Alauda*, 2: 85-121

Moulai, R., 1997. Composition, structure et dynamique des populations d'oiseaux du Jardin d'essai du Hamma (Alger) et essai d'estimation des populations d'étourneaux *Sturnus vulgaris* (Linné,1758) (Aves, Sturnidae) dans leurs dortoirs. Thèse Magister, Inst. natio. agro., El-Harrach 152p.

Moulaï, R. Doumandji, S., 1996. Aperçu sur le régime alimentaire du Torcol fourmilier *Jynx torquilla mauretanica* Rothschild, 1909 (*Aves-Picidae*) au Jardin d'essai du Hamma. *IIème Journée nationale ornithologique*, 19 et 20 mars 1996, *Lab. Ornith., Dép. Zool.agri. for. Inst. nati. agro.*, El Harrach, p. 69

Niethammer, G., 1938. *Handbuch der deutschen vogelkunde*. Ed. Akademische Verlagsgesellschaft M.B.H., Leipzig, 545 p.

Perrier, R., 1940 - *La faune de la France – Hyménoptères.* Ed. Librairie Delagrave, Paris, T. 7, 211 p.

Sahki-Benabbas, I., Bakiri, A., Doumandji, S.,

2007. Cinq années d'études sur le régime alimentaire du Torcol fourmilier *Jynx torquilla mauretanica* Rothschild, 1909 (*Aves, Picidae*) en milieu suburbain près d'Alger. *Journées Internationales de la Zoologie agricole et forestière* 8 - 10 *avril* 2007, *Inst. nati. agro., El Harrach*. p. 93.

Taibi, A., Bendjoudi, D., Doumandji, S., 2010. Les lardoires de la Pie-grièche méridionalis *Lanus meridionalis* dans les stations de Ramdhania et de Baraki (Mitidja). *Journées nationales Zoologie agri. for.,* 19 - 21 *avril* 2010, *Inst*. *nati. agro., El Harrach*, *p*. 149.

Yoshimur, M., Hirata, T., Nakajima, A., Onoyama, K., 2003. Ants found in scats and pellets taken from the nests of the Japanese Wryneck *Jynx torquilla japonica*. *Ornithol. Sci*. 2: 127 - 131.