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Faunal diversity in a cereal medium of Chlef region (Algeria)

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Abstract

Cereals are a staple food in North Africa, particularly in Algeria. But their production is diminished every year, especially by depredation by pests that is why we conducted this study. It consists of an inventory of the fauna subservient to a cereal medium (durum wheat fields) in the Chlef region. For this, we used pitfall traps and capture by the sweep net. This allowed us to identify 72 species of which 62 species were of insects (86.11%). In terms of numbers, this fauna includes 770 individuals comprising 715 insects (92.86%). The rest is represented by crustaceans (2.21%), gastropods and mammals (1.17%), arachnids (1.04%) and reptiles (0.65%). The insects are dominated by the orthopterans (44.2%), followed closely by the coleopterans (36.4%). The other orders are less represented. This fauna was considered more or less diversified, but their diversity is high in spring and summer, a little less in autumn and lower in winter. Regarding the status of the fauna inventoried, the pests of crops represent 79.22%. However, the species considered as useful to plants and agriculture generally reach 17.69%. Thus, the preservation and protection of these indigenous auxiliary allows the regulation of pest populations and contribute, even in part, at the increased production of that food.

Keywords: Pests, auxiliaries, cereals, agriculture, fauna, diversity

Introduction

The All over the world, the cereals occupy the first place due to the occupation of farmland, because they constitute the staple food of the population worldwide ^[1]. In Algeria, the production of cereals occupy about 80% of the useful agricultural area (UAA) in the country ^[2], and the consumption of this food is about 219kg / capita / year ^[3]. Although the extension of crops, the yields remain still very low and insufficient. Indeed, grain products account for over 40% of the value of food imports ^[4]. National production is reduced each year, mainly by depredation by pests. However, the annual harvest was 40 million quintals in 2015 and 35 million quintals in 2014 against 61.2 quintals in 2009 ^[5]. In order to cope with this problem, it is necessary to discern the agrobiocenosis whose interactions are complex and diverse. This allows us to implement reasonable and effective actions of protection or struggle to increase production of this food so important.

Materials and methods

Work was conducted over a year, it consist to inventory the fauna subservient to a cereal medium (hard wheat fields) located approximately at 8 kilometers in the east of Chlef city. For this, we used pitfall traps or Barber pots that are deposited in a regular triangle with a perimeter of 180 meters, or a black trap on each corner and a yellow trap in the middle of each side. So the yellow traps attract flying and heliophilous insects, while the black traps are effective for geophilic insects, accustomed to take refuge in the crevices and litter. The trapped animals are collected every 15 days and stored in glass jars containing alcohol 70%, before being analyzed in the laboratory. After each sampling, the place of traps is changed in order to avoid excessive depletion of the surrounding fauna (wildlife).

This method allows the capture of small arthropod species. That is why we have associated this method with mowing or sweep net capture. This approach allows collecting flying arthropods and those hidden in the grass and bushes, especially the edges of the studied medium

For analyzing the results, we used the following ecological indexes:

The centesimal frequency (Fc) or relative abundance (AR%) was expressed as the ratio of the number of individuals of a species found (Ni) on the total number of individuals of all species (N) ^[6]: $Fc = Ni \cdot 100 / N$

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The occurrence frequency (Fo%), also known as frequency of appearances is the percentage ratio of the number of surveys containing species i (R_i) on the total of surveys realized (R) [6].
 $Fo. = R_i. 100 / R$

The diversity index of Shannon-Wæver or Shannon-Wiener corresponds to the following equation: $H = - \sum_i P_i (\log P_i)$

P_i is the ratio of the total number of individuals that are counted of a species I [7]. It provides information on species richness than the abundance [8]. It is often accompanied by the equitability index.

The equitability index also called index of equal distribution [9] and represents the ratio of the Shannon index calculated on the theoretical maximum index [$E = H / H_{max}$ where $H_{max} = S \log_2(S)$ (S being the number of species)] [10], and is very useful for comparing potential dominance between stations or between sampling dates.

Results and Discussions

The fauna found in the studied medium

Table 1: Numbers, centesimal frequency and frequency of occurrence of animal classes

Classes	Number of species	Centesimal frequency of species	Number of individuals	Centesimal frequency of individuals	Frequency of occurrence
Oligochaeta	1	1.39	7	0.90	4.16
Gastropoda	4	5.55	9	1.17	8.33
Crustacea	1	1.39	17	2.21	12.5
Arachnida	2	2.77	8	1.04	8.33
Insecta	62	86.11	715	92.86	100
Reptilia	2	2.77	5	0.65	16.66
Mammalia	2	2.77	9	1.17	8.33
Total	72	100	770	100	-

In the parcel of studied cereals, we identified 72 species, including 62 species of insects (86.11%) and 4 species of gastropods (5.55%). The Arachnids, reptiles and mammals are represented by two species against one species only for crustaceans and oligochaetes.

In terms of numbers, the fauna found accounts a total of 770 individuals including 715 insects, or 92.86%. The rest is

represented by crustaceans (2.21%), gastropods and mammals (1.17%), arachnids (1.04%) and reptiles (0.65%). In terms of frequency of occurrences (Fo.%), the value is 100% for insects. For other classes, the rates mentioned vary from 4.16% to 16.66%.

Insects found in the medium studied

Table 2: Numbers, centesimal frequency and frequency of occurrence of different insect orders

Orders	Number of species	Centesimal frequency of species	Number of individuals	Centesimal frequency of individuals	Frequency of occurrence
Mantoptera	2	3.22	5	0.7	12.5
Orthoptera	15	24.19	316	44.19	79.16
Dermaptera	2	3.22	-	-	-
Heteroptera	9	14.52	80	11.19	29.16
Homoptera	2	3.22	8	1.12	8.33
Coleoptera	18	29.03	260	36.36	91.66
Hymenoptera	7	11.29	25	3.5	37.5
Diptera	4	6.45	12	1.68	20.83
Lepidoptera	3	4.84	9	1.26	16.66
Total	62	100	715	100	-

The insect fauna of the studied medium contains 62 species including 18 species of beetles (29%) and 17 orthoptera species (24.2%). On the contrary, in terms of numbers, the orthopterans dominate with 316 individuals representing a centesimal frequency of 44.2%, closely followed by the coleopterans with 260 individuals, representing a centesimal frequency of 36.4%. The other orders are less represented, however, it is only mentioned 80 heteropterans (11.2%), 25 hymenopterans (3.5%), 12 dipterans (1.7%), 9 lepidopterans (1.3%) and finally 8 homopterans (1.1%). In terms of occurrence frequencies, they are the coleopterans that are present in more sampling with a 91.7% of frequency of occurrence. They are closely followed by Orthoptera that have been found in 79.2% of surveys. The frequencies of occurrences of the other orders are 37.5% for the Hymenoptera, 29.16% for the Heteroptera, 20.8% for Diptera

and less than 20% for the Lepidoptera, the Mantoptera and Homoptera.

Temporal distribution of fauna

The results relating to the evolution of populations of the different species found in the studied medium show that only coleopterans and orthopterans are present almost throughout the year. Nevertheless their number reached their maximum in June where 68 coleopterans out the total of 260 (26.2%) and 90 orthopterans out the total of 316 (Fc.% = 28.5%) are counted. From this month, the number of the two orders regressed significantly in winter. Then it begins to increase from March. The other orders of the class Insecta have been seen only in spring and summer. While the gastropods, the vertebrates and oligochaetes represented by *Lumbricus* are distinguished exclusively in spring and autumn.

Table 3: Numbers by order of the fauna encountered during the different months of the year

Classes-	Orders	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Totals
Oligocheta	Haplotaxidea	5											2	7
Gastropoda	Pulmonea	4										3	2	9
Crustacea	Isopoda					2				5	10			17
Arachnida	Aranea									4	3	1		8
Insecta	Mantoptera					3	2							5
	Orthoptera	3	-	6	23	82	90	46	29	18	10	7	2	316
	Heteroptera				28	21	17	12		2				80
	Homoptera				8									8
	Coleoptera	1	3	8	18	62	68	49	22	13	9	7	-	260
	Hymenoptera				4	3	10	7		1				25
	Diptera								4	6	2			12
Lepidoptera				7	2								9	
Reptilia	Saurea					2	3							5
Mammalia	Rodentia					2	1				4	2		9
Total		13	3	14	88	179	191	114	55	49	38	20	6	770

Temporal and seasonal diversity of the medium

The evolution in the time of the diversity of animal species is studied through calculating the diversity index of Shannon-Wiever and the equitability during the different seasons in each medium. The values of those two indices calculated during each season showed that the faunal diversity is high in spring and summer, a little less in autumn and lower in winter.

Indeed, the value of the index of Shannon-Wiever reached 3.51 bits in spring and 3.07 bits in summer against only 2.13 bits in autumn and 0.66 bits in winter.

The values of equitability reflect those of the index Shannon-Wiever. However, it is 0.32 in winter, 0.64 in autumn and exceeds 0.8 in the spring and summer.

Table 4: Values of the Shannon-Wiever index of diversity and equitability calculated during the four seasons

Environment	Parameters	Winter	Spring	Summer	Autumn
Cereals (Durum wheat)	H' (en bits)	0.66	3.51	3.07	2.13
	H' max (en bits)	2.08	4.09	3.8	3.33
	E	0.32	0.86	0.8	0.64

Status of the identified fauna

Among the 72 identified species, it is counted 41 pests of crops, so 56.94%, 20 auxiliary (Fc.% = 27.77%) all of the mare predators (Table 3). In terms of numbers, from 770 individuals, 610 are pests (79.22%). The animals considered useful to plants and agriculture generally account about 137 predators (Fc.% = 17.69%). Other species are divided into

pollinator (1.04%) and polyphagous species (1.95%). The studied medium seems to be balanced and diversified. When there is an imbalance, the pullulations of certain pests take part of the ecological functioning of the agricultural system. On the contrary, a natural environment doesn't present such pullulations thanks to the interactions between species; these natural environments are much more diversified.

Table 3: Numbers, frequency and status of the inventoried fauna

Species	Pests	Auxiliary		Pollinators	Others	Total
		Prédators	Parasitoids			
Number of species	41	20	0	3	8	72
Fréquency of species (%)	56.94	27.77	00	41.66	11.11	100
Number of individuals	610	137	00	8	15	770
Frequency of individuals (%)	79.22	17.69	00	1.04	1.95	100

Discussion

The fauna found

The fauna of the studied medium is dominated by insects. However, the dominance of this group is noted in all ecosystems. Indeed, the importance of Insecta, especially in intensive growing cereal was also distinguished in the South of Deux-Sèvres with a frequency of 93.6% [11]. Generally the invertebrates dominate clearly the current biodiversity by the number of species previously described, but also by the fact that those organisms are spread everywhere and occupy all the ecological niches present on earth. Further, the insects account for more than the half of the current living species where that is approximately counted 1,000,000 species at present, of which 350,000 species of Coleoptera, 150,000 Diptera and 120 000 Lepidoptera [12].

In turn this entomofauna is dominated by orthopterans, followed closely by coleopterans. The hemipterans and the hymenopterans are less present; contrariwise the other groups

are represented by only one or two species. In France, on a cereal parcel 500 animal species represented by 400 000 individuals were captured [13]. In New Zealand, 106 species on wheat and 95 species on barley were identified [14]. On the other side 64 species were found on winter wheat in Slovakia [15]. The variability of the abundance of arthropod populations is higher in agro-ecosystems rather than in natural ecosystems [10].

In our study area, only coleopterans and orthopterans are present throughout most of the year. Their number reached its maximum in May and June. Afterward, their populations regress and become nothing or nearly in winter, before starting to increase from March. It seems that the distribution of Coleoptera does not depends on the space only, but also according to the seasons. Indeed, it described that the Senegalese savannah coleopterans represent 68.6% of the fauna in July, 43.3% in September and only 26.2% in January [16].

A wide diversity of Orthoptera was emphasized in a natural medium, in the Massif of Maures [17]. In winter with the diminution of temperature, the most of insects enter in diapause and the entomofauna decrease. It is to notify that Hymenoptera and Diptera are revealed in winter in the eastern of Algeria with frequencies of abundance respectively 3.83% and 9.81%. It was mentioned that there are some insects very resistant to cold because they contain glycerol, formed from glycogen, which acts as antifreeze and which can decrease the freezing of the internal liquid to less than 20 °C, allowing them to resist to the cold of winter [10].

Many other groups of animals have not been perceived in these surveys. Some species proliferate or become scarce without the cause is well elucidated. Some insects appear suddenly and just quickly become scarce [10].

The diversity

The diversity of fauna in the cereal medium was more or less important. The evolution of farming contributes to the enrichment of diversity. It creates and preserves special ecosystems and habitats. Thus, the mosaic made by cultivated fields, separated by hedges and ditches providing the resource to certain types of flora and microfauna. It is also the place of hibernation for many insects, buffer places against wind and water erosion, or as areas of denitrification [18]. The relationship between agriculture and biodiversity are in interactions. Agricultural practices are at the deep of the mechanism by an action on the diversity of species and landscapes [19].

The values of diversity index of Shannon-Wiener and those of equitability calculated during each season reflect a great diversity in the medium studied in all seasons. The seasonal variation of diversity is subject to several factors. Agricultural practices, including soil labor carried out in cereal plot could be behind this imbalance. Further, the use of insecticides, especially those with an extensive spectrum of activity can reduce the numbers and the diversity of arthropods found in cereal crops [20].

Status of animal species found in the studied medium.

The determination of the status of a species that either useful or harmful is very difficult due to the mobility and changes in the diet exercised by various environmental factors. In this study, the phytophagous species are considered as harmful; however the auxiliary and pollinators are classified as useful to plants.

The cereal medium fauna in question shelters a fauna constituted up to 80% of the pests. This is explains that this fauna is dominated by grasshoppers. These in general and particularly locusts are all phytophagous and are very known by their vegetable food intakes even by their damage on different crops [21]. In fact millions of people died of hunger because of the insects in particular in Algeria [6]. But the coleopterans have a diverse diet.

The dominance of phytophagous insects has been reported in cereal crops [13-15]. Phytophagous insects are very selective both to the plant species that they prefer and to their parts that they ingest. Indeed, there are devourers of leaves, sucking of nectar, eaters of pollen and rodents of roots, stems or trunks [22]. The pests of cereals described in the study area are also reported by several authors as devastating cereals in Algeria and many regions of the world [13-15].

Besides these pests, an auxiliary fauna is noted, even with relatively low frequencies, but its role in limiting pest populations is not to neglect. The arthropods predators are

represented by insects, arachnids, spiders and mites which 220,000 predatory species are currently known in the world [23]. Some species are predators both at larval stage and adult stage, such as the Coccinellidae (Coleoptera), Forficulidae (Dermaptera), some families of Hemiptera and some Neuroptera. Others are predators only in the larval stage as Syrphidae and Cecidomyiidae (Diptera)

Most species are carnivorous and considered as natural generalist auxiliaries in the agrosystems [24]. On the other hand, the Carabidea are a very diverse group with more than 40,000 species in the world. They commonly have long legs that allow them to move quickly, to capture prey and avoid other predators [25].

A species was observed in this environment and which interest is particular, that is the *Lumbricus* which plays an important role in aeration of soil, giving the plant a fertile and productive soil [26]. The positive effect of earthworms on the plant production is partly explained by their very close relationship with the root system of plants (Hameed *et al.*, 1993). Among others to the stabilization of soil carbon and reduction the phenomena of erosion by intensifying water percolation [27].

Conclusion

The medium studied consist on a rich and varied fauna, but widely dominated by insects. This fauna was considered diversified, although this diversity varies from one season to another. It counts a lot of pests that may attack and cause losses to agricultural production. But the part of auxiliary that biologically regulates the populations of those pests is also important. Just preserve them, in other words to integrate agriculture into the ecosystem functioning.

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