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Assessment of the Diversity of Lepidoptera and the Importance of Useful and Harmful Species in Palm Groves (Algeria)

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ABSTRACT

The census of Lepidoptera in palm groves of Algeria was the highest number of Rhopalocera (52.2%) followed by Heterocera (48.8%). The inventory carried out in 5 palm groves stations identified 13 families, which the Lycaenidae are the most captured with 266 individuals (20%). Overall, this type of environment is relatively diverse (Shannon Weaver Index: H' = 3.17 bits), with a tendency towards balance (Equitability Index: E = 0.76). The first palm grove was characterized by the highest richness quantified with 49 species (Average richness: Sm = 9.8 ± 14.9), with a total of 62 species for all stations. Among the latter, Zizeeria knysna (Individual number: IN= 190), Mirificarma interrupta (IN = 143), Pieris rapae (IN = 121) and Cynthia cardui (IN = 113) were the most recorded. The maximum capture was recorded during the months of April (IN = 183) and October (IN = 184) with a temperature approaching 24 °C. Concerning agricultural interest and phenological status, non-harmful species were highly captured (841), which the majority are sedentary (IN = 465). They were represented by non-harmful migratory Rhopalocera (IN = 293) and non-harmful sedentary Heterocera (IN = 275).

Keywords: *Diversity, Lepidoptera, Migration, Harmfulness, Palm Grove, Algeria.*

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1. INTRODUCTION

Species belonging to Lepidoptera live in interaction with many plant and animal species. They are sensitive to pesticides, natural environmental processes and climate change, including temperature, that affects migratory insects, particularly butterflies (Lafranchis, 2000; Sparks et *al*., 2007; Sujayanand and KaruppaiaH, 2016). Migrations of this group increase in amplitude with higher temperatures, both in terms of individuals' number and migratory species (Sparks et *al*., 2007). They concern Rhopalocera such as Pieridae; Danaidae, Nymphalidae and Heterocera such as Sphingidae and Noctuidae (Williams, 1957).

The phenomenon of insect migration contributes to changing stand distribution and dynamics, where it can introduce new species to new geographical regions (Sujayanand and Karuppaiah, 2016).

Indeed, some Lepidoptera species, especially larval ones, are probably more destructive to agricultural crops and forest trees than other insect groups (Kumar, 2013). This is the case of *Ectomyelois ceratoniae*, which can cause very significant economic losses about 90% on pomegranates and 20% on dates (Vreysen et *al*., 2006); similarly for *Virachola livia* that caused about 48% of losses on pomegranates (Obeidat and Akkawi, 2002), and also for *Tuta absoluta* between 80 and 100% on tomatoes (Gebremariam, 2015). Given their importance, several authors have taken an interest in this taxon worldwide (Kristensen et *al*., 2007; Sutrisno, 2008; Vieira, 2008; Chittaro and Pasche, 2009; Elanchezhian et *al*., 2014; Macgregor et *al*., 2014; Bippus, 2017; Choi et *al*., 2017; Ullah et *al*., 2017). On the other hand, in Algeria, studies were fragmentary and very rare (Speidel and Hassler, 1989; Samraoui, 1989; Allache et *al*., 2012; Barkou et *al*., 2017; Ouamane et *al*., 2017), particularly in palm groves in the south of the country (Bouras et *al*., 2018). This study aims to study the diversity of Lepidoptera in palm groves, the effect of climatic factors on species distribution and structure, also the development of the phenological status and importance of harmful species in palm groves in Algeria.

2. MATERIALS AND METHODS

2.1. Study area

This study was carried out in the region of Ouargla (29° 13' to 33° 42' N.; 3° 06' to 5° 20' E.) located about 800 km in the southeastern Algeria. This region is at an altitude of 157 m. It is an oasis of agricultural activity strongly dominated by phoeniciculture, which constitutes, to this day, a main source of life for several families in the Saharan regions (Dubost, 1991). In 2015, the lowest average temperatures were recorded in January (10.8°C), while the highest temperatures were recorded in August (36.1°C). In addition, this region was characterized by a dry period that occurs every month of the year and belongs to the Saharan bioclimatic zone in mild winter (2006 to 2015).

Within this region, five palm groves characterized by the absence of phytosanitary treatments were selected.

Palm grove 1: It is located at an altitude of 134 m (31°59'33''' N.; 5°17'34'' E), covers an area of 6000 m² and includes 120 feet of *Phoenix dactylifera*, accompanied by some fruit trees such as *Punica granatum*, *Ficus carica*, *Vitis vinifera* and forage crops such as *Medicago sativa* and *Hordium vulgar*. In addition to these latter, the vegetable crops were represented by *Allium cepa*, *Daucus carota*, *Spinacia oleracea*, *Lactuca sativa*, *Vicia faba*, *Capsicum annuum*, *Solanum melongena*, *Brassica oleracea* and *Mentha aquatica*. Some spontaneous plants were recorded in this station, including *Cynodon dactylon*, *Polypogon monspeliensis*, *Convolus arvensis*, *Chenopodium murale*, *Anagalys arvensis*, *Malva parviflora* and *Sonchus maritimus*. Irrigation was done by submergence from well-organized and maintained gutters. It was limited to four faces by other palm groves.

Palm grove 2: It was located at an altitude of 134 m (31°59' 10'' N.; 5°17' 35'' E.) and covers an area of 4900 m^2. The total number of date palm trees was 70 feet. Some plants were grown under intercropping palm trees such as *A. cepa*, *D. carota*, *S. oleracea*, *L. sativa*, *V. faba*, *Coriandrum sativum*, *C. annuum*, Lucerne and barley. For spontaneous plants, it should be mentioned the presence of *C. dactylon*, *A. arvensis*, *Sonchus oleraceus*, *C. murale*, *Conyza canadensis*, *Suaeda fructicosa*, *Cynanchum acutum* and *M. parviflora*. It was limited by neighboring palm groves from all orientations. In this station, the irrigation was done by submersion.

Palm grove 3: It was located at an altitude of 136 m (32 ° 02'30 '' N, 5 ° 28'99 '' E.) and occupying an area of 10000 m^2. This palm grove has 215 date palms. The fruit trees were presented only by 2 *V. vinifera* trees and 2 *P. granatum* trees. For the cultivated vegetable crops, there were *S. oleracea*, *D. carota*, *S. melongena*. The forage crops noted in this station are *M. sativa* and *H. vulgar*. Some spontaneous plants were also present such as *C. dactylon*, *Lavatera cretica*, *P. monspeliensis*, *C. acutum*, *S. fructicosa*, *C. murale*, *S. oleraceus*, *A. arvensis*, *Setaria verticillata* and *Frankenia pulverulenta*. The irrigation system was of drip type. It was limited to four faces by other palm groves.

Palm grove 4: It was located at an altitude of 134 m (31°56' 98'' N; 5°18' 56'' E) and covers an area of 10000 m^2. The date palm trees dominate in this station with 120 feet. The station contains one tree of *P. granatum*. There were forage crops such as *M. sativa* and *H. vulgar*. The spontaneous plants of *C. dactylon*, *S. verticillata*, *P. monspeliensis*, *C. murale*, *F. pulverulenta* and *A. arvensis* were also present. Irrigation was done by submersion for date palm. This station was limited by other palm groves on the three sides and the road for the fourth face.

Palm grove 5: It was located at an altitude of 123 m (32°08'29'' N; 5°17'78'' E.) and covers an area of 10000 m^2. It has 141 date palms. It was noted that there are 3 trees of *V. vinifera* and some vegetable crops such as *S. oleracea*, *S. melongena*, *C. annuum* and *A. cepa*. The spontaneous plants recorded in this station were *P. monspeliensis*, *S. verticillata*, *Zygophyllum album*, *C. acutum*. The station is irrigated by the drip system and limited by sand dunes on three sides and a palm grove for the fourth side.

2.2. Methodology

Throughout the experimental period (13 months) at the five stations, the sampling of Lepidoptera was carried out by using 5 methods with a frequency of one exit per month/station. The first one was the Barber trap method, which was used to sample invertebrates that moving on the ground surface. For this purpose, 8 traps were placed in line with a distance of 5m apart, near date palms and fruit tree trunks. The second method was mowing with a mower net, which was used to collect insects that are in flight or on an herbaceous stratum. Color traps, which are plastic containers made of colors (3 yellow and 3 blue), were also used to attract arthropods because of their color. Light traps were used to capture nocturnal species. A single trap suspended on the leaves of date palm throughout the night was retrieved early in the morning. Three sugar water traps were also placed on the palm trees for three days to attract insects from the surrounding area through their sense of smell.

The contents of each trap were retrieved in a Petri dish containing the date, station name and trap type. Samples were then analyzed at the laboratory, where several keys were used to determine the captured specimens (Heiko, 2006; Gilbert and Zalat, 2007; Handfieid, 2011; Thibaudeau et *al*., 2013).

2.3. Data analysis

For the exploitation of results, we used ecological indices, in particular the index diversity of Shannon-Weaver (H'), expressed in bits and given by the formula: $H' = \Sigma\ qi \log_2 qi$ where qi was the relative frequency of the category taken into consideration (Ramade, 1984). Equitability (E) was calculated by the ratio of observed diversity (H') to maximum diversity, with values ranging from 0 to 1 (H' max) (Blondel, 1979). Relative abundance (RA %) was expressed as a percentage of individual number of a species, family, order or class (IN) in relation to all stands of all species (N) (Faurie et *al*., 2003). Total richness (S) was the total number of species in a stand considered in a given biotope (Ramade, 2003). The average richness (Sm) represents the average number of species found in each survey (Ramade, 2003). For statistical analyses, the analysis of variance (ANOVA) was used for normal data, otherwise the Kruskal-Wallis test was used to compare the distributions of several samples.

3. RESULTS

The diversity values (H') of the Lepidoptera sampled in palm groves vary from 2.39 (station 4) to 3.1 bits (station 1), with a global diversity value of 3.17 bits for all stations (Fig. 1). For the Pielo index, the values vary from 0.74 (station 4) to 0.88 (station 5) (Fig. 2). These latter values express a tendency towards balance between individuals of butterfly species recorded in the different palm groves.

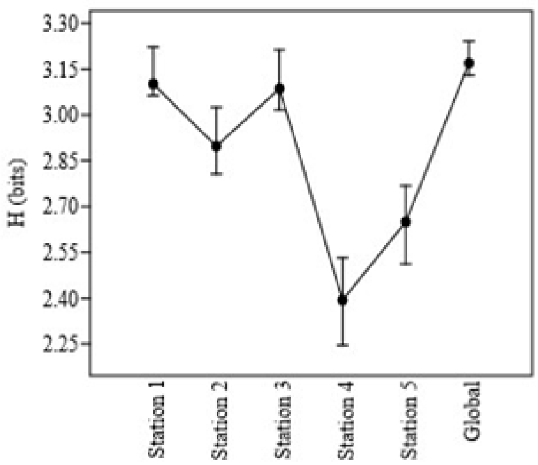

Figure 1: Shannon diversity (H') applied to Lepidoptera species

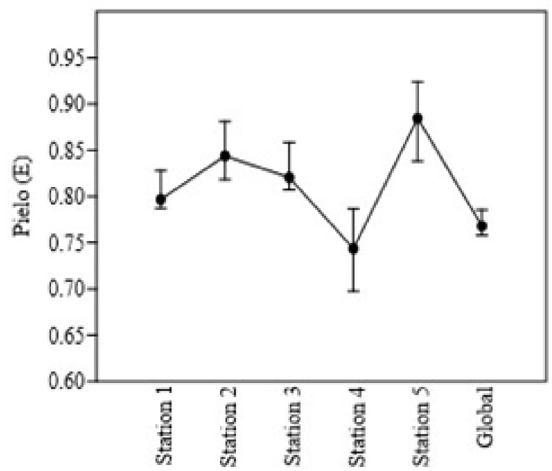

Figure 2: Equitability (E') applied to Lepidopteran species

The comparison between the two suborders shows that there was a significant difference (p = 0.0135). The most recorded suborder was Rhopalocera with values ranging from 1 to 190 individuals (mean = 48.9 ± 59). Heterocera are poorly recorded with values ranging from 1 to 143 (mean = 13.6 ± 23.6).

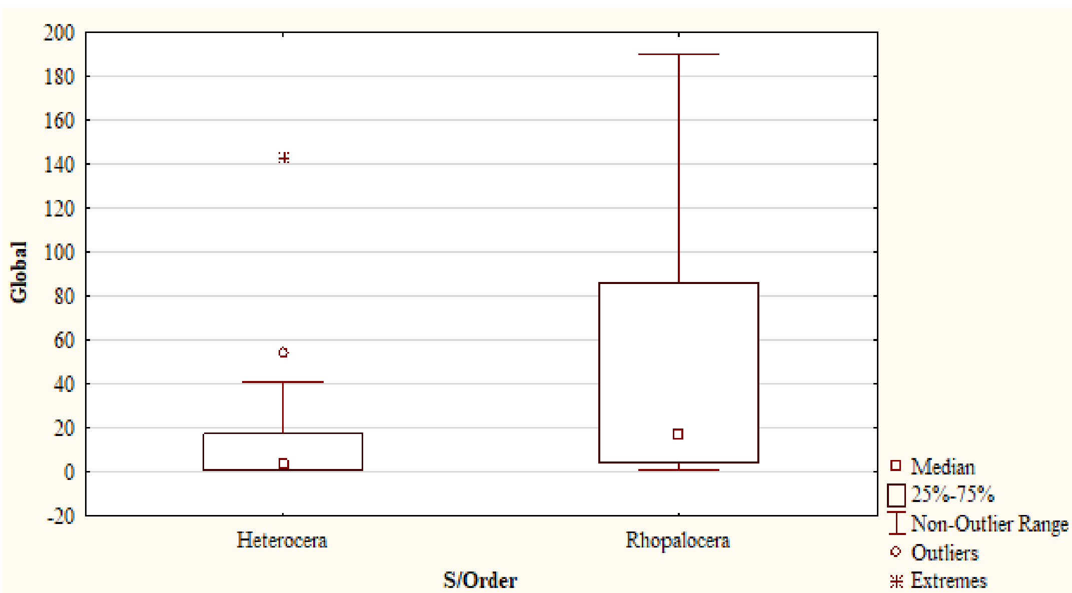

Figure 3: Box-plot of Lepidoptera classified according to suborders

Overall, this study captured 1337 individuals divided into 13 families (Fig. 4). The highest number of individuals was noted for Lycaenidae with a total of 266 individuals (mean = 53.2 ± 81.5), followed by Nymphalidae with 201 individuals (67 ± 57.9). The lowest value was noted for Pterophoridae with only 2 individuals (Fig. 4). The comparison between the different families shows that there was a significant difference (p = 0.0411) according to the captures.

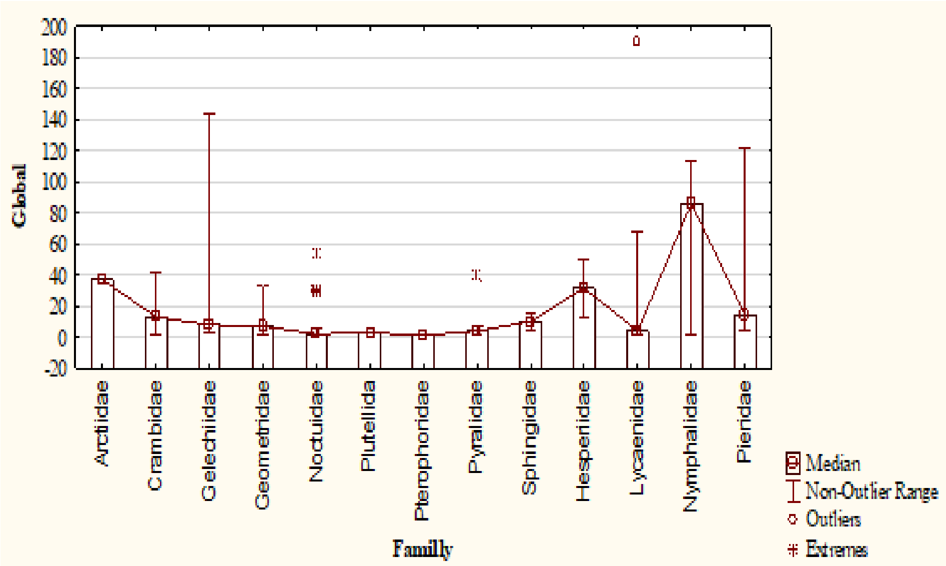

Figure 4: Importance of Lepidoptera families in palm groves in Algeria

In terms of stations, Heterocera individuals were highly captured in station 1 with a total of 216 individuals (6 ± 8 individuals) compared to only 56 individuals trapped in station 5 (3.7 ± 3.8) (Fig. 5). The same was observed for Rhopalocera, where 265 individuals are caught in station 1 (20.4 ± 23.1) and only 28 individuals recorded in station 5 (5.6 ± 4.1). The comparison between the captures of Heterocera and Rhopalocera shows the existence of very significant differences at station 1 ($p < 0.000$) and station 4 ($p < 0.000$).

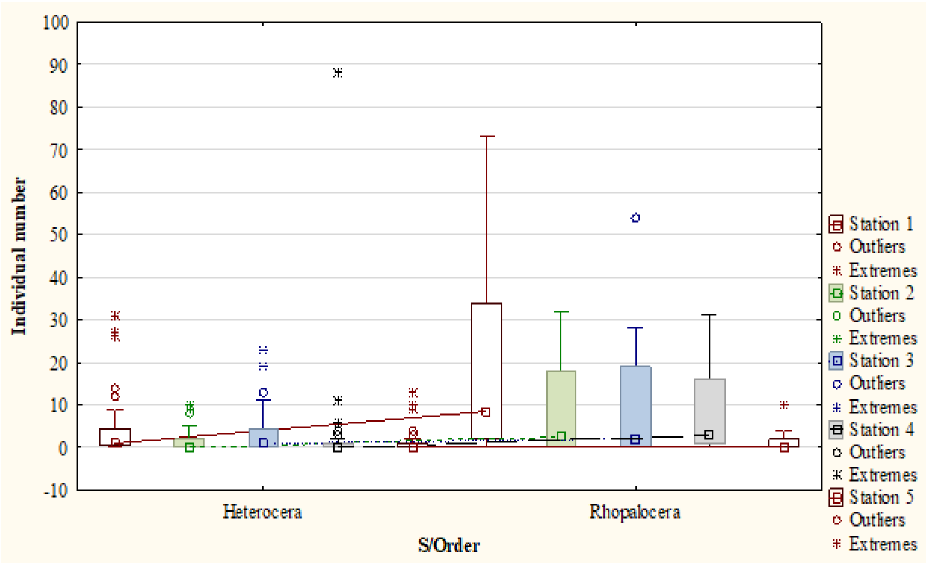

Figure 5: Distribution of Lepidoptera suborders according to stations

A total of 62 species of Lepidoptera were recorded in the palm groves of Ouargla (Tab. 1). Station 1 was characterized by the highest richness with 49 species (Sm = 9.8 ± 14.9 species). While the lowest value was recorded in station 5 with 20 species (Sm = 4.2 ± 3.8). The same was observed for individuals, where 481 individuals were caught in station 1 and only 84 individuals in station 5.

Table 1: Individuals number (IN), total (S) and average (Sm) richness of Lepidoptera species inventoried in the palm groves of Ouargla

	Station 1	Station 2	Station 3	Station 4	Station 5	Global
IN	481	200	315	257	84	1337
S	49	31	43	25	20	62
Sm	9,82	6,45	7,33	10,28	4,2	21,56
SD	14,86	7,7	10,35	18,11	3,83	37,33

SD : standard deviation.

As for species, *Zizeeria knysna* (IN = 190), *Mirificarma interrupta* (IN = 143), *Pieris rapae* (IN = 121) and *Cynthia cardui* (IN = 113) are the most captured. On the other hand, the lowest species recorded were represented by only one individual, such as *Palpita vitrealis*, *Agrotis ipsilon* and *Xenochlorodes olympiaria* (Tab. 3; Appendix). In terms of stations, *Zizeeria knysna* (54 < IN < 73) and *Mirificarma interrupta* IN = 88) were the most identified (Tab. 3; Appendix).

The abundance's evolution curve as a function of some climatic parameters shows the presence of four peaks, the most important of which are those of April and October, with maximum captures of 183 and 184 individuals at T = 24 °C (Fig. 6). The two main peaks were related to the outbreak period of *Mirificarma interrupta* (IN = 69) and *Pieris rapae* (IN = 43) in April and *Cynthia cardui* (IN = 49) in October. On the other hand, the minimum capture was recorded in January (IN = 2) and February (IN = 13) when T < 12.5°C.

Concerning the species, the results show a maximum catch richness recorded in June (T = 33°C), October (T = 25°C) and November (T = 17°C) with 27 species, against only 2 species in January (T = 11°C) (Tab. 3). It should be noted that the precipitation has no influence on densities and diversity of Lepidoptera in palm groves (Fig. 6).

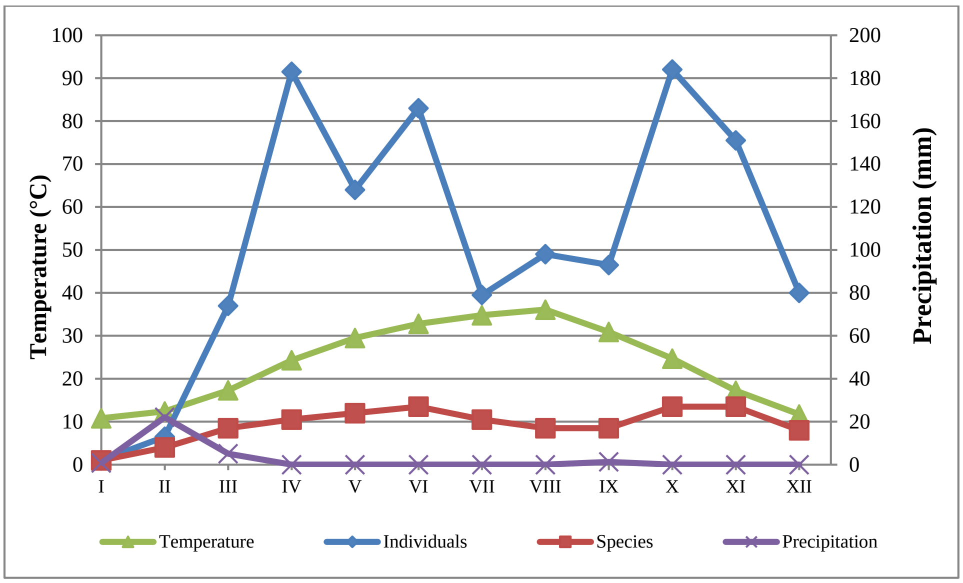

Figure 6: Monthly distribution of Lepidoptera individuals and species according to temperature and precipitation

Table 3 - Number of individuals (Ni) of Lepidoptera species recorded in the palm groves of Ouargla (Algeria)

	Palm groves					
Species	**Station 1**	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Global**
Utetheisa pulchella	9	2	7	6	13	37
Achyra nudalis	12	2	4	1	-	19
Aporodes floralis	-	-	-	4	-	4
Palpita vitrealis	-	-	1	-	-	1
Nomophila noctuella	12	5	10	4	2	33
Euchromuis gozmanyi	1	1	-	-	-	2
Hellula undalis	1	-	1	-	-	2
Hodebertia testalis	2	-	3	2	-	7
Hydriris ornatalis	1	-	1	-	-	2
Euchromuis ocellea	-	1	1	-	-	2
Duponchelia fovealis	3	-	2	-	2	7

Cornifrons ulceratalis	2	4	5	-	2	13
Orthonama obstipata	1	-	-	-	-	1
Rhodometra sacraria	3	-	10	-	-	13
Xenochlorodes olympiaria	1	-	-	-	-	1
Scopula immutata	8	10	8	4	3	33
Mirificarma interrupta	26	9	19	88	1	143
Aproaerema anthyllidella	-	1	2	-	-	3
Tuta absoluta	-	2	1	-	-	3
Syncopacma polychromella	-	1	3	-	9	13
Earias insulana	2	1	3	-	-	6
Agrotis ipsilon	1	-	-	-	-	1
Anumeta straminea	-	-	1	-	-	1
Autophila dilucida	1	-	-	-	1	2
Autographa gamma	1	-	-	-	-	1
Cerocala rothschildi	-	-	1	-	-	1
Grammodes stolida	1	-	1	-	-	2
Helicoverpa armigera	1	-	-	-	-	1
Helicoverpa zea	4	-	2	-	-	6
Heliothis peltigera	14	5	5	4	2	30
Heliothis nubigera	1	-	-	-	3	4
Spodoptera exigua	1	-	1	-	-	2
Thysanoplusia daubei	4	-	1	-	-	5
Thysanoplusia orichalcea	1	-	-	-	-	1
Trichoplusia ni	31	8	11	3	1	54
Arenipses sabella	-	1	-	-	-	1
Acontia lucida	1	-	-	-	-	1
Eublemma cochylioides	9	5	13	4	-	31
Eublemma parva	-	1	1	-	-	2
Plutella xylostella	1	1	1	-	-	3
Agdistis meridionalis	1	-	-	-	-	1
Amblyptilia acanthadactyla	-	1	-	-	-	1
Spoladea recuvalis	14	4	11	-	4	33
Pyrausta purpuralis	27	10	1	1	2	41
Paratalanta hyalinalis	-	-	23	-	-	23
Ectomyelois ceratoniae	5	9	5	11	10	40
Hyles livornica	12	2	2	-	-	16
Macroglossum stellarum	1	-	-	2	1	4
Gegenes nostrodamus	4	-	3	2	4	13
Gegenes pumilio	18	6	8	16	2	50

Zizeeria knysna	73	32	54	31	-	190
Lampides boeticus	47	7	11	3	-	68
Virachola livia	2	-	-	1	-	3
Leptotes pirithous	1	-	-	3	-	4
Azanus ubaldus	-	-	-	1	-	1
Cynthia cardui	34	24	28	17	10	113
Danaus chrysippus	19	22	28	15	2	86
Vanessa atalanta	2	-	-	-	-	2
Pieris rapae	47	18	19	27	10	121
Pieris brassicae	2	4	1	2	-	9
Colias croceus	13	1	1	5	-	20
Pontia daplidice	3	-	1	-	-	4

Despite all these, there were positive correlations between most stations, particularly between station 2 and 3 (r = 0.87; p <0.00) and between station 1 and 2 (r = 0.85; p <0.00) (Tab. 2), unlike stations 4 and 5 (r = 0.21; p <0.00) which do not have correlations.

Table 2: Correlation matrix of Pearson applied to the Lepidoptera trapped at different stations (r \ p; α = 0.05)

	Station 1	Station 2	Station 3	Station 4	Station 5
Station 1	-	1,97E-18	9,09E-15	6,76E-06	0,030636
Station 2	**0,85102**	-	1,26E-20	7,75E-06	0,0015508
Station 3	**0,79715**	**0,87565**	-	2,52E-06	0,035558
Station 4	0,53715	0,53423	0,55746	-	0,095387
Station 5	0,27483	0,39361	0,2675	0,21369	-

By classifying the individuals caught according to their phenological status and agronomic importance (Fig. 7), it can be seen that non-harmful species were highly captured (841 individuals). The majority of these latter were sedentary and noted with values ranging from 1 to 190 individuals (31 ± 56.9). For species classified as harmful (496 individuals), they were most often represented by migratory species, with values ranging from 1 to 121 individuals (18 ± 29.7).

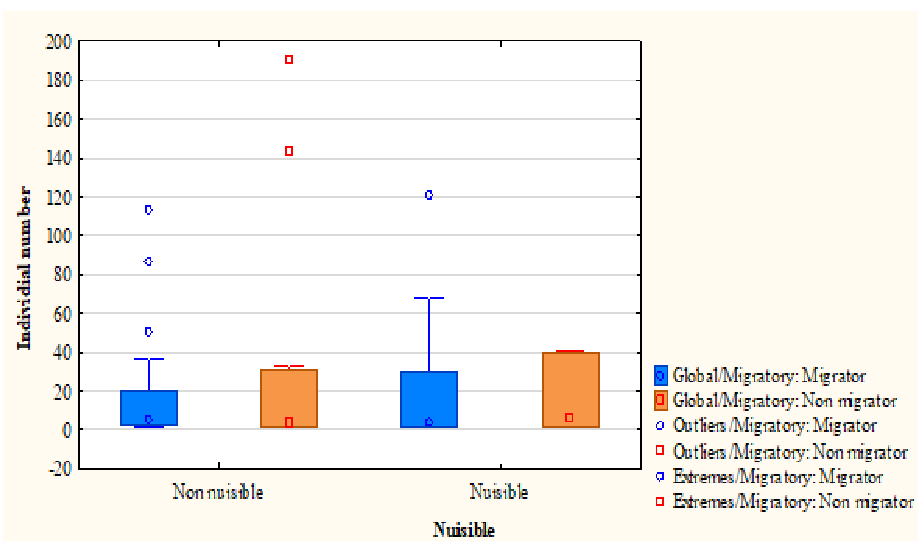

Figure 7: Box-plot of migratory Lepidoptera species according to their agronomic importance

In terms of species activity (Fig. 8), non-harmful migratory Rhopalocera are more abundant with 293 individuals (32.5 ± 41.4). For Heterocera, non-harmful sedentary were higher with 275 individuals by values ranging from 1 to 143 (19.6 ± 37.4), while for non-harmful migratory, they were poorly recorded (83 individuals) with values ranging from 1 to 37 (9.2 ± 11.3). In addition, it should be noted that harmful sedentary Rhopalocera were not trapped in palm groves throughout the sampling period. Also, migratory species were more highly rated (733 individuals) than sedentary species (564 individuals).

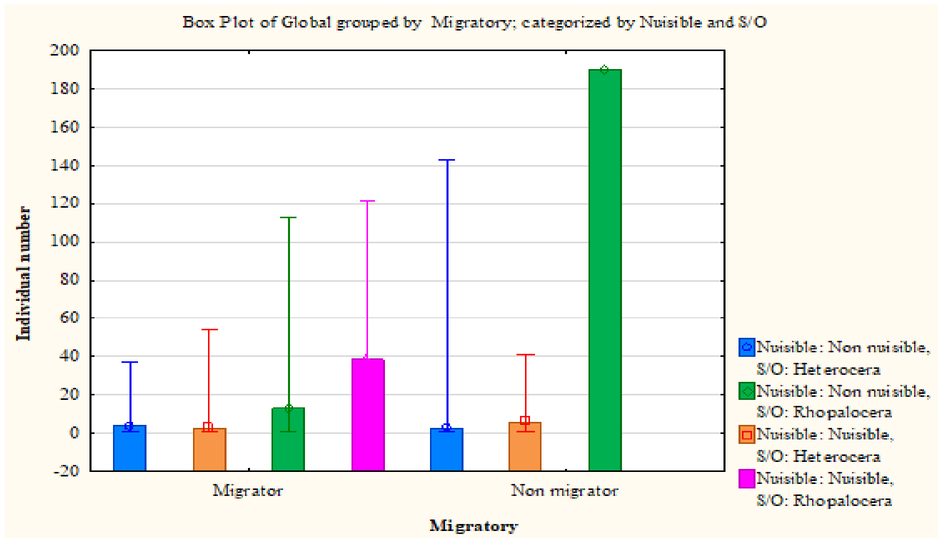

Figure 8: Box-plot of Lepidoptera suborders according to the phenological status and agronomic importance

4. DISCUSSIONS

The Lepidoptera diversity in palm groves of Algeria was relatively important, where it was close to 3.17 bits (2.39 ≤ H' (bits) ≤ 3.1 bits), contrary to what was often claimed about the fauna of Saharan environments (Catalisano, 1986). Moreover, a work in a palm grove from the same study area, Zeghti et *al.* (2015) reported much lower values, ranging from 0.68 bits to 2.53 bits, justified by a relatively low sampling effort compared to the current study. The same was true for forest environments in the north of the country, characterized by values ranging from 2.12 bits to 2.73 bits (Kacha et *al*., 2017) and even in India, which recorded values between 2.07 bits and 2.33 bits (Elanchezhian et *al*., 2014).

The Lepidoptera fauna inventoried in the 5 different study stations tends towards equilibrium (0.74 ≤ E ≤ 0.88). These latter results confirm those noted in the same study region (0.68 ≤ E ≤ 0.76) by Zeghti et *al.* (2015), in Algeria (0.68 ≤ E ≤ 0.79) by Kacha et *al.* (2017) and in India (0.76 ≤ E ≤ 0.83) by Elanchezhian et *al.* (2014).

Rhopalocera (mean = 48.9 ± 59 individuals) were more captured than Heterocera (mean = 13.6 ± 23,6), with significant differences (p = 0.0135). These results can be probably justified by the activity and life style of the two groups, which requires completely different sampling methods and effort for their captures (Laaksonen et *al*., 2006). Nevertheless, these results confirm those noted by Kacha et *al.* (2017) who report the importance of Rhopalocera (IN = 549 individuals) compared to Heterocera (IN = 302 individuals) in forests in Algeria. Similarly in Palestine, where Rhopalocera was the most abundant (69%) than Heterocera (31%) (Dardona et *al*., 2015). On the other hand, other authors, such as Craioveanu and Rakosy (2011) reported the opposite, with 3189 individuals of Heterocera and 885 individuals of Rhopalocera in semi-natural habitats in Romania.

Sampling of Lepidoptera over a period of 13 months, in the five selected palm groves, resulted in the capture of 1337 individuals belonging to 13 families. These results confirm those of Nur et *al.* (2017) which mention the caught of 14 families at forest levels in Malaysia. On the other hand, other authors report a higher number of families, reaching 17 families. This difference can be justified by the importance of the sampling period (Kacha et *al*., 2017) or the sampling size, to say the number of individuals caught (Craioveanu and Rakosy, 2011).

In the sampled palm groves, some families were highly captured, such as Lycaenidae with 266 individuals (53.2 ± 81.5 individuals) and Nymphalidae with 201 individuals (67 ± 57.9 individuals), while others were poorly captured, which implies a significant difference (p = 0.04). These differences have already been reported by Beskardes (2012) who mentioned Nymphalidae (148 individuals) and Pieridae (128 individuals); Kacha et *al.* (2017) reported Nymphalidae (280 individuals) and Erebidae (149 individuals), while Craioveanu and Rakosy (2011) and Nur et *al.* (2017) reported Geometridae and Noctuidae.

In terms of richness, the palm groves of Ouargla were home to a total of 62 species, with obvious variability depending on station between 20 species (Sm = 4.2 ± 3.8) and 49 species (Sm = 9.8 ± 14.9 species). These results were similar to those noted by Kumar (2013) which mentioned 68 species recorded in three sites in India. In addition, other authors reported lower values, notably Zeghti et *al.* (2015) which mentioned only 11 species inventoried during 5 months in a palm grove in Ouargla. On the other hand, Craioveanu and Rakosy (2011) recorded a total of 368 species inventoried in 4 semi-natural habitats in Romania. There are several factors that can play a decisive role in the diversity of Lepidoptera in a biotope, including altitude, seasons and floral diversity (Sutrisno, 2008), that in turn was highly influenced by abiotic factors such as temperature, humidity, wind and precipitation (Kumar, 2013).

It should be recalled that the maximum number of species caught in palm groves was recorded when temperatures were between 17 and 33 °C (S = 27 species). This suggests that these were the favorable temperatures for Lepidoptera in Saharan environments, notably *Mirificarma interrupta* (IN = 69), *Pieris rapae* (IN = 43) in April (T =24 C) and *Cynthia cardui* (IN = 49) in October (T =24 C). Gilbert and Raworth (2005) reported strong activities for *Pieris rapae* at temperatures ranging from 17 to 29°C.

In terms of species, some were more abundant than others. The most recorded ones are *Zizeeria knysna* (IN = 190 individuals), *Mirificarma interrupta* (IN = 143 individuals), *Pieris rapae* (IN = 121 individuals) and *Cynthia cardui* (IN = 113 individuals). While among the least rated ones are *Palpita vitrealis*, *Agrotis ipsilon* and *Xenochlorodes olympiaria* with only one individual. In the same region Zeghti et *al.* (2015) mentioned *Utetheisa pulchella* (IN = 16 individuals) and *Zizeeria knysna* (IN = 15 individuals). Craioveanu and Rakosy (2011) recorded *Melanargia galathea* (IN = 346 individuals) and *Argynnis aglaja* (IN = 102 individuals). On the other hand, Kumar (2013) reported *Pieris canida* (IN = 47 individuals).

According to the suborders, captures vary depending on the stations with a very significant difference for station 1 ($p < 0.00$) and station 4 ($p < 0.00$). They vary between 56 (station 5) and 216 individuals (station 1) for the Heterocera, while for the Rhopalocera, traps vary from 28 (station 5) to 265 individuals (station 1). Station 1 was the highest bidder in terms of individuals' number, because it was characterized by the existence of large Lucerne plots (cultivated under date palm trees), unlike the other stations. As a result, the permanent presence of nectariferous flowers seems to be a determining factor in the attractiveness of Lucerne to Lepidoptera (Manil and Chague, 2014).

Despite all these, there were positive correlations between most of stations, particularly between station 2 and 3 ($r = 0.87$; $p < 0.00$) and between station 1 and 2 ($r = 0.85$; $p < 0.00$). Unlike stations 4 and 5 ($r = 0.21$; $p < 0.00$) which do not have correlations.

Lepidoptera caught in the 5 palm groves were represented by non-harmful species that were highly captured (841 individuals), the majority of which were sedentary (465 individuals) and harmful species (496 individuals), most of which were migratory (397 individuals). In other words, non-harmful migratory Rhopalocera (293 individuals) and Heterocera, non-harmful sedentary species (275 individuals) were more trapped. It should be mentioned that in the Sahara, the phoenicultural environment has thus created a favorable microclimate ensuring the protection of insects that have an economic or non-economic interest (Munier, 1973, Dhouibi, 2000; Bouguedoura et *al*., 2010). They can be migratory or sedentary under the influence of several factors, including food and climate (Reppert et *al*., 2010).

5. CONCLUSION

Palm groves were very favorable environment for Lepidoptera. They contained a very surprising diversity recorded all year round, but showed fluctuations conditioned by vegetation cover, climatic factors and biological characteristics of the species. The most abundant species were *Zizeeria knysna*, *Mirificarma interrupta*, *Pieris rapae* and *Cynthia cardui*. In addition, the most of identified species are considered to be non-harmful sedentary and harmful migratory.

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