

# Geographical variation in diversity of pollinator bees at natural ecosystem (Algeria)

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**Abstract-** Bees help plant biodiversity and food security. 25.000 species of Apoidea apiforms are estimated in the world. However, too little inventory flora and fauna are made part of the Maghreb (North Africa). In Algeria, only a few preliminary studies of early last century revealed the presence of wild bees, but they treat only a small part of Algeria. The purpose of this study is to show the distribution and the biodiversity of wild bees in the natural ecosystem in North and South-eastern Algeria through three major bioclimatic zones which differ by altitude and vegetation. These areas are: sub-humid represented by Blida and Rouiba regions, semi-arid represented by Boudouaou, and per-arid represented by Biskra. The work took place during the period from 2000 to 2011. The transect vegetation is the method adopted to measure the species richness and abundance of wild bees. Three main sampling methods were employed to collect the maximum number of species. The results show an inventory of over 6000 specimens. They are spread about 180 taxa belonging to 23 genera and five families. New species and subspecies are recorded for different areas. The families of wild bees are represented by the Apidae, the Andrenidae, the Halictidae, the Megachilidae and the Colletidae with the respective rates :35.26%, 26.84%, 20%, 12.63% and 26%.

**Keywords-** Apoidea apiforms; wild plants; diversity; bioclimatic regions; Algeria

## I. INTRODUCTION

The bees are insects belonging to the superfamily Apoidea or apoïdsapiforms. They constitute a group of more than 25.000 species throughout the world [1]. Bees are present in most ecosystems, where they are responsible for the pollination of flowering plants. It is the largest bee activity, in terms of interest to humans. Bees help to pollinate 80% of flowering plants; they provide probably 75% of the pollination requirements of crops [2]. A dozen species of bees are used for pollination

throughout the world [3]. Example of the genus *Osmia* that pollinate apple blossom in Japan, plum and almond trees in the United States of America and in Spain and fields of alfalfa in North America [4]. Like honey bees, wild bees are widely studied around the world in recent decades [5-10]. In the Maghreb, particularly Algeria, studies to date has focused on diversity and biogeography of Apoidea and remains fragmented and limited. According Rasmont et al. [11] North Africa probably has a very high diversity similar or even greater than that of California. The case studies conducted in Algeria and Morocco go back to the last century. They are those of Saunders [12], Alfken [13] and Schulthess [14]. The most recent works concern the systematic monograph in the east and south East of Algeria [15], in the plain of Mitidja and near Bouira [16;17;18], and in the region of TiziOuzou [19]. It is in this context that this work fits.

The aim will be to promote the value of bees. The hypotheses were: (1) fauna of wild bees is diverse in the area mid-northern Algeria and in the Northeastern Sahara, (2) the regional distributional patterns may be identified and described, (3) bee diversity is limited by environmental factors.

## II. MATERIALS AND METHODS

### A. Characterization of the Study Sites

The biogeographical variations in diversity of bee species are processed in transect North-South-Eastern regions of Algeria. This is four regions from three bioclimatic zones at natural ecosystem on wild plants (Fig. 1).

-Sub-humid bioclimatic zone: Blida locality (36° 43'

N and 2° 49' E, 163 m. altitude, average annual temperature: 19.7°C.; Annual rainfall: 662.61 mm; Sunshine: 2584h.). The selected site is located at the University Saad Dahleb (Soumâa). Rouiba site (Algiers) (36°44'N et 3°17'E, 19 m. alt.; average annual temperature: 18.1°C.; Annual rainfall: 575,2 mm; Sunshine:2720 h.),

-Semi-arid bioclimatic zone: site of Boudouaou (36°43'N et 3°24'E, 17 m. alt.; average annual temperature: 17.4°C.; Annual rainfall: 538.1 mm; Sunshine: 2800 h.);

-Saharian (per-arid) bioclimatic zone: Biskra locality at two sites: sites of Dhibia and Sidi Okba (34°4'N et 5°44'E, 300 m. alt.; average annual temperature: 22.71C.; Annual rainfall:100.1 mm.; Sunshine: 3258h. ).

#### B. Sampling of Apidae

The method adopted to measure the species richness and abundance of wild bees in these communities is the transect vegetation adapted to herbaceous plants. A plot of 1 ha. was chosen to sample bees. Surveys and catch insects carried out at regular frequencies. For the winter, summer and fall seasons, in natural or undisturbed, bees were sampled once a week at stations in Blida, Rouiba and Boudouaou between 7 h. and 15 h. (Gmt + 1). In spring period, two samplings were made per week. For stations of Biskra, the outputs are twice a week in winter and spring seasons because the weather in the South area is different from those of the North and flowering plants is earlier, it reached its peak in March. In this period, we see the flight of most species of bees and the flowering of a plant up and stealing the majority of bees. Three main sampling methods were employed to collect the maximum number of species. We used an entomological net, cups colorful and plastic bags. Some of the reference specimens are deposited at the Agronomic National School of Algiers (Algeria), the rest is at the Professor Rasmont collection at the Mons-Hainaut University, Belgium and at the Natural History Museum of London, United Kingdom.

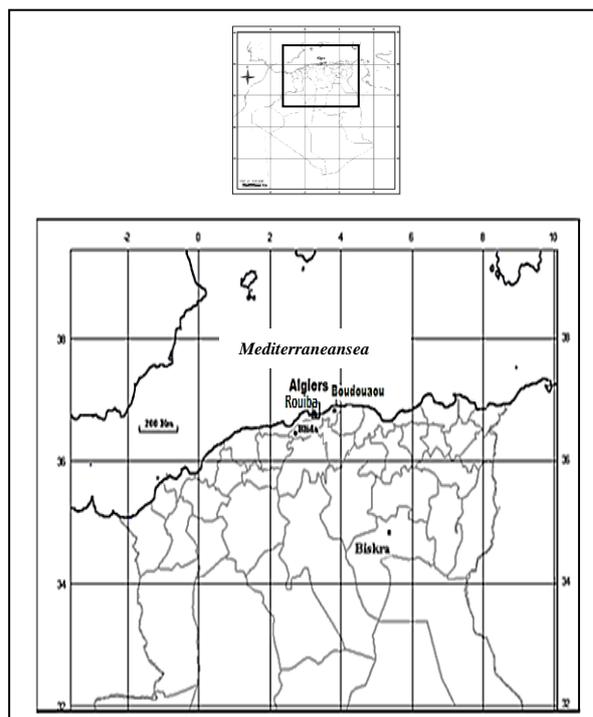


Figure 1. Sites localization

#### C. Statistical Analysis

NTSYS software [20] enables different types of analysis, such as the ACP (Principal Component Analysis). The ACP used in this work can view the affinities between sites depending on the species diversity.

All data in this work have been encoded and managed by the software Data Fauna Flora (DFF) [21]. The D.F.F. is a database developed specifically to link and organize field observations (stations, plants, specimens).

Mapping data was performed using the Carto Fauna Flora software version 2.0 [22] and MapInfo Professional version 5.5[23].

To compare the abundance between sites, analysis of variance by the General Linear Model (GLM) was used. This analysis is made to the program SYSTAT version 12, SPSS 2009.

#### D. Identification

The captured bees were determined by Alain Pauly for species of Halictidae, Pierre Rasmont and Michaël Terzo for certain species of Anthophorini, Michael Kuhlmann for some species of Colletidae and Sebastien Patiny for certain species of Andrenidae.

### III. RESULTS AND DISCUSSION

#### A. Composition and Specific Diversity of Apoidea apiforms

The total of bee fauna in this study is 5160 individuals which are distributed among 173 taxa, 39 subgenera and five families. Louadi [24] reported 3897 specimens in Constantine, distributed among five families, 18 genera and 56 species. This study has note new species and subspecies of wildlife Apoidea in Algeria that were not cited by Alfken [13] such as *Anthophora (Lophanthophora) "plumosa" Pérez*, *Eucera (Heterucera) squamosa* Lepeletier, 1841, *Eucera (None or uncertain) nitidiventris* Mocsary, 1978, *Xylocopa (Koptortosoma) pubescens* Spinola, 1838, *Ammobates (Ammobates) punctatus* Fabricius, 1804. Species diversity is different across the study areas and bioclimatic zones. No species is common to all four sites. It is essentially a qualitative difference of wildlife among the four sites. We found that only the species *Andrena flavipes* is ubiquitous, it is distributed over the three study localities belonging to the sub-humid bioclimatic zones (Blida, Rouiba) and semiarid (Boudouaou). It is absent in Biskra (Fig. 2). This taxon is endemic to North Africa [15]. It is reported by Saunders [12] in eastern Algeria in particular in Annaba (Bone) and Constantine. In the sub-humid zone represented the sites of Blida and Rouiba, the Apidae are the most diverse with 29% of taxa. The diversity taxa is different, this is due to climatic factors, altitude and floral resources.

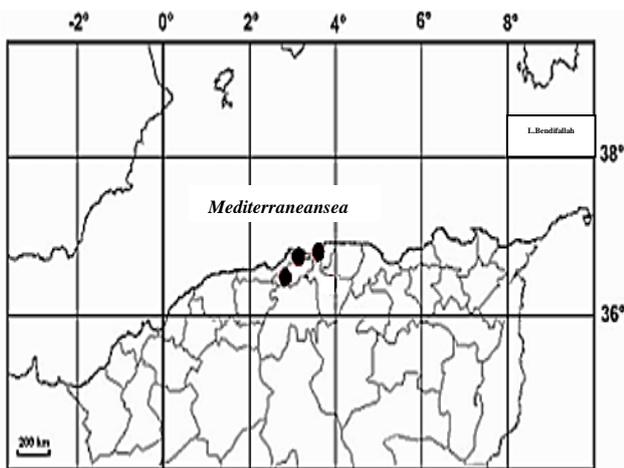
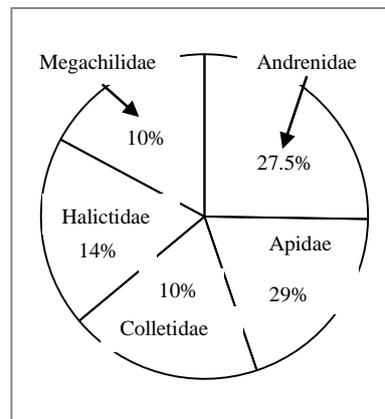


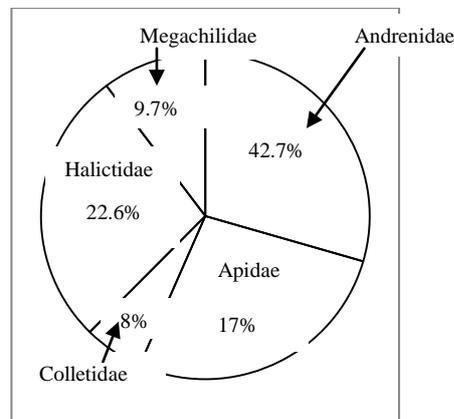
Figure2. Distribution of the solitary bee *Andrena flavipes* Panzer, 1799

In the semi-arid zone represented by the site Boudouaou, the Andrenidae are represented by the higher rate with 42%. Concerning the Saharian zone represented by the Biskra region with the two sites Sidi-Okba and Dhibia the Apidae are more important with 42%, the Megachilidae are better represented with 11.5%

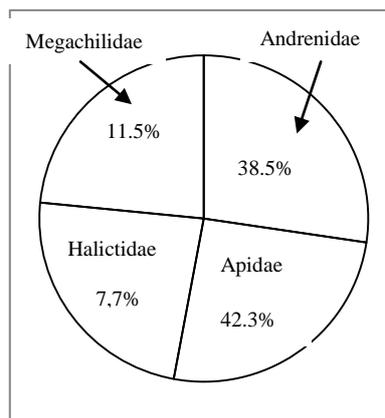
compared to 7.7% Halictidae, they were xeric bees (Fig. 3).



Sub-humid zone



semi-arid zone



Saharian zone

Figure 3. Diversity of wild bee families through each bioclimatic zone

Regarding the abundance of bee families (Fig. 4), the Andrenidae abound in all study areas compared to other families. We deduce that the non-uniform distribution of species in different areas suggests differences in their ecological affinities.

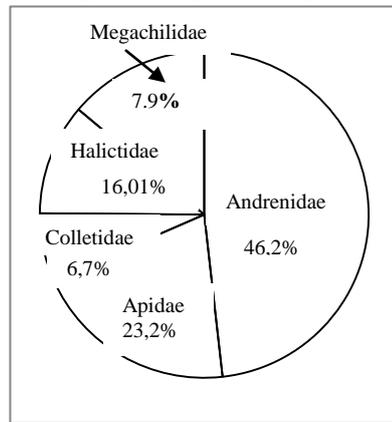
The main factors limiting the distribution and diversity of wild bees are nesting sites [25], climatic conditions [26], the availability of floral resources for the pollen [27] and trophic and spatial competition [28].

**B. Distribution and Biodiversity of Wild Bees Through The Study Areas**

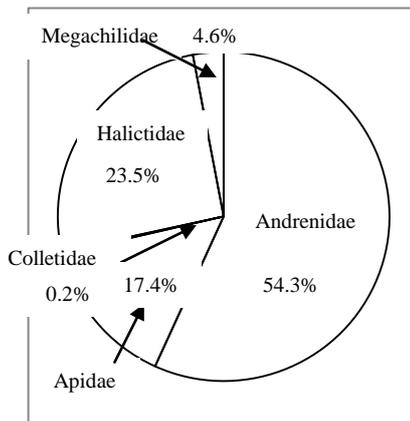
The distribution and biodiversity of wild bee species are treated according to the ecological indices (Table 1).

TABLE 1 – COMPARATIVE DIVERSITY OF DIFFERENT SITES

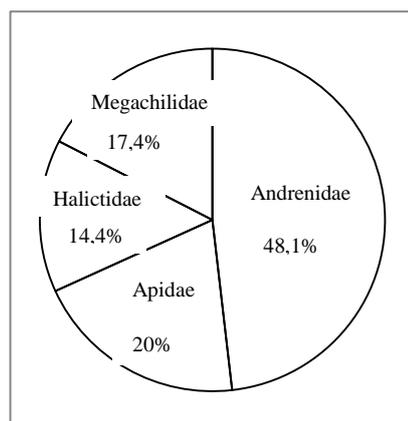
Sites Parameters	Blida	Rouiba	Bou-douaou	Biskra
Ni: number of individuals	881	3725	284	270
Specific richness	20	102	17	26
H': Shannon-Waever diversity index	3.50	5.42	2.04	4.25
E: Equitability	0.80	0.76	0.46	0.90
E s: Hurlbert index	15	31	10	21
SD: Standard deviation	44.05 ± 53.96	64.04 ± 10.87	14.2 ± 40.80	10.38 ± 8.30
Kruskal-Walis test	T = 26.08      d.d.l. = 6      p = 0.0003			
Number of records	20	71	24	16
Number of sites	1	1	1	2



Sub-humid zone



semi-arid zone



Saharian zone

Figure 4. Abundance of wild bee families through each bioclimatic zone

The impression of diversity rather generated by large representation graphical distribution of abundance of Apoidea species (Fig. 5) is confirmed by the important value of expectancy Hurlbert the site of Rouiba where can expect 31 species in 100 specimens taken at random. But this values relatively low for sites of Blida, Boudouaou and Biskra, which are respectively 15, 10 and 21 hoped bee species in 100 individuals. Compared to the same index in the Constantine site (17 species) [29] strengthens the idea of richness rather important in the North against the South. These data confirm the important rich fauna of Algeria. Rasmont et al. [11] point out that this diversity is even greater if we include the whole of Algeria.

Analysis of variance of the bee abundance between sites demonstrated by the GLM test gives F-ratio = 8.500 with a probability less than 1%. This confirms a highly significant diversity in abundance among the study sites.

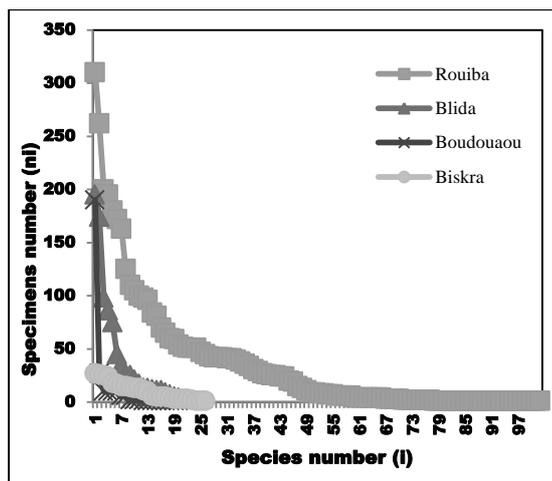


Figure 5. Graphical distribution of species abundance of Apoidea in the abscissa and ni the ordinate for the four study areas

#### IV. CONCLUSION

In this study, 173 taxa of wild bees, including 5160 specimens are found in three bioclimatic zones, sub-humid (Blida, Rouiba), semi-arid (Boudouaou) and Sahara (Biskra). These species are divided into five families. There are 22 genera and 39 subgenera. The family Apidae is best represented with 65 taxa. For the abundance of individuals, Andrenidae constitute almost half of the fauna bees trapped. Based on this study, the following conclusions are made (1) Fauna of wild bees is diverse in the Northern and Southern areas of Algeria. (2) The distribution of species in different areas is non-uniform. (3) Wild bees are diversified according to climatic factors and availability of favorite plants characterizing each bioclimatic zone. This study is a starting point for future research. Given the originality of wild bees in these areas of study, it would be appropriate to generalize the establishment of comprehensive listings in all regions of Algeria.

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#### REFERENCES

[1] C.D. Michener, *The Bees of the World*, The Johns Hopkins Univ. Press, Baltimore, 2007, p.943.  
 [2] G.P. Nabhan, S.L. Buchmann, *Services Provided by Pollinators*, in: G. Daily (Eds.), *Nature's Services: societal dependence on natural ecosystems*, Island Press, Washington, United States, 1997, p.583.  
 [3] C. Kremen, N.M. Williams, R.W. Thorp, *Crop pollination from native bees at risk from agricultural intensification*.

*Proceedings of the National Academy of Sciences U.S.A.*, 99 (2002) 16 812-16 816.

[4] S.W.T. Batra, *Bees and pollination in our changing environment*, *Apidologie* 26 (1995) 361-370.

[5] E. Scheuchl, *Clé illustrée des genres de la super-famille des Apoidea. Illustrierte Bestimmungstabellen der Wildbienen Deutschlands und Österreichs, Band I, Anthophoridae, Gattungen*, Bonn, 2000, p.158.

[6] F. Amiet, M. Herrmann, A. Müller, R. Neumeyer, *Fauna Helvetica - Apidae 5 (Ammobates, Ammobatooides, Anthophora, Biastes, Ceratina, Dasygaster, Epeoloides, Epeolus, Eucera, Macropis, Melecta, Melitta, Nomada, Pasites, Tetralonia, Thyreus, Xylocopa)*, Centre suisse de cartographie de la faune (CSCF), Neuchâtel, 2007, p.356.

[7] N. Gallai, J.-M. Salles, J. Settele, B. Vaissière, *Economic valuation of the vulnerability of world agriculture confronted with pollinator decline*, *Ecological Economics* 68 (2009) 810-821.

[8] S. Iserbyt, *La faune des bourdons (Hymenoptera : Apidae) du Parc National des Pyrénées occidentales et des zones adjacentes*, *Annales de la Société Entomologique de France* 45 (2) (2009) 217-244.

[9] D. Michez, S. Patiny, B.N. Danforth, *Phylogeny of the bee family Melittidae (Hymenoptera: Anthophila) based on combined molecular and morphological data*, *Systematic Entomology* 34 (2009) 574-597.

[10] C.D. Eardley, M. Kuhlmann, A. Pauly, *The bee genera and subgenera of sub-sahara Africa*, *Abc Taxa*, 2010, p.145.

[11] P. Rasmont, P.A. Ebmer, J. Banaszak, G. Van Der Zanden, *Hymenoptera Apoidea Gallica. Liste taxonomique des abeilles de France, de Belgique, de Suisse et du Grand-duché de Luxembourg*, *Bulletin de la Société Entomologique de France* 100 (hors série) (1995) 1- 98.

[12] E. Saunders, *Hymenoptera Aculeata collected in Algeria. Part III - Anthophila*. *Trans., British Entomological Society* 2 (1908) 177-273.

[13] J.D. Alfken, *Beitrag zur Kenntnis der Bienenfauna von Algerien*, *Mémoire de la Société Entomologique de Belgique* 22 (1914) 185-237.

[14] A. Schulthess, *Contribution à la connaissance de la faune des Hyménoptères de l'Afrique du Nord*, *Bulletin de la Société d'Histoire Naturelle d'Afrique du Nord* 15 (6) (1924) 93-320.

[15] K. Louadi, M. Terzo, K. Benachour, S. Berchi, S. Aghib, N. Maghni, N. Benarfa, *Les Hyménoptères Apoidea de l'Algérie orientale avec une liste d'espèces et comparaison avec les faunes ouest-paléarctiques*, *Bulletin de la Société Entomologique de France* 113 (4) (2008) 459-472.

[16] L. Tazerouti-Bendifallah, K. Louadi, S. Doumandji, *Diversité des abeilles sauvages sociales et solitaires, et leur importance à travers les milieux aride et semi-aride en Algérie*, *Review of Arid Regions of Medenine-Tunisia*

(21) (2008) 1184-1193.

[17] L. Bendifallah, K. Loudi, S. Doumandji, Apoidea et leur Diversité au Nord d'Algérie, *Silva Lusitana* 18 (1) (2010a) 85-102.

[18] L. Bendifallah, K. Louadi, S. Doumandji, A study on wild bees as pollinators of weeds and herbal medicinal plants in Mitidja region, Algeria, *Arab Journal of Plant Protection* 28 (2) 2010b) 107-113.

[19] M. Aouar-Sadli, K. Louadi, S. Doumandji, Pollination of the broad bean (*Vicia faba* L. var. *major*) (Fabaceae) by wild bees and honey bees (Hymenoptera: Apoidea) and its impact on the seed production in the Tizi-Ouzou area (Algeria), *African Journal of Agricultural Research* 3 (4) (2008) 266-272.

[20] F.J. Rohlf, NTSYS-pc version 1.8, Numerical and Multivariate Analysis System, Applied Biostatistic Inc., New-York, 1993, p.242.

[21] Y. Barbier, P. Rasmont, CartoFauna-Flora, logiciel de cartographie de données biogéographiques, Version 2.0, Université Mons-Hainaut, 2000, p. 59.

[22] Y. Barbier, P. Rasmont, M. Dufrene, J.-M. Sibert, Data Fauna Flora, Version 1.0, Université Mons-Hainaut, 2000, p.106.

[23] MapInfo Professional version 5.5, MapInfo Corporation Troy, New-York, Available online at : <http://www.mapinfo.com>.

[24] K. Louadi, Systématique, éco-éthologie des abeilles (Hymenoptera, Apoidea) et leurs relations avec l'agrocénose dans la région de Constantine, Ph.D. Thesis, Univ. de Constantine, 1999.

[25] S.G. Potts, P.G. Willmer, Abiotic and biotic factors influencing nest-site selection by *Halictus rubicundus*, a ground nesting halictine bee, *Ecological Entomology* 22 (1997) 319-328.

[26] A. Pekkarinen, Oligolectic bee species in Northern Europe (Hymenoptera, Apoidea), *Entomologia Fennica* 8 (4) (1997) 205-214.

[27] R.L. Minckley, W.T. Wcislo, D. Yanego, S.L. Buchmann, Behavior and phenology of a specialist bee (*Dieunomia*) and sunflower (*Helianthus*) pollen availability, *Ecology* 75 (5) (1994) 1406-1419.

[28] C.D. Michener, Biogeography of the bees, *Annals of the Missouri Botanical Garden* 66 (1979) 277-347.

[29] K. Louadi, S. Doumandji, Diversité et activité de butinage des abeilles (Hymenoptera, Apoidea) dans une pelouse à Thérophytes de Constantine (Algérie), *Canadian Entomologist* 130 (1998) 1-12.