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Inventory of Culicidae of the wetland (of the West region of Annaba)

Zineb Dahchar, Wafa Oudainia, Fatiha Bendali-Saoudi and Noureddine Soltani

Abstract

We have contributed, for a period of 12 months, from October 2013 to September 2014, to the development of an inventory of culicidal fauna. The study area is located in the western region of the city of Annaba, classified by RAMSAR on 4 June 2003. For the sampling of specimens, two different sites were considered: urban and rural areas. The systematic identification established the determination of 7 genera and 12 species. Three species belonging to *Culex* (*Cx. pipiens*, *Cx. torrentium* and *Cx. laticinctus*); the genus *Anopheles* was represented by 4 species (*An. plumbeus*, *An. maculipennis*, *An. claviger* and *An. sergentii*). The other five genera were represented by only one species *Culiseta glaphyoptera*, *Uranotaenia unguiculata*, *Orthopodomyia pulcripalpis*, *Ochlerotatus atropalpus* and *Aedes aegypti*. The species *Culex pipiens* is best represented by its frequency and abundance in the various sites, the other species are very rare. However, we record the abundance of *Anopheles maculipennis* in the rural site.

Keywords: Biodiversity, culicidae, inventory, wetland

1. Introduction

The mosquitoes are haematophagous Diptera, with a great economic importance and of particular medical interest. In epidemiology, they can be vectors of several pathogens causing serious infectious diseases and sometimes death. They are responsible for the transmission of malaria and arboviruses such as yellow fever, The West Nile fever, The Chinkoungoua and the Zika ainsu virus as the nuisance caused by their undesirable night stiches [1, 5]. On the other hand, the culicidal species are a behavior that differs from one region to another in their range, which influences their vectorial role [6]. Over the past 20 years, The Culicidian fauna of Algeria has been the subject of a great number of works which are particularly interested in the systematics, Biochemistry, morphometry, chemical and biological control in different regions of the country. In the north of Algeria in the region of Constantine we quote the work of [7-8]. In the Tébessa region, Colo and Oum El Bouaghi the works of [9, 12], which examined the inventory and study of the bioecology of Culicidae. Also in the East of Algiers and Tizi Ouzou we note the works of [13], And in the West Algeria precisely in Tlemcen those of [6]. A few inventories have been undertaken in the arid zones of the Algerian South (Sahara) by [14-15] In Oued Righ (Touggourt and Djamaâ) and the works of [16-17] in the Biskra region.

Our study was devoted in a first part to the systematic inventory of mosquito species in the West region of Annaba, precisely in the commune of Berrahal considered, as wetlands and classified by RAMSAR on 04 June 2003. The inventory was established in the city, including the various cities that represent our urban site. Other stations were chosen outside the city, representing the rural site. The second part of our work is to determine the ecological indices, to specify the relative abundance of the inventoried species.

2. Material and methods

2.1. Presentation of the study area

The wilaya of Annaba comprises 06 daïras regrouping 12 communes. The region concerned by the present study is located in the territory of the commune of Berrahal, At the level of dwellings. The commune of Berrahal (Fig.1) is located in the south-west Of the agglomeration, Chief place of wilaya of Annaba, of which it is administratively dependent. It is distant from the latter by 30 km, This municipality extends over an area of 17910, 12 ha. It is limited to the North by the communes of Oued El Aneb and Treat and To the south by the

communes of Chorfa and Eulma and the communes of d'El Bouni and Sidi Amar limited to the East, to the west by the communes of the wilaya of Skikda [18].

The urban site corresponds to the cities of the commune of

Berrahal, is divided into three sites, each part of the site has two stations. The rural site is represented by 3 stables and two stagnations (larval deposit). The study area was visited from October 2013 to September 2014.



Fig 1: Geographical location of the sampling site (Berrahal). (Google earth, 2016).

2.2. The biological model

The Culicidae are Arthropods, Antennates, belonging to the class of Insects (hexapods), Order of Diptera (Presence of a single pair of wings) and the suborder of the nematocera (larva apode). Adults are characterized by long and thin aerials with multiple items, Having long mouthpieces in the form of a rigid horn, of the pitcher-sucker type. The life cycle of the insect has two morphologies and two distinct and very different biologies, The one aquatic larval and the other imaginary aerial, (Holometabolic development) [19-20,1].

2.3. Sampling technique

The capture of adults was carried out at the level of the buildings; By means of a glass tube which is gently was placed on the mosquito at rest. When the tube is moved the insect flies towards the bottom, then closes the tube and opens it inside the breeding cage [20]. The larvae were collected with a ladle of 500 milliliters, the latter is immersed in water and then moved with a uniform movement while avoiding the eddies, ten to twenty samples per point.

2.4. Mounting and conservation techniques

Once the larvae have died, were stored in eppendorf tubes containing 10% NaOH for 48 h, to render the chitin transparent and to destroy the tissues attached to the cuticles, Thus facilitating microscopic observation. Then, the larvae was rinsed with distilled water and was mounted on a slide and a cover slip in a drop of glycerin in order was identified systematically [20].

2.5. Culicidae Identification Keys

The systematic identification of Culicidae was carried out

mainly using the software of African mosquitoes [5, 21-22].

2.6. Ecological indices

The ecological indices which hold our attention for the exploitation of our results are the quality of the sampling by determining the total and average richness [23], The centesimal frequency, The Shannon-Weaver index [24], The equality index [25] and relative frequency or abundance [26].

3. Results

3.1. Culicidal fauna composition

The realization of this study on the Culicidian fauna of the region West of the Annaba, Allowed us to establish an inventory from a total of 5784 mosquito specimens. The number of identified species is 12 species established in Table 1. The Aedini tribe is represented by two species: *Oc. atropalpus*, *Ae. aegypti*, The Culicini tribe is formed by three genera, that of the *Culex*, which contains three species, they are: *Cx. pipiens*, *Cx. torrentium* and *Cx. lactinctus*, the genus *Orthopodomyia* has only one species this is *Or. pulcralpilis* and the genus *Uranotaenia* present by the species *U. unguiculata*, The Culisetini tribe is formed by a single species, it is *Cs. glaphyoptera*, the Anophelinae tribe is formed by four species, *An. plumbeus*, *An. maculipennis*, *An. claviger* and *An. sergentii*. The analysis of the structure of the culicidian settlement revealed that the month of August presents the greatest abundance with 987 individuals distributed with five (5) species and the month of February has the lowest population with 153 individuals distributed with six (6) species (Fig. 2).

Table 1: Total wealth of Culicidae in the West region of Annaba, during a year (2013-2014). *U: Uranotaenia; Or: Orthopodomyia; Cx: Culex; Cs.: Culiseta; Oc: Ochlerotatus; An:Anopheles; Ae: Aedes.*

Species	Month											
	Nov.	Déc.	Janv.	Fév.	Mar.	Avr.	Mai.	Jun.	Jul.	Aou.	Sep.	Oct.
<i>U. unguiculata</i> Edwards 1913	/	02	02	01	/	/	/	/	/	/	/	/
<i>Or. pulcripalpis</i> Rodani 1872	/	26	12	/	09	10	5	/	/	16	07	/
<i>Cx. pipiens</i> Linnaeus 1758	422	464	166	104	318	283	128	502	413	817	765	826
<i>Cx. torrentium</i> Martini 1925	/	/	/	08	11	09	08	06	11	08	11	04
<i>Cx. laticinctus</i> Edwards 1913	/	/	/	4	11	10	06	08	06	09	14	02
<i>Ae. aegypti</i> Linnaeus 1762	/	/	02	/	/	/	/	/	/	/	/	/
<i>Cs. glaphyoptera</i> Schiner 1864	06	33	48	01	/	04	/	/	/	/	/	/
<i>Oc. atropalpus</i> Coquillett 1902	01	02	04	02	/	/	/	/	/	/	/	/
<i>An. plumbeus</i> Stephens 1828	/	/	/	/	03	/	/	/	/	/	/	/
<i>An. claviger</i> Meigen 1804	/	/	/	/	/	/	/	05	/	/	/	/
<i>An. maculipennis</i> Favre 1903	/	/	/	/	/	/	25	73	93	37	/	/
<i>An. sergentii</i> Theobald 1907	/	/	/	/	/	/	01	/	/	/	/	/
Total	429	527	234	120	352	316	173	594	523	887	797	832

3.2.1. Diversity and fairness indices

In the urban site, total wealth was high with 9 species, and the abundance is 5475 individuals. The results reported in Table 2, present the values of the diversity index of Shannon & Weaver (H'), of the maximum diversity (H' max) and of the equirepartition (E) at the urban site. The diversity index reveals values ranging from 0.44 for the third station to 0.93

for the second station, this value presents a species rich stand (09 species). In terms of fairness, It allows to compare stand structures displays values between 0.13 and 0.35 in the six stations, These values tend to 0 indicating that populations are not balanced among themselves and almost all numbers are concentrated on a species.

Table 2: Total and average wealth. Shannon–Weaver diversity index (H'), maximal diversity index (H' max) and equitability (E) of the Culicidae in the 3 urban sites. (Sts: station, Sts1: St2).

Species	Site 1		Site 2		Site 3	
	St.1	St.2	St.1	St.2	St.1	St.2
<i>U. unguiculata</i> Edwards 1913	01	01	02	/	/	01
<i>Or. pulcripalpis</i> Rodani 1872	08	08	14	15	22	18
<i>Cx. pipiens</i> Linnaeus 1758	248	287	1092	1179	1145	1172
<i>Cx. laticinctus</i> Edwards 1913	/	06	11	15	13	03
<i>Cx. torrentium</i> Martini 1925	01	06	12	18	21	11
<i>An. maculipennis</i> Meigen 1818	/	06	16	05	21	/
<i>An. claviger</i> Meigen 1804	/	01	/	/	02	/
<i>An. plumbeus</i> Stephens 1828	/	/	/	/	/	/
<i>Cs. glaphyoptera</i> Schiner 1864	14	25	12	03	09	29
<i>Oc. atropalpus</i> Coquillett 1902	/	/	/	/	/	/
<i>Ae. aegypti</i> Linnaeus 1762	/	/	01	/	/	01
<i>An. sergentii</i> Theobald 1907	/	/	/	/	/	/
Effective / station	272	340	1160	1235	1233	1235
H' / station	0.51	0.93	0.44	0.92	0.53	0.38
S/ station	5	8	8	6	7	7
H' max	2.32	3	3	2.58	2.8	2.8
E / station	0.22	0.31	0.14	0.35	0.18	0.13

In the rural site, the total wealth was also important with 8 species, But the abundance was less: 309 individuals. The results shown in Table 3 present the values of the Shannon & Weaver diversity index in the rural site. The values of this index vary between 0 for the third station with a single

species, To 1.63 for the fifth station that is rich in species (4 species). However fairness, has a value of 0.13 at the second station, which explains why the populations are not balanced. On the other hand it tends to 1 with a value 0.81 at the fourth station, indicating a balance between populations.

Table 3: Total and average wealth. Shannon – Weaver diversity index (H'), maximal diversity index (H' max) and equitability (E) of the Culicidae in the rural site St1; St2; St3: stables. St4; St5: breeding sites.

Station	Espèces	St 1	St 2	St 3	St 4	St 5
<i>U. unguiculata</i> Edwards 1913		/	/	/	/	/
<i>Or. pulcralpalpis</i> Rodani 1872		/	/	/	/	/
<i>Cx. pipiens</i> Linnaeus 1758		/	/	/	05	80
<i>Cx. laticinctus</i> Edwards 1913		/	/	/	02	20
<i>Cx. torrentium</i> Martini 1925		/	/	/	/	07
<i>An. maculipennis</i> Meigen 1818		90	50	40	/	/
<i>An. claviger</i> Meigen 1804		01	01	/	/	/
<i>An. plumbeus</i> Stephens 1828		03	/	/	/	/
<i>Cs. glaphyoptera</i> Schiner 1864		/	/	/	/	/
<i>Oc. atropalpus</i> Coquillett 1902		/	/	/	01	08
<i>Ae. aegypti</i> Linnaeus 1762		/	/	/	/	/
<i>An. sergentii</i> Theobald 1907		/	/	/	01	/
Effective / station		94	51	40	09	115
H' / station		0.28	0.13	0	1.63	1.28
S / station		3	2	1	4	4
H' max		1.58	1	0	2	2
E / station		0.18	0.13	0	0.81	0.64

3.2.2. Centesimal frequency

The cumulative results in Fig. 3 & 4 show the relative abundance values that vary from one species to another and from one site to another. Depending on the effective, we note that the most frequent species in both sites is *Cx. pipiens* with

a rate of 93.57% in the urban site and 27.5% in the rural site, however other species are very rare because they are present in less than 25% of surveys. We record that the species *An. maculipennis* is abundant in the rural site with 58.25%.

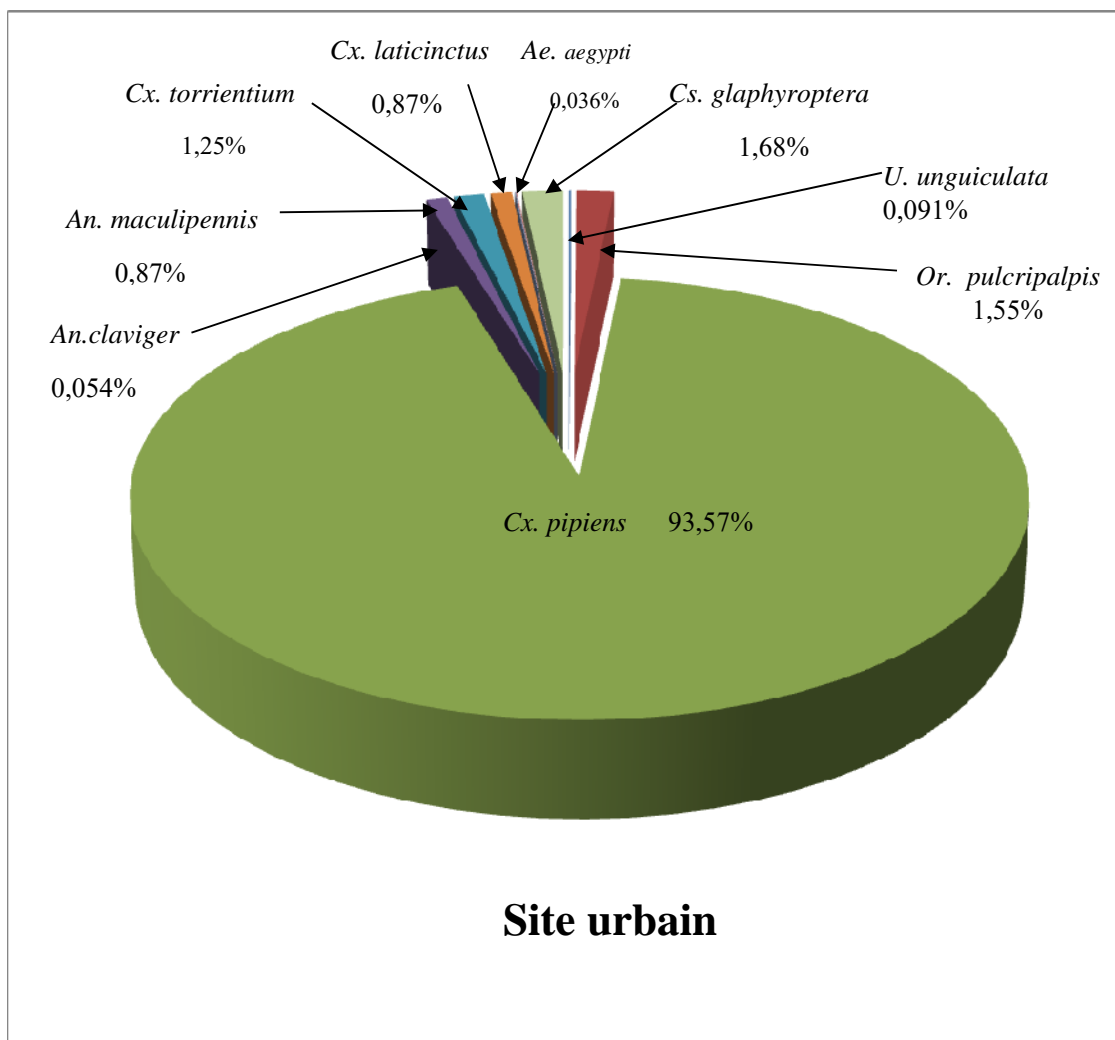


Fig 3: Centesimal frequency of Culicidae species in the urban site (2013-2014).

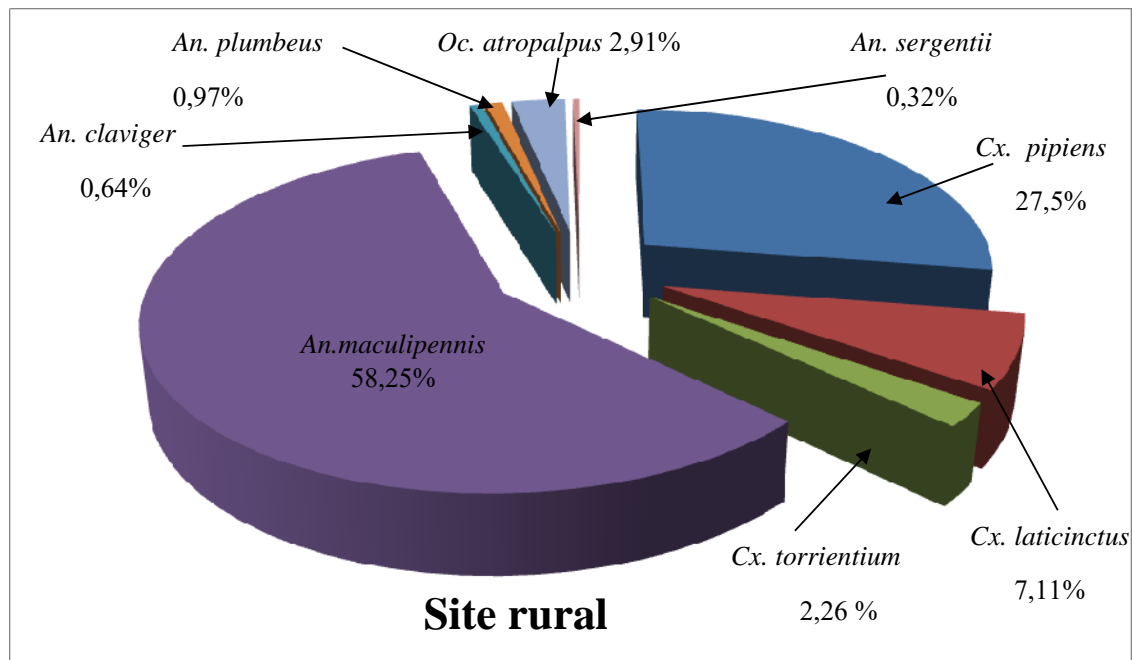


Fig 4: Centesimal frequency of Culicidae species in the rural site (2013-2014).

4. Discussion

The composition of the Culicidian stand sampled in our study area, reveals the existence of two sub-families: the Culicinae and the Anophelinae with six genera: *Culex*; *Uranotaenia*; *Orthopodomyia*; *Culiseta*; *Aedes*; *Anopheles*; *Ochlerotatus*, and 12 species: *U. unguiculata*; *Or. pulcralpis*; *Cx. pipiens*; *Cx. laticinctus*; *Cx. torrentium*; *Cs. glaphyoptera*; *An. plumbeus*; *An. maculipennis*; *An. claviger*; *An. sergentii*; *Oc. atropalpus*; *Ae. aegypti*. The species *Cx. pipiens* is the best represented and most frequent with a rate of 93.57% in the urban site and 27.5% in the rural site. This species is the main domestic and enthusiastic mosquito, is the autogenous form. Which stings at night in conurbations and poses problems to urban hygiene services. However other species are very rare because they are present in less than 25% of surveys. We record that the species *An. maculipennis* is abundant in the rural site with 58.25%. *Cx. pipiens* is a species widespread in Mediterranean Africa and what the work of [6, 7, 10, 13, 15, 16, 27-30]. Indeed it is a species endowed with a great power of ecological plasticity whose larvae develop in the deposits as well epigeous and hypogeous or the water there is very polluted by the organic matter. Among the works carried out on the Culicidae of Algeria, those of [31] carried out in the region of Algiers, Which counted 27 species. On the other hand [27], Report that the fauna of Algeria is rich with 48 species. In the Annaba region, work by [1] revealed the presence of 17 species belonging to five genera. However, the work of [32] carried out in Annaba and El Kala, Reveal the existence of 11 species belonging to 2 sub-families that of Culicinae (*Cs. longiareolata*, *Cx. pipiens*, *U. unguiculata*, *Cx. theileri*, *Or. pulcralpis*, *Cx. pusillus*, *Cx. laticinctus*, *Cs. ochroptera*) and that of Anophelinae (*An. labranchiae*, *An. sacharovi*, *An. algeriensis*).

On the other hand, in the Constantine region, [7] noted the presence of 7 species of Culicidae belonging to 2 subfamilies, the Anophelinae and the Culicinae, it is *Cx. pipiens*, *Cx. theileri*, *Cx. hortensis*, *Cs. longiareolata*, *An. labranchiae* and *U. unguiculata*.

On the other hand, in the region of Mila (West of Constantine), the inventory carried out by [8], Noted the

presence of 12 species of Culicidae belonging to 2 subfamilies, that of the Anophelinae and that of the Culicinae. It is *Cx. pipiens*, *Cx. modestus*, *Cx. theileri*, *Cx. hortensis*, *Cx. antennatus*, *Cx. laticinctus*, *Cx. deserticola*, *Cx. sp.*, *C. longiareolata*, *An. labranchiae*, *An. pharoensis* and *U. unguiculata*. On the other hand in the West region of Algeria (Tlemcen), [6] noted the presence of 20 species of Culicidae. While [33] confirmed the existence of 12 species, to two sub-families: Anophelinae with one species (*An. Labranchiae*) and Culicinae represented by 4 genera: the *Culex* genus is the most abundant with 8 species (*Cx. mimeticus*, *Cx. perexiguus*, *Cx. pipiens*, *Cx. theileri*, *Cx. modestus*, *Cx. hortensis*, *Cx. impudicus* and *Cx. territans*), the genus *Aedes* (*Ae. Caspius*), the genus *Culiseta* (*Cs. Longiareolata*), and finally the genus *Uranotaenia* has contained only one species: *U. unguiculata*. In the region of Tébessa, [9] noted the presence of 10 species of Culicidae belonging to a single sub-family that of Culicinae; *Ae. caspius*, *Cx. pipiens*, *Cx. theileri*, *Cx. hortensis*, *Cx. perexiguus* and *Cx. laticinctus*, *Cs. longiareolata*, *Cs. annulata* and *Cs. subochrea*. Whereas in the same region (Tebessa) [10] revealed the presence of 9 species belonging to a single sub-family (Culicinae) and three genera, *Culex* with 5 species (*Cx. pipiens*, *Cx. theileri*, *Cx. hortensis*, *Cx. perexiguus* and *Cx. laticinctus*), *Culiseta* and *Ochlerotatus*. Moreover, the results of [34] carried out in the same region, revealed the existence of 24 species, divided into four groups; the *Culex* group which is represented essentially by the species *Cx. pipiens*, group 2 of *Culiseta* consists for the most part of *Cs. longiareolata*, group 3 which is less represented, Includes the *Aedes*. Group 4 is the weakest represented by *U. unguiculata* and *An. labranchiae*.

According to [35], seven species were present in the urban environment of the Skikda region (*Cs. fumipennis*, *Or. pulcralpis*, *Cs. glaphyoptera* and *Cs. longiareolata*). In the same region Skikda [11] revealed the presence of 13 species in Collo (*U. unguiculata*; *Or. pulcralpis*; *Cx. pipiens*; *Cx. laticinctus*; *Cx. impudicus*; *Cx. pusillus*; *Cx. hortensis*; *Cx. theileri*; *Cs. annulata*; *Cs. ochroptera*; *Cs. glaphyoptera*; *Cs. longiareolata*; *An. maculipennis sacharovi*. [36] reported the presence of 16 species in the Souk-Ahras area belonging to

three sub-families, Culicinae represented by 4 genera; *Culex* with 5 species (*Cx. pipiens*, *Cx. theileri*, *Cx. modestus*, *Cx. simpsoni*, *Cx. quinquefasciatus*, *Cx. hortensis* and *Cx. arbieeni*); *Aedes* with 3 species (*Ae. punctur*, *Ae. quasirusticus* and *Ae. pulcritarsis*); *Culiseta* with 3 species of which one could not be identified (*Cs. longiareolata*, *Cs. fumipennis*), *Orthopodomyia* represented by one species (*orpulporalpis*) and the *Anopheles* genus represented by 2 species (*An. algeriensis* and *An. labranchiae*). The work of [12] carried out in the region of Oum El Bouagui revealed the existence of six genera: *Culex*; *Uranotaenia*; *Orthopodomyia*; *Culiseta*; *Coquillettidia*; *Anopheles* and 14 species: *U. unguiculata*; *Or. pulcripalpis*; *Cx. pipiens*; *Cx. pusillus*; *Cx. territans*; *Cx. impudicus*; *Cx. laticinctus*; *Cx. hortensis maderensis*; *Cs. ochroptera*; *Cs. longiareolata*; *Cs. glaphyroptera*; *Co. richiardii*; *An. algeriensis*; *An. maculipennis sacharovi*, belonging to two sub-families: the Culicinae and the Anophelinae.

However, some inventories have been undertaken in the arid zones of the Algerian South (Sahara), such as the work of [15] in Oued Righ (Touggourt and Djamaâ) and those of [16] in Biskra, and which mentioned 22 species of Culicidae belonging to the six genera (*Aedes*, *Anopheles*, *Culex*, *Culiseta*, *Uranotenia*, *Orthopodomyia*). Similarly, the work of [17] identified 11 species, divided into two sub-families: the Culicinae and the Anophelinae and four genera: *An. multicolor*; *Ae. caspius*; *Ae. vexans*; *Cx. pipiens*; *Cx. theileri*; *Cx. deserticola*; *Cx. modestus*; *Cx. torrentium*; *Cx. pusillus*; *Cx. antennatus*; *Cs. longiareolata*. Thus, [37] in their morphotaxonomic study of Culicidae larvae, in the M'Zab-Ghardaïa region, identified 10 species: *Oc. caspius*, *An. sergentii*, *Cx. deserticola*, *Cx. theileri*, *Cx. pipiens*, *Cx. hortensis*, *Cx. laticinctus*, *Cs. longiareolata*, *Cs. subochrea*, *U. unguiculata*.

5. Conclusion

The inventories were carried out at three urban sites and five different rural sites. Field surveys, allowed to inventory 12 species of Culicidae belonging to 7 genera (*Aedes*, *Anopheles*, *Culex*, *Culiseta*, *Uranotenia*, *Orthopodomyia*, *Ochlerotatus*) and 12 species: *U. unguiculata*; *Or. pulcripalpis*; *Cx. pipiens*; *Cx. laticinctus*; *Cx. torrentium*; *Cs. glaphyroptera*; *An. plumbeus*; *An. maculipennis*; *An. claviger*; *An. sergentii*; *Oc. atropalpus*; *Ae. aegypti*, belonging to two sub-families: the Culicinae and the Anophelinae. Relative abundance reveals that *Cx. pipiens* is the most abundant species with the highest population 5123 individuals with 93.57% abundance at the urban site and 85 with an abundance of 27.5% at the rural site, however the other species are very rare because they are present less than 25% of surveys. We record that the species *An. maculipennis* is abundant in the rural site with 58.25%.

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7. References

- Bendali-Saoudi F. Etude bioécologique, Systématique et Biochimique des Culicidae (Diptera- Nematocera) de la région d'Annaba. Lutte Biologique anticulicidienne. Thèse de Doctorat d'Etat en Science Naturelle, Université Badji Mokhtar Annaba, Algérie, 2006.
- Himmi O. Les culicides (Insecte, Dipteres) du Maroc : systématique, Ecologie et Etudes Epidémiologiques Pilotes, Thèse de Doctorat d'Etat en Biologie, spécialité Ecologie, 2007.
- Berchi S, Aouati A, Louadi K. Typology of favourable biotopes to the larval development of *Culex pipiens* L. 1758 (Diptera-Culicidae), source of nuisance at Constantine (Algeria). *Ecologia mediterranea*, 2012; 38(2).
- Organisation Mondiale de la Santé, 2013. 10 Faits sur le paludisme. <http://www.who.int/features/factfiles/malaria/fr/>
- Schaffner F, Angel G, Geoffroy B, Hevry JP, Rhaiem A, Brunhes J. Moustique d'Europe. Institut de recherche pour le développement IRD. Logiciel d'identification, 2001.
- Hassain K. Biogéographie et biotypologie des Culicidae (Diptera: Nematocera) de l'Afrique méditerranéenne. Bioécologie des espèces les plus vulnérantes (*Ae. caspius*, *Ae. mariae* et *Cx. pipiens*) de la région occidentale Algérienne. Thèse doc D'état. Univ Tlemcen, 2002, 203.
- Berchi S. Bioécologie de *Culex pipiens* (Diptera, Culicidae) dans la région de constantine et perspective de lutte. Thèse Doc. Es. Science. Université de constantine, 2000a.
- Messai N, Berchi S, Boulknafed F, Louadi K. Inventaire systématique et diversité biologique de Culicidae (Diptera: Nematocera) dans la région de Mila (Algérie). *Entomologie faunistique –Faunistic Entomology*. 2011; 63(3):203-206.
- Tine-Djebbar F. Bioécologie des moustiques de la région de Tébessa et évaluation de deux régulateur de croissance (halofénozide et méthoxyfénozide) à l'égard de deux espèces de moustiques *Culex pipiens* et *Culiseta longiareolata*: toxicologie, morphométrie, biochimie et reproduction. Doc.es. Sciences, Université d'Annaba, 2009, 170.
- Bouabida H, Djebbar F, Soltani N. Etude systématique et écologique des Moustiques (Diptera: Culicidae) dans la région de Tébessa (Algérie). *Faun. Entomol*, 2012; 65:99-103.
- Boudemagh N, Bendali-Saoudi F, Soltani N. Inventory of *Culicidae* (Diptera: Nematocera) in the region of Collo (North-East Algeria). *Ann. Biol. Res*. 2013; 4(2):94-99.
- Oudainia W. Etude bioécologique et systématique des Culicidae de la région d'Oum El Bouaghi. Effet de la température sur l'agressivité et la biologie de *Culex pipiens*. Thèse de Doctorat L.M.D (3ème cycle) en Ecologie Animale. Option: Biologie des Populations. Département de Biologie. Faculté des Sciences. Université Badji Mokhtar Annaba, 2015.
- Lounaci Z. Biosystématique et bioécologique des Culicidae (Diptera – Nematocera) en milieu rurale et agricole. Thèse de Magister. INA., El Harrach, 2003.
- Clastrier J, Senevet G. Les moustiques du Sahara central. *edi institut pasteur d'Algérie*et laboratoire d'entomologie der service antipaludique de la délégation générale du gouvernement en Algérie, 1961; XXIX(2).
- Bebba N. Etude comparative des effets des insecticides sur les populations larvaires de Culicidae de Constantine et Oued Righ (Touggourt et Djamaâ). *Mém Mag.*, Université de Constantine, 2004, 179.
- Merabeti B, Ouakid ML. Contribution à l'étude des moustiques (diptera : Culicidae) dans les oasis de la

- région de biskra (Nord Est D'algerie). Actes du Séminaire International sur la Biodiversité Faunistique en Zones Arides et Semi-arides, 2011, 185-189.
17. Benhissen S, Habbachi W, Masna F, Mecheri H, Ouakid ML, Bairi AM. Inventaire des Culicidae Des Zones Arides: Cas Des Oasis d'Ouled Djellal (Biskra; Algérie) Revue ElWahat pour les Recherches et les Etudes. ISSN, 2014; 7(n°2):1112 -7163.
 18. Centre de la protection des forêts de Berrahal, 2013.
 19. Rhodain F, Perez C. Précis d'entomologie médicale et vétérinaire. Maloine. S A Editeur 27, Rue de l'école médecine 75006, Paris, 1985.
 20. Bendali-Saoudi F. Etude de *Culex pipiens pipiens* anautogène. Systématique, biologie, lutte (*Bacillus thuringiensis israelensis* serotype H14, *Bacillus sphaericus* 1953) et deux espèces d'hydracariens. Thèse de Magister en Arthropodologie, Univ. d'Annaba, 1989.
 21. Guitsevich AV, Monchadski AS, Shtakelberg A. Fauna of the U. S.S.R., Diptera Family Culicidae, 1974; III (4):408.
 22. Himmi O, Dakki M, Trari B, EL Agbani A. Les Culicidae du Maroc, clé d'identification avec données biologiques et écologiques. Travaux Institut Scientifiques, Série Zoologie, Rebat, 1995; 44(50).
 23. Blondel J. L'analyse des peuplements d'oiseaux. Element d'un diagnostic écologique. La méthode d'échantillonnages fréquentiels progressifs (E.F.P.). Rev. Ecol. Terre et vie. 1975; 29(4):533-589.
 24. Daget P. Les modèles mathématiques en écologie. (ed). Masson. Paris, 172.
 25. Ramade F. Eléments d'écologie. Ecologie fondamentale. Ed. Mc Graw-Hill. Paris, 1976, 1984, 397.
 26. Dajoz R. Précis d'écologie. (ed). Duno. Paris, 1971, 434.
 27. Brunhes J, Hassaine K, Rahaim A, Hervy JP. Les Culicidae d'Afrique méditerranéenne. Liste et répartition des espèces. Bulletin de la société Entomologique de France, 2000; 8(2):91-100.
 28. Hamaidia H. Inventaire et biodiversité des Culicidae (Diptera-Nématocéra) dans la région de Souk Ahras et de Tébessa (Algérie). Thèse de Magister. Université de Constantine, 2004.
 29. Messai N, Berchi S, Bouknafd F, Louadi K. Inventaire systématique et diversité biologique de Culicidae (Diptera: Nematocera) dans la région de Mila (Algérie). Entomologie Faunistique-Faunistic Entomology. 2010; 63(3):203-206.
 30. Tahraoui Ch. Abondance saisonnière des Culicidae dans l'écosystème humide du parc national d'El-Kala. Identification et lutte. Mémoire de Magistère en Biologie Animale Environnementale. Option: Biologie et Ecologie Animale, 2012.
 31. Senevet G, Andarelli NL. Les Moustiques de l'Afrique du Nord et du bassin méditerranéen, III: les *Aedes*, 2ème partie: description des espèces du sous genre Ochlerotatus, groupe H. Arch. Inst. Past. Algérie, 1960; XXXIV:51-74.
 32. Ben-Malek L. Etude bioécologique des Culicidae des zones urbaines et rural de l'extrême Nord-est Algérien. Lutte bactériologique par le *Bacillus thuringiensis israelensis* sérotype H14 à l'égard des adultes femelles et des larves néonates d'*Anopheles maculipennis labranchiae*, 2010.
 33. Lounaci Z, Doumandji S. Biodiversité des Culicidae (Diptera, Nematocera) d'intérêt médical et vétérinaire du marais de Réghaia et Tizi Ouzou (Algerie). Communication orale. 11ème Journée entomologique de Gembloux. Université de Liège, 2013.
 34. Aissaoui L. Etude éco-physiologique et systématique des Culicidae dans la région de Tébessa et lutte biologique. Thèse de doctorat en Biologie animale, Université d'Annaba, 2014.
 35. Merabet-Nouri N. Étude Bioécologique et Épidémiologique des Culicidae dans la région d'Annaba et de Skikda. Thèse de Magister en Ecologie Animale. Option : Interactions négatives dans les communautés animales (Parasitisme et prédation). Université d'Annaba, 2010.
 36. Hamaidia K. Biodiversité des moustiques de la région de Souk-Ahras et lutte chimique : aspects écologique, morphométrique, biochimique et toxicologique. Thèse de doctorat en Biologie animale, Université d'Annaba, 2014.
 37. Boukraa S, Baba Aissa N, Abdelaziz B, Ali Ben Ali-Lounaci Z, Doumandji S, Frédéric F. Les moustiques (Diptera : Culicidae) de la région du M'Zab-Ghardaïa, Algérie : biodiversité et importance médico-vétérinaire. Conference Paper. In proceeding of: 11ème journée entomologique de Gembloux, At Gembloux, Belgique, 2013.