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Culicidae Diptera insects of some temporary pools of the Mamora forest: inventory and dynamics

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Abstract
Diptera Culicidae Insects are responsible for the transmission to humans and animals of many parasitic diseases. It needed a fight against the vector species of these diseases. Most often, the control of Dipteridae is at wetland levels. However from an ecological point of view, for a given geographical area, before elaborating any control strategy, it is necessary to determine the systematic identification, the geographical distribution and the evolution of the abundance of Diptera of the regions are necessary. Thus, in the present work is interested in the determination of the inventory of Culicidae Diptera of the temporary pools of the western part of the Mamora forest (Morocco). The qualitative and quantitative sampling was carried out during flooding in the 2016/2017 agricultural year.

The results showed that the populations of the culicids of four temporary pools studied are composed of 9 species name distributed in a stable manner between the temporary pools studied. The species richest pond has 5 species, and the poorest one species. Biotopic heterogeneity may be the main factor in this imbalance in the distribution of species between pools. *Culex pipiens* is most common in ponds and *Culiseta longiareolata* only collected in one pool. The evolution of species abundance varies with species and pools. *Anopheles labranchia*, *Culex pipiens* and *Ochlerotatus caspius* when present with high densities. On the contrary, *Ochlerotatus caspius* and *Culiseta longiareolata* present when they have low densities. The other species present themselves with intermediate densities.

Keywords: culicidae diptera, density, temporary mare, Mamora forest, Morocco

1. Introduction

Among insects, mosquitoes (Diptera Culicidae) are considered to be one of the important zoological groups that would integrate into the field of public health [1, 2]. They are vectors of numerous and serious parasitic diseases including malaria, leishmaniasis and viruses caused by the zika virus [3]. The type of parasites transmitted to the victims varies according to the species. Thus, for a given geographical area, the determination of the specific structure, the mapping and the dynamics of the species of the area are of great interest to elaborate any strategy of fight against the vector species of pathogens.

In Morocco, as reported by Ramdani (1997) [4], mosquitoes are widely distributed in Morocco and their nuisance has increased with urban and rural development leading to the creation of new breeding grounds favorable to larval development. In addition, for over forty years, ecological studies on mosquito species in Morocco have been undertaken by several authors including Mestari (1997) [5], Ramdani (1997) [4] and Himmi *et al*., (1998) [6]. Thus, several regions have been prospected, mainly coastal areas.

2. Material and Methods

2.1 Study areas

Four temporary pools in the Mamora forest have been prospected. In each site we carried out physicochemical analyzes of the water, determined the structure and the evolution of the abundance of the species. The study was carried out during the impoundment in 2016/2017. The number of sampling stations per site studied depends on the heterogeneity of this station.

Dayet Sidi Amira

It is located about 15 km east of Rabat near the forest house of Sidi Amira. It is a bowl with almost flat bottom. The impoundment is temporary and 4 to 5 months. The vegetation, both aquatic and terrestrial, begins to appear as soon as impoundment begins and the flora consists of herbaceous formations of hygrophilous species, a characeae (*Chara canescens*) and other filamentous algae (*Spirogyra sp*). The border vegetation consists of phanerogams including *Ranunculus aquatilis* and *Glyceria fluitans*.

Dayet Eddis

Temporary water accumulation located in the western part of the Mamora forest. It is of a temporary, an area of 8800 m^2 and a depth of up to 60 cm. It is fed by precipitation, runoff and ground water when it swells. The aquatic vegetation consists mainly of *Panicum repens*, *Ranunculus aquatilis*, *Lemna gibba* and filamentous algae.

Dayet Zdegh

It is a semi-permanent pond of 2 hectares of surface which is located 7 km east of the city of Kenitra. The water depth can reach one meter and the aquatic vegetation is rich in filamentous algae and *Ranunculus aquatilis.*

Daya Twila

It is an elongated, semi-permanent pond of about one hectare of surface and is located 7 km east of the town of Salé. The depth of the water can reach one meter and the aquatic vegetation is rich in filamentous algae and *Ranunculus aquatilis*.

2.2 Methods of collecting the fauna studied

In all the sites chosen, the larvae were harvested every fortnight. Each sampling session consists of a set of 10 strokes, made over a distance of 1 meter by the same person, using a troubled net of 20 cm in diameter and 0.5 mm of mesh. The shots are made at different places in the house. The harvest of each sample is stored in a one-and-a-half-liter polystyrene bottle and transported to the Kenitra Faculty of Sciences "Nutrition, Health and Environment" laboratory for systematic determination of harvested species.

For any species, knowing the surface of the opening of the troubling net, the length of the volume of water swept and the number of larvae collected, the density of the individuals is calculated. Note that the evolution of densities makes it possible to characterize the dynamics of the species.

In the case of the qualitative study of the fauna, more than 10 samples of sampling according to the heterogeneity of the medium were carried out.

2.3 Methods of sampling water

According to the dates reported in Table 1, we measured in situ water temperature (Tp), electrical conductivity (Cd), dissolved oxygen (Od) and pH with devices of land. The other variables were analyzed at the Laboratory level Kenitra Faculty of Sciences (Morocco). The assays are either volumetric and spectroscopic according to the methods of analysis proposed by Rodier (1984) [7]. These variables are Nitrites (Nit), Orthophosphates (OPh), Total Alcalimetric Title (TAC), Calcium (Ca) content, Magnesium (Mg) content, Hydrometric Title (TH) and chloride content (Cl).

3. Result and Discussion

3.1 Species harvested, specific wealth of cottages and resorts, and species frequencies

As shown in Table 1, with 7 species at the Sidi Amira temporary pond and 5 species at Sidi Amira, this pool is the richest in species. This important wealth can be explained by its high plant content and a long duration of their flooded phase, ecological conditions that can promote in the environment more ecological niches. Then comes the Eddis pond with 4 species. The shallow depth and the large surface of this pond could be factors of specific wealth of this pond. Twila pond has only two species. Its significant depth could reduce the developmental area of some culicid species and the high frequency of frogs is another reason. This last phenomenon and the same for the pond Zdegh.

Table 1: Harvested species in the prospected stations

Prospected temporary pools and stations		*Anopheles labranchiae*	*Culex pipiens*	*Culex hortensis*	*Culex theileri*	*Culex mod estus*	*Culex im pudicus*	*Culiseta longiareolata*	*Culiseta a nnulata*	*Ochlerotatus caspius*
Sidi Amira	S1 (Daya)	+	+		+	+	+	+		
	S2 (Puit)		+		+		+	+	+	
Eddis	S3		+		+	+				
Zdegh	S4	+	+			+				+
Twila	S5	+		+				+	+	

Moreover, with the presence of *Culex pipiens* in 4 stations belonging to 4 ponds. *Anopheles labranchiae, Culex modestus* and *Culiseta longiareolata* in three ponds each. But this presence is not the same for the species mentioned. *Culex theileri*, and *Culiseta annulata* was collected only in clear and deep water: Twila pond and well of Sidi Amira. Note that only one species, the Zdegh pond is the poorest species.

3.2 Evolution of density and ecological overview of harvested species

3.2.1 *Anopheles labranchiae* (Falleroni, 1926)

3.2.1.1 Evolution of the density

Daya Sidi Amira (fig. 1)

The first larvae appeared at the end of December; a maximum of 107 individuals/m^3 and an average density of 51.7 individuals/m^3. A single peak of density located at the end of February.

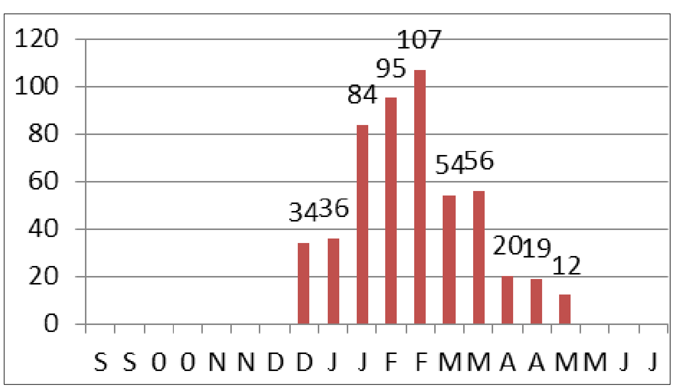

Fig 1: Evolution of the density of *A. labranchiae* in the Sidi Amira daya

Daya Zdegh (fig. 2)
Beginning of the larval phase at the end of November, a maximum of 131 individuals / m^3 and an average density of 85.75 individuals / m^3. Two density peaks first in early January and the other in early April.

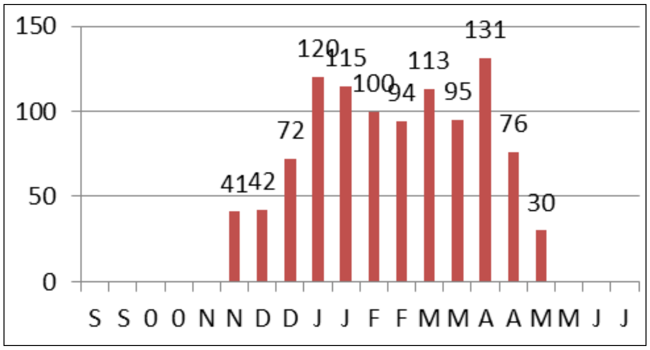

Fig 2: Evolution of the density of *A. labranchiae* in the Zdegh daya

3.2.1.2 Ecological overview
Anopheles labranchiae is the major vector of malaria in the Maghreb, particularly in Morocco Himmi (1995) [8]. It is a species of accumulations of water exposed to the sun [9], temporary or permanent and not exceeding 1900 m altitude [8]. The water of the deposits is shallow, soft or slightly brackish [10, 11], weakly mineralized with a rich plant cover filamentous algae [12, 13].
This species inhabits temporary pools, puddles, low-flow streams and rice paddies. In addition, in the environments studied, the first larvae appeared in autumn except for the rice fields where this occurred in May. Larval densities differ remarkably from one biotope to another. Himmi (1995) [8] reported that this species shows an annual presence from autumn to spring

3.2.2 *Culex pipiens* L.
3.2.2.1-Evolution of the density
D. Sidi Amira (Fig. 3)
Appearance of the first larvae at the end of November, the maximum density is 63 individuals / m^3 the average density is 39.83 individuals / m^3, and a single peak density that lasted throughout the month of February and the beginning of March.

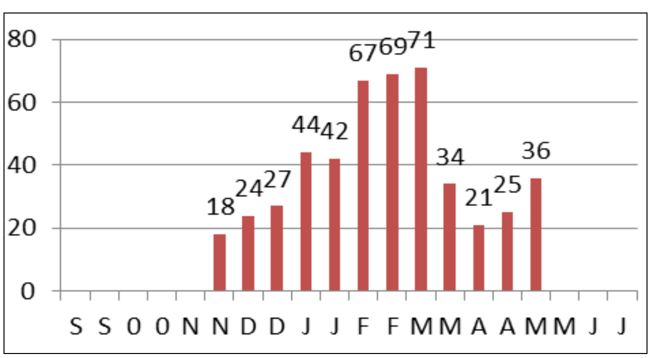

Fig 3: Evolution of the density of *C. pipiens* in the Sidi Amira pool

D. Zdegh **(Fig. 4)**
Beginning of the cycle was at the end of November, an average density of 106.25 individuals/ m^3, a maximum density of 209 individuals / m^3 which was noted in early April, a single density peak.

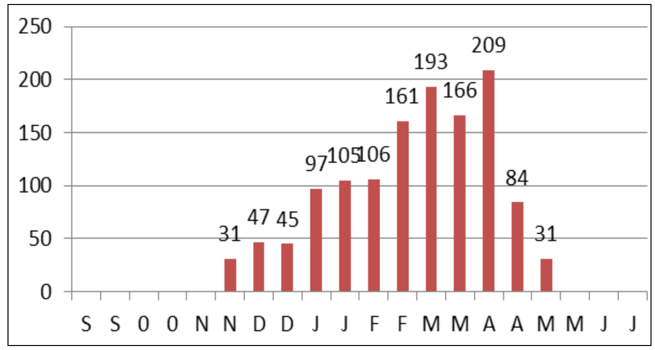

Fig 4: Evolution of the density of *C. Pipiens* in the Zdegh daya

Dayet Eddis (Fig. 5)
The first larvae were recorded at the end of November, the average density was 109 individuals / m3, a maximum density of 213 individuals / m^3 and several density peaks.

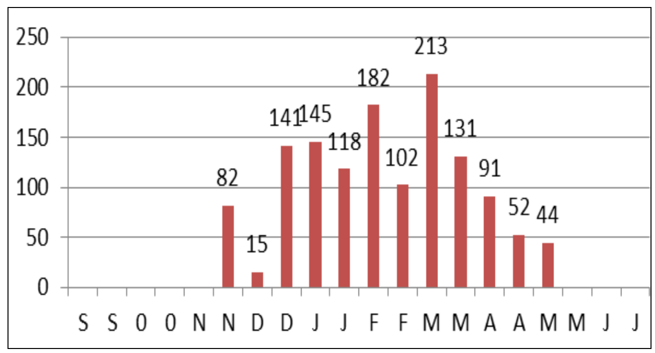

Fig 5: Evolution of *C. pipiens* density in Dayet Eddis

3.2.2.2 Ecological overview
A harmful species by its bites for humans, with a broad ecological validity [14, 15]. It is common in Morocco and can live even in polluted environments [16] and develops in both low and high temperature stations, at varying water heights and at different pH levels. and little oxygenated, However, it does not tolerate heavy mineralization and salinity Himmi (1995) [8]. These latter authors and Berchi *et al*., (2012) [17] have described it as ubiquitous, with continuous development whatever the medium. Similarly, Vézilier *et al*., (2012) [18] reported that this species may develop resistance to pesticides.

3.2.3 *Culex hortensis* Ficalbi, 1889 (Fig. 6)
3.2.3.1 Evolution of the density
The larval phase began at the end of November, the mean density was 21, at individuals / m^3, the densities noted were low, a maximum density of 42 individuals / m^3 and two density peaks, one at the end of December and the other in early February.

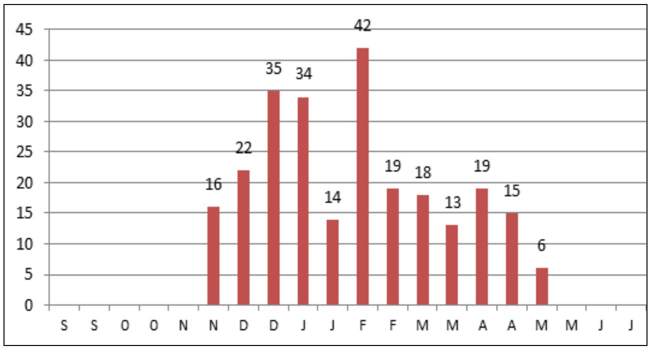

Fig 6: Evolution of the density of *C. hortensis* in Dayet Twilav

3.2.3.2 Ecological overview

This species colonizes different rural or urban areas and can develop in small areas with fresh and clean water or large areas (canals, ponds) where the vegetation is rich. It is often found with *Culiseta annulata* and *Culex pipiens*. It hibernates in the adult state and does not prick the man and feeds exclusively on amphibians [19].

3.2.4 *Culex Theileri* Theobald, 1903

3.2.4.1 Evolution of the density

- Sidi Amira (Daya) (Fig. 7)

The beginning of the larval phase in late November, the larval density remained low with an average density of 25.25 individuals / m^3, a maximum density of 42 individuals / m^3 which was noted at the end of February and two density peaks.

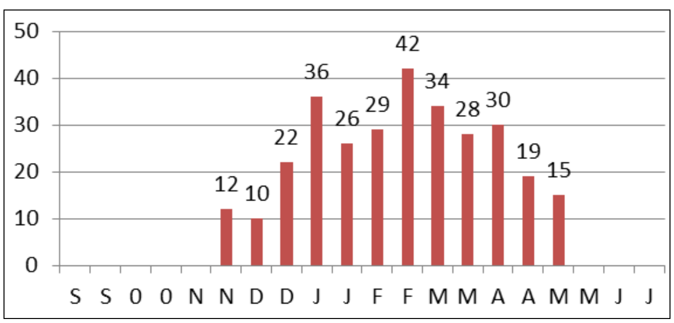

Fig 7: Evolution of the density of *C. theileri* in Sidi Amira daya

Dayet Eddis (Fig. 8)

The beginning of the larval phase at the end of November, the larval density is low, an average density of 26.83 individuals / m^3, a maximum density of 52 individuals / m^3 which was noted at the end of February and two density peaks.

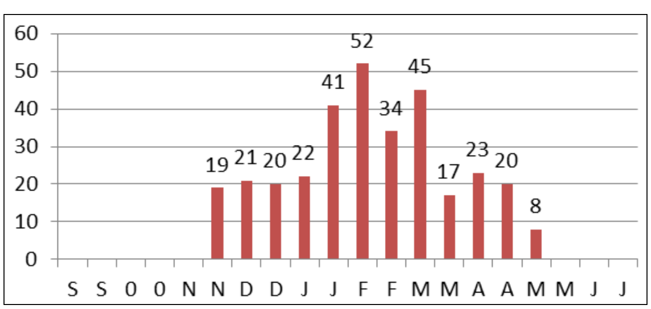

Fig 8: Evolution of the density of *C. theileri* in the dayet Eddis

3.2.4.2 Ecological overview

Species harmful to humans by its bites but which, in South Africa, was found naturally infected by West Nile and Sindbis viruses. It has a range extending from South Africa to Russia from Europe and Morocco to India and Nepal. According to Himmi (1995) [8], it is frequent in Morocco and can develop there with high densities However, elsewhere the density of its populations is very variable from one zone to another and its deposits present or not an abundant upright vegetation: ponds, marshes, rivers, cisterns, residual puddles, springs, irrigation canals, rice fields. The temperature of the environment influences the egg hatch rate and a temperature of 36 ° C appears to be very favorable [20].

3.2.5 *Culex modestus* Ficalbi, 1890

3.2.5.1 Evolution of the density

Sidi Amira (Daya) (Fig. 9)

Appearance of the first larvae at the end of November, very low larval densities, an average density of 10.54 individuals / m^3, a maximum density of 26.83 individuals / m^3 and two density peaks, the first at the end of December and the second in early February.

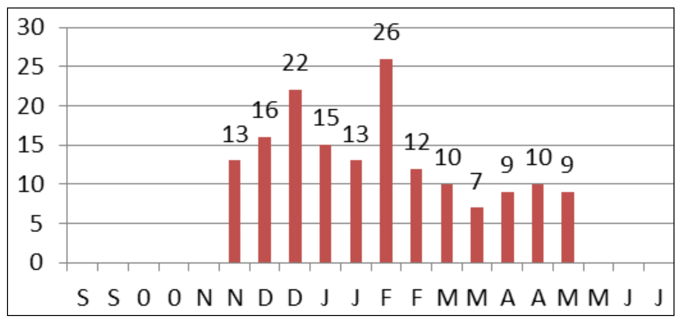

Fig 9: Evolution of the density of *Culex modestus* in Sidi Amira daya

Dayet Eddis (Fig. 10)

The first larvae appeared at the end of November, the average density was 54.91 individuals / m^3, a maximum density of 82 individuals / m^3 and the average density remained high from the end of December until the beginning of May.

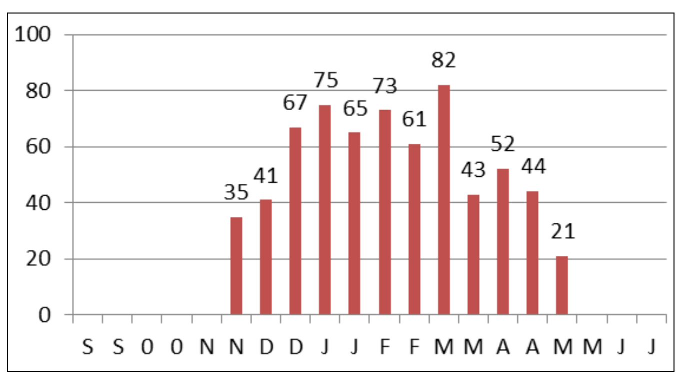

Fig 10: Evolution of *Culex modestus* density in Dayet Eddis

Daya Zdegh (Fig. 11)

Early larvae onset at the end of November, low to medium larval densities, an average density of 33.08 individuals / m^3, a maximum density of 67 individuals / m^3 and a single density peak noted at the end of the month Of March.

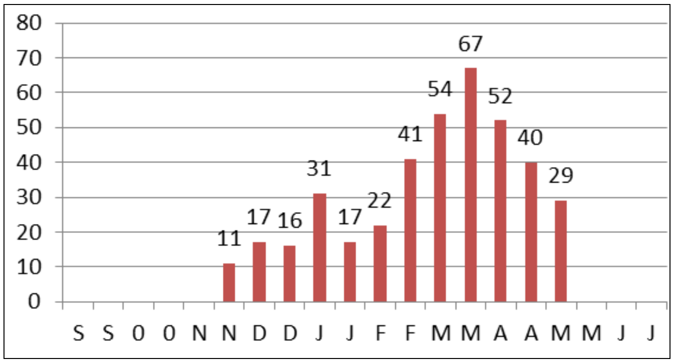

Fig 11: Evolution of *Culex modestus* density in Zdegh daya

This species is harvested in temporary pools; the first larvae appeared in February, when the biotopes were flooded and the larval densities were very low, Himmi (1995) [8] reported that this species is strictly spring.

3.2.5.2 Ecological overview

The main vector of West Nile Virus (WNV) in Europe, *Culex modestus* is commonly found in delta regions, lakes and ponds [21]. The waters of its cottages are generally soft, rarely brackish. Indeed, it has been reported in shallow waters (857 mg / l) Mohrig (1965) [22] has even indicated that high salinity inhibits larval development. The pH of its deposits is often acidic [22, 23].

3.2.6 *Culex impudicus* Ficalbi, 1890
3.2.6.1 Evolution of the density
Sidi Amira (Daya) (Fig. 12)

The first larvae appeared at the beginning of December, larval densities often remained low, an average density of 27, 30 individuals / m^3, a maximum density of 68 individuals / m^3 and a peak density 5al tat the end of January.

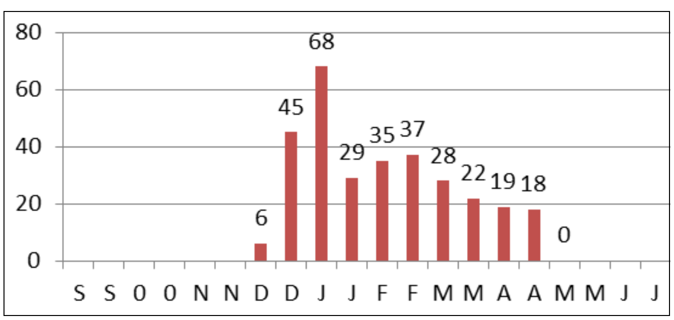

Fig 12: Evolution of *Culex impudicus* density in Sidi Amira daya

3.2.6.2 Ecological overview

Mediterranean species whose range extends east to Iran and has been reported in Morocco, Algeria and Tunisia. It is very common in clear water environments, fresh and glowing but can be varied environments [8]. According to the latter author, it develops in environments with low mineralization, having a large water depth and medium to high temperatures. According to Romi *et al*., (2004) [24] *Culex impudicus*, being in part ornithophile, could transmit WNV in migratory birds to non-migratory birds during the spring.

3.2.7 *Culiseta longiareolata* Macquart, 1838
3.2.7.1 Evolution of the density
Sidi Amira (Daya) (Fig. 13)

The larval cycle began at the end of November, hopper densities were low, an average density of 30.41 individuals / m^3, a maximum density of 44 individuals / m^3, noted in early February, and a single peak density.

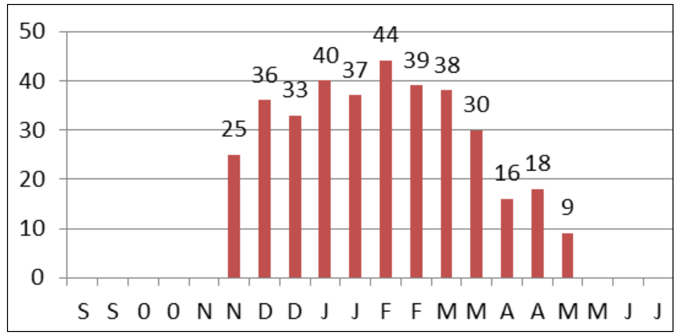

Fig 13: Evolution of *Culiseta longiareolata* density in Sidi Amira daya

3.2.7.2 Ecological overview

A broad ecological mosquito that can develop in fresh or brackish, temporary or semi-temporary waters and even in polluted waters. However, for Morocco, its optimal development has been noted in low mineralized waters [6]. It should be noted that most Culiseta species are adapted to the cold and that this genus is found in all the world except in South America [6].

3.2.8 *Culiseta annulata* (Schrank 1776)
3.2.8.1 Evolution of the density
Sidi Amira (Well) (Fig. 14)

Appearance of the first larvae at the end of November, an average larval density of 60 individuals / m^3, a maximum density of 97 individuals / m^3 which was noted at the beginning of January and two density peaks in early January and early March.

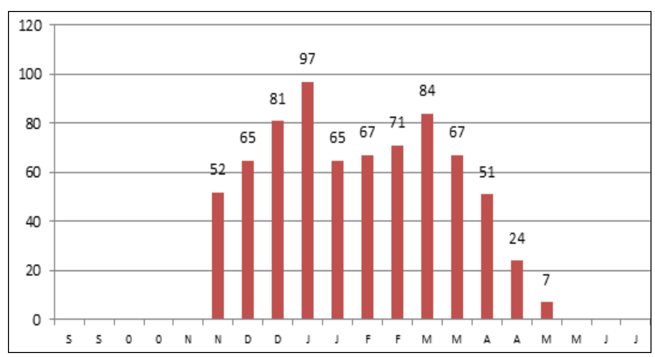

Fig 14: Evolution of the density of *Culiseta annulata* in the well of Sidi Amirav

3.2.8.2 Ecological overview

The species is present throughout Europe, from the northernmost regions to the Mediterranean ; it has also been reported in Morocco, Algeria and Tunisia. Larvae develop in a wide variety of artificial, natural and even polluted habitats but are very common in nitrogen-rich waters [25], artificial media are preferred. Females bite all warm-blooded vertebrates but with a preference for birds and the species could transmit the myxomatosis virus.

3.2.9 *Culiseta longiareolata* Macquart, 1838
3.2.9.1 Evolution of the density
Daya Zdegh (Fig. 15)

Beginning of the larval phase in late November, an average density of 61.05 individuals / m^3, a maximum density of 116 individuals / m^3 and two density peaks, in early January and early March.

The appearance of the first larvae can be therefore automno-winter. Larval densities may be medium to high and the species may inhabit temporary, semi-temporary or permanent aquatic biotopes. Himmi *et al.*, (1998) [6] listed it as the ultimate fall species, but Ramdani (1997) [4] collected it all year round.

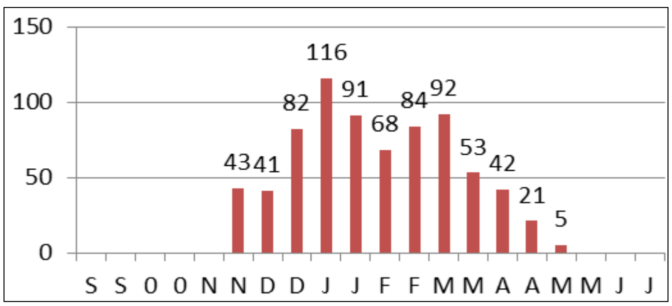

Fig 15: Evolution of *Ochlerotatus caspius* density in the Zdegh daya

3.2.9.2 Ecological overview
A frequent species in the coastal plains of Morocco [6]. The vegetation cover characterizes biotopes favorable to the development of its pre-imaginal populations [6]. Females can lay eggs in aquatic environments rich in plant debris [26]. Its growth rate is optimal when the salinity of water reaches 29.8 g/ l [27].

4. Conclusion
In the hydrosystems of the studied geographical zone the culicidian fauna consists of 9 species values thus testifying an important specific richness in these insects. However, the importance of this wealth varies from one hydrosystem to another. Thus, the deposit of Sidi Amira (5 species) is the richest in culicidae and Twila pond is the poorest. The biotopic heterogeneity could be of this imbalance of the distribution of the species between the ponds. *Culex pipiens* is the most common and *Culiseta longiareolata* and the least common. *Anopheles labranchia*, *Culex pipiens* and *Ochlerotatus caspius* when present occur at high densities. On the contrary, *Ochlerotatus caspius* and *Culiseta longiareolata* present when they have low densities. The other species present themselves with intermediate densities. The evolution of the abundance of the species thus varies according to the species and the ponds, the effect of the factor "season" is a factor of the variation of the density

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