

Biodiversity and distribution of larvae of the genus *Culex* (Diptera: Culicidae) in the Gharb Region: case of the Province of Sidi Slimane, Morocco

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Abstract. Mosquitoes play an important role in the transmission of many diseases as vectors of several pathogens: viral, parasitic, etc. which cause health problems to humans and even animals. The analysis of the specific composition of Culicidae in the different larval sites of the province of Sidi Slimane shows first of all that each habitat has a particular faunistic characteristic. Indeed, six species of the Culicinae family were inventoried during the 2018 hydrological cycle in the different larval sites surveyed: *Culex pipiens*, *Culex hortensis*, *Culex theileri*, *Culex modestus*, *Culex brempiti*, *Culex laticinctus*. The geographical distribution of these species differs according to the requirements of each species. The physico-chemical, pedological, faunistic, floristic... etc. parameters of each environment play an important role in the biodiversity of this fauna, which explains the differences in specific richness of each larval biotope.

1 Introduction

Mosquitoes play an important role in the transmission of many diseases as vectors of several pathogenic germs: viruses, parasites, etc. (Becker et al. 2010) [1], may constitute a major public health problem. As a result, several species are among the most important arboviral vectors in the world (Tandina et al. 2018), [2] Jones et al. 2020, [3], such as Chikungunya (Prudhomme et al., 2019) [4] and Zika (Kauffman & Kramer, 2017) [5]. The study of the ecology and geographical distribution of these insects, capable of causing real

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health problems for humans and animals, is essential for the development of an effective control program (Hadji et al. 2014) [6]. In-depth knowledge of the typologies and characteristics of breeding sites, biotic and abiotic factors that determine the behaviors and requirements of these species in their preferred environments ensure the adoption of a better approach to control and orientation of actions by guaranteeing the reduction or elimination of mosquito larvae and their breeding sites. It is in this perspective that this work falls under the main objective of which is to study the biodiversity and the distribution of larvae of the genus *Culex* (Diptera: Culicidae) in the Gharb Region: case of the Province of Sidi Slimane, Morocco. The geographical distribution of these species differs from one lodging to another according to the requirements of each species according to the climatic, physico-chemical, pedological, faunal, floristic parameters, etc. from each environment.

2 Materials and Methods

2.1 Geographic location

The Province of Sidi Slimane, located between 34° 16 North and 5° 55 West, is limited to the north and east by Sidi Kacem Province of (Rabat-Salé-Kénitra region); to the south-east by the Prefecture of Meknes (region of Fez-Meknes); to the south by the Province of Khémisset (Rabat-Salé-Kénitra region) and to the west by the Province of Kénitra (Rabat-Salé-Kénitra region). It covers about 1492 km².

2.2 Population

The Sidi Slimane population is estimated at 320,407 hab. (2014 General Census), with an average density of 192 hab. /Km².

2.3 Administrative division

According to the administrative division of June 2009, the Province of Sidi Slimane is composed of 9 rural communes: Kcebie, Sfafa, Boumaiz, Msaada, Oled Hsin, Dar Belamri, Azghar, Oled Ben Hammadi, Amer Chamalia and two urban communes (or municipalities): Sidi Slimane, its chieflocation, and Sidi Yahya of Gharb (Figure 1).

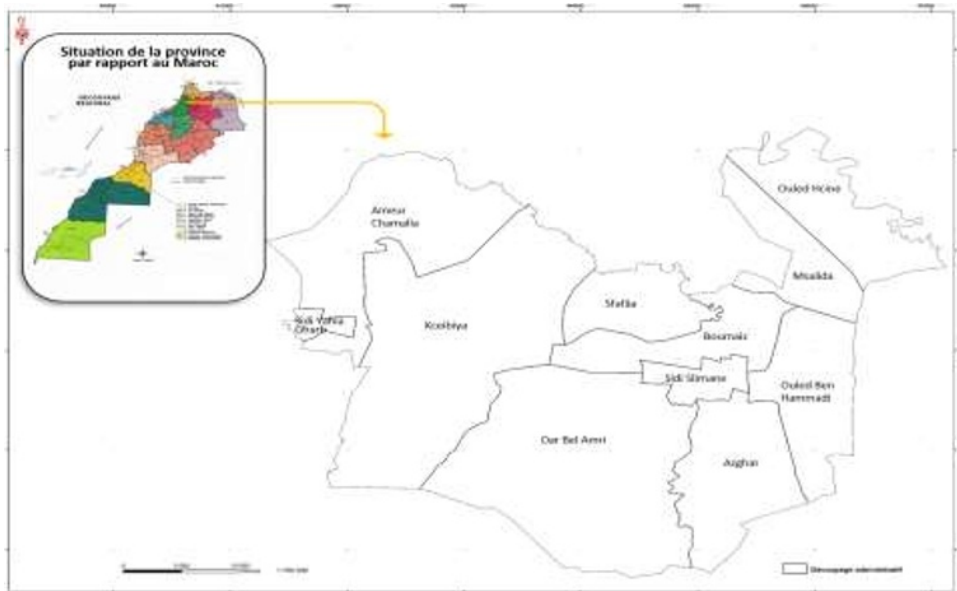


Fig. 1. Map of the Province of Sidi Slimane and its location in the map of Morocco. Source: Province of Sidi Slimane, Ministry of the Interior (Urban Planning and Environment Division).

2.4 The larval deposits prospecting

For locating the preferred egg-laying sites of the Anopheles, it is essential to investigate systematically all the places that can serve as larval lodgings, even those that are difficult to access. The choice of stations was made taking into account both the proximity and the distance of the urban agglomerations of the larval deposits, the different types of aquatic environments (seguias, merjas, dayas, oueds, wells, etc.), the epidemiological history of the location of the larval roosts, etc.

2.5 The larval fishery

Larval samples are taken using a 0.1 mm mesh-free plankton net, or a rectangular plastic tray with a white background, and place them in a tray filled with water, then remove them with an entomological pipette and store them in a tube that contain alcohol at 70° [7], bearing the name of the deposit and the date of sampling. For the shallow environments, a plankton net with 200 µm mesh opening and 40 cm in diameter is dragged in many places at each station to have a representative sample. This capture method has been adopted by several authors ([8]; [9]; 10]). For locating the preferred egg-laying sites of the Anopheles, it is essential to investigate systematically all places that can serve as larval roosts, even those that are difficult to access. The choice of stations was realized according to the same considerations described during the prospection of larval gites.

Culicidae at different larval stages were collected from different locations in Sidi Slimane Province (Morocco) during the 2018 hydrological cycle. As a result, sampling is realized at specific intervals, during the favors climatic conditions for species sampling by two larval fisheries per month for the sentinel roosts and once per month for the other roosts. Subsequently, the examinations and identification of the harvested species were realized at the Laboratory of Biology and Health: Environment and Parasitology Team of the Faculty of Science of Kenitra (Morocco). Species identification was performed under a microscope

on basis of the morphological characteristics [11], using the key for determining Mediterranean African culicidae: Institute of Development and Research ([12]; [13]), a new computer-assisted identification tool.

3 Results

The faunistic inventory of the subfamily Culicinae (Diptera) is composed of six species of the genus *Culex* which has an important medical and veterinary role. Indeed, the Table 1 shows the distribution of these six species in seven larval gites in the study area. The biological diversity in species shows a specific richness that varies from one environment to another in the different biotopes surveyed, depending on various parameters that influence their distribution.

3.1 Presentation of the results of the larval harvest and the spatial distribution of culex species in the study area

This study allowed us to identify six species of Culicidae of the *Culex* genus, which *Culex pipiens* specie is the best represented and the most frequent. It is encountered in effect in all the lodgings of different natures with a total of 345 individuals, equable a frequency of 44.33%. It is followed by *Culex modestus* with 170 individuals (a frequency of 21.80%), followed by *Culex hortensis* with 98 individuals (a frequency of 12.57%), and *Culex theileri* with 86 individuals (a frequency of 11.02%). These species can be considered as the most dominant species in our study area (Table 1). On the other hand, the two species *Culex laticinctus* with 42 individuals, (a frequency of 5.38%), and *Culex impudicus* with a number of 39 individuals (a frequency of 5%), are considered to be the least abundant species in the study region.

Table 1. The percentage of species identified in the study area.

<i>Family</i>	<i>Genus</i>	<i>Specie</i>	<i>Number of identified specie</i>	<i>Percentage %</i>
Culicidae	Culex	<i>Culex pipiens</i>	345	44,23
		<i>Culex laticinctus</i>	42	5,38
		<i>Culex modestus</i>	170	21,80
		<i>Culex theileri</i>	86	11,02
		<i>Culex hortensis</i>	98	12,57
		<i>Culex impudicus</i>	39	05
	Total	06	780	100 %

The distribution of larvae of the genus *Culex* in the province of Sidi Slimane is very variable and depends on several factors. Indeed, during the rainy season, we attest to a high abundance of the genus *Culex* due to the high number of larval gites, especially in temporary nature. On the other hand, in the dry season the number of roosts decreases by the drying up of temporary roosts. About the spatial distribution of the culicidian species identified, we note, of course, that the *Culex pipiens* specie reigns by colonizing all the larval gites surveyed (100%). The *Culex modestus* specie colonizes 71.43% of the larval

gites subject to study. These two last species largely dominate the geographical area studied. Three other species, *Culex theileri*, *Culex hortensis* and *Culex laticinctus* moderately colonize the larval gites with respective distribution rates of 51.14%, 51.14%, and 42.86%. The *Culex impudicus* specie represents only a minim part of the culicidian population colonizing the larval gites in question, with a distribution rate hardly exceeding 14.29%. It is therefore a less frequent specie in the larval gites surveyed (Table 2).

Table 2. Distribution of prospected species in the study stations. (G : Sidi Haggouch, G2: Soualem , G3: Dar Gueddari , G4: Dar Belamri, G5: Laabiat , G6: Larmoud, G7: Kceibia)

Gîtes	G1	G2	G3	G4	G5	G6	G7
<i>Espèces</i>							
<i>Culex pipiens</i>	+	+	+	+	+	+	+
<i>Culex laticinctus</i>	+	-	-	-	+	-	+
<i>Culex modestus</i>	+	+	-	+	-	+	+
<i>Culex theileri</i>	+	+	-	-	+	+	-
<i>Culex hortensis</i>	+	-	+	-	+	-	+
<i>Culex impudicus</i>	-	-	+	-	-	-	-

3.2 Specific richness

It is a parameter that presents the total number of species recorded in the various stations surveyed during the study period (Table 2, Figure 2). This richness varies from one biotope to another. Indeed, the Sidi Haggouch gite has a higher specific richness equal to 6 corresponding to a percentage of 21%, followed by Soualem gite with a specific richness of 5 having a percentage of 18%, the Kceibia and Laabiat gites present an average specific richness of 4 with a percentage of 14% and finally the Dar Gueddari, Dar Belamri, Larmoud gites with a low specific richness of 3 with a percentage of 11%.

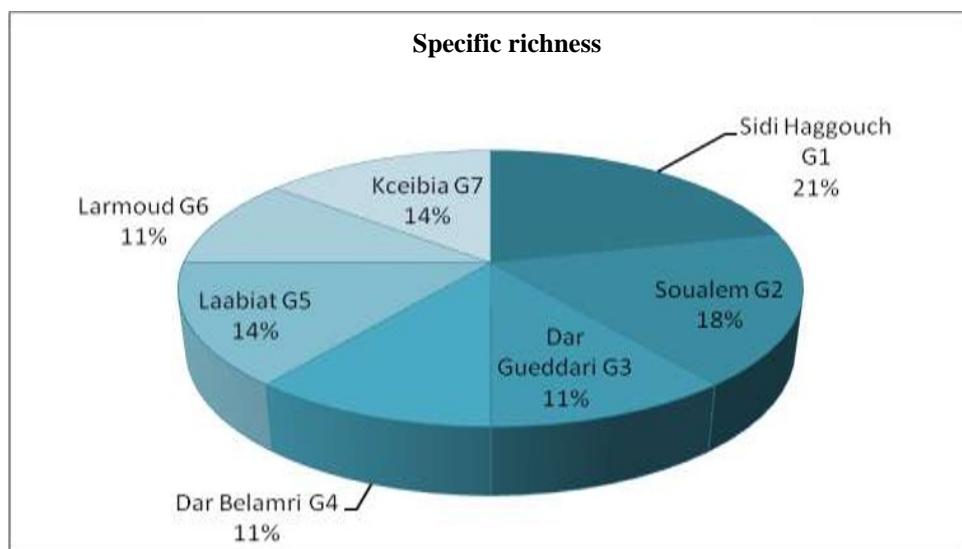


Fig. 2. The variation in specific richness in the larval gites surveyed.

4 Discussion

The six inventoried species: *Culex pipiens*, *Culex hortensis*, *Culex theileri*, *Culex modestus*, *Culex brempiti* and *Culex laticinctus*, in the different biotopes prospected of the study area in the North West of Morocco are consistent with the Culicidian fauna inventoried by Aïssaoui [14] in the Tébessa region of Algeria. The *Culex pipiens* species seems very abundant and dominant in the study area, so the different populating studied are largely dominated by this specie. These results confirm those found by Hadji et al., [13]. It is present in almost all surveyed environments and throughout the year [15]. Hassaine [16] classified *Culex pipiens* among the species with a very wide distribution in Mediterranean Africa. *Culex modestus* is strongly present in the study area. This result contradicts those of Himmi [15]. However, the three other species *Culex theileri*, *Culex hortensis* and *Culex laticinctus* are moderately present in the sites surveyed. These species have certain requirements as to the environment to be colonized. These results are agree with those of Hadji et al., [17]. *Culex impudicus* is the least represented specie in the study area. It is reported by Himmi [15] as a specie that develops in very various environments, but generally in clear and fresh water. Moreover, this mosquito has a predilection for shady gites.

5 Conclusion

The Culicidian fauna of the province of Sidi Slimane is very diversified. We inventoried six species of the genus *Culex*: *Culex pipiens*, *Culex hortensis*, *Culex theileri*, *Culex modestus*, *Culex brempiti*, and *Culex laticinctus*. *Culex pipiens* is widely represented in the study area, inventoried in all prospected gites concerned by this study. It is a ubiquitous species and adapts to all environments. The other species are very localized at the level of a few surveyed localities. *Culex pipiens*, *Culex hortensis*, *Culex modestus*, *Culex laticinctus* and *Culex theileri* are present and more associated with other species inventoried in the various gites. The specific richness varies from one biotope to another according to the requirements of each prospected species. In general, the periods of activity of the culicidian species are attached either to the impoundment by the rains (case of the species which attain their maximum abundance in autumn-winter), or to the temperature which induces a warming of the waters of the species colonizing the shallow and more hot (case of species which attain their maximum abundance in spring-summer).

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