Bioecology of Culicidae (Diptera; Nematocera) of Taksebt dam of Tizi-Ouzou (Algeria)

1Lounaci Z., 2Doumandji S., 2Doumandji- Mitiche B., 1Taguemout M.

1Department of Agronomy, University of Mouloud Mammeri, PB15000 Tizi Ouzou, Algeria.
2Department of Agricultural and Forest Zoology, Upper Agronomical National School, El Harrach., Algeria. Avenue Hassan Badi-El Harrach, Algeria.

Address For Correspondence:
LOUNACI, Zohra, Department of Agronomy, University of Mouloud Mammeri, Tizi Ouzou, Algeria. Phone: +213 774015595; E-mail: New.lounaci@yahoo.fr; Postal: Street Segna, 16112, Reghaia, Bt & Aprt. 23, Algiers, Algeria.

This work is licensed under the Creative Commons Attribution International License (CC BY).
http://creativecommons.org/licenses/by/4.0/

Received 12 July 2016; Accepted 18 September 2016; Available online 22 September 2016

ABSTRACT

Background: The Culicidae’s bioecological study is performed from April to August 2014 at Taksebt dam (Tizi-Ouzou). Whose it is considered as a protected area of national importance. It is gathering in fact favourable conditions in settlement and multiplication of terrestrial and aquatic insects and to maintaining wild mammals. As result to this remarkable diversity. Its biological functions confer on this potential wetland a capacity to be produced and nourish living matter and to become a tank of the biodiversity. Three natural sites have been selected as stations and are the study object of their mosquitoes larvae population (upstream, near the dam’s dike and downstream of the dam Taksebt). Capture of Culicidae larvae is made by use of a stringer net. Objective: It is underway that not much works have been conducted on richness of Diptera Culicidae among Entomofauna settling humid ecosystems such as the dam Taksebt of Tizi Ouzou in Algeria. So, the choice of the present work is made in view of Culicidae species importance within present anthropod fauna at level of Taksebt dam. Their identification and study of their bio ecology are essential, to guide and to refine preventive fight method such as surveillance of larval habitats of pathogenic vectors agent’s species. Results: Eight species belonging to two sub-families are identified; it is about Anopheles labranchiae, Culex hortensis, Culex impudicus, Culex theileri, Culex peregrinus, Culiseta longiareolata, Aedes caspius and Aedes vexans. This study allows us to specify the distinctive morphological characters of species harvested at the larval stage. In terms of number by species and by station, it should be noted that Culex hortensis is strongly present in upstream, and in downstream of the dam with respectively 419 individuals (65%) and 356 individuals (97%). These two environments represent breeding sites the most favourable to larvae. By contrast, in the centre of the dam, Culex impudicus is the first place with a number of 39 individuals (65%). The populations dynamics of Culex hortensis revealed that species is developing in summer and seems to follow a classic thermophilic trend. Conclusion: Based upon behavior and ecology of the identified mosquito species, studied various sites of the Taksebt Dam of Tizi Ouzou seem to provide a suitable environment and breeding sites for the proliferation of the species of Culicidae in particular Anopheles labranchiae potential vectors of arbovirus and those being a problem of real nuisance for the close inhabitants.

KEYWORDS: Bioecology, Culicidae, Taksebt dam; population’s dynamics.

INTRODUCTION

In Algeria, Culicidae constitute the biting insects the most harmful to populations, some species may transmit infectious diseases (malaria particularly). Regular anti-mosquito campaigns are being conducted against these insects to reduce their nuisance at level of urban and rural centres. Efficiency of such struggle whether chemical or biological, is dependent of ecology knowledge of these insects. It is a fact that undeniable success are obtained against numerous outbreaks of malaria. However, it should be emphasised that malaria has not vanished from Mediterranean Africa, which remains at hypo-endemic status and may reoccur at any time under its epidemic form under influence of climatic circumstances favouring anopheline development [46, 25, 23]. Furthermore, it would be appropriate to monitor not only the possible arrival of new vectors as Aedes albopictus which has been recently established in Europe and in the major countries of Mediterranean Basin [31, 1, 43, 65, 49, 67] including...
Algeria in North-Africa [37]. It should also be pointed out the introduction of new pathogenic agents such as West Nile virus, which is regularly circulating on the Mediterranean littoral which one of vectors is Culex pipiens [22, 56, 5, 19]. Europe is also at risk of introduction of mosquito-borne alphavirus from Americas [16], and Arboviruses particularly dengue, chikungunya, and Zika viruses, transmitted by the yellow fever mosquito, Aedes aegypti [32, 2]. This rapid global spread was favored by international trade, especially of used tyres, and by its physio-local and ecological plasticity, which allow the species to thrive in a wide range of climates and habitats [67]. Other mosquitoes pathogenic agent’s vectors are a real scourge by their painful and annoying bites constitute in fact a nuisance problem [10, 33]. It is within this context that initiation of mosquito’s study in the region is a necessary prerequisite towards a more general study. In Algeria, ecological studies on Culicidae remain fragmentary [34, 33, 11] because it concerns above all systematic and morphometrics [6, 8, 14, 13, 44, 9, 35, 57, 59], biology and chemical struggle [51, 52, 7, 6, 15] with this in mind that involves our study on Culicidae of Taksebt’s dam which constitutes an ecosystem whose objective is:

- to take an inventory of Culicidae species present in this humid area; and determine biodiversity
- to study seasonal dynamics of preimaginal population (larvae and nymphs) of the main Culex hortensis species.

This bioecological study constitutes an essential contribution to all reasoned action in species preservation, environments and preventing against Culicidae nuisance and vector-borne diseases.

**MATERIAL AND METHODS**

**Study sites:**

The present study took place in 2014 in Taksebt’s dam (36° 24’ 15”N; 4° 45’ 46”E). The dam is located on Oued Aissi of approx. 10 km south-east of Tizi-Ouzou town (Fig 1). The whole site presents a capacity of 175 millions of m3 that is spreading on a surface of 550 hectares. It is fed by rain water and the melting snowpack of Djurdjura. Oued Assi comes down from Djurdjura Massif, generally towards North-South direction until its confluence into Oued Sebaou. This last one in turn flows into the Mediterranean. This region belongs to subhumid bioclimatic stage with temperate winter according to data of 1998 to 2013. The annual rainfall is of 808 mm. They are generally spreading from October to April with peaks in December, January and February.
Culicidae fauna monitoring was performed with help of 15 serial samplings made at intervals of 8 days on duration of 4 months (May to August 2014). Three epigeous sites (in the open air) are retained as stations and are subject of study of their mosquitoes larvae populations; their choice is supported on representativeness of Culicidae larvae in a productive sites batch, accessibility, sustainability and no treatment by chemical product. (Fig. 1 and 2):

Station I:
- is located on the upstream side of the dike (36°40’12.39”N; 4° 6’51.44”E) at about 800 m to South of the dike where small ponds are formed due to the water level decrease of the dam. This site is surrounded by trees layer composed essentially of *Populus nigra*, *populous alba* and *Nerium oleander* (Fig. 2a).

Station II:
- is located near the dam’s dike36°40’31.24”N;4° 6’57.93”E). Three vegetative strata: herbaceous, shrubby and tree are present (Fig. 2b).

Station III:
- is located on the downstream of Taksebt’s dam (36°40’50.34”N, 4° 7’0.67”E). It is constituted of waters coming from dam’s overflow that form small ponds. This station is rich in dense vegetation composed of *Asphodelus microcarpus*, of *Juncus acutus* and of *Typha angustifolia* (Fig. 2c).

Fig. 2: Station of Taksebt’s dam. a: Upstream of the dam, b: near the dam’s dike, c: downstream of the dam (Lounaci, 2014).

Sampling technique of Culicidae populations:
Sampling of preimaginal stages (larval) have been made according to the technique of dipping (dipper blow) [54, 62, 48, 21]. The dipper of known capacity (c=1l) is put into water, then moved with care avoiding to make turmoil. Ten blows of dipper are therefore made in different spots of the site with a space of 1 m. In laboratory; larvae are selected by species, by stages and counted. For determination of those ones, we consulted works of [53, 57, 58]. This one-time study has also been facilitated by use of identification software of Culicidae of Mediterranean Africa performed by [18].

Ecological index:
Results obtained on bioecology of Culicidae in Taksebt’s dam are treated by ecological index. The specific richness in species (S) the relative abundance expressed in percentage ((pi = ni x 100/N is the ratio of individuals number of Culicidae species ni to total number of individuals of all species inventoried N is frequency of occurrence (constancy) of species in each of the study stations. Constancy (C) is calculated with index C = P x 100 /N, where P is the number collected containing species studied and N is the total number of collections made [27, 50]. In each site studied, diversity index of Shannon-Weaver (H’) is the fairness (F) are calculated. The first, H'=−∑ᵢ₌₁ᵢ₌₃piLog₂pi where pi = ni /N is the relative frequency of individuals category according to i. is used to measure and evaluate diversity of mosquito species for each of the three study stations. Equitability (E) = H’/ H’max (where H’max =log2S) was calculated to measure the distribution of individuals within species irrespective of species richness. It varies from 0, if only one species dominates, to 1, if all species show similar abundance [60].

Results:
In total 1062 larvae of Cuticidae are inventoried on 2014 in Taksebt’s dam (tab 1). Morphological identifications show presence of 8 species belonging to two sub-families: Anophelinae and Culicinae. Among captured species in all stations, *Culex hortensis* (72, 98%) and *Culiseta longiareolata* (19, 68 %) are the most abundant
On upstream of the dam, 636 Culicidae individuals spread between 4 species are captured (Table 1). *Culex hortensis*, species batracophile is strongly dominant (65.88%) (Fig. 3). In this environment, this species is omnipresent. *Culiseta longiareolata*, ornithophilous species comes in second rank with a rate of 32.39%.

On the dike, 60 individuals spread between six species are inventoried (Table 1). *Culex impudicus* predominates with a percentage of 65% (Fig.4), followed by *Anopheles labranchiae* (13.33%) and *Aedes caspius* (11.66%). The occurrence frequency of *Culex impudicus* is of 26.66%, and this makes it as accessory specie class, and between 6.66% and 13.33% for other species which are accidental.

---

**Table 1**: relative abundance, RA%; frequency occurrence (constancy), Co; of Culicidae larvae per sampling station in 2014 in Taksebt’s dam

<table>
<thead>
<tr>
<th>Species</th>
<th>Station I: Upstream of the dam</th>
<th>Station II: near the dam’s dike</th>
<th>Station III: downstream of the dam</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ni</td>
<td>A.R.%</td>
<td>F.O.%</td>
</tr>
<tr>
<td>Anopheles labranchiae</td>
<td>8</td>
<td>13,33</td>
<td>6,66</td>
</tr>
<tr>
<td>Aedes caspius</td>
<td>7</td>
<td>11,66</td>
<td>13,33</td>
</tr>
<tr>
<td>Aedes vexans</td>
<td>1</td>
<td>1,67</td>
<td>6,66</td>
</tr>
<tr>
<td>Culex hortensis</td>
<td>419</td>
<td>65,88</td>
<td>93,33</td>
</tr>
<tr>
<td>Culex perexiguus</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Culex theileri</td>
<td>5</td>
<td>0,79</td>
<td>6,66</td>
</tr>
<tr>
<td>Culex impudicus</td>
<td>6</td>
<td>0,94</td>
<td>13,33</td>
</tr>
<tr>
<td>Culiseta longiareolata</td>
<td>206</td>
<td>32,39</td>
<td>20</td>
</tr>
<tr>
<td>Totals</td>
<td>636</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

(A): Accidental; (Ac): Accessory ; (O): Omnipresent.

---

**Fig. 3**: Relative abundance of Culicidae species inventoried upstream of the Taksebt’s dam.
Fig. 4: Relative abundance (R.A. %) of Culicidae species inventoried near the dike of Taksebt’s dam.
Downstream of the dam 366 individuals belonging to three species are inventoried (Table 1). *Culex hortensis* (97.2%) remains the dominant species; (Fig 5). This last one, qualified as a constant, presents an occurrence frequency of 86.66%. *Culex impudicus* (F.O=20%) and *Culiseta longiareolata* (F.O=13.33%) are accidental.

Fig. 5: Relative abundance (R.A.%) of Culicidae species inventoried upstream of the Taksebt’s dam.

The taxonomic diversity differs according to stations (table 2). The specific richness and diversity index of Shannon-Weaver are higher in the stations I and II corresponding to the proximity of the dike and upstream of Taksebt’s dam with $S = 6$, $H' = 1.61$ bits and $S = 4$, $H' = 1.04$ bits respectively. In fact, fairness is higher in both stations expressing a trend towards balance between present species number (Table 1).

Table 2: Specific richness, $S$ : and diversity index (Shannon–Wiener diversity, $H'$; Equitability ,$E$) of Culicidae’s larvae per station in 2014 in Taksebt’s dam.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Stations</th>
<th>Upstream of the dam</th>
<th>near the dam’s dike</th>
<th>downstream of the dam</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S$</td>
<td>4</td>
<td>6</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>$H'$ (bits)</td>
<td>1.04</td>
<td>1.61</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>$H'$ max ( bits)</td>
<td>2</td>
<td>2.58</td>
<td>1.58</td>
<td></td>
</tr>
<tr>
<td>$E$</td>
<td>0.52</td>
<td>0.62</td>
<td>0.13</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 6 presents seasonal dynamics of *Cx. hortensis* upstream of Taksebt’s dam on period from May to August 2014. The choice of this species is justified by its dominance in our study region with a population of 775 individuals, being 72, 97% of the total number. The monitoring of the seasonal dynamics of *Cx. hortensis* shows in the beginning of May, population is composed of larvae L1, L2 and L3. Presence of young larvae testifies that an outbreak occurred and coincided with the first temperatures rise. Then a progressive population increase is remarked, so no individual of *Cx. hortensis* is captured at the end of the study period.
8 species of Culicidae, among 48 listed in Algeria [17] have been harvested during our prospecting in North Algeria region. This richness resides in biotopes diversity offered to the development of Culicidae. In Taksebt’s dam of Tizi-Ouzou, it is the Gender of Culex which respectively constitutes 87% of the harvesting.

From the 3 study’s stations, it is the station II located near the dike of Taksebt’s dam which welcomes the highest number of species of Culicidae with relative abundance equal to 75% against 50% and 37% for upstream and downstream of the dam. Needless to say that dam is richer in different sites with dense and diversified vegetal cover composed essentially of Typha angustifolia and Olea europaea.

In Taksebt’s dam of Tizi-Ouzou, Culex hortensis (65, 88%) presents the bulk of catches. Females of Cx. hortensis, feed particularly on amphibians and reptiles [68]. This species has never been involved in pathogenic transmission for human [56]. Larvae of this species may occupy natural sites such as ponds or marshes and so artificial environment such as throughs and irrigation basins [66, 16]. By using the same sampling technique [40, 12] have identified in swamp of Reghaia 7 species of Culicidae, these are: An. Labranchiae, Cx. pipiens, Cx. mimeticus, Cx. perexiguus, Cx. impudicus, Cx. longiareolata and Uranotaenia unguiculata. [39] noted that Cx. pipiens, (58,48 %) and Cs. longiareolata, (39,5 %) are the most abundant in this environment. These two species occupy as well natural environment than artificial and they are frequently associated to human activities. [17] have classified these two species among ones with larger distribution at level of Mediterranean Africa. [3] report that artificial larval habitats can be colonized by a great diversity of species and high abundance as well, and human artifacts left by the public area collecting water may favor increased mosquito populations. In the North-East of Algeria, 13 mosquito species have been inventoried by [14] in region of Collo. These authors report that maximal frequency of Cx. pipiens in humid sub-humid stages with mild winter and totals more than 50% of Culicidae fauna captured. [44] have inventoried over period of ten months, 12 species of Culicidae in region of Mila. In this locality belonging to semi-arid bioclimatic stages, Cx. pipiens (61, 14 %) and Cx. longiareolata (15, 06%) are the most abundant. By contrast, in the same bioclimatic stage of Constantine region, only six species of Culicidae are identified on a period of two years [10]. This author underlines dominance of Cx. pipiens in different urban environments (R.A = 99%) peri urban (R.A = 98%). In the North-West of Algeria (Tlemcen), [33] noted on the same sampling period, presence of 20 Culicidae species belonging to two sub-families: Anophelinae and Culicinae in different natural and artificial sites. Cx. pipiens (22, 26 %) take the first rank of captures. In Highlands (Tebessa) of arid bioclimatic stage, works of [13] allowed identifying 9 species of Culicidae belonging to sub-family of Culicinae whose species quoted above constitute the essential of harvest with 62, 01% and 32, 57 % respectively. Few larvae specimens of An. labranchiae are captured only in the center of Taksebt’s dam (13%). Recent data show population expansion of this potential vector of Plasmodium falciparum (Haemosporida : Plasmodiidae) in Maghreb particularly in Morocco [45, 46, 20, 36, 25, 23, 24]. These authors demonstrate its adaptation in artificial sites (rice-farming) and occupy as well oueds and swampy areas. In this study, the seasonal dynamics of Cx. hortensis follows a classic thermophilic trend, larvae of first stages 11 and 12 of Cx. hortensis have been found from the first sampling made on 5 May 2014, and we noted absence of nymphs. What is all goes to say, it is about larvae of a new generation. The outbreaks are multiplying in this site, to record a peak on 7th July with a population of 89 individuals, which is coinciding with temperatures increases (Fig 3). All environmental warming may influence the development cycle of numerous aquatic insects, notably Culicidae [38, 30, 55]. Then, population gradually decreases with individual’s dominance of larval development of the last stages (L3, L4 and nymph), to record at last zero values of Cx. hortensis’s individuals in sampling of 16 and 24 August.
due to raising of temperature generating therefore, an intense water evaporation, and consequently a drop in water level and to the drying of the sites. Temperature can favour preimaginal population development of *Cx. hortensis* because in sites of Taksebt’s dam, the highest larvae populations are observed from May (Fig 3). [28, 64.] report that temperature and food quantity intervene in regulation process of the larvae development speed of *Ae. caspius*. So the spring period is associated to a strong proliferation of preimaginal stages. Several studies demonstrate that high temperatures seem to favour abundance of mosquito larvae and to reduce their development time, particularly larvae of *Culex* species [29]. According to [11], larval development is faster when water temperature increases. It determines *Cx. pipiens* larva’s development speed acting principally on larval evolution duration and to a lesser degree on nymphal evolution duration. [4] reports that larval development of *Ae. aegypti* is soaked not only by low temperatures, but also by high temperatures. That is explaining shortage (decrease) of *Cx. hortensis*’s larval number from end of July and also their absence in August. According to [38, 30, 26, 41], Any warming or cooling of the environment can disturb development cycle of several aquatic insects notably in Culicidae. Furthermore [63] underlines in addition of ecological factors influence on larval development, there are pregnant females’ attractiveness according to a site that may explain presence of larval stages. According to [62] oviposition is determined by the site’s structure which can be easy access for females.

**Conclusion:**
Biocological study of Culicidae in Taksebt’s dam of Tizi-Ouzou is based on dipping technique use, during a period of 4 months going from 5th May to 28 August 2014. Eight species, belonging to two sub-families are identified. Those one of Anopheleinae with a single species, in this case *An. labranchiae*: potential causal agent of malaria and those one of Culicinae with seven species; these are *Cx. hortensis, Cx. impudicus, Cx. theileri, Cx. perexigua, Cx. longiareolata, Ae. vexans* (virus vector of Tahyna), and at last *Ae. caspius*. Medical entomologist and veterinarian think that these are the main vector of infectious diseases, quoting West Nil virus, which is transmitted, to human by *Ae. caspius*. From the 3 study’s stations, it is the station II located near the dike of Taksebt’s dam which welcomes the highest number of species of Culicidae. In terms of number by species and by station, it should be noted that *Cx. hortensis* is strongly present in upstream, and in downstream of the dam. One-time study carried out on population of *Cx. hortensis* is based on the monitoring of variation in time and space of immature stages. So, larval number is relatively high in sites bordered by diversified vegetation. Population explosion provoked by positive climate conditions in May and June allows to this species to settle study sites. In summer period, from end of July, absence of larvae in the site would be due to a temporary nature of these environments. In an additional study, other sampling techniques for mature stage capture are taken into account. However, it is important to further studies on inventory, taxonomy and ecology of these organisms for year-round in order to cover all seasons and being able to detect period of these mosquitoes’ intense proliferations. Also it should be necessary to extend the study towards other regions, particularly on species with high transmission risk or having origin of intense nuisance. That should allow us to put in place, permanently, the appropriate means to fight and to control their populations. This issue is important because it concerns public health. We need to bring attention on risk of vector agents’ arrival carrying exotic diseases from African Sahel and this is due to the global warming. The whole information should obviously be reinforced by new studies on the ground, with particularly a more detailed analysis about determinism of some processes; already would give an image on spatio-temporal distribution of Culicidae species. This information is likely to be used in fighting organisation against these vectors.

**ACKNOWLEDGEMENTS**

We heartily thank all the staff of Hydraulic Service Department of Wilaya Tizi-Ouzou for their collaboration on the ground. The collection of Culicidae would not be possible without their assistance.

**Contributions to knowledge Subject:**
This study contributes to the knowledge of Culicidae fauna of the wetlands which present a context particularly favorable to the developments of certain transmissible vectorial diseases. This study put the point on the remarkable richness, abundance, the diversity and the monthly fluctuation of Culicidae in one of these zones (Dam Taksebt Algeria) subjected to considerable ecological upheavals. This with a view to put at the disposal of actors of fight against the diseases transmitted by the mosquitoes adatabase reliable and brought up to date necessary for planning, the follow-up and the evaluation of antivectoriel operations of fight.

**REFERENCES**


