



Place of Diptera in the Sahara wetlands of Algeria (Ouargla, Northern Sahara)

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Abstract

The present study focuses on the inventory of the dipterian fauna of four wetlands in the Ouargla region (Northern Sahara, Algeria). These are the lake of Hassi Ben Abdallah, Sebkhath Sefioune lake, Chott Ain El Beida and the palm grove of the ksar (oasis). For a systematic inventory of species, different techniques are used. This inventory reveals a dipterian fauna that is rich in 106 species divided into 43 families. The family Ephydriidae is indeed the best represented, with 14 species (47.6%). It is followed by the Dolichopodidae with 14 species (13.9%) with the dominance of the species *Asyndetus appendiculatus* (10.1%). In the lake of Hassi Ben Abdallah, 81 species of Diptera are inventoried, they are distributed among 35 families. In Sebkhath Sefioune and during the 12 months, 60 species were inventoried, distributed in 30 families. On the other hand, in the Chott Ain El Beida, 27 species were caught. They are distributed among 15 families. In the ksar palm grove, 38 species were recorded, distributed in 22 families. It is noted that 17 species are common to the four wetlands in the Ouargla region. However, 27 species are only found at the level of the lake of Hassi Ben Abdallah, with 14 species caught only at lake Sebkhath Sefioune and 9 species of Diptera are specific to the ksar palm grove. It should be noted that no specific species were reported at Chott Ain El Beida. The latter is the least diversified station. The ksar palm grove is the most balanced environment in terms of families and dipterian species compared to the other stations. The lake of Hassi Ben Abdallah has the most species.

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Introduction

Diptera is one of the most numerically important orders of the insect class (Duvallet *et al.*, 2017). Diptera is cosmopolitan by their distribution, they are commonly united in the same hostility, that of the inappropriate insects, unclean, dangerous by their contact and their bite. Indeed, many species play an active role in the transmission of diseases, which can be mild, severe, or even deadly. Their knowledge and identifications are indispensable for physicians, ecologists, hygienists, zoologists and entomologists (Séguy, 1924). Medical and veterinary entomology considers that Diptera, especially hematophagi, are the main vectors of infectious diseases, such as malaria, which is transmitted to humans by a dozen culicids. In spite of the unpleasantness and of certain species, most play an important ecological role, not only do they participate in the elimination of excreta (coprophagous species) but also of cadavers (species saprophages). Aquatic species account for more than 10% of the fish diet (Fontaine *et al.* 1976).

Some families of Diptera (Chironomidae) have a positive ecological role both in the larval and in the aquatic environment the adult state (Dejoux, 1981). They are an abundant source of energy for many species of predators, in both aquatic and terrestrial environments. They are detritus feeders which intervene in the chain of saprophages and also play a considerable role in the functioning of aquatic ecosystems. of stagnant water, immature stages are eaten by insects (dragonfly larvae, dytic larvae), and fish, adults are preyed upon by insects, amphibians, reptiles, birds and bats (Coldrey and Bernard, 1999; Bourassa, 2000). Algeria has several wetlands, which are among the most precious resources in terms of biological diversity and natural productivity (Boumezbeur, 2004). The wetlands are an important habitat for the fauna in the Sahara, particularly the Diptera. At the same time, the palm grove is an integral part of the Saharan ecosystem and constitutes an ideal environment for the protection of insects of ecological, agronomic and economic interest (Munier, 1973). The richness and dipterian diversity that can be found in the Saharan regions of

Algeria has been the subject of research work by some authors such as Boukraa *et al.* (2011), who studied the populations of sandflies, vectors of the agents responsible for leishmaniasis in the region of M'Zab (Ghardaïa). Merabti (2015), interested in the composition and structure of Culicid populations in the Biskra region. Chennouf *et al.* (2017) and Chennouf (2018), study arthropodological fauna in the Hassi Ben Abdallah and Sebkhath Sefioune lakes in the Ouargla region.

Materials and methods

Choice of stations

The region of Ouargla (31°58' N., 5° 20' E.) is located in the southeast of Algeria, 800 km from the capital Algiers. The Ouargla region is characterized by a particularly contrasted climate despite the relatively northern latitude (Rouvillois Brigol, 1975). Aridity is expressed not only by high summer temperatures and low rainfall but also by the high evaporation due to dry air (Ould El Hadj, 2002).

The dry period lasts all year round. In the framework of this research, we have chosen four wetlands, the lake of Hassi Ben Abdallah, the lake of Sebkhath Sefioune, the Chott Ain El Beida and a palm grove of the l'ksar (oasis).

Lake of Hassi Ben Abdallah: The lake of Hassi Ben Abdallah has an area of 10 ha and a maximum depth of 4.7 meters. It is located west of the commune of Hassi Ben Abdallah at a distance of 1 km from the national road linking the communes of Sidi Khouiled to Hassi Ben Abdallah.

The waters of the lake originally come from the water table of the Ouargla basin, but also the drainage waters of the Ouargla basin (B.H.S., 2015).

Lake Sebkhath Sefioune: The lake of Sebkhath Sefioune is at an altitude of 129 m. It is located north of the Ouargla oasis at 52 km. In the recent past, this area has been dry. It is from November 2009 that drainage water from the city of Ouargla was diverted to Sebkhath Sefioune (Bouchibi Baaziz *et al.*, 2010).

Chott Ain El Beida: The Chott Ain El Beida is located not far from the city of Ouargla at 8 Km. It is sandwiched between the palm grove of Ouargla to the west and south, the palm grove of Ain El Beida to the east and it opens on northern dune formations. It should be remembered that this Chott is a Saline depression whose flooded part is constituted by the Sebkha, with a surface of 6853 ha. Stretching in a north-western, south-eastern direction over a length of 5.3 km, its width varies from 01 to 1.5 km. It is traversed by a network of drains that channel the excess water from the palm grove of Ouargla. In 2004, the Chott d'Ain El-Beida, is classified in the list of the convention international Ramsar Convention, to protect the rich fauna and flora of this area (TAD, 2004).

Ksar palm grove: It is a palm grove with an unorganized plantation, located 1 km northeast of the city of Ouargla. It covers an area of 7 ha. It is characterized by a plantation of date palm (*Phoenixdactylifera* L). Irrigation is of the submersion type. This palm grove has 153 feet of date palms and fodder crops. It is worth noting the presence of drains in the palm grove.

Qualitative inventory

The sampling of the dipterian fauna (larvae and adults), lasted 12 months, covering all seasons. The monitoring of Diptera is carried out through a series of samples taken in and around the lakes: Hassi Ben Abdallah Lake, Chott de Ain El Beida and Sebkhath Sefioune and at the level of the phoenic environment at intervals of 30 days.

Through a systematic inventory of species, different techniques are used. For trapping Diptera, the Barber jars recommended by Benkhelil (1991) were used. The larvae are caught with cloud nets and submerged nets (Zahradić and Severa, 1988). Light traps allow retaining Diptera when they are brought closer to the light (Benkhelil, 1991). Colored traps (orange, yellow, green and blue) are used to capture adults (Lamotte and Bourliere, 1969), for Diptera on the herbaceous stratum, the mowing net is used (Benkhelil, 1991).

Identification of samples

The trapped species are recovered in pots containing 70° alcohol bearing the number of the trap pot and the date of trapping. At the laboratory level, the samples are examined, determined and counted using a binocular magnifying glass. These samples were brought back to the zoology laboratory of Algiers under the assistance of Professor Marniche Faiza at the National Superior Veterinary School of Algiers for confirmation of the species of diptera. On the basis of dichotomous keys and works let us quote those of Seguy (1923), MC. Alpine *et al.* (1981), Perrier (1983), Mc Alpine *et al.* (1992), Matille (1993), Haupt (2000), McGavin (2000) and Bouchard (2004).

Results

For the present study, 17743 individuals are inventoried. They are divided between 3893 individuals for Lake Hassi Ben Abdallah and 11535 individuals for Lake Sebkhath Sefioune, 1661 individuals at Chott Ain El Beida and 654 individuals in the palm grove. The inventoried species are described and classified, this inventory shows a richness of 106 species divided into 43 families, 31 Brachycera and 12 Nematocera (Table 2).

Among the families, the Ephydriidae family is better represented, with 14 species (47.6%), especially the species *Notiphila* sp. with 17.2%. It is followed by Dolichopodidae with 14 species (13.9%) with the dominance of the species *Asyndetus appendiculatus* (10.1%). The Chironomidae represent 6.6%. The family Culcidae comes in fourth place with 3 species (4.43%). Sphaeroceridae (4.3%); Sarcophagidae (4.05%); Hybotidae (3.8%); Muscidae (3.02%). The other families are poorly represented (Table 2).

For the lake of Hassi Ben Abdallah 81 species of Diptera are inventoried. They are distributed among 35 families. In this area 49.65% of the species belong to the family Ephydriidae, with the species *Notiphila* sp. which remains the best-represented species, it accounts for 26.6%, followed by the species *Hydrellia* sp. (16,2 %). In second place comes the family Dolichopodidae with 25.7%; in this family the species

most represented is the dominant is *Asyndetus appendiculatus* (17.3%), followed by *Dolichopus campestris* (3.9%). The Chironomidae contribute 5.3% (Table 2).

At lake Sebkhat Sefioune and during the study period, 60 species were recorded, divided into 30 families. The family Ephydriidae is the most dominant (73.7%)

of all Diptera captured. In this family, the species *Notiphila* sp. (36.7%) is the most noticed, followed by *Hydrellia* sp. (27.5%). The family Chironomidae comes second with 15.8% and 1819 individuals. The Muscidae family represents 2.8% of the species harvested in the Sebkhat Sefioune lake; these are *Musca domestica* (1.3%) and *Hydrotaea* sp. (1.22%), which are the most dominant (Table 2).

Table 1. Geographic location and types of vegetation found in the four stations in the Ouargla region.

Station	Wetland	Type of plants	Geographical coordinates
Station 1	Lake Hassi Ben Abdallah	<i>Tamarix gallica</i> L.	32° 01'54" N, 5° 44'66" E
		<i>Phragmites communis</i> Trin.	
		<i>Juncus maritimus</i> Lam.	
Station 2	Lake Sebkhat Sefioune	<i>Phragmites communis</i> Trin.	32° 19'16 "N, 5° 22' 6"E
		<i>Sueda fructicosa</i> Forssk.	
		<i>Tamarix gallica</i> L.	
		<i>Halocnemum strobilaceum</i> (Pall.) M. Bieb	
Station 3	Chott Ain El Beida	<i>Halocnemum strobilaceum</i> (Pall.) M. Bieb	31°57'14.3"N, 5°22'13.6"E
		<i>Tamarix gallica</i> L.	
Station 4	Palm grove of l'ksar	<i>Phoenix dactylifera</i> L.	31° 43'57"N, 5° 66'20" E
		<i>Cressacretica</i> L.	
		<i>Sonchus maritimus</i> L.	
		<i>Spergularia salina</i> L.	
		<i>Cynanchum acutum</i> L.	

The inventory of the dipterian fauna at Chott Ain El Beida resulted in the capture of 27 species. They are distributed among 15 families and 2 suborders. The family best represented remains that of Ephydriidae (53.09%) especially these aquatic larvae which are the most dominant (45.6%). The Sarcophagidae contribute by a single species *Sarcophaga* sp. (15.6%). The family Piophilidae represents the 9.09% at Chott Ain El Beida, it is represented only by one species *Piophila* sp. In this wetland, the Dolichopodidae (6.4%) are represented by the species *Hercostomus gracilis* (5.9%) and *Asyndetus appendiculatus* (0.54%). It should be noted that the remaining eight families are poorly represented. For the ksar palm grove, 38 species are listed. They are divided into 22 families. In this oasis, and contrary to the other stations, the family Dolichopodidae is the best represented (23.2%) with the species *Asyndetus appendiculatus* which represent the majority of

individuals caught, that is 146 individuals (22.3%); *Hercostomus gracilis* with 5 individuals (0.76%); and *Chrysotus laesus* with only one individual (0.15%). It should be noted that for the first time species of the family Dolichopodidae are reported in Algeria. In second place comes the Hybotidae with *Platypalpus* sp. (14.7%), followed by the family Culcidae (13.6%) with the species *Culex* sp. (7.6%) and *Anopheles* sp. (5.3%). The family Ephydriidae contributes 13.15% with mainly the species *Notiphila* sp. (3.7%); *Scatella praia* (3.5%); *Ephydra* sp.1 (3.4%). They are followed by Sphaeroceridae and the single species *Leptocera* sp. (11.9%); Syrphidae (6.12%), with a dominance of the species *Eupeodes corollae* (4.6%), followed by *Eristalis aereus* (1.4%). The family Muscidae participates by 3.7%. In this family, the species *Musca domestica* (1.7%) is the most noticed. Drosophilidae (3.06%) are represented by the species *Drosophila bifasciata* (2.5%) (Table 2).

Table 2. The richness and relative abundance of Diptera species inventoried at each of the study stations.

Famille	Espèce	Code	S1		S2		S3		S4		
			Nb.	AR%	Nb.	AR%	Nb.	AR%	Nb.	AR%	
Ephydriidae	<i>Ochthera mantis</i> (De Geer, 1776)	Sp 1	-	-	1	0,01	-	-	-	-	
	<i>Ephydra</i> sp.1	Sp 2	13	0,33	11	0,10	43	2,59	22	3,36	
	<i>Ephydra</i> sp.2	Sp 3	-	-	1	0,01	-	-	-	-	
	<i>Scatophila</i> sp.	Sp 4	2	0,05	-	-	1	0,06	6	0,92	
	<i>Setacera</i> sp.	Sp 5	-	-	-	-	-	-	6	0,92	
	<i>Caenia</i> sp.	Sp 6	1	0,03	-	-	-	-	-	-	
	<i>Gymnoclasiopa</i> sp.	Sp 7	43	1,10	14	0,12	-	-	-	-	
	<i>Hydrellia</i> sp.	Sp 8	631	16,21	3166	27,45	1	0,06	2	0,31	
	<i>Notiphila</i> sp.	Sp 9	1034	26,56	4237	36,73	29	1,75	24	3,67	
	<i>Paracoenia</i> sp.	Sp 10	5	0,13	40	0,35	7	0,42	3	0,46	
	<i>Typopsilopa</i> sp.	Sp 11	23	0,59	347	3,01	-	-	-	-	
	<i>Scatellapraia</i> (Wirth et Stone, 1956)	Sp 12	83	2,13	38	0,33	57	3,43	23	3,52	
	<i>Scatella</i> sp.	Sp 13	42	1,08	25	0,22	-	-	-	-	
	Ephydriidae sp.ind.	Sp 14	56	1,44	623	5,40	757	45,5	-	-	
Piophilidae	<i>Piophila</i> sp.	Sp 15	6	0,15	-	-	151	9,09	1	0,15	
Syrphidae	<i>Eristalis</i> sp.	Sp 16	-	-	-	-	-	-	1	0,15	
	<i>Eristalis aereus</i>	Sp 17	-	-	-	-	-	-	9	1,38	
	<i>Eupeodescorollae</i> (Fabricius, 1794)	Sp 18	1	0,03	-	-	-	-	30	4,59	
Muscidae	<i>Helophilus</i> sp.	Sp 19	1	0,03	6	0,05	-	-	-	-	
	<i>Muscadomestica</i> (Linnaeus, 1758)	Sp 20	103	2,65	146	1,27	3	0,18	11	1,68	
	<i>Hydrotaea</i> sp.	Sp 21	33	0,85	141	1,22	20	1,20	7	1,07	
	<i>Azelia</i> sp.	Sp 22	7	0,18	-	-	3	0,18	6	0,92	
	<i>Phaonia</i> sp.	Sp 23	3	0,08	7	0,06	-	-	-	-	
	<i>Muscina</i> sp.	Sp 24	1	0,03	1	0,01	-	-	-	-	
	<i>Muscina stabulans</i> (Fallén, 1817)	Sp 25	2	0,05	8	0,07	-	-	-	-	
	Muscidae sp.	Sp 26	3	0,08	16	0,14	3	0,18	-	-	
	Fanniidae	<i>Fannia</i> sp.	Sp 27	8	0,21	1	0,01	-	-	-	-
		<i>Fannia scalaris</i> (Fabricius, 1794)	Sp 28	1	0,03	95	0,82	-	-	-	-
Anthomyiidae	<i>Anthomyia</i> sp.	Sp 29	2	0,05	-	-	-	-	-	-	
	<i>Delia</i> sp.	Sp 30	-	-	1	0,01	-	-	-	-	
	Anthomyiidae sp.	Sp 31	3	0,08	2	0,02	3	0,18	16	2,45	
Lauxaniidae	<i>Lauxania nigrimana</i> (Coquillett, 1902)	Sp 32	-	-	-	-	-	-	3	0,46	
Psilidae	Psilidae sp.ind.	Sp 33	-	-	1	0,01	-	-	-	-	
Scathophagidae	<i>Scathophaga</i> sp.	Sp 34	-	-	-	-	-	-	2	0,31	
	<i>Norellia</i> sp.	Sp 35	3	0,08	-	-	-	-	-	-	
Dolichopodidae	<i>Chrysotus laesus</i> (Wiedemann, 1817)	Sp 36	39	1	-	-	-	-	1	0,15	
	<i>Hercostomus gracilis</i> (Loew, 1857) **	Sp 37	63	1,62	-	-	97	5,84	5	0,76	
	<i>Asyndetus appendiculatus</i> (Loew, 1869)**	Sp 38	674	17,31	27	0,23	9	0,54	146	22,3	
	<i>Aphrosylus venator</i> (Loew, 1857) **	Sp 39	-	-	37	0,32	-	-	-	-	
	<i>Tachytrechus insignis</i> (Stannius, 1831) **	Sp 40	2	0,05	-	-	-	-	-	-	

	<i>Tachytrechusalatus</i> (Becker, 1922) **	Sp 41	21	0,54	10	0,09	-	-	-	-
	<i>Sciapusplatypterus</i> (Fabricius,1805)	Sp 42	1	0,03	-	-	-	-	-	-
	<i>Sciapus</i> sp.	Sp 43	40	1,03	-	-	-	-	-	-
	<i>Dolichopus</i> sp.	Sp 44	2	0,05	-	-	-	-	-	-
	<i>Dolichopus latipennis</i> (Loew , 1857)**	Sp 45	1	0,03	-	-	-	-	-	-
	<i>Dolichopus campestris</i> (Meigen, 1824) **	Sp 46	151	3,88	3	0,03	-	-	-	-
	<i>Dolichopus griseipennis</i> (Stannius, 1831) **	Sp 47	5	0,13	-	-	-	-	-	-
	<i>Tenchophorus</i> sp.	Sp 48	1	0,03	-	-	-	-	-	-
	<i>Hydrophorus</i> sp.	Sp 49	-	-	2	0,02	-	-	-	-
Phoridae	<i>Megaselia</i> sp.	Sp 50	15	0,39	28	0,24	-	-	-	-
	Phoridae sp.	Sp 51	39	1	7	0,06	1	0,06	16	2,45
Sphaeroceridae	<i>Leptocera</i> sp.	Sp 52	53	1,36	289	2,51	22	1,32	78	11,9
	<i>Poecilomella</i> sp.	Sp 53	-	-	1	0,01	-	-	-	-
Sarcophagidae	<i>Sarcophaga africa</i> (Wiedemann, 1824)	Sp 54	-	-	-	-	-	-	1	0,15
	<i>Sarcophaga carnaria</i> (Linnaeus, 1758)	Sp 55	1	0,03	-	-	-	-	-	-
	<i>Sarcophaga</i> sp.	Sp 56	14	0,36	9	0,08	259	15,6	-	-
Drosophilidae	<i>Drosophila</i> sp.1	Sp 57	42	1,08	77	0,67	1	0,06	4	0,61
	<i>Drosophila</i> sp.2	Sp 58	6	0,15	-	-	-	-	-	-
	<i>Drosophila bifasciata</i> (Pomini, 1940)	Sp 59	-	-	-	-	-	-	16	2,45
Calliphoridae	<i>Lucilia sericata</i> (Meigen,1826)	Sp 60	2	0,05	2	0,02	1	0,06	1	0,15
	<i>Lucilia</i> sp.	Sp 61	1	0,03	2	0,02	-	-	-	-
	<i>Chrysomya albiceps</i> (Wiedemann,1819)	Sp 62	4	0,10	1	0,01	-	-	-	-
Agromyzidae	<i>Phytomyza</i> sp.	Sp 63	24	0,62	42	0,36	-	-	-	-
	<i>Liriomyza</i> sp.	Sp 64	11	0,28	-	-	-	-	-	-
	<i>Agromyza</i> sp.	Sp 65	-	-	3	0,03	-	-	-	-
	<i>Pseudonopomyza</i> sp.	Sp 66	15	0,39	-	-	-	-	-	-
Tephritidae	<i>Trupanea stellata</i> (Fuesslin, 1775)	Sp 67	-	-	-	-	-	-	1	0,15
	<i>Urophora</i> sp.	Sp 68	-	-	-	-	1	0,06	1	0,15
Hybotidae	<i>Platypalpus</i> sp.	Sp 69	4	0,10	-	-	5	0,3	96	14,7
	<i>Tachydromia</i> sp.	Sp 70	1	0,03	-	-	-	-	-	-
Opomyzidae	<i>Opomyza</i> sp.	Sp 71	2	0,05	-	-	-	-	-	-
	Opomyzidae sp.ind.	Sp 72	7	0,18	14	0,12	-	-	-	-
Tabanidae	<i>Atylotus agrestis</i> (Wiedemann, 1828)	Sp 73	-	-	1	0,01	-	-	1	0,15
Brachystomatidae	Brachystomatidae sp.ind.	Sp 74	-	-	-	-	-	-	16	2,45
Empididae	<i>Hilara</i> sp.	Sp 75	1	0,03	-	-	-	-	-	-
	Empididae sp.	Sp 76	10	0,26	14	0,12	-	-	1	0,15
Carnidae	<i>Hemeromyia</i> sp.	Sp 77	51	1,31	-	-	91	5,48	6	0,92
Sciomyzidae	<i>Limnia</i> sp.	Sp 78	4	0,10	-	-	-	-	-	-
Bombyliidae	Bombyliidae sp.ind	Sp 79	-	-	1	0,01	-	-	-	-
Chloropidae	<i>Chlorops</i> sp.	Sp 80	-	-	10	0,09	-	-	-	-
	<i>Elachiptera</i> sp.	Sp 81	2	0,05	-	-	-	-	-	-
	Chloropidae sp. ind.	Sp 82	1	0,03	-	-	-	-	-	-
Nemestrinidae	<i>Nemestrinus</i> sp.	Sp 83	2	0,05	-	-	-	-	-	-

Otitidae	<i>Ceroxys</i> sp.	Sp 84	65	1,67	-	-	-	-	-	-
	Otitidae sp.ind.	Sp 85	1	0,03	1	0,01	-	-	-	-
Acroceridae	Acroceridae sp.ind	Sp 86	23	0,59	-	-	-	-	-	-
Tachinidae	Tachinidae sp.ind	Sp 87	4	0,10	1	0,01	-	-	-	-
Stratiomyidae	<i>Odontomyia</i> sp.	Sp 88	2	0,05	-	-	-	-	-	-
	Stratiomyidae sp. ind.	Sp 89	1	0,03	7	0,06	-	-	-	-
Cecidomyiidae	Cecidomyiidae sp.ind.	Sp 90	7	0,18	2	0,02	-	-	-	-
Mycetophilidae	Mycetophilidae sp.ind.	Sp 91	3	0,08	1	0,01	-	-	-	-
Trichoceridae	<i>Trichocera</i> sp.	Sp 92	1	0,03	-	-	-	-	-	-
Dixidae	Dixidae sp. ind.	Sp 93	-	-	25	0,22	-	-	-	-
Psychodidae	<i>Psychodaphalaenoides</i> (Linnaeus, 1758)	Sp 94	-	-	4	0,03	-	-	-	-
	<i>Psychodaalternata</i> (Say,1824)	Sp 95	-	-	65	0,56	-	-	-	-
	Psychodidae sp.ind.	Sp 96	3	0,08	1	0,01	-	-	-	-
Scatopsidae	<i>Swammerdamella</i> sp.	Sp 97	7	0,18	-	-	-	-	-	-
	Scatopsidae sp.ind.	Sp 98	4	0,10	1	0,01	-	-	-	-
Sciaridae	<i>Bradysia</i> sp.	Sp 99	33	0,85	3	0,03	-	-	-	-
Chironomidae	Chironomidae sp.	Sp 100	208	5,34	1819	15,77	85	5,12	2	0,31
Tipulidae	<i>Tipula</i> sp.	Sp 101	-	-	1	0,01	-	-	-	-
Ceratopogonidae	Ceratopogonidae sp.	Sp 102	6	0,15	-	-	-	-	1	0,15
Culcidae	Culcidae sp.	Sp 103	2	0,05	42	0,36	1	0,06	4	0,61
	<i>Anopheles</i> sp.	Sp 104	64	1,64	21	0,18	2	0,12	35	5,35
	<i>Culex</i> sp.	Sp 105	36	0,92	33	0,29	8	0,48	50	7,65
Simuliidae	Simuliidae sp. ind.	Sp 106	1	0,03	-	-	-	-	-	-
43	106	106	3893	100	11535	100	1661	100	654	100

(Nb.: Number of individuals; (+): presence; (-): absence; AR%: relative abundance; **: Dolichopodidae species reported for the first time in Algeria; S1: Hassi Ben Abdallah lake; S2: Sebkhat Sefioune lake; S3: Chott Ain El Beida; S4: ksar palm grove).

From the results in Table 2, it appears that 11 families of Diptera found in the two suborders are common to the four wetlands in the Ouargla region. Ephydriidae is best endowed in species with the aquatic larvae as a species. The dominant features were identified by the submersion net and the dip net in the three lakes. In the second position comes the Dolichopodidae with the species *Asyndetus appendiculatus*, followed by the larvae of the Chironomidae; then the Culcidae with *Culex* sp. and *Anopheles* sp. However, 5 families are found only at the lake of Hassi Ben Abdallah. They are characterized by species-specific to this lake. This station totals more species and families, these are the family Sciomyzidae (*Limnia* sp.), Nemestrinidae (*Nemestrinus* sp.), Acroceridae, Trichoceridae (*Trichocera* sp.), and Simuliidae with 4 families captured only at lake Sebkhat Sefioune (Psilidae, Bombyliidae, Dixidae and Tipulidae). Two species are

divided into two families and the suborder Brachycera are only found in the palm grove of the ksar, these are the Brachystomatidae and the Lauxaniidae with the species *Lauxanianigrimana*. However, it should be noted that no specific family has been reported in the Chott Ain El Beida. For the correspondence factor analysis AFC (Fig.1), axes 1 and 2 represent a high percentage of inertia (81.52%).

The graphical representation of axes 1 and 2 shows the existence of groupings (A, B, C, D and E) distributed among the four stations. Note that Stations 1 and 2 are identical in terms of species types and are characteristic of wetlands of the lake type. Station 4 contains specific species because it is a palm grove. Station 3 located in the center of the large palm grove of Ouargla is characterized by species characteristic of both palm groves and lakes.

Group A contains the fourteen species of Diptera specific to the Sebkhath Sefioune lake. Among this Diptera, it is necessary to note *Psychoda alternata*, *Psychoda phalaenoides*, *Ochthera mantis*, *Delia* sp. etc. Species of the genus *Psychoda* are widespread in this plant because of the sewage that feeds this lake and the passage of camels during the year. The species of the genus *Psychoda* are pathogenic since they develop in stables, farms, or sewage disposal pipes from houses.

The 17 species that makeup Group B are ubiquitous and exist in all four stations. They are the species *Scatella praira*, *Musca domestica*, *Asyndetus appendiculatus*, *Culex* sp. Chironomidae sp, *Hydrellia* sp, *Notiphila* sp, *Anopheles* sp. Group C Diptera species are specific to the fourth station, the ksar palm grove. It has 9 species, such as *Eristalis aereus*, *Lauxania nigrimana*, *Sarcophaga africa*, *Drosophila bifasciata* and *Trupaneastellata*. Group D bears the species characteristic of the lake of Hassi Ben Abdallah. Among the 27 species are *Tachytrechus insignis*, *Sciapus platypterus*, *Dolichopus arggra*, *Dolichopus hygroceleuthus*, *Dolichopus griseipennis*, *Sarcophaga carnaria* ...etc. Group E formed by 24 species common between the lake of Hassi Ben Abdallah and Sebkhath Sefioune (*Muscina stabulans*, *Fannia scalaris*, *Tachytrechus alatus*, *Dolichopus campestris*, *Chrysomya albice ps*,). Three species are common in the three lake type wetlands, Hassi Ben Abdallah Lake, Sebkhath Sefioune Lake and Chott Ain El Beida (*Sarcophaga* sp., Ephydriidae sp. and Muscidae sp.). *Urophora* sp. is the only common species between Chott Ain El Beida and the ksar palm grove. Six species are common between Hassi Ben Abdallah Lake, Chott Ain El Beida and the ksar palm grove. These are the species *Piophilina* sp., *Azelia* sp., *Hercostomus gracilis*, *Platypalpus* sp., *Hemeromyia* sp. and *Scatophila* sp. However, it should be noted that no specific species has been reported from Chott Ain El Beida. Diptera uses a variety of strategies to exploit the scarce resources of this arid band while avoiding extreme ecological conditions. This is the case in the region of Ouargla or at the level of wetlands, they seek

favorable ecological areas. The proliferation in a given place of a Dipterian fauna is better suited to the hypothesis of an improvement in trophic resources than to that of a direct action of climatic factors. Certainly a localized water supply, in an arid context, also plays an important role both in the final phase of embryonic development and on the survival of certain larvae at the level of the lakes and palm groves studied. It thus creates a privileged site. Table 2 shows that the lakes of Hassi Ben Abdallah and Sebkhath Sefioune are characterized by high diversity, followed by the ksar palm grove and lastly Chott Ain El Beida (Ramsar site).

Several factors promote this diversity, spontaneous vegetation that grows is worth mentioning, including *Phragmites australis* (Poaceae), *Zygophyllum album* (Zygophyllaceae), *Halocnemum strobilaceum* (Chenopodiaceae), etc. However, the presence of water throughout the year promotes the growth and development of the region's wildlife (Hassi Ben Abdallah lake and Sebkhath Sefioune are fed by the drainage water from the city of Ouargla). In addition, a large number of water birds live in the lakes throughout the seasons. As an example the pink flamingo (*Phoenicopterus roseus*), *Tadorna tadorna*, *Anas clypeata*, *Egretta garzetta*, *Himantopus himantopus*, at Sebkhath Sefioune and Chott Ain El Beida.

The latter is the least diversified station; this result is explained by the drying up of this lake for several months during the year. The environment phœnicicole (the palm grove of the ksar) is the most balanced in families and dipterian species compared to the other stations (for example the Ephydriidae family dominates in the three lakes with more than 50% of all species recorded).

Discussion

The four wetlands Sebkhath Sefioune, lake Hassi Ben Abdallah, Chott Ain El Beida and the palm grove of the ksar in this arid locality by an oasis effect escaping the effects of drought due to a localized supply of continuous water. According to El Bashir (1996),

insects use various strategies to exploit scarce resources while avoiding the extreme ecological conditions of the Sahara. The conditions at the two study stations, allowing the existing species to

continue to thrive at a time of the year when their numbers should have been limited due to severe environmental conditions such as drought and scarcity, are very favourable (Dreux, 1980). of food.

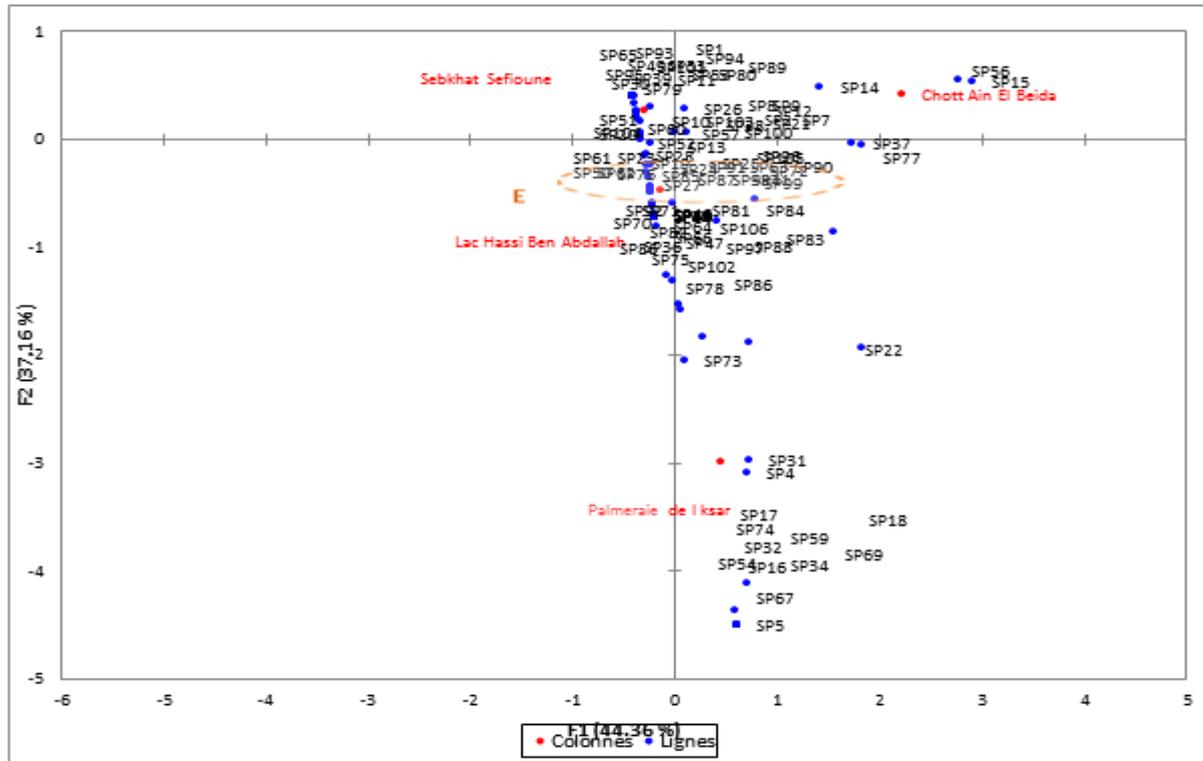


Fig. 1. Factor map of diptera species inventoried at the four study stations (AFC).

This is the case of the dipterian fauna at the lakes of Hassi Ben Abdallah, Sebkhat Sefioune, Chott Ain El Beida and the ksar palm grove seeking favorable ecological zones in the region of Ouargla. To this end, Chouihat (2019) reports in three palm groves in Ghardaïa in the Algerian Sahara, using three sampling methods, Barber pots, mowing net and yellow plates, 52 species of Diptera, distributed among 26 families, of which 6 families belong to the suborder Nematocera and 20 families are Brachycera. Boukraa (2009), in three stations those of the Laadiraa breeding farm and two palm groves in the Ghardaïa region, reports 44 Nematocera species belonging to 8 families including Psychodidae, Culicidae, Ceratopogonidae, Mycetophilidae, Sciaridae, Cecidomyiidae and Chironomidae. Diptera participates in the feeding of waterfowl. Meddour *et al.*, (2015) reported that insect species, ingested by the Northern Shoveler *Anas clypeata* at Sebkhet El-Malehare part of 5 orders and Diptera come in first

position (86.7%). The most dominant species with the dip net are Chironomidae sp., Ephydriidae sp., *Culex* sp. larvae of the Chironomidae play an important role in water filtration. Some chironomids are bioindicators of very poor water quality if they are massively present. Chironomidae larvae can account for up to 80% of fish food (Matile, 1993).

The four study stations in this arid area of the Northern Sahara, host a more diverse dipterian fauna.

These species-friendly biotopes meet requirements in terms of periodicity of impoundment, with a salinity level that allows the development of halophilic vegetation (Harant and Rioux, 1953; Gabinaud *et al.*, 1975).

Conclusion

The study of dipterian fauna in the wetlands of the Ouargla region conducted at Hassi Ben Abdallah lake,

Sebkhat Sefioune lake, Chott Ain El Beida and the ksar palm grove (oasis) using six sampling techniques revealed the existence of 106 species divided into 43 families and 2 suborders. The species of Diptera recorded in the lakes of Hassi Ben Abdallah and Sebkhat Sefioune, are more numerous compared to those of the ksar palm grove and lastly Chott Ain El Beida. It is noted the dominance of the family Ephydriidae in the three lakes, on the other hand in the ksar palm grove, the family Dolichopodidae is the best represented. The four wetlands (Hassi Ben Abdallah lake, Sebkhat Sefioune lake, Chott Ain El Beida and the ksar palm grove) in this arid area of the Northern Sahara constitute a privileged biotope for the proliferation and development of a Dipterian fauna, following the oasis effect of this habitat. The species in presence, find on the spot a rather diversified food. Their proliferation in these places is more consistent with the hypothesis of an improvement in trophic resources than with the direct action of climatic factors.

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