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Inventory of the invertebrate fauna at the level of the lake of Birds (North-east-Algeria)

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Abstract
The present study is an update of fauna biodiversity of the Lake of Birds (El Taref Algeria Wilaya). The study was conducted in five selected stations at the level of the shore of the lake. Our sampling reported 3 685 individuals harvested. According to the decreasing order of their abundance, we have the Crustacea class: the Cladocera (*Daphnia magna*, *Simocephalus vetulus* and *Simocephalus expinosus*). Invertebrates are represented by five taxa. Three families of Coleoptera: Noteridae (*Hydrocanthus iricolor)*; Dytiscidae (*Dytiscus semisulcatus*, *Dytiscus circumflexue*, *Dytiscus marginalis*, *Dytiscus dimidiates*, *Agabus brunneus*, *Agabus binaries*, *Laccophylus poecilus*, *Laccophilus minitus*, *Hydroporus pubescens,*); Hydrophilidae (*Berosus frontifoveatus*, *Berosus luridu*, *Berosus affinis*, *Hydophylus piceus***,** *Berosus signaticollis*, *Enochrus halophiles)* have been systematically identified. However, the diagnosis of Hemiptera gave rise to four families, with five species: Notonectidae (*Notonecta glauca*, *Anisops sardea*); Pleidae (*Plea minutissima*), Corexidae (*Corixa punctata*) and the Nepidae family (*Nepa cinerea*). Diptera follows them with the following species: (*Culex pipien*, *Culex modestus*, *Culex thieleri*, *Culiseta morsitans and Anopheles sacharovi*. Hydrachnidia reveals the presence of four species belonging to three families: Eylaidae *(Eylais hamata*), Pionidae (*Piona nodata*, *Piona uncata*); Hydryphantidae (*Eupatra rotunda).* Aeshnidae has only one species *Boyeria irene*.

Keywords: Biodiversity, inventory, invertebrate, arthropod

1. Introduction
Invertebrates represent more than 95% of the species of the animal kingdom [1] are present, almost all types of ecosystems and are a very important part of terrestrial and aquatic biodiversity. Arthropods are invertebrates that respond to a well-defined type of organization, constitute one of the most important branches of the animal kingdom, as much by the number of species (80 to 85% of the known animal species) than by that of the individuals.
Insects constitute more than 70% of the specific biodiversity known to the animal kingdom [2]. Besides this numerical importance; the role of insects in nature is well established. They play an important role in the functioning of aquatic ecosystems [3]. Insects are excellent witnesses to the quality of the habitats where they meet. This is how they are used as bio indicators of water quality [4]. In addition to this role, they are a food source for many invertebrates and several species of fish [5, 6]. In the domain of health, insects cause many nuisances to humans, mainly due to the presence of hematophagous species such as Culicidae, Simulia and Tabanidae [7]. Among the 27 orders of insects existing all over the world. Only 11 orders have representatives with at least one phase of their development adapted to aquatic life (Apterygota, Pterygota, Diptera, Lepidoptera, Coleoptera, Neuroptera, Odonata, Plecoptera, Ephemeroptera Trichoptera, Heteroptera).
However, Crustaceans whose carapace is formed of chitin impregnated with limestone are generally aquatic Arthropods, with bronchial breathing. They are different from other classes, by the presence of two pairs of antenna and by the possession of many appendices for its aquatic representatives [8]. The fluctuation of populations is influenced by various factors, such as the temperature, the phytoplankton, The density of predators, in particular the fishes [9].
Among the arthropods, Hydracarians, al socalled Hydrachnellae Hydracarina, or Hydrachnidia represent the most important group of fresh water Arachnida. These are Chelicerates of the class Arachnids, it represents 6 000 species of animals [10]. They occupy the aquatic environments, see the wetlands, the temporal pools, The Lagoons, Also, they are generally found in the area of the littoral zone, as well as in the benthos of the lakes [11, 12, 13, 10]. Hydracarians perform their development cycle by stasis, with a larval passage often required

on an invertebrate host of aquatic or semi-aquatic insect, In order to complete their life cycle [14].

The objective of this work concerns the making an inventory, qualitative and quantitative, aquatic invertebrate species, in the region of Taref, at the Lake of Birds. In the same way, we were interested, to their spatio-temporal distributions, in the different study stations, during one year (March 2015-February 2016). Our study was devoted in a first part, to the systematic determination of the species of aquatic invertebrates at the level of the lake of birds. The second part, consists in determining the structural characterization of stands by ecological indices.

2. Materials and Methods

2.1 Presentation of the study area

2.1.1 Lake of birds

Located at an altitude of 36 ° 47'N 08 ° 7'e and presents a surface more or less oval [15] stretched to the north-west by a tail of Pond, Characteristic of shores weakly tilted and small depth [16]. [17] the lake extending over 150 ha, with a depth of 2.5 m maximum and a deposit of organic matter of 1 to 3 cm. [18] Indicate that various pressures exerted on the lake, threatening its ecological integrity and that it occupies only, 70 ha in rainy period and 40 ha in dry period, with a deposit of organic matter of 20 cm. Currently after planimetric estimations, the lake is spread over 46 ha with a surface of open water, 35 ha and a depth of 2 m. Ecological surveys carried out on the waters for Tunisia and Algeria [19] reports that the lake has a maximum salinity of 0.3 ‰ in September and October (Figure 1).

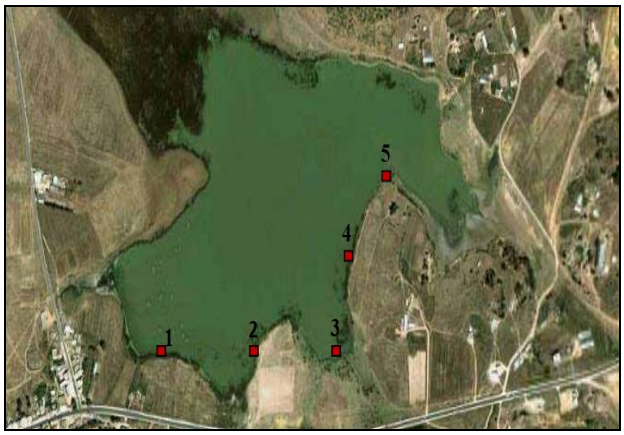

Fig 1: Geographical location of Birds Lake. Location of the five stations (Google maps).

Fig 2: Station 1

Fig 3: Station 2

Fig 4: Station 3

Fig 5: Station 4

Fig 6: Station 5

2.2 Sampling technique
Culicidae and associated invertebrates were sampled using a 500 milliliter ladle.
The latter is immersed in water, then moved in a uniform motion avoiding the eddy. The sorting of collected specimens is done in the laboratory.

2.3 Mounting technique
The systematic identification of the specimens and to distinguish the different chitinous pieces, 5% NaOH was used, which renders the structure transparent and destroys the tissues attached to the cuticles. The specimens so treated will be rinsed and mounted on slide and coverslips in a drop of glycerine.

2.4 Identification key
The observations were made using a binocular loupe, and under a light microscope. The generic and specimen-specific diagnosis of specimens was performed according to the dichotomous keys [20], and computer software (Mosquito identification software of Europe [21], based on a set of criteria and descriptors, very specific structural. Crustacean systematic rely on diagnosis of the head, thorax, legs and abdominal appendages [22], the aquatic Heteroptera rests on the following characteristics: the hemelytra, the tasks of the periphery of the membrane the head and the legs, the middle of the thorax according to [23]. The Hydrachnidia group was identified from the keys [24] and [25].

2.5 Ecological indices
The ecological indices that hold our attention for the exploitation of our results are the quality of the sampling, total and average richness [26], frequency or relative abundance [27], the Shannon- Weaver index [28] and the equidistribution index [29].

3. Results
3.1 Inventories and study of the stand at the Lac the Birds
The bi-monthly samples are spread over 12 months (March 2015-February 2016), five stations selected at the periphery of the lake (Figures 2, 3, 4, 5 and 6). Table 1 displays a relatively different abundance. The months of March, February and April are the richest in abundance, the months of August and July being the weakest. The harvested species belong to six Orders and Thirteen Families: those of the Noteidae, Hydrophilidae, Dytixidae, Notonectidae, Pleidae, Corexidae, Nepidae, Culicidae, Eylaidae, Pionidae, Hydryphantidae, Daphnidae and Aeshnidae.

Table 1: The species harvested at the Lake of Birds by month, by station and by species.

Groups	Families	Species	Numbers	Stations				
				S1	S2	S3	S4	S5
Coleoptera Linnaeus 1775	Noteridae Thomson 1860	*Hydrocanthus iricolor* Say1823	24	08	04	07	05	/
	Hydrophilidae Latreille 1802	*Berosus frontifoveatus* Kuwert 1888	18	11	07	/	/	/
		Berosus luridus Linnaeus1761	26	12	05	05	04	/
		Berosus affinis Brullé 1835	27	10	17	/	/	/
		Hydroporus pubescen Gyllenhaal 1808	18	05	07	03	03	/
		Hydophylus piceus Linnaeus 1775	25	15	04	02	/	24
		Berosus signaticollis Charpentier 1825	153	68	44	14	18	09
		Enochrus halophilus Bedel 1858	56	16	23	10	04	02
	Dytixidae Leach 1815	*Dytiscus semisulcatus* Linnaeus 1775	10	07	03	/	/	/
		Dytiscus circumflexue Ahrens 1811	22	12	10	/	/	/
		Dytiscus marginalis Linnaeus 1758	24	14	10	/	/	/
		Dytiscus dimidiatus Bergsträsser 1778	32	10	09	12	/	/
		Agabus brunneus Fabricius 1768	18	10	08	/	/	/
		Agabus bifarius Leach 1817	5	05	/	/	/	/
		Laccophylus poecilus Klug 1834	10	10	/	/	/	/
		Laccophilus minitus Linnaeus 1758	45	25	10	10	/	/
Hemiptera Linnaeus 1775	Notonectidae Latreille 1802	*Notonecta glauca* Latreille 1802	152	95	25	12	05	15
		Anisops sardea Latreille 1802	286	120	90	22	35	19
	Pleidae Fieber 1851	*Plea minutissima* Leach 1817	397	157	99	42	47	52
	Corexidae Leach 1815	*Corixa punctata* Illiger 1807	460	209	122	42	65	22
	Nepidae Linnaeus 1775	*Nepa cinerea* Linnaeus 1758	12	07	05	/	/	/
Diptera Linnaeus 1775	Culicidae Meigen 1860	*Culex pipiens* Linné 1758	52	22	10	07	12	01
		Culex modestus Ficalbi 1889	72	28	20	15	09	/
		Culex thieleri Theobald 1903	15	07	04	04	/	/
		Culisita morsitans Theobald 1901	42	21	05	07	05	02
		Anopheles sacharovi Meigen 1818	19	10	07	02	/	/
Acari Leach 1817	Eylaidae Leach 1815	*Eylais hamata* Koenike 1897	31	12	05	03	04	07
	Pionidae Thor 1900	*Piona nodata* Müller 1781	26	11	07	08	/	/
		Piona uncata Koenike 1888	31	10	14	/	07	/
	Hydryphantidae Piersig 1896	*Eupatra rotunda* Piersig 1906	12	07	05	/	/	/
Cladocera Latreille 1829	Daphnidae Straus 1820	*Daphnia magna* Straus 1820	796	225	142	154	188	87
		Simocephalus vetulus Müller 1776	424	/	/	188	149	87
		Simocephalus expinosus koch 1841	478	/	/	275	114	89
Odonata Fabricius 1793	Aeshnidae Rambur 1842	*Boyeria irene* Fonscolombe 1838	47	10	07	12	13	06

3.2 Ecological Indices
The results mentioned in Table 2, highlight the total wealth, limited to 34 species, with an abundance of 3 865 individuals. The specific wealth is as follows: 32 species belonging to the station1; 29 species at station 2; 23 species at station 3, 18 species at station 4 and 14 species at station 5, which has the lowest abundance. The diversity indices of station 1 and station 2 show successive values of 0.16 and 0.17, these

values indicate a specific diversity presented by 34 species. As regards equitability, at station 4 the value 0.79, this parameter constitutes an expression of the degree of equitability of the stand. The more it tends to 1, the more the population is balanced, on the other hand, if it tends to 0, almost all the population is concentrated, the equitability has values between 0.03 and 0.08, at the level of the stations 1, 2, 3, 5, which explains why populations are not balanced.

Table 2: Ecological Indices. Total and average wealth, diversity index of Schanon-Weaver (H'), maximum diversity index (H' max) and the equidistribution index (E).

Stations Indic écologique	Station1	Station2	Station3	Station4	Station5
Effectif/station	1182	721	856	279	422
H'/station	0.16	0.17	0.12	3.30	0.33
S/station	32	30	23	18	14
H' max	5	4.90	4.52	4.16	3.80
E/station	0.03	0.03	0.02	0.79	0.08
N. total d'individus			3 865		
N. de relevés			12		
Richesse totale			34		
Richesse moyenne			322.08		

3.3 Percentage frequency or relative abundance of inventoried species

Frequency is a parameter that makes it possible to study the distribution of a species in a given region. The results recorded in Table 1 indicate that Cladocerans and Hemiptera present rare species, in less than 50% of the surveys (Figure 7). Other species are very rare, because they are present in less than 25% of the surveys in the five study stations.

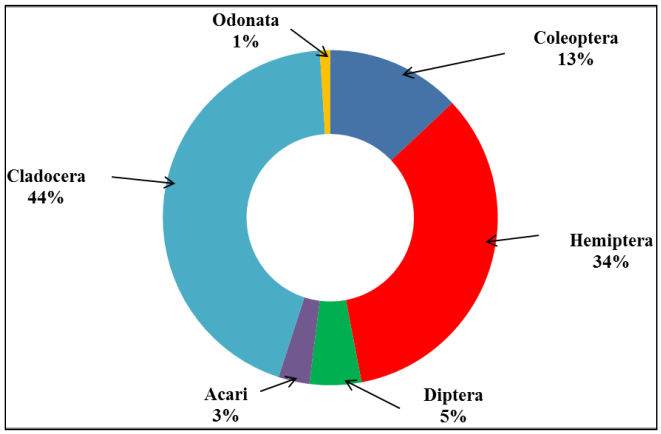

Fig 7: Distribution of groups in Birds Lake (2015-2016).

3.4 Kinetic abundance of the different groups

The distribution of species, changes according to the months, and stations. Their abundance varies according to environmental factors. It decreases at the end of autumn. Biodiversity during the summer has clearly decreased during the months of July and August. The months of February, March, April and May represent the maximum abundance (Figures 8, 9, 10, 11 and 12).

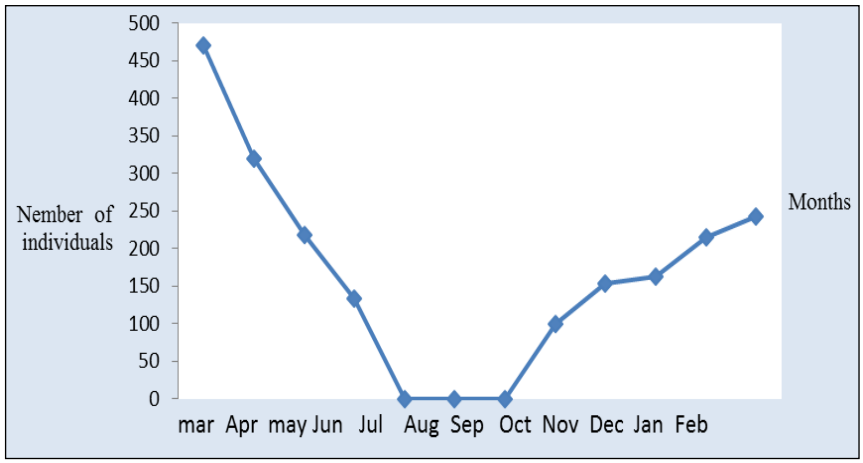

Fig 8: Abundance of Cladocerans at the level of Birds Lake (2015-2016).

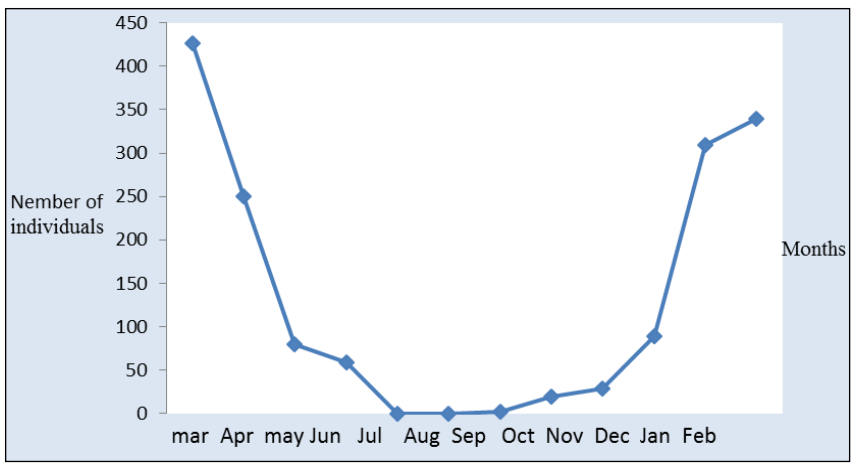

Fig 9: Abundance of Hemiptera in Lake Birds (2015-2016).

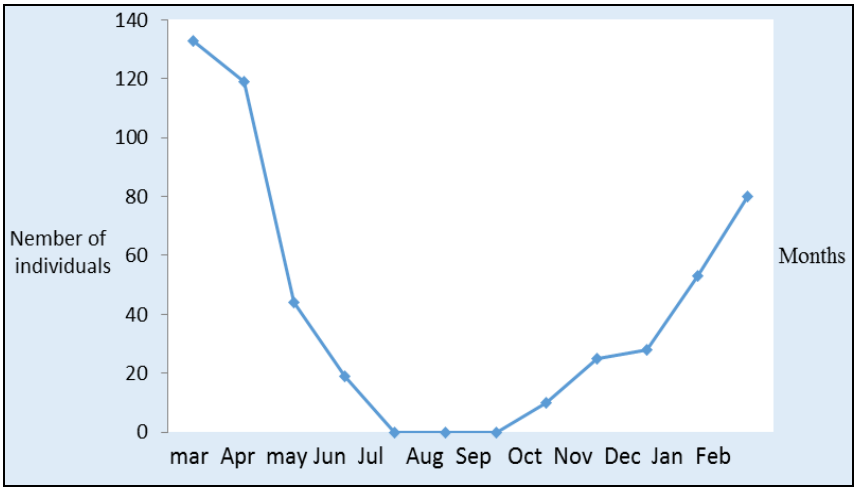

Fig 10: Abundance of Coleoptera at the Lake of Birds (2015-2016).

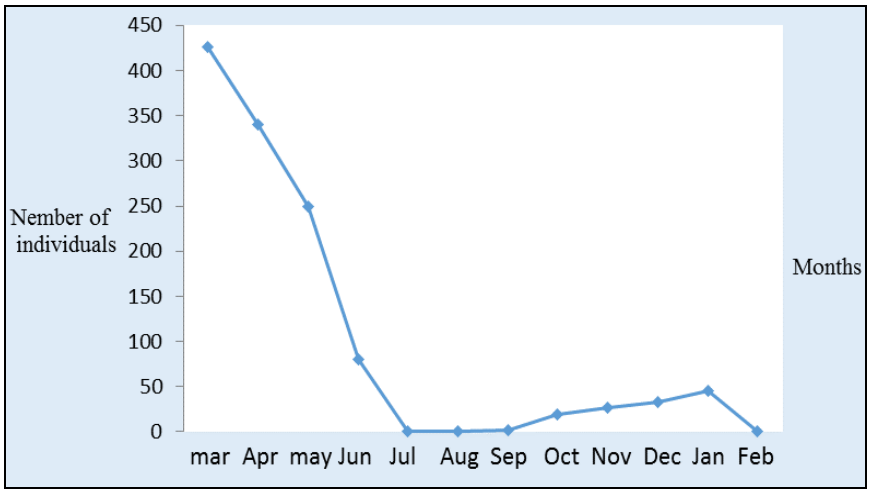

Fig 11: Abundance of Diptera at the Lake of Birds (2015-2016).

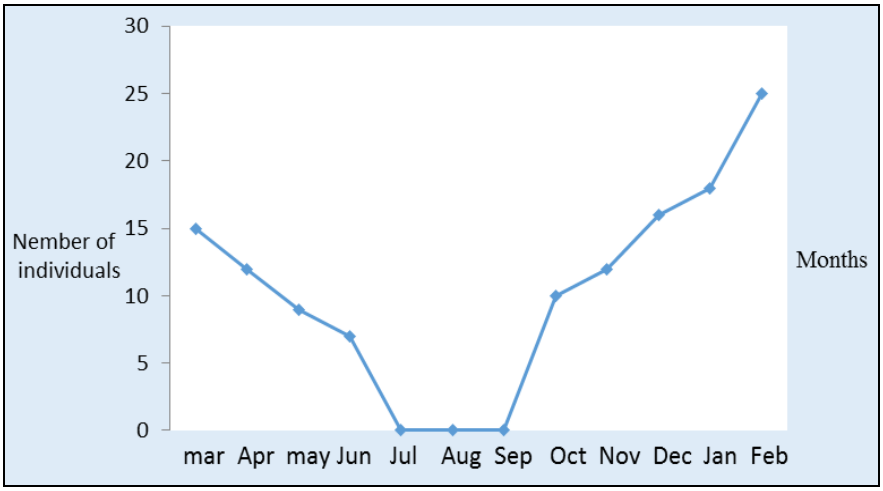

Fig 12: Abundance of Hydrachnidia at the Lake of Birds (2015-2016).

4. Discussion

Algeria is the largest country in North Africa covering an area of 238,174,100 ha (2,381,741 km²) with a width of 1622 km and a length of 2000 km. This large expanse combined with geological features, and geographical factors and the country's climatic factors show from north to south a series of ecosystems, sheltering a diversity of habitats and a diversity of species, with a fringe of littoral ecosystem, ranging from island and marine ecosystems, with a fringe of coastal ecosystem, through forest and mountain ecosystems, followed by steppe ecosystems, then the Saharan ecosystem and including the wet ecosystem found in these different ecosystems.

The macrobenthic fauna of Algeria is relatively diversified. In our work, we are interested in the classification of the species harvested during our sampling. Crustaceans are generally aquatic Arthropods, they are an important part of zooplankton; the most well-known freshwater zooplankton is

Daphnia, they contribute to ecological balances in many ways used as living food for many species, filtering the water for food and thus ensuring population control, The fluctuation of populations is influenced by various factors, such as temperature, phytoplankton, predator density, especially During a stay at the Marismas of the Guadalquivir at the level of Andalusia (April 30-May 17, 1965), Marazanof has studied some Invertebrates of the main aquatic environments; he identified 7 Ostracoda, 13 Cladocera, 19 Heteroptera, 10 Hydracarians that were new to the Marismas and some of them to Spain [30]. All Crustacean species identified in our samples (*Daphnia magna*, *Simocephalus vetulus* and *Simocephalus expinosus*) were rated by the various authors working in the study area.

Among the species that are of biological and environmental importance, hydracarians (Acari: Hydrachnidia), which constitute an important group in terms of ecological monitoring. These excellent indicators of the quality of the habitat radiated since the Triassic by 6000 described species, occupying almost all freshwater environments, representing a high aquatic biodiversity [10, 12, 13, 31]. They are presented in our samples by the species of the following families: Eylaidae (*Eylais hamata*), Pionidae (*Piona nodata*, *Piona uncata*), Hydryphantidae (*Eupatra rotunda*). According to Messikh [32] who worked on the biodiversity of hydracariens and the physicochemical characteristics of habitats in four locations of the wetland complex in northeastern Algeria, identified nine species belonging to five families. The dominant species are: *Eylais hamata* (24%), *Piona alpicola* (22%), *Arrenurus novus* (13%), *Eylais sp*. (12%), *Piona nodata* (10%), *Arrenurus batillifer* (10%), *Hydrochoreutes intermedius* (4, 5%), *Diplodontus sp*. (3, 5%) and *Hydrachna globosa* (3,4%) [11].

The Insect class represents the largest number of species, with 53% of all identified arthropods. The latter are divided into three orders that of Coleoptera, Hemiptera and Diptera.

Coleoptera are among the most abundant insects in freshwater, in the perfect state, imago, or in the larval state, are very diverse and they are present in all major habitats with the exception of the polar and marine regions. They are also adapted to different ecological roles. The biology of species is very diverse, with sometimes very strict ecological requirements that make them excellent bioindicators (case of saproxylic species or coprophagous beetles) [33]. They are presented in our samples with 16 species covering 3 families: Noteridae (*Hydrocanthus iricolor*); Dytiscidae (*Dytiscus semisulcatus*, *Dytiscus circumflexue*, *Dytiscus marginalis*, *Dytiscus dimidiatus*, *Agabus brunneus*, *Agabus bifarius*, *Laccophylus poecilus*, *Laccophilus minitus*); Hydrophilidae (*Berosus frontifoveatus*, *Berosus luridu*, *Berosus affinis*, *Hydroporus pubescens*, *Hydophylus piceus***,** *Berosus signaticollis*, *Enochrus halophilus*).

However, the composition of the fauna sampled includes the heteropterans.They are the only Hemiptera with representatives who are more or less strictly aquatic [34]. They are hemimetabolic insects that move from the egg stage to the adult stage by five larval stages.

Some feed on other insects (zooplas) while others are phytophagous [35]. The list of African aquatic Heteroptera species, although already long, is probably still incomplete. Harvests and subsequent studies will not only describe new species, but will also clarify the geographical distribution of known species. For some groups (Microvelia, Micronectinae.), thorough revisions would be desirable. The Hemiptera in our samples are represented by four families and five species: the Notonectidae (*Notonecta glauca*, *Anisops sardea*); pleidae (*Plea minutissima)*; Corexidae (*Corixa punctata)* Et Nepidae (*Nepa cinerea*). These species have been cited by some authors in North Africa and Algeria.

On the other hand a family of medical and veterinary interest, the Culicidae Family, has been part of the biodiversity of our sampling. It belongs to the Order of Diptera and the Sub-Order of Nematocerae. According to Seguy [36] it comprises about 3000 species [37]. In Algeria, 50 species and 6 different genera are grouped in two sub families that of Anophelinae and that of Culicinae [38], they are harmful and vectors of epidemic and formidable diseases. They are presented in our samples by five species: *Culex pipiens*, *Culex modestus*, *Culex thieleri*, *Culiseta morsitans* and *Anopheles sacharovi*. Benmalek [39], Hamaidia in the region of Souk-ahras [40] and Skikda Boulkenfet [41] cited five species of Diptera: *Culex pipiens*, *Culex modestus*, *Culex thieleri*, *Anopheles sacharovi* has been identified by Benmalek in the region of Souk-Ahras [42] and Oudainia in Oum El Bouaghi [43], *Culex pipiens and Culex thieleri* quoted by Dahchar in the Annaba region [44] *Culiseta morsitans* cited by Houmani in the El Taref region [45].

The most recent odontological studies carried out in the Algerian territory focused on Numidia, situated in the north-east of the country by Samraoui and *al* [46,47]. This region is home to exceptional biodiversity and a total of 45 Odonata species (~ ¾ of Algerian species) have been recorded [47].

Recent studies show that Hydracarian species harvested in north-eastern Algeria by Mansouri in his study of Lake Birds hydrachnidia in ElKala region [48] had cited four species: *Eylais hamata*, *Piona nodata*, *Piona uncata* and *Eupatra rotunda* and at Tonga Lake level in the works of Bendali-Saoudi [31] and Messikh [32] identified for two consecutive years: *Piona uncata* and *Eylais hamata. Eupatra rotunda and Eylais hamata* cited by Boudmagh in the Collo area [49]. The work done by Carronde the alluvial zone of the Rhone at Belley in France, in general found the following species: *Dytiscusse misulcatus*, *Dytiscus marginalis*, *Dytiscus dimidiatus*, *Agabus brunneus*, *Laccophylus poecilus*, *Laccophilus minitus*, *Berosusaffinis*, *Hydroporus pubescens*, *Hydophylus piceus*, *Berosus signaticollis*, *Enochrus halophilus* [50], The two species of Coleoptera present in our sampling *Laccophilus minitus* and *Berosus affinis* were identified by Amri in Morocco as a student, the structure of taxonomic diversity of the benthic population [51] and the species *Laccophilus minituscité* by Boukali-Hacene in the region of Tlemcen [52]. The species of *Hydrocanthus iricolor* harvested by Sanogo in the study of macroinvertebrates in two lakes made it possible to highlight the spatio-temporal distribution of macroinvertebrates bioindicators of water quality in Burkina Faso [53].

However, with regard to Hemiptera, the five species we have identified: *Notonecta glauca*, *Anisops sardea*, *Plea minutissima*, *Corixa punctata* and *Nepa cinerea* have been cited by Annani in his study, Aquatic hemiptera from northeastern Algeria: distribution, phenology and conservation [54]. On the other hand, the same species have been identified by Laurince in his systematic study of insect species in the ponds of five fish farms in southern Côte d'Ivoire, in order to make a contribution to the knowledge of the entomofauna of this ecosystem [55], likewise in Morocco, Lmohdi performed a systematic survey of 504 individuals of aquatic Heteroptera, which allowed him to identify 22 species

[56]. On the other hand, in the group of invented cladocerans, Daphnia magna was cited by Samraoui [57]. While the species *Simocephalus expinosusa* has been identified by Chakri [58].

An analysis of this aquatic biodiversity has highlighted the low diversification of stands in continental ecosystems of North Africa. Indeed, most families and genera are poor in species: Noteidae, Dytiscidae, Hydrachnidae, Notonectidae, Daphnidae on the other hand, these taxa have a large specific variety in European aquatic networks. The significant decline in this diversity is due to the high temperatures and the minimum rainfall rate.

5. Conclusion

Invertebrate data for aquatic ecosystems harvested during the period from March 2015 to February 2016 in five selected stations at the periphery of Lake Birds. In our work we are interested in the classification of some harvested arthropods. The harvested species belong to six Orders and fourteen families: that of Coleoptera (Noteidae, Hydrophilidae, Dytixidae); Hemiptera (Notonectidae, Pleidae, Corexidae, Nepidae); Diptera: (Culicidae); Mite (Eylaidae, Pionidae, Hydryphantidae); Crustacean (Daphnidae), and Odonate (Aeshnidae).

All species identified systematically are an important part of the aquatic ecosystem.Some species such as Hydrachnidia are considered as predatory predators, at all active states; they play a significant role in regulating the fauna of these biotopes. They contribute to the maintenance and development of other animal species. They are in this sense good indicators and their presence, reveals a sure sign of the faunistic richness of the fresh waters.

6. Acknowledgements

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