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Ecology and Biodiversity of underground water in the region of Nord Constantinois (North Eastern Algeria)

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ABSTRACT

We studied for the first time the Ecology and biodiversity of underground water in the region of Nord Constantinois (North Eastern Algeria). The results obtained from the investigations of 16 wells and 04 sources from Mars 2015 to Mars 2017 at five administrative regions; Constantine, Mila, Guelma, Skikda and Oum El Bouaghi in eastern of Algeria showed that this aquatic fauna is composed of 25 taxa (families) and 4649 individuals and is dominated by 40% insects and 16% Gastropoda. Only a few stygobitic species were harvested in the study region as the 'Pseudoniphargussp', 'Echinogammarussp', 'Thermocyclopssp' and 'Eucyprisvirens'. The maximum of diversity is present in wells when the water is of good quality, but it decreases in case of pollution. Stygobitic species are generally more sensitive to pollution than other aquatic sow species, they contain the indicator species of the water quality. The knowledge and this comparative review of the diversity of the fauna of wells located in the same region can be used in a first approach as a base for purposes of monitoring and environmental management.

Keywords: *Macro-Invertebrates, Stygobic, Aquatic Fauna, Bio-Indicators, Water-Quality, Underground Water, Nord-Constantinois, North Eastern Algeria.*

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1. INTRODUCTION

Groundwater is considered to be a true underground ocean participating in the cycle of water; it also constitutes a reservoir of wildlife (Issartel et al, 2007). Ecological research on the underground aquatic fauna and particularly of groundwater table at the level of the wells represents one of the aspects of the applied phreatobiology that has been known as the update appropriate method (Cvetkov, 1968) and an important development (Lakhdari, 2014). Early stygobiological research began in Europe and has been multiplied rapidly (Botosaneanu, 1986). Knowledge in this area relates to one-time samples of biogeographically order (Pesce, 1981; Malard, 2003), or the study of a particular biotope (Peck, 1998), or a study of systematic order (Pesce, 1981 and AïtBoughrous, 2007). Then, the study of underground hydrobiology was undertaken in other continents, especially in Africa, and only comments were published in 1950 (Nourrisson, 1956, Lakhdari, 2014). In North Africa, Stygobiologicals searches were conducted in Morocco by (Boutin & Boulaouar, 1983; Messouli, 1988; Yacoubi - Khebiza, 1990). These researches showed that the wealth of stygobic wildlife was very variable from one region to the other because of the endemic nature of these species (Boutin, 1996).

In Algeria, the knowledge of the diversity of subterranean aquatic fauna remains limited, despite the relatively old data (Gurney, 1908), this research was rare and partial. There are the faunistic surveys carried out by (Racovitza, 1912), Monod (1924), Gauthier (1928), Nourrisson (1956), Delamare (1960), Pesce & Tete (1978), (Pesce et al., 1981) and (Lakhdari, 2014). Also, the underground fauna has been the subject of systematic studies to inventory the stygobal species of the alluvial water of Oued Tafna in Telemcen (Chebika 2003, Belaidi et al 2004, Mahi 2007, Belaidi et al., 2011, and Haicha, 2013). And, as for the subterranean aquatic fauna of North-East Algeria, it has been the subject of some contributions (Merzoug et al., 2010).
The aim of this study was to determine the ecology and the biodiversity of the subterranean aquatic fauna and represent the results of a stygobiological research through wells in the region of Nord Constantinois (Eastern Algeria).

2. MATERIALS AND METHODS

Study Area

The Nord Constantinois region is located in northern Algeria, in a wide area consisting of mountains, valleys, and plateaus between the Mediterranean Sea and the Sahara Desert, where the landscape is dominated by steppe vegetation. This area has a semi-arid climate with cold winters, and an annual mean temperature of 22.7°C, and average annual rainfall 510mm.
Due to the very considerable area we tried to choose points as we obtain the maximum covered area some of these points

were located in urban area and the other ones were in agricultural or mountains & forests areas

The studied stations are located in five administrative regions; Constantine with 7 sampling points (5 wells & 2 sources), Mila with 5 sampling points (4 wells and 1 source), Guelma with 3 sampling points (3 wells), Skikda with 2 sampling points (1 well and 1 source) and Oum El Bouaghiwith 2 sampling points (2 wells)

The area of study is located between latitudes of 36 ° 05 ' and 36° 66' N and longitudes of 6°00 and 7° 15

The sampled points are shown in the map below (Figure 1).

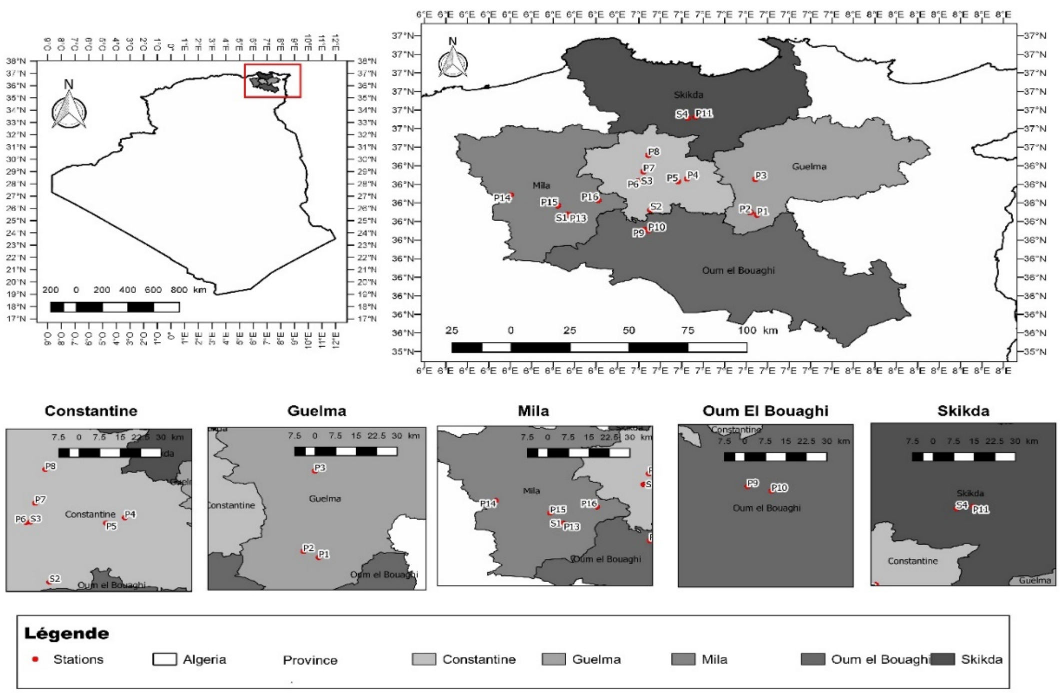

Figure 1: Geographical location of the 20 sampled stations.

Sampling and Statistical analysis

After prospecting the field, 16 wells and 04 sources were chosen, and a seasonal aquatic wildlife and water sample from these wells was taken under consideration, the sampling was done from Mars 2015 to Mars 2017.

Seasonal wildlife samples were carried out in wells with a net phreatobiological, based on the model firstly developed by Cvetkov (1968), and slightly amended by Boutin (1996). The effectiveness of this method of sampling has been recognized by (Boutin & Boulanouar, 1983) for the capture of planktonic and nectonicals wildlife.

However, this technic was supplemented by the use of baited traps that are often more effective for the harvest of wildlife creeping, interstitial or fossorial, in particular for some specific crustaceans such as the isopods (Boutin & Boulanouar, 1983).

The fauna of the sources was sampled by direct filtration of water through a silk net 300 μm mesh, stirring the sediments close the wells sides in the source upstream of the net (Messouli, 1984).

The wildlife harvested during each sampling was fixed in place where 98% pure ethanol was used, and then extracted, sorted, counted and finally identified in the laboratory; the settlement of the origin aboveground, which is usually formed by the larvae of immature insects, does not characterize the groundwater. So, the wildlife aboveground was determined only at the level of the family.

The data analysis was performed using Microsoft Office EXCEL 2016 suite and the given data that have been preceded were the species abundance of each well and source (the total number of individuals collected in each of the stations during the study).

3. RESULTS

Global fauna Composition

The analysis of fauna of 16 wells and 4 sources in the region of the study revealed that these ecotones are home to aquatic fauna which average taxonomic richness is close to 8.9 taxa by the station, but actually varies from 4 to 13 taxa from one station to the other. Four zoological groups were represented in our collections. They include the Arthropods that are most plentiful (68%), Mollusks (16%), Annelids (12%), and flatworm Platelminthe by (3%). (Figure 2).

If we classify these groups by classes, we can find 10 classes that are represented. They include the Insecta that are most plentiful (40%), Gastropoda (16%), Turbellaria & Clitella (12%), Ostracoda (8%) and flatworm Maxillopoda & Malacostraca & Arachnidaby (4%) (Figure 3).

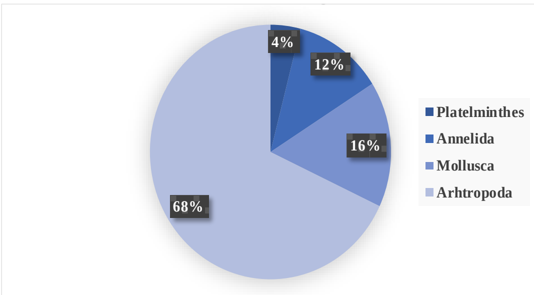

Figure 2: General Structure of Zoological groups(Phylums)

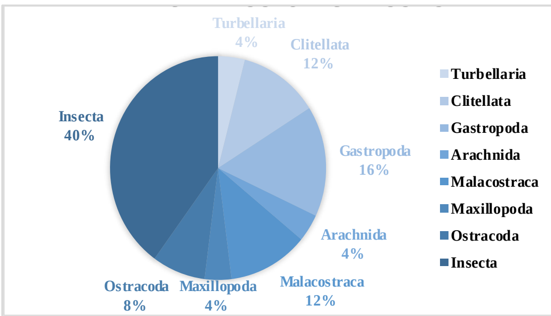

Figure 3: General Structure of Zoological groups (Classes)

Abundance and Frequency

The analysis of the spatial variation in the number of wildlife individuals harvested at the different stations (Figure 4) that is shown below can tell us that Thermocyclops is the dominant taxon in these habitats with 1004 individuals. However, the amphipods or wildlife stygobic "Pseudoniphargus" indicators of pollution in 15 from 16 wells by 587 individuals but it was absent from all sources.

The spatial variation in the number of wildlife individuals harvested at the different stations expressed by the abundance percentage (Ac %) is also shown by Figure 5.

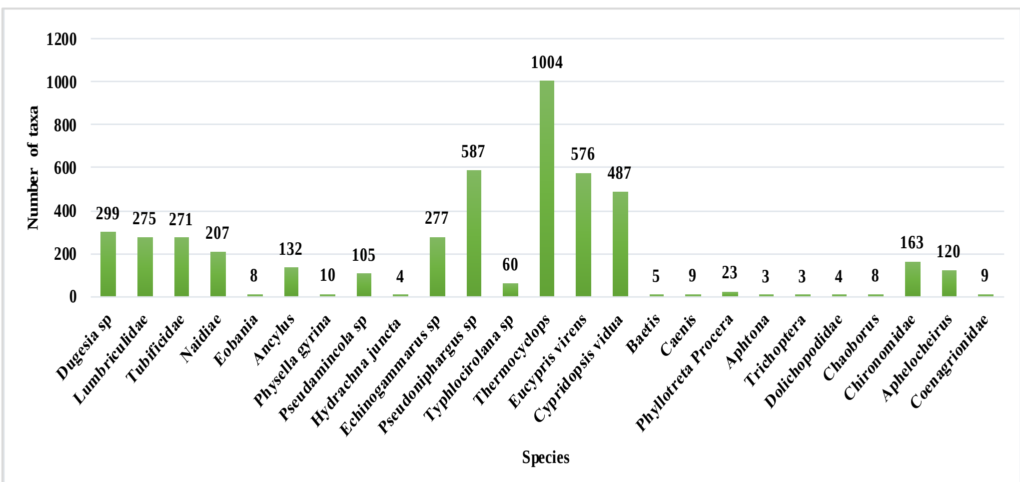

Figure 4: Spatial variation in the number of wildlife individuals harvested at the different stations

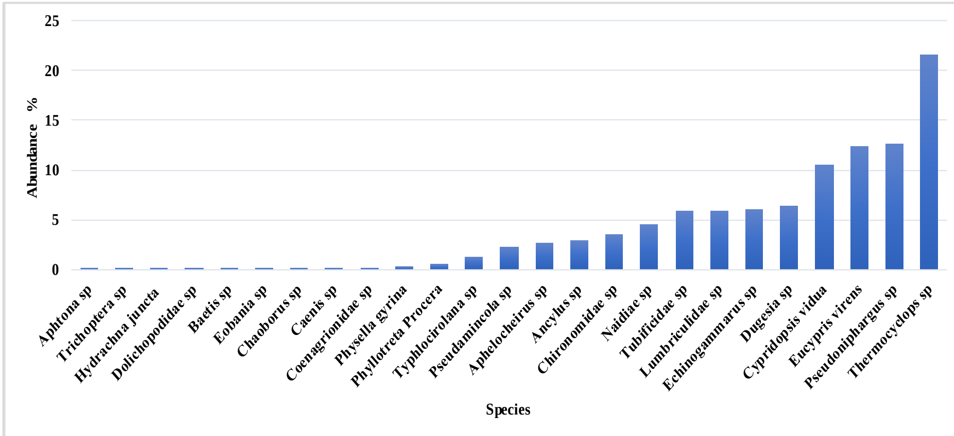

Figure 5: Spatial variation in the number of wildlife individuals harvested at the different stations

The analysis of Figure 6 relating percentage frequency of species harvested at the different, stations shows a large variation of the frequency between species, it also can help us in the classification of species between accidental, accessory, regular, and constant; these results are shown in Table 1 and Figure 7.

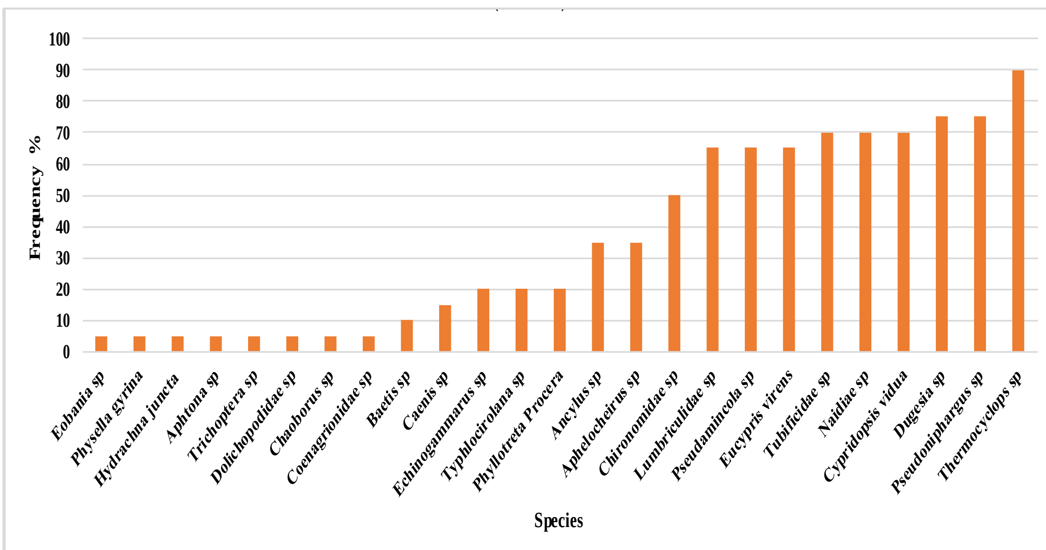

Figure 6: Percentage frequency of species harvested at the different stations

Table 1: Percentage of abundance (Ac%) &frequency (Fi%) of species and classification

N°	Species	Ac(%)	Fi(%)	Fi Class
1	Dugesia sp	6,43	75	Constant
2	Lumbriculidae sp	5,92	65	Regular
3	Tubificidae sp	5,83	70	Regular
4	Naidiae sp	4,45	70	Regular
5	Eobania sp	0,17	5	Accidental
6	Ancylus sp	2,84	35	Accessory
7	Physella gyrina	0,22	5	Accidental
8	Pseudamincola sp	2,26	65	Regular
9	Hydrachna juncta	0,09	5	Accidental
10	Echinogammarus sp	5,96	20	Accidental
11	Pseudoniphargus sp	12,63	75	Constant
12	Typhlocriolana sp	1,29	20	Accidental
13	Thermocyclops sp	21,6	90	Constant
14	Eucypris virens	12,39	65	Regular
15	Cypridopsis vidua	10,48	70	Regular
16	Baetis sp	0,11	10	Accidental
17	Caenis sp	0,19	15	Accidental
18	Phyhhotreta Procera	0,49	20	Accidental
19	Aphtona sp	0,06	5	Accidental
20	Trichoptera sp	0,06	5	Accidental
21	Dolichopodidae sp	0,09	5	Accidental
22	Chaoborus sp	0,17	5	Accidental
23	Chironomidae sp	3,51	50	Regular
24	Aphelocheirus sp	2,58	35	Accessory
25	Coenagrionidae sp	0,19	5	Accidental

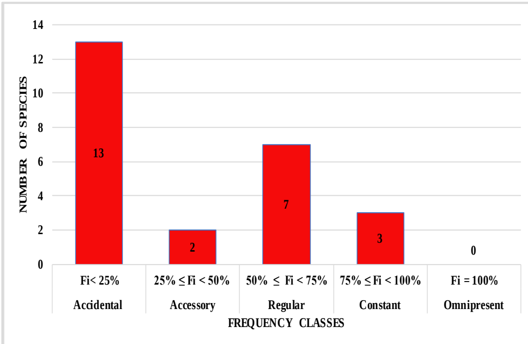

Figure 7. Frequency classes of species harvested at the different stations

There were a total of 25 taxa, the number of constant taxa was 3 represented by Pseudoniphargussp, Thermocyclopssp, and Dugesiasp; there were also 7 regular taxa, 2 accessory taxa and 13 accidental taxa.

Taxonomic richness

The analysis of Figure 8 relating to the spatial distribution of the taxonomic richness, shows a variation of the wealthy taxonomy from one well to another.

There was a total of 25 taxa, the number of taxa fluctuated between a minimum of 04 taxa collected in the wells (P6, P7, P14, P15) and a maximum of 13 taxa collected in the source S1;7 sampling points have delivered more than 10 taxa (P12, P13, P16, S1, S2, S3, and S4) and the rested 13 others ones have delivered only 4 to 10 taxa (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P14, and P15).

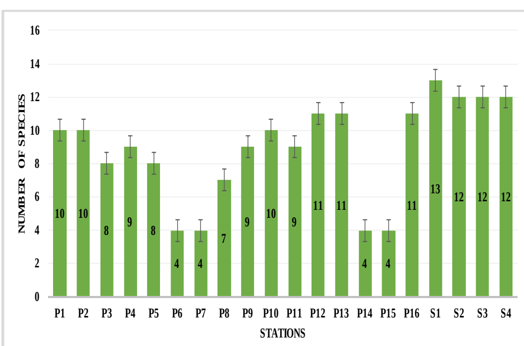

Figure 8: Spatial Variation of the taxonomic richness of wildlife harvested in the different resorts

4. DISCUSSION

Most of the studied wells are located far from the city in fields or pasture areas. Also, the main causes of pollution of the water in these wells are most likely related to the discharges of raw sewage flowing in small channels often used for irrigation, or more simply to evacuating water away from houses; in all cases, these wastewaters can seep up to the water table which is not very deep in general; so, infiltration of the wastewater, leads to the low oxygen levels. Finally, the lack of the protection in a greater number of wells contributes to the enrichment of the organic water because of the wind flows of leaves and other plant debris that will be on-site decomposers.

Considering the fauna, the taxonomic richness observed in wells in the study area is moderately higher than that in the other regions surveyed in Algeria.

Only 25 taxa and 4649 individuals were harvested during this study. This wealth remains lower than that recorded in the 12 wells dug at the level of the alluvial groundwater of Oued Tafna (Belaidi et al. 2011), 16 wells from the Oum-El-Bouaghi area in the Northeast Algerian (Merzoug et al, 2010), and in 16 wells in the Mascara region (Lakhdari, 2014). This high number of taxon is probably the result of higher harvested species in sampling efforts which are mostly of superficial origins.

They were mostly aboveground fauna, constituted mainly by the Group of insects represented by the Diptera, Culicidae, Chironomidae, and to a lesser extent the Ephemeroptera Baetidae. Beside insects, there came the Crustaceans such as the Amphipod Echinogammarus, CyclopoidaeCopepods and Ostracods. The presence of these species depends on the Morphometry of the well, its development and its protection on the surface. Indeed, 70% of the studied wells were without protection with an average depth of water. As well, all groups of invertebrates were represented in the wells; and the aboveground fauna is dominated numerically and taxonomically by the insects with a rate respective of 45 percent and 16 percent for Gastropoda have a wide distribution in wells, and a great capacity to colonize the polluted and unpolluted habitats, and in case of the lack of protection for the majority of the wells which induces a colonization by the air, they form the most abundant group.

These are invertebrates known by their tolerance to pollution, and generally prefer high temperatures (Haouchine, 2011).

The stygofauna of the studied water were represented by 'Pseudoniphargussp', 'Echinogammarussp', 'Thermocyclopssp' and 'Eucyprisvirens'. These appearances of crustaceanhave been observed in the groundwater of all the studied regions (Racovitza, 1912; and Nourrisson, 1956), and 37 species were found in Algeria, and only Pseudoniphargusstygobies were captured in almost wells but this number remains largely lower than average Tafna (Belaidi et al. 2011), and in the region of Oum El Bouaghi (Merzoug et al. 2010).

The scarcity of wildlife stygobies in wells in the study area could indicate deterioration in the quality of the well water because of their role as species bioindication (Belaidi et al. 2004).

In our case, the low richness of the stygofauna would be linked to the water contamination in many studied wells, by seepage of especially agricultural fertilizers and pollution.

In addition, some species of pollution-resistant from aboveground origin are present in the majority of the prospected wells, as it is the case of the larvae of Chironomidae and Culicidae insects (Lakhdari, 2014).

The most recent studies have shown that the diversity and sometimes even the presence of underground aquatic wildlife vary based on the quality of the waters (Lafont et al. 1992; Aïtboughrous, 2007).

5. CONCLUSION

This first approach, by helping to improve the knowledge of the underground aquatic fauna of Algeria, contributed to the study of the groundwater in the region of study. The fauna analysis carried out in this work, represented a relatively rich aquatic fauna qualitatively and quantitatively. It is composed of only 21 taxa (7582 inds). A single taxon was identified as a stygobic species, which was a crustacean of the kind of Pseudoniphargus, that we only know 2 species: "Pseudoniphargus Africanus and Pseudoniphargus macrotelsoni.

The results also showed the hydraulic importance of exchanges between surface waters and the ground-waters, particularly wells. This significance lies among others in the enrichment of the underground medium in organic matter representing the stygofauna. This work has been an additional step in improving the knowledge of the fauna of the Algerian stygobic. It might be contributed to the specific determinations made, delineating the range of each species particularly amphipods such as Pseudonifargidae.

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