World Journal of Environmental Biosciences

Available Online at: **www.environmentaljournals.org**

Volume7, Issue 2: 39-44

ISSN 2277- 8047

Ecology and Biodiversity of Underground Water in A Semi-Arid Region of the Hauts Plateaux of Eastern Algeria

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ABSTRACT

We studied for the first time the Ecology and biodiversity of underground water in a semi-arid region of the hauts plateaux of Eastern Algeria. The results obtained from the investigations of 24 dug wells and 01 source from September 2014 to May 2016 at the regions of 'Ain Beida and Ksar Sbihi' in Oum El Bouaghi city eastern Algeria showed that this aquatic fauna is composed of 21 taxa (families) and 7582 individuals, and is dominated by 56% insects and 25% crustaceans. Only a stygobitic species was harvested in these regions 'Pseudoniphargus sp'. 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 comparative review of the diversity of the fauna of wells located in the same region can be used for purposes of monitoring and environmental management.

Keywords: *Underground Water, Hauts Plateaux, Stygobic, Insects, Eastern Algeria.*

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Received: 06 January 2018
Accepted: 25 March 2018

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 Aït Boughrous, 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 stygobitic 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 and Khaldoun et al, 2013).

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 hauts plateaux of eastern Algeria.

2. MATERIEL AND METHODS

Study area

The Hauts Plateaux is located in northern Algeria, in an 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 an annual mean temperature of 25°C, and average annual rainfall less than 400 mm (Zoubiri et al., 2018). The studied stations are located in two distinct regions; the first in the South of Oum El Bouaghi city, and the second in its North (Figure 1).

Ain Beida region

The watershed of Ain Beida is a part of the whole basins of the Constantine's hauts plateaux (ARNH), it covers about 2432 Km2. The area is located between latitudes of 35 ° 22 ' and 35 ° 56' N and longitudes of 6 ° 7 and 49 ° 34 ' E, in an endorheic basin and semiarid climate. These two characteristics negatively affect groundwater resources and superficies both quantitatively and qualitatively. Two main runoffs found their path within the perimeter of the town of Ain Beida, one in Oued El Hassi in the North, and the other in Oued Isfer to the South. The region belongs to the eastern part of the geological field. Two geological formations can be distinguished: first arable land, training of slope and old alluvium, then limestone scabs resulting from concentrations of carbonates dissolved in the water (Figure 1).

Ksar Sbihi region

The study area is located at the limit between Chebket Sellaoua and Tamlouka basin. It belongs to the domain in the North of Algeria '15' 00 is 36 ° 05' North, 7 ° 00'. Geological formations are sedimentary rocks, including a large part of marine origin. Considering the hydrographic hairy, there are very little developed, only a few smaller wadis comparable to real streams criss-cross the plain, and there are various tributaries of the Oued Charef, the Oued El Melah (Figure 1).

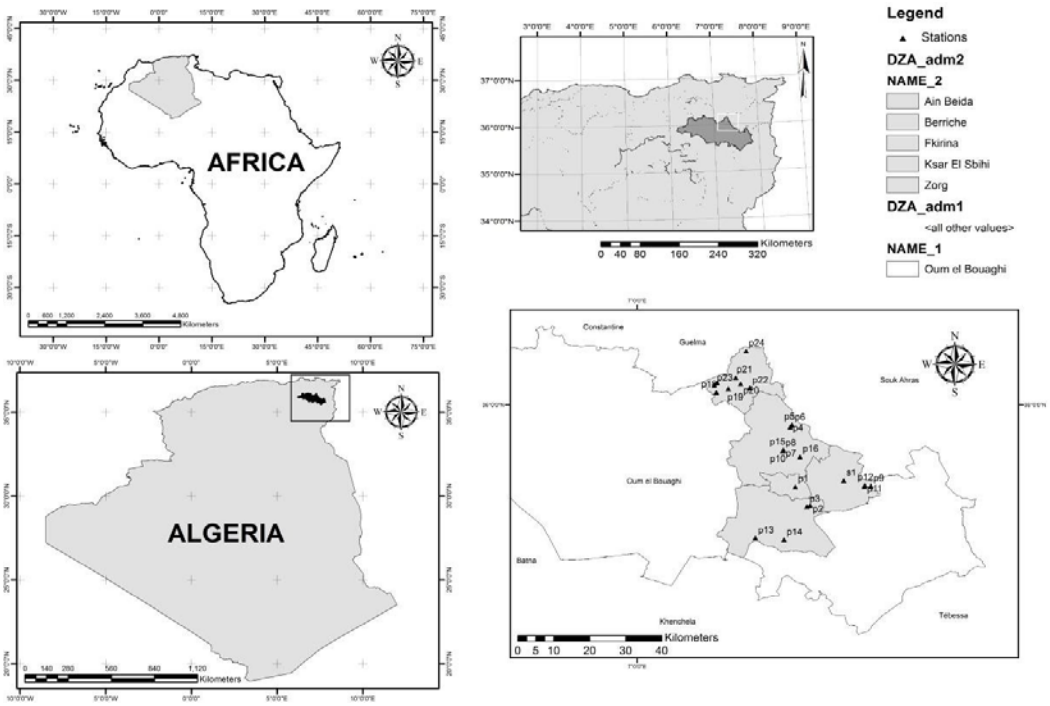

Figure 1. Geographical location of 25 sampled stations.

Sampling and Statistical Analyses

After prospecting the field, 24 wells and a 01 source were chosen, and a seasonal aquatic wildlife and water from these wells were taken under consideration, and the sampling was done from the month of September 2014 to May 2016. Seasonal wildlife samples were carried out in wells with a net phreatobiological, based on the model first 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 technique 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 certain 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 factorial correspondence analysis (FCA) was performed on the data from the maximum values of the abundance of the species of each well and the source (the total number of individuals collected in each of the stations during the study), appearing in table 1. The data has been processed using software ADE4 (Doledec & Chessel, 1994).

3. RESULTS

Global fauna Composition

The analysis of fauna of 24 wells and a source in the region of the study revealed that these ecotones are home to aquatic fauna which average taxonomic richness is close to 11.4 taxa by the station, but actually varies from 7 to 15 taxa from one station to the other. Four zoological groups were represented in our collections. They include the insects that are most plentiful (56%), crustaceans (25%), mollusks (16%) and Arachnids (3%). (Figure.02).

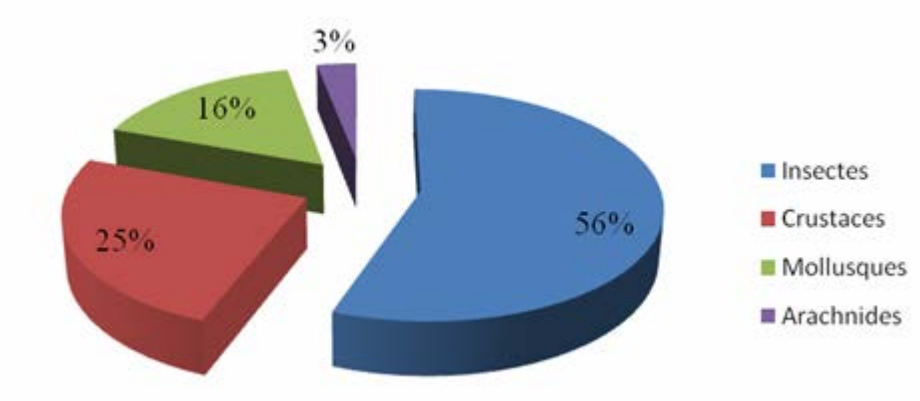

Figure 2. General Structure of Zoological groups

Abundance

The Diptera Culicidae is the taxon dominant in these habitats with 1170 individuals. However, the amphipods or wildlife stygobic "Pseudoniphargus" indicators of pollution in P1, P2, P3, P4, P5, P6 wells were 53 individuals. "Echinogammarus haraktis" Echinogammaridae can be found in half of the studied wells, it presented some resistance to pollution. This species was present with 933 individuals (Figure 03).

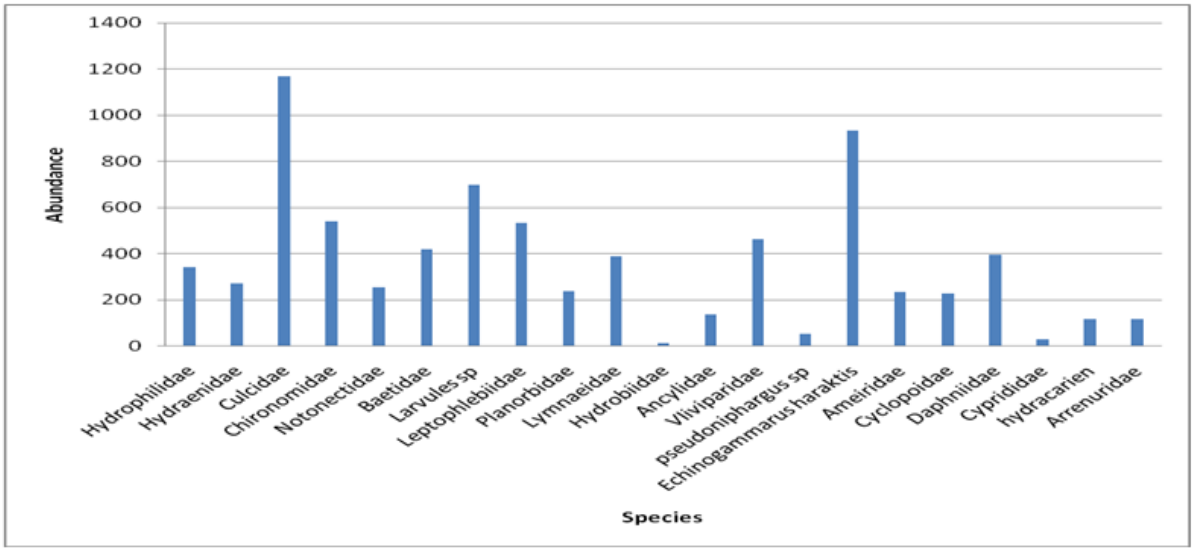

Figure 3. Spatial Variation in the number of individuals of wildlife harvested in the different wells

Taxonomic richness

The analysis of figure 04 relating to the spatial distribution of the taxonomic richness, shows a variation of the wealthy taxonomy from one well to another. There were a total of 21 taxa, the number of taxa fluctuated between a minimum of 07 taxa collected in the well P19 and a maximum of 15 taxa collected in Wells P16 and P9. The majority of the wells have delivered more than 10 taxa (P7, P8, P9, P10, P11, P12, P13, P14, P15, P16, P17, P21, P22, and P24). Others have delivered only 7 to 10 taxa like the P1, P2, P3, P4, P5, P6, P18, P19, P20, and P23et S1.

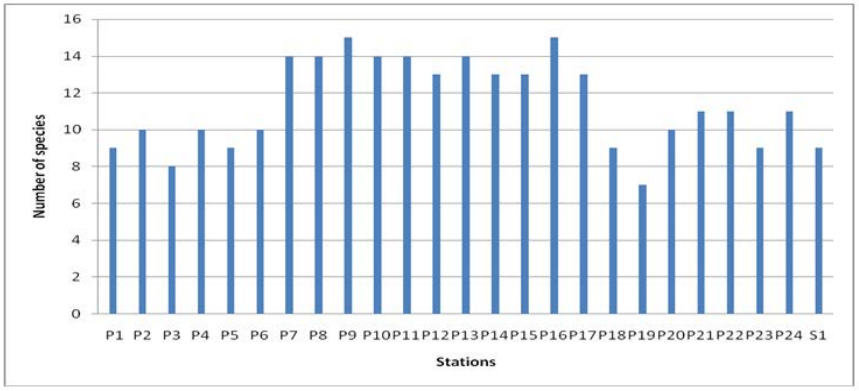

Figure 4: Spatial Variation of the taxonomic richness of wildlife harvested in the different resorts

Spatio-temporal variation

There were 21 taxa in 25 stations. The distributions are represented in two coordinate system axes (Figure 5), which quite explain 70% of the total variance. There were three separate groups:

The first group: includes wells P9, P11, P13, P16, P17, P19, P20, P21, P22, P23 and P24 which are wells without cover, so not protected, have delivered a fauna that is both diverse and abundant (with 09 taxa), generally characterized by insects such as the Culicidae that are dominant in number, Ostracods (Daphinidae) and gastropods (Hydrobiidae) that are indicators of the presence of organic matter.

The second group: this group brings together a set of 06 wells P7, P8, P10, P12, P14 and P15, and source S1 which wildlife is at once less diverse (06 taxa only) and less abundant. This fauna is presented mainly by amphipods (Echinogamarus haraktis) which presents some resistance to contamination agents.

The third group: it brings together 07 wells P1, P2, P3, P4, P5, P6, and P18, which are all protected from wind contributions, but located far enough away from the inhabited places. The fauna of this group is clearly revealed by the presence of wildlife stygobic (Pseudoniphargus) which is the indicator of a good water quality (Figure 5).

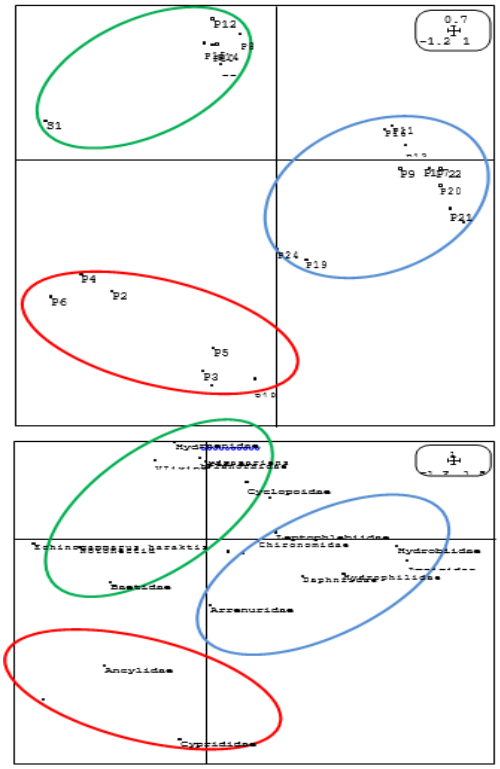

Figure 5: Graphical presentation of factorial correspondence analysis (FCA) showing the distribution of taxa throughout different stations in the region. Factorial plan 1x2 indicates around 70 % of the total variation (Axe 1: 32.77%; Axe 2: 21. 84 %; Axe 3: 14,05%).

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 21taxa and 7582 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, Cyclopoidae copepods and Ostracods. Finally, the shellfish are very weakly represented by gastropods Planorbidae and the Viviparidae. The presence of these species depends on the Morphometry of the well, its development and its protection on the surface. Indeed, 60% 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 55 percent and 38 percent. Diptera 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). Dominance of the Culicidae family with a relative abundance of 45%, is the most common. It colonizes the sets of wells during all sampling campaigns, this is in line with (Mahi 2007). Crustaceans represent 25% of the harvested wildlife. They are represented by three taxa: that amphipods are more abundant than copepods and Ostracods. Their harvest was performed only at the level of the well P2, P4, P6, P7, P8, P10, P12, P14, P15, P18, P19, P24 and S1 for the Amphipod Echinogammarus. The stygofauna of the studied water was represented by a crustacean. This appearance of crustacean has been observed in the groundwater of all the studied regions (Racovitza, 1912; and Nourrisson, 1956), and 37 species found in Algeria, and only Pseudoniphargus stygobies were captured in the wells P1, P2, P3, P4, P5, and P6. 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 except wells P3, P8 and P13, by seepage of especially agricultural fertilizers widely used in the region of plain Ghriss. 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; Aït boughrous, 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.

6. ACKNOWLEDGEMENTS

Authors are thankful to Pr. Christophe Piscart (Ecobio) - University of Rennes I for his help in determining species, and Mr. Rebbah abderraouf chouaib for his help in preparing the Map.

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