International Journal of Advanced Science and Research
ISSN: 2455-4227; Impact Factor: RJIF 5.12
Received: 19-01-2019; Accepted: 22-02-2019
www.allsciencejournal.com
Volume 4; Issue 2; March 2019; Page No. 37-41

Commented inventory of molluscs in the wetlands of the Gharb plain (Morocco)

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Abstract
Due to their rich biodiversity, wetlands are of multiple ecological, economic and climatic interest. For the sustainability of these multiple interests and for other functions provided by these types of ecosystems, the assessment of the degree of biodiversity is necessary. Thus, the determination of the specific inventory of systematic taxa is the basis for assessing the degree of quality of this biodiversity. Through this work we have developed a commented inventory of Molluscs from the wetlands of an important plain in Morocco: Gharb. Qualitative surveys of these wetlands have shown that the plain shellfish population is composed of 21 species arranged in 14 genera, 11 families, 3 Orders and two classes. The Gastropods class has 18 species and the Lamellibranch class has only 3 species. In addition, most of the inventoried species are common in other wetlands in Morocco. No species is specific to the plain studied. In addition, the majority of species are holarctic.

Keywords: biodiversity, wetlands, molluscs, Morocco

1. Introduction
Human actions are the main cause of the qualitative and quantitative degradation of wetlands [1]. Indeed, under the influence of agriculture, aquaculture, river development, the extraction of living or inert materials and the direct or indirect emission of pollutants, the quantity of water quality, the main driver of these ecosystems, is constantly deteriorating. However, wetlands are vital to the survival of humankind, are highly productive on the planet and, in addition to producing water through their high biodiversity, ensure the productivity of countless species of plants and animals [2].
Wetlands are therefore floristic and faunistic treasures since they are home to a large number of plant and animal species the profile of which they can serve as migratory stages, breeding grounds, wintering grounds or as a feeding ground [3]. Thus, these biological functions give wetlands a much higher biological productivity than other environments. However, this productivity cannot be optimal without the presence of a rich and balanced biodiversity, and the preservation and sustainability of these two characteristics [4]. For a given wetland, an assessment of the status of this biodiversity is therefore necessary. However, this evaluation always begins with the elaboration of inventories of the species of the different systematic groups in the environment.
In the same vision, the objective of this work is to develop a commented inventory of molluscs in the wetlands of the Gharb plain, a geographical area located in northwestern Morocco that hosts Morocco's largest hydrological network.
In addition, molluscs occupy biotopes in water bodies, from small temporary pools and streams to rivers and large lakes. In each of these biotopes, molluscs can meet in places and the different sites must be carefully examined when searching for them.
It should be noted that in order to recognize the specific structure of the malacological populations of the studied plain and to give an overview of the ecological characteristics of the species harvested in Morocco and throughout the world, we have used the results of our sampling and the results of some previous work to establish a commented inventory of the malacological fauna of the Gharb plain.

2. Material and Methods
2.1 Site studied
The Gharb plain is located in northwestern Morocco, spreads along the shores of the Atlantic Ocean and covers a geographical area of about 616,000 ha. It lies between the meridians 3°50 and 6°35 West and the parallels 33°05 and 35°10 and is in the form of a large and low basin bordered to the north by the hills of Lala Zohra and to the south by the Maamoura plateau; To the east, it is bounded by pre-Rife wrinkles and to the west by the Atlantic Ocean, along which appears a dune cordon that is cut into cliffs, the succession of which is interrupted to the north by the gully of the Moulay Bousselham lagoon (fig 1).
From a pedological point of view, current or sub-current alluvial deposits of recent Gorbic acid cover the entire lower wound and correspond to more or less sandy silts or black clay soils (shots) [5, 6].

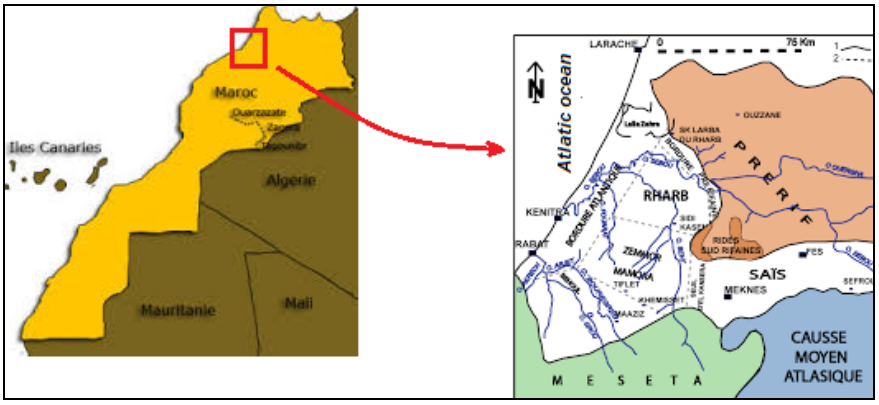

Fig 1: Gharb Paine: Hydrological network

From a hydrological point of view, the whole basin is the most important hydrographic basin in Morocco because their annual contributions are around 6.6 billion m^3, or about 30% of the national hydraulic potential. The main watercourse of the plain is the Sebou, which enters from the east and makes a wide curve to the north before reaching the south to reach the ocean at the Kenitra-Mehdia zone. The main tributaries of Oued Sebou are Oued Ouargha on the right bank, with an overall ratio representing almost half of the total (47%) and Oued Beht on the left bank which presents (5%) of the total water supply. The Gharb lakes cover an area of 1.9% of the plain. They are wet depressions and entirely low swampy bottoms whose extent oscillates according to winter inputs and evaporation in summer. These wetlands are distributed on either side of the Oued Sebou.

The climate is Mediterranean in nature, with oceanic influences in the west and continental influences in the east.

2.2 Method of qualitative study of the studied fauna

During the years 2014/2015 we surveyed fifty stations in the wetlands of the region. The choice of these stations is made in such a way as to cover all the wetlands of the plain while taking into account their heterogeneity (lakes, temporary rivers, etc.). The different points identified at each station were qualitatively sampled, preferably in spring and summer, seasons that correspond to the maximum population size. The cloudy flounder pressed together with a 450 micron mesh vacuum was used for qualitative harvests. This material is pulled over a length of one meter. Samples were fixed in the field by adding a 5% formaldehyde solution (10% when the sample contained a lot of organic matter).

2.3 Sorting and determination

Species were sorted and determined in the laboratory using a binocular magnifying glass (maximum magnification 40. Specimen identification was performed at the most accurate taxonomic level possible. Class, order, family, genus, species thanks to existing guides and the help of specialists. For each species mentioned we mentioned habitat and geographical distribution. The identification of taxa is carried out by a key to the determination established by Kharboua (1988) [7], referring to the work of Girod *et al* (1980) [8], Giusti and Pezzoli (1980) [9] and Kristensen (1985) [10].

3. Results and Discussion

We harvested 21 species, this list of species was completed by other species harvested by other authors, namely Kharboua (1988) [7], Maqboul (1996) [11], Fadli (2003) [12].

3.1 Systematic overview of species

Class Gastropoda

Under Class: Pulmonata

Order: Basommatophora

Family: Lymnaeidae
- *Lymnaea truncatula* Muller, 1774
- *Lymnaea peregra* Muller, 1774
- *Lymnaea stagnalis* Linné, 1758
- *Lymnaeapalustris* Muller, 1774

Family: Planorbidea
- *Planorbarius planorbis* Linné, 1758
- *Gyraulus laevis* Linné, 1758

Family: Physidae
- *Physa acuta* Draparnaud, 1805

Family: Ancylidae
- *Ancylus fluviatilis* Muller, 1774

Family: Acroloxidae
- *Acroloxis lacustris* Linné, 1774

Order: Stylommatophora

Family: Succinneidae
- *Succinea debilis* Morelet, 1859

Under Class: Prosobranchia

Family: Melanopsidae
- *Melanopsis praemorsa* Linné, 1758
- *Melanopsis costellata* Ferussac, 1923
- *Melanopsis scalaris* Gassies, 1856
- *Melanopsis mourebeyensis* Pallary, 1936
- *Melanopsis cariosus* Linné, 1858

Family: Hydrobiea
- *Mercuria confusa* Frauenfeld, 1838

Family: Nereidtidea
- *Theodoxus fluviatilis* (Linnaeus, 1758)

Class Lamellibranchia
Order: Eulamellibrancia

Under Order: Schizodonta

Family: Unionidae
- *Unio durieuib* Philipsson, 1788
- *Anodonta cygnea* Linné, 1758
- *Margaritana margaritifer* Linnée, 1758

Under Ordre: Heterodonta

Family: Sphaeriidae
- *Pisidium casertanum* Poli, 1791

3.2 Ecological and biogeographical overview of inventoried species

Lymneidae

Lymnaea truncatula

In Morocco: unusual species, it is found in the Agadir region, the Ouarzazate region, the Atlantic and Rifine regions and in all the coastal meseta. This species is the intermediate host of the Fasciola hepatica pathogen responsible for hepatobiliary distomatosis, which affects ruminants and more rarely humans in Morocco [13, 14]. It is classified by Saud (1995) [15] as a species that is dependent on running water. But it often colonizes waters with a low flow very rich in organic matter and diatomaceous earth [16] and the height of the water is a limiting factor [17].
Geographical distribution: Holarctic species.

Lymneae peregra

Common species throughout Morocco [16]. It occurs in permanent standing water [7], irrigation canals, and is less widespread in marshes and rivers. Saoud (1995) [15] adds that this species is abundant in biotopes rich in vegetation and highly mineralized water with varying degrees of organic matter content.

Geographical distribution: Palearctic species.

Lymneae stagnalis

In Morocco the species is very localized. It is reported in the Tingitana peninsula, the Middle Atlas and the Gharb plain [11]. It occurs in ditches, merjas, dayas and low-flow streams and resists salinity of 7% [16].
Geographical distribution: Holarctic species.

Lymneae palustris

In Morocco the species is reported in the regions of Tangier, the Gharb and Oued Bou Regreg. It is classified among the eurytope species [7] and is found in merjas, ditches, canals, more rarely in rivers [11].
Geographical distribution: Holarctic species.

Plnorbidae

Planorbis planorbis

In Morocco this species is collected in the plain of Tadla and the plain of Gharb [12]. It lives in calm waters rich in aquatic vegetation. It sinks deep into the mud and tolerates slightly brackish environments [16].

Geographical distribution: Holarctic species.

Gyraulus laevis

A common species in the north of the country that frequents permanent standing water and rarely temporary water. Ramdani *et al* (1987) [16] and Saud (1995) [15] indicated that she may have two breeding periods, one in spring and the other in fall.
Geographical distribution: Holarctic species.

Physidae

Physa acuta

A common species throughout the country that lives in all continental water formations including rivers, streams, springs, merjas, dayas etc. Ghamizi *et al* (1997) [17] and Rondelaud *et al* (2001) [18] add that this species is highly invasive and competitive. In addition, Adityag and Raut (2002) [19] describe this species as serious pests of certain plants of economic interest and Cheung and Lam (1989) [20] have indicated that it can accumulate cadmium.
Geographical distribution: species reported in all parts of the world.

Ancylidae

Ancylus fluviatilis

Gastropods that frequent springs, streams and rivers where they attach themselves strongly to stones. It is uncommon on muddy substrates [8, 16]. It is very common in the rivers of Morocco, the lakes of the Middle Atlas and the Gharb plain.
Geographical distribution: species from Europe, Middle East, North Africa and Ethiopia.

Acroloxidae

Acroloxus lacustris

It was collected from the Middle Atlas and Gharb plain [12] and lives in ponds, marshes, canals. With her biotope dry, she sinks into the mud [7].
Geographical distribution: species from Europe and North Africa.

Succineidae

Succinea debilis

Species harvested in the rivers of the Sebou river basin. It mainly frequents the vegetation that surrounds rivers and aquatic plants emerging from the water [16].
Geographical distribution: species from Europe and North Africa.

Melanoids

Melanopsis preamorsa

In Morocco this species is common to low watercourses and springs. It lives in colonies attached to stones and plants in rivers, streams, irrigation channels and hot springs. Tazi *et al* (2001) [21] reported that this species occupies aquatic biotopes at low elevations, high temperatures, high dissolved salt content and low flow.
Geographical distribution: circum-Mediterranean species.

Melanopsis costellata

Common species in the running waters of Morocco. It is found in rivers, preferably in high-flow streams.
Geographical distribution: circum-Mediterranean species.

Melanopsis scalaris

In Morocco, this species is found in wadi Sebou and its tributaries and in wadi Oum-Er'Rbia. She has about the

same demands and lifestyle as Melanopsis praemorsa and Melanopsis costellata with whom she can live [16].
Geographical distribution: species from North Africa and Spain.

Melanopsis mourebeyensis
It is an endemic species of Morocco. It has been reported by Maqboul (1996) [11] in rivers in the Gharb plain and can live in rivers, streams and is often associated with M. praemorsa in rivers.

Geographical distribution: Western Europe and Morocco.

Hydrobiidae
Mercuria confused
In Morocco, it is found in the Tingitan peninsula, the coastal meseta, North Eastern Morocco, the Agadir region, the Haouz plain and the salt springs of oued Oum-Erbia [22]. It is a species that frequents springs, merjas and slow flowing rivers.

Geographical distribution: Western Europe and Morocco

Theodoxus fluviatilis
It is rarely harvested from the Tadla and Gharb plains in calm streams and it prefers hot springs and sometimes rivers [16].

Geographical distribution: Species from North Africa and Europe that are dependent on running water environments.

Unionidae
Unio durieui
In Morocco, the species lives in running water with a low flow and a muddy or sandy silty bottom [15]. It sinks into the mud when the layer of water separating it from the air becomes thin.

Geographical distribution: Palearctic species

Margaritana mrgaritifera
In Morocco, this species has been reported by Kharboua (1988) [7] in wadi Sebou and by Fadli (2003) [12] in wadi Oum-Erbia. It inhabits the torrential waters of rivers and great rivers.

Geographical distribution: species from Europe and North Africa.

Sphaeriidae
Pisidium casertanum
Common species throughout the country. It inhabits all continental aquatic environments, even temporary [23], and prefers muddy bottoms.

Geographical distribution: species from Europe, North Africa and the Middle East.

Moreover, it should be noted that Planorbarius metidjensis Forbes, 1838 and *Bulinus truncatus* which are known as vectors of schistosomiasis in Morocco and which are historically reported in the Gharb plain [24] are not harvested in their current state, in the Gharb plain.

4. Conclusion
With 21 inventoried species, the aquatic mollusc population of the Gharb plain is specifically rich. It is also diversified since these 21 species are classified into 14 genera, 11 families, 3 Orders and two classes. However, we note that the Gastropod class has only three species. Thus, the specific diversity of the population of the Gharb plain is in favour of the Gastropod class. No species is exclusive to the plain studied and there is Lymnaea truncatula, which is a vector of Fasciola hepatica, a parasite responsible for human fasciolosis and ruminants. It should also be noted that from a biogeographic point of view, the majority of the inventoried species are holarctic.

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