

Study of Reptilian Species Inventoried In Two Moroccan Atlantic Lagoons: Oualidia and MerjaZerga.

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Abstract

The wetlands in Morocco are one of the important factors in ecological functioning. These areas, including lagoons, are home to many plant and animal species that find suitable habitat in these ecosystems to complete their life cycle. Despite this richness, many reptilian taxa have not been identified to date. The objective of this study is to make a comparative inventory of the reptiles of the lagoon of Oualidia and that of MerjaZerga. These two lagoons are among the most interesting Moroccan wetlands and listed as sites of international importance at the RAMSAR convention. The results obtained from this study show the frequencies of the reptilian individuals caught in the sampling sites MerjaZerga and Oualidia are respectively 45.80% (n = 120) and 54.20% (n = 142), with an average of / output of 40 individuals at the MerjaZerga site and an average / output of 47.33 ± 23.98 individuals at the Oualidia site. The identification of the captured individuals made it possible to list six species and five families. In fact, five species are identified in Oualidia (*Acanthodactylus lineomaculatus* (63 individuals), *Tarentola mauritanica* (21 individuals), *Agama imparealis* (16 individuals), *Chalcides mionecton* (22 individuals) and *Chalcides polylepis* (20 individuals) and a single species in MerjaZerga, (*Acanthodactylus lineomaculatus*). Both sites are characterized by a dominance of the species *Acanthodactylus lineomaculatus*. The occurrence index is highest in the MerjaZerga site (100%), and in the Oualidia zone 66.67% for the species *Acanthodactylus lineomaculatus* and *Chalcides mionecton*. This study thus enriches the taxonomic heritage of the region by confirming existing ones.

Keywords: reptile - lagoons - capture - wealth - MerjaZerga – Oualidia

INTRODUCTION

The Earth Summit in Rio de Janeiro held in 1992, comes to end all threats to biodiversity and ecosystem services [1], [2], [3] and [4]. According to the World Wide Fund for Nature (WWF) (Sylvain Biget, 2016), the Living Planet index between 1970 and 2012, which visualizes the evolution of number of vertebrate populations (fish, birds, mammals, reptiles, amphibians in the world) decreased by 52%.

Morocco is known for being the home of a wide variation of ecosystems ranging from desert to forest. However, despite this wealth of biodiversity and because of the limited literature available, many taxa remain unidentified despite the fact that the first work on the establishment of catalogs and determination keys dates back to 1925 [5] and [6]. As a result, in 2007, the National Museum of Natural History in Paris and the Scientific Institute surveyed three Moroccan areas; Rabat-Kenitra, Ifrane-Azrou (Middle Atlas) and Tetouan (Martil-M'diq).

Nevertheless, the Convention on Biological Diversity including that of Reptiles and Amphibians, established in August 21, 1995, Morocco decided to develop an implementation strategy that aims to identify the constituent elements of this fauna, to collect data surveillance and identify processes and activities that pose threats to its conservation.

It is for this purpose, that we are interested on the herpetofauna of two lagoons known in Morocco by their richness in vegetable and animal species; the lagoons of Merja Zerga and Oualidia. This study aims to better understand the biodiversity in these two ecosystems in terms of reptile and determine the characteristics related to the abundance, constancy and density of the listed species.

MATERIAL AND METHODS

Study Area

* The lagoon of Merja Zerga (34°47'N and 6°13'W) is located north of the Moroccan Atlantic coastline. The region is characterized by a Mediterranean-type climate, subject to oceanic influences. The average air temperature is 18°C with a significant annual temperature difference (26°C). Elliptical in shape, with a maximum length of 9 km, a maximum width of 5 km and an area of 35 km². The water temperature of the lagoon varies between 13 and 15°C in winter and 27 and 28°C in summer.

* The Oualidia lagoon is in the form of an authentic inlet stretching parallel to the Moroccan Atlantic coast, whose main axis is oriented NE-SW. Located at a distance of 79 km south of El Jadida and 64 km north of Safi. Its geographical coordinates are 32 ° 47'07''N, 9 ° 02'50''W and 32 ° 40'42''N, 8 ° 52'30''W. The total area of the lagoon is estimated at 4 km². Its length is 7 km; its width is 0.5 km.

Period of the study, sampling and identification method.

The study took place in 2013/2014. The sampling method adopted consisted of making time-spaced outputs. Three outings were made during the spring, summer and fall seasons. The characteristics of the captured individuals are noted in specific sheets prepared in our laboratory.

The study was conducted from two types of approaches practiced by most herpetologists, the direct sighting of Reptiles released, which consists in capturing the species manually (hunting in sight) but sometimes we are satisfied observing them with the naked eye, photographing them and observing their behavior in their natural environment. We have also captured some species by laying Barber traps,

“Barber pots”, this is a classic technique for trapping: A container filled with a conservation liquid is buried in the soil, the species that move on the ground surface fall into the Barber pot where a trap has been installed. The identification was made from various keys of determination and by comparison with the reference collections of the Scientific Institute of Rabat.

Statistical analysis

The main parameters we used to describe the formation and structure of the sampled herpetofauna are:

1. Density: Represented by the total density or primary density index (Id), expressed as the number of reptiles observed over 1000 m of pathways in a homogeneous medium [7] and by the specific gravity or secondary density index (ds) calculated for each species in each formation.

2. Wealth: Expressed by total wealth (S), as well as average wealth.

3. Diversity (H ‘): The diversity of each formation was calculated by the index proposed by Shannon and Weaver. We also calculated equitability at each formation level, as well as habitat amplitude for each species.

The results are expressed either in frequencies (qualitative variable) or in average (quantitative variable). A Chi-square statistical test is applied to confirm the hypotheses and multiple analysis for the projection of the modalities of the studied variables (Multiple Correspondence Analysis).

RESULTS AND DISCUSSION

Enumeration of captured and observed reptiles / site

Table (1) presents the results of catches of Lacertilians by sampling site (MerjaZarga and Oualidia), per field trip per month during the study period (2013-2014). The results are expressed in absolute frequencies and in relative frequencies expressed in percentages for each output. The chi-square independence test shows that the sample sites factor is significantly associated with the sampling month (chi-square = 17.02, p <0.000). In addition, 262 individuals are captured and observed throughout the sampling period. They are distributed as follows, 119 individuals are captured during the trips of the months of August and September which represents a relative frequency of 45.42%, followed by the Autumn outing with a relative frequency of 31.30% (n = 82 individuals) and lastly comes the April / May exit with 61 individuals caught and observed which represents a relative frequency of 23.28%. Indeed, the catch is much more important during the summer and moderately frequent in autumn and spring. However, the frequencies of the indi-

viduals caught in the sampling sites Merja Zerga and Oualidia are respectively 45.80% (n = 120) and 54.20% (n = 142), with an average / output of 40 individuals at the site of Merja zerga and an average / output of 47.33 ± 23.98 individuals at the site of Oualidia. The reduced gap test between the two sites showed a significant difference (p <0.05) during the April / May release and the August / September release, and a non significant difference during the November / December release. During the spring release, 65.57% (n = 40) of the catches are taken at the Merja Zerga site against 34.43% (n = 21) at Oualidia. However, during the summer outing 66.39% (n = 79) of the catches were successful at the Oualidia site against 33.61% (n = 40) at Merja Zerga, whereas during the release in autumn almost the same number was captured of individuals in both sites (40 individuals).

Table 1. Chronology of field trips and number of reptiles captured and observed / site

Samplingmonth	Sampling sites		Total
	MerjaZarga	Oualidia	
Release in spring	40 (65,57%) (a)	21 (34,43%) (b)	61 (23,28%)
Release in Summer	40 (33,61%) (a)	79 (66,39%) (b)	119 (45,42%)
Release in autumn	40 (48,78%) (a)	42 (51,22%) (a)	82 (31,30%)
Total	120(45,80%)	142(54,20%)	262

Groups with the same letter do not differ significantly at the 5% level.

Taxonomic structure of the two sites studied.

The identification of the captured individuals (Table 2) made it possible to list 6species in total and 5 families. In addition, at the Oualidia site, 5 species belonging to 4 different families, *Acanthodactylus lineomaculatus*(63 individuals), have been identified; *Tarentola mauritanica*(21 individuals); *Agama Impalearis*(16 individuals); *Chalcides mionecton*(22 individuals) and *Chalcides polylepis*(20 individuals). However, only one species is recorded at the MerjaZerga site; it is *Acanthodactylus lineomaculatus*(120 individuals)

Table 2. Checklist of identified species at both sites during the study period

Site	Family	species	Release			Abundance Total (%)	occurrence index in %	Shannon index
			I	II	III			
Oualidia (n=142)	Lacertidée	<i>Acanthodactylus lineomaculatus</i>	0	42	21	63 (44,37)	66,67	-0,52
	Gékonidée	<i>Tarentola mauritanica</i>	0	21	0	21 (14,79)	33,33	-0,41
	Agamidés	<i>Agama impalearis</i>	0	16	0	16 (11,27)	33,33	-0,35
	Scincidées	<i>Chalcidesmionecton</i>	21	0	1	22 (15,49)	66,67	-0,42
		<i>Chalcidespolylepis</i>	0	0	20	20 (14,08)	33,33	-0,40
MerjaZarga (n=120)	Lacertidée	<i>Acanthodactyluslineomaculatus</i>	40	40	40	120 (100)	100	0

Percentage frequency (Fc) = (n / N) × 100; C (%) = (Pi / P) × 100 according to [8],

I: release spring; II : release Summer; III: release autumn

Relative abundance of species identified in Table (2),

* The site of Oualidia is characterized by a dominance of the species *Acanthodactylus lineomaculatus*, with a centesimal frequency of 44.37% (n = 63) of which 66.67% (n = 42) during the summer outing and 33.33 % (n = 21) during autumn. However, the relative abundance of species of the family Scincidae reaches 29.57% (n = 42) of which 15.49% (n = 22) belong to the species *Chalcides mionecton* where 21 individuals are captured during spring release and 14, 08% (n = 20) belong to the species *Chalcides polylepis* caught in autumn. For the family Gekonidae, the relative abundance is 14.79% (n = 21), all the individuals are captured during the summer period and all belong to the species *Tarentola mauritanica*, similarly for the family of Agamidae represented by the *Agama impalearis* species are characterized by a centesimal frequency of 11.27%.

* The Merja Zerga site is characterized by a total abundance of the family Lacertidae and especially of the species *Acanthodactylus lineomaculatus*, the centesimal frequency thus reaches 100%.

Through field trips to both sites, 6 species divided into 5 families could be identified and observed. This large number and despite the temporal and spatial limitations, reflects the richness of the two sites in Lacertiliens. The species *Acanthodactylus lineomaculatus* and *Chalcides mionecton* are described as abundant species (encounter frequency greater than 15% and above) whereas the species *Tarentola mauritanica*, *Agama impalearis* and *Chalcides polylepis* are considered influential species (encounter frequency between [5- 15%])

Constancy or index of occurrence Table (2):

Consistency (C) is the ratio of the number of surveys containing the species studied (Pi) to the total number of surveys (P) expressed as a percentage [9]. $C (\%) = (P_i / P) \times 100$. However, this occurrence index is highest for the species *Acanthodactylus lineomaculatus* in the Merja Zerga site (100%), whereas in the Oualidia zone this index is 66.67% for the species *Acanthodactylus lineomaculatus* and *Chalcides mionecton*, so these species are referred to as constant species (at 50% or more of their frequency of occurrence). For the other species *Tarentola mauritanica*, *Agama impalearis* and *Chalcides polylepis* are classified as accessory species (are present in 25 to 49% of the samples)

Density [10]

The results concerning the density (total density or primary density index and specific density) in the two sites are presented in Table 3. This table shows that the primary density index (total density) in the Oualidia site. (35.5 individuals / Km²) is ten times higher than that displayed at the site of Merja Zerga (3.43 individuals / Km²). However, in the Oualidia area, the density distribution specific to the species identified shows that this density is maximal for the species *Acanthodactylus lineomaculatus*, with a density of 15.75 individuals per square kilometer whereas for the other species this density fluctuates between 4 and 5.5 individuals / Km². For the zone of Merja zerga, the specific density equal to the total density equal to 3.43 individuals / Km². So, we can conclude that the site of Oualidia has a much higher density than the site of Merja Zerga.

Table3. Presentation of the density (specific and total) of the two sampling sites

Site	species	Density = number of individuals / Km ²	
		Specific/ Km ²	total/ Km ²
Oualidia (Area = 4 Km ²)	<i>Acanthodactylus lineomaculatus</i>	15,75	35,5
	<i>Tarentola mauritanica</i>	5,25	
	<i>Agama impalearis</i>	4	
	<i>Chalcides mionecton</i>	5,5	
	<i>Chalcides polylepis</i>	5	
MerjaZerga (Area=35 Km ²)	<i>Acanthodactylus lineomaculatus</i>	3,43	3,43

Shannon's diversity index, SHANNON & WEAVER (1949) and equitability Blondel, (1975).

The Shannon index provides information on species diversity in a study environment. When all individuals belong to the same species, the diversity index is zero. $H' = -\sum P_i \log_2 P_i$, with $p_i = n_i / N$. the results for this index are presented in the table (2). Indeed, the Shannon diversity index in the Oualidia site is 2.10 bits. However, this index is null in the site of MerjaZerga ($H' = 0$).

The index of equitability or equidistribution (E) is the ratio between the calculated diversity (H') and the maximum theoretical diversity (H'_{max}), the calculation of this index in the Oualidia site is 0.293, this value is less than 0.5 which means that almost all the numbers tend to be concentrated on a single species. In the zone of Merja Zerga, this index is zero which confirms the taxonomic homogeneity of the individuals caught.

Global analysis

The joint analysis of the following criteria: species, sampling sites, type and time of release by multiple correspondence analysis is presented in Figure (1). The results of this analysis show a significant consistency of these criteria between them, this is translated by a Cronbach index of 0.79. The two axes alone absorb 67% which confirms the strong compatibility of the criteria with respect to the two axes. This projection shows two distinct groups supporting all that has been deduced before.

* The first group located on the positive side of axis I, is characterized by the species inhabiting the lagoon of MerjaZerga (*Acanthodactylus lineomaculatus*). The capture of this species is frequent during the spring / summer.

* The second group is that of the species caught at the site of Oualidia, this group is positioned on the negative side of the axis 1, it is defined by the species *Tarentola mauritanica*, *Agama impalearis* and *Chalcides polylepis*. These species are abundant during the summer.

* A third intermediate group composed of the species *Chalcides mionecton* located on the positive side of the axis II, this species is captured in the spring. However, the first two groups evolve independently of the third especially in the period of onsetand the habitat type.

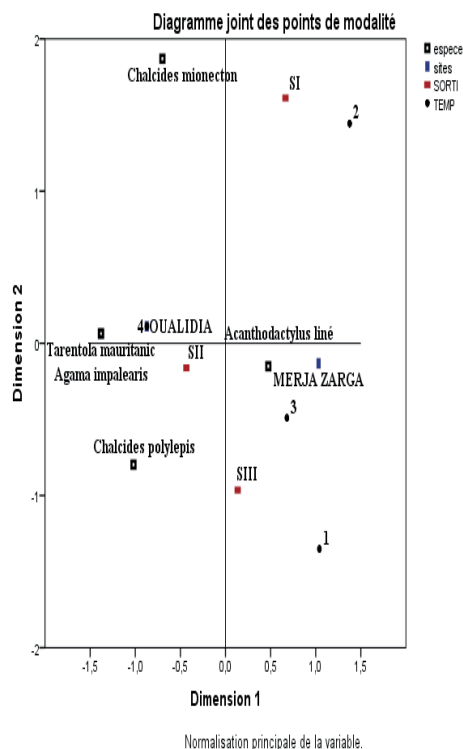


Figure 1. Presentation of terms according to the ACM (Multiple Correspondence Analysis)

The work that we carried out in the two Moroccan lagoons Merja zerga and Oualidia, presents a peculiarity in the field of the general ecology and the confirmation of taxa especially in humid zones. Despite the difficulties encountered during capture and the very short trapping period, a taxonomic profile of certain Lacertilien species was restored at these two sites. The results of the identified species show great richness, such as 5 species belonging to 4 families at the Oualidia site which are *Acanthodactylus lineomaculatus*; *Tarentola mauritanica*; *Agama impalearis*; *Chalcides mionecton* and *Chalcides polylepis*. However, only one species is recorded at the MerjaZerga site; it is *Acanthodactylus lineomaculatus*. In her study, [11] listed the species *Tarentola mauritanica* in April 2007, in the downstream of OuedYquem (South of Rabat) and in the Biological Reserve of Sidi-Boughaba (South of Kenitra), CharijTanou (Ifrane-Azrou region) (Middle Atlas in June 2007. In 2014, [12]; listed in the south of Kabylie in Algeria, the following species: *Tarentola mauritanica* with an abundance of 24.13% compared to 14.79% for ours, recalling that this species *T. mauritanica* is found in stony environments, old houses ... etc. [13] Concerning the species *Agama impalearis*, a study conducted by [14] in 1998, identified this species in an arid environment in a jujube steppe located in the central Jbilets, Western Morocco, so, we noticed abundances exceeding 10% in both sites, which indicates a wealth of these localities in small vertebrates.

For the site of Oualidia, we could not also mention the presence of three species: *Chamaeleo chamaeleon*, *Mesalina olivieri*, *Psammodromus algirus*, however this site is part of their range [15]. This difference may be related to the mode of data collection, the direct observations being more reliable and reproducible, but limited to the sectors covered.

Nevertheless, the majority of the species described in the old works like that of [16] or even more recent [15] are found

in the current state, the only difference is the relatively high density and rarefaction of population numbers for some species. Some species, are subservient and linked to a particular environment, especially the most ecologically demanding, and therefore the most vulnerable to changes in environmental factors. Others have a large ecological amplitude even if the density of their populations is sometimes low.

In addition, these wetlands are favorable environments that would allow the coexistence of several species. As well as, the spatial distribution of the species at the two sites is a function of the type of soil and the importance of the sandy fraction of the environment which reflects the organization of the herpetofauna population in these sites.

Reptiles in general and Lacertilians in particular are organisms that are dependent on their biotope. Although all habitats are of paramount importance for each species, we can classify the habitats in the two sites according to a preference which can be the following one:

1. Beaches and dunes with a sandy substrate and favorable environments for *Acanthodactylus lineomaculatus*.

2. Forest and border of the fields with a compact substrate and sometimes with debris of leaves of trees, shelter *Chalcides mionecton* and *polylepis*.

3. Stony environments which constitute favorable environments of *Agama impalearis*

Morocco is known for its highly diversified biotopes (deserts, mountain forests, rivers, coasts, lagoons, etc ...), most of which are affected by human activity and some of which are seriously threatened with extinction. To protect these ecological sites and their biodiversity, the authorities are called upon to:

- * Establish research strategies on threatened environments;
- * Address the awareness of the populations exploiting these environments;
- * Include the local communities in the rehabilitation of these environments and their biodiversity.

CONCLUSION

At the end of the explorations carried out in the two sites of Oualidia and MerjaZerga during the years 2013 and 2014, six species were captured, including five species in the Oualidia site and one species in the MerjaZerga site. These results come to confirm the existence of certain species in both sites. The realization of new catching campaigns in other sites of the region will make it possible to identify new species or to enrich the atlases of distributions to better know the current biodiversity of the small vertebrates of Morocco.

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