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BIOLOGICAL'S INDICATORS OF DESERTIFICATION IN MOROCCO

Dr. Khalid Bouraada*, Pr. Guy Chavanon & Dr. Mariam Essafi*****

* University Sidi Mohamed Ben Abdellah. Faculty of Science and Technology (F.S.T), Department of Biology, Laboratory of Ecology and Environment Functional (L.E.F.E), Fes Morocco

** University Mohamed Premier, Faculty of Science, Department of Biology, Oujda, Morocco

*** Regional Laboratory of Epidemiology and Hygiene Middle, Public Health Service and Epidemiological Surveillance, Regional Directorate of Health, Region Fes-Meknes, Ministry of Health

Abstract:

In this study we have established desertification's biotic indices which allowed us to select thirty Saharan species bio-indicators of desertification put in evidence a drought thrust gradient from south to north (Merzouga, Erfoud, Boudnib and Figuig) which we can distinguish a group of Saharan species that is only found in the Saharan stations indicating a normal desertification is the case : Ammogiton peltieri jolyi espanol, Anemia Scelosodis laticollis Chatanay Erodius exilipes Lucas, Podalgus cuniculus reichei, Ocnera hispida Forskal, Prionotheca coronata Ol., Mesostene angustata E. (s.lat.), Micipsa mulsanti Lavrat., Eurycaulus (s.str.) marmottani Fair., Plocaderus caroli., and who is assigned index 1.

A group of Saharan species and encountered in the Saharan stations and stations in the Nordic (Tendrara, Bouarfa, Rich and Bouanane) and desertification indicating more thrust is the case : Anthia sexmaculata F., Julodis aequinoctilis var. deserticola, Scarabeus bannuensis Jans., Paracylindromorphus pinuis Frm., Oterophloeus humerosus Faimaire. Mesostene angustata E. (s.lat.), Compalita olivieri Dej., Tentyria longicollis Lucas., Zophosis bicarinata ranatae et Pimelia cordata (s.lat.) Kr.) could avonce to the continental environment and which is assigned the index 2.

And finally a group of Saharan species and encountered in the pre-Saharan and Saharan stations (Guercif, NE Missour, Ain Beni Mathar and Midelt) indicating an average desertification and this is the case: Dicranoplia deserticola Luc. Pimelia angulata lesnei Peyerh., Adesmia biskrensis asperrima, Tentyria senegalensis Solier, Cymindis suturalis pseudosuturalis, Erodius bicostatus Solier, Machlopsis elongaluta Quedenfelt, Zophosis mozobita Fairm. and Hetererocantha depressa.) frankly migrates to the north and put in evidence a desertification thrust from the South to the North and we attribute that the index 3.

Index Terms: Beetles, Dunes, Northern Fringe, Eastern Region, Desertification's Biotic Indices, Sahara & Morocco

1. Introduction:

The edification of continental sand formations following a particular process and the sands of the North-Western Sahara are the successive erosions products whose process has been described in outline [1]. The formation of these dunes is a consequence of desertification of this environment and is primarily linked to an irreversible reduction of vegetation cover leading to the denudation of the soil. Bare soil falls prey to wind erosion. This desertification is manifested by a new final distribution of the soil. The furniture part is carried away by the deflation that accumulates elsewhere in the form of dunes to sandy fractions and as loess and clay to silt fraction.

Denude the soil and then comes accumulate under the combined action of the terrain wind.... Sandy deposits of exogenous origin that gradually are moving dunes. The best sandy-fixing exogenous origin who gradually are moving dunes. The best local fixers seem to be as drinn grasses (*Aristida pungens*) and very locally alfa (*Stipa tenacissima*) and various shrubs or bushes.

Unevenly distributed the desert sand constitutes buildings of forms and varied dimensions including not only the immense massive dune if features that are ergs north. But the dunes of the Sahara are only the result of accumulation of sand by river and wind erosion the trampling of herds and clearings abusive.

The statements shall have been focused on spring like period (April and May) and covered various stations in East and South East Moroccan (Guercif Ain Beni Methar, NE Missour, Tendrara, Boudnib, Bouârfa, Rich, Figuig, Erfoud and Merzouga).

We will limit ourselves in this work to treat and profounder the point that seem interesting and on which the general data are required. We try to determine some biological indicator species of desertification.

The great taxonomic richness stations Tendrara Figuig and Bouârfa in these taxonomic groups is mainly related to the presence of favorable conditions (temperature, humidity, trophic sources, etc.). That allows them a good blossoming.

The highest densities of wildlife depth are recorded has Figuig, Bouârfa, Tendrara and what is more or less hand in hand with the Evolution of abundance. The density of soil-dwelling species is constituted mainly of larvae and strictly species of sand [2]. It is relatively low (between 1 and 10 ind./m^3). The analyses by A.F.C. allowed us to put in evidence that the distribution of population of beetles and of vegetation harvested in the 12 stations is under the direct influence of the environment or they live. It therefore clears analysis of the faunal affinity three major groups [2].

- ✓ The first is formed by the Nordic stations (Guercif NE of Missour Midelt and Ain Beni Mathar) housing of faunal species of mediterranea dunes.
- ✓ The second group is formed by stations in the (Tendrara Bouârfa Rich and Boudnib) presenting a level of similarity to the relatively high level of fauna had in part to their proximity.
- ✓ The last group is formed by the southern stations (Merzouga Erfoud Boudnib and Figuig) and houses a frankly Saharan population. The harvested taxa in its stations are spread along a geographical gradient North-South. The North extremity is formed by the species characteristics of the Mediterranean area while the southern extremity is composed by species (flora and vegetable characteristics the Saharan fringe) [3].

In Morocco as in Algeria and Tunisia the insect fauna of beetles stand is the most representative in the sandy environment. However the majority of works devoted to the study of this population were beginning to establish limits on the systematics and geographical distribution of different species cataloged: [4], [5], [6], [7], [8], [9], [10], [11], [13], [14], [1], [15], [16], [17].

The present work is the result of our research for a better understanding of entomological groups of beetles of mobile dunes of eastern Morocco and western northern fringe of the Sahara. It thus extends our previous study [18], [19], [20].

The statements shall have been focused on spring like period (April and May) and covered various stations in East and South East Moroccan (Guercif, Ain Beni Methar, NE Missour, Tendrara, Boudnib, Bouârfa, Rich, Figuig, Erfoud and Merzouga). The achievement of entomological catalog to the sandy middle proves therefore useful

and necessary. This region was chosen to the extent that it has not been a thorough study on entomological organization.
Then this work has been as comprehensive and far by many researchers' amateurs or professionals who have worked for the different families of the Beetle's order. Very little of this work provides a thorough ecological study specific to species of sand [21].

2. Material and Methods:

Repartee on a trajectory almost 4000km for the benefit of our stations we took into account various criteria. The first is the fact that all these sandy formations are mobile at least partially (see Tendrara). We also took into consideration the geographical parameters climate and accessibility (Fig. 1).

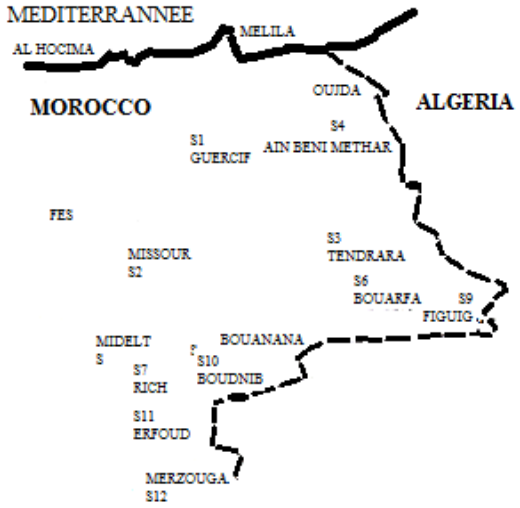

Figure 1: Stations of Studies (1/1500000)

The twelve stations therefore have in common the presence of mobile sand formations and a height generally not exceeding 2 m (except for the station Merzouga and Erfoud).

2.1 Choice of Methods of Hunt Beetles: Tree technical have been used for harvesting of beetles:

2.1.1 Hunting by View: We saw hunts by direct capture of beetles on the sand on the inside burrows on the plant species where they exist under stones (in the few cases where there were few stones in the station) and in the feces camel, donkeys goats and cows.

2.1.2 Sieving: The sieving destiny especially to the study of burrowing beetles including larvae. A volume determined (50 dm^3 of the sand, Bouraada (1996) is going through a sieve of 2 mm mesh leaving only the grains of sand. This method allows reap the larvae and locate the buried wildlife. It also allows determining the density of burrowing species harvested.

2.1.3 Trapping: The trapping method is to capture beetles in interception traps and attractive forms of plastic pots 15 cm in height and 8 cm in diameter baited with a solution constituted by a mixture of beer and salt. This technique is used by many researchers including the study of riparian carabid in Morocco Oriental [22] [23] and in the study of beetles of sandy areas. 10 traps per station are downhill into the ground and online willing to walk downhill dunes and are in the ground right up to their edges. For dissimilar and prevent their silting we used a plastic cover system (Fig. 2). This method is very effective for catching nocturnal activity insects.

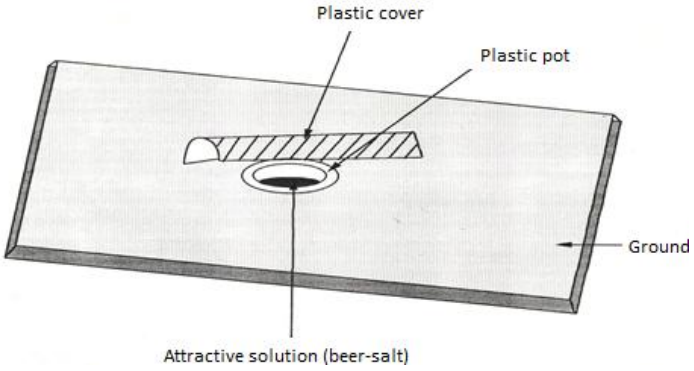

Figure 2: An Attractive Trap (Bouraada, 1996)

3. Results and Discussion:

3.1 Taxonomical Inventory: In our inventory we have inventoried 87 species represented by 1792 individuals and distributed in 75 genus and 36 different families. The captured of *Tentyria longicollis* luca. at Merzouga station has to confirm the presence of this species on Moroccan territory. Furthermore *Scarites striatus* Dej., *Eurycaulus marmottani* (S.str) Fair. and *Micipsa mulsanti* Lavrat. are three species of which their presence is confirmed in Morocco [24]. On the other hand many other species are new to the region or see their enlarged regional distribution area [25].

3.2 Exclusives Species: Every station possesses a number of unique species according to ecological character biogeographic, climatic etc. The largest number of these species is harvesting in Merzouga station and that of Figuig with respectively 7 and 5 species. These are mainly the Saharan stations.

3.3 Ecological Distribution of Beetles for Establishing Biotic Indices of Desertification: The interpretation of the list of harvested species of beetles serve as a database for the study of the Evolution of the population of beetles dunes. The idea to establish a table of biotic indices of desertification is inspired by the method of Verneaux J. [26] used for the determination of biotic indices in a spatial gradient in a stream by allowing Following establish a diagram depicting the changes in this index.

The application of this method to describe the state of desertification of a medium gives very encouraging results and promising although it still has to develop and enrich other Saharan species that dates back to the North and that we have not sampled in the present study travail. This allowed us to distinguish some species strictly Saharan most of which are characteristics of dune environments (Tab. I). These species of beetles obtained will be used by the base following data for the establishment of biotic indices desertification. So we are taken to look for Saharan species in the northern part.

The establishment of biotic indices based on desertification shook geographical gradient obtained by the Factorial Analysis of Correspondence (Fig. 3). We will therefore take some Saharan species as bio-indicator of desertification a few will submit an amendment to their ecological distribution of air while we will eventually eliminate other and this is the case *Megacephala euphratica* which is an endemic species and some back to Spain and *Aphodius palmetincola* Luke. Which is also a Saharan species but may rise up to the Mouth of Moulouya [27] Moreover *Compalita olivieri* Del. Saharan Africa is a species found in Tendrara and Merzouga but also exists in the Middle Atlas and Beni Snassen. And by analysis of A.F.C. it goes back to the North. It is a bio-indicator species of desertification but that changes its position. This analysis allowed us to establish three desertification's biotic index (Tab. I and Tab. II):

Index 1: Includes Saharan species and that we encountered in the Saharan stations and indicating desertification normal

Index 2: Gathers Saharan species and encountered in the pre-Saharan and Saharan stations and indicating desertification average.

Index 3: Consolidates Saharan species and encountered in the Saharan stations and Nordic stations and indicating more thrust desertification.

Tableau I, Taxonomical inventory for establishment of biotic index of desertification

Increating desertification: N → S

Code	Taxon \ Station	Guercif S1	N-E.Missour S2	Midelt S3	Aïn Beni Mathar S12	Tendrara S11	Bouârfa S9	Rich S4	Bouânane S8	Figuig S10	Boudnib S7	Erfoud S5	Merzouga S6	
1	*Ammogiton peltieri* jolyi												36	
2	*Anemia sardoa*												9	
3	*Scelosodis laticollis*sy												2	
4	*Erodius exilipes* Lucas.											39	45	
5	*Podalgus cuniculus* reichei											3		
6	*Ocnera hispida* forskal										9	1	5	
7	*Prionotheca coronata* Ol.									47		77	55	Index 1
8	*Mesostene angustata* E.									4		4		
9	*Micipsa mulsanti* Lavrat.									2				
10	*Eurycaulus marmottani* Fair.									1				
11	*Plocaderus caroli*.									1				
12	*Anthia sexmaculata* F.					76	53	7	68	78	100	77	95	
13	*Julodis aequinoctilis* icola						10	1	2	7	1			
14	*Scarabeus bannuensis* Jans.								1					
19	*Paracylindromorphus pinuis*						1			2				
15	*Oterophloeus humerosus*					1							6	Index 2
16	*Mesostene angustata* E.					1							6	
17	*Compalita olivieri* Dej.					1				1			1	
18	*Tentyria longicollis* Lucas.					1							1	
20	*Zophosis hicarinata ranatne*					4	1	1		1				
21	*Pimelia cordata* (s.lat.) Kr.					8	7			1				
22	*Dicranoplia deserticola* Luc.			1						1		1	2	
23	*Pimelia angulata lesnei*				1			1		65		18		
24	*Adesmia biskrensis asperrima*				1			1				6		
25	*Tentyria senegalensis* Solier				1							10		
26	*Cymindis pseudosuturalis*		1	1	1	2	3	1	1	1	1			Index 3
27	*Erodius bicostatus Solier*			33	3	1	1			3				
28	*Machlopsis elongaluta*				1			1						
29	*Zophosis mozobita* Fairm.	1	1		1	1								
30	*Heterocantha depressa*		1			1								

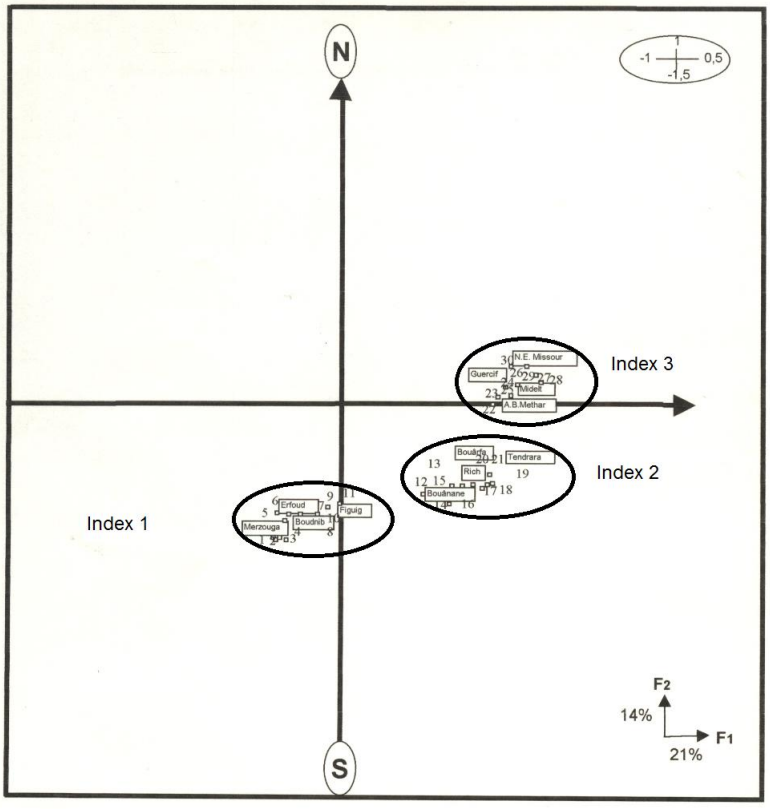

Figure 3: A.F.C. of Table faunal statements shall for the establishment of biotic indices of desertification

(Projection of taxa on F1xF2 map)

Table II: Bio-indicator species of desertification

desertification Index	Bio-indicator species of desertification.
Index 1	*Ammogiton peltieri* jolyi espanol, *Anemia sardoa*, *Scelosodis laticollis* Chatanay, *Erodius exilipes* Lucas, *Podalgus cuniculus* reichei, *Ocnera hispida* forskal, *Prionotheca coronata* Ol., *Mesostene angustata* E. (s.lat.), *Micipsa mulsanti* Lavrat., *Eurycaulus* (s.str.) *marmottani* Fair., *Plocaderus caroli*.
Index 2	*Anthia sexmaculata* F., *Julodis aequinoctilis* var. *deserticola*, *Scarabeus bannuensis* Jans., *Paracylindromorphus pinuis* Frm., *Oterophloeus* sp. *propre humerosus* Faimaire., *Mesostene angustata* E. (s.lat.), *Compalita olivieri* Dej., *Tentyria longicollis* Lucas., *Zophosis bicarinata ranatae, Pimelia cordata* (s.lat.) Kr.
Index 3	*Dicranoplia deserticola Luc., Pimelia angulata lesnei Peyerh., Adesmia biskrensis asperrima, Tentyria senegalensis* Solier, *Cymindis suturalis pseudosuturalis, Erodius bicostatus Solier, Machlopsis elongaluta* Quedenfelt., *Zophosis mozobita* Fairm., *Hetererocantha depressa*.

We therefore select thirty bio-indicator species of Saharan desertification including eleven species are always presented in the Saharan region: Merzouga Erfoud Boudnib and Figuig and that index is assigned 1. Ten species were able to advance to the continental environment: Tendrara, Bouârfa, Rich and Bouânane and who is credited with the index 2. While frankly 9 species have migrated north: Guercif, NE Missour, Ain Beni Methar and Midelt and put in evidence a desertification thrust from the South to the North and who is credited with the index 3.

4. Conclusion:

The establishment of biotic indices desertification's allowed us to select thirty bio-indicator species of Saharan desertification which eleven (11) species [*Ammogiton peltieri* jolyi espanol, *Anemia sardoa*, *Scelosodis laticollis* Chatanay, *Erodius exilipes* Lucas, *Podalgus cuniculus* reichei, *Ocnera hispida* forskal, *Prionotheca coronata* Ol., *Mesostene angustata* E. (s.lat.), *Micipsa mulsanti* Lavrat., *Eurycaulus* (s.str.) *marmottani* Fair., *Plocaderus caroli*.] are always exhibit in the Saharan region: Merzouga, Erfoud, Boudnib and Figuig and that index is assigned 1. Ten species [*Anthia sexmaculata* F., *Julodis aequinoctilis* var. *deserticola*, *Scarabeus bannuensis* Jans., *Paracylindromorphus pinuis* Frm., *Oterophloeus* sp. *propre humerosus* Faimaire., *Mesostene angustata* E. (s.lat.), *Compalita olivieri* Dej., *Tentyria longicollis* Lucas., *Zophosis bicarinata ranatae et Pimelia cordata* (s.lat.) Kr. could avonce to the continental environment: Tendrara, Bouarfa, Rich and Bouanane and who is credited with the index 2. While 9 species [*Dicranoplia deserticola Luc., Pimelia angulata lesnei Peyerh., Adesmia biskrensis asperrima, Tentyria senegalensis* Solier, *Cymindis suturalis pseudosuturalis, Erodius bicostatus Solier, Machlopsis elongaluta* Quedenfelt., *Zophosis mozobita* Fairm., *Hetererocantha depressa*.] frankly migrates to the north: Guercif NE Missour Ain Beni Mathar and Midelt and put in evidence a desertification thrust from the South to the North and we attribute that the index 3.

5. References:

1. F. Pierre. Ecology and Entomology stand bright sands of North-West. National Center for Scientific Research. Biological Series (1), pp. 332, 1958.
2. K. Bouraada, G. Chavanon and H .Chergui. The settlement of Beetles of the dunes fixed by perennial grasses in the Oriental Morocco. Acta. Inst. Agron. Vét., Rabat, (Marocco) Vol. (19), 4, pp. 219-230, 2015..
3. M. Antoine. On some Carabids Moroccans. Bull. Soc. Sc. Nat. from Morocco. (23), 43-55, 1943.
4. M. Antoine. Carabid beetles of Morocco: 1th part. Mem. Soc. Sc. Nat. Phy. Morocco Zool. (1), pp. 1-177, 1955.
5. M. Antoine. Carabid beetles of Morocco: 2nd part. Mem. Soc. Sc. Nat. Phy. Morocco Zool. (2), pp. 1-157, 1957.
6. M. Antoine. Carabid beetles of Morocco: 3rd part. Mem. Soc. Sc. Nat. Phy. Morocco Zool. (6), pp. 1-150, 1959.
7. M. Antoine. Carabid beetles of Morocco: 4th part. Mem. Soc. Sc. Nat. Phy. Morocco Zool. (8), pp. 1-170, 1961.
8. M. Antoine. Carabid beetles of Morocco: 5th part. Mem. Soc. Sc. Nat. Phy. Morocco Zool. (9), pp. 1-153, 1962.
9. C. Alluaude. Report of a mission in the Zoological South Eastern Morocco. Bull. Soc. Sc. Nat. Morocco Bull.Soc.Sc.Nat. from Morocco. t. IV, (1-6), pp. 12-19, 1924.
10. C .Alluaude. Zoological Excursion Beach Saidia (Morocco Oriental). Bull. Soc. Sc. Nat. from Morocco. t.v, (3), pp. 47-49, 1925.
11. P. Bruneau de mire. The Sphorides of Algeria, (Col. Pterostichidae). Rev.Fr.Ent., t.XXV, fasc. 4, pp. 66-286, 1958.
12. P. Peyerimhoff. Beetles Western Sahara. Bull, Soc. Sc. Nat. Phys. Morocco, (9), pp. 90-164, 1943.
13. P. Peyerimhoff. Study and description of Moroccans Beetles II. Bull, Soc. Sc. Nat. Phys. Morocco (9), pp. 90-164, 1947.
14. L. Kocher. Catalog comments from Morocco beetles Tenebrionidae. Trav. Inst. Sc. Cherifien. Morocco. Fasc. VI. Ser. Zool. (12), pp. 1-185, 1956.
15. L. Kocher. Catalogue of beetles comments Morocco. New Addenda and corrigenda. Trav. Inst. Sc. Cherifien. Maroc. Fasc. X bis., Ser. Zool. (34), pp. 1-132, 1969.
16. A. RAYMOND. Insects of various orders crops Central Sahara during a mission of the National Center for Scientific Research in 1947-1948. Bull. Soc. Sc. Nat. Maroc. XXXII, 1° sem, pp. 77-89, 1948.
17. K. Bouraada. The settlement of the dunes of plants and beetles fixed by perennial grasses in Morocco Oriental. Thesis 3rd cycle Kingdom. Mohamed V Fac. Sc. Oujda, pp. 1-137, 1996.
18. H. LABRIQUE and G. CHAVANON. Results of an entomological survey campaign in Morocco Oriental (Coleoptra Tenebrionidae). Scientific notebook -Museum of Natural History in Lyon Issue. 2, pp. 75-87, 2001.
19. G. Chavanon and K. Bouraada. 2nd Note on the Scarabaeoidea of Morocco Oriental addenda and corrigenda, The Entomologist 51 (6), pp. 257-262, 1995.
20. F. BERNARD. The endemism of the Saharan fauna aspects for six groups of land animals. C.R. Soc. Biogeogr., 361, pp. 130-137, 1964.
21. K. Bouraada. The settlement of Beetles and plants of the dunes mobiles in the in the eastern region and oriental Morocco. Thesis Ph.D. Mohamed V Fac. Sc. Oujda, pp. 1-107, 2003..

22. G. Chavanon and L. Chavanon. Studies on the lower Moulouya (Eastern Morocco) II-news data on Carabici Beetles the mouth (Copleoptera Carabidae). Bull. Men. Soc. Lins. Lyon, 61 pp. 1992.
23. K. Bouraada, G. Chavanon and H. Chergui. Stand in Beetles of fixed dunes with perennial grasses in the eastern region of Morocco. Acte. Inst. Agron. Vét., Rabat, (Morocco) Vol. (19), 4, pp. 219-230, 1999.
24. G. Chavanon and K .Bouraada. New Beetles or interesting to the region of Figuig (Southeast Morocco): supplements and new data New. Review. Ent. Paris. T. 13 (4), pp. 287-293, 1996.
25. J. VERNEAUX. Biological method and problem of the determination of the quality of running water. Bull. Ecol., t, 15, 1. pp. 47-52, 1984.
26. G .CHAVANON. Studies on the lower Moulouya (Morocco oriental). III- The beetles of the border and affluent of the Za river. The Entomologiste. t, 7, pp.34-43, 1993.