Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

JEZS Journal of Entomology and Zoology Studies

ISSN 2320-7078
JEZS 2014; 2 (6): 39-44

Received: 31-10-2014
Accepted: 14-11-2014

Rabia Aoujdad
Laboratory of Biodiversity and Animal Resources, Ibn Tofail University, B.P 133, 14000, Kenitra, Morocco.

Abdelaziz Maqboul
Laboratory of Biodiversity and Animal Resources, Ibn Tofail University, B.P 133, 14000, Kenitra, Morocco.

Mohamed Fadli
Laboratory of Biodiversity and Animal Resources, Ibn Tofail University, B.P 133, 14000, Kenitra, Morocco.

Mohamed Fekhaoui
Laboratory of Zoology and Animal Ecology, Scientific Institute of Rabat, BP 703 Agdal, Rabat, Morocco.

Correspondence:
Rabia Aoujdad
Laboratory of Biodiversity and Animal Resources, Ibn Tofail University, B.P 133, 14000, Kenitra, Morocco.

Structure and organization of the crustaceans cladoceran populations in Moroccan ricefields

Rabia Aoujdad, Abdelaziz Maqboul, Mohamed Fadli and Mohamed Fekhaoui

Abstract
We undertake in this work a qualitative descriptive study of crustaceans cladoceran population in different habitats of Moroccan ricefield. Among the 50 species identified by Ramdani (1986) [18] in Moroccan stagnant water, 30 species of cladoceran were identified in our study area. The biotypology study of crustaceans cladoceran population demonstrated the presence of 3 principle species groups which have spatio-temporal distribution despite of the short period of the study imposed by the imperative of submersion period. Those groups are: summer species, autonmal species and species which have large distribution spectre along rice growing. Therefore, agrosystem "rice" has a structure, dynamics and evolution which corresponds to that of natural lakes where the impoundment is shorter or longer during the year. Associated with biotic conditions, the hydrological cycle of rice, temperature and oxygen levels affect the distribution, occurrence and abundance of species.

Keywords: Crustaceans cladoceran, systematic, spatio-temporal distribution, hydrological cycle, biotypology, moroccan ricefields.

1. Introduction

World rice farming occupies an area 1.49 million km^2 of land. This surface representing the total of freshwater lakes area estimated between 1.2 and 2.0 million km^2 [1]. In addition to their economic importance, ricefields represent an important ecological and scientific capital due to two main factors:

- late artificially flooded from May to September, during the drying of natural temporary ponds,
- evaporation and groundwater has no significant influence on the level of water that is fed regularly by irrigation.

Several multidisciplinary studies have been conducted with the aim to understand the functioning of this artificial agrosystem [2, 3, 4], to study the fauna [5, 6, 7], and its weedy vegetation [8, 9]. In Morocco, rice farming is practiced exclusively in the Gharb plain and Loukkos basin. Indeed, due to favorable climatic and soil conditions offered by these regions and richness of its natural water systems, rice has been a spectacular success in terms of area and production. Scientific investigations in the country carried out on this agrosystem are very limited and focus on plant pathology aspects of culture [7, 13, 14]. Faunal research on Moroccan ricefield are limited to a few malacological inventories.

We proceed in this work a qualitative descriptive study of this population in different stations of Moroccan ricefields of the Gharb plain. We report a complete inventory of cladoceran species sampled, allowing to fill gaps in the field of zooplankton inventories in natural aquatic environments. At last part, we state spatio-temporal distribution of cladoceran species and their ecological affinities.

2. Materials and methods

2.1. Choice of stations

Fourteen (14) stations were selected for study between 1993 and 1994. The choice of these stations was based on species richness, abundance of taxa, aquatic vegetation and the maximum coverage of the three rice-growing areas. The stations were selected in the three rice-growing areas of Gharb plain (Fig. 1):

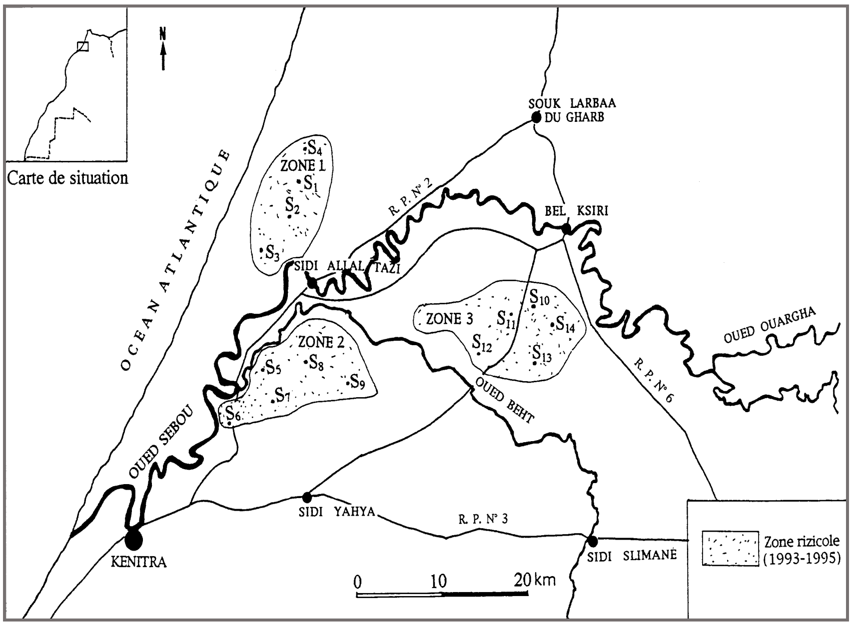

Fig 1: Location of the sampling stations in Moroccan ricefields

Tazi area (zone 1 in the card)
This area is located in the Sidi Allal Tazi region, 57 Km Kenitra. These ricefields area are irrigated by a canal of the river Sebou. Selected stations in the study area are S1, S2, S3, S4.

Moghrane rice area (zone 2 in the card)
Located in the Moghrane region on the left bank of the Sebou river far from 22 Km to Kenitra. Ricefields in this area have Beht river as a source of irrigation. In this area, we chose the following stations : S5, S6, S7, S8, S9.

Belksiri area (zone 3 in the card)
Located in the region of Bel Ksiri, 62 km from the city of Kenitra. Water flooding come from the irrigation canal which receives water from the Sebou River downstream of Sidi Allal Tazi. Stations S10, S11, S12, S13 and S14 are part of this ricefield area.

2.2. Procedures for sampling and analysis of biological material
The faunistic samples were taken in spring and summer of 1993-1994 between June and September, in four fixed sampling points in the littoral area of the land rice, three with and one without the presence of vegetation.
We used the net plankton for qualitative and semi- quantitative sampling. The net used was 0.05 mm diameter mesh, 20 cm of opening diameter and 25 cm depth. The volume of water filtered is theoretically calculated using the formula: $V = \pi r^2.d$, where d is the slice surveyed (in meters) water and r is the radius of the net mouth. The procedure involved dragging the net twice for 10 to 15 seconds in the different parts of each sampling point. However, this method apparently only allows sampling of cladoceran inhabiting the water between the macrophytes, making unfeasible the sampling of some individuals that were adhered to plants. The samples were fixed in 4% neutral formalin immediately after collection.
In laboratory, the organisms were observed under optical microscope and stereomicroscope with identification performed from the usual dissection methods for microcrustaceans and specialized bibliography [15]. For each sample, the quantification was carried out through three 2 mL replicates into Sedgwick-Rafter-type chambers, prepared specifically for this volume. The samples with a low number of organisms were counted in full.

2.3. Data analysis
We used correspondence analysis (FCA) to search for the spatio-temporal succession and affinities of cladoceran population. A double-entry table of 29 species and 112 surveys (14 stations x 4 months x 2 years = 112 surveys) was analyzed. A class of density was associated to each species-survey.

Table 1: Density classes used in the FCA

Classes	Density interval
0	0 ind/m^3
1	1-100 ind/m^3
2	100-1000 ind/m^3
3	>1000 ind/m^3

3. Results
3.1. Faunal inventory
The purpose of this inventory is to enhance taxonomic knowledge of crustaceans cladoceran zoological group in Moroccan ricefields. Species identification was based on the identification key developed by [16, 17]. Twenty-four cladoceran species were recorded, distributed among the families Sididae (1), Bosminidae (1), Chydoridae (12), Daphniidae (10), Moinidae (3) and Macrothricidae (3).

Family: Sididae
Diaphanosoma brachyurum - Lievin, 1848.

Family: Bosminidae
Bosmina longirostris - O.F. Müller, 1785.

Family: Chydoridae
Sub-family: Chydorinae
Dunhevedia crassa - King, 1853.

Pleuroxus laevis - Sars, 1862.
Pleuroxus aduncus – Jurine, 1820.
Chydorus sphaericus - O.F. Müller, 1785.
Leydigia quadrangularis - Leydig, 1860.

Sub-family: Aloninae
Acroperus harpae - Baird, 1835.
Alona rectangula - Sars, 1862.
Alona elegans - Kurz, 1874.
Alona guttata - Sars, 1862.
Alona costata - Sars, 1862.
Oxyurella tenuicaudis - Sars, 1862.
Graptoleberis testudinaria - Fisher, 1848.

Family: Daphniidae
Ceriodaphnia reticulata - Jurine, 1820.
Ceriodaphnia laticaudata - P.E. Müller, 1867.
Ceriodaphnia dubia - Richard, 1894.
Ceriodaphnia quadrangula - O.F. Müller, 1785.
Simocephalus vetulus - O.F. Müller, 1776.
Simocephalus expinosus - Koch, 1841.
Scapholeberis aurita - Fisher, 1849.
Daphnia pulex - Leydig, 1860.
Daphnia longispina - O.F. Müller, 1785.
Daphnia magna - Straus, 1820.

Family: Moinidae
Moina brachiata - Jurine, 1820.
Moina micrura - Kurz, 1874.
Moina macrocopa - Straus, 1820.

Family: Macrothricidae
Macrothrix laticornis - Jurine, 1820.
Macrothrix rosea - Jurine, 1820.
Macrothrix hirsuticornis - Norman et Brady, 1867.

3.2. Biotypology
The analysis of the data matrix (29 species/112 sampling) by the correspondence analysis showed that the total of the three principal axes of inertia is 31.6%.

Table 2: inertia explained and eigenvalues of the first three FCA axis

Axes	Eigenvalues	Inertia rate (%)	Cumulative inertia (%)
1	0,346	14,0	14,0
2	0,233	9,4	23,4
3	0,202	8,2	31,6

The projection of samples into factorial plan F1/F2 (Fig. 2), which recorded 23.4% of the total inertia, point out a 4 homogenous of group of sampling:

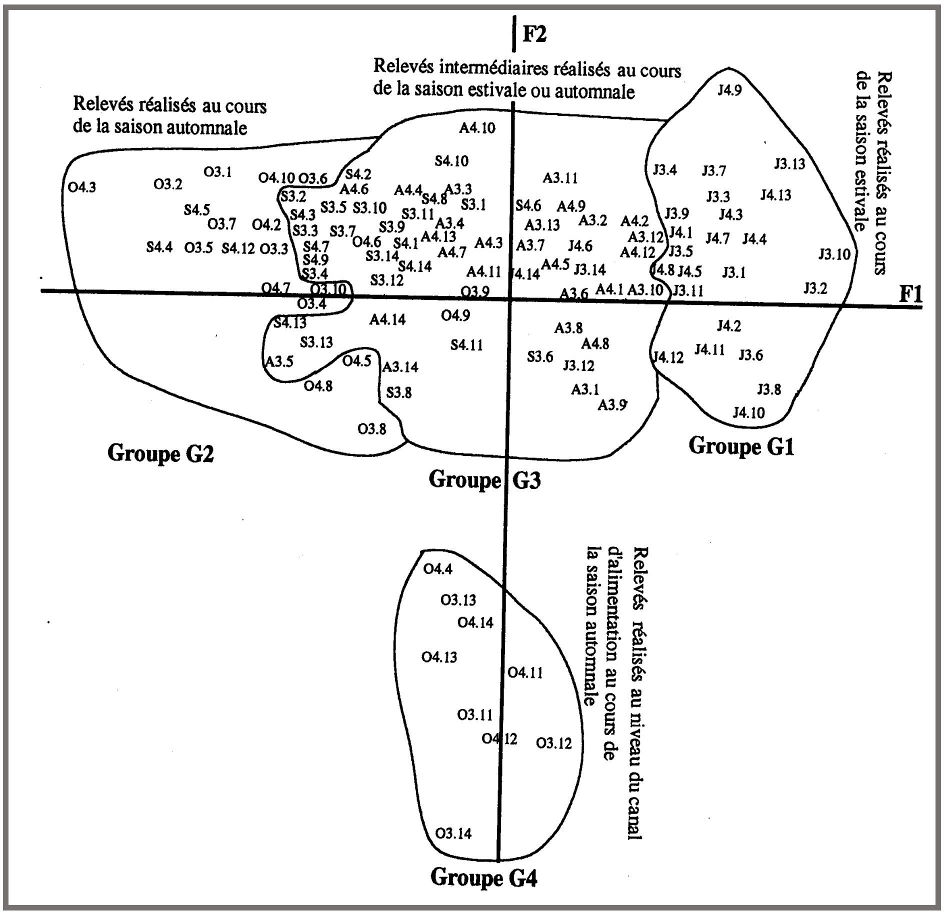

Fig 2: projection of the sampling stations into factorial plan F1/F2

Group 1: grouped in the positive side of factorial plan, corresponding to surveys done during the summer season.

Group 2: located on the negative side of the factorial plan F1/F2. This group corresponds to the surveys done during the end of the rice culture coinciding with the beginning of the fall season.

Group 3: this group is characterized by the intermediate surveys grouped near the center of gravity of the factorial plan. Most of these intermediate group surveys were done throughout the rice cycle.

Group 4: consisting of surveys done at the water supply channel of ricefields. These surveys are located towards the center to the negative side of the factorial axis F2.

Moreover on this factorial plan F1/F2, species of crustaceans cladoceran shows a distribution in 4 main groups (Fig. 3):

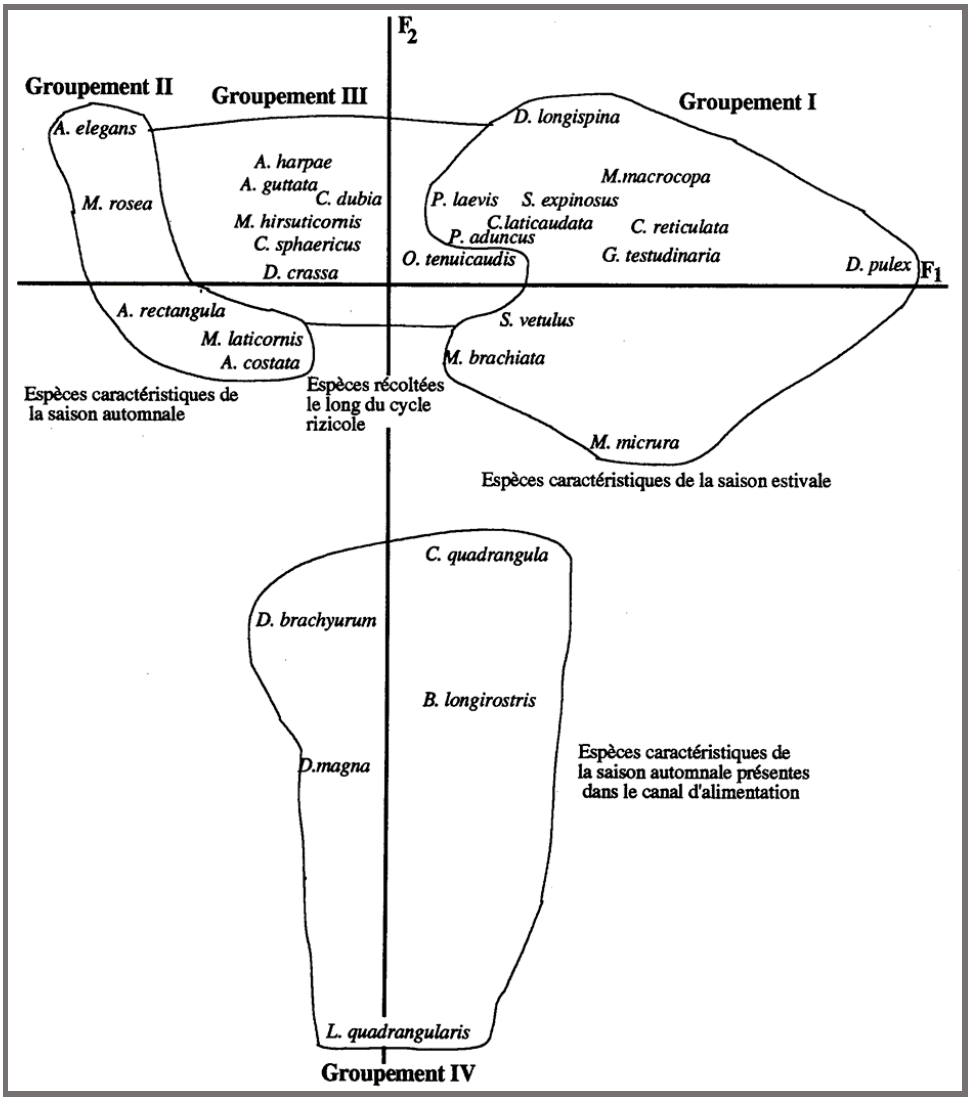

Fig 3: Spatio-temporal distribution of crustaceans cladoceran into factorial plan F1/F2

Group 1: It is located to the positive side of the F1 axis, formed mainly by species often harvested during the summer phase. These species have a monthly distribution focused in early flooding of ricefields. They are *Graptoleberis testudinaria, Pleuroxus laevis, Pleuroxus aduncus, Ceriodaphnia reticulata, Ceriodaphnia laticaudata, Simocephalus vetulus, Simocephalus expinosus, Daphnia pulex, Daphnia longispina, Moina brachiata, Moina micrura* and *Moina macrocopa.*

Group 2: This group of species, located on the negative side of the F1 axis, formed by taxa collected during the fall season. These species are *Alona rectangula, Alona elegans, Alona costata, Macrothrix laticornis* and *Macrothrix rosea.*

Group 3: Located near the center of the factorial F1/F2. The association is composed of species sampled throughout the rice cycle. These species are characterized by the existence of high specific seasonal variations. They are especially *Acroperus harpae, Alona guttata, Ceriodaphnia dubia, Macrothrix hirsuticornis, Chydorus sphaericus, Dunhevedia crassa* and *Oxyurella tenuicaudis.*

Group 4: The species in this group, occupying the negative pole of the axis F2, were most often sampled in the irrigation canal. They are *Diaphanosoma brachyurum, Bosmina longirostris, Leydigia quadrangularis, Ceriodaphnia quadrangula* and *Daphnia magna.*

4. Discussions

Composition of Moroccan cladoceran ricefields revealed the conventional taxonomic composition of small lacustrine environments. Indeed, among the 50 species identified by [18] in Moroccan stagnant water, 30 species of cladoceran were identified in our study area. *Moina macrocopa* which until now has been harvested in Morocco and in the lagoon basin in Marrakech [19] was also sampled in the ricefields of the Gharb plain.

With 8 genera and 12 species, the Chydoridae family was the most represented in the ricefields of the Gharb plain. The species of this family were considered by many authors as conventional cladoceran of shallow environments and coastal areas of lakes. Daphniidae family was represented by 4 genera and 10 species *Simocephalus vetulus* and *Simocephalus expinosus* are most abundant. The Moinidae family was represented in the ricefields of the Gharb plain by three species: *Moina brachiata, Moina micrura* and *Moina macrocopa*. The Bosminidae and Sididae Families were respectively represented in the ricefields of the Gharb plain *Bosmina longirostris* and *Diaphanosoma brachyurum.*

In comparison with other countries, this specific composition is similar to the French [3] and Italian ricefields [2, 5]. The numbers of species harvested respectively were 32 and 36 taxa.

The spatio-temporal distribution of cladoceran species listed in 14 stations during two successive rice cycles is marked by the individualization of 4 groups of species that are in the same direction of the gradient of seasonality. Species characteristic of the summer phase belong mostly to the Daphniidae and Moinidae families: *Ceriodaphnia reticulata, Ceriodaphnia laticaudata, Simocephalus vetulus, Simocphalus expinosus, Daphnia pulex, Daphnia longispina, Moina brachiata, Moina micrura* and *Moina macrocopa*. The summer development of *Daphnia* populations has also been reported by [20] in Catcheou pool (France), [3] in the Camargue ricefields, [21] in the Créteil lakes, [22] in barrage Hassan I (Morocco), [23] in the reservoir Takerkoust and [24] in the reservoir Allal El Fassi.

Appearance of Daphniidae is mainly related to a well-oxygenated environment. However, in the Moroccan rice, their appearance coincided with the summer phase where rising water temperature affect the oxygen solubility dissolved in water. In this respect, Pacaud [25] suggested that *Daphnia pulex* can colonize habitats poor in oxygen because they synthesize hemoglobin. On the other hand, *Ceriodaphnia reticulata* and *Ceriodaphnia laticaudata* are two species characteristic of warm water and can grow at high temperatures [17, 26, 27] that can explain their presence during the summer season.

From the end of the summer, the proliferation of rice ground vegetation influences the general conditions in the environment particularly the physico-chemical, nutritional and biotic conditions. Indeed, the conditions of oxygenation and pH are profoundly changed influenced by the reduction of luminous flux reaching water. This could be the cause of the disappearance of species which have preference of summer conditions (summer species). Therefore, the fall population, dominated by species from irrigation water, formed by species of Chydoridae and Macrothricidae families: *Alona elegans, Alona costata* and *Alona rectangula, Macrothrix laticornis* and *Macrothrix rosea*. The occurrence of these species during this period is attributable of their diet and their preference for environment rich vegetation. This explanation was also given by [14, 23, 25, 28, 29].

5. Conclusion

Despite of the short period of the study imposed by the imperative of submersion period, we have been able to demonstrate spatio-temporal distribution of cladoceran species. Therefore, agrosystem "rice" has a structure, dynamics and evolution which corresponds to that of natural lakes where the impoundment is shorter or longer during the year. The hydrological cycle of rice, the vegetative cycle of *Oryza sativa* and herbarium, temperature and oxygen levels appear to be the main agents influencing the distribution, occurrence and abundance of species of cladoceran in this agrosystem. Associated with biotic relationships such as predation, interspecific and intraspecific competition for food, it follows a species succession during summer and autumn phases.

6. References

1. Hutchinson E. A treatise on limnology. II- Introduction to lake biology and limnoplankton. John Wiley, New York, 1967, 1115.
2. Moroni A. Richerche sulle acque astatiche. L'ecosistema di risaia. Boll Zool 1967; 34:145-146.
3. Pont D. Recherches quantitatives sur le peuplement de copépodes, cladocères et ostracodes des rizières de Camargue. Ph. D thesis, University of Provence, Aix Marseille 1, 1983, 353.
4. Thackeray SJ, Henrys PA, Jones ID, Feuchtmayr H. Eight decades of phenological change for a freshwater cladoceran: what are the consequences of our definition of seasonal timing? Freshwater Biology 2012; 57(2):345-359.
5. Ferrari I, Bachiorri FA, Margaritora FG, Rossi V. Succession of cladoceran in northan Italian ricefields. Hydrobiologia 1991; 225:309-318.
6. Poleo J, Aguero D. Rodents and birds in the ricefields of Guarico River, Venezuela Aug. (SPA) Arroz Am 1992; 13(2):8-9.
7. Berrady K. Recherches bio-écologiques sur le développement entomologique des rizières de la plaine du Gharb (Maroc). Ph.D thesis, University of Ibn Tofail, Kénitra, Morocco, 1997, 160.
8. Elazegui FA, Rapusas HR, Teng PS, Nesbit HJ. Assessing the prevalence of rice pests in Cambodia. Int. Rice Res. Newsl. Illus. Dec 1992; 17(6):26-27.
9. Luong MC. Studies on the resistance of traditional rice varieties to major insect pests and diseases in the Mekong Delta. Omonrice 1992; 2:78-85.
10. Benkirane R. Contribution à l'étude des maladies du riz au Maroc. Ph.D thesis, University of Ibn Tofaïl, Kénitra, Morocco, 1995, 145.
11. EL Oirdi M, Douira A, Benkirane R. Comparaison du caractère pathogène de quelques isolats marocains de *Pyricularia oryzae* vis à vis de certaines variétés de riz. Rev. Amélior. Milieu aride 1995; 7:231-240.
12. Tajani M. Etude de quelques contraintes de la riziculture marocaine, cas de la pyriculariose due à *Magnaporthe grisea:* impacts et moyens de lutte. Ph.D thesis, University of Ibn Tofail, Kénitra, Morocco, 2000, 132.
13. Maqboul A, Aoujdad R, Fadli M, Mokhtar N. Study of dynamics of *Pyha acuta* (Mollusca, Gastropoda) in the moroccan ricefields. Fifth Arab Congress of Plant Protection, 1994.
14. Aoujdad R. Ecologie des crustacés Cladocères des zones humides de la plaine du Gharb et du Bassin du Bas-

Loukkos. Ph.D thesis, University of Ibn Tofail, Kénitra, Morocco, 2007, 217.
15. Smirnov NN. Cladocera: the Chydoridae and Sayciinae (Chydoridae) of the word. Guides to the identification of microinvertebrates of the continental waters of the world, number 11. Amsterdam, Academic Publishing, 1996.
16. Margaritora FG. Guide per il riconosciemento delle specie animali delle acque interne italiane. Cladoceri 1983; 22:1-169.
17. Amoros C. Crustacés Cladocères. Bulletin Société Linnéenne Lyon 1984; 3(4):71 145.
18. Ramdani M. Ecologie des crustacés (copépodes, cladocères et ostracodes) des mares temporaires (Dayas) marocaines. Ph.D thesis, University of Provence, Aix Marseille 1, 1986, 217.) marocaines. Ph.D thesis, University of Provence, Aix Marseille 1, 1986, 217.
19. Benider A. Caractères démographiques de *Moina macrocorpa* (Cladocera: Moinidae) en élevage au laboratoire. Ph.D thesis, University of Cadi Ayyad, Marrakech, Morocco, 1991, 75.
20. Terzian E. Ecologie des mares temporaires de l'Isoetion dans la Crau et l'Esterel (France). Ph.D thesis, University of Aix-Marseille, 1979, 210.
21. Lacroix G. Ecologie des peuplements de cladocères des gravières en eau. Ph.D thesis, University of Pierre et Marie Curie, Paris, 1987, 294.
22. Benzekri MA. Qualité des eaux du lac-réservoir Hassan I (Maroc): hydrochimieet dynamique pluriannuelle du zooplankton. Ph.D thesis, University of Cadi Ayyad, Marrakech, Morocco, 1992, 187.
23. Tifnouti A. Structure et organisation du peuplement zooplanctonique dans le lac réservoir Lalla Takerkoust. Ph.D thesis, University of Cadi Ayyad, Marrakech, Morocco, 1993, 268.
24. Jabari A. Structure et dynamique des populations zooplanctoniques de la retenue de barrage Allal El Fassi. Ph.D thesis, University of Sidi Mohemed Ibn Abdellah, Fes, Morocco, 1998, 226.
25. Pacaud A. Contribution à l'écologie des Cladocères. Bull Biol suppl 1939; 25:260.
26. Eitam A, Blaustein L, Van Damne K, Dumont HJ, Martens K. Custacean species richness in temporary pools: relationships with habitat traits. Hydrobiologia 2004; 525:25- 130.
27. Nevalainen L, Luoto TP, Kultti S, Sarmaja-Korjonen K. Spatio-temporal distribution of sedimentary Cladocera (Crustacea: Branchiopoda) in relation to climate. Journal of Biogeography 2013; 40:1548-1559.
28. Roberston AL. The population dynamics of Chydoridae and Macrothricidae (Cladocera: Crustacea) from the River Thames, U.K. Freshwater Biology 1983; 24:375-389.
29. Aranguren-Riaño N, Guisande C, Ospina R. Factors controlling crustaceans zooplankton species richness in Neotropical lakes. Journal of Plankton Research 2011; 33(8):1295-1303. 356.