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Diversity of terrestrial isopods at the Oued Laou region (Northeast of Morocco): preliminary results

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Abstract. The terrestrial isopodofauna of Morocco is still unknown and no recent investigations have been done on the woodlice. The field work is carried out on April 2004 at the catchment area of Oued Laou. Nineteen stations were explored in relation with the altitude and the vegetation. Different biotopes were reported, the beach, the manure heaps, the forest of *Olea europaea, Lavandula dentata, Juncus* sp, *Pistacia lentiscus, Juniperus oxycedrus, Juniperus phoenicea, Trifolium stellatum, Centaurea calcitrapa, Ditrichia vescosa,* etc. In the terrestrial isopod community, five families were identified: Tylidae, Philosciidae, Porcellionidae, Armadillidiidae and Armadillidae with respectively *Tylos europaeus; Chaetophiloscia* sp; six species of *Porcellio* (*P. hoffmanseggii, P. laevis, P. lamellatus, P. echinatus, Porcellio* sp 1 and *Porcellio* sp 2), three species of *Porcellionides* (*P. Pruinosus, P. sexfasciatus* and *Porcellionides* sp), *Chaetophiloscia* sp, *Philoscia* sp, *Soteriscus gaditanus, Agabiformius lentus, Lucasius myrmecophilus, Leptotrichus panzeri*; two species of *Armadillidium* (*A. vulgare* and *A. granulatum*) and *Armadillo officinalis. P. hoffmanseggii* is the most common species. *Tylos europaeus* and *Porcellio lamellatus* are closed to the beach whereas *Porcellionides pruinosus* is related to the manure heaps.

Keywords: Diversity; Terrestrial Isopods; Biotopes; Biodiversity

Diversité des Isopodes terrestres de la région de Oued Laou (nord-ouest du Maroc) : résultats préliminaires

Résumé. Les isopodes terrestres du Maroc sont mal connus et très peu de travaux récents leurs ont été réservés. Afin de contribuer à la connaissance de cette isopodofaune, une campagne de terrain a été réalisée en Avril 2004 dans le bassin versant d'Oued Laou. Ce qui a permis d'échantillonner dans 19 stations sélectionnées en fonction de l'altitude et de la couverture végétale. Divers biotopes ont fait l'objet de nos investigations, la plage, le compost, les ordures ménagères, les forêts d'*Olea europaea, Lavandula bidentata, Juncus* sp., *Pistacia lentiscus, Juniperus oxycedrus, Juniperus phoenicea, Trifolium stellatum, Centaurea calcitrapa, Ditrichia vescosa,* …. La communauté des isopodes récoltés comprend cinq familles : Tylidae, Philosciidae, Porcellionidae, Armadillidiidae et Armadillidae, représentées respectivement par *Tylos europaeus; Chaetophiloscia* sp ; six espèces de *Porcellio* (*P. hoffmanseggii, P. laevis, P. lamellatus, P. echinatus, Porcellio* sp1 et *Porcellio* sp2). Trois espèces de *Porcellionides* (*P. pruinosus, P. sexfasciatus* et *Porcellionides* sp), *Soteriscus gaditanus, Agabiformius lentus, Lucasius myrmecophilus, Leptotrichus panzeri*; deux espèces d'*Armadillidium* (*A. vulgare* et *A. granulatum*) et *Armadillo officinalis. P. hoffmanseggii* est l'espèce la plus commune. Les deux espèces, *Tylos europaeus* et *Porcellio lamellatus*, sont inféodées à la plage, alors que *Porcellionides pruinosus* est cantonné au compost et aux ordures ménagères.

Mots clés : Diversité, Isopodes terrestres, Biotopes, Biodiversité.

INTRODUCTION

Isopods have been collected during the past more than one century ago, in the world in general. In the North Africa regions, this collect was started with some explorations like the journey of Gaston Buchet (Dollfus 1896a, 1896b) and extensively during the past 30 years in some regions.

In Morocco, Arcangeli (1932) and De Félice (1939) indicated that there was a high diversity in terrestrial isopods, biotopes and bioclimatic regions. The great area from the Rif to the Atlas could accommodate an important and interesting biodiversity in fauna and flora in general. However, no recent investigations have been done on the terrestrial isopodofauna when we compared this region with the Middle East (Syria, Lebanon, Palestine and Jordan), where 72 species of terrestrial isopods are known (Schmalfuss 1998).

Vandel (1962) described many terrestrial isopod species in France and in Europe. In Greek, a great number of species have been described, of which 69% are endemic (Spyros & Sinos 1998). In Tunisia, several studies about terrestrial isopods were done (Rezig & Nasri 1992, Achouri & Charfi-Cheikhrouha 2000, 2001, 2002, Achouri *et al.* 2003 Medini & Charfi-Cheikhrouha 1998, Hamaied & Charfi-Cheikhrouha 2004).

New investigations in Morocco could exhibit many particularities such as a high percentage of endemics and a high biodiversity in the terrestrial isopods related to the complex topography, paleogeography and ecological history of the country.

In the present study, we intend to identify the Isopod fauna, and to estimate some ecological parameters including richness species, abundance, diversity, and dominance among habitat types in Oued Loau catchment area.

MATERIALS AND METHODES

Description of the study area

The study area involves the Oued Loau catchment area, which characterized by the Mountain Rif. Samplings have been done in nineteen localities indicated in table I.

Our first contact with the two sites Oued Laou and Chefchaoun was during a field work in April 2004. This opportunity allowed us to appreciate the highest importance and the interest of this site, to note and to collect a varied and interest information about biodiversity in general and the Isopod fauna diversity in this region particularly.

The biotopes and habitats could be separated into grassland, forest, beach, closed to the habitats and manure heaps. In all localities, hand sampling of terrestrial isopods was used. Specimens were collected from under the stones and in dead leaf.

Laboratory analysis

Individuals collected were taken to the laboratory, the large size specimens could be identified in the field some of them were alive and will be used for further investigations (dynamic and genetic populations) whereas the remaining specimens were preserved in 70% ethanol. Subsequently, all individuals were counted and sexed, using a binocular microscope. Some species unidentified are under taxonomic revision (e.g. *Acaeroplastes* sp, *Porcellio* sp 1 and sp 2, *Chaetophiloscia* sp, *Philoscia* sp).

RESULTS

Terrestrial Isopods were collected from Nineteen stations, where altitude varied from 12 m to 417 m and the vegetation was represented by *Olea europea*, *Lavandula dentata*, *Juncus* sp., *Pistacia lentiscus*, *Juniperus oxycedrus*, *Juniperus phoenicea*, *Trifolium stellatum*, *Centaurea calcitrapa*, *Ditrichia viscosa*,... (Tabl. I).

Composition of the Isopod fauna

In the terrestrial isopod community, five families were identified: Tylidae, Philosciidae, Porcellionidae, Armadillidiidae and Armadillidae with more than 1000 specimens of 20 species, distributed respectively 70% in Porcellionidae 10% in Armadillidiidae and Philosciidae, and 5% in Tylidae and Armadillidae (Tabl. II). The family Porcellionidae is the most represented with six genera *Acaeroplastes*, *Agabiformius*, *Leptotrichus*, *Porcellio*, *Porcellionides* and *Soteriscus*. The genera *Porcellio* exhibited the most important number of species (6) *P. hoffmannseggii* Brandt 1833, *P. laevis* Latreille 1804, *P. lamellatus*, *P. echinatus* and two species not yet identified. *Porcellionides* was represented by three species the cosmopolitan species, *P. pruinosus* (Brandt 1833), *P. sexfasciatus* (Budde-Lund 1879) and one species under taxonomic revision. The others genera *Acaeroplastes*, *Agabiformius*, *Leptotrichus*, *Lucasius*, and *Soteriscus* were represented respectively by one species. *Acaeroplastes* sp, *A. lentus*, *L. panzeri* and *S. gaditanus*. Both Armadillidiidae and Philosciidae were presented in this study by two species respectively, *A. vulgare* (Latreille 1804) and *granulatum* Brandt, 1833, and *Philoscia* sp and *Chaetophiloscia* sp. The families Tylidae and Armadillidae showed one species respectively *Tylos europaeus* and *Armadillo officinalis* Duméril 1816.

Species richness

During this field survey, twenty species of isopods were found at least. Five species were relatively more abundant, while the remaining fifteen were found occasionally. A number of four to nine specimens were occurred in six stations; only one species inhabiting 4 localities, *A. vulgare* was present in one station and *P. pruinosus* in three stations. Whereas in the remaining stations, two to six species were collected (Tabl. I).

Isopod diversity

The highest species diversity was related to the high flora diversity (stations 1, 5, 7, 9, 10, 16). *Armadillo officinalis*, *Armadillidium vulgare*, *Porcellionides pruinosus*, *Porcellio* laevis and *P. hoffmannseggii* showed the highest frequency ranging from 26.3% to 63.1%, (Tabl. III).

The Mediterranean species *Armadillo officinalis* was common in the whole of the localities except in the beach stations. Both *P. hoffmannseggii* and *A. vulgare*, settled all calcareous habitats, and drier lowland localities with ruderal vegetation. The anthropic species *P. pruinosus* was found in manure heaps, closed to the habitats. Whereas, *Tylos europaeus*and *Porcellio lamellatus*, are closed to the beach. *Porcellionides sexfasciatus* was collected from a cave with *Leptotrichus panzeri* and *Lucasius myrmecophilus*.

Abundance

The total isopod sample consisted of 1763 individuals representing twenty species; *P. pruinosus* (584), *S. gaditanus* (311), *T. europaeus* (234), and *P. sexfasciatus* (147) were the most abundant in the Oued Laou catchment. However, *A. officinalis*, *P. hoffmannseggii* and *A. vulgare* showed the important presence index (Tabl. III).

DISCUSSION

Morocco, as a result of its complex topography and paleogeographic history, has been an important centre habitat for Oniscidea. The two regions richest in species are the Rif mountainous and the region near the beach. Both *A. officinalis* and *P. hoffmannseggii* were dispersal in both little samples, under stones and at tree feet and tree stumps. However *P. pruinosus* and *P. sexfasciatus* lived aggregated in particular habitats like compost and the manure heaps, whereas *Tylos europaeus* and *Porcellio lamellatus* are closed to the beach. *Philoscia* sp, *Chaetophiloscia* sp and *Soteriscus gaditanus* were found in sympatric under rocks in laying fallow humid enough.

Table I: Biotopes and species collected

Station	Latitude; longitude Altitude (A)	Biotope and vegetation	Species collected
1	N 35 30 351; W 05 09 297 A : 22 m	Near to the small river. *Lentiscus*, *Juniperus phoenicea*, *Nerium oleander* and others herbaceous plants (graminaceous), ...	*Porcellionides pruinosus*, *Agabiformius lentus*, *Porcellio lamellatus*, *Porcellio hoffmannseggii*, *Porcellio laevis*, *Acaeroplastes* sp
2	N 35 34 299; W 05 03 425	The east part of the bay, near the beach	*P. lamellatus*, *Tylos europaeus*
3	N 35 24 312; W 05 03 510	Alluvial fan (relatively newly built) under the stones and household refuse.	*Porcellio laevis*, *Porcellionides sexfasciatus*
4	N 35 27 309; W 05 03 465 A : 57 m	Compost in the Tergha region.	*Porcellionides pruinosus*, *Porcellio laevis*
5	N 35 24 226; W 05 02 567 A : 117m	Under the stones. *Lentiscus*, *cystus*, *Olea Daphnie gnidium*, *Lavandula dentata*	*Agabiformius lentus*, *Porcellio laevis*, *Armadillo officinalis*
6	N 35 23 343; W 05 09 712 A : 16m	Compost in the East of the town of Oued Laou.	*Porcellionides pruinosus*
7	N 35 23 343; W 05 09 712 A : 32 m	The side of the small mountain. Dominant vegetation: *Juniperus phoenicea*, *Lentiscus*, dwarf palm, *Daphnie*, *Joncus*, *Olea*, almond tree, others plants herbaceous (graminaceous), *lavendula dentata*, ...	*Armadillo officinalis*, *Porcellio* sp 2, *Chaetophiloscia* sp, *Philoscia* sp
8	N 35 24 706; W 05 07 972 A : 12 m	In a cow dung	*Porcellionides pruinosus*
9	N 35 24 686; W 05 11 815 A : 94 m	Herbaceous (*Trifolium stellatum*, *Centaurea calcitrapa*), *Pistacia lentiscus*, *Ditrichia vescosa Avina* sp.	*Armadillidium vulgare*, *Porcellionides* sp, *Armadillo officinalis*, *Soteriscus gaditanus*
10	N 35 23 645; W 05 13 392 A : 146 m	Near the mouth of the river in the limit of the *Juncus* sp., stripped beach, humid enough. *Hordeum muricatum* (graminaceous) *sedum* sp. *Ononis viscosa*, *Asparagus albus* polygonaceous	*Armadillidium vulgare*, *Porcellio laevis*, *Porcellio echinatus*, *Porcellio hoffmannseggii*
11	N 35 21 731; W 05 13 405 A : 178 m	Only one plant species whitch was (leguminous papilionaceous with yellow flower)	*Armadillidium vulgare*
12	N 35 20 548; W 05 14 387 A : 214 m	Cave	*Porcellionides sexfasciatus*, *Lucasius myrmecophilus*, *Leptotrichus panzeri*
13	N 35 19 487; W 05 18 269 A : 237 m	In the same locality at a higher altitude and under the stones with one *scorpionidea*, *Iulus* and larva of Insect. Plants dominants: *Lentiscus*, *Cyprus*, *Juniperus*	*Armadillo officinalis*, *Lucasius myrmecophilus*
14	N 35 23 624; W 05 13 234 A : 207 m	Bank of a river	*Armadillidium granulatum*, *Armadillo officinalis*
15	N 35 15 231; W 05 16 359 A : 315 m	In the downstream part of the dam	*Chaetophiloscia* sp, *Porcellio echinatus*, *Porcellio laevis*
16	N 35 07 849; W 05 17 266 A : 434 m	North side of a cork oak forest	*Armadillo officinalis*, *Acaeroplastes* sp, *Armadillo granulatum*, *Armadillidium vulgare*, *Porcellio* sp2
17	N 35 11 197; W 05 18 783 A : 283 m	Under stone in the cow dung	*Philoscia* sp, *Soteriscus gaditanus*, *Porcellio* sp1
18	N 35 11 197; W 05 18 783 A :402 m	Under stone	*Soteriscus gaditanus*, *Philoscia* sp, *Porcellio echinatus*
19	N 35 18 695; W 05 11 402 A : 353 m	Under rocks	*Chaetophiloscia* sp, *Soteriscus gaditanus*, *Philoscia* sp.

Table II: Terrestrial isopod species collected from Morocco (Oued Laou and Chefchaouen areas)

Families	Species
Tylidae (5%)	*Tylos europaeus* Budde Lund, 1885
Porcellionidae (70%)	*Acaeroplastes* sp
	Agabiformius lentus (Budde Lund, 1885)
	Lucasius myrmecophilus
	Leptotrichus panzeri (Audouin, 1825)
	Porcellio lamellatus Budde-Lund, 1879
	Porcellio laevis Latreille, 1804
	Porcellio hoffmannseggii Brandt, 1833
	Porcellio sp1
	Porcellio sp2
	Porcellio echinatus
	Porcellionides pruinosus (Brandt, 1833)
	Porcellionides sexfasciatus Budde-Lund, 1879
	Porcellionides sp
	Soteriscus gaditanus
Armadillidiidae (10%)	*Armadillidium vulgare* (Latreille, 1804)
	Armadillidium granulatum Brandt, 1833
Armadillidae (5%)	*Armadillo officinalis* Duméril, 1816
Philosciidae (10%)	*Philoscia* sp
	Chaetophiloscia sp

The establishment of biogeographical categories is influenced by the groups of organisms considered. Each group responds differently to the prevalent paleogeographical and climatic conditions. Since plants are the group that is most directly dependent on the geological and climatic conditions, it seems reasonable to use the phytogeographical categories as a reference system. In terrestrial isopods, the most common distribution type is the holo-Mediterranean (Schmalfuss 1998). In this case, five genera *Agabiformius*, *Leptotricus Porcellionides*, *Armadillidium* and *Armadillo* have holo-Mediterranean distributions. The autochthonous distribution of the genus *Armadillidium* comprises the circum-Mediterranean regions. Additionally, the genus populates central and northern Europe, the coastal regions of the Black Sea, and Caucasus to the western shore of the Caspian Sea. From the species numbers given for different countries, it becomes apparent that there is an extremely high density in Italy and Greece (55) ex-Yugoslavia (30) (Schmalfuss 1998).

Table III: Species composition and abundance of terrestrial isopods in 19 stations

Species	Total number of localities	Frequency (%)	Abundance	Relative abundance (%)
Armadillo officinalis	12	63,15	70	4,00
Porcellio hoffmannseggii	9	47,63	49	2,80
Armadillidium vulgare	7	36,84	40	2,20
Porcellionides pruinosus	5	26,31	584	33,12
Porcellio laevis	5	26,31	47	2,67
Porcellionides sexfasciatus	3	15,79	147	8,34
Porcellio sp1	3	21,05	13	0,74
Porcellio sp2	3	15,79	90	5,10
Porcellionides sp	3	15,79	18	1,02
Soteriscus gaditanus	3	15,79	311	17,64
Acaeroplastes sp	3	15,79	4	0,72
Porcellio lamellatus	2	10,52	10	0,56
Porcellio echinatus	2	10,52	40	2,27
Agabiformius lentus	2	10,52	13	0,74
Tylos europaeus	2	10,52	234	13,27
Armadillidium granulatum	2	10,52	31	1,76
Philoscia sp	2	10,52	34	1,93
Chaetophiloscia sp	1	5,26	6	0,34
Leptotricus panzeri	1	5,26	18	1,02
Lucasius myrmecophilus	1	5,26	4	0,23

The pertinent example is the genus *Porcellio*. In traditional systematic, it is treated as a valid genus with holo-Mediterranean distribution, having additionally colonized central and northern Europe and the Sahara. There are, however, well-founded arguments that *Porcellio* is a poly- or paraphyletic unit consisting of tow different phyletic lines that have been lumped together because of convergent similarities. The southern group comprises the species commonly ascribed to the *leavis* and the *hoffmannseggii*. It is distributed troughout North Africa and deep into the Sahara. In the western part, it has crossed the trait of Gibraltar and colonized the southern part of of the Iberian Peninsula (Schmalfuss 1998).

The genus *Lucasius* represented an occidental form, while *Leptotrichus* and *Agabiformius* were an oriental one. The origin centre of *Lucasius* appeared the massif betico-rifain which separated the Mediterranean to the Atlantic in a long period of the tertiary (Vandel 1962). *Porcellionides* was represented by the cosmopolitan species *pruinosus* which was accompanied the human activities and went with him every where. This species was most probably originally from the Mediterranean region. Actually, it was impossible to base with best way his original centre (Vandel 1962). Both *P. pruinosus* and *P. sexfasciatus* were collected in Europe, Asia, Africa and they had been the subject of several studies in Tunisia (Achouri & Charfi-Cheikhrouha

2000, 2001, 2002; Achouri *et al*. 2003). In this study, the specimens of *P. pruinosus* and *P. sexfasciatus* represented the majority in samples which could be allocated to the particular habitats occupied by these species (compost, manure heap...) where mesoclimatic could be effect their distribution, while other species (*A. officinalis*, *Acaeroplastes* sp, *A. granulatum*, *A. vulgare*, *Porcellio hoffmanseggii* and *Porcellio* sp 2 etc.) shared their shelters (stone, rocks, etc.). In woodland, the association of isopod species with habitat types is strongly affected by soil and humus types (Judas & Hauser 1998). Warburg *et al.* (1984) identify climate as a main factor affecting isopod distribution and abundance.

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