

Distribution of aquatic beetles from the east of Morocco (Coleoptera, Polyphaga)

Y. Mabrouki, A. F. Taybi, G. Chavanon, A. Berrahou, A. Millán

Mabrouki, Y., Taybi, A. F., Chavanon, G., Berrahou, A., Millán, A., 2018. Distribution of aquatic beetles from the east of Morocco (Coleoptera, Polyphaga). *Arxius de Miscel·lània Zoològica*, 16: 185–211, Doi: <https://doi.org/10.32800/amz.2018.16.0185>

Abstract

Distribution of aquatic beetles from the east of Morocco (Coleoptera, Polyphaga). We present old and new faunistic and distributional data on aquatic Polyphaga (Coleoptera) from the east of Morocco, comprising the Oriental Region and the basin of Moulouya River. A checklist of 91 species belonging to 27 genera and seven families is provided. *Ochthebius quadrifossulatus* (Hydraenidae) and *Pomatinus substriatus* (Dryopidae) are new records for the basin of Moulouya River, and *Helophorus occidentalis*, *H. discrepans*, *H. flavipes*, *Hydrochus flavipes*, *Anacena globulus*, *Enochrus fuscipennis* and *Hydrobius fuscipes*, all belonging to the family Hydrophilidae, and *Limnebius furcatus*, *Ochthebius aeneus* and *O. merinidicus* (all Hydraenidae) are new for the entire studied area of Eastern Morocco. We found a clear dominance of the Palearctic elements, mainly Mediterranean, with a high proportion of Ibero–Maghrebian endemisms. This chorotype pattern is similar to those observed for other macroinvertebrates orders in the same study area.

Data published in GBIF ([Doi: 10.15470/saajc8](https://doi.org/10.15470/saajc8))

Key words: Aquatic Coleoptera, Inventory, Northeastern of Morocco, Moulouya, Monitoring, New records

Resumen

Distribución de escarabajos acuáticos del este de Marruecos (Coleoptera, Polyphaga). Se presentan antiguos y nuevos datos faunísticos y de distribución de Polyphaga (Coleoptera) acuáticos del este de Marruecos, incluidas la región oriental y la cuenca del río Moulouya. Se aporta un listado de 91 especies pertenecientes a 27 géneros y siete familias. *Ochthebius quadrifossulatus* (Hydraenidae) y *Pomatinus substriatus* (Dryopidae) constituyen nuevos registros en la cuenca del río Moulouya y *Helophorus occidentalis*, *H. discrepans*, *H. flavipes*, *Hydrochus flavipes*, *Anacena globulus*, *Enochrus fuscipennis* e *Hydrobius fuscipes*, pertenecientes todos ellos a la familia Hydrophilidae, y *Limnebius furcatus*, *Ochthebius aeneus* y *O. merinidicus* (todos ellos Hydraenidae) son nuevos en la totalidad del área estudiada del este de Marruecos. Encontramos un claro predominio de elementos paleárticos, principalmente mediterráneos, con una elevada proporción de endemismos ibero–magrebíes. Este patrón corotípico es similar a los observados en otros órdenes de macroinvertebrados en la misma área de estudio.

Datos publicados en GBIF ([Doi: 10.15470/saajc8](https://doi.org/10.15470/saajc8))

Palabras clave: Coleópteros acuáticos, Inventario, Nordeste de Marruecos, Moulouya, Monitorización, Nuevos registros

Resum

Distribució d'escarabats aquàtics de l'est del Marroc (Coleoptera, Polyphaga). Es presenten antigues i noves dades faunístiques i de distribució de Polyphaga (Coleoptera) aquàtics de l'est del Marroc, incloent-hi la regió oriental i la conca del riu Moulouya. S'aporta una llista de 91 espècies pertanyents a 27 gèneres i set famílies. *Ochthebius quadrifossulatus* (Hydraenidae) i *Pornatinus substriatus* (Dryopidae) són nous registres a la conca del riu Moulouya i *Helophorus occidentalis*, *H. discrepans*, *H. flavipes*, *Hydrochus flavipes*, *Anacena globulus*, *Enochrus fuscipennis* i *Hydrobius fuscipes*, tots pertanyents a la família Hydrophilidae, i *Limnebius furcatus*, *Ochthebius aeneus* i *O. merinidicus* (tots Hydraenidae) són nous a tota l'àrea estudiada de l'est del Marroc. Vam trobar un clar predomini d'elements paleàrtics, principalment mediterranis, amb una proporció elevada d'endemismes iberomagribins. Aquest patró corotípic és similar als observats en altres ordres de macroinvertebrats a la mateixa àrea d'estudi.

Dades publicades a GBIF ([Doi: 10.15470/saajc8](https://doi.org/10.15470/saajc8))

Paraules clau: Coleòpters aquàtics, Inventari, Nord-est del Marroc, Moulouya, Monitoratge, Nous registres

Received: 18/07/2018; Conditional acceptance: 16/08/2018; Final acceptance: 22/08/2018

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Introduction

The biodiversity crisis is one of the major challenges facing humanity today (Purvis and Hector, 2000). This massive erosion is due to the increasing acceleration of species' extinction rate due to anthropogenic activity, causing an irreversible loss of biological information with unpredictable consequences (Kerr and Currie, 1995; Rands et al., 2010). We live in an unprecedented era of biodiversity loss and biologists predict that tens of thousands of species and millions of populations will be extinct in the coming decades (Purvis and Hector, 2000; Barnosky et al., 2011). Biological diversity of continental aquatic ecosystems is generally higher than most other ecosystems (Darwall et al., 2008). As a result, the loss of biodiversity within inland waters would be much greater than in other ecosystems (Allan and Flecker, 1993; Ricciardi and Rasmussen, 1999).

Aquatic macroinvertebrates play a vital role in terms of biodiversity and ecosystem functioning, and consequently in the stability of ecosystems (Wallace and Webster, 1996). They also allow the diagnosis of alterations causes, the establishment of criteria for protection and restoration of interesting ecosystems and finally the integrated management of watersheds (Abellán et al., 2007). Thus, good knowledge of the species presence and distribution is necessary to protect biodiversity (Millán et al., 2014). In this framework, we

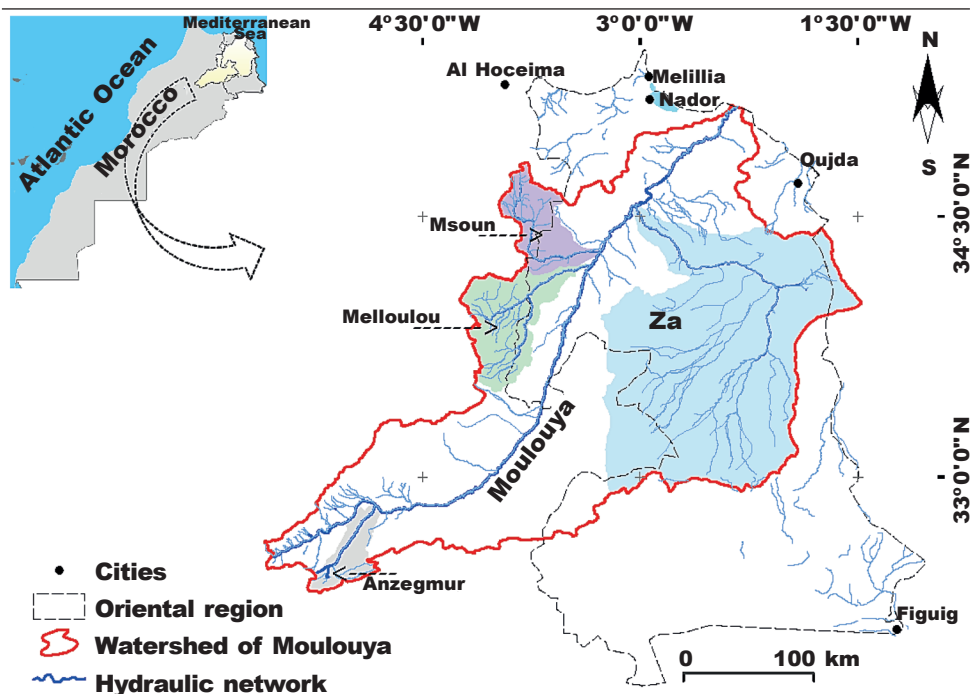


Fig. 1. The Oriental Region of Morocco and the basin of Moulouya River.

Fig. 1. Región oriental de Marruecos y cuenca del río Moulouya.

carried out several studies regarding monitoring of aquatic ecosystems based on macroinvertebrate communities in Oriental Morocco and the basin of Moulouya River (Daoudi et al., 2017; Mabrouki et al., 2016b, 2017a, 2017c, in press; Taybi, 2016; Taybi et al., 2016b, 2017b, 2018a), including aquatic Adephegata beetles (Taybi et al., 2017a).

Water beetles make up a large part of aquatic invertebrates (Jäch and Balke, 2008), so they are ideal candidates to be used as indicators of biodiversity of aquatic ecosystems, given their great specific and functional diversity, the great variety of habitats they are able to colonize and the general good taxonomic and faunistic knowledge (Bilton et al., 2006; Sánchez-Fernández et al., 2006).

With the aim of improving knowledge of the water beetles in the east of Morocco and completing previous studies (see Taybi et al., 2017a) on this group, we compiled a commented checklist of new and old records on the presence and distribution of the aquatic beetles belonging to the suborder Polyphaga) from Oriental Morocco and the Moulouya basin.

Material and methods

Study area

Morocco is currently divided into 12 regions, including the Oriental Region (fig. 1), which occupies almost all the eastern side of the country and covers an area of 90,127 km² (see Taybi et al., 2017a for details). The Oriental Region includes the wilaya of Oujda (Oujda–Angad prefecture) and the provinces of Berkane, Driouch, Figuig, Guercif, Jerada, Nador and Taourirt.

The watershed of the Moulouya (fig. 1), which includes nearly 43,412 km² of eastern Morocco, covers much of the Oriental Region. With a length of 600 km, the Moulouya is the largest Moroccan river flowing into the Mediterranean. The main tributaries are the Oued Ansegmir, Oued Melloulou, Oued Za and Oued Msoun, all permanent. Other tributaries are intermittent (3–5 flashfloods on average per year) (Bensaad et al., 2017; Mabrouki et al., 2017c).

Sampling

In field surveys conducted from 2014 to 2017, more than 100 localities were collected along the basin of Moulouya River and Oriental Region of Morocco (see appendix for the complete list of localities). Most of these sampling sites were visited at least three times. Our goal was to document maximum macroinvertebrate biodiversity in the different microhabitats prospected at each sampling site.

The samples of benthic fauna were collected using a kick net, landing nets and clamps. The macroinvertebrates, including water beetles, were identified to species level, placed in accordingly labeled tubes with alcohol at 70% or 96%, and deposited in the collections of aquatic macroinvertebrates at the Laboratory of Water Sciences, Environment and Sustainable Development of the University Mohammed Premier from Oujda (Morocco), and the Department of Ecology and Hydrology, Faculty of Biology, University of Murcia (Spain).

Chorological study

The chorological categories proposed for the 91 species of Oriental Morocco and the Moulouya watershed were ranked according to La Greca (1964, 1975) and Vigna Taglianti et al. (1992) for the western Palearctic fauna.

Abbreviations

The new species for Moulouya basin are marked by #, and those for the entire area by *.

Results

A checklist of 91 species belonging to 27 genera and seven families is provided (appendix 1). It is also published in GBIF as a dataset ([doi: 10.15470/saajc8](https://doi.org/10.15470/saajc8)).

Family Helophoridae Latreille, 1802

***Helophorus (Empleurus) porculus* Bedel, 1881**

Distribution: Atlanto–Mediterranean species. This is a mountain taxon in Morocco where it is known in the Middle Atlas and Anti Atlas (Benamar, 2015). In the Oriental region it was previously recorded at Oujda by Chavanon et al. (2004).

***Helophorus (Empleurus) rufipes* (Bosc, 1791)**

Distribution: Atlanto–Mediterranean species. In Morocco it is distributed in the northern part (Benamar, 2015). In the Oriental region it was recorded from Nador (Bennas, 2002).

***Helophorus (Eutrichelophorus) oxygonus* Bedel, 1881**

Material examined: Ait Boulmane, 03.05.14, 2 males, 2 females; Ait Oha Ohaki, 13.06.14, 1 male; Aghbalou, 13.06.14, 2 females; Sources O. Bered, 01.06.14, 1 male; Sources Berkine, 07.08.14, 2 males, 1 female.

Distribution: West Mediterranean species. In Morocco it is known from some localities in the north (Benamar, 2015). In the Oriental region it was recorded from Debdou (Benamar,

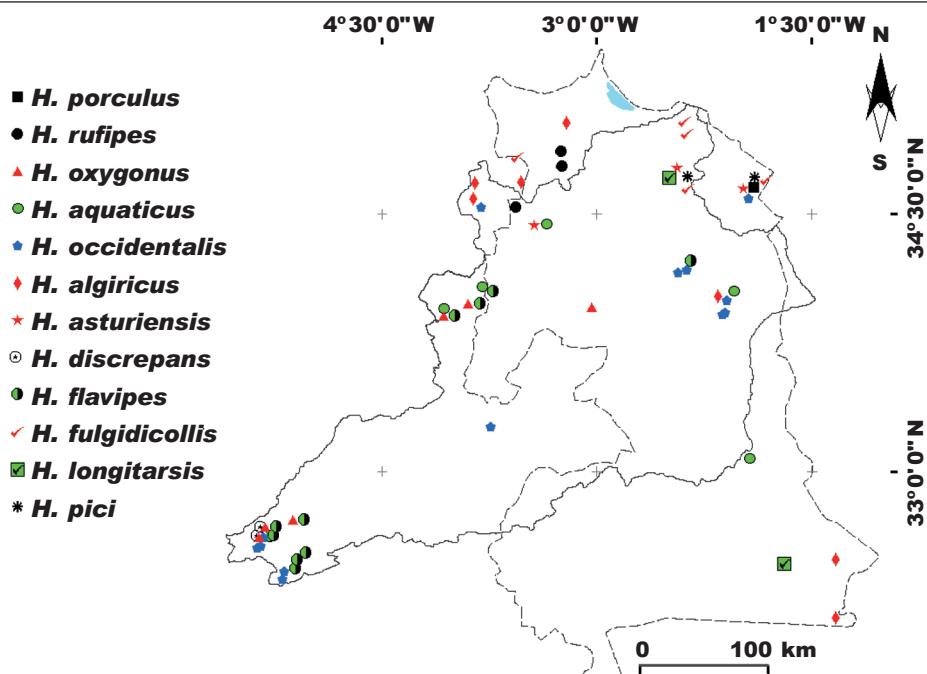


Fig. 2. Distribution of Helophoridae species in the study area.

Fig. 2. Distribución de especies de Helophoridae en el área de estudio.

2015). During the sampling period, the species was found in the Eastern Middle Atlas (fig. 2). This species is not listed for Morocco in the catalogue of Hydrophiloidea from Palearctic region but for Algeria (Fikacek et al., 2015). Recently it has been recorded in the oriental part of the Rif Mountain (unpublished data).

Helophorus (Helophorus) cf. aquaticus (Linnaeus, 1758)

Material examined: sources O. Bered, 01.06.14, 1 male, 2 females; Douar Ifrane, 07.08.14, 1 male.

Distribution: Euro–Maghrebian species. In Morocco it is known from some very scattered localities in the northern part (Benamar, 2015). In the Oriental region it was recorded from Charef River (Benamar, 2015). During the sampling period, the species was found in the Middle Eastern Atlas, corresponding to upstream of Melloulou River (fig. 2). Despite this species having been recorded several times in Morocco, Fikacek et al. (2015) did not include it in any of the Maghrebian countries, so its presence in Morocco and the study area need confirmation.

Helophorus (Helophorus) occidentalis Angus, 1983*

Material examined: Ait Boulmane, 03.05.14, 1 male; Ait Oha Ohaki, 13.06.14, 2 males; Aghbalou, 13.06.14, 2 males, 1 female; Irhdís, 14.07.14, 25 males and females; Boumia, 15.07.14, 15 males and females; Anzar Oufounas, 15.07.14, 32 males and females; Aval Anzar Oufounas, 15.07.14, 2 females; Anzegmir avant barrage, 15.07.14, 15 males and females; Outat Al Haj, 15.07.14, 3 males; Oued Charef, 17.05.14, 2 males, 1 female; Pont O.

Charef, 07.08.14, 3 males; Petite cascade, 07.08.14, 2 males; Pont Gafait, 17.05.14, 1 male.

Distribution: Ibero–Maghrebian species. In Morocco it is located mainly in the Middle Atlas (Benamar, 2015). *H. occidentalis* was found in the Upper and Middle Moulouya and in the Highlands (fig. 2). It is a new taxon for the studied area. It should be noted that morphologically it is not possible to separate this species from *Helohphorus maritimus* Rey, 1885, so its identification is only assumed because of the distribution of the specimens.

***Helophorus (Rhopalhelophorus) algiricus* Motschulsky, 1860**

Distribution: Maghrebian species. In Morocco it is widely distributed in the northern part of the country including in the study area (Chavanon et al., 2004; Benamar, 2015) (fig. 2).

Helophorus (Rhopalhelophorus) discrepans* Rey, 1885

Material examined: Ait Oha Ohaki, 13.06.14, 6 males, 3 females; Aghbalou, 13.06.14, 4 males.

Distribution: Turranic–Euro–Maghrebian species. In Morocco it was recorded in the Middle Mountains and the Anti Atlas (Angus, 1987). *H. discrepans* was found in the Upper Moulouya (fig. 2). It is a new taxon for the studied area.

***Helophorus (Rhopalhelophorus) fulgidicollis* Motschulsky, 1860**

Distribution: West Mediterranean species. In Morocco it is known from a few localities in the far north (Benamar, 2015). In the Oriental region it was recorded from the region of Nador (Bennas, 2002) and around Oujda (Chavanon et al., 2004).

***Helophorus (Rhopalhelophorus) asturiensis* Kuwert, 1885**

Distribution: West Mediterranean species. In Morocco it is known from a few localities in the far north (Benamar, 2015). In the Oriental region it was recorded from Oujda (Chavanon et al., 2004).

***Helophorus (Rhopalhelophorus) longitarsis* Wollaston, 1864**

Material examined: Barrage Raknat Naam, 21.05.16, 2 males, 2 females.

Distribution: Turranic–Euro–Maghrebian species. In Morocco it is known from some very scattered localities in the northern part (Benamar, 2015). In the Oriental region it was recorded around Oujda (Chavanon et al., 2004). During the sampling period, *H. longitarsis* was found in a dam near Figuig (fig. 2).

***Helophorus (Rhopalhelophorus) pici* Guillebeau, 1893**

Distribution: Maghrebian species. In Morocco it is known only from three localities: two refer to the Dades gorges in the region of Souss–Massa–Draa (Bouzidi, 1989) and one in the studied region around Oujda (Chavanon et al., 2004). We were unable to study material of this species, but Chavanon et al. (2004) refer that it was identified by Robert Angus, a specialist on this genus.

Helophorus (Rhopalhelophorus) flavipes* Fabricius, 1792

Material examined: Ait Boulmane, 03.05.14, 8 males, 10 females; Ait Oha Ohaki, 13.06.14, 5 males, 5 females; Aghbalou, 14.07.14, 4 males, 4 females; Boumia, 15.07.14, 1 male, 2 females; Anzar Oufounas, 15.07.14, 1 male; Aval Anzar Oufounas, 15.07.14, 2 males; Anzegmir avant barrage, 15.07.14, 3 males, 3 females; Missouri, 15.07.14, 1 male; Pont Gafait, 17.05.14, 3 females; Barrage Za, 07.08.14, 3 males; Sources O. Bered, 01.06.14, 2 females; Amont O. Bered, 07.08.14, 4 males, 3 females; Confluence Zbzit O. El Bared, 23.03.14, 1 male.

Distribution: Palearctic species. In Morocco it has a disperse presence in the northern part (Benamar, 2015). *H. flavipes* was found in the Upper Moulouya and in the Highlands (fig. 2). It is a new taxon for the studied area.

Family Hydrochidae Thomson, 1859

Hydrochus flavipennis* Küster, 1852

Material examined: Ait Boulmane, 03.05.14, 3 males, 2 females; Ait Oha Ohaki, 13.06.14, 1 male; Aghbalou, 14.07.14, 1 male; Irhdis, 13.06.14, 2 males; Aval Anzegmir, 15.07.14, 5 males, 6 females, 17 larvae; O El Bared, 27.03.14, 3 males, 5 females.

Distribution: Atlanto–Mediterranean species. In Morocco it is spread mainly in the north part (Benamar, 2015). *H. flavipennis* Küster, 1852 was found in the Upper Moulouya (fig. 3). It is a new taxon for the studied area. Although this species is not mentioned for Morocco in Fikacek et al. (2015), it is a relatively common species in this country (Benamar, 2015); however, a deeper taxonomical study is needed to disentangle the possible existence of a complex of species within this species.

***Hydrochus grandicollis* Kiesenwetter, 1870**

Distribution: West–Mediterranean species. Quite rare in Morocco, known from some very scattered localities (Benamar, 2015). In the Moulouya basin, it was recorded from Berkane (Benamar, 2015).

***Hydrochus smaragdineus* Fairmaire, 1879**

Material examined: Ait Boulmane, 03.05.14, 1 male; Ait Oha Ohaki, 13.06.14, 10 males, 13 females; Oued Charef, 17.05.14, 2 males, 1 female; Petite cascade, 17.05.14, 2 males; Douar Ifrane, 07.08.14, 1 female.

Distribution: West Mediterranean species. In Morocco it is scattered in the northern part (Benamar, 2015). In the Oriental region it was recorded from the Beni Snassen mountains (Chavanon et al., 2004). Our study significantly increases its previous range of distribution in the study area (fig. 3).

Family Hydrophilidae Latreille, 1802

***Anacaena bipustulata* (Marsham, 1802)**

Material examined: Amont O. Bered, 07.08.14, 1 male, 1 female.

Distribution: Euro–Maghrebian species, widely distributed in the northern part of Morocco (Chavanon et al., 2004; Benamar, 2015). During the sampling period, *A. bipustulata* was found upstream of Melloulou River (fig. 4).

Anacaena globulus* (Paykull, 1798)

Material examined: Irhdis, 14.07.14, 2 males, 2 females; Sources O. Bered, 01.06.14, 1 male.

Distribution: Euro–Maghrebian species. In Morocco it is confined to the north–west (Benamar, 2015). *A. globulus* was found in the Eastern Middle Atlas (fig. 4). It is a new species for the study area.

***Anacaena lutescens* (Stephens, 1829)**

Material examined: Ait Boulmane, 13.06.14, 1 male, 3 females; Ait Oha Ohaki, 13.06.14, 1 male.

Distribution: Holarctic species. In Morocco it is confined to the extreme north–west (Benamar, 2015). In the Oriental region it was recorded from Berkane (Benamar, 2015). During the sampling period, *A. lutescens* was found in the Upper Moulouya (fig. 4).

***Paracymus aeneus* (Germar, 1824)**

Distribution: Centroasiatic–Euro–Mediterranean species, dispersed throughout the Morocco (Benamar, 2015). In the Oriental region it was recorded from the region of Nador (Bennas, 2002; Chavanon et al., 2004).

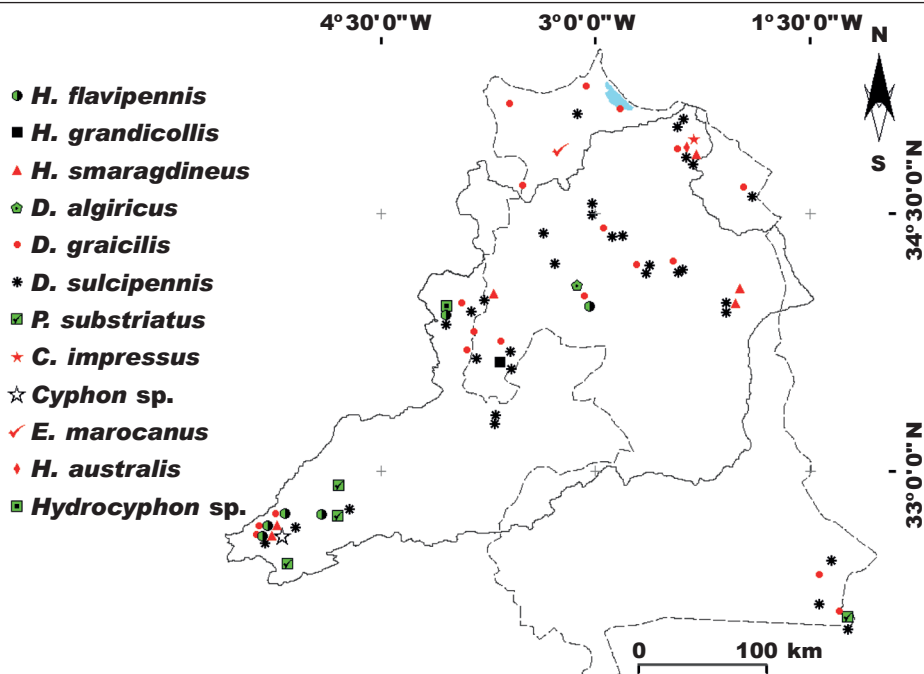


Fig. 3. Distribution of Hydrochidae, Dryopidae and Scirtidae species in the study area.
 Fig. 3. Distribución de especies de Hydrochidae, Dryopidae y Scirtidae en el área de estudio.

***Berosus (Berosus) affinis* Brullé, 1835**

Material examined: Ait Boulmane, 13.06.14, 1 male; Ait Oha Ohaki, 13.06.14, 6 males, 9 females, 6 larvae; Aghbalou, 14.07.14, 7 males, 6 females; Irhdís, 13.06.14, 14 males and females; Barrage Za, 07.08.14, 1 male; Amont Taourit, 19.07.14, 4 females; Sources Berkine, 07.08.14, 1 male; Amont Berkine, 07.08.14, 1 larvae; Douar Imzaghrou, 15.08.14, 2 larvae; Debdou, 27.04.16, 1 male, 1 female; Bassin Oujda, 23.04.16, 3 females.

Distribution: Atlanto–Mediterranean species, widely distributed in Morocco (Benamar, 2015). Our study considerably increases its range in the Oriental region and the Moulouya basin (fig. 4).

***Berosus (Berosus) hispanicus* Küster, 1847**

Material examined: Pont Hassan II, 03.14.14, 3 females, 3 larvae; Pré–Estuaire, 03.14.14, 3 females; Kariat Arekman, 01.05.16, 2 males, 2 females.

Distribution: Afrotropical–Mediterranean species. Widely distributed in Morocco (Benamar, 2015). In the Oriental region and the Moulouya watershed, *B. hispanicus* is linked to the coastal domains (fig. 4).

***Berosus (Enoplurus) guttalis* Rey, 1883**

Distribution: West Mediterranean species. Not very common in Morocco, known from some very dispersed localities (Benamar, 2015). In the Oriental region it was recorded around Nador (Bennas, 2002).

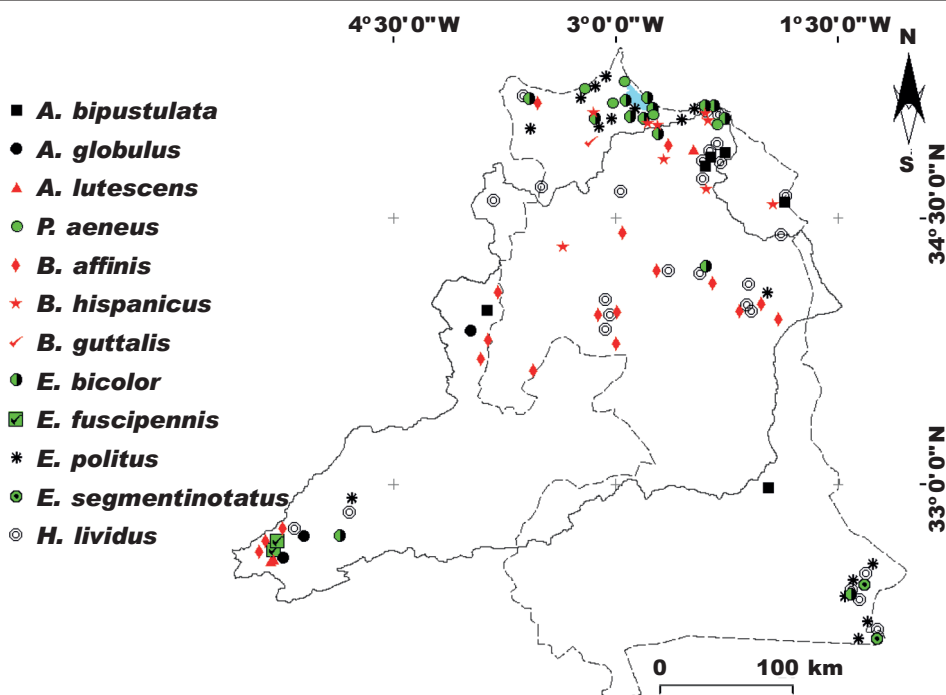


Fig. 4. Distribution of Hydrophilidae species in the study area.

Fig. 4. Distribución de especies de Hydrophilidae en el área de estudio.

***Enochrus (Lumetus) bicolor* complex**

Material examined: Pont Gafait, 17.05.14, 1 male, 1 female; Oued Messoussate, 02.05.16, 1 female; Figuig, 22.05.16, 1 female.

Distribution: West–Palearctic species. Widely distributed in Morocco (Benamar, 2015). Our study increases its distribution area in the Oriental region and the Moulouya watershed (fig. 4).

Enochrus (Lumetus) fuscipennis* (Thomson, 1884)

Material examined: Ait Oha Ohaki, 13.06.14, 1 male, 2 females; Aghbalou, 13.06.14, 2 males.

Distribution: West–Palearctic species. Quite rare in Morocco, known only in a few localities scattered in the north (Benamar, 2015). This is a new species for the area studied, *E. fuscipennis* was found in the Upper Moulouya (fig. 4).

***Enochrus (Lumetus) politus* (Küster, 1849)**

Material examined: Ain Chebbak, 28.04.16, 2 males, 2 females; Barrage Zriga, 21.05.16, 7 males, 10 females; Oued Oumassine, 12.05.16, 1 male, 2 females; Kariat Arekman, 01.05.16, 3 females; Dardoura, 02.05.16, 3 males, 2 females; Oued Ouzej, 30.04.16, 3 males, 3 females.

Distribution: Holo–Mediterranean species. Widely distributed in Morocco (Benamar, 2015). On the other hand, this study greatly increases its range in the Oriental region and the catchment area of the Moulouya (fig. 4).

***Enochrus (Lumetus) segmentinotatus* Kuwert, 1888**

Distribution: Afrotropical–Palearctic species. In Morocco it is known only from the Western Rif (Benamar, 2015) and from the Oriental region in Figuig (Chavanon et al., 2004).

***Helochares lividus* (Forster, 1771)**

Material examined: Ait Oha Ohaki, 13.06.14, 2 females; Irhdís, 13.06.14, 2 males, 2 females; Pont Hassan II, 18.05.14, 2 males; Pré–Estuaire, 18.05.14, 5 larvae; Oued Charef, 17.05.14, 1 male; Pont O. Charef, 07.08.14, 1 female; Barrage Za, 07.08.14, 1 female; Sidi Moussa, 29.05.17, 1 male; Abou Lekhal, 22.05.16, 2 females; Barrage Sfisef, 21.05.16, 1 larva.

Distribution: Atlanto–Mediterranean species. Widely distributed in the northern part of Morocco (Chavanon et al., 2004; Benamar, 2015). Our study significantly increases its range in the Oriental region and the Moulouya basin (fig. 4).

Hydrobius fuscipes* (Linnaeus, 1758)

Material examined: Ait Boulmane, 13.06.14, 4 males, 2 females ; Ait Oha Ohaki, 13.06.14, 3 males, 3 females.

Distribution: Holarctic species. In Morocco it is known from a few localities scattered in the north (Benamar, 2015). *H. fuscipes* was found in the Upper Moulouya corresponding to the Eastern Middle Atlas (fig. 5). It is a new species for the study area

***Hydrochara flavipes* (Steven, 1808)**

Distribution: Turanic–Euro–Maghrebian species. In Morocco it is known from some localities scattered in the north (Benamar, 2015). In the studied area, it was recorded in the Middle Moulouya (Alluud, 1926).

***Hydrophilus pistaceus* Laporte, 1840**

Material examined: Oued Mariouari, 12.05.16, 1 larva; Sidi Moussa, 29.05.17, 2 males, 2 females.

Distribution: West–Mediterranean species. In Morocco it is distributed in the northern part (Benamar, 2015). During the sampling period, *H. pistaceus* was found in Mariouari River in the North and Jbel Sidi Moussa (fig. 5).

***Laccobius (Dimorpholaccobius) atratus* Rottenberg, 1874**

Material examined: Ait Oha Ohaki, 13.06.14, 1 male; Aval Anzar Oufounas, 15.07.14, 1 male; Outat Al Haj, 15.07.14, 3 males; Pont Hassan II, 18.05.14, 1 male; Amont Gafait, 17.05.14, 2 males, 4 females; Pont Gafait, 17.05.14, 4 males, 6 females; Sources Berkine, 07.08.14, 1 male, 2 larvae.

Distribution: Atlanto–Mediterranean species. Not common in Morocco, known from some disperse localities (Benamar, 2015). It was recorded recently in the study area at Jerada (Benamar, 2015). Our study may increase its distribution considerably (fig. 5).

***Laccobius (Dimorpholaccobius) atrocephalus atrocephalus* Reitter, 1872**

Material examined: Anzar Oufounas, 15.07.14, 2 males; Anzegmir avant barrage, 15.07.14, 1 male; Aval Anzegmir, 15.07.14, 3 males, 3 females; Missouri, 15.07.14, 2 males; Pont Hassan II, 18.05.14, 1 female; Oued Charef, 17.05.14, 2 males, 3 females; Pont O. Charef, 07.08.14, 2 females; Petite cascade, 17.05.14, 2 males; Oued Lakhrouf, 07.08.14, 2 females; Amont Gafait, 17.05.14, 2 females; Pont Gafait, 17.05.14, 9 males, 4 females; Barrage Za, 07.08.14, 1 female; Confluence Zbzit O. El Bared, 23.03.14, 2 females; Barrage Zriga, 21.05.16, 1 male, 3 females; Barrage Sfisef, 21.05.16, 1 male, 4 females; Abou Lekhal, 22.05.16, 9 males, 12 females.

Distribution: Afrotropical–Mediterranean species. Widely distributed in the northern part of Morocco (Benamar, 2015). Our study significantly increases its range in the Oriental region and the basin of Moulouya River (fig. 5).

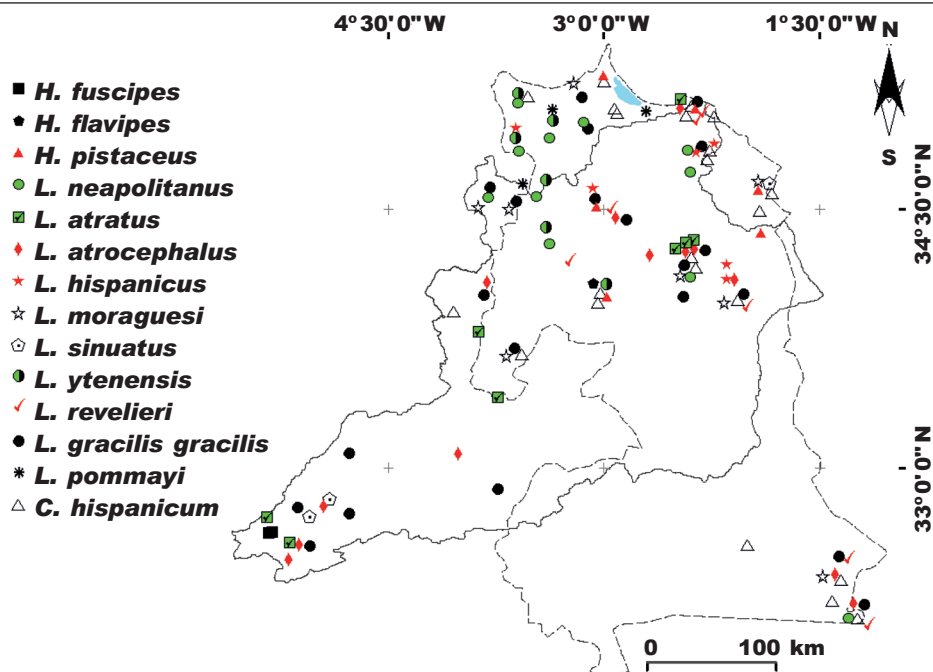


Fig. 5. Distribution of Hydrophilidae species in the study area.
 Fig. 5. Distribución de especies de Hydrophilidae en el área de estudio.

***Laccobius (Dimorpholaccobius) hispanicus* Gentili, 1974**

Distribution: West Mediterranean species. In Morocco, the species is distributed mainly in the northern part (Benamar, 2015). In Eastern Morocco, it was recorded from Zeghzal River and Nador vicinity (Bennas, 2002; Chavanon et al., 2004).

***Laccobius (Dimorpholaccobius) moraguesi* Régimbart, 1898**

Material examined: Oued Kert, 12.05.16, 3 males, 2 females.

Distribution: Holomediterranean species. In Morocco it is confined to the far north, including the studied area (Chavanon et al., 2004; Benamar, 2015). During the sampling period, it was found in the Oriental Rif (fig. 5).

***Laccobius (Dimorpholaccobius) neapolitanus* Rottenberg, 1874**

Distribution: West Mediterranean species. Widely distributed in the northern part of Morocco (Benamar, 2015), including the Oriental region (Bennas, 2002; Chavanon et al., 2004).

***Laccobius (Dimorpholaccobius) sinuatus* Motschulsky, 1849**

Distribution: Euro–Maghrebian species. In Morocco it is common in the northern part (Benamar, 2015). In the Moulouya basin, it was recorded from Upper Moulouya (Berrahou et al., 2001).

***Laccobius (Dimorpholaccobius) ytenensis* Sharp, 1910**

Material examined: Mare à Debdou, 27.04.16, 1 male, 1 female, 1 larva.

Distribution: Euro–Maghrebian species. In Morocco it is confined to the northwest (Benamar, 2015). In the study area, it was recorded from the Oriental Rif (Bennas, 2002). During the sampling period, *L. ytenensis* was found around Debdou (fig. 5).

***Laccobius (Hydroxenus) revelieri* Perris, 1864**

Distribution: Afrotropical West–Mediterranean species. In Morocco it is known from a few localities in the north–west (Benamar, 2015). In the Oriental region it was recorded from Figuig (Chavanon et al., 2004).

***Laccobius (Microlaccobius) gracilis gracilis* Motschulsky, 1855**

Material examined: Irhdis, 13.06.14, 1 female; Anzegmir avant barrage, 15.07.14, 1 male; Oued Charef, 17.05.14, 1 male; Pont O. Charef, 07.08.14, 1 male; Amont Gafait, 17.05.14, 2 males; Pont Gafait, 17.05.14, 5 males; 5 females; Amont Taourit, 07.06.14, 1 male; Amont O. Bered, 07.08.14, 1 female; Abou Lekhal, 22.05.16, 6 males, 5 females.

Distribution: Euro–Mediterranean species. Widely distributed in the northern part of Morocco (Chavanon et al., 2004; Benamar, 2015). Our study can significantly increase its range in the Oriental region and the catchment area of the Moulouya (fig. 5).

***Laccobius (Notoberosus) pommayi* Bedel, 1881**

Distribution: Maghrebian species. In Morocco it is confined to the extreme north (Benamar, 2015). In the Oriental region it was recorded from Nador (Bennas, 2002).

***Coelostoma (Coelostoma) hispanicum* (Küster, 1848)**

Material examined: Sources O. Bered, 01.06.14, 3 males, 3 females; Debdou, 27.04.16, 2 males; Source Tiffert, 28.04.16, 1 female; Aval Zeghzel, 28.04.16, 2 males; Jbel Mehser, 19.09.15, 3 males, 2 females; Beni Waklane, 31.05.17, 2 females; Wertass, 31.05.17, 3 males; Dardoura, 02.05.16, 1 female; Oued Ouzej, 30.04.16, 2 females; Oued Selouane, 30.04.16, 1 female; Gourougou, 06.02.15, 3 males; Oued Mariouari, 12.05.16, 1 male; Barrage Sfisef, 21.05.16, 1 female; Figuig, 22.05.16, 1 male.

Distribution: West–Mediterranean species. Widely distributed in the northern part of Morocco (Benamar, 2015). Our study makes it possible to increase its range considerably in the Oriental region and the Moulouya basin (fig. 5).

Family Hydraenidae Mulsant, 1844

***Hydraena (Hydraena) rigua* d’Orchymont, 1931**

Material examined: Irhdis, 13.06.14, 2 males, 2 females; Anzar Oufounas, 15.07.14, 2 females; Aval Zeghzel, 28.04.16, 1 male.

Distribution: Maghrebian species. Widely distributed in the northern part of Morocco and in the study area (Berrahou et al., 2001; Chavanon et al., 2004; Benamar, 2015). During the sampling period, *H. rigua* was found in the Upper Moulouya and in Oued Zeghzel (fig. 6).

***Hydraena (Hydraena) scabrosa* d’Orchymont, 1931**

Distribution: Maghrebian species. Not common in Morocco, known from a few localities in the north (Benamar, 2015). In the Oriental region and the Moulouya watershed, it was recorded from Zeghzel (Chavanon et al., 2004).

***Hydraena (Phothydraena) cf. hernandoi* Fresneda and Lagar, 1990**

Material examined: Irhdis, 13.06.14, 1 female.

Distribution: Ibero–Maghreb species. In Morocco it is scattered in the northern part (Benamar, 2015). It could be a new taxon for the Moulouya watershed, but it must be confirmed by the capture of a male. Only one female was found during the sampling period in the Upper Moulouya (fig. 6).

***Limnebius (Bilimneus) evanescens* Kiesenwetter, 1866**

Distribution: Ibero–Maghrebian species. In Morocco it is scattered in the northern part (Benamar, 2015). In eastern Morocco, it was recorded from Berkane (Benamar, 2015).

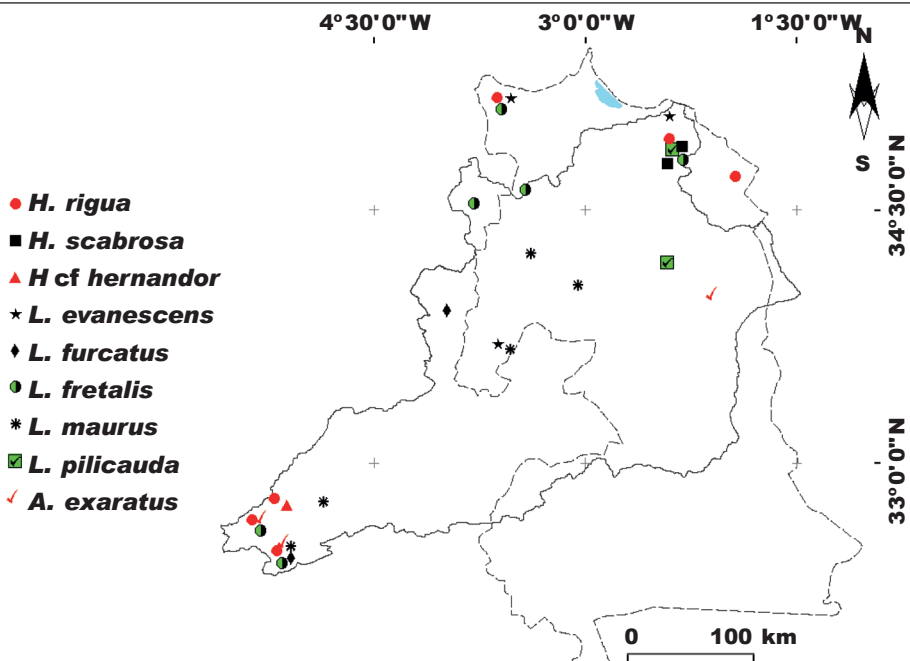


Fig. 6. Distribution of Hydraenidae species in the study area.

Fig. 6. Distribución de especies de Hydraenidae en el área de estudio.

***Limnebius (Limnebius) fretalis* Peyerimhoff, 1913**

Material examined: Ait Oha Ohaki, 13.06.14, 1 male, 2 females; Anzar Oufounas, 15.07.14, 1 male.

Distribution: Ibero–Maghrebian species. In Morocco it is distributed mainly in the north (Benamar, 2015). In the study area, it was recorded from eastern Rif (Bennas, 2002) and Berkane (Benamar, 2015). During the sampling period, *L. fretalis* was found in the Upper Moulouya, including Anzegmir River (fig. 6).

Limnebius (Limnebius) furcatus* Baudi di Selve, 1872

Material examined: Anzar Oufounas, 15.07.14, 1 male; Sources O. Bered, 01.06.14, 2 males.

Distribution: West Mediterranean species. In Morocco it is confined to the north–west (Benamar, 2015). It is a new species for the study area. *L. furcatus* was found in Anzegmir and Melloulou Rivers, corresponding respectively to the Eastern High Atlas and Middle Atlas (fig. 6).

***Limnebius (Limnebius) maurus* Balfour–Browne, 1979**

Material examined: Aval Anzar Oufounas, 15.07.14, 1 female; Aval Anzegmir, 15.07.14, 2 males, 1 female; Tindint, 15.07.14, 1 male.

Distribution: Ibero–Maghrebian species. In Morocco it is confined to the north–west (Benamar, 2015). In Eastern Morocco, it was reported from Debdou (Benamar, 2015). During the sampling period, *L. maurus* was found in Anzegmir River and Middle Moulouya (fig. 6).

***Limnebius (Limnebius) pilicauda* Guillebeau, 1896**

Distribution: Maghrebian species. In Morocco it is scattered in the northern half (Benamar, 2015). In the Oriental region it was recorded from Berkane and Jerada (Benamar, 2015).

***Ochthebius (Aulacochthebius) exaratus* Mulsant, 1844**

Distribution: Southern Palearctic Afrotropical species. In Morocco it is confined to the north–west (Benamar, 2015). In the Moulouya basin, it was recorded from High Moulouya and upstream Za River (Berrahou et al., 2001; Benamar, 2015).

Ochthebius (Asiobates) aeneus* Stephens, 1835

Material examined: Ait Boulmane, 13.06.14, 1 male; Aval Anzar Oufounas, 15.07.14, 1 male; Outat Al Haj, 15.07.14, 2 males; Sources O. Bered, 01.06.14, 1 male; Amont O. Bered, 07.08.14, 2 females; Douar Ifrane, 07.08.14, 1 female; Sources Berkine, 07.08.14, 1 male; Confluence Zbzit O. El Bared, 23.03.14, 1 male.

Distribution: Atlanto–Mediterranean species. Known in Morocco of some scattered localities (Benamar, 2015). It is a new taxon for the study area. During the sampling period, the species was found along Anzegmir and Melloulou Rivers and later in Middle Moulouya (fig. 6).

***Ochthebius (Asiobates) maculatus* Reiche, 1869**

Distribution: Holo–Mediterranean species. In Morocco it is scattered to the north (Benamar, 2015). In the area studied, it was recorded from Nador and Melg El Ouidane (Bennas, 2002; Chavanon et al., 2004).

***Ochthebius (Ochthebius) auropallens* Fairmaire, 1879**

Distribution: Holo–Mediterranean species. In Morocco it is known only from a few localities scattered in the northern half (Benamar, 2015). In the study area, it was recorded from Outat Al Haj and Zeghzal (Chavanon et al., 2004).

***Ochthebius (Ochthebius) bifoveolatus* Waltl, 1835**

Distribution: West Mediterranean species. In Morocco it is scattered throughout the country (Benamar, 2015). In the Oriental region it was recorded around Nador (Bennas, 2002).

***Ochthebius (Ochthebius) cuprescens* Guillebeau, 1893**

Distribution: West–Mediterranean species. In Morocco it is known from some localities scattered to the north (Benamar, 2015). In the Oriental region it was recorded from Figuig (Chavanon et al., 2004).

***Ochthebius (Ochthebius) difficilis* Mulsant, 1844**

Material examined: Barrage Zriga, 21.05.16, 1 female; Abou Lekhal, 22.05.16, 1 male.

Distribution: Species Holo–Mediterranean. In Morocco it is distributed in the northern half (Benamar, 2015). In the Oriental region it was recorded from Figuig (Chavanon et al., 2004) and Jerada (Benamar, 2015).

***Ochthebius (Ochthebius) marinus* (Paykull, 1798)**

Distribution: Holarctic species. In Morocco and the Oriental region, it was recorded at the mouth of Moulouya (Chavanon et al., 2004).

***Ochthebius (Ochthebius) mauretanicus* Jäch, 1990**

Distribution: Maghrebian species. In Morocco it is related mainly to the Rif (Benamar, 2015). In the Oriental region it was recorded around Nador (Bennas, 2002).

***Ochthebius (Ochthebius) mediterraneus* (Ienișteea, 1988)**

Material examined: Barrage Zriga, 21.05.16, 1 female.

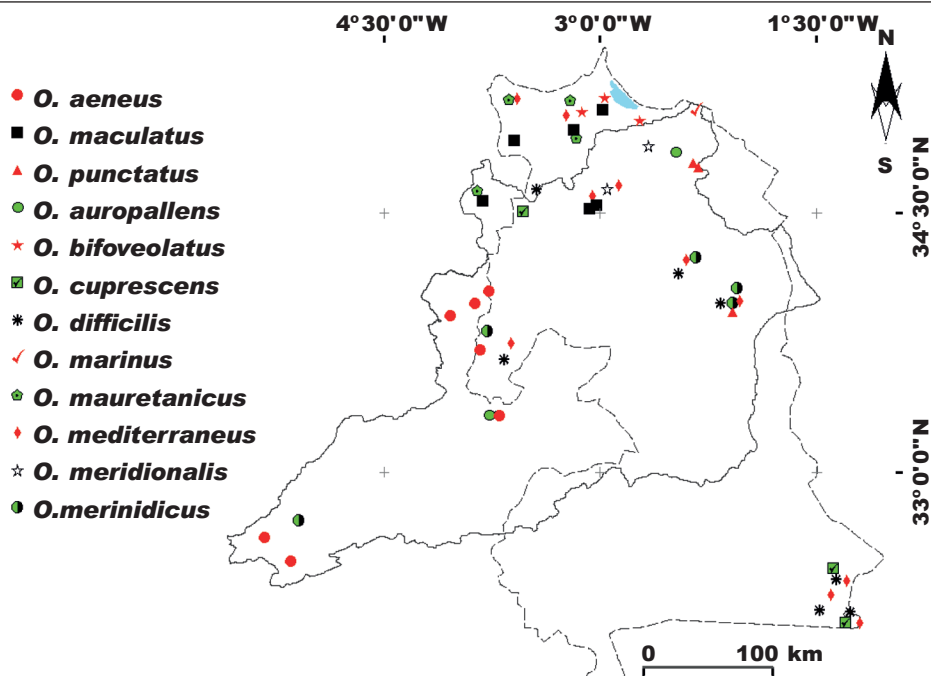


Fig. 7. Distribution of Hydraenidae species in the study area.

Fig. 7. Distribución de especies de Hydraenidae en el área de estudio.

Distribution: Holo–Mediterranean species. In Morocco it is widely distributed in the northern part including the study area (Chavanon et al., 2004; Benamar, 2015). During the study period, *O. mediterraneus* was found in the south of the Oriental region around Figuig (fig. 7).

***Ochthebius (Ochthebius) meridionalis* Rey, 1885**

Distribution: Centroasiatic–Euro–Mediterranean species. In Morocco it is known from some remote localities in the northern half (Benamar, 2015). In the Oriental region it was recorded from Lower Moulouya (Bennas, 2002).

Ochthebius (Ochthebius) merinidicus* Ferro, 1985

Material examined: Boumia, 15.07.14, 1 male; Oued Charef, 17.05.14, 2 males; Petite cascade, 17.05.14, 1 female; Amont Gafait, 17.05.14, 1 male; Amont Berkine, 07.08.14, 1 female.

Distribution: Ibero–Maghrebian species. In Morocco it is known from some localities, scattered in the northern part (Benamar, 2015). This is a new taxon for the study area. During the sampling period, *O. merinidicus* was found in Za and Melloulou Rivers, in addition to Upper Moulouya (fig. 7).

***Ochthebius (Ochthebius) nanus* Stephens, 1829**

Distribution: West–Euro–Maghrebian species. In Morocco it is scattered throughout the northern half (Benamar, 2015). In the Oriental region it was recorded from Oujda and Zeghzzel (Chavanon et al., 2004).

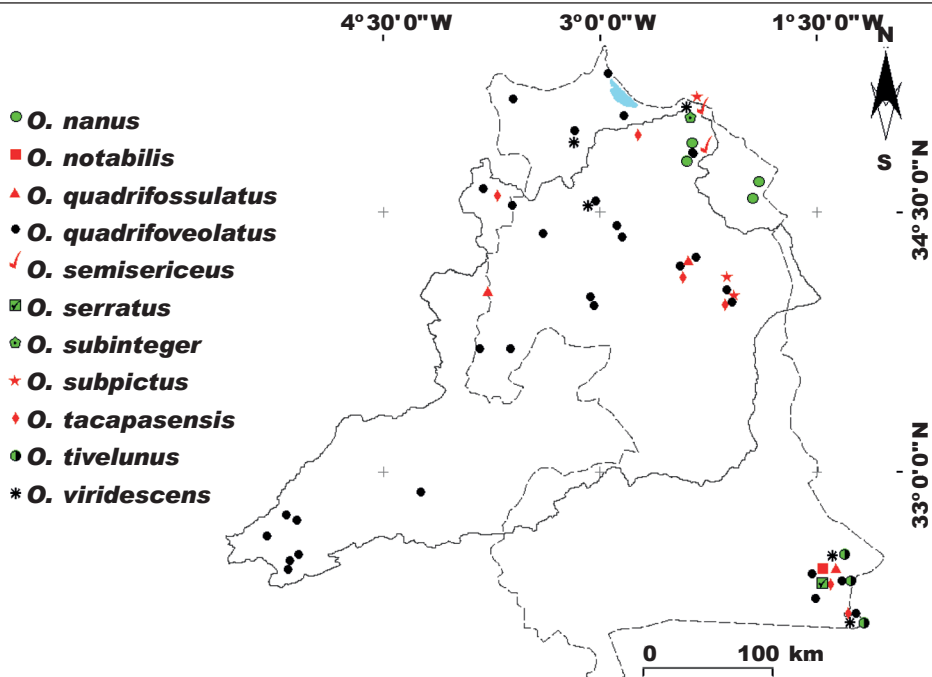


Fig. 8. Distribution of Hydraenidae species in the study area.

Fig. 8. Distribución de especies de Hydraenidae en el área de estudio.

***Ochthebius (Ochthebius) notabilis* Rosenhauer, 1856**

Distribution: Ibero–Maghrebian species. In Morocco it is known from a few localities in the north (Benamar, 2015). In the Oriental region it was recorded from Figuig (Benamar, 2015).

***Ochthebius (Ochthebius) punctatus* Stephens, 1829**

Material examined: Pont O. Charef, 07.08.14, 1 male.

Distribution: Atlanto–Mediterranean species. In Morocco it is known from a few localities in the north (Benamar, 2015). In the Oriental region it was recorded from Zeghzel (Chavanon et al., 2004). During the sampling period, the species was found in the Za River (fig. 8).

***Ochthebius (Ochthebius) quadrifossulatus* Waltl, 1835#**

Material examined: Pont Gafait, 17.05.14, 1 male.

Distribution: Ibero–Maghrebian species. In Morocco it is distributed in the north–west (Benamar, 2015). In the Oriental region it was reported from Figuig (Benamar, 2015). On the other hand, it is a new species for the basin of Moulouya River. During the sampling period, *O. quadrifossulatus* was found in the Za River (fig. 8).

***Ochthebius (Ochthebius) quadrioveolatus* Wollaston, 1854**

Material examined: Ait Oha Ohaki, 13.06.14, 1 male; Irhdís, 14.07.14, 1 female; Anzar Oufounas, 15.07.14, 15 males and females; Anzar Oufounas, 15.07.14, 3 males, 4 females; Anzegmir avant barrage, 15.07.14, 1 female; Tamdafelt, 13.06.14, 1 male; Oued Charef, 17.05.14, 5 males, 5 females; Amont Gafait, 17.05.14, 1 female; Pont Gafait, 17.05.14, 5 females; Debdou, 27.04.16, 1 female; Barrage Zriga, 21.05.16, 1 female; Abou Lekhal, 22.05.16, 1 male, 1 female.

Distribution: Afrotropical–Mediterranean species. Widely distributed in the northern part including the studied area (Benamar, 2015). It is the most abundant *Ochthebius* in the Moulouya watershed and the Oriental region (fig. 8).

***Ochthebius (Ochthebius) semisericeus* complex**

Distribution: West–Mediterranean species. In Morocco it is known only in the Oriental region, from where it was recorded from Lower Moulouya (Chavanon et al., 2004). This taxon needs a deep morphological study to confirm its taxonomical status.

***Ochthebius (Ochthebius) serratus* Rosenhauer, 1856**

Distribution: Ibero–Maghrebian species. In Morocco it is known from a few localities in the north (Benamar, 2015). In the Oriental region it was recorded from Figuig (Benamar, 2015).

***Ochthebius (Ochthebius) subinteger* Mulsant and Rey, 1861**

Distribution: Western–Palearctic species. In Morocco it is known from three localities in the north (Benamar, 2015). In the Oriental region it was recorded from Nador (Bennas, 2002).

***Ochthebius (Ochthebius) subpictus* Wollaston, 1857**

Material examined: Oued Charef, 17.05.14, 1 male.

Distribution: Holo–Mediterranean species. In Morocco it is scattered almost all over the country (Benamar, 2015). In the Oriental region it was recorded from the mouth of Moulouya (Chavanon et al., 2004). During the sampling period, the species was found in the Za River (fig. 8).

***Ochthebius (Ochthebius) tacapasensis tacapasensis* Ferro, 1983**

Material examined: Barrage Zriga, 21.05.16, 3 males, 4 females; Barrage Sfisef, 21.05.16, 1 male; Abou Lekhal, 22.05.16, 2 males, 5 females.

Distribution: West–Mediterranean species. Widely distributed in Morocco including the studied area (Bennas, 2002; Chavanon et al., 2004; Benamar, 2015). During the sampling period, *O. tacapasensis* was found in the southeast of the Oriental region (fig. 8).

***Ochthebius (Ochthebius) tivelunus* Ferro, 1984**

Material examined: Barrage Zriga, 21.05.16, 1 male, 3 females.

Distribution: Endemic Moroccan species, known from only from some localities (Benamar, 2015). During the sampling period, *O. tivelunus* was found around Figuig (fig. 8).

***Ochthebius (Ochthebius) viridescens* lenieștea, 1988**

Distribution: Mediterranean species. In Morocco it is dispersed mainly in the north–west (Benamar, 2015). In the Oriental region it was recorded from region of Nador (Bennas, 2002) and Figuig (Chavanon et al., 2004).

Family Elmidae Curtis, 1830

***Elmis maugetii velutina* Reiche, 1879**

Material examined: Sources Berkine, 07.08.14, 2 males, 1 female, 3 larvae.

Distribution: Maghrebian subspecies. In Morocco it is known from the Rif, the High and Middle Atlas (Benamar, 2015). In the area studied, it was recorded from Upper Moulouya (Berrahou et al., 2001). During the sampling period, the species was found in Melloulou River (fig. 9).

***Esolus parallelepipedus* P. W. J. Müller, 1806**

Distribution: South–Euro–Mediterranean species. In Morocco it is linked to the north (Benamar, 2015). In the Oriental region it was recorded from Zeghzzel (Benamar, 2015).

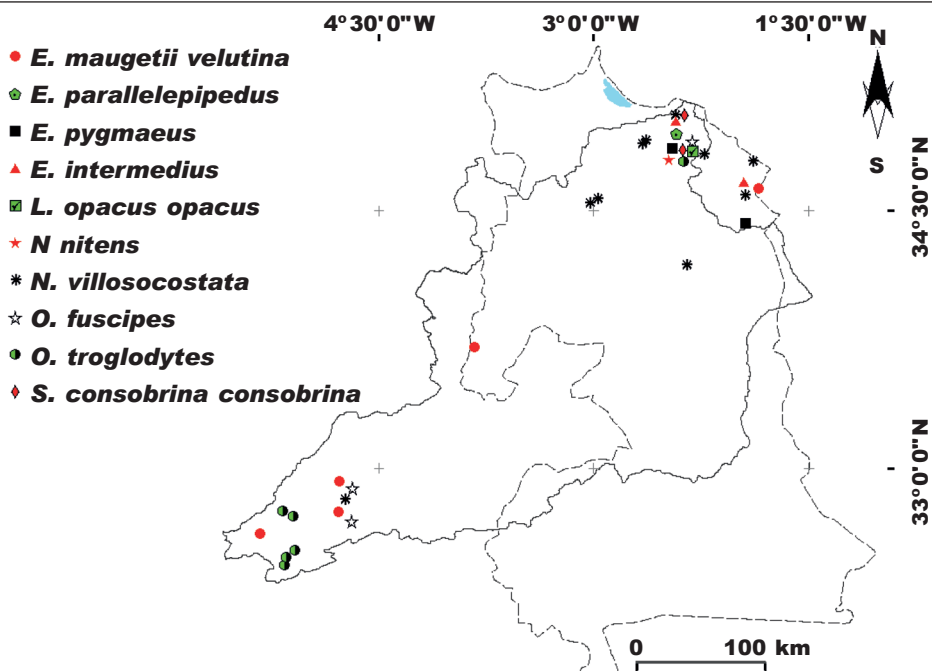


Fig. 9. Distribution of Elmidæ species in the study area.

Fig. 9. Distribución de especies de Elmidæ en el área de estudio.

***Esolus pygmaeus* P. W. J. Müller, 1806**

Distribution: Euro–Mediterranean species. In Morocco it is confined mainly to the northwest (Benamar, 2015). In the Oriental region it was recorded from Oujda and Zeghzal (Chavanon et al., 2004).

***Limnius intermedius* Fairmaire, 1881**

Distribution: Euro–Mediterranean species. In Morocco it is widely distributed in the northern part (Benamar, 2015). In the Oriental region it was recorded from Oujda and Lower Moulouya (Chavanon et al., 2004).

***Limnius opacus opacus* P. W. J. Müller, 1806**

Distribution: Euro–Mediterranean species. In Morocco it is confined to the great massifs (Benamar, 2015). In the Oriental region it was recorded from Zeghzal (Chavanon et al., 2004).

***Normandia nitens* P. W. J. Müller, 1817**

Distribution: Euro–Mediterranean species. In Morocco, it is known especially in the Middle Atlas (Dakki, 1986). In the Oriental region it was recorded from Zeghzal (Chavanon et al., 2004).

***Normandia villosocostata* Reiche, 1879**

Material examined: Sebra, 03.04.14, 12 larvae; Safsaf, 03.04.14, 7 larvae; Pont Hassan II, 03.04.14, 13 larvae.

Distribution: Maghrebian species. Widely distributed in the northern half of Morocco, thus the area of our study (Chavanon et al., 2004; Benamar, 2015). It is the most abundant Elmidæ in the Moulouya watershed and the Oriental region (fig. 9).

***Oulimnius fuscipes* Reiche, 1879**

Distribution: Ibero–Maghrebian species. Widely distributed in the northern half of Morocco (Benamar, 2015). In the Oriental region it was recorded from Zeghzal (Chavanon et al., 2004).

***Oulimnius troglodytes* Gyllenhal, 1827**

Material examined: Irhdis, 14.07.14, 1 male; Boumia, 15.07.14, 1 female; Anzar Oufounas, 15.07.14, 28 males and females; Aval Anzar Oufounas, 15.07.14, 7 larvae; Anzegmir avant barrage, 15.07.14, 13 larvae.

Distribution: Atlanto–Mediterranean species. In Morocco it is known from few disperse localities (Benamar, 2015). In the Oriental region it was recorded from Tafoghalt (Chavanon et al., 2004). During the sampling period, *O. troglodytes* was found in the Upper Moulouya including Anzegmir River (fig. 9).

***Stenelmis consobrina consobrina* Dufour, 1835**

Distribution: Holo–Mediterranean species. In Morocco it is confined to the north (Benamar, 2015). In the Oriental region it was recorded from Lower Moulouya (Chavanon et al., 2004).

Family Dryopidae Billberg, 1820

***Dryops algiricus* Lucas, 1846**

Distribution: Holo–Mediterranean species. In Morocco it is widely distributed in the northern part (Benamar, 2015). In the watershed of the Moulouya and the Oriental region, it was recorded from Nador (Bennas, 2002) and Debdou (Benamar, 2015).

***Dryops gracilis* Karsch, 1881**

Material examined: Ait Oha Ohaki, 13.06.14, 4 males; Aghbalou, 13.06.14, 1 male; Irhdis, 14.07.14, 3 males, 4 females; Boumia, 15.07.14, 1 male; Pont Gafait, 17.05.14, 1 female; Barrage Za, 07.08.14, 1 female; Amont Taourit, 07.06.14, 1 female; Amont O. Bered, 07.08.14, 1 male; Sources Berkine, 07.08.14, 3 females; Amont Berkine, 07.08.14, 4 males, 1 female.

Distribution: Afrotropical–Mediterranean species. Widely distributed in Morocco including in the studied area (Chavanon et al., 2004; Benamar, 2015). Our study significantly increases its distribution area in the basin of the Moulouya and the Oriental region (fig. 3).

***Dryops sulcipennis* A. Costa, 1883**

Material examined: Ait Boulmane, 03.05.14, 2 males, 2 females; Ait Oha Ohaki, 13.06.14, 5 males, 5 females; Boumia, 15.07.14, 2 males; Barrage Za, 07.08.14, 1 male; Sources O. Bered, 01.06.14, 1 male, 1 female; Amont O. Bered, 07.08.14, 3 males, 3 females; Sources Berkine, 07.08.14, 1 male, 1 female; Confluence Zbzit O. El Bared, 23.03.14, 2 females.

Distribution: Holo–Mediterranean species. In Morocco it is widely distributed in the northern part and thus in the study area (Chavanon et al., 2004; Benamar, 2015). Our study significantly increases its distribution range in the basin of the Moulouya and the Oriental region (fig. 3).

***Pomatinus substriatus* P. W. J. Müller, 1806#**

Material examined: Anzar Oufounas, 15.07.14, 2 larvae.

Distribution: Turranic–European–Mediterranean species. In Morocco it is widely dispersed in the northern part (Benamar, 2015). In the Oriental region it was recorded from Figuig (Alluaud, 1926). It is a new species for the Moulouya. During the sampling period, *P. substriatus* was found Upstream of Anzegmir River (fig. 3).

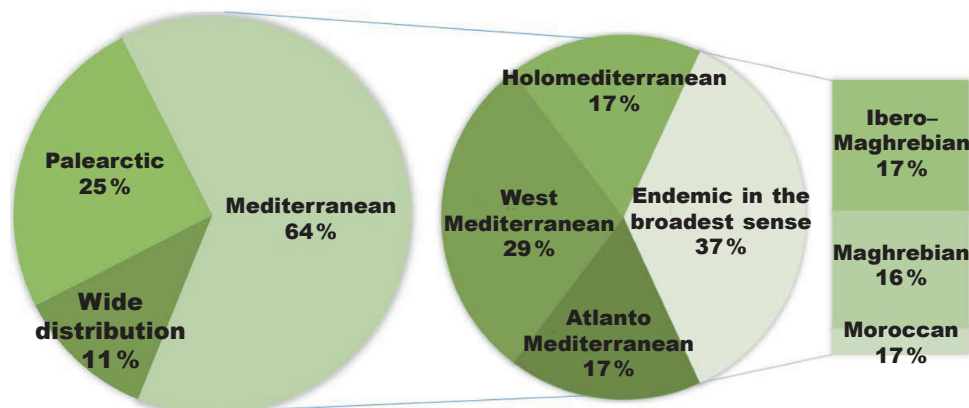


Fig. 10. Chorological categories of the studied species.

Fig. 10. Categorías corológicas de las especies estudiadas.

Family Scirtidae Fleming, 1821

***Cyphon siculus* Tournier, 1868**

Material examined: Ait Boulmane, 03.05.14, 4 larvae; Ait Oha Ohaki, 13.06.14, 3 larvae.

Distribution: West Mediterranean species. In Eastern Morocco, it was recorded from Berkane (Chavanon et al., 2004) (fig. 3). Only larvae were collected, so we need caught adults to confirm its presence in the study area.

***Elodes marocanus* Pic, 1939**

Distribution: Moroccan endemic species, *marocanus* was before a variety of *chobauti* Abeille, 1894 and became a full species. In eastern Morocco, it was recorded from Guerrouaou (Chavanon et al., 2004).

***Hydrocyphon australis* Lindner, 1864**

Material examined: Sources O. Bered, 01.06.14, 3 larvae; Aval Zeghzal, 28.04.16, 3 larvae.

Distribution: West Mediterranean species. In eastern Morocco, it was recorded from Zeghzal (Chavanon et al., 2004) where it was found during the sampling period (fig. 3). Only larvae were collected, so we need caught adults to confirm its presence in the study area.

Discussion

The ninety-one species of Polyphaga found in this study (including the two doubtful species) represent an important richness, proportionally comparable to the number of species found in other areas with similar environmental conditions (Sánchez-Fernández et al., 2004) and more deeply studied for this group of water beetles. Our study adds considerably to the previous knowledge about these insects in the study area, with two new records for the Moulouya basin and ten species for the entire area. These species are: *Ochthebius quadrifossulatus* and *Pomatinus substriatus*, new to the Moulouya basin, and *Helophorus occidentalis*, *H. discrepans*, *H. flavipes*, *Hydrochus flavipennis*, *Anacaena globulus*, *Enochrus fuscipennis*, *Hydrobius fuscipes*, *Limnebius furcatus*, *Ochthebius aeneus* and *O. merinidicus*, new to the

entire study area.

This number of species reflects a high aquatic habitat heterogeneity in the study area, in a wide variety of water bodies, from lotic with low conductivity waters, to very highly saline and lentic waters (Chavanon et al., 2004). Unfortunately, these habitats are currently not only endangered due to climate change, but also due to the drying up of several streams, deforestation and urbanization by intensification of agriculture, infrastructure development, water pollution by fertilizers for agriculture, mosquito control and, especially, by wastewaters (Bensaad et al., 2017; Mabrouki et al., 2016a, 2017a; Taybi et al., 2016a; Yahya et al., 2017). Indeed, many species recorded earlier in the Oriental region were not collected, a finding observed for other aquatic macroinvertebrates groups (Mabrouki et al., 2016b, 2017a; Taybi et al., 2017a, 2017b), several species of which have decreased their regional range.

The species pool of aquatic Polyphagous beetles from Oriental Morocco and the watershed of the Moulouya can be subdivided into three main chorological categories (fig. 10): first, the Mediterranean chorotypes, that are dominant and which constitute 64% of the recorded species; second, the Palearctic chorotypes that constitute 25%; and third, the Cosmopolitan chorotypes that constitute 11% and whose distribution extends beyond the Mediterranean either in India or in the Afrotropical region. Within the Mediterranean Polyphagan elements, there is a clear predominance of the endemic chorotype in the broadest sense (55%), followed by the West–Mediterranean chorotype (27%) and finally the Atlanto and Holomediterranean, each with 17%. Despite being a Maghrebian country, the Ibero–Maghrebian endemics showed a similar richness value to that of the Maghrebian endemics. A similar pattern has been found in Polyphaga for all the Moroccan territory (Benamar, 2015).

The clear dominance of the Palearctic elements, typically Mediterranean, and the high rate of Ibero–Maghrebian endemism in the coleopterological population of the study area shows a strong similarity to the chorotypes found for other macroinvertebrates orders (Mabrouki et al., 2016b, 2017a; Taybi et al., 2017a, 2017b, 2018b).

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Appendix 1. Sampling sites with indications of the locality, altitude, geographic coordinates and type of the aquatic environment: DM, dam; AQ, abandoned quarry; AC, artificial channel; AP, artificial pond; RV, river; LG, Lagoon; PD, pond; AS, artificial source; NS, natural source.

Apéndice 1. Sitios de muestreo con indicaciones de la localidad, altitud, coordenadas geográficas y tipo de ambiente acuático: DM, embalse; AQ, cantera abandonada; AC, canal artificial; AP, estanque artificial; RV, río; LG, laguna; PD, estanque; AS, fuente artificial; NS, fuente natural.

Sampling sites	Geographic coordinates	Alt (m)	Sampling dates	Habitat
Ait Boulmane	32° 36' 56.6" N – 5° 19' 49.2" W	1,650	03.05.14–13.06.14–14.07.14	RV
Ait Oha Ohaki	32° 37' 28.7" N – 5° 18' 32.8" W	1,640	03.05.14–13.06.14–14.07.14	RV
Source Arbalou	32° 40' 33.4" N – 5° 17' 20" W	1,670	03.05.14–13.06.14–14.07.14	RV
Krouchene = Irhdis	32° 44' 49.6" N – 5° 10' 17.1" W	1,616	03.05.14–13.06.14–14.07.14	RV
Boumia	32° 43' 3.4" N – 5° 5' 52.7" W	1,515	02.05.14–14.06.14–15.07.14	RV
Zaïda	32° 49' 3" N – 4° 57' 33" W	1,455	02.05.14–14.06.14–15.07.14	RV
Anzar Oufounas	32° 25' 45" N – 5° 9' 24.8" W	1,895	02.05.14–14.06.14–15.07.14	NS
Aval Anzar Oufounas	32° 28' 41.66" N – 5° 8' 53.42" W	1,780	02.05.14–14.06.14–15.07.14	RV
Anzegmir avant barrage	32° 31' 4.1" N – 5° 5' 3.2" W	1,702	02.05.14–14.06.14–15.07.14	RV
Aval Anzegmir	32° 44' 32" N – 4° 54' 51" W	1,455	02.05.14–14.06.14–15.07.14	RV
Tamdafelt	32° 52' 43.86" N – 4° 14' 16.4" W	985	02.03.14–14.06.14–15.07.14	RV
Missour	33° 3' 7.96" N – 3° 58' 41.7" W	870	02.05.14–14.06.14–15.07.14	RV
Outat Al Haj	33° 19' 46.8" N – 3° 42' 14.2" W	770	02.05.14–14.06.14–15.07.14	RV
Tindint	33° 39' 11" N – 3° 35' 20.6" W	640	02.05.14–14.06.14–15.07.14	RV
Moulouya amont Melloulou	34° 12' 59.3" N – 3° 21' 6.8" W	362	23.03.14–24.05.14–07.07.14	RV
Moulouya Aval Melloulou	34° 14' 29.86" N – 3° 19' 13.4" W	355	23.03.14–24.05.14–07.07.14	RV
Moulouya Amont Za	34° 33' 36.3" N – 3° 2' 33.4" W	230	23.03.14–24.05.14–07.07.14	RV
Moulouya aval Za	34° 33' 41.09" N – 3° 1' 49.77" W	222	03.04.14–24.05.14–22.06.14	RV
Sebra	34° 53' 11" N – 2° 39' 45" W	60	03.04.14–24.05.14–22.06.14	RV
Safsaf	34° 54' 27.53" N – 2° 38' 8.86" W	50	18.03.14–18.05.14–23.06.14	RV
Pont Hassan–II	35° 3' 5.7" N – 2° 25' 42.4" W	9	18.03.14–18.05.14–23.06.14	RV
Pré–Estuaire	35° 5' 51.4" N – 2° 23' 19" W	3	18.03.14–18.05.14–23.06.14	RV
Sources O El Bared	33° 54' 40.2" N – 4° 2' 40.7" W	931	27.03.14–01.06.14–11.07.14	RV + NS
Amont O El Bared	33° 58' 59.01" N – 3° 52' 15.8" W	630	23.03.14–08.06.14–07.08.14	RV
Douar Ifrane	34° 2' 20.8" N – 3° 46' 34.1" W	570	23.03.14–08.06.14–07.08.14	RV

Appendix. (Cont.)

Sampling sites	Geographic coordinates	Alt (m)	Sampling dates	Habitat
Sources Berkine	33° 42' 43.25" N – 3° 50' 5.83" W	1,150	22.03.14–14.06.14–07.08.14	RV + NS
Amont Berkine	33° 48' 58.2" N – 3° 47' 7.4" W	970	27.03.14–15.06.14–15.08.14	RV
Pont Oued Zbzit	34° 1' 36.6" N – 3° 45' 38.6" W	595	23.03.14–08.06.14–15.08.14	RV
Confluence Zbzi O El Bared	34° 3' 02.25" N – 3° 46' 34.1" W	565	23.03.14–08.06.14–15.08.14	RV
Douar Imzaghrou	34° 5' 15.75" N – 3° 43' 14.7" W	525	23.03.14–08.06.14–15.08.14	RV
Pont Taddarte	34° 10' 21.4" N – 3° 33' 25.4" W	445	23.03.14–08.06.14–15.08.14	RV
Entrée Guercif	34° 12' 53.5" N – 3° 23' 34.1" W	377	23.03.14–08.06.14–15.08.14	RV
Aval Melloulou	34° 13' 1.15" N – 3° 20' 40.4" W	363	23.03.14–15.06.14–15.08.14	RV
Oued Charef	33° 58' 53.5" N – 2° 5' 7.5" W	925	19.03.14–17.05.14–07.08.14	RV + NS
Pond O Charef	33° 59' 33.1" N – 2° 4' 11" W	918	19.03.14–17.05.14–07.08.14	RV
Petite cascade	34° 3' 56.8" N – 2° 3' 20.2" W	900	19.03.14–17.05.14–07.08.14	RV
Oued Lakhrouf	34° 5' 54.8" N – 2° 2' 38.1" W	897	19.03.14–17.05.14–07.08.14	RV
Grandes cascades	34° 7' 5.7" N – 2° 5' 26.8" W	875	19.03.14–17.05.14–07.08.14	RV
Amont Gafait	34° 14' 31.61" N – 2° 20' 11.98" W	785	19.03.14–17.05.14–07.08.14	RV
Pont de Gafait	34° 13' 36.8" N – 2° 23' 34.5" W	767	19.03.14–17.05.14–07.08.14	RV
Gafait	34° 14' 21.6" N – 2° 24' 34.8" W	750	19.03.14–17.05.14–07.08.14	RV + AS
Barrage Za	34° 12' 23.1" N – 2° 38' 52.3" W	625	19.03.14–17.05.14–07.08.14	RV + DM
Amont Taourirt	34° 25' 15.6" N – 2° 52' 52.9" W	370	07.06.14–19.07.14–19.07.14	RV
Aval de Taourirt	34° 28' 44.51" N – 2° 59' 10.3" W	295	03.04.14–07.06.14–19.07.14	RV
Melg el Ouidane	34° 32' 46.51" N – 3° 1' 31.1" W	240	03.04.14–07.06.14–19.07.14	RV
Debdou	33° 57' 32.64" N – 3° 2' 26.9" W	1,344	27.04.16	AS
Mare à Debdou	34° 3' 51.4" N – 2° 58' 54.1" W	880	27.04.16	PD
Source Tiffert	35° 2' 16.8" N – 2° 25' 36.0" W	83	28.04.16	NS
Aval Zeghzel	34° 53' 08.3" N – 2° 20' 34.1" W	268	28.04.16	RV
Ain-chabbak	35° 6' 18.7" N – 2° 20' 45.0" W	2	28.04.16	PD
Bassin-Oujda	34° 39' 03.5" N – 1° 53' 59.2" W	627	07.11.15–26.02.16–23.04.16	AP
SIBE Saïdia	35° 07' 09.8" N – 2° 20' 15.3" W	0	21.02.16	PD
Canal de Saïdia	35° 05' 59.0" N – 2° 19' 42.1" W	9	22.02.16	AC
Jbel Mehser	34° 29' 24.1" N – 1° 54' 57.6" W	1,268	19.09.15	AS

Appendix. (Cont.)

Sampling sites	Geographic coordinates	Alt (m)	Sampling dates	Habitat
Source Himer	34° 25' 32,5" N – 1° 53' 54" W	1,030	18.11.15	NS
Amont Himer	34° 25' 30,2" N – 1° 53' 31.1" W	1,019	18.11.15	RV
Source Zeghzzel	34° 50' 20.3" N – 2° 21' 21.6" W	442	01.02.15	AS
Ain–Sfa	34° 45' 12.3" N – 2° 08' 36.0" W	652	01.02.15	AS
Ain–Almou	34° 50' 15.2" N – 2° 10' 22.5" W	1,200	06.06.16	AS
Cherraa	34° 56' 43.6" N – 2° 24' 48.5" W	80	06.06.16	PD
Carrière Oujda	34° 34' 50.8" N – 1° 56' 13.9" W	719	17.07.16	AQ
Source Aghbal	34° 55' 14.0" N – 2° 06' 52.5" W	307	27.07.16	AS
Canal Berkane	34° 56' 06.8" N – 2° 18' 41.1" W	154	27.08.16	AC
Mares à Saidia	35° 07' 04.1" N – 2° 19' 44.9" W	0.37	20.06.17	PD
Sidi Moussa	34° 24' 26.0" N – 1° 53' 7.0" W	1,096	29.05.17	RV
Beni Waklane	34° 50' 24.0" N – 2° 15' 36.0" W	795	31.05.17	RV
Wertass	34° 53' 33.9" N – 2° 18' 01.3" W	2,49.5	31.05.17	RV
Laâyoune	34° 35' 42.2" N – 2° 27' 17.9" W	586.8	31.05.17	RV
Tancherfi	34° 25' 27.3" N – 2° 33' 33.2" W	818.2	02.06.16	RV
Oued Isly	34° 47' 24.2" N – 1° 53' 17.4" W		03.06.17	RV
Saguia Selouane	35° 05' 14.3" N – 2° 56' 03.8" W	84	30.04.16	AC
Kariat Arkmane	35° 06' 16.5" N – 2° 44' 55.1" W	19	01.05.16	AC
Dardoura	35° 03' 11.0" N – 2° 54' 18.9" W	134	02.05.16	RV
Oued Ouzej	35° 00' 21.8" N – 2° 59' 30.8" W	168	30.04.16	RV
Oued Selouane	35° 04' 36.7" N – 2° 55' 29.1" W	52	30.04.16	RV
O Messoussate	35° 03' 48.6" N – 2° 54' 23.0" W	68	02.05.16	RV
Marchica (1)	35° 10' 47.2" N – 2° 55' 19.3" W	5	22.05.15	PD
Marchica (2)	35° 09' 19.9" N – 2° 54' 24.3" W	3	02.05.16	LG
Rio de Oro	35° 17' 14.9" N – 2° 56' 37.7" W	12	18.05.15	RV
Mont Gourougou	35° 13' 55.2" N – 2° 59' 57.1" W	542	05.02.15–06.02.15–07.02.15	RV
Oued Tifassour	35° 16' 21.0" N – 3° 5' 14.4" W	17	12.05.16	RV
Oued Oumassine	35° 9' 50.0" N – 3° 6' 36.0" W	79	12.05.16	RV

Appendix. (Cont.)

Sampling sites	Geographic coordinates	Alt (m)	Sampling dates	Habitat
Oued Kert	35° 12' 48.9" N – 3° 11' 1.4" W	6	12.05.16	RV
Oued Mariouari	35° 18' 21.6" N – 2° 58' 38.9" W	85	12.05.16	RV
Barrage Arabat	35° 01' 03.9" N – 2° 52' 36" W	102	05.04.14	DM
Canal Bouareg	35° 05' 37.1" N – 2° 53' 36.3" W	25.8	29.09.16	AC
Canal Granja	35° 05' 47.2" N – 2° 55' 29.4" W	39.9	29.09.16	AC
Souk Mercredi	35° 06' 47.3" N – 2° 44' 38.4" W	0.23	27.10.16	PD
Lagune Nador 3	35° 11' 38.6" N – 2° 55' 33.2" W	2.23	17.06.17	PD
Oued Ikhalfiwan	35° 16' 40.3" N – 3° 05' 22.6" W	13.57	04.10.17	RV
Embouchre Kert	35° 13' 30.2" N – 3° 11' 37.3" W	1	04.10.17	RV
Aval O Selouane	35° 07' 47.9" N – 2° 53' 01.8" W	1	01.12.17	RV
Raknat Naam	32° 27' 11.3" N – 1° 41' 18.7" W	1,168	21.05.16	DM
Barrage Zriga	32° 21' 29.5" N – 1° 19' 36.4" W	1,026	21.05.16	DM
Barrage Sfisef	32° 20' 23.9" N – 1° 21' 04.6" W	1,005	21.05.16	DM
Seguia de Figuig	32° 06' 47.3" N – 1° 14' 08.8" W	902	22.05.16	AC
O Abbou Lekhal	32° 10' 05.3" N – 1° 13' 42.4" W	868	22.05.16	RV
Dayat Lahjal	32° 29' 29.9" N – 1° 39' 47.6" W	1,161	22.05.16	PD
Oued Anwal	32° 40' 46.60" N – 3° 5' 39.74" W	1,194	20.11.16	RV
Oued Ait Aïssa	32° 19' N – 03° 29' W	1,121	21.11.16	RV
Barrage Zelmou	32° 08' N – 02° 54' W	880	22.11.16	DM