

## Communities of Chironomidae (Diptera) from four ecological zones delimited by the Mediterranean coastal ecosystems of Morocco (Moroccan Rif). Updated list and faunal data from the last two decades

Kawtar KETTANI,<sup>1\*</sup> Joel MOUBAYED-BREIL<sup>2</sup>

<sup>1</sup>University Abdel Malek Essaadi, Ecology, Systematics and Biodiversity Conservation Team, Tétouan, Morocco; <sup>2</sup>Freshwater & Marine biology, 10 rue des Fenouils, F-34070 Montpellier, France

\*Corresponding author: kettani.ka@gmail.com

### ABSTRACT

Based on a large material collected during the last two decades in 43 sites covering a wide range of habitats (fresh and brackish water) we delimited four ecological zones, which extend between sea level and high mountain areas located above 1000 m. The four ecological zones are: Zone 1 (Estuarine zone including pools, ponds, lagoons and wet meadows, altitude 0-10 m); Zone 2 (Potamal, alt. 10-350 m); Zone 3 (Lower basin of streams and wadis (alt. 350-1000 m); Zone 4 (Upper basin of streams, wadis, springs and peat bogs, alt. >1000 m). An updated list of 256 species/taxa belonging to Chironomidae (Diptera) has been established which complements previous data for the chironomid fauna of Morocco. The list includes 72 (28%) new records for the fauna of Morocco, 21 (8%) undescribed species and probably 2 new genera (1 Orthocladiinae and 1 Tanytarsini). Spatial distribution of species by subfamilies is highlighted in the four ecological zones where faunal comparative results are: Buchonomyinae (1 species); Tanytarsini (21); Diamesinae (8); Orthocladiinae (143); Chironominae (82, including 40 Chironomini and 42 Tanytarsini). Currently, a total of 410 valid species are reported from Morocco. The low frequency of both listed and undescribed species in Mediterranean coastal ecosystems is linked to the limited faunal knowledge of wetland coastal areas and fragility of lowland habitats, which are regarded as true hotspots.

**Key words:** Moroccan Rif; Mediterranean coastal ecosystems; Diptera Chironomidae; faunal updated data; new records; conservation.

**Received:** November 2017. **Accepted:** May 2018.

**This paper was presented at the 20<sup>th</sup> International Symposium on Chironomidae, Trento, Italy, 2-8 July 2017. Session: Ecology and Biomonitoring.**

### INTRODUCTION

The present investigation was carried out on 43 sites through the Mediterranean wetland areas of Morocco (Moroccan Rif) and conducted during the last two decades, between 1991 and 2016, where three large biogeographic areas are present (Western Rif, Central Rif and Eastern Rif). A preliminary list of the Moroccan Chironomidae focused on the rivers of the Middle Atlas was published by Azzouzi *et al.*, (1987) followed by the additional data of Azzouzi (1992), which dealt with hydrobiological studies from the southern region (High Atlas). Following Azzouzi's contributions, Kettani and others (1994, 1995, 1997, 2010, 2011) completed the list of the chironomid fauna of some rivers in the Rif and provided data for the North of Morocco. According to Kettani and Langton (2012) there are about 388 known taxa/species in Morocco. Therefore, the faunal knowledge of this family for Morocco is still limited, patchy and needs to be completed.

The chironomid fauna of Moroccan Mediterranean

ecosystems remains little known. All previous records had dealt with a limited geographical area covering a few streams, some large rivers and wadis (Sebou, Tensift, Martil, Laou). Many other wetland areas had remained partly investigated or entirely unexplored. A larger area of the Moroccan Rif has been investigated covering more diverse habitats delimited by the coastal Mediterranean ecosystems. According to the latest updated list of the known Chironomidae from Morocco (Kettani and Langton, 2011, 2012), 388 taxa/species were reported including 338 identified to specific level and 53 to generic level.

In the present paper an updated list of 256 taxa/species (identified by the second author) is provided in Supplementary Tab. S1, which complements previous data for the chironomid fauna of Morocco. The list includes 72 new records (28%) for Morocco, 21 (8%) undescribed species and probably 2 new genera (1 belonging to Orthocladiinae and 1 to Tanytarsini). Consequently, the list provided by Kettani and Langton is upgraded to 410 taxa/species currently known from this country.

**METHODS**

The investigated area corresponds to the Rifian chain, called the Rif, which includes the most mountainous region of northern Morocco (Fig. 1). The Rif is bordered by the Mediterranean Sea to the north, Algeria to the east and the Atlantic Ocean to the west. The maximum altitude is 2452 m on the Jbel Tidirrhine. The Rif belongs to the Gibraltar Arc or Alborán Sea geological region, part of the Alpine orogenic belt.

The climate is mainly of Mediterranean type and is characterised by high levels of precipitation and drainage, with an average annual rainfall and soil drainage above 1100 mm. The north of Morocco is considered very rich and diverse in vegetation cover (Valdés *et al.*, 2002) including nearly all of the Moroccan forest species (Médaïl and Quézel, 1999).

The coast is dominated mainly by coarse sand beaches and pebbles with widespread scree. The watercourse regime is often intermittent or even dry. Some rivers operate only after abundant and continuous rains. Torrential flows are often reported in the area. Most of the investigated temporary streams lie in small catchment basins.

In this diverse Rifain context, a multitude of coastal watersheds extend along the Mediterranean coast: Fnideq at the west to Saïdia, high peaks of the Rif at the east.

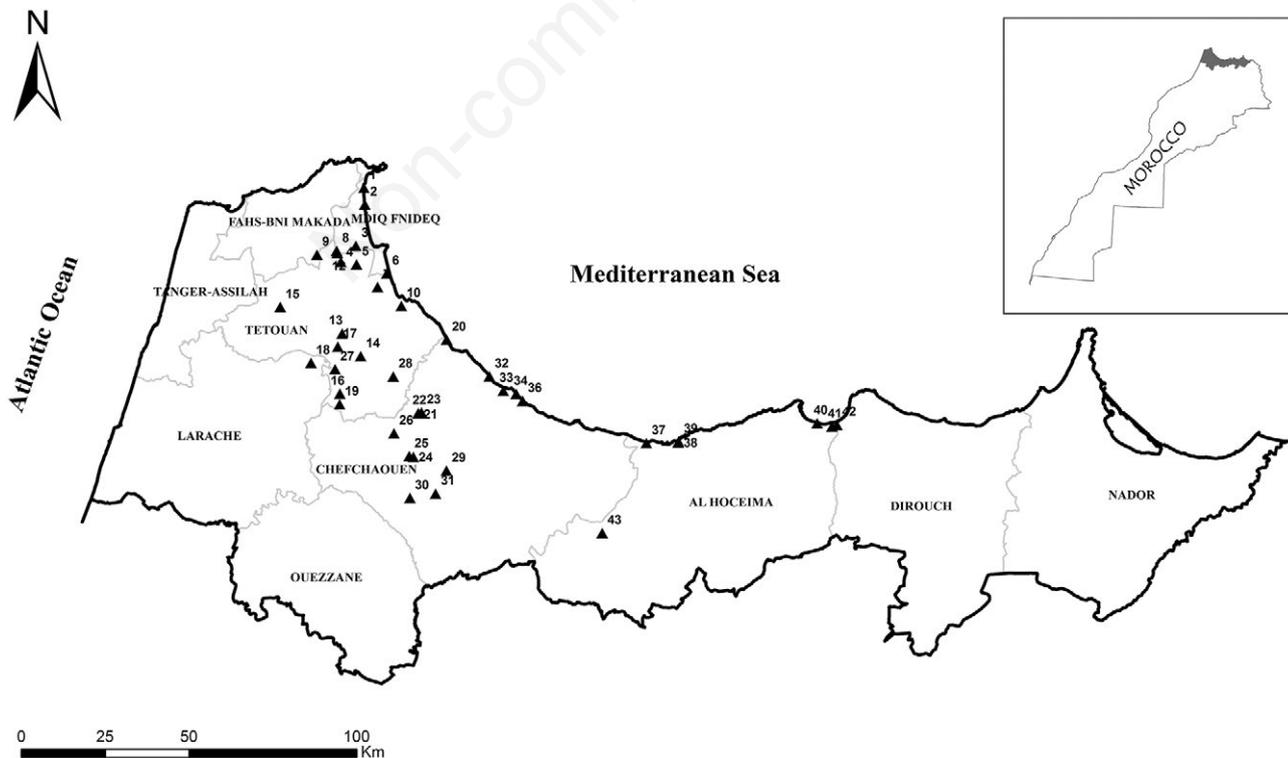
**Studied sites**

The collection sites (43, Fig. 1) include 37 localities (31 aquatic and 6 terrestrial) which were investigated between 1991 and 2016. The various sites are covered by three broad biogeographic areas: the Western Rif with 14 sites, the Central Rif with 22 sites and the Eastern Rif with 7 sites. The Central Rif, the most diverse part of the Rifian massif, is regarded as the most original entity, with respect to the local floral diversity.

**Sampling procedure**

The studied material was mainly collected using standard methods: Surber net for the benthos (larvae and pupae); Brundin drift nets for pharates, pupae, drifting pupal exuviae and drowned adults floating on the surface of the water; Malaise trap supplemented by aerial sweep netting for adults. The examined material consists of 85% (male adults), 10% (pupae), 5% (pharate adults). All specimens were preserved in 70-80% alcohol and later processed as outlined in Moubayed-Breil (2016).

Four ecological zones, extended along the previous three biogeographic areas (Western Rif, Central Rif and Eastern Rif) comprize the Mediterranean coastal ecosystems of Morocco. Typology and main environmental data for the four ecological zones can be summarized as follows:



**Fig. 1.** Major physiographic subregions of the Moroccan Rif with the geographical location of the 43 sampled sites.

**Zone 1 (altitude 0-10 m).** Lowest part of potamal (estuarine areas) where habitats consist of rocky and sandy shores with saline pools, ponds and lagoons, and wet meadows dominated by brackish aquatic vegetation (*Juncus* spp., *Typha* spp., *Salicornia* spp., *Phragmites* spp., *Dittrichia viscosa* (L.) Greuter, etc.). This zone is markedly affected by human activities, pollution and eco-tourism;

**Zone 2 (altitude 10-350 m).** Mainly corresponds to the lower basin of large rivers and streams including the potamal section; generally characterized by low slope and relatively deep water. The riparian vegetation is dominated by *Nerium oleander* L., *Tamarix* sp., *Pistacia lentiscus* L., *Cistus monspeliensis* L., *Rubus ulmifolius* Schott, and the trees *Populus alba* L. and *Pinus pinaster* Aiton;

**Zone 3 (altitude 350-1000 m).** Rhithral section where there are shady stretches of streams and wadis including bryocolous and hygropetric habitats, small to large waterfalls and riffles with sandy to gravely substrata. Major riparian forest, aquatic and subaquatic vegetation mainly belong to riparian species including: *Nerium oleander*, *Tamarix africana* Poir., *Pistacia lentiscus*, *Cistus albidus* L., *Tetraclinis articulata* (Vetel) Mast., *Erica arborea* L., *Quercus suber* L., *Alnus glutinosa* (L.) Gaertn. and *Pinus pinaster*;

**Zone 4 (altitude >1000 m).** Epirhithral section of streams and wadi, high mountain springs and peat bogs extending above 1000 m in altitude. Encountered riparian trees include: *Abies marocana* Trab. (fir forest), *Cedrus atlantica* (Endl.) Carrière (cedar forest), *Quercus canariensis* Willd. (Zénaie) and *Quercus ilex* L.

the Moroccan Rif region, including 71 genera in 6 sub-families (Tab. 1): Buchonomyinae (1 species), Tanypodinae (21 species), Diamesinae (8), Prodiamesinae (1), Orthoclaadiinae (143) and Chironominae (82). Of the 256 listed species, there are 72 (28%) new records for the fauna of Morocco, including 21 (8%) undescribed species which seem to be new for science and 2 new genera, increasing the total number of known valid species to 410 for this country.

Of the 72 new records 54 species belong to Orthoclaadiinae (75%), 15 (21%) to Chironominae, 2 to Tanypodinae and only 1 to the Diamesinae. Among the total of 71 genera, 7 are reported for the first time from Morocco: *Acricotopus*, *Camptocladus*, *Hydrobaenus*, *Smittia*, *Thienemannia*, *Cladopelma* and *Stenochironomus*. The highest number of species for Morocco now belongs to the Orthoclaadiinae (30 genera, 143 species) followed by the Chironominae (23, 82). The most diverse genera are: *Cricotopus* (22 species) followed by *Eukiefferiella* (15). A lower number of species (less than 10) belongs to the following genera: *Bryophaenocladus*, *Limnophyes*, *Orthocladus*, *Tanytarsus*, *Rheocricotopus*, *Micropsectra*, *Rheotanytarsus*, *Chironomus*, *Polypedilum*, *Pseudosmittia*, *Smittia*. Three orthoclad genera with potential biogeographic value (*Heleniella*, *Krenosmittia* and *Thienemannia*) have still not been encountered in the investigated areas.

### Ecological and biogeographic approach

The distribution pattern of specific richness along the four ecological zones revealed the presence of four distinct communities (Tab. S1). The highest diversity is recorded in the rhithral of middle basins of streams and rivers (zone 3) with 188 species, followed by zone 2 (152). Zones 1 and 4 are represented by fewer species: respectively 80 and 88. The highest diversity reported in the metarhithral of streams (zone 3: 188 species, 73%) and potamal section of large

## RESULTS AND DISCUSSION

### Faunal approach

An updated list of 256 species is here reported from

**Tab. 1.** Distribution by subfamilies of genera/species (number and percentage) of Chironomidae in the four ecological zones of the Moroccan Rif (Mediterranean coast, N-Morocco). Typology of the four ecological zones: 1, estuarine zone including pools and wet meadows (altitude 0-10 m); 2, Potamal (alt. 10-350 m); 3, lower basin of streams and wadi (alt. 350-1000 m); 4, upper basin of streams, springs, peat bogs (alt. >1000 m).

Chironomidae (subfamilies) / Ecological zones	Zone 1	Zone 2	Zone 3	Zone 4
Buchonomyinae: 1/1	-	1	1	-
Tanypodinae: 12/21	6	17	14	4
Diamesinae: 4/8	-	3	6	3
Prodiamesinae: 1/1	1	1	1	-
Orthoclaadiinae: 30/143	30	63	124	73
Chironominae: 23/82	43	67	42	8
Chironominae-Chironomini: 15/40	28	37	16	-
Chironominae-Tanytarsini: 8/42	15	30	26	8
Total genera=71/Total species=256	80	152	188	88
%	31	59	73	34

rivers (zone 2: 152, 59%), reveals an important ecological potential for the occurrence of a great number of species. In particular, the high specific richness of zone 4 is certainly related to the heterogeneity of habitats, which consists mainly of short sections of rhithral with small riffles and waterfalls. Fourteen taxa were recorded exclusively from this section: *Diamesa hamaticornis* Kieffer, *D. insignipes* Kieffer, *Bryophaenocladus* sp.3, *Cricotopus* (*C.*) *pulchripes* Verrall, *C.* (*Paratrachocladus*) sp.2, *Hydrosmittia ruttneri* (Strenzke & Thienemann), *Orthocladus* (*O.*) sp.1, *Parametrioctenus valescurensis* Moubayed & Langton, *Paraphaenocladus exagitans* (Johannsen) ssp.1, *Psectrocladius* (*Allopsectrocladius*) *platypus* (Edwards), *P.* (*Psectrocladius*) *octomoculatus* Wülker, *Demicryptochironomus* (*Irmakia*) *neglectus* Reiss, *Rheotanytarsus distinctissimus* (Brundin), and *R. reissi* Lehmann.

The lowest number of species (80) is reported from zone 1, where the Chironominae is represented by 43 species. This decrease in richness is certainly due to human activities and disturbances that include pollution and variation in flow observed near the coast (most estuaries are dry over long periods of the year). The estuarine zone and coast constitute a vulnerable habitat which suffers nowadays greatly from both natural (climate change) and anthropogenic effects. Five species occurring in zone 1 are exclusively reported from this area: *Hydrobaenus conformis* (Holmgren), *Chironomus* (*Baeotendipes*) *noctivagus* (Kieffer), *Chironomus aprilius* Meigen, *C. salinarius* Kieffer and *Tanytarsus formosanus* Kieffer. In addition 16 other new records for Morocco have been recorded from the coast: *Acricotopus lucens* (Zetterstedt), *Bryophaenocladus tuberculatus* (Edwards), *Camptocladus stercorarius* (DeGeer), *Cricotopus* (*C.*) *caducus* Hirvenoja, *C.* (*C.*) *ephippium* (Zetterstedt), *Limnophyes habilis* (Walker), *L. madeirae* Sæther, *L. natalensis* (Kieffer), *Nanocladus dichromus* (Kieffer), *Smittia pratorum* Goetghebuer, *Cladopelma virescens* (Meigen), *Cryptochironomus supplicans* (Meigen), *Stenochironomus gibbus* Fabricius, *Stictochironomus rosenschoeldi* (Zetterstedt), *Tanytarsus ejuncidus* (Walker), and *T. mendax* Kieffer.

The poor specific richness of zone 4 (only 88 species) compared to that of the other zones, is closely related to limited investigations and the low number of explored localities (only 6 sites). Nevertheless, it is important to highlight that in this community, 48 taxa (19%) are considered to be new records for Morocco, including 14 undescribed taxa with 2 new genera (1 Orthoclaadiinae and 1 Tanytarsini). In addition, *Zavreliomyia barbatipes* (Kieffer), *Z. berberi* Fittkau, *Corynoneura celtica* Edwards and *Lithotanytarsus dadesi* Reiss are exclusively reported from this mountainous area.

The presence of 21 new undescribed species and 2 new genera in high mountain areas (zone 4) highlights the

importance of cold and stenothermic habitats, which are considered to be hotspots of diversity and endemism. Therefore, this mountain range of the Moroccan Rif deserves greater consideration and preservation, where more hydrobiological plans are still necessary to be implemented in the years to come.

---

## ACKNOWLEDGMENTS

We wish to thank our colleagues Dr P.S. Cranston, Dr N. Prat and Dr P. Ashe for their constructive suggestions and corrections, which markedly improved the manuscript.

---

## REFERENCES

- Azzouzi A, Laville H, 1987. [Premier inventaire faunistique des Chironomidés (Diptera, Chironomidae) du Maroc]. [Article in French]. Ann. Limnol.-Int. J. Limn. 23:217-224.
- Azzouzi A, Laville H, Reiss F, 1992. [Nouvelles récoltes de Chironomidés (Diptera) du Maroc]. [Article in French]. Ann. Limnol.-Int. J. Lim. 28:225-232.
- Benabid A, 2000. [Flore et écosystèmes du Maroc. Évaluation et préservation de la biodiversité]. [Book in French]. Ibis Press, Paris: 357 pp.
- Kettani K, Vilchez A, Calle D, El Ouazzani T, 1994. [Les Chironomidés (Diptera) du bassin de l'Oued Laou (Versant méditerranéen du Rif, Maroc)]. [Article in French]. Ann. Limnol.-Int. J. Lim. 30:25-32.
- Kettani K, Vilchez A, Calle D, El Ouazzani T, 1995. [Nouvelles récoltes de Chironomidés (Diptera) du Maroc: Les Chironomidés de l'Oued Martil (Rif)]. [Article in French]. Ann. Limnol.-Int. J. Lim. 31:253-261.
- Kettani K, Calle D, El Ouazzani T, 1997. [Nuevas especies de Quironomidos (Insecta - Diptera) en el alto Laou (Rif, norte de Marruecos)]. [Article in Spanish]. Zool. Baetica 8: 181-189.
- Kettani K, Langton P, 2011. New data on the Chironomidae (Diptera) of the Rif (Northern Morocco). Pol. J. Entomol. 80:583-595.
- Kettani K, Langton P, 2012. [Les Chironomidae du Maroc (Diptera, Nematocera)]. [Article in French]. Bull. Soc. Entomol. Fr. 117:411-424.
- Médail F, Quézel P, 1999. Biodiversity hotspots in the Mediterranean Basin: setting global conservation priorities. Conserv. Biol. 13:1510-1513.
- Moubayed-Breil J, 2016. On the genus *Cricotopus* v. d. Wulp, 1874 (*tremulus*-group) from continental France and Corsica with description of *C. mantetanus* sp. n. and *C. royanus* sp. n. [Diptera, Chironomidae, Orthoclaadiinae]. Ephemera 17:71-104.
- Valdés B, Rejdali M, Achhal el Kadmiri A, Jury JL, Montserrat JM, 2002. [Catalogue des plantes vasculaires du nord du Maroc, incluant des clés d'identification]. [Book in Spanish]. Consejo superior de investigacione científicas: 1007 pp.