

Research Article

An updated checklist of the Culicinae (Dip., Culicidae) in north-eastern Morocco, with new distribution data

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Abstract. Several species of mosquitoes from the subfamily Culicinae play a significant role in public health as vectors of arboviruses. Of the over 3000 recorded Culicinae species worldwide, 43 are present in Morocco. Of these, 14 are recognized as potential vectors of viruses such as West Nile (WNV), Zika (ZIKV), yellow fever (YFV), and chikungunya (CHIKV). This study aims to update the distribution of mosquito species in north-eastern Morocco. Larval surveys conducted at 20 sites yielded the collection and identification of 13 species across four genera. *Culex* was the dominant genus with eight species and the widest distribution. *Aedes* followed *this* with three species. The genera *Culiseta* and *Uranotaenia* were each represented by a single species. Five of these species are potential arbovirus vectors, and seven are new records for the study region. This updated inventory of the culicid fauna, including new reports and data on ecological distribution, greatly enhances our understanding of the Culicinae community composition in north-eastern Morocco. These results provide a vital basis for assessing arboviral risks and implementing targeted vector control strategies, thereby helping to improve public health measures in the region.

Keywords: *Aedes*, *Culex*, *Culiseta*, *Uranotaenia*, Rif Morocco

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Introduction

Mosquitoes (Diptera: Culicidae) are a globally important group of arthropods, comprising over 3,729 species found worldwide (Harbach, 2026), from tropical to temperate regions. They have a considerable impact on public and veterinary health, particularly the hematophagous species of the Culicinae subfamily, which act as competent vectors for a multitude of pathogens. These insects transmit parasites that cause malaria and filariasis. Still, they are most notable for transmitting emerging or re-emerging arboviruses, including dengue virus (DENV), Zika virus (ZIKV), chikungunya virus (CHIKV), yellow fever virus (YFV), West Nile virus (WNV), and Rift Valley fever virus (RVFV) (Trari & Dakki, 2017). Morocco is recognised as a high-risk area for the emergence of vector-borne diseases, given its strategic geographical location, climatic diversity, and increased exposure to international trade, particularly with Europe and sub-Saharan Africa. This also promotes the rapid spread of insect vectors, thereby exposing a large proportion of the population to these health threats (Guimerà *et al.*, 2005; Perrings *et al.*, 2005).

To date, 43 mosquito species have been recorded in the country (Trari & Dakki, 2017). Of these, at least 14 species, belonging to the subfamily Culicinae, have been confirmed as potential vectors of human and animal pathogens (Trari *et al.*, 2017). These insects have been extensively studied worldwide, including in our country. However, there is a significant knowledge gap in the Eastern Rif region of northeastern Morocco. Systematic entomological inventories are sorely lacking in this region, leaving the local species diversity, species distribution,

and vector potential largely unknown. This study aims to address this issue. An inventory of mosquito species in this region is an essential preliminary step for any accurate assessment of arboviral risk. By mapping species diversity and distribution and identifying potential vectors, this work provides an indispensable scientific basis. These data are essential for implementing targeted epidemiological surveillance programs and appropriate vector control strategies, thereby actively contributing to the protection of public health in northeastern Morocco and beyond.

Materials and methods

Study area and sampling sites

This study was conducted in the Eastern Rif region of northeastern Morocco. The study area encompasses the provinces of Al Hoceïma, Nador, and Driouch and forms the eastern extension of the Rif mountains range. Geographically, the Eastern Rif is bordered by the Mediterranean Sea to the north, the Central Rif to the west, the Algerian border to the east, and the Taza-Oujda corridor to the south. The region has a Mediterranean climate, ranging from semi-arid to arid, with an average annual rainfall of 200-400 mm. Targeted sampling was conducted within this area, with a specific focus on the coastal province of Al Hoceïma. This province exhibits a more pronounced maritime-influenced Mediterranean climate, with generally higher rainfall than the broader region. For this study, twenty sites were selected; their geographical location within the study area is presented in Fig. 1. A sampling campaign was conducted across 20 distinct sites in Morocco, particularly in the Eastern Rif region, due to the lack of data on arbovirus vector mosquitoes. This three-year study (February 2021 to December 2023) targeted 20 larval breeding sites of various types, including both natural and artificial habitats (Table 1).

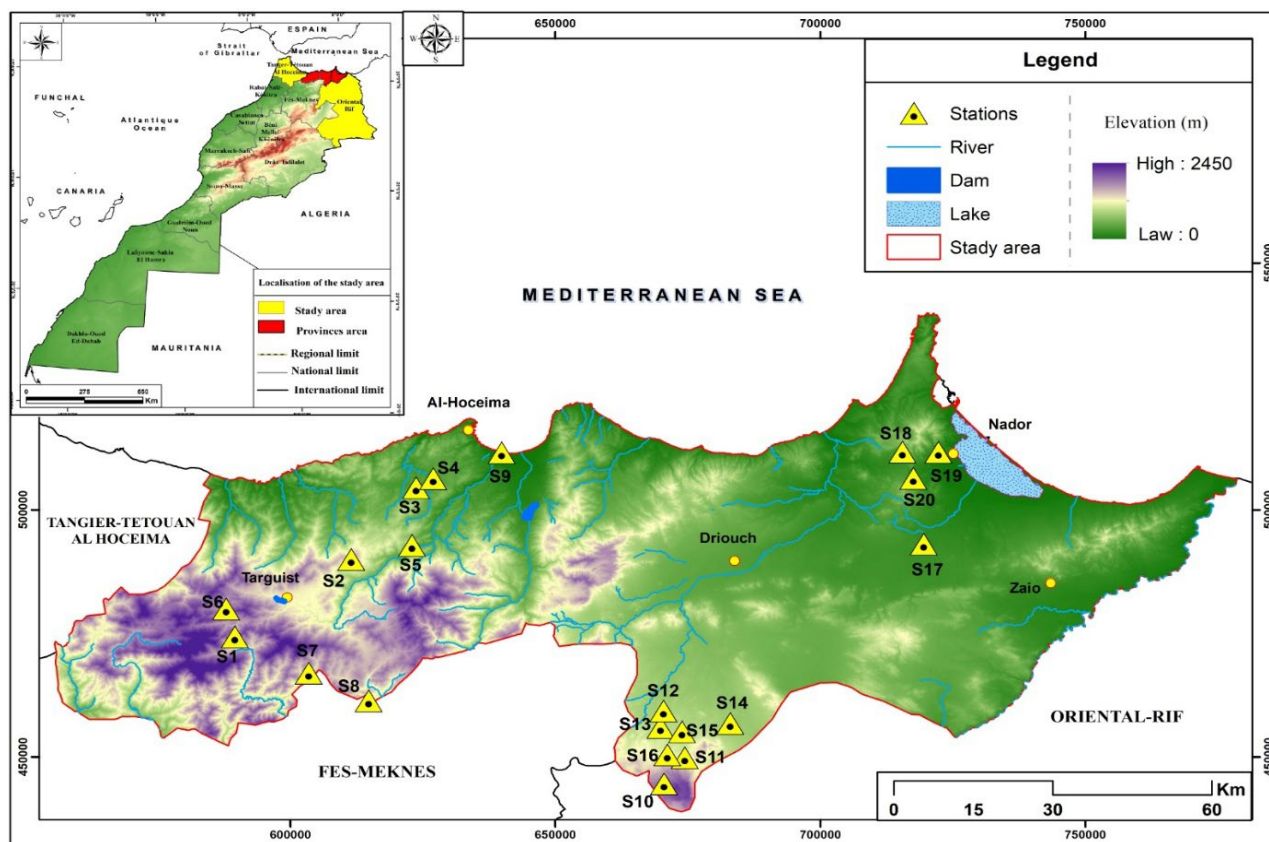


Fig.1. Distribution map of the study area showing the investigated sites

Table 1. Sampling sites in the Oriental Rif Region, Northeastern Morocco

Code	Stations	Localities	Altitude	Latitude	Longitude
S1	Bni bounsar	Al Hociema	1250	34°50'32.85"N	4°25'17.63"W
S2	Tigart	Bni Hdifa	1205	35° 0'27.90" N	4°11'30.96"W
S3	Oued Merika	Bni Hdifa	246	35° 8'11.09"N	4° 5'3.14"W
S4	Oued Bouham	Ait Kamra	244	35° 8'26.70"N	4° 0'40.37"W
S5	Bni Abdelah	Al Hociema	747	35° 3'14.96"N	4° 5'17.37"W
S6	Oued Taghzout	Tabrant	1070	34°46'22.31"N	4°31'43.32"W
S7	Oued Sra1	Al Hociema	284	34°31'33.79"N	4°37'1.46"W
S8	Oued Sra 2	Al Hociema	290	34°31'32.38"N	4°38'2.50"W
S9	Oued Boukidan	Plage Souani	278	35°11'49.62"N	3°51'47.11"W
S10	Ain Lahssan	Driouch	525	34°22'38.46"N	3°31'33.83"W
S11	Zaouia	Driouch	690	34°37'56.2"N	3°29'49.6"W
S12	Ain Zohra 1	Driouch	822	34°39'36.42"N	3°32'23.96"W
S13	Ain Zohra 2	Driouch	834	34°39'20.24"N	3°33'16.34"W
S14	Taouima	Nador	290	35° 6'46.08"N	2°55'37.44"W
S15	Khouilaf 1	Driouch	587	34°38'43.51"N	3°20'55.71"W
S16	Khouilaf 2	Driouch	764	34°39'58.64"N	3°31'34.13"W
S17	Ain Ayad	Driouch	862	34°38'41.37"N	3°32'21.79"W
S18	Zeghanghane	Nador	124	35°08'42.2"N	3°00'56.6"W
S19	Bouarouro 1	Nador	249	35° 9'27.73"N	2°54'22.00"W
S20	Bouarouro 2	Nador	250	35° 9'16.67"N	2°54'20.82"W

Sampling Method

Monthly sampling was conducted based on two main criteria: the presence of mosquito larvae at a given breeding site and the site accessibility. Larvae were collected using the dipping technique (Coffinet *et al.*, 2009). Semi-quantitative larval sampling was performed using a Langeron net. The number of dips taken varied according to the size (surface area) of each breeding site and the apparent larval density. During each collection event, Pasteur pipettes were used to capture the larvae collected. All samples were meticulously labelled with the date, location, and breeding site identification number. Finally, the fauna samples were preserved in 70% alcohol for subsequent analysis.

Laboratory Analysis

The collected mosquitoes were identified at the species level using morphological criteria and the Moroccan identification key (Himmi *et al.*, 1995) as well as the CD-ROM key by (Brunhes *et al.*, 2000). Morphological identification was conducted at two facilities: The Laboratory of Ecology, Systematics, and Conservation of Biodiversity (LESCB), Faculty of Sciences, Abdelmalek Essaâdi University, Tetouan, Morocco, and the National Institute of Hygiene (NIH), Rabat, Morocco.

Results

We identified 13 species (Fig. 2), members of four genera (*Aedes*, *Culex*, *Culiseta*, and *Uranotaenia*) of the subfamily Culicinae, collected in north-eastern Morocco. Five of these species are potential arbovirus vectors, and seven are new records for the study region.

Ae. (Och.) pulcritarsis (Rondani, 1872)

Aedes pulcritarsis exhibits specialized larval ecology, developing exclusively in dendrolimnic habitats characterized by tannin-rich waters containing decomposing plant matter. The species shows a marked preference for oak tree cavities. Within our study area, the species was identified in similar habitats within an *Eucalyptus* plantation, where larvae were collected in plant detritus-rich water, alongside *Uranotaenia unguiculata*. From a vector perspective, *Ae. pulcritarsis* is not considered a significant nuisance and is not implicated in the transmission of known human pathogens. This study reports the first occurrence of this species in the study area.

***Ae. (Och.) caspius* (Pallas, 1771)**

At the Bouarouro site, we identified *Aedes caspius*. *Aedes detritus* s.l. and *Cx. pipiens* were also found. These species were primarily located in large larval habitats characterized by fresh to slightly brackish water. These habitats were characterized by aquatic vegetation and a notable abundance of algae, creating favourable ecological conditions for larval development.

***Ae. (Och.) detritus* (Haliday, 1833)**

Aedes detritus has been observed at three sites (Bouarouro 1, Bouarouro 2, and Oued Boukidan), where it occasionally co-occurs with *Aedes caspius*, particularly at Bouarouro. This strictly halophilic species primarily develops in large, brackish larval habitats such as estuaries, coastal marshes, semi-permanent ponds, and stagnant lagoons. The larvae develop specifically in habitats with high salinity.

***Cx. (Cux.) brumpti* Galliard, 1931**

Culex brumpti were identified in a larval habitat characteristic of the Oued Sra station. This site is characterized by small collections of stagnant water with a rocky, shallow bottom. This study reports the first occurrence of this species in the study area.

***Cx. (Cux.) laticinctus* Edwards, 1913**

Larvae were collected in a wide variety of biotopes, including both polluted and clean freshwater habitats. They were found in both natural habitats (rock pools, springs) and artificial habitats (cisterns, barrels, water storage basins, and irrigation canals). This ecological plasticity explains its abundance in the region.

***Cx. (Cux.) mimeticus* Noè, 1899**

Culex mimeticus has been recorded in several localities within the study area, including Zeghanghane, Ain Lahssan, Tigart, Bni Bounssar, Taghzout, Ain Zohra, Ain Ayad, Khouilaf, and Taouima. This wide distribution indicates notable adaptability to diverse lentic environments. The larval stages of *Cx. mimeticus* were primarily observed in natural habitats with stagnant or slow-flowing water.

***Cx. (Cux.) perexiguus* Theobald, 1903**

The *Culex perexiguus* was identified in several localities within the study area, notably in Bni Bounssar, Oued Sra, Khouilaf 2, and Zeghanghane. Its larval ecology is characterized by high plasticity, with development observed in various freshwater habitats.

***Cx. (Cux.) pipiens* Linnaeus, 1758**

In our study area, *Cx. pipiens* was identified in the majority of surveyed sites (Oued SRA, Khouilaf, Tigart, Zeghanghane, Oued Merika, Taghzout, Khouilaf 2, Zaouia, Ain Lahssan, Bni Bounssar, Bouarouro), confirming its status as the most abundant species. It was found in a variety of breeding sites, including organically rich, polluted waters, wastewater, streams (wadis), and natural and artificial habitats ranging from permanent to temporary.

***Cx. (Cux.) theileri* Theobald, 1903**

Culex theileri was identified in several localities within the study area (Oued SRA, Zeghanghane, Ain Lahssan, Bni Bounssar, Taghzout, Ain Ayad). Its larval habitat varied from small collections (rock pools) to larger ditches. A common feature of all positive breeding sites was the presence of organic matter, in the form of plant debris or pollution, indicating a marked preference for freshwater.

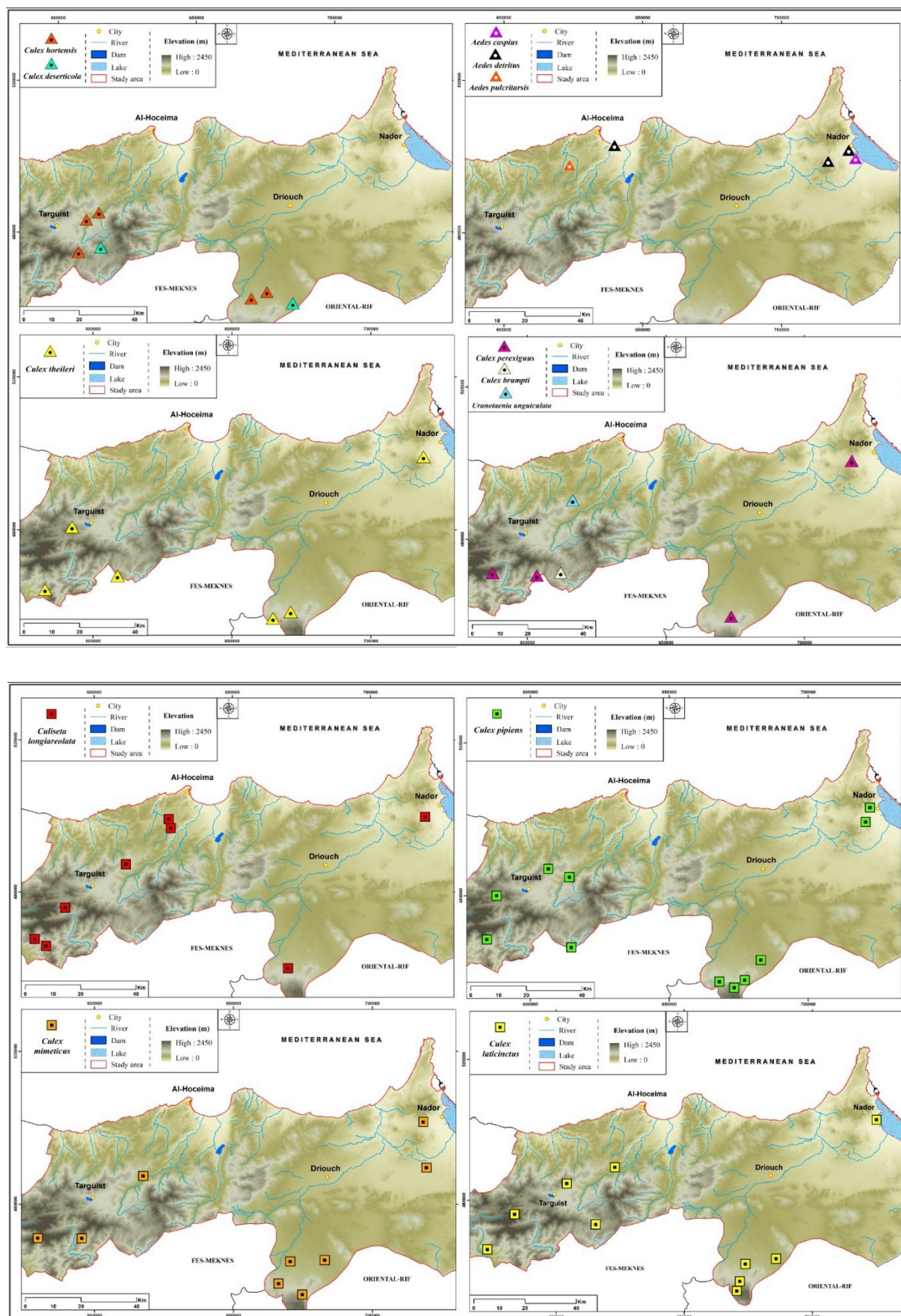


Fig.2. Spatial distribution of Culicinae species in the study area

Cx. (Mai.) deserticola Kirkpatrick, 1925

Culex deserticola was identified in our study area, specifically in the Oued Sra and Khouilaf. Localities. It was found in rocky-larval habitats characterized by fresh, stagnant water. This is the first time it has been recorded in the study area.

Cx. (Mai.) hortensis Ficalbi, 1889

Culex hortensis was identified in three distinct localities within the study area: Oued Sra1, Tigart, Bni Bounssar Ain Zohra1 and Ain Zohra 2. Collections revealed larval development of this species in natural stagnant freshwater habitats as well as in anthropogenic water storage basins. This observation constitutes the first confirmed record of *Culex hortensis* in this region.

Cs. (All.) longiareolata (Macquart, 1838)

Culiseta longiareolata was recorded at several sites in the study area, including Oued Sra 1, Oued Sra 2, Oued Bouham, Ain Zohra, Zeghanghane, Bni Bounssar, Taghzout, Bni Abdelah, and Tigart. This ubiquitous species, known for its high ecological plasticity, was collected in a wide variety of freshwater larval habitats. Its preferred habitats included natural features such as temporary pools and rock holes, as well as artificial structures like water storage basins. These sites often had stagnant water. This study reports the first confirmed occurrence of *Cs. longiareolata* in the study area.

Ur. (Pfc.) unguiculata Edwards, 1913

Uranotaenia unguiculata develops mainly in shallow marshes with abundant vegetation. Its larvae adopt a position parallel to the water surface, similar to Anopheles, while adults exhibit specialized zoophilic behavior, targeting amphibians and reptiles. In our study area, the presence of *Ur. unguiculata* larvae was confirmed in freshwater collections rich in plant detritus within an eucalyptus plantation, where the species was found alongside *Aedes pulcritarsis*. This observation constitutes the first record for this species in the geographical area under consideration.

Discussion

Aedes (Ochlerotatus) pulcritarsis and *Uranotaenia unguiculata* were collected together in dendrolimnetic habitats (tannin-rich waters with plant debris) within a eucalyptus plantation. This ecological association has not been previously documented in Morocco. *Aedes pulcritarsis*, a Palearctic species closely related to *Ae. berlandi* (Severini *et al.*, 2009), has been recorded in Italy (Severini *et al.*, 2009), Spain (Eritja *et al.*, 2000; Bueno-Marí *et al.*, 2012), France (Moussiegt, 1991; Schaffner, 1998), and Maghreb countries, including Tunisia (Sicart, 1942; Moussiegt, 1983; Bouattour, 2013), Algeria (Bettioui, 2008), Austria (Bakran-Lebl *et al.*, 2022), and Morocco (Trari *et al.*, 2002; Trari & Dakki, 2017). It remains relatively uncommon in Morocco (Trari, 2017). Our observation confirms its presence in a previously unreported area and specifies its preferred habitat (tree holes with tannic waters).

Uranotaenia unguiculata, a species native to Palestine and the only tropical representative of its genus in the Mediterranean (Senevet & Andarelli, 1959), is widespread in southern Eurasia (Šebesta *et al.*, 2010) and has been reported in southern Europe (Schaffner, 1998; Almeida *et al.*, 2005; Severini *et al.*, 2009; Bueno-Marí *et al.*, 2012). In North Africa, it has been recorded from Egypt to Morocco (Harbach *et al.*, 1988; Trari, 2017), with a more marked presence on the Moroccan Atlantic coast. Our study extends its distribution to a new locality and confirms its development in freshwater rich in decomposing vegetation. *Culex brumpti*, recorded for the first time in our study area (Oued Sra), was originally described in Corsica (Galliard, 1931) and later found in Sardinia (Aitken, 1954), Italy (Severini *et al.*, 2009), and France, exclusively in Corsica (Schaffner, 1998), but not in Spain (Bueno-Marí *et al.*, 2012). In Morocco, it was first identified in the Gharb North Atlantic coastal plain (Bailly-Choumara, 1968, 1972) and the Marrakesh region (Bailly-Choumara, 1968), and confirmed near Fez (El Ouali

Lalami *et al.*, 2010). Its presence in small, stagnant bodies of water with a rocky, shallow bottom aligns with its known ecology.

Aedes caspius and *Aedes detritus* co-occurred at Bouarouro in large larval habitats characterized by fresh to slightly brackish water with aquatic vegetation and abundant algae. *Ae. caspius* has a broad Palearctic distribution, ranging from Europe to Central Asia and North Africa, including Morocco and Egypt (Robert *et al.*, 2019). It is particularly abundant in the Mediterranean basin, reported in Italy, Belgium, France (Balenghien *et al.*, 2008; Carron *et al.*, 2008), Spain (Gutierrez-Lopez *et al.*, 2019), and North African countries (Egypt, Libya, Algeria, Tunisia, and Morocco). In Morocco, this species, first described as *Aedes punctatus* (Séguy, 1930), is prevalent in both coastal and inland wetlands, particularly at low altitudes (Trari, 2017). Our study confirms its ecological plasticity. *Aedes detritus* is a Palearctic species primarily found in coastal areas of Europe and North Africa. In Europe, it is well-documented along the coastlines of the United Kingdom (Blagrove *et al.*, 2016), Italy (Mancini *et al.*, 2017), Belgium (Boukraa *et al.*, 2015), France (Bregues *et al.*, 2014), and Spain (Ruiz-Arrondo *et al.*, 2019). In North Africa, it has been reported in Egypt (Abdel-Hamid *et al.*, 2011), Tunisia (Ben Ayed *et al.*, 2019), Algeria (Metge & Hassaine, 1998), and Morocco (Trari, 2017). In Morocco, *Ae. detritus* is strictly limited to Atlantic (Tanger-Tantan) and Mediterranean (Tanger-Saïdia) coastal zones due to its dependence on saline larval habitats (Trari, 2017). Its presence in three of our sites corresponds to this distribution.

Both species are competent vectors for several arboviruses: *Ae. caspius* for Tahyna virus (Pilaski & Mackenstein, 1985), West Nile virus (Orshan *et al.*, 2008; Ergunay *et al.*, 2014), Rift Valley fever virus (Turell *et al.*, 1996; Tantely *et al.*, 2015), Sindbis virus (Lundström, 1999), and Usutu virus (Cook *et al.*, 2018). *Aedes detritus* is a competent vector for Zika, chikungunya, Japanese encephalitis, West Nile virus and Rift Valley fever (Balenghien *et al.*, 2008; Mackenzie-Impoinvil *et al.*, 2015; Tantely *et al.*, 2015; Lumley *et al.*, 2018; Blagrove *et al.*, 2020). *Culex pipiens* was the dominant species in our sampling (11 localities), confirming its status as the most abundant and ubiquitous species in Morocco (Amraoui *et al.*, 2012a). This cosmopolitan species is widely distributed across temperate regions, particularly in the Mediterranean basin (Amraoui *et al.*, 2012a; Brugman *et al.*, 2018), and is found in Europe, North Africa, Asia, Australia, and the Americas. It exists in two morphologically identical but ecologically distinct biotypes: the *pipiens* form (anautogenous, eurygamous, heterodynamic) and the *molestus* form (autogenous, stenogamous, homodynamic) (Farajollahi *et al.*, 2011). In Morocco, *Cx. pipiens* comprises two main forms (urban *pipiens* and rural *molestus*), as well as hybrids, which coexist in regions such as Marrakech and Casablanca (Amraoui *et al.*, 2012b). Its presence in polluted waters, wastewater, wadis, and natural and artificial habitats demonstrates remarkable adaptation to anthropized environments. This ubiquity is concerning because *Cx. pipiens* is a major vector of West Nile virus (Amraoui *et al.*, 2012a), Usutu virus (Calzolari *et al.*, 2010), and Rift Valley fever virus (Meegan *et al.*, 1980).

Culex laticinctus, found in 10 very diverse localities (rock pools, springs, cisterns, irrigation canals, polluted or clean waters), shows rare ecological plasticity for a species primarily associated with desert regions of the Mediterranean basin. It is widespread in Africa and Mediterranean regions, ranging from the Canary Islands to the Middle East (Gutsevich *et al.*, 1974; Becker *et al.*, 2010). It is present in Europe, particularly in Italy, Spain (Severini *et al.*, 2009) (Eritja *et al.*, 2000; Bueno-Marí *et al.*, 2012), Portugal (Ribeiro *et al.*, 1988; Almeida *et al.*, 2005), Malta, Greece, Romania, Turkey (Snow & Ramsdale, 1999), and Croatia (Zitko & Merdic, 2006). In North Africa, it has been reported in Egypt (Harbach *et al.*, 1988), Libya (Goodwin, 1961), Tunisia (Moussiegt, 1983; Bouattour, 2013), Algeria (Messai *et al.*, 2011; Bouabida *et al.*, 2012; Boudemagh *et al.*, 2013), and Morocco (Trari *et al.*, 2002; Trari *et al.*, 2017). First reported in northern Morocco (Himmi, 2007), our study confirms its presence in several new localities.

Culex perexiguus identified at four localities (Fig. 2), exhibits great adaptability to various freshwater habitats. This species is widely distributed across North Africa and Southwest Asia, extending as far as India (Harbach *et al.*, 1988). It has been reported in Italy (Severini *et al.*, 2009), Spain (Eritja *et al.*, 2000; Bueno-Marí *et al.*, 2012), Albania, Bulgaria, Greece, Portugal (Snow & Ramsdale, 2004), Malta (Gratt, 2009), Saudi Arabia (Al Ahmad *et al.*, 2011), and North African countries including Egypt (Harbach *et al.*, 1988), Mauritania (Hamon *et al.*, 1966), Libya (Goodwin, 1961), Tunisia (Moussiegt, 1983; Bouattour, 2013), Algeria (Tine-Djebbar *et al.*, 2011; Bouabida *et al.*, 2012), and Morocco (Trari *et al.*, 2002; Trari *et al.*, 2017). It is a confirmed vector of West Nile virus (Cornel *et al.*, 1993; Miller *et al.*, 2000; Jupp, 2001). *Culex mimeticus* observed in nine localities (Fig. 2),

prefers stagnant or slow-flowing waters in natural habitats. This species is widely distributed across the Far East, the Middle East, and the Mediterranean basin. In Europe, it has been recorded in Italy (Severini *et al.*, 2009), France (Schaffner, 1998), and Spain (Eritja *et al.*, 2000; Bueno-Marí *et al.*, 2012; Bueno-Marí *et al.*, 2014). In North Africa, it is primarily found in mountainous regions such as the Algerian Tell and in steppes (Senevet & Andarelli, 1959). Records also exist from Egypt (Harbach *et al.*, 1988), Algeria (Sergent, 1909; Bouabida *et al.*, 2012), Tunisia (Sicart, 1942; Moussiegt, 1991; Bouattour, 2013), and Morocco (Trari *et al.*, 2002; Trari *et al.*, 2017). In Morocco, although common, it shows a preference for mid- to high-altitude regions (Trari, 2017).

Culex theileri presents in six localities (Fig. 2), was consistently found in freshwater rich in organic matter (plant debris or pollution). This species is widely distributed throughout the Mediterranean region, the Canary Islands, Iraq, Yemen, Aden, India, and southern and eastern Africa (Senevet & Andarelli, 1959). In Europe, it has been found in Spain (Eritja *et al.*, 2000; Bueno-Marí *et al.*, 2012), including the Canary Islands (Martínez-De La Puente *et al.*, 2012), France (Schaffner, 1998), Italy (Severini *et al.*, 2009), and more recently Malta (Schaffner *et al.*, 2010). In North Africa, it has been reported in Egypt (Harbach *et al.*, 1988), Algeria (Messai *et al.*, 2011; Tine-Djebbar *et al.*, 2011; Bouabida *et al.*, 2012; Benhissen *et al.*, 2014), Tunisia (Moussiegt, 1983; Bouattour, 2013), and Morocco (Trari *et al.*, 2002; Trari *et al.*, 2017), where it occupies a broad distribution range (Trari, 2017). *Culex theileri* is a confirmed vector of West Nile virus in Morocco (Amraoui *et al.*, 2012a). *Culex deserticola*, a Saharan species originally described in Egypt (Kirkpatrick, 1925), was found at Oued Sra and Khoulif. This species is widely distributed across the southern Mediterranean region, from Morocco to Southwest Asia. It has recently been observed in Spain (Ramos *et al.*, 2002) and northern Algeria (Messai *et al.*, 2011), showing signs of northward expansion, including in Morocco, where it has now exceeded its historical limits (Gaud, 1947). These observations suggest adaptation to environmental changes. Its presence in our area represents the first record for the study area.

Culex hortensis, often confused with *Cx. deserticola* in the past (Callot, 1942; Senevet, 1947), was formally identified in five localities (Fig. 2). This species is primarily found in southern Europe, North Africa, and the Atlantic islands. In Europe, it has been reported in Italy (Severini *et al.*, 2009), Spain (Aranda *et al.*, 2000; Eritja *et al.*, 2000; Bueno-Marí *et al.*, 2012; Bueno-Marí *et al.*, 2014), France (Schaffner, 1998), and Belgium (Boukraa *et al.*, 2015). In North Africa, it has been identified in Algeria (Messai *et al.*, 2011; Bouabida *et al.*, 2012), Tunisia (Moussiegt, 1983; Bouattour, 2013), and Morocco (Trari *et al.*, 2002; Trari *et al.*, 2017), where it remains widely distributed, particularly in high-altitude areas. This is the first confirmed record for our region. *Culiseta longiareolata* was recorded in nine sites (Fig. 2), demonstrating a strong capacity to colonize stagnant freshwater habitats. This species is widely distributed across the Palearctic region, India, eastern and southern Africa, as well as the Canary and Azores archipelagos. In Europe, it is present in Greece (Linton *et al.*, 2007), France (Rageau *et al.*, 1970), Spain (Aranda *et al.*, 2000; Eritja *et al.*, 2000; Bueno-Marí *et al.*, 2012; Bueno-Marí *et al.*, 2014), Italy (Severini *et al.*, 2009), the Canary Islands (Martínez-De La Puente *et al.*, 2012), Austria, Slovenia (Seidel *et al.*, 2013), and Germany (Becker & Hoffmann, 2011). Its presence has been documented in several North African countries, including Egypt (Harbach *et al.*, 1988), Mauritania (Hamon *et al.*, 1966), Libya (Vermeil, 1953; Goodwin, 1961), Tunisia (Moussiegt, 1983; Bouattour, 2013), Algeria (Messai *et al.*, 2011; Tine-Djebbar *et al.*, 2011; Bouabida *et al.*, 2012; Boudemagh *et al.*, 2013; Benhissen *et al.*, 2014; Dahchar *et al.*, 2016), and Morocco (Trari *et al.*, 2002; Trari *et al.*, 2017).

Conclusion

Due to the high competence of certain species in transmitting pathogens to humans and animals, mosquitoes represent the most significant group of vectors in public health. Therefore, characterizing the culicid fauna and its geographical distribution is essential for assessing potential transmission risks and anticipating epidemic outbreaks. Our inventory identified 13 species of mosquito in the eastern Rif region, divided into four genera: *Culex*, *Aedes*, *Culiseta*, and *Uranotaenia*. Five of these species are recognized as potential vectors of arboviruses: *Aedes caspius*, *Aedes detritus*, *Culex pipiens*, *Culex theileri*, and *Culex perexiguus*. Notably, *Aedes detritus*, a major arbovirus vector in Morocco, has been reported for the first time. In addition, seven species are new records for the study area: *Aedes detritus*, *Aedes pulcritarsis*, *Culex brumpti*, *Culex deserticola*, *Culex hortensis*, *Culiseta longiareolata*,

and *Uranotaenia unguiculata*. Accurate mapping of species presence and ecological distribution is essential for estimating the true Culicinae diversity and accurately assessing vector risk. This fundamental knowledge is a prerequisite for designing and implementing targeted and effective control strategies. The rapid detection of changes in local biodiversity provides health authorities with crucial information, enabling them to respond proactively and mitigate the impact of vector populations on public health

Author's Contributions

Samya Jdiaa Conceptualizing, writing and review; **Hanan Hazyoun**: writing and review; **Moulay Anass Louah**: Supervision, Writing - Review and Editing, Project administration, Resources; **Oumnia Himmi**: Supervision, Conceptualization, Writing - Review and Editing.

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Data Availability Statement

All data generated or analyzed during this study, including detailed methodology, are available from the corresponding author upon reasonable request.

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Ethics Approval and Consent to Participate

Insects were used in this study. All applicable international, national, and institutional guidelines for the care and use of animals were followed. This article does not contain any studies with human participants performed by the authors.

Consent for Publication

Non applicable

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

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Research Article

چک لیست به روز شده از پشه های (Dip., Culicidae) در شمال شرقی مراکش، با داده های جدید پراکنش

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چکیده: چندین گونه پشه از زیرخانواده Culicinae به عنوان ناقل آربوویروس ها (ویروس های بندپازاد)، نقش مهمی در سلامت عمومی دارند. از بیش از ۳۰۰۰ گونه Culicinae ثبت شده در سراسر جهان، ۴۳ گونه در مراکش وجود دارند. از این تعداد، ۱۴ گونه به عنوان ناقلان بالقوه ویروس هایی مانند ویروس نیل غربی (WNV)، زیکا (ZIKV)، تب زرد (YFV) و چیکونگونیا (CHIKV) شناخته می شوند. هدف از این مطالعه، به روزرسانی پراکنش گونه های پشه در شمال شرقی مراکش است. بررسی های لاروی انجام شده در ۲۰ مکان منجر به جمع آوری و شناسایی ۱۳ گونه متعلق به چهار جنس شد. *Culex* با هشت گونه و وسیع ترین پراکندگی، جنس غالب بود. پس از آن *Aedes* با سه گونه قرار داشت. جنس های *Uranotaenia* و *Culiseta* هر کدام با یک گونه نشان داده شدند. پنج گونه از این گونه ها ناقلان بالقوه آربوویروس هستند و هفت گونه رکوردهای جدید برای منطقه مورد مطالعه هستند. این فهرست به روز شده از گونه های کولیسید، شامل گزارش ها و داده های جدید در مورد توزیع اکولوژیکی، درک ما از ترکیب جامعه کولیسینه در شمال شرقی مراکش را تا حد زیادی افزایش می دهد. این نتایج مبنای حیاتی برای ارزیابی خطرات آربوویروسی و اجرای استراتژی های کنترل ناقل هدفمند فراهم می کند و در نتیجه به بهبود اقدامات بهداشت عمومی در منطقه کمک می کند.

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