



New records of *Megaselia* Rondani (Diptera: Phoridae) from Morocco with notes on distribution and habitats

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ABSTRACT. *Megaselia* Rondani, 1856 is a megadiverse genus of scuttle flies, commonly found worldwide. This article reports on the recent discovery of 31 species of *Megaselia* newly recorded in Morocco, collected in various regions, including the Rif Mountain, the Atlantic Plain and the Atlas Mountains, covering numerous habitats, such as forests, grasslands, agricultural fields, riverbanks, springs, ponds, peat bogs, and lake with the purpose of assessing a wide variety of habitats and understanding the ecological preferences of *Megaselia* species. These new findings have increased the total of Moroccan phorid fauna to 45 species so far. Of these, 43 are *Megaselia* species.

Keywords: ecology, fauna, megadiverse, North Africa, scuttle flies

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INTRODUCTION

The family Phoridae (scuttle flies) are characterised by their enormous morphological and ecological diversity, inhabiting a wide range of environments, both indoors and outdoors. These flies are found in aquatic habitats, caves, crops, meadows, pastures, moors, forests and woodlands (Disney, 1994). Due to their wide variety of species, Phoridae differ greatly in their larval and adult feeding habits, as they can act as predators, parasites, parasitoids, phytophagous, decomposers, pollinators, fungivores and even omnivores (Disney, 1994; Bonet et al., 2011). These diverse feeding habits of Phoridae make ecosystems dynamic because they support their functioning and thus provide various ecological services. Brown et al. (2015) have classified the family Phoridae into five subfamilies (Sciadocerinae, Chonocephalinae, Termitoxeniinae, Metopininae and Phorinae), but Disney (2021) proposed a tentative classification of four subfamilies (Sciadocerinae, Chonocephalinae, Metopininae and Phorinae). Within the Metopininae, *Megaselia* Rondani, 1856 is considered the largest genus in the whole family, with around 1700 of the approximately 4450 species described within scuttle flies (Brown, 2024). *Megaselia* are very active flies with rapid, jerky movements that are more likely to move by walking than by flying (Miller, 1979; Harrison & Cooper, 2003).

The Moroccan phorid fauna has received little attention as only a single species of genus *Megaselia* (*M. minor* (Zetterstedt, 1848)) and two species of genus *Diplonevra* (*D. crassicornis* (Meigen, 1830) and *D. tangeriana* (Becker, 1913)) were recorded in the country, leading to the inclusion of only three species

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for this speciose family in the catalogue of the Diptera of Morocco (Kettani et al., 2022). Recently, eleven new species of *Megaselia* (*M. albicaudata* Wood, 1910; *M. berndseni* Schmitz, 1919; *M. clemonsi* Disney, 1984; *M. halterata* Wood, 1910; *M. hibernans* Schmitz, 1934; *M. involuta* Wood, 1910; *M. lata* Wood, 1910; *M. nigra* Meigen, 1830; *M. rufipes* Meigen, 1804; *M. scalaris* Loew, 1866; *M. sylvatica* Wood, 1910) were added by Sliman et al. (2024). Given that more species are expected to be discovered in a country known for its high biodiversity in terms of species, habitats and landscapes (García et al., 2010), entomological surveys have been carried out to study this understudied family of Diptera with the aim to fill the gaps in our knowledge of this megadiverse genus by providing new records for an updated checklist of Moroccan *Megaselia*.

MATERIAL AND METHODS

This study is based on the examination of 747 specimens of Phoridae collected during entomological field surveys carried out between 2009 and 2023 in various terrestrial and wetlands habitats mainly in the Rif Mountains in the north of Morocco and to a lesser extent in the Atlas Mountains. A total of 53 sites were studied (Fig. 1), including forests, maquis, lowlands, riparian strips, marshes, springs, and lakes with altitudes ranging from 10 to 2760 m above the sea level. Specimens were collected using entomological sweep nets (SN) and Malaise traps (MT), transferred thereafter to bottles using aspirators and preserved in 70% alcohol. Dissection of the genitalia (according to Disney, 2001) was initiated under a stereomicroscope by carefully detaching it from different parts of the insect's body. Once the dissection was complete, the genitalia were transferred to a new drop of Berlese's liquid and subsequently covered with a coverslip. The photographs from the adult specimens (in alcohol) were captured using a 1/2.5-inch CMOS sensor (5.1 megapixels) integrated into the KERN® stereomicroscope (OBE 114). Additionally, photographs from the habitats were taken using a Canon® 1000D digital camera in field conditions. Material cited in this work is deposited at the Laboratory of Ecology, Systematics and Conservation of Biodiversity (Abdelmalek Essaadi University, Morocco) and in the private collection of Esben Bøggild (Hobro, Denmark). The identification of the examined material was mainly based on Schmitz et al. (1938–1981), Schmitz & Beyer (1965), Schmitz & Delage (1974, 1981), Disney (1989), Disney & Durska (1998) and Disney & Prescher (2015). For each species, information is given on the material examined, its distribution worldwide and some notes on its ecology by characterising the main features of the habitat surveyed.

Geographical abbreviations. NPHAO – National Park of Haut Atlas Oriental; NPIF – National Park of Ifrane; NPKH – National Park of Khénifra; NPTB – National Park of Toubkal; NPTS – National Park of Talassemtane; NPTZ – National Park of Tazekka; PNPB – Project of Natural Park of Bouhachem; SBEI – Site of Biological and Ecological Interest.

RESULTS

Our surveys in various biogeographical regions of Morocco have led to the discovery of many previously unknown *Megaselia* species in the country. Overall 31 species are recorded from Morocco for the first time, and so the total number of *Megaselia* species has risen to 43.

Taxonomic hierarchy

Class Insecta Linnaeus, 1785

Order Diptera Linnaeus, 1758

Family Phoridae Curtis, 1833

Genus *Megaselia* Rondani, 1856

Type species. *Megaselia crassineura* Rondani, 1856 (= *Phora costalis* Roser, 1840)

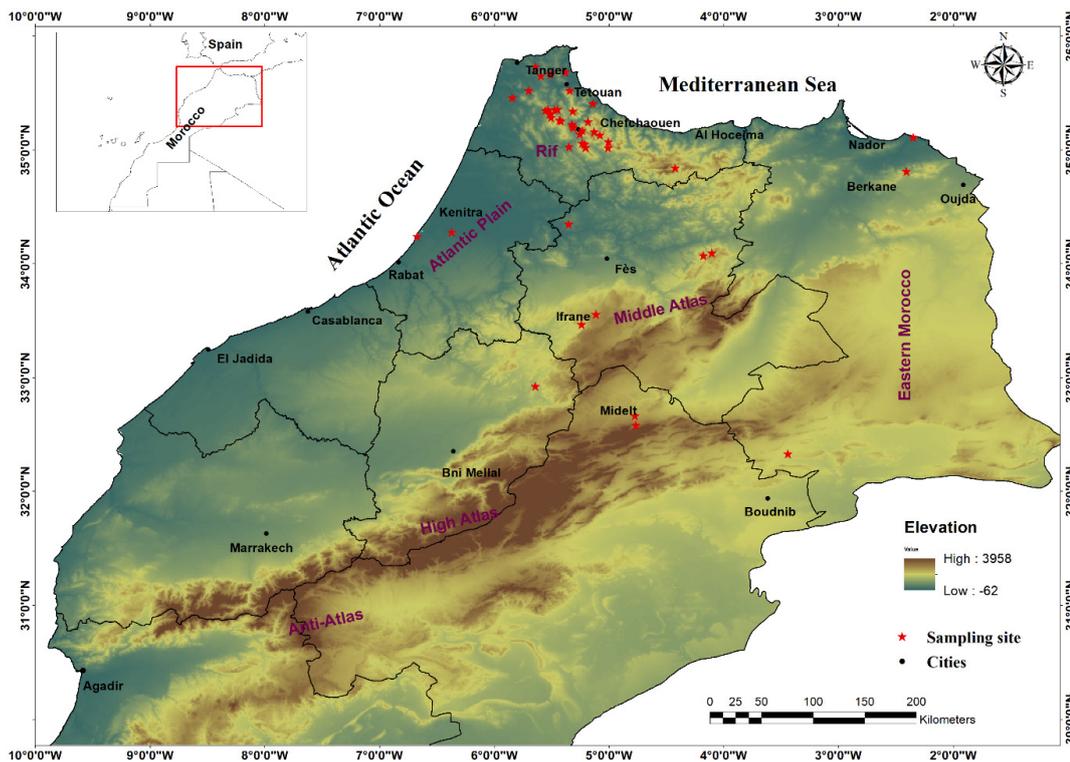


Figure 1. Location of sampling sites in the northern part of Morocco.

***Megaselia affinis* (Wood, 1909)**

Material examined. 2♂♂, Rif, Fahs-Anjra, El Mkhalel, Rmel, 35°38'57.4"N 05°35'41.4"W, 372 m, 16.v.2022, SN, leg.: F.Z. Sliman.

Distribution. Europe (Langourov, 2021). Morocco (**New record**).

Habitat. This species was collected in a maquis with rocky soil of a clay-calcareous nature crossed by a small stream and bordered by vegetation mainly composed of *Carlina racemosa*, *Cistus monspeliensis*, *Conyza canadensis*, *Erica arborea* and *Pistacia lentiscus* (Fig. 4B).

***Megaselia altifrons* (Wood, 1909) (Fig. 2A)**

Material examined. 1♂, Rif, Larache, Tazia, Dayat Tazia (PNPB), 35°20'52"N 05°33'12"W, 733 m, 21.v.-6.vi.2016, MT, leg.: K. Kettani.

Distribution. Europe, Asia (Iran) (Langourov, 2010). Morocco (**New record**).

Habitat. This species was captured around a pond (Dayat Tazia) lined by *Quercus suber*, at 733 m of altitude within a cork oak forest (Fig. 4C).

***Megaselia basispinata* (Lundbeck, 1920) (Fig. 2B)**

Material examined. 2♂♂, Rif, Larache, Tazia, Dayat Tazia (PNPB), 35°20'52"N 05°33'12"W, 733 m, 21.v.-6.vi.2016, MT, leg.: K. Kettani; 1♂, Atlantic Plain, Rabat, Kénitra, Forest Maâmora (SBEI), 34°16'37.99"N 06°22'12"W, 82 m, 5.iii.2017, SN, leg.: Y. Fekrani; 1♂, Rif, Larache, Taida, Oued Tisgriss, 35°21'12"N 05°31'57"W, 501 m, 20.iv.2021, SN, leg.: L. Zouhair.

Distribution. Holarctic and Neotropical regions (Schmitz, 1940, 1941; Langourov, 2004). Morocco (**New record**).

Habitat. In Morocco, this species seems to prefer cork oak stands, where it was found around a pond (Dayat Tazia) lined by *Quercus suber*, in the forest of Maâmora dominated by the cork oak, and on the riverbank of Oued Tisgriss also lined by *Quercus suber* (Figs 4C, 4D).

***Megaselia brevicostalis* (Wood, 1910) (Fig. 2C)**

Material examined. 1♂, Rif, Chefchaouen, Zawya, Merja Souk, 35°04'09"N 05°00'24"W, 1076 m, 16.iv.2021, SN, leg.: M. Nourti; 1♂, Rif, Chefchaouen, Jbel Tissouka, Amrah (NPTS), 35°8'19.719"N 05°15'11.588"W, 805 m, 15.v.2021, leg.: F.Z. Sliman.

Distribution. Holarctic and Neotropical regions (Schmitz, 1940, 1941; Langourov, 2010). Morocco (**New record**).

Habitat. This species was found around wetlands such as swamps and peat bogs surrounded by pine forest (*Pinus halepensis*) at middle to high altitudes (Fig. 4E).

***Megaselia brevior* (Schmitz, 1924) (Fig. 2D)**

Material examined. 4♂♂, Rif, Al Hoceima, Beni Bounsar, 34°50'30.944"N 04°25'23.638"W, 1340 m, 1–30.vi.2022, MT, leg.: K. Kettani; 2♂♂, Middle Atlas, Khénifra, Jbel Bouhayati, 32°55'19.2"N 05°38'37.0"W, 820 m, 6.v.2023, SN, leg.: H. Oubrahimi.

Distribution. Europe, Azores, Asia (Iran) (Langourov et al., 2014). Morocco (**New record**).

Habitat. This species was collected in a mixed forest dominated by fruit trees and some shrub species such as *Juniperus communis* and *Pistacia lentiscus* at Beni Bounsar in the Rif and in an agricultural field along the Oum er Rbia River in the Middle Atlas (Fig. 4F).

***Megaselia diversa* (Wood, 1909) (Fig. 2E)**

Material examined. 1♂, Rif, Chefchaouen, Jbel Talassemtane (NPTS), 35°7'50.163"N 05°4'50.49"W, 1554 m, 13.iv.2009, SN, leg.: A. Taheri; 1♂, Rif, Larache, Tazia, Dayat Tazia (PNPB), 35°20'52"N 05°33'12"W, 733 m, 21.v.–6.vi.2016, MT, leg.: K. Kettani; 1♂, Rif, Chefchaouen, El Khizana, Oued Ouara (NPTS), 35°03'10.4"N 5°14'00.8"W, 883 m, 10.iii.2020, SN, leg.: L. Zouhair; 1♂, Rif, Chefchaouen, Fifi, Oued Bouztate, 35°01'35.25"N 05°20'55.93"W, 1265 m, 6.v.2021, SN, leg.: K. Kettani; 1♂, Rif, Chefchaouen, Talassemtane, Bni M'hamed (NPTS), 35°09'32.1"N 05°07'46.9"W, 1330 m, 10.vi.2021, SN, leg.: L. Zouhair; 5♂♂, Rif, Al Hoceima, Targuist, Beni Bounsar, 34°50'30.944"N 04°25'23.638"W, 1340 m, 1–30.iv.2022, MT, leg.: K. Kettani (Figs 4C, 4F, 4G, 4H).

Distribution. Holarctic (Langourov, 2021). Morocco (**New record**).

Habitat. This species is widespread in the Rif where it inhabits a wide variety of ecosystems at altitudes ranging from 733 to 1554 m. Habitats include mixed forests dominated by fir and oak stands and the edge of wetlands such as peat bogs and rivers. The analysis of the periods in which this species was captured suggests that their flight occurred from March to July.

***Megaselia elongata* (Wood, 1914) (Fig. 2F)**

Material examined. 2♂♂, Rif, Larache, Jbel Bouhachem, Amghart (PNPB), 35°21'53.0"N 5°28'09.0"W, 424 m, 29.iv.–22.v.2019, MT, leg.: K. Kettani.

Distribution. Europe, Asia (Israel) (Langourov, 2021). Morocco (**New record**).

Habitat. This species was only found in a matorral scattered with a few cork oak trees at an altitude of 429 m (Fig. 4I).

***Megaselia flavicans* Schmitz, 1935 (Fig. 2G)**

Material examined. 1♂, Rif, Tétouan, Yarghit, Oued Zarka, 35°31'14.6"N 5°20'30.0"W, 220 m, 27.iv.2009, SN, leg.: K. Kettani.

Distribution. Europe, Asia (Türkiye) (Langourov & Sakalian, 2001; Langourov, 2021). Morocco (**New record**).

Habitat. This species was found on the edge of a small waterfall lined by the oleander, *Nerium oleander* at 220 m of altitude (Fig. 4J).

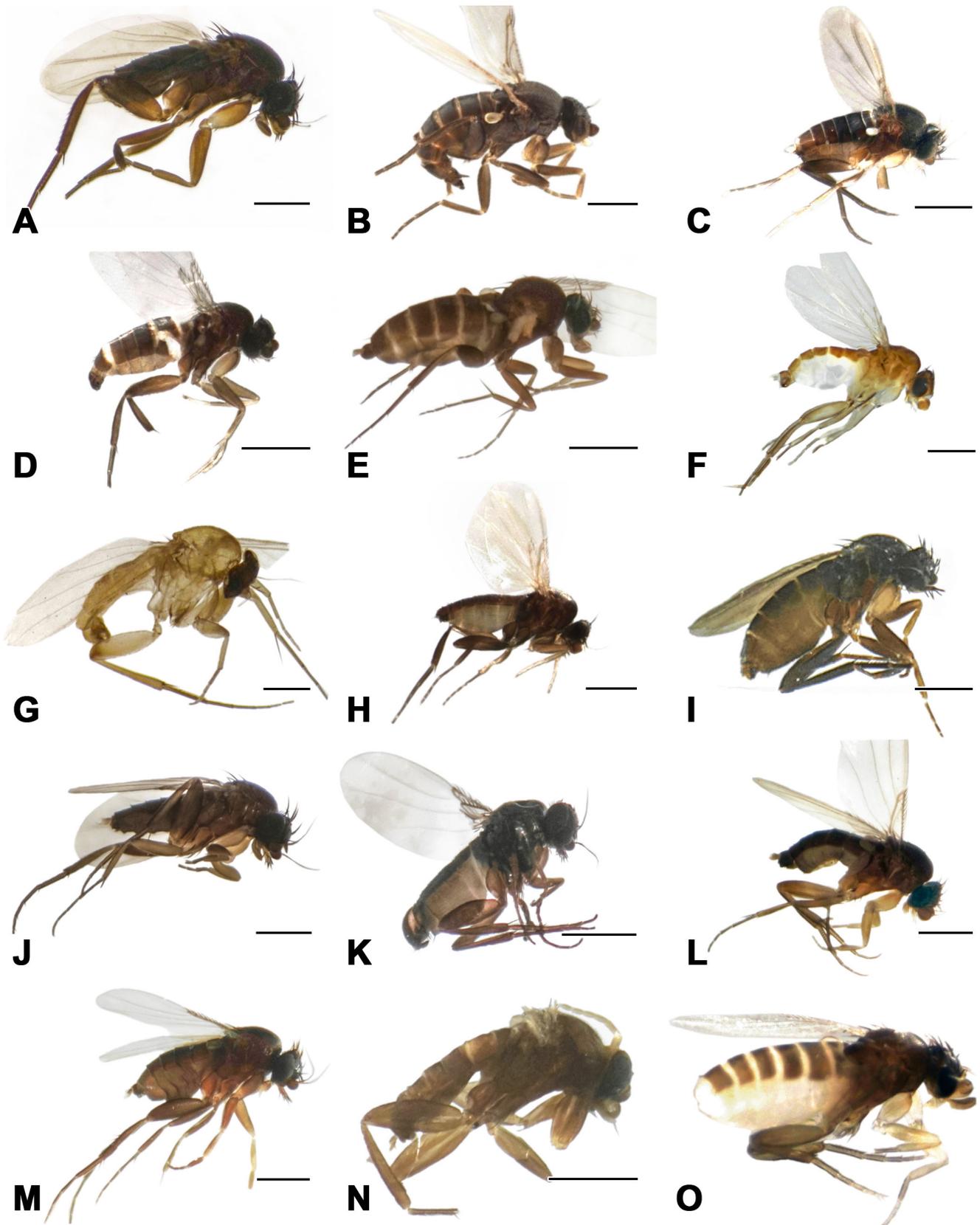


Figure 2. Species of *Megaselia* from Morocco. **A.** *M. altifrons* (Wood, 1909); **B.** *M. basispinata* (Lundbeck, 1920); **C.** *M. brevicostalis* (Wood, 1910); **D.** *M. brevior* (Schmitz, 1924); **E.** *M. diversa* (Wood, 1909); **F.** *M. elongata* (Wood, 1914); **G.** *M. flavicans* Schmitz, 1935; **H.** *M. giraudii* (Egger, 1862); **I.** *M. glabrifrons* (Wood, 1909); **J.** *M. hilaris* Schmitz, 1927; **K.** *M. latifrons* (Wood, 1910); **L.** *M. ledburiensis* (Brues, 1915); **M.** *M. limpachensis* Disney & Prescher, 2015; **N.** *M. manicata* (Wood, 1910); **O.** *M. marekdurskii* Disney, 1998. (Scale bars = 0.5 mm).

***Megaselia giraudii* (Egger, 1862) (Fig. 2H)**

Material examined. 1♂, Eastern Morocco, Berkane, Cherarba, Oued Moulouya (SBEI), 35°06'31.7"N 02°20'51.1"W, 10 m, 22.xii.2018, SN, leg.: N.H. El Ouazzani; 2♂♂, Rif, Khemis Anjra, Oued Khemis, 35°39'58.0"N 05°30'21.1"W, 63 m, 27.iii.2021, SN, leg.: L. Zouhair; 1♂ Atlantic Plain, Kénitra, Réserve Sidi Boughaba (SBEI), 34°15'09.4572"N 06°40'05.527"W, 18 m, 15.vi.2021, SN, leg.: F.Z. Sliman; 1♂, Middle Atlas, Taza, Tazekka, Jbel Bouhayati (NPIF), 34°5'33"N 04°6'13"W, 1471 m, 14.iii.2023, SN, leg.: F.Z. Sliman.

Distribution. Holarctic (Namaki Khameneh et al., 2019; Langourov, 2021). Morocco (**New record**).

Habitat. This species has a wide distribution across different biogeographical zones in Morocco, where it inhabits a wide variety of ecosystems over a broad altitudinal range (10 to 1471 m). Habitats include downstream river banks, lakes and mixed forest at high altitudes dominated by cedar trees (Fig. 4K).

***Megaselia glabrifrons* (Wood, 1909) (Fig. 2I)**

Material examined. 1♂, Rif, Chefchaouen, Talassemtane, Maison forestière (NPTS), 35°21'23"N 05°26'55"W, 1696 m, 10.vi.2021, SN, leg.: K. Menouar.

Distribution. Europe, North America (Langourov, 2021). Morocco (**New record**).

Habitat. This species was found in the fir forest (*Abies pinsapo* subsp. *maroccana*) of the Talassemtane mountain at 1696 m of altitude (Fig. 4H).

***Megaselia hilaris* Schmitz, 1927 (Fig. 2J)**

Material examined. 1♂, Rif, Jbel Bouhachem, Beni Arouss, Riba (PNPB), 35°13'32.30"N 05°19'24.35"W, 1421 m, 29.iv.–22.v.2019, MT, leg.: K. Kettani.

Distribution. Europe (Colyer, 1969), Morocco (**New record**).

Habitat. This species was captured in a mixed forest with diverse tree stands, such as *Pinus pinaster* ssp. *maghrebiana*, *Quercus faginea* and *Quercus suber*, as well as shrubs such as *Pistacia lentiscus* (Fig. 4L).

***Megaselia latifrons* (Wood, 1910) (Fig. 2K)**

Material examined. 1♂, Rif, Larache, Tazia, Dayat Tazia (PNPB), 35°20'52"N 05°33'12"W, 733 m, 21.v.–6.vi.2016, MT, leg.: K. Kettani; 1♂, Rif, Chefchaouen, Aïn Kchour, Marabout My Abdeslam (PNPB), 35°18'59.3"N 5°31'16.1"W, 1140 m, 26.vi.2017, SN, leg.: K. Kettani; 1♂, High Atlas, Midelt, Aït Hdiddou, Imilchil, Lac Tislit (NPHAO), 32°19'44.33"N 03°26'25.55"W, 2254 m, 29.vi.2017, SN, leg.: Y. Fekrani; 1♂, Eastern Morocco, Berkane, Beni Snassen, Tafoughalt (SBEI), 34°48'40.068"N 02°24'30.477"W, 786 m, 12.iv.–22.vi.2021, MT, leg.: H. Maamri & O. Ziane; 3♂♂, Rif, Tétouan, Aïn Lahcen, 35°33'16.2"N 5°33'02.7"W, 313 m, 10.iv.2021, SN, leg.: L. Zouhair; 1♂, Rif, Larache, Taida, Oued Tisgriss (PNPB), 35°21'12"N 05°31'57"W, 501 m, 20.iv.2021, SN, leg.: L. Zouhair; 1♂, High Atlas, Midelt, Titaouine (NPHAO), 32°34'54.244"N 04°46'1.458"W, 1732 m, 24.v.2021, SN, leg.: K. Menouar; 1♂, Rif, Chefchaouen, Fifi, Oued Bouzate, 35°01'35.25"N 05°20'55.93"W, 1265 m, 6.v.2021, SN, leg.: K. Kettani.

Distribution. Europe, Asia (Israel) (Langourov, 2010, 2021), Morocco (**New record**).

Habitat. This species is spread over the main biogeographical regions in Morocco, including the Rif, Eastern Morocco, Middle Atlas and the High Atlas, inhabiting a variety of terrestrial and wetland environments such as forests, lakes, riverbanks, and near springs but all share a common cork oak-dominated vegetation cover (Figs 4C, 4M).

***Megaselia ledburiensis* (Brues, 1915) (Fig. 2L)**

Material examined. 1♂, Rif, Larache, Tazrout, Adrou (PNPB), 35°13'32.30"N 05°19'24.35"W, 580 m, 29.iv.2019, SN, leg.: K. Kettani.

Distribution. Europe, Canary Islands, Asia (Israel, Iran) (Langourov, 2010, 2021). Morocco (**New record**).

Habitat. This species was captured in a mixed forest including *Pinus pinaster*, *Quercus ilex*, and *Quercus suber*, with an undergrowth scattered with *Cistus* spp. and *Pistacia lentiscus* (Fig. 4N).

***Megaselia limpachensis* Disney & Prescher, 2015 (Fig. 2M)**

Material examined. 1♂, Rif, Ouezzane, Ain Beida, Souk El Had, Oued Loukous, 35°01'21.0"N 05°25'14.0"W, 140 m, 11.iv.2021, SN, leg.: L. Zouhair.

Distribution. British Isles, Switzerland. (Welch et al., 2024). Morocco (**New record**).

Habitat. This species was captured on a riverbank with diversified riparian vegetation, dominated by *Juncus*, *Scirpus*, *Phragmites*, *Typha* and trees such as *Salix cinerea* and *Salix purpurea* (Fig. 4C).

***Megaselia manicata* (Wood, 1910) (Fig. 2N)**

Material examined. 3♂♂, Rif, Larache, Tazia, Dayat Tazia (PNPB), 35°20'52"N 05°33'12"W, 733 m, 21.v.–6.vi.2016, MT, leg.: K. Kettani; 1♂, Rif, Beni Leit, Lemtahane, Dar Abdeslam (PNPB), 35°16'14.3"N 5°26'07.5"W, 966 m, 7.vi.–30.v.2017, MT, leg.: K. Kettani.

Distribution. Europe, Canary Islands (Coe, 1956; Langourov, 2021). Morocco (**New record**).

Habitat. This species was collected on the edge of a marsh surrounded by a pine stand and also around a pond surrounded by a cork oak stand (Figs 4C, 4O).

***Megaselia marekdurskii* Disney, 1998 (Fig. 2O)**

Material examined. 1♂, Rif, Fahs-Anjra, Melloussa, Forêt Tafoughalt, 35°43'45.0"N 05°38'26.0"W, 243 m, 1.x.2019, SN, leg.: M. Doukali.

Distribution. Europe (France, Poland) (Disney & Siffointe, 2014). Morocco (**New record**).

Habitat. This species was found at a low altitude (243 m) in a forest dominated by *Pinus pinaster* (Fig. 5A).

***Megaselia meconicera* (Speiser, 1925) (Fig. 3A)**

Material examined. 1♂, Rif, Chefchaouen, Talassemrane, Azilane (NPTS), 35°10'35.2"N 5°12'05.2"W, 1250 m, 4–10.vii.2013, MT, leg.: K. Kettani.

Distribution. Holarctic (Namaki Khameneh et al., 2019). Morocco (**New record**).

Habitat. This species was only found in the National Park of Talassemrane in the Rif in a mixed forest dominated by fir and cedar stands at an altitude of 1250 m (Fig. 4A).

***Megaselia melanocephala* (von Roser, 1840) (Fig. 3B)**

Material examined. 1♂, Rif, Al Hoceima, Targuist, Beni Bounsar, 34°50'30.944"N 04°25'23.638"W, 1340 m, 1–30.iv.2022, MT, leg.: K. Kettani.

Distribution. Europe, North Africa (Tunisia), Asia (Israel) (Schmitz, 1940, 1941; Langourov, 2021). Morocco (**New record**).

Habitat. This species was collected in the same habitat as *Megaselia brevior*. Even though the Malaise trap was set up on this site for six consecutive months from April to October 2022, the flight of this species was only reported during the month of June in our samples (Fig. 4F).

***Megaselia parvula* Schmitz 1930 (Fig. 3C)**

Material examined. 1♂, Rif, M'diq, Barrage Smir (Ramsar site), 35°41'6.486"N 05°22'50.883"W, 27 m, 18.vi.–27.vii.2016, MT, leg.: K. Kettani; 1♂, High Atlas, Midelt, Bouzmella (NPHAO), 32°39'53.0"N 04°46'33.9"W, 1440 m, 24.v.2021, SN, leg.: K. Menouar.

Distribution. Russia (Daghestan), United Arab Emirates (Disney, 2006). Morocco (**New record**).

Habitat. In Morocco this species seems to prefer wetlands, where it was captured at the edge of a dam as well as in a meadow (Fig. 5A).

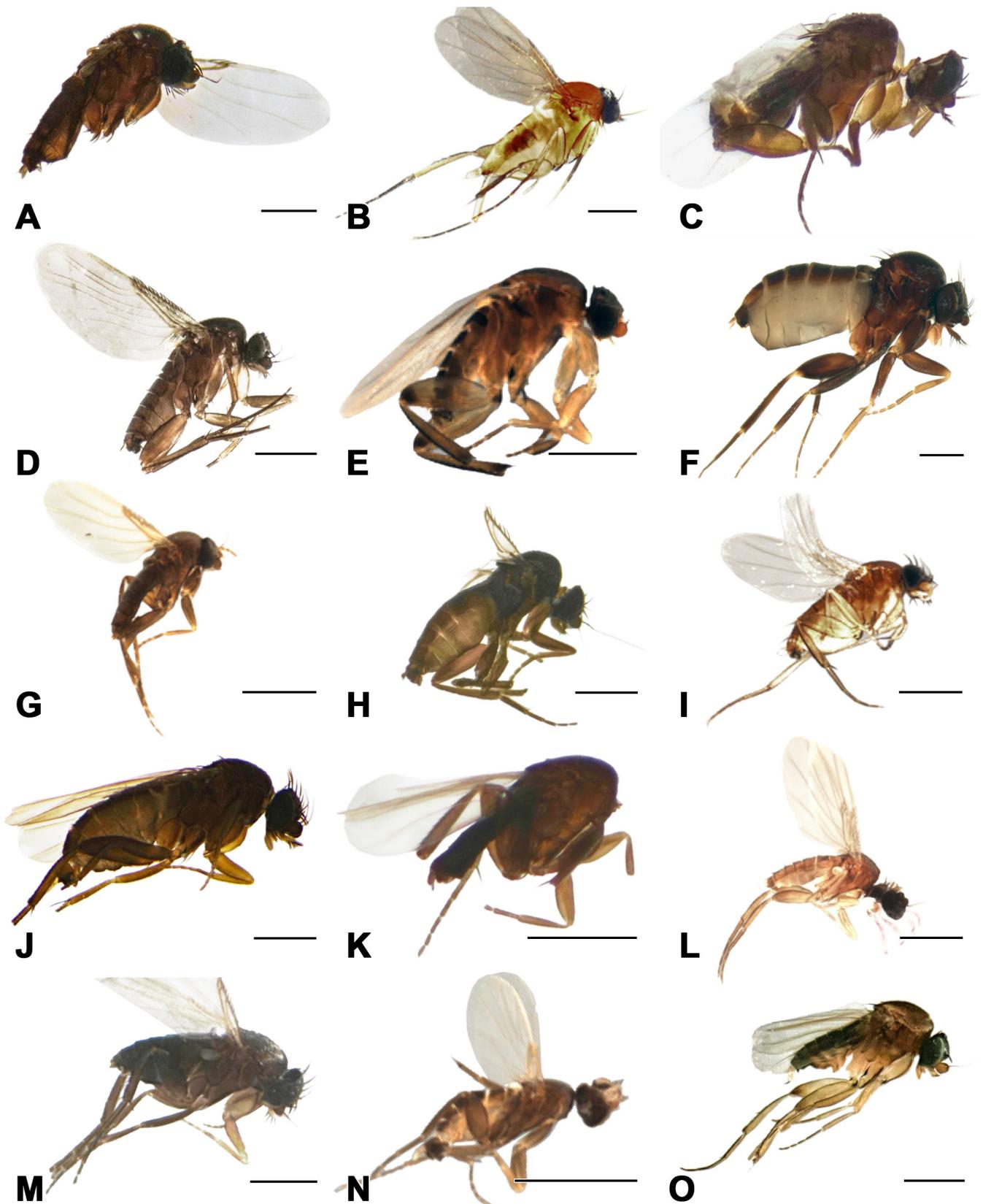


Figure 3. Species of *Megaselia* from Morocco. **A.** *M. meconicera* (Speiser, 1925); **B.** *M. melanocephala* (von Roser, 1840); **C.** *M. parvula* Schmitz 1930; **D.** *M. pleuralis* (Wood, 1909); **E.** *M. plurispinulosa* (Zetterstedt, 1860); **F.** *M. posticata* (Strobl, 1898); **G.** *M. pumila* (Meigen, 1830); **H.** *M. pusilla* (Meigen, 1830); **I.** *M. spinicineta* (Wood, 1910); **J.** *M. stichata* (Lundbeck, 1920); **K.** *M. subnudipennis* (Schmitz, 1919); **L.** *M. subpleuralis* (Wood, 1909); **M.** *M. trichorrhoea* Schmitz, 1921; **N.** *M. verralli* (Wood, 1910); **O.** *M. xanthozona* (Strobl, 1892) (Scale bars = 0.5 mm).

***Megaselia pleuralis* (Wood, 1909) (Fig. 3D)**

Material examined. 1♂, Eastern Morocco, Berkane, Beni Snassen, Tafoughalt (SBEI), 34°48'40.068"N 02°24'30.477"W, 786 m, 12.iv.–22.vi.2021, MT, leg.: H. Maamri & O. Ziane; 1♂, Rif, Al Hoceima, Targuist, Beni Bounsar, 34°50'30.944"N 04°25'23.638"W, 1340 m, 1.iv.–30.iv.2022, MT, leg.: K. Kettani.

Distribution. Sub-cosmopolitan (Namaki Khameneh et al., 2019; Langourov, 2021). Morocco (**New record**).

Habitat. This species was collected in mixed oak forests during the spring at middle altitudes (Figs 4F, 4M).

***Megaselia plurispinulosa* (Zetterstedt, 1860) (Fig. 3E)**

Material examined. 1♂, Rif, Chefchaouen, Jbel Talassemthane (NPTS), 35°7'50.163"N 05°4'50.49"W, 1554 m, 13.iv.2009, SN, leg.: A. Taheri; 1♂, Rif, Tétouan, Jbel Bouhachem, Amsemlil, Oued Amsemlil (PNPB), 35°15'36.84"N 05°25'56.58"W, 1059 m, 22.v.2010, SN, leg.: K. Kettani; 2♂♂, Rif, Beni Leit, Lemtahane, Dar Abdesalam (PNPB), 35°16'15.3"N 5°26'05.3"W, 966 m, 7–30.v.2017, MT, leg.: K. Kettani; 1♂, Rif, Chefchaouen, Akchour, Chellal Sghir (NPTS), 35°14'20.9"N 5°10'41.3"W, 450 m, 7.vi.–14.vii.2017, MT, leg.: K. Kettani; 1♂, Rif, Larache, Jbel Bouhachem, Amghart (PNPB), 35°21'53.0"N 5°28'09.0"W, 424 m, 29.iv.–22.v.2019, MT, leg.: K. Kettani; 2♂♂, Rif, Fahs-Anjra, Khemis Anjra, Oued Khemis, 35°39'58.0"N 05°30'21.1"W, 63 m, 27.iii.2021, SN, leg.: K. Kettani; 1♂, Rif, Larache, Taida, Oued Taida (PNPB), 35°12'40.32"N 05°18'56.519"W, 590 m, 20.iv.2021, SN, leg.: K. Menouar & L. Zouhair; 3♂♂, Rif, Al Hoceima, Targuist, Beni Bounsar, 34°50'30.944"N 04°25'23.638"W, 1340 m, 1–30.iv.2022, MT, leg.: K. Kettani; 1♂, Rif, Tétouan, Aouchtame, 35°24'24.77"N 05°8'22.51"W, 17 m, 16.v.2023, SN, leg.: K. Kettani; 1♀, Middle Atlas, Ifrane, Ain Vittel (NPIF), 33°33'17.339"N 05°6'47.091"W, 1569 m, 13.x.2023, SN, leg.: F.Z. Sliman.

Distribution. Europe, Canary Islands, Asia (China, Iran, Türkiye) (Schmitz, 1940, 1941; Namaki Khameneh et al., 2019). Morocco (**New record**).

Habitat. This species was captured in numerous localities across Morocco from a wide variety of terrestrial habitats (forests, maquis, grassland) and wetlands (riparian banks, coastal shoreline, near a waterfall, peat bog) over a wide range of altitudes (17–1569 m) (Figs 4F, 4H, 4I, 4O, 5C).

***Megaselia posticata* (Strobl, 1898) (Fig. 3F)**

Material examined. 1♂, Rif, Al Hoceima, Targuist, Beni Bounsar, 34°50'30.944"N 04°25'23.638"W, 1340 m, 1–30.iv.2022, MT, leg.: K. Kettani.

Distribution. Europe, Asia (Iran) (Langourov et al., 2014, 2021). Morocco (**New record**).

Habitat. This species was collected in the same habitat (Beni Bounsar) as *Megaselia brevior*, at high altitudes. It was only caught during April even though a Malaise trap was set over six months (from April to September) (Fig. 4F).

***Megaselia pumila* (Meigen, 1830) (Fig. 3G)**

Material examined. 1♂, Rif, Chefchaouen, Talassemthane, Azilane (NPTS), 35°10'31.8"N 5°12'09.2"W, 1250 m, 4.vii.–15.viii.2013, MT, leg.: K. Kettani; 1♂, Rif, Larache, Tazia, Dayat Tazia (PNPB), 35°20'52"N 05°33'12"W, 733 m, 21.v.–6.vi.2016, MT, leg.: K. Kettani; 1♂, Rif, Chefchaouen, Ain Kchour, Marabout My Abdeslam (PNPB), 35°18'59.4"N 5°31'29.4"W, 1140 m, 26.vi.2017, SN, leg.: K. Kettani; 1♂, Rif, Chefchaouen, Akchour, Chellal Sghir (NPTS), 35°14'20.7"N 5°10'40.8"W, 450 m, 7.vi.–14.vii.2017, MT, leg.: K. Kettani; 1♂, Rif, Jbel Bouhachem, Beni Arouss, Riba (PNPB), 35°13'32.30"N 05°19'24.35"W, 1421 m, 29.iv.–22.v.2019, SN, leg.: K. Kettani; 1♂, Rif, Larache, Jbel Bouhachem, Centre forestier de Bouhachem (PNPB), 35°09'42.0"N 5°20'11.9"W, 987 m, 29.iv.–22.v.2019, MT, leg.: K. Kettani; 1♂, Rif, Tétouan, Jbel Bouhachem, Amsemlil (PNPB), 35°15'34.6"N 5°25'56.2"W, 1067 m, 1.vii.2019, SN, leg.: K. Kettani; 4♂♂, Rif, Chefchaouen, Tissemlal, Sfehat Telj (NPTS), 35°11'10"N 05°12'41"W, 1700 m, 5.x.2019, SN, leg.: K. Kettani; 1♂, Rif, Larache, Taida, Oued Taida (PNPB), 35°12'40.32"N 05°18'56.519"W, 590 m, 20.iv.2021, SN, leg.: K. Menouar & L. Zouhair; 1♂, Rif, Jbel Kelti, Douar Adder, Oued Tanina, 35°21'17.7"N 5°16'33.6"W, 1195 m, 22.iv.2021, SN, leg.: K. Menouar & L. Zouhair; 1♂, Rif, Chefchaouen, Fifi, Dayat Fifi, 35°1'20.955"N 05°12'17.806"W, 1205 m, 6.v.2021, SN, K. Kettani; 6♂♂, Rif, Chefchaouen, Talassemthane, Maison forestière (NPTS), 35°21'23"N 05°26'55"W, 1696 m, 10.vi.2021, SN, leg.: K. Menouar.

Distribution. Europe, Asia (Israel, Russian Far East), North Africa (Tunisia) (Schmitz, 1928; Langourov, 2010, 2021). Morocco (**New record**).

Habitat. This species is widespread across the Western and Central Rif, occupying a wide variety of ecosystems at altitudes ranging from 450 to 1696 m. The occupied habitats represent mostly mixed forests dominated by fir and oak stands and also the edges of wetlands such as peat bogs and rivers. Many of the sites inhabited by this species belong to protected areas such as the Project of Natural Park of Bouhachem and the National Park of Talassemtane (Figs 4A, 4C, 4H, 4L 5C, 5D, 5I).

Megaselia pusilla (Meigen, 1830) (Fig. 3H)

Material examined. 1♂, Rif, Chefchaouen, El Khizana, Oued Ouara (NPTS), 35°02'27.2"N 5°13'54.7"W, 883 m, 10.iii.2020, SN, leg.: K. Kettani; 1♂, Rif, Fahs-Anjra, Marj Loua, 35°38'57.4"N 5°35'41.4"W, 372 m, 22.ii.2021, SN, leg.: F.Z. Sliman; 1♂, Rif, Tétouan, Aïn Lahcen, 35°32'48.5"N 5°33'32.4"W, 313 m, 10.iv.2021, SN, leg.: L. Zouhair; 1♂, Rif, Chefchaouen, Beni Zid, Ikadjouen, Oued Ouara (NPTS), 35°03'35.1"N 5°14'00.9"W, 700 m, 6.v.2021, SN, leg.: K. Kettani; 1♂, Rif, Chefchaouen, Fifi, Dayat Fifi, 35°02'21.7"N 5°12'43.1"W, 1205 m, 6.v.2021, SN, leg.: K. Kettani; 2♂♂, High Atlas, Midelt, Source Titaouine (NPHAO), 32°34'54.2"N 4°46'01.2"W, 1733 m, 24.v.2021, SN, leg.: K. Menouar; 1♂, Rif, Al Hoceima, Targuist, Beni Bounsar, 34°50'30.944"N 04°25'23.638"W, 1340 m, 1–30.iv.2022, MT, leg.: K. Kettani; 1♂, Middle Atlas, Fès-Meknès, Taza, Jbel Tazekka (NPTZ), 34°04'12.0"N 4°10'37.0"W, 1668 m, 15.iii.2023, SN, leg.: F.Z. Sliman.

Distribution. Europe, Asia (Iran, China), North America (Schmitz, 1928; Coe, 1956). Morocco (**New record**).

Habitat. This species has a wide distribution across the northern part of Morocco, mainly in the Rif, the Middle, and High Atlas, where it was captured in a wide variety of habitats, including forest environments composed of mixed oak (*Quercus canariensis*, *Quercus rotundifolia*), ranging from 372 to 1733 m in altitude, as well as cedar stands and *Juniperus thurifera* woodlands. It was also collected in wetlands, including peat bogs, mountain springs, and riverbanks, whose banks are lined with diverse shrub and herbaceous stands, including *Ampelodesma mauritanica*, *Arbutus unedo*, *Cistus monspeliensis*, *Cytisus triflorus*, *Erica arborea*, *Juncus communis*, and *Nerium oleander* (Figs 4F, 4G, 5D, 5E).

Megaselia spinicincta (Wood, 1910) (Fig. 3I)

Material examined. 1♂, Rif, Tétouan, Dar Chaoui, Bghaghza, 35°31'17.4"N 05°41'58.2"W, 105 m, 17.iv.2021, SN, leg.: K. Kettani.

Distribution. Europe, Asia (Iran) (Garcia-Romero & Barrientos, 2017). Morocco (**New record**).

Habitat. This species was found in a maquis scattered by *Quercus suber* trees at 105 m of altitude (Fig. 5F).

Megaselia stichata (Lundbeck, 1920) (Fig. 3J)

Material examined. 1♂, Eastern Morocco, Berkane, Beni Snassen, Tafoughalt (SBEI), 34°48'40.068"N 02°24'30.477"W, 786 m, 12.iv.–22.vi.2021, MT, leg.: H. Maamri & O. Ziane.

Distribution. Europe, Macaronesia, Asia (Israel, Iran) (Langourov, 2004). Morocco (**New record**).

Habitat. This species was found in the Eastern part of Morocco, captured in a dense holm oak forest at 786 m (Fig. 4M).

Megaselia subnudipennis (Schmitz, 1919) (Fig. 3K)

Material examined. 1♂, High Atlas, Toubkal, Azib Tamsoult (NPTB), 31°05'21.8"N 07°57'59.3"W, 2760 m, 2.vii.2020, SN, leg.: Y. Fekrani.

Distribution. Europe, Asia (Iran, United Arab Emirates) (Namaki Khameneh et al., 2019). Morocco (**New record**).

Habitat. This species was captured in a perhumid bioclimatic area at Jbel Toubkal in a mountain habitat overgrown with spiny xerophytes and scattered with *Juniperus thurifera* at high altitude (2760 m) (Fig. 5G).



Figure 4. Habitats of Moroccan *Megascelia*. **A.** Azilane (NPTS); **B.** El Mkhalel; **C.** Tazia (PNPB); **D.** Forest of Maâmora (SBEI); **E.** Zawya; **F.** Malaise trap set in Beni Bounsar; **G.** Oued Ouara; **H.** Talassemthane (NPTS); **I.** Amghart; **J.** Zarka River; **K.** Sidi Boughaba (SBEI); **L.** Riba (PNPB); **M.** Tafoughalt (SBEI); **N.** Adrou (PNPB); **O.** Lemtahane (PNPB). (© A., C., F-J., L., O.: K. Kettani; B., D., E., K.: F.Z. Sliman; M.: H. Maamri).

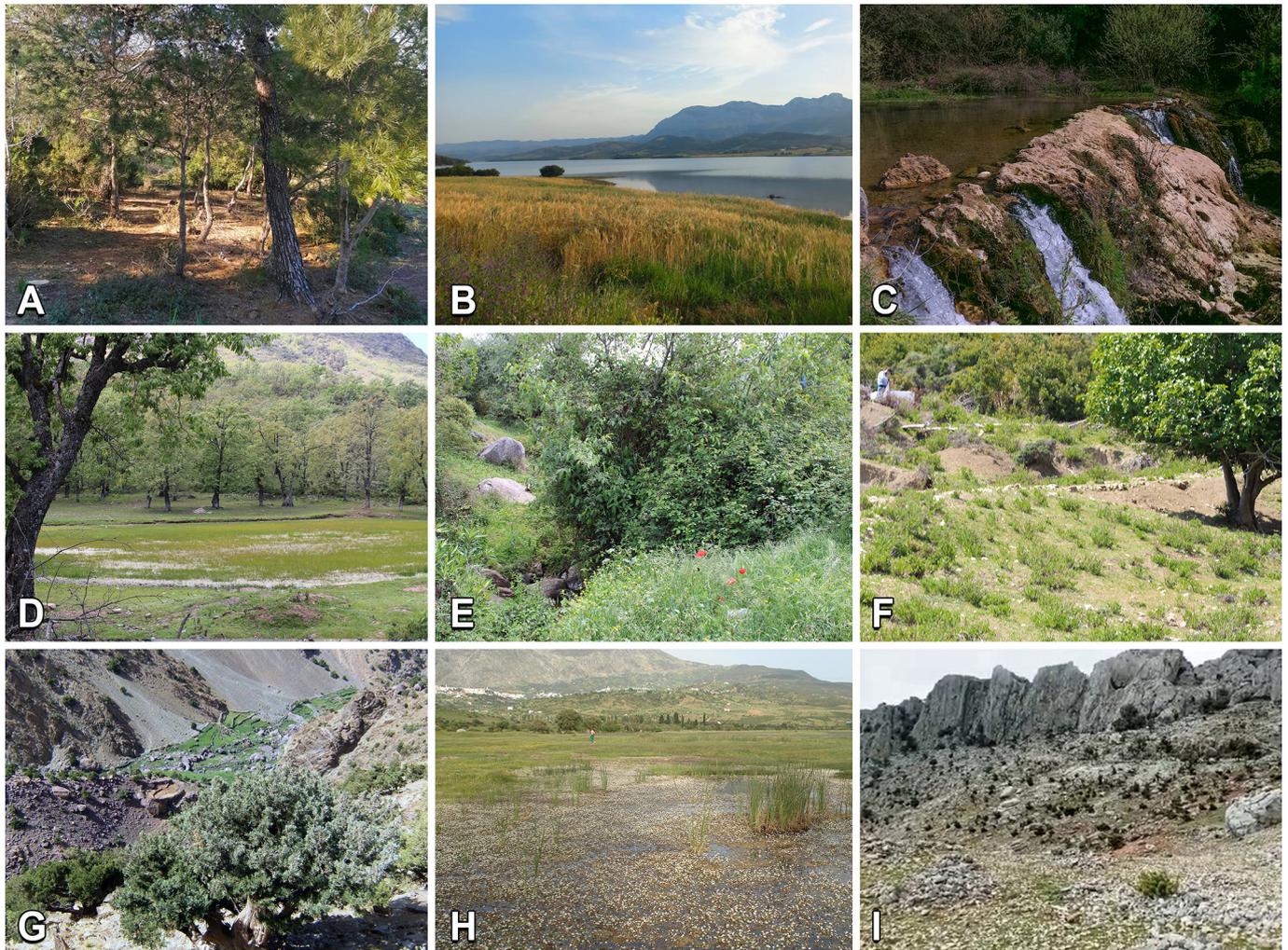


Figure 5. Habitats of Moroccan *Megaselia*. **A.** Melloussa; **B.** Barrage Smir (SBEL); **C.** Chellal Sghir Akchour (NPIS); **D.** Dayat Fifi; **E.** Ikadjouen; **F.** Dar Chaoui; **G.** Azib Tamsoult (NPTB); **H.** Marj Amlay; **I.** Jbel Kelti. (© A.: M. Doukale; B.– F., H.: K. Kettani; G.: Y. Fekrani; I.: K. Menouar).

Megaselia subpleuralis (Wood, 1909) (Fig. 3L)

Material examined. 1♂, Rif, Larache, Tazrout, Adrou (PNPB), 35°13'32.30"N 05°19'24.35"W, 580 m, 29.iv.2019, SN, leg.: K. Kettani; 1♂, Rif, Tétouan, Dar Chaoui, Bghaghza, 35°31'17.4"N 05°41'58.2"W, 105 m, 17.iv.2021, SN, leg.: K. Kettani; 1♂, Rif, Larache, Taida, Oued Tisgriss (PNPB), 35°21'12"N 05°31'57"W, 501 m, 20.iv.2021, SN, leg.: L. Zouhair; 1♂, Rif, Chefchaouen, Talassemtane, Bni M'hamed (NPTS), 35°09'32.1"N 05°07'46.9"W, 1330 m, 10.vi.2021, SN, leg.: L. Zouhair.

Distribution. Europe, Madeira, Asia (Israel, Iran), North America (Langourov, 2004, 2010). Morocco (New record).

Habitat. This species seems to inhabit mainly mixed cork oak and fir forests as well as the edges of wetlands and rivers at a wide range of altitudes in the Rif Region (Figs 4H, 4N, 5F).

Megaselia trichorrhoea Schmitz, 1921 (Fig. 3M)

Material examined. 1♂, Rif, Chefchaouen, Dardara, Amlay, marj Amlay (NPTS), 35°11'44.0"N 5°18'36.0"W, 280 m, 6.v.2021, SN, leg.: K. Kettani.

Distribution. Europe (Disney, 1991). Morocco (New record).

Habitat. This species was collected in a flooded meadow (Amlay) at 280 m altitude (Fig. 5H).

***Megaselia verralli* (Wood, 1910) (Fig. 3N)**

Material examined. 5♂♂, Rif, Larache, Tazia, Dayat Tazia (PNPB), 35°20'52.0"N 5°33'12.0"W, 733 m, 21.v.–6.vi.2016, MT, leg.: K. Kettani; 2♂♂, Rif, Larache, Beni Arouss, Marabout My Abdesalam (PNPB), 35°19'02.0"N 5°30'25.0"W, 1283 m, 26.v.2017, SN, leg.: K. Kettani; 1♂, Rif, Chefchaouen, Akchour, Chellal Sghir (NPTS), 35°14'39.8"N 5°09'48.9"W, 450 m, 7.vi.–14.vii.2017, MT, leg.: K. Kettani; 2♂♂, Rif, Jbel Kelti, Douar Adder, Oued Tanina, 35°20'45.5"N 5°19'01.7"W, 1195 m, 22.iv.2021, SN, leg.: K. Menouar & L. Zouhair.

Distribution. Europe, Canary Islands, Asia (Israel, Iran) (Namaki Khameneh et al., 2019; Langourov, 2021). Morocco (**New record**).

Habitat. This species was mainly found around wetlands in forest environments, at the edge of a pond bordered by *Quercus suber* trees and along the riverbank of watercourses bordered by *Arbutus unedo*, *Quercus rotundifolia*, *Laurus nobilis*, *Nerium oleander*, *Pistacia lentiscus* and *Tetraclinis articulata*. It was also collected from a dense mixed oak forest stand (*Quercus canariensis*, *Quercus suber*) (Figs 4C, 5C, 5I).

***Megaselia xanthozona* (Strobl, 1892) (Fig. 3O)**

Material examined. 1♂, Rif, Chefchaouen, Talassemrane, Azilane (NPTS), 35°10'07.5"N 5°14'07.8"W, 1250 m, 4.vii.–15.viii.2013, MT, leg.: K. Kettani; 2♂♂, Rif, Chefchaouen, Ain Fouara, Zawya Foukia (NPTS), 35°06'29.0"N 5°11'11.2"W, 944 m, 15.iv.2016, SN, leg.: A. Aghdir; 1♂, Rif, Chefchaouen, Fifi, Dayat Fifi, 35°00'48.2"N 5°12'20.8"W, 1205 m, 6.v.2021, SN, leg.: K. Kettani; 1♂, Rif, Chefchaouen, Akchour, Oued Farda (NPTS), 35°08'22.2"N 5°06'19.2"W, 520 m, 16.v.2016, SN, leg.: K. Kettani; 14♂♂, Rif, Larache, Tazia, Dayat Tazia (PNPB), 35°21'28.5"N 5°33'43.5"W, 733 m, 21.v.–6.vi.2016, MT, leg.: K. Kettani; 4♂♂, Rif, Tétouan, Jbel Bouhachem, Amsemlil (PNPB), 35°15'34.6"N 5°25'56.2"W, 1067 m, 23.iv.2017, SN, leg.: K. Kettani; 2♂♂, Rif, Beni Leit, Bouhachem, Lemtahane, Dar Abdeslam (PNPB), 35°16'14.9"N 5°25'48.0"W, 964 m, 7.vi.–30.v.17, MT, leg.: K. Kettani; 6♂♂, Rif, Chefchaouen, Akchour, Chellal Sghir (NPTS), 35°14'39.8"N 5°09'48.9"W, 450 m, 7.vi.–14.vii.2017, MT, leg.: K. Kettani; 1♂, High Atlas, Midelt, Bouzmella (NPHAO), 32°39'53.0"N 4°46'33.9"W, 1440 m, 24.v.2021, SN, leg.: K. Kettani; 1♂, Eastern Morocco, Berkane, Beni Snassen, Tafoughalt (SBEI), 34°48'40.1"N 2°24'30.5"W, 786 m, 12.iv.–22.vi.2021, MT, leg.: F.Z. Sliman; 2♂♂, Rif, Al Hoceima, Targuist, Beni Bounsar, 34°50'30.944"N 04°25'23.638"W, 1340 m, 1–30.iv.2022, MT, leg.: K. Kettani; 1♂, Rif, Chefchaouen, Beni Salah, Bab Tariouant, 35°01'06.3"N 5°00'34.9"W, 1429 m, 20.v.2022, SN, leg.: F.Z. Sliman; 5♂♂ 1♀, Middle Atlas, Ifrane, Maison de la Cédraie (NPIF), 33°27'59.3"N 5°14'23.8"W, 1220 m, 5.vii.2023, SN, leg.: K. Kettani.

Distribution. Europe, Asia, North Africa (Algeria, Egypt, Libya, Tunisia) (Schmitz, 1940, 1941; Rabieh et al., 2013; Sadeghi et al., 2013). Morocco (**New record**).

Habitat. This species has a wide distribution in the main biogeographical zones in Morocco, mainly in the Rif, Eastern Morocco, Middle Atlas, and High Atlas, where it inhabits a wide variety of ecosystems with altitudes ranging from 450 to 1440 m, covering a range of terrestrial and wetland environments like forests (*Quercus canariensis*, *Quercus suber*, *Quercus ilex*), maquis, meadows, peat bogs, waterfalls, ponds and riverbanks (Figs 4A, 4C, 4F, 4M, 4O, 5C, 5D).

DISCUSSION

The study of Moroccan phorids has attracted less interest than other Diptera (Kettani et al., 2022), despite the large number of species worldwide and the diversity of their habitats (Ament & Brown, 2016; Disney, 2021). However, our study has made it possible to add 31 new species of *Megaselia* to the Moroccan phorid fauna, which constitutes a comprehensive contribution to our knowledge of the biodiversity of these flies in the region. The combined geographical ranges of these species cover the main regions in the northern part of Morocco, in particular the Rif, Eastern Morocco, the Atlantic Plain and the Atlas Mountains.

The recorded species of *Megaselia* showed diverse habitat preferences, ranging from forests, meadows, and agricultural fields to wetlands like riverbanks, marshes and peat bogs. Both terrestrial and wetland environments are inhabited by these species, often sharing vegetation dominated mainly by cork oak. Furthermore, we noticed that some *Megaselia* species appeared to show a preference for specific habitat types based on information gathered at the collection site, but these findings require further ecological studies to ascertain the ecological requirements of each species. For instance, the species *Megaselia affinis*, *M. basispinata*, *M. elongata*, *M. glabrifrons*, *M. hilaris*, *M. ledburiensis*, *M. marekdurskii* and *M. meconicera* seem to prefer forests and mixed forest. *M. altifrons* and *M. brevicostalis* were found in swamps and peat bogs surrounded by pine forest and *Quercus suber*, *M. parvula* seems to prefer wetlands and was captured at the edge of a dam and in a meadow, *M. flavicans*, *M. limpachensis*, *M. manicata* and *M. verralli* appear to be associated with wetlands, being captured on riverbanks lined by *Nerium oleander* and on the edge of ponds bordered by *Quercus suber* trees. *Megaselia verralli* was also collected from a dense mixed oak forest stand. While some species are found in a wide variety of habitats with no distinct ecological requirements such as the cases of *Megaselia brevior*, *M. diversa*, *M. giraudii*, *M. latifrons*, *M. plurispinulosa*, *M. pusilla* and *M. xanthozona* which colonize a wide range of ecosystems at different altitudes, inhabiting at the same time various terrestrial and wetland environments like forests, matorral, meadows, peat bogs, waterfalls, ponds, and riverbanks. The 31 species identified in this study are new to the Moroccan fauna, all except five species (*Megaselia manicata*, *M. melanocephala*, *M. pumila*, *M. spinicincta* and *M. xanthozona*) are also new to North Africa.

Finally, it is important to highlight that most of these new records extend the geographic distribution of this family to North Africa, where they were previously unknown (Kettani et al., 2022), leading us to believe that many more records are likely to be discovered in the country if sampling efforts are stepped up given the great diversity of this family and the scarcity of studies dedicated to these flies.

AUTHOR'S CONTRIBUTION

The authors confirm their contribution to the paper as follows: F.Z. Sliman: writing the original draft, collecting and identification of specimens; K. Kettani: designing the research, correcting the original draft and all subsequent revised versions of the manuscript, collecting specimens; R.H.L. Disney: confirming the identifications, finalizing the review of the corrected versions of the manuscript. All authors read and approved the final version of the manuscript.

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AVAILABILITY OF DATA AND MATERIAL

The specimens listed in this study are deposited at the Laboratory Ecology, Systematics and Conservation of Biodiversity (Abdelmalek Essaadi University, Morocco) and in the private collection of Esben Bøggild (Hobro, Denmark) and are available from the curator, upon request.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study only included arthropod material, and all required ethical guidelines for the treatment and use of animals were strictly adhered to in accordance with international, national, and institutional regulations. No human participants were involved in any studies conducted by the authors for this article.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTERESTS

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

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گزارش‌های جدید از گونه‌های جنس *Megaselia* (Diptera: Phoridae) در مراکش، با نکاتی از انتشار و زیستگاه‌ها

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چکیده: آرایه جنس *Megaselia* Rondani, 1856، یک جنس با تنوع فوق‌العاده زیاد از مگس‌های خزنده است که به طور گسترده در سراسر جهان یافت می‌شوند. این مقاله به کشف ۳۱ گونه از جنس *Megaselia* که به تازگی در مراکش شناسایی شده‌اند، می‌پردازد. این گونه‌ها در مناطق مختلفی از جمله کوه‌های ریف، منطقه جلگه‌ای و کوه‌های اطلس که شامل زیستگاه‌های متنوعی مانند جنگل‌ها، مراتع، مزارع کشاورزی، حاشیه رودخانه‌ها، چشمه‌ها، برکه‌ها، باتلاق‌های خزهای و دریاچه‌ها هستند، جمع‌آوری شده‌اند. هدف از این تحقیق ارزیابی تنوع زیستگاه‌ها و درک ترجیح اکولوژیک گونه‌های جنس *Megaselia* است. بر اساس یافته‌های جدید، مجموع گونه‌های مگس‌های خانواده Phoridae در کشور مراکش به ۴۵ گونه افزایش یافت که از این تعداد، ۴۳ گونه متعلق به جنس *Megaselia* هستند.

واژگان کلیدی: اکولوژی، فون، فوق متنوع، شمال آفریقا، مگس‌های خزنده