The biting midge *Forcipomyia paludis* as a parasite of Odonata in North Africa (Diptera: Ceratopogonidae)

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Abstract. In June and July 2013, at two streams in the Middle Atlas Mountains, Morocco, ceratopogonid midges were photographed on and taken from the wings of six species of odonates. The specimens were identified as *Forcipomyia paludis*, a widespread European ceratopogonid midge new to Africa. The data increase the range of known hosts with the addition of *Cordulegaster princeps*, *Gomphus simillimus maroccanus* and *Onychogomphus boudoti*.

Further key words. Dragonfly, Anisoptera, Maghreb, Morocco, first record

Introduction

Females of *Forcipomyia (Pterobosca) paludis* (Macfie, 1936) suck haemolymph from the veins of odonate wings (Wildermuth & Martens 2007). In the western Palaearctic, it is the only ceratopogonid species known to parasitize adult dragonflies. In Europe, 79 species and seven subspecies of odonates have been recorded as hosts (Martens et al. 2008, 2012; Wildermuth 2012; Manger & van der Heijden 2015; Vinko et al. 2017; Cordero-Rivera et al. 2019; Wildermuth et al. 2019). So far, in the western Mediterranean it is recorded from continental Spain, Mallorca, Sardinia and France (Dell'Anna et al. 1995; Martens et al. 2008; Martens 2012; Nielsen et al. 2014; Cordero-Rivera et al. 2019). Here, we present the first African as well as the southernmost record.

Study sites and methods

On 18/19-vi-2013 and 03/04-vii-2013, JPB photographed and collected odonates with midges on their wings at two streams in the Middle Atlas, Khenifra region, Morocco; namely oued Merera (32°53'50"N, 5°29'51"W, 1170 m a.s.l.), visited on 18-vi-2013 and 04-vii-2013, and oued Arougou (32°55'33"N, 5°33'34"W, 1150 m a.s.l.), visited on 19-vi-2013 and 03-vii-2013. Each odonate specimen was preserved in ethanol in individual vials, with as many midges as possible, and sent to PH for identification. As midges detached easily upon capture, the number collected was often less than the number actually infesting the host dragonfly, particularly in the case of the larger host species. In the lab, PH carefully dissected the midges from the

odonate's wings under a dissecting microscope, and transferred them into liquefied phenol. Later the specimens were put on a plate with a drop of Canada balsam (according to Wirth & Marston 1968) and dissected using two watchmakers tweezers.

Results

Infestations were recorded on six anisopteran species: namely *Boyeria irene*, *Cordulegaster princeps*, *Gomphus simillimus maroccanus*, *Onychogomphus boudoti*, *Onychogomphus forcipatus unguiculatus* and *Onychogomphus uncatus* (Table 1). Oued Merera is a middle-sized permanent stream of *ca* 3 m width, continuously bordered by trees in a landscape of forest, open agricultural fields and fallow lands. The water is swift, of neutral pH, and highly turbid due to soil erosion in its Triassic red shale basin. There is almost no human settlement in the upper watershed and no pollution was perceptible at the time of the visit. Oued Arougou is a smaller stream

Fig. 1. Biting midges *Forcipomyia paludis* on the wings of a female *Cordulegaster princeps*. Oued Merera, Khenifra province, Morocco (18-vi-2013). Photo: JPB

Table 1. Odonate adults with *Forcipomyia paludis* on their wings at the two streams, oued Merera (loc. 1) and oued Arougou (loc. 2), in the Middle Atlas, Morocco.

Species	Sex	No. of midges	Type of record	Locality	Date
Boyeria irene	male	1	coll.	1	04-vii-2013
Boyeria irene	male	1	coll.	1	04-vii-2013
Gomphus similimus maroccanus	female	1	photo	1	18-vi-2013
Gomphus similimus maroccanus	female	1	photo	1	18-vi-2013
Gomphus similimus maroccanus	female	8	coll.	1	04-vii-2013
Onychogomphus f. unguiculatus	male	1	coll.	1	04-vii-2013
Onychogomphus f. unguiculatus	male	6	photo	1	18-vi-2013
Onychogomphus boudoti	male	1	photo	2	03-vii-2013
Onychogomphus boudoti	male	1	photo	2	03-vii-2013
Onychogomphus uncatus	male	2	coll.	1	04-vii-2013
Onychogomphus uncatus	male	3	photo	2	03-vii-2013
Cordulegaster princeps	male	7	coll.	1	04-vii-2013
Cordulegaster princeps	female	44	photo	1	18-vi-2013
Cordulegaster princeps	female	1	coll.	1	18-vi-2013

originating from the limestone and dolomite rock layers of the lower Lias. Its clear calcareous water flows slowly to swiftly in an open landscape of fields, scattered human settlements, isolated marshes and seepage water. The site was described by Ferreira et al. (2014). The specimens from Morocco did not differ in any diagnostic characters from European material in the collection of PH.

Discussion

The present records are the first ones demonstrating the presence of *F. paludis* in Africa. Until now, the southernmost records were from Sardinia (Dell'Anna et al. 1995), Mallorca (Nielsen et al. 2014) and continental Spain (Cordero-Rivera et al. 2019). Many records are available from southern France (Martens et al. 2008). We expect that either the Atlas ranges or the Sahara form the southern limit of *F. paludis*, and that the species is limited to the western Palaearctic. The African records are supported by collected specimens. Additionally, digital photography is a very useful tool for recording the presence of the species in its known range and for collecting data on odonate hosts (Martens et al. 2008). In several cases these photos result in first national records (*cf.* Clarebout 2013; Manger & Martens 2013; Černý 2014; Leuthold & Wildermuth 2014). *Cordulegaster princeps*, *Gomphus simillimus maroccanus* and *Onychogomphus boudoti* were not previously recorded as hosts for *F. paludis*.

There are occasions, especially at the limits of its known range, when it is desirable to collect voucher specimens. To obtain these specimens AM developed a simple method: (1) Catch the Odonate with an insect net. (2) As quickly as possible transfer the odonate together with its midges from the insect net into a glassine envelope. At this stage the midge generally detaches. (3) Transfer the midge(s) carefully from the envelope into a small tube of ethanol (70–96 %).

In sub-Saharan Africa, another ceratopogonid occurs, which is known from odonate adults, *Forcipomyia mollipes* (Macfie, 1932) (Macfie 1932; Clastrier & Legrand 1991). It is easily separated from *F. paludis* by having no claws.

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