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Forcipomyia paludis as a parasite of Odonata in Belgium (Diptera: Ceratopogonidae; Odonata), with notes on its ecology and habitat

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Abstract

The biting midge *Forcipomyia paludis* is the only ceratopogonid species known to parasitise Odonata in Europe. This parasite is widely distributed in the Western Palaearctic, but has only once been formally cited for one damselfly species in Belgium. However, many photographs of parasitised Odonata are stored in the citizen science website www.waarnemingen.be in Belgium. A thorough analysis of 2,300 photographs from four sites from 2019 and 2020 resulted in the finding of 100 photographs of 32 species of odonate being parasitised in Belgium. We also found two species, *Coenagrion scitulum* and *Sympetrum vulgatum* for the first time mentioned as hosts. Virtually all *F. paludis* (99%) were found at the sites Buitengoor and Hageven. Biting midges were found in at least 13% of the photographs from Buitengoor and 3% in Hageven. Most records date from the end of May to the end of July. The parasite prevalence was low: 87% of the individuals carried only one or two midges. They seemed to have a slight preference for the forewings over the hind wings (59% versus 41%), but no difference was found between the right and the left wings. The presence of biting midges on Odonata was correlated with the presence of *Cladium mariscus* vegetation. This vegetation type might be the larval habitat of *F. paludis*.

Zusammenfassung

***Forcipomyia paludis* als Libellenparasit in Belgien (Diptera: Ceratopogonidae; Odonata), mit Anmerkungen zur Ökologie und zum Habitat der Art** – Die Gnitze *Forcipomyia paludis* ist der einzige bekannte Vertreter der Ceratopogonidae in Europa, die an Libellen parasitiert. Die Art ist in der westlichen Paläarktis weit verbreitet, für Belgien existierte erst eine einzige publizierte Fundmeldung. Demgegenüber liegen zahlreiche Fotografien von parasitierten Libellen auf der belgischen Citizen Science Website www.waarnemingen.be vor. Eine gründliche Analyse von 2.300 Fotografien von vier Feuchtgebieten in Flandern in den Jahren 2019 und 2020 führte zu 100 fotografischen Nachweisen von insgesamt 32 parasitierten Libellenarten in Belgien. Zwei Arten, *Coenagrion scitulum* und *Sympetrum vulgatum*, waren bisher als Wirte von *F. paludis* nicht bekannt. Nahezu alle Fotos von Gnitzen

(99 %) stammen aus den Gebieten Buitengoor und Hageven. Gnitzen wurden auf mehr als 13 % der Fotos von Buitengoor und 3 % der Fotos von Hageven festgestellt. Die Mehrzahl der Nachweise datierte aus der Periode Ende Mai bis Ende Juli. Die Intensität der Parasitierung war niedrig: 87 % der parasitierten Libellen trugen nur eine oder zwei Gnitzen. Es bestand eine leichte Präferenz für die Vorderflügel gegenüber den Hinterflügeln (59 % versus 41 %), kein Unterschied bestand beim Vergleich von linken und rechten Flügeln. Die Gnitzenfunde auf Libellen fanden in Gebieten statt, in denen *Cladium mariscus* vorkommt. Dieser Vegetationstyp könnte als larvaler Lebensraum von *F. paludis* infrage kommen.

Introduction

Species from the insect subfamily Forcipomyiinae are predators on large or smaller insects (Gosseries 1991). The biting midge *Forcipomyia paludis* (Macfie, 1936) is a small insect known to cling firmly to the wings of Odonata and to suck haemolymph from their veins, thus acting as a temporary ectoparasite of dragonflies and damselflies (Wildermuth & Martens 2007). It is the only ceratopogonid species known to parasite adult odonates in Europe (Martens & Wildermuth 2008). Therefore we assume that all biting midges that we found are of that species.

A first overview of the presence of biting midges on Odonata is given by Martens et al. (2008). Since then a lot of attention has been given to dragonflies as hosts for parasites resulting in the publication of first observations in several countries (e.g. Dominiak & Michalczuk 2009; Manger & Martens 2013; Černý 2014; Leuthold & Wildermuth 2014; Nielsen et al 2014; Vinko et al. 2017). Most records however originate from Austria, France, Germany, the Netherlands, Spain, and Switzerland (Martens et al. 2008, 2012; Wildermuth 2012; Manger & van der Heijden 2016; Cordero-Rivera et al. 2019). This parasite was also found on odonates in North Africa (Boudot et al. 2019) and in the Caucasus (Wildermuth et al. 2019). The number of known odonate host amounts to 81 species and eight subspecies (Boudot et al. 2019). Until now, only one record of *F. paludis* parasitising on Odonata in Belgium was published (Claerebout 2013) and was based on a photo taken on 29 May 2010 of *Coenagrion pulchellum* in Comines-Warneton in the west of Belgium.

As the species is often overlooked in the field, the best way to look for the presence of this species is to check odonate photographs (Martens & Wildermuth 2008). In most cases the biting midges detach from their odonate host when they are captured in an insect net (Martens et al. 2008). Most records of parasitised Odonata by ceratapogonid midges are the result of checking personal photographs, which are often confined to a small number of sites or a limited number of days in the field. Only in some papers photographs of Odonata were more systematically checked for these ectoparasites (Martens et al. 2012; Wildermuth 2012; Cordero-Rivera et al. 2019). The last authors used a web scraping technique to analyse circa 33,000 photographs from Spain hosted in Biodiversidad Virtual (www.biodiversidadvirtual.org).

As I personally found this parasite several times in recent years, I checked the online portal for nature observations in Belgium www.waarnemingen.be / www.observations.be on the presence of biting midges attached on dragonflies and damselflies. I limited myself to four sites and to the available pictures from the years 2019 and 2020. This analysis resulted in the finding of many more records of infested Odonata in Belgium and gained us more insight in some aspects of the ecology of *F. paludis* and its probable larval habitat.

Material and methods

The present work is the result of a search on the Belgian data portal www.waarnemingen.be / observations.be on the presence of the biting midge *Forcipomyia paludis* on dragonflies. This nature data portal hosts among other things recent observations of dragonflies from Belgium. Up to the end of October 2020 more than 668,000 records and 250,000 photos of Odonata were available (https://waarnemingen.be/stats/). Up to then, no less than 34,538 pictures from 2019 and 42,761 pictures were available from Flanders region and the capital district of Brussels. It is clear that only a small number of dragonfly pictures could be checked for the presence of *F. paludis*. In a first phase, we selected two sites, Buitengoor in Mol and Hageven in Neerpelt, where we knew that *Forcipomyia* was present. Both sites harboured a rich and diverse dragonfly fauna and were investigated on a regular basis by many citizen scientists who often support their observations with a photo. We limited ourselves to dragonfly records evidenced by the presence of photographic material from 2019 and 2020. We further compared the results from both sites with two other sites: the forest and heathland complex of Averbode and Tielenkamp, which also have a rich dragonfly fauna, are well investigated, and where no *F. paludis* had been observed so far.

Study area

All four investigated areas are situated on sandy soils in the north-eastern part of Belgium (Fig. 1). The distance between each of them varies between 20 km and 40 km.

Buitengoor (51.21750° N, 5.17917° E) is a reserve of circa 90 ha in the municipality of Mol and is characterised by a mosaic of wet heathlands, fens, marshes, and wet alluvial forest. It addition to the natural nutrient poor, slightly acid seepage water, limestone-rich water from the nearby Campine canal, with water coming from southern Belgium and northern France, enters the area resulting in the occurrence of *Molinion caeruleae* vegetation and patches of *Cladium mariscus*.

The nature reserve Hageven (51.25666° N, 5.41333° E) at Neerpelt is situated at the border with the Netherlands and with 600 ha is a rather large protected area. It consists of dry and wet heathlands, bogs, marshland, and small forest

patches. Here also, calcareous nutrient rich water enters the area through several small canals which receive water from the same Campine canal as Buitengoor and result also in the presence of *Cladium mariscus* vegetation.

Tielenkamp (51.26510° N, 4.90830° E) in Tielen is a predominantly forested area of around 500 ha with a heathland nucleus and with the presence of several oligotrophic pools. The vegetation becomes more mesotrophic towards the stream.

Averbode Bos en Heide (51.03444° N, 4.97861° E) is a complex of roughly 1,000 ha around the abbey of Averbode. Until 15 years ago, most of the area consisted of pine forests, which were planted on the former heathlands and nutrient poor grasslands. Due to a restoration programme, many of the open vegetation was restored and nearly 43 ha of shallow, acidic waters were created or restored.

Results

Altogether 2,307 pictures of Odonata, of which 1,099 from 2019 and 1,208 from 2020, from these four sites were checked for the presence of *F. paludis* (Table 1). Although roughly the same number of photographs were analysed for both years, the number of cases that biting midges attached to odonate was much higher

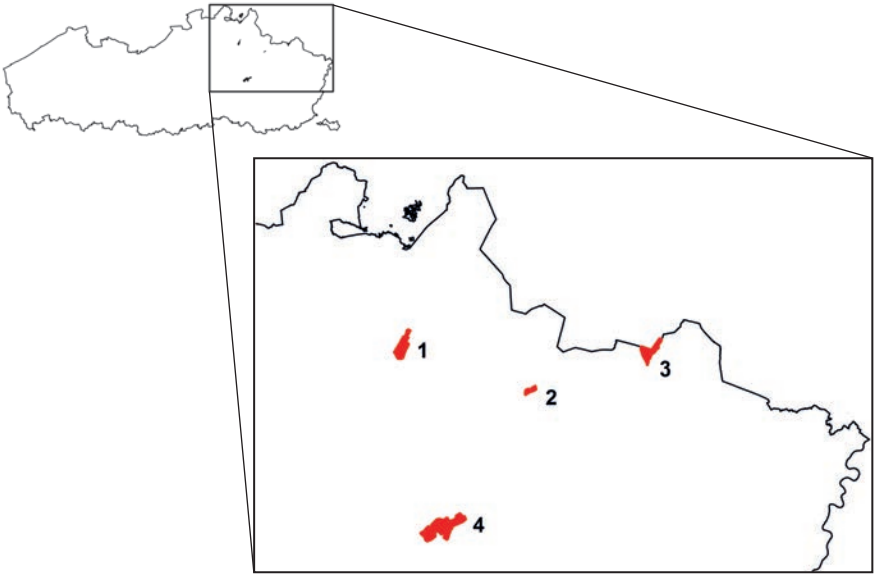

Figure 1. Map of Flanders (northern Belgium) with the four investigated sites. – **Abbildung 1:** Karte von Flandern (nördliches Belgien) mit den vier untersuchten Gebieten: (**1**) Tielenkamp, (**2**) Buitengoor, (**3**) Hageven, (**4**) Averbode Bos en Heide.

Table 1. Number (N) of analysed photographs per year for each of the four investigated sites in Flanders (northern Belgium) and number of ceratopogonid midges per year and site and infection rate. – **Tabelle 1:** Anzahl (N) ausgewerteter Fotos und gefundener Gnitzen für die beiden Jahre und die vier Untersuchungsgebiete sowie die Infektionsrate.

	2019			2020			All		
	N photos	midges	%	N photos	midges	%	N photos	midges	%
Buitengoor	228	23	10,1	293	36	12,3	521	59	11,3
Hageven	619	12	1,9	632	28	4,4	1251	40	3,2
Averbode	134	0	0,0	199	1	0,5	333	1	0,3
Tielen	118	0	0,0	84	0	0,0	202	0	0,0
Total	1,099	35	3,2	1,208	65	5,4	2,307	100	4,3

in 2020 (65%) than in 2019 (35%). Except one in Averbode, all ceratopogonid midges were found in the sites Buitengoor and Hageven. Based on the number of available photographs of Odonata for each site, the infection rate was yearly higher than 10% in Buitengoor and around 2–4% in Hageven.

From these four sites and two years we found exactly 100 times photographic evidence of the presence of *Forcipomyia* midges attached to 32 dragonfly and damselfly species, 16 Zygoptera and 16 Anisoptera (Appendix 1). This corresponds with 55% of the species having populations in Flanders. Two of them, *Coenagrion scitulum* and *Sympetrum vulgatum*, are mentioned for the first time as being host of biting midges. *Forcipomyia paludis* was 53 times present on males and 45 times on females. The sex could not be determined from two photographs. This slightly larger share of presence on male individuals is artificial and is a reflection of the presence of imagines of both sexes at the sites.

The season of biting midges attached to Odonata lasted from mid-May to early August (Fig. 2). The first evidence is from *Libellula quadrimaculata* photographed on 13 May 2019 in Buitengoor, the last dates from 8 August 2019 of a female *Sympecma fusca* from Hageven. A male of *Orthetrum coerulescens* photographed on 24 August 2019 in Hageven was omitted from the dataset as the dipteran on the abdomen could not be identified as being *F. paludis*. Most infested odonates were found from the third decade in May until the end of July.

A total of 165 ceratopogonid midges were detected attached to dragonflies. The frequency distribution of the number of attached *Forcipomyia* midges per dragonfly, split up for males and females is presented in Figure 3. The two most infected individuals were both females, one *Leucorrhinia dubia* was host of eleven midges and a *Stylurus flavipes* female had nine midges. The parasite load was low, i.e. 70% of all infested individuals carried only one midge and 86.7% of them were infested with one or two ceratopogonid midges.

The position of each attached biting midge on odonate body was determined (Fig. 4). Only once was a ceratopogonid midge found on the abdomen, i.e. a male of

O. coerulescens. All other midges (99.4%) were attached to the wings. In 17 (10%) cases, all Zygoptera, it was not possible to determine the exact position of the midges, because wings were folded. In some cases the midges could be attributed to the left wings or the right wings. The biting midges seem to have a preference for the forewings (75 midges or 45%) over the hindwings (53 cases or 32%). No difference was found between the left wings (75 cases) or the right wings (73 cases).

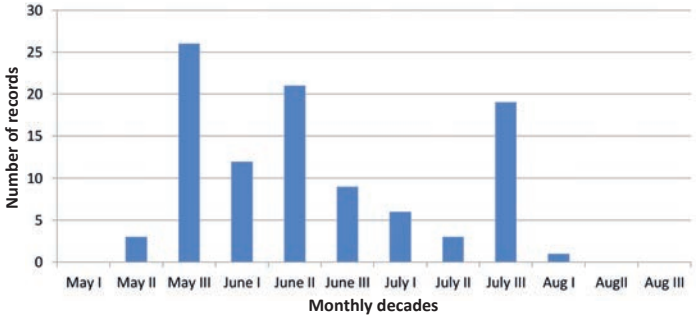

Figure 2. Phenology of *Forcipomyia paludis* on Odonata, based on photographic evidence from four sites in Flanders (northern Belgium). Months are devided in decades. – **Abbildung 2:** Phänologie der *F. paludis* auf Libellen in Flandern (nördliches Belgien). Datenzusammenstellung aufgrund von fotografischen Nachweisen. Die Monate sind in Dekaden geteilt.

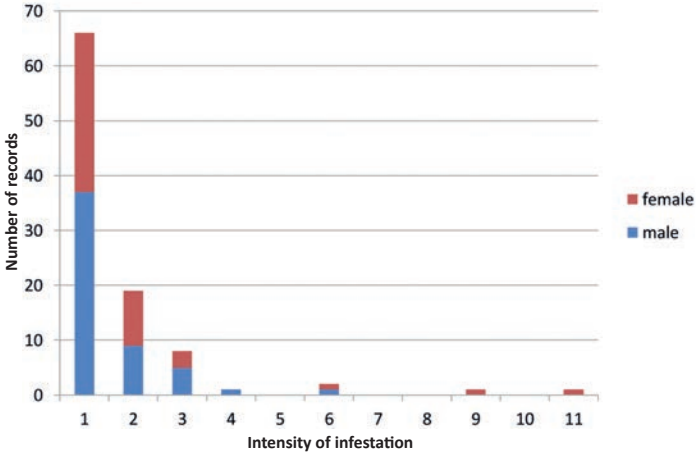

Figure 3. Intensity of infestation of biting midges for male and female Odonata based on photographic evidence from four sites in Flanders (northern Belgium). – **Abbildung 3:** Verteilung der Befallsstärke durch Gnitzen auf männlichen und weiblichen Libellen, basierend auf Fotobelegen aus vier Untersuchungsgebieten Flanderns (N Belgien).

Discussion

The general distribution pattern of *F. paludis* in Europe has become much better understood in the last ten years. Nevertheless the number of records of infested odonate is still very low for most countries. Only from (southern) France, Germany, Switzerland, the Netherlands, and Spain more than 50 observations are reported (Martens et al. 2008, 2012; Wildermuth 2012; Manger & van der Heijden 2016; Cordero-Rivera et al. 2019). Until now, only one case has been published from Belgium (Claerebout 2013) and with this overview, the number increased to 101. Although the number of known Odonata species infested by *F. paludis* in the Western Palaearctic is high (Boudot et al. 2019), we add here *Coenagrion scitulum* (Fig. 5) and *Sympetrum vulgatum* (Fig. 6) to the list, which contains 83 species and eight subspecies now. With the exception of *Coenagrion pulchellum* all other 31 species are new odonate hosts of *F. paludis* for Belgium.

Based on our systematic review of more than 2,300 photographs from four sites, we can decide that the probability of finding an odonate with biting midges is not randomly distributed. Except one case in Averbode, all records are from Buitengoor and Hageven. Of the available photographs of Odonata in the dataportal www.waarnemingen.be 10% were infested in 2019 and 12% in 2020 in Buitengoor, and 2% in 2019 and 4% in 2020 in Hageven (Table 1). There was also a lower contamination rate in 2019 (3.2%) than in 2020 (5.4%) for all sites. The reason for this remains unclear and might be due to yearly variations.

We found parasitised odonates mainly from the end of May till the end of July (Fig. 2), with the first record from 13 May and the latest from 8 August. Surprisingly

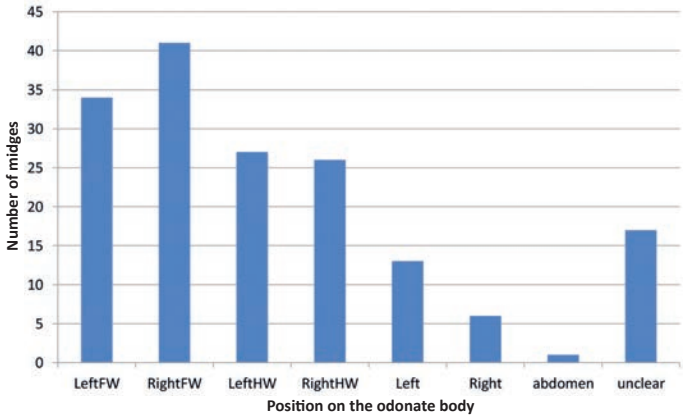

Figure 4. Preference of the attached *Forcipomyia paludis* for the different parts of the odonate body, based on photographic evidence from four sites in Flanders (northern Belgium). "Unclear" relates to wing position. – **Abbildung 4:** Präferenz saugender *F. paludis* für verschiedene Körperteile der Libellen, basierend auf Fotobelegen aus vier Untersuchungsgebieten Flanderns (N Belgien). „Unclear" bezieht sich auf die nicht geklärte Flügelposition.

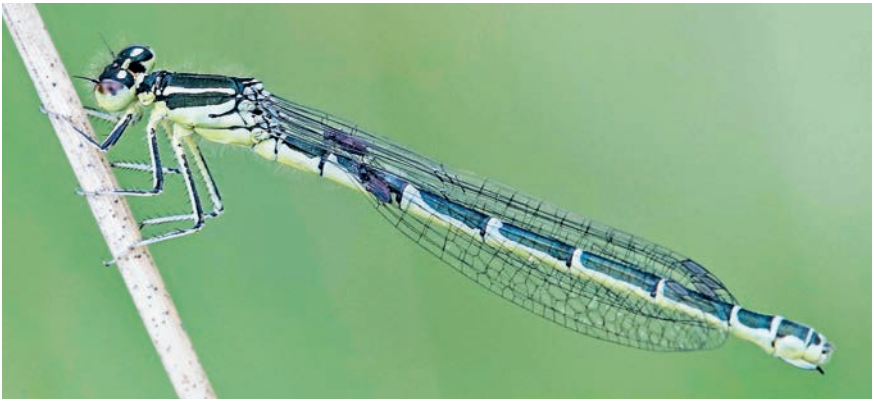

Figure 5. Female *Coenagrion scitulum* with two biting *Forcipomyia paludis* on the wing. Buitengoor, Belgium, 06-vi-2019. – **Abbildung 5:** Weibchen von *C. scitulum* mit zwei saugenden *F. paludis* auf den Flügeln. Buitengoor, Belgien, 06.06.2019. Photo: Robert Pieters

Figure 6. *Sympetrum vulgatum* female with one *Forcipomyia paludis* on the left forewing. Hageven, Belgium, 29-vii-2019. – **Abbildung 6:** Weibchen von *S. vulgatum* mit einer *F. paludis* auf dem linken Vorderflügel. Hageven, Belgien, 29.07.2019. Photo: Stefan Nimmegeers

nearly no photographs with infested odonates are available from August or September, although many species are still on the wing until the end of September in Belgium (De Knijf et al. 2006). We can exclude a bias in lower frequency rate of visiting Buitengoor and Hageven, the two sites which hold nearly all observations. Both sites are frequently surveyed in August and Hageven is the only site for *Sympetrum depressiusculum* in Belgium, a species which is intensively monitored in August. Our results correspond very well with the observations already made by Martens et al. (2008), Wildermuth (2012), Vinko et al. (2017), and Codero-Rivera et al. (2019). One explanation could be that during spring and the start of the flight season temperature is lower than during summer causing individuals to rest longer in the wet vegetation and are so prone to a higher probability rate of getting infested. Hassall et al. (2010) demonstrated that water mite infestation in dragonflies was higher in the cooler season. This may also be the case of odonates infested by biting midges.

With only 165 biting midges found on 100 Odonata pictures, the intensity of infestation is rather low at our investigated sites (Fig. 3). Not less than 70% of all infested individuals carried only one ceratopogonid midge and 86.7% of them were infested with one or two midges. Martens et al. (2008) found that 52% of all individuals carried one midge, ranging from 60.8% in Zygoptera (excluding *Calopteryx*), 40.8% in *Calopteryx*, and 49.5% in Anisoptera. This may suggest a lower infection rate at the two sites in Belgium, but this can also be the result of yearly variation as we found or caused by spatial variation or a combination of both. Only 5% of the odonates in our study sites carried more than three biting midges. This corresponds very well with the findings by Martens et al. (2008) and Wildermuth (2012).

Biting midges were almost exclusively found on the wings (Fig. 4) and only exceptionally on the thorax or abdomen, i.e. on a male of *O. coerulescens*. Our results confirm the outcomes by Martens et al. (2008) and Wildermuth (2012). This is attributed to the feeding behaviour of the biting midges, which suck haemolymph and air from the main veins in the basal half of the wings (Wildermuth & Martens 2007). If we exclude the 17 cases where it was not possible to determine the exact position, we found a slight preference for the forewings (58.6%) over the hindwings (41.4%). The same result was found by Manger (2021) in the Netherlands. No difference was found between the left wings (75 cases) or the right wings (73 cases).

Not much is known about when and where Odonata are infested. It is supposed that midges attack their hosts when these are perched (Martens et al. 2008). In some cases odonates are infected during the emergence phase as proven by Cordero-Rivera et al. (2012). They report on the observation of a larva of a male *Onychogomphus uncatus* ready to emerge while a midge was already flying around the larva. During emergence, when the dragonfly was still in a vertical position and the abdomen was not yet extracted, the eye was already infected. Such an early infection was also observed in *Aeshna juncea* in Georgia when *F. paludis* was already present just before maiden flight (Seehausen et al. 2019). Our ob-

servation of an infested female *Stylurus flavipes* on 18 July 2020 in Buitengoor (Fig. 7) is an interesting case as it indicates infection after emergence. The species only reproduces in the Albert Canal in Belgium (De Knijf et al. 2014), where every year several thousands of exuviae are counted. This artificial canal with concrete banks within a highly urbanised and industrial area is at least 14 km away from Buitengoor. As biting midges are confined to marshland and wet areas (Gosseries 1991) it is very unlikely that the female was infested during emergence at the canal.

Biting midges or Ceratopogonidae are recorded in very diverse biotopes, but are particularly abundant in wetlands. The larvae are aquatic, amphibious, or terrestrial, where they live in mud or sand on watershores or on algae covered soils and substrates, and terrestrial larvae live under bark or on wet or damp wood (Gosseries 1991), but this varies greatly from one genus and even from one spe-

Figure 7. Heavily infested female *Stylurus flavipes* with nine *Forcipomyia paludis*: three on the left forewing and on the right hindwing, two on the right forewing (both at the underside) and one on the left hindwing. Buitengoor, Belgium, 18-vii-2020. – **Abbildung 7:** Weibchen von *S. flavipes*, mit neun *F. paludis* auf den Flügeln stark befallen: je drei auf dem linken Vorderflügel und dem rechten Hinterflügel, zwei auf dem rechten Vorderflügel (beide an der Unterseite) und eine auf dem linken Hinterflügel. Buitengoor, Belgien, 18.07.2020. Photo: Robert Pieters

cies to another (Claerebout 2013). It is still not known where *F. paludis* develops (Wildermuth 2012). The two sites Hageven and Buitengoor are both characterised by the inlet of calcareous rich canal water, diverted from the river Meuse. This practice started nearly 150 years ago and resulted in the presence of lime-rich fens and marshlands, both atypical vegetation types in an otherwise sandy acidic landscape. At both sites well developed reed *Phragmites australis* vegetations with patches of Great Fen Sedge *Cladium mariscus* are present. The latter species is also present in the Wieden-Weerribben, observation sites of *F. paludis* in the Netherlands (Manger & Martens 2013). *Cladium mariscus* is also present at some other sites in the Netherlands where *F. paludis* was also recently found (M. Wasscher pers. comm.). Interesting to note is that *F. paludis* was originally described from Wicken Fen, UK (Martens & Wildermuth 2008), an important plant area and one of the best UK examples of lime-rich fens with *C. mariscus* (www.plantlife.org.uk/uk/nature-reserves-important-plant-areas/important-plant-areas/wicken-fen). The general distribution pattern of this plant species in Germany (https://www.floraweb.de/webkarten/karte.html?taxnr=1584) fits very well the distribution of *F. paludis* in Germany as shown in Martens et al. (2012). Although this is purely a correlation and we cannot prove causality, we suppose that sites vegetated with *C. mariscus* are important as larval habitat for *F. paludis.* As dragonflies and damselflies are good fliers, it is obvious that not every observation of an individual infested with biting midges relates to the reproduction site of the dipteran. This is most likely the case of the observation in Averbode. A more systematic review of Odonata photographs from sites with *C. mariscus* and sites from where this species is absent at various places in Europe might be a next step to gain more insight in the reproduction habitat of *F. paludis.*

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Hansruedi Wildermuth has an enormous impact on our knowledge on the habitat requirements, management, and ecology of European dragonflies and damselflies. Therefore, we are proud to have a present for his 80th birthday on one of the topics he initiated years ago. I would like to thank Andreas Martens for the inspiring discussion we had and for providing literature, as well as David and Ros Sparrow for the English correction. This analysis was not possible without the help of so many people who made their observations of dragonflies and damselflies available on the citizen science data portal waarnemingen.be / observations.be. Photos of the following observers were used here: Eugeen Aerts, Mirella Brynseels, Marie Rose Buyst, Lieven Decrick, Stijn De Win, Jurgen De Wolf, Dirk Eysermans, Paul Hugh, Guy Janssens, Rob Kuyken, Raphael Lebrun, Garben Logghe, Pierre Munch, Stefan Nimmegeers, Robert Pieters, Rudi Rademaekers, Ron Schippers, Jack Thora, Marc Van Beirs, Hilde Vandevoorde, Paul Vangerven, Johan Van Laethem, Wim Van Sompel, Johan Vervaeke, Reinhilde Verweyen and F. Walraven. I further want to thank my colleague Vincent Smeekens who prepared the map of Flanders.

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Appendix 1. Records of Odonata with attached biting midges based on photographs from sites in Flanders, northern Belgium: **B** Buitengoor, **H** Hageven, and **A** Averbode; **ind** individual. Names of photographers are given. – **Anhang 1:** Nachweise von Libellen mit Gnitzenbefall, basierend auf Fotobelegen aus Untersuchungsgebieten Flanderns, Nordbelgien: **B** Buitengoor, **H** Hageven und **A** Averbode; **ind** Individuum. Die Namen der Fotografen sind angegeben.

Chalcolestes viridis	1 ind, 26-vii-2020, H, P. Hugh
Lestes sponsa	1 ♀, 22-vi-2019, H, Van den Berg; 3 ♀, 17-vi-2020, B, J. Thora
L. virens	2 ♀, 22-vi-2019, H, J. De Wolf; 1 ♀, 29-vii-2020, H, J. Thora
Sympecma fusca	1 ♀, 21-vii-2019, H, J. Van Laethem; 1 ♀, 08-viii-2019, H, R. Schippers; 1 ♀, 23-vii-2020, H, P. Hugh; 1 ind, 25-vii-2020, H, P. Hugh; 1 ♀, 29-vii-2020, H, J. Thora
*Calopteryx splenden*s	1 ♂, 23-vi-2019, H, M.R. Buyst; 1 ♂, 16-vi-2020, B, P. Munch; 1 ♀, 17-vii-2020, H, J. Vervaeke; 1 ♂ 1 ♀, 28-vii-2020, H, F. Walraven; 1 ♂, 30-vii-2020, H, S. Nimmegeers
C. virgo	1 ♀, 27-v-2019, H, R. Verweyen
Platycnemis pennipes	1 ♀, 07-vi-2019, B, J. Thora; 1 ♀, 14-vi-2019, B, J. Thora; 1 ♂ 1 ♀, 17-vi-2019, B, J. Thora; 1 ♂, 23-vi-2019, B, J. Thora; 1 ♂, 02-vi-2020, B, R. Rademaekers; 1 ♀, 17-vi-2020, B, J. Thora; 1 ♂, 30-vii-2020, H, S. Nimmegeers
Coenagrion puella	1 ♂, 07-vi-2019, H, R. Schippers; 1 ♂, 14-vi-2019, B, J. Thora; 1 ♂, 22-vi-2019, H, R. Schippers; 1 ♂, 31-v-2020, H, R. Schippers; 1 ♂, 11-vi-2020, B, J. Thora; 1 ♂, 17-vi-2020, B, J. Thora
C. pulchellum	1 ♂, 27-v-2020, H, R. Kuyken; 3 ♂, 31-v-2020, H, R. Schippers
C. scitulum	1 ♂, 06-vi-2019, B, R. Pieters; 2 ♀, 07-vi-2019, B, R. Pieters

Enallagma cyathigerum	1 ♀, 09-vi-2019, B, J. Thora
Erythromma najas	1 ♂, 22-v-2020, B, J. Thora
Erythromma viridulum	1 ♀, 14-vi-2019, B, J. Thora
Ischnura elegans	1 ♂, 23-vi-2019, B, J. Thora; 1 ♀, 22-v-2020, B, J. Thora; 1 ♂, 31-v-2020, B, J. Thora; 1 ♂ 1 ♀, 31-v-2020, H, R. Schippers; 1 ♂ 1 ♀, 10-vi-2020, B, J. Thora
Ischnura pumilio	2 ♀, 07-vi-2019, B, J. Thora; 1 ♀, 22-v-2020, B, J. Thora; 1 ♂, 22-v-2020, B, J. Thora; 1 ♀, 29-vii-2020, B, L. Decrick
Pyrrhosoma nymphula	1 ♂, 14-v-2019, B, G. Logghe
Aeshna isosceles	1 ♂ , 14-vi-2019, B, J. Thora; 1 ♂, 31-v-2020, B, J. Thora; 1 ♂, 31-v-2020, H, R. Schippers
Anax imperator	1 ♂, 31-v-2020, B, J. Thora; 1 ♂, 17-vi-2020, B, J. Thora
Stylurus flavipes	1 ♀, 18-vii-2020, B, P. Hugh, R. Pieters, H. Vandevoorde, G. De Knijf
Cordulegaster boltonii	1 ♀, 18-vii-2020, B, P. Hugh, R. Pieters, H. Vandevoorde, G. De Knijf
Cordulia aenea	1 ♂, 31-v-2020, B, S. De Win
Somatochlora flavomaculata	1 ♂, 23-vii-2020, B, R. Pieters
Leucorrhinia dubia	1 ♀, 18-v-2019, B, J. Thora; 1 ♀, 14-vi-2019, B, R. Pieters
Libellula fulva	1 ♂, 07-vi-2019, H, R. Schippers; 1 ♀, 30-v-2020, B, R. Lebrun; 1 ♂, 31-v-2020, H, R. Schippers
L. quadrimaculata	1 ♀, 13-v-2020, B, J. Thora; 1 ♂, 22-v-2020, B, J. Thora; 1 ♂, 31-v-2020, B, J. Thora; 1 ♂, 31-v-2020, H, R. Schippers; 1 ♂, 12-vi-2020, B, M. Brynseels
Orthetrum brunneum	1 ♀, 11-vi-2020, B, S. De Win
O. cancellatum	1 ♂, 31-v-2020, A, G. Janssens; 1 ♂, 12-vi-2020, B, M. Brynseels; 1 ♂, 14-vi-2020, B, J. Thora;
O. coerulescens	1 ♂, 06-vi-2019, B, R. Pieters; 1 ♀, 14-vi-2019, B, J. Thora; 1 ♀, 09-vii-2019, B, J. Thora; 2 ♂, 31-v-2020, B, J. Thora; 1 ♂, 31-v-2020, H, R. Schippers; 1 ♀, 03-vi-2020, H, P. Vangerven; 1 ♂, 12-vi-2020, B, M.Brynseels; 1 ♀, 16-vi-2020, B, W. Van Sompel; 1 ♂, 17-vi-2020, B, J. Thora; 1 ♀, 03-vii-2020, B, R. Rademaekers
Sympetrum depressiusculum	1 ♀, 22-vii-2020, H, D. Eysermans
S. sanguineum	1 ♂, 22-vi-2019, H, R. Schippers
S. striolatum	1 ♀, 22-vi-2019, B, P. Munch; 1 ♂, 22-vi-2019, H, R. Schippers; 1 ♀, 06-vii-2019, B, J. Thora; 1 ♂, 09-vii-2019, B, J. Thora; 1 ♀, 02-vii-2020, B, J. Thora; 1 ♂, 23-vii-2020, H, M. Van Beirs; 1 ♂, 26-vii-2020, B, R. Rademaekers; 1 ♂, 29-vii-2020, H, J. Thora
S. vulgatum	1 ♀, 29-vii-2019, H, S. Nimmegeers; 1 ♀, 02-vii-2020, H, P. Vangerven; 1 ♀, 22-vii-2020, H, E. Aerts; 1 ♀, 23-vii-2020, H, P. Hugh