Checklist of the Belgian blackflies (Diptera: Simuliidae)

Koen LOCK[1]

[1] Merelstraat 27, B-9000 Gent (e-mail: Koen_Lock@hotmail.com)

Abstract

Based on a revision of the collection present in the Royal Belgian Institute of Natural Sciences, on material collected in the field and on a critical review of the literature, an updated checklist of the Simuliidae occurring in Belgium was composed. In addition, it is indicated in which regions and provinces each species has been encountered. Several previously mentioned species could not be confirmed and were omitted. *Simulium* (*Nevermannia*) *angustitarse* (Lundstrom, 1911), *Simulium* (*Nevermannia*) *armoricanum* Doby & David, 1961 and *Simulium* (*Simulium*) *argyreatum* Meigen, 1838 were added to the Belgian fauna.

Keywords: Belgium, Nematocera, *Simulium* (*Nevermannia*) *angustitarse*, *Simulium* (*Nevermannia*) *armoricanum*, *Simulium* (*Simulium*) *argyreatum*

Samenvatting

Gebaseerd op een revisie van de collectie aanwezig in het Koninklijk Belgisch Instituut voor Natuurwetenschappen, materiaal verzameld in het veld en een kritisch revisie van de literatuur werd een bijgewerkte soortenlijst opgesteld van de Simuliidae die voorkomen in België. Bovendien werd aangegeven in welke gewesten en provincies elke soort reeds werd aangetroffen. Verschillende eerder gemelde soorten konden niet worden bevestigd en werden geschrapt. *Simulium* (*Nevermannia*) *angustitarse* (Lundstrom, 1911), *Simulium* (*Nevermannia*) *armoricanum* Doby & David, 1961 en *Simulium* (*Simulium*) *argyreatum* Meigen, 1838 werden aan de Belgische fauna toegevoegd.

Résumé

Basée sur une révision de la collection présente à l'Institut royal des Sciences naturelles de Belgique, du matériel collecté sur le terrain et une revue critique de la littérature, une liste actualisée des Simuliidae de Belgique a été constituée. Dans cette liste, les régions et les provinces dans lesquelles ont été observées les espèces sont également mentionnées. Plusieurs espèces rapportées auparavant pour la Belgique et qui n'ont pas pu être confirmées ont été supprimées. *Simulium* (*Nevermannia*) *angustitarse* (Lundstrom, 1911), *Simulium* (*Nevermannia*) *armoricanum* Doby & David, 1961 et *Simulium* (*Simulium*) *argyreatum* Meigen, 1838 ont été ajoutés à la faune belge.

Introduction

Blackflies or Simuliidae are a family of Nematocera (Diptera). Females suck blood from mammals and birds and can also transfer bacteria, nematodes, protozoa and viruses. The most notorious is undoubtedly the nematode *Onchocerca volvulus* (Leuckart, 1893) of which the endosymbiotic bacteria cause river blindness in Africa, Central and South America. In Belgium, no diseases are transmitted to humans, but their bites can cause serious itching and swelling. Also for cattle, blackflies can be a considerable nuisance in Belgium and sometimes, animals have to be moved from certain meadows.

Blackfly larvae are often dominant suspension feeders in running waters and are therefore an important link between organic matter and fish. Larvae and pupae are sensitive to aquatic pollution and do not occur in waters where the oxygen content is too low due to organic pollution. As a result of

the improving water quality during the last decades, blackflies are becoming more widespread (LOCK *et al.*, 2014).

A lot of species names that were used in the past now refer to other species, some of which are also present in Belgium. Half of the British species reported by DAVIES (1968) for example, have now a different name (BASS, 1998). These changes in nomenclature led to a lot of confusion. Most Belgian entomologists only mentioned a few species of which the identity can no longer be confirmed. TONNOIR (1921) was the first who studied Simuliidae in more detail and he mentioned eight species for the Belgian fauna, but no additional data were given. VAN DEN NEUCKER (1985, 1987) studied material of 16 species, eight of which were not previously reported for the Belgian fauna. VAN DEN NEUCKER (1991) reported another three additional species, which were reported in an unpublished thesis for which unfortunately no reference was given. LOCK *et al.* (2014) made detailed distribution maps for the 12 species that were found in Flanders by the Flemish Environmental Agency. LOCK & VAN BUTSEL (2017) made an inventory of the Province of Brabant wallon and listed four species. Here, an updated checklist is presented and it is indicated in which provinces each species occurs. In addition, three species are added to the Belgian fauna: *Simulium* (*Nevermannia*) *angustitarse* (Lundstrom, 1911), *Simulium* (*Nevermannia*) *armoricanum* Doby & David, 1961 and *Simulium* (*Simulium*) *argyreatum* Meigen, 1838.

Material and methods

All the material of Belgian Simuliidae present in the Royal Belgian Institute of Natural Sciences (R.B.I.N.S.) was studied: the slide collection, the dry collection and the material sampled by the Flemish Environmental Agency. Pupae of *S. angustitarse, S. armoricanum* and *S. argyreatum* were deposited to the R.B.I.N.S. collection (I.G. 33.782).

For last-instar larvae and pupae in Flanders and the Netherlands, the key of LOCK & VAN MAANEN (2014) can be used, but in Wallonia some additional species occur and the key of BASS (1998) or LECHTHALER & CAR (2005) should be used. Adults can be identified with the key of DAVIES (1968), however, care should be taken because a lot of species names have been changed since then. A translation of DAVIES (1968) in Dutch with currently used names can be obtained from the author.

Results

In total, 22 species could be confirmed for the Belgian fauna. All species are discussed below in alphabetical order, followed by a section in which the species that were omitted from the checklist are discussed. A checklist is presented with indication of the regions and provinces in which each species has already been found (Table 1).

Prosimulium (*Prosimulium*) *tomosvaryi* (Enderlein, 1921)

This species was reported from Ferrières by VAN DEN NEUCKER (1985, 1987). However, the old record of *Prosimulium* (*Prosimulium*) *hirtipes* (Fries, 1824) from Hockai (GOETGHEBUER, 1929, 1931) almost certainly refers to *P. tomosvaryi* as well (see further). The species seems to be quite common in unpolluted streams south of the Sambre-Meuse valley. *P. tomosvaryi* tolerates high iron concentrations (BASS, 1998) and in the Hautes Fagnes region, it can be found in iron-rich streams with a low pH draining peatland areas.

Simulium (*Boophthora*) *erythrocephalum* (De Geer, 1776)

Simulium erythrocephalum was long overlooked and was first reported from Balen, Retie, Genval and Lacuise (VAN DEN NEUCKER, 1985, 1987). It turned out to be a very common blackfly in the eastern half of Flanders (LOCK *et al.*, 2014). The species occurs all over Belgium, except the western part: it was only found once in the Province of West-Vlaanderen and not yet in the Province of Hainaut. Despite intensive searching, there are also no recent records from the Province of Brabant wallon (LOCK & VAN BUTSEL, 2017). The species tolerates lower current velocities than other Simuliidae and as a result, it is the most common species in some lowland regions, such as the Campine region (LOCK

Table 1. Checklist of the Belgian blackflies (Simuliidae). * indicates the presence of a species.

	Antwerpen	Brabant wallon	Brussels Capital Region	Hainaut	Liège	Limburg	Luxembourg	Namur	Oost-Vlaanderen	Vlaams-Brabant	West-Vlaanderen
Prosimulium (*Prosimulium*) *tomosvaryi* (Enderlein 1921)				*	*		*	*			
Simulium (*Boophthora*) *erythrocephalum* (De Geer 1776)	*	*	*		*	*	*	*	*	*	*
Simulium (*Eusimulium*) *angustipes* Edwards 1915	*	*		*		*			*	*	*
Simulium (*Eusimulium*) *aureum* Fries 1824						*					
Simulium (*Hellichiella*) *latipes* (Meigen 1804)									*	*	
Simulium (*Nevermannia*) *angustitarse* (Lundstrom 1911)		*									
Simulium (*Nevermannia*) *armoricanum* Doby & David 1961							*	*			
Simulium (*Nevermannia*) *costatum* Friederichs 1920		*		*		*		*	*	*	
Simulium (*Nevermannia*) *cryophilum* (Rubtsov 1959)				*	*		*	*			
Simulium (*Nevermannia*) *lundstromi* (Enderlein 1921)	*					*		*			
Simulium (*Nevermannia*) *vernum* Macquart 1826	*	*	*	*	*	*	*	*	*	*	*
Simulium (*Simulium*) *argyreatum* Meigen 1838					*		*	*			
Simulium (*Simulium*) *intermedium* Roubaud 1906					*		*	*			
Simulium (*Simulium*) *morsitans* Edwards 1915	*					*					
Simulium (*Simulium*) *noelleri* Friederichs 1920	*		*	*	*	*	*	*	*	*	*
Simulium (*Simulium*) *ornatum* Meigen 1818	*	*	*	*	*	*	*	*	*	*	*
Simulium (*Simulium*) *posticatum* Meigen 1838			*		*		*				
Simulium (*Simulium*) *reptans* (Linnaeus 1758)					*		*	*			
Simulium (*Simulium*) *trifasciatum* Curtis 1839		*	*		*		*	*	*	*	*
Simulium (*Simulium*) *tuberosum* (Lundstrom 1911)				*	*		*	*			
Simulium (*Simulium*) *variegatum* Meigen 1818					*		*	*			
Simulium (*Wilhelmia*) *equinum* (Linnaeus 1758)	*	*	*	*	*	*	*	*	*	*	
Simulium (*Wilhelmia*) *lineatum* (Meigen 1804)					*		*	*			
Number of species	8	8	7	9	15	10	16	17	9	9	6

et al., 2014) and large parts of the Netherlands (LOCK & VAN MAANEN, 2014). *S. erythrocephalum* tolerates high conductivities and usually lives in waters with a pH above 7 (BASS, 1998). Females are vicious blood suckers: it is the most important pest species in the Palearctic region and high losses of cattle have been reported (LECHTHALER & CAR, 2005).

Simulium (*Eusimulium*) *angustipes* Edwards, 1915

TONNOIR (1921) first reported this species, but according to VAN DEN NEUCKER (1985, 1987), who re-examined this material, it was actually *Simulium* (*Eusimulium*) *aureum* Fries, 1824. LOCK *et al.* (2014) found it a lot in material from Flanders dating from 1997 till present, but no older Belgian material was present in the R.B.I.N.S. collection. The species mainly inhabits small lowland brooks with nutritious water (LECHTHALER & CAR, 2005), which could explain why the species is that common in the northern part of Belgium nowadays.

Simulium (*Eusimulium*) *aureum* Fries, 1824

The material that was collected in Hockai by TONNOIR (1921) and identified by VAN DEN NEUCKER (1985, 1987) could not be confirmed, because the slides made by the latter are no longer associated with the dry R.B.I.N.S. collection. LOCK *et al.* (2014) only found the species in a few streams with a

good ecological water quality in the Campine region in the Province of Limburg. The species mainly lives in small streams with a low pH and draining heaths and moors (BASS, 1998).

***Simulium* (*Hellichiella*) *latipes* (Meigen, 1804)**

The name *S. latipes* was long used for another species currently known as *Simulium* (*Nevermannia*) *vernum* Macquart, 1826 and earlier records (TONNOIR, 1921; GOETGHEBUER, 1931; VERBEKE, 1950) probably refer to the latter species. All confirmed records of *S. latipes* were from the neighbourhood of Melle in the Province of Oost-Vlaanderen (GOETGHEBUER, 1943; VERBEKE, 1950; VAN DEN NEUCKER, 1985; LOCK *et al.*, 2014). On 7.V.2018, I also found it in Walenbos near Sint-Joris-Winge in the Province of Vlaams Brabant. The species develops in temporary streams and has only a single spring generation (BASS, 1998).

***Simulium* (*Nevermannia*) *angustitarse* (Lundstrom, 1911)**

This species is reported here for the first time for the Belgian fauna. Two pupae were found on 29.IV.2017 in the stream Ru Milhoux near Maransart (Province of Brabant wallon, 31UFS0413, 70 m a.s.l.). The pupae possess four long and very slender gill filaments on each side, the lower two filaments lack a common stalk (Fig. 1). The cocoon is loosely woven with small holes, but without a well-developed horn nor a thickened anterior margin (Fig. 1). *S. angustitarse* is typically found in clean, cold stenotherm brooks with slow permanent current and some vegetation (LECHTHALER & CAR, 2005).

***Simulium* (*Nevermannia*) *armoricanum* Doby & David, 1961**

Simulium armoricanum is reported here for the first time for Belgium. On 4.III.2017, a pupa was found in the stream Rau de Belvaux near Hermeton-sur-Meuse (Province of Namur, 31UFR3561, 130 m a.s.l.) and on 6.III.2017, four pupae were found in a small tributary of the stream L'Hinsone near Awenne (Province of Luxembourg, 31UFR6549, 330 m a.s.l.). The species lives in hill streams (BASS, 1998). Pupae can be recognised by the four gill filaments on both sides that are directed straightly forward and are lying close together (Fig. 2). The cocoon consists of bulk texture and has a horn (Fig. 2). The thoracic cuticle of the pupa is covered with large thoracic tubercles with an angular outline.

***Simulium* (*Nevermannia*) *costatum* Friederichs, 1920**

This blackfly was reported by DELIGNE & DE VOS (1981), LOCK *et al.* (2014) and LOCK & VAN BUTSEL (2017) from headwaters in forests in the loamy ecoregion and the Fagne-Famenne-Calestienne ecoregion and it might be expected in the Gaume ecoregion as well. The species is rarely found more than 100 m below the stream source and is generally associated with permanent springs issuing from chalk or limestone strata (BASS, 1998).

***Simulium* (*Nevermannia*) *cryophilum* (Rubtsov, 1959)**

This species was first reported by DELIGNE & DE VOS (1981) from Treignes. The species was also reported in an unpublished study mentioned by VAN DEN NEUCKER (1991), but no further data were given. Its occurrence in Belgium is confirmed here: it was collected at small, clean streams south of the Sambre-Meuse valley, more specifically in Rièzes, Francorchamps, Pepinster, Sourbrodt, Awenne, Mirwart and Senzeille.

***Simulium* (*Nevermannia*) *lundstromi* (Enderlein, 1921)**

TONNOIR (1921) reported *S. angustitarse* for Belgium, which is the name that was used at that time for *S. lundstromi*. A female of *S. lundstromi* collected in Hoogstraten on 21.VIII.1918 by A. Tonnoir was indeed found in the R.B.I.N.S. collection. The species was also found in several streams with a lot of vegetation in the Campine region (LOCK *et al.*, 2014) and more recently also in the stream La Somme in Somal.

Fig. 1. Lateral view of pupa of *Simulium* (*Nevermannia*) *angustitarse* (Lundstrom, 1911) (photograph by Koen Lock).

Fig. 2. Lateral view of pupa of *Simulium* (*Nevermannia*) *armoricanum* Doby & David, 1961 (photograph by Koen Lock).

Fig. 3. Lateral view of pupa of *Simulium* (*Simulium*) *argyreatum* Meigen, 1838 (photograph by Koen Lock).

***Simulium* (*Nevermannia*) *vernum* Macquart, 1826**

Simulium vernum was already reported by JACOBS (1878) and later also by VAN DEN NEUCKER (1985, 1987), LOCK *et al.* (2014) and LOCK & VAN BUTSEL (2017). As mentioned previously, also older records of *S. latipes* (TONNOIR, 1921; GOETGHEBUER, 1931; VERBEKE, 1950) probably refer to this species. It is a widespread species from unpolluted small streams, which has been found in all Belgian regions and provinces.

***Simulium* (*Simulium*) *argyreatum* Meigen, 1838**

TONNOIR (1921) reported *S. argyreatum* for Belgium, but at that time, this name was used for the species currently known as *Simulium* (*Simulium*) *noelleri* Friederichs, 1920. Here, the species is reported for the first time with certainty for the Belgian fauna. Pupae were found in turbulent stony streams: on 22.IV.2017 in La Hedrée near Waha (Province of Luxembourg, 31UFR6762, 240 m a.s.l.), on 16.V.2017 in La Petite Rour near Sourbrodt (Province of Liège, 31UGR9696, 560 m a.s.l.), on 21.V.2017 in La Houille near Sart-Custinne (Province of Namur, 31UFR3840, 340 m a.s.l.) and on 25.V.2017 in Mirwart (Province of Luxembourg, 31UFR6146, 250 m a.s.l.). The pupae can be recognised by six gill filaments, which arise from the basal trunk in sequence: the lowermost pair first and the uppermost last (Fig. 3). The thorax lacks antero-dorsal lumps (Fig. 3). The cocoon lacks a horn, but has a thickened anterior margin and covers the pupa completely (Fig. 3).

***Simulium* (*Simulium*) *intermedium* Roubaud, 1906**

VAN DEN NEUCKER (1985, 1987) first reported this species from Belgium. It only seems to occur sparsely in streams south of the Sambre-Meuse valley, however, it might have been overlooked due to its resemblance to *Simulium* (*Simulium*) *ornatum* Meigen, 1818. The species is often associated with streams draining heathland (BASS, 1998).

***Simulium* (*Simulium*) *morsitans* Edwards, 1915**

TONNOIR (1921) reported this species, but gave no further details. VAN DEN NEUCKER (1985) reported it from Chiny and Warre, but these records could not be confirmed. LOCK *et al.* (2014) found *S. morsitans* in slow flowing streams and rivers with a lot of vegetation in the Campine ecoregion.

***Simulium* (*Simulium*) *noelleri* Friederichs, 1920**

TONNOIR (1921) first reported this species from Belgium, but no further details were given. VAN DEN NEUCKER (1985) reported it from Retie, Brussel, Sourbrodt and Lacuisine. *S. noelleri* was also found in streams all over Flanders (LOCK *et al.*, 2014). The species has been observed in all Belgian regions and provinces except the Province of Brabant wallon. *S. noelleri* can reach very high densities and it is also able to colonise artificial substrates (BASS, 1998). In Belgium, it is certainly not restricted to pond outlets as suggested by most authors (i.e. BASS, 1998; LECHTHALER & CAR, 2005).

***Simulium* (*Simulium*) *ornatum* Meigen, 1818**

The species has been reported by TONNOIR (1921), GOETGHEBUER (1931), LECLERCQ (1950), DELIGNE & DE VOS (1981), VAN DEN NEUCKER (1985), LATTEUR *et al*. (1992), LOCK *et al.* (2014) and LOCK & VAN BUTSEL (2017). It is Belgium's most common species and it has been observed in all regions and provinces. The species is relatively tolerant to polluted water and it can be found in most types of streams and rivers.

***Simulium* (*Simulium*) *posticatum* Meigen, 1838**

Simulium posticatum was first recorded from Les Epioux near Lacuisine by LECLERCQ (1978) and VAN DEN NEUCKER (1985) reported it from Chiny and Lacuisine. In the R.B.I.N.S. collection, material dating from 1943 was present from Rouge Cloître in Auderghem, but the species is currently probably no longer present in the Brussels Capital Region. Recently, I found the species in the River

Ourthe in Bomal and in Verlaine and in the River Eau Rouge in Stavelot. *S. posticatum* usually inhabits slow-flowing rivers with a lot of vegetation (BASS, 1998).

***Simulium* (*Simulium*) *reptans* (Linnaeus, 1758)**

Although the species was often reported (JACOBS, 1878; LAMEERE, 1907; MEUNIER, 1911; GOETGHEBUER, 1912; MARÉCHAL, 1927; LECLERCQ, 1950; VAN DEN NEUCKER, 1985, 1987, 1991), none of these records could be confirmed. Especially older records might refer to other species, because at that time only a few species were well known. Recent records indicate that the species lives in stony rivers south of the Sambre-Meuse valley.

***Simulium* (*Simulium*) *trifasciatum* Curtis, 1839**

This species was first recorded from Brussel, Ohain, Ukkel, Embourg and Malonne by VAN DEN NEUCKER (1985, 1987). In Flanders, the species was restricted to small streams in the loamy ecoregion LOCK *et al.* (2014). Recently, the species could no longer be found in the Province of Brabant wallon (LOCK & VAN BUTSEL, 2017). The species is often associated with calcareous spring sources (BASS, 1998).

***Simulium* (*Simulium*) *tuberosum* (Lundstrom, 1911)**

VAN DEN NEUCKER (1985, 1987) reported the species from Bihain, Lacuisine and Neupont. The species seems to be common in unpolluted stony streams and rivers in the Ardennes and the Thiérache ecoregions. The species occurs in stony streams and rivers (BASS, 1998).

***Simulium* (*Simulium*) *variegatum* Meigen, 1818**

Simulium variegatum was reported by DE MEIJERE (1900), but this record was later questioned by TONNOIR (1921) and VAN DEN NEUCKER (1985, 1987). The presence of this species in Belgium can now be confirmed. The species turned out to be quite common in turbulent stony streams and rivers south of the Sambre-Meuse valley.

***Simulium* (*Wilhelmia*) *equinum* (Linnaeus, 1758)**

This species was reported by TONNOIR (1921), COLLART (1936), LECLERCQ (1950), VAN DEN NEUCKER (1985), LOCK *et al.* (2014) and LOCK & VAN BUTSEL (2017). In Flanders, the species was mainly found in the basins of the River Nete and the River Dijle, where it occurred in streams and rivers with a lot of vegetation. The R.B.I.N.S. collection holds one specimen from Melle captured in 1941, but the species seems to be no longer present in the Province of Oost-Vlaanderen. The species seems to be more common in rivers south of the Sambre-Meuse valley, which are usually less polluted.

***Simulium* (*Wilhelmia*) *lineatum* (Meigen, 1804)**

VAN DEN NEUCKER (1985, 1987) first reported this species from Sy, Herbeumont, Lacuisine and Gedinne. *S. lineatum* is usually found together with the closely related *S. equinum*, but is more sensitive and it only occurs in rivers south of the Sambre-Meuse valley.

Species omitted from the checklist

GOETGHEBUER (1929, 1931) reported *Prosimulium* (*Prosimulium*) *hirtipes* (Fries, 1824) from the River Hoegne near Hockai. One female he collected was present in the R.B.I.N.S. collection, but females are very difficult to identify and the identification could not be confirmed. However, when the River Hoegne was visited on 2.V.2017, only larvae and pupae of *Prosimulium* (*Prosimulium*) *tomosvaryi* (Enderlein, 1921) were found. DELIGNE & DE VOS (1981) reported *P. hirtipes* from Treignes, but also in that region, only *P. tomosvaryi* was found during recent sampling efforts. *P. tomosvaryi* was initially described as a variety of *P. hirtipes* and was not recognised as a separate species before DAVIES (1966) elevated it to species level, which explains why GOETGHEBUER (1929,

1931) reported *P. hirtipes*, but not why DELIGNE & DE VOS (1981) reported it, although they might have used old identification literature. *P. hirtipes* usually lives in mountainous areas, most frequently between 500 and 800 m, while *P. tomosvaryi* is the only lowland species of the genus, which has its maximum distribution between 200 and 500 m (LECHTHALER & CAR, 2005). For all those reasons, it can be assumed that the records from Hockai and Treignes refer to the species currently known as *P. tomosvaryi*.

GOETGHEBUER (1912) reported *Simulium* (*Byssodon*) *maculatum* (Meigen, 1804) from the region of Virton, where he visited the valleys of the Rau de Rabais, Rau du Chou and Rau de Laclaireau, which are all small streams. However, *S. maculatum* inhabits large rivers with slow current velocity like the River Volga and the River Danube (LECHTHALER & CAR, 2005). Also LAMEERE (1907) lists *S. maculatum* for Belgium, however, from his description it is obvious that a species from the subgenus *Wilhelmia* was intended. *S. maculatum* is therefore removed from the checklist.

Simulium (*Nevermannia*) *dunfellense* Davies, 1966 was reported in an unpublished study mentioned by VAN DEN NEUCKER (1991), however, this species is endemic to the British isles. Also *Simulium* (*Nevermannia*) *urbanum* Davies 1966 was reported in the same unpublished study mentioned by VAN DEN NEUCKER (1991). No material of this study was conserved and therefore, both species were removed from the checklist.

Simulium (*Simulium*) *monticola* Friederichs, 1920 is a typical species for rapid mountain rivers with turbulent waters and big stones, situated at middle and high altitudes (LECHTHALER & CAR, 2005). VAN DEN NEUCKER (1985) reported this species from a small stream running through a meadow near Hamoir, where also *S. ornatum* was present. *S. monticola* is unlikely to occur in such a habitat and as the identification could not be confirmed, the species was removed from the checklist. Possibly, the closely related *S. argyreatum* was found.

Discussion

Some additional species might still be expected to be found in Belgium, especially in Wallonia, which is less well investigated. In the Netherlands, additional recorded species are: *Prosimulium* (*Prosimulium*) *hirtipes* (Fries, 1824) and *Simulium* (*Simulium*) *paramorsitans* Rubtsov, 1956, however, *P. hirtipes* was only found once in the River Rhine near Lobith and *S. paramorsitans* once in the River Vecht (LOCK & VAN MAANEN, 2014). For both species, it is doubtful whether they maintain sustainable populations in the Netherlands. Possibly, it were specimens originating from upstream, which were washed out from their original habitat.

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