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Notes on some aquatic larvae of several fly families in Flanders (Diptera: Athericidae, Chaoboridae, Dixidae, Sciomyzidae and Tabanidae)

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Abstract

Macroinvertebrates have been collected by the Flemish Environment Agency (VMM) to assess the ecological water quality in Flanders. Specimens of several families of aquatic Diptera, that were collected between 1997 and 2009, were identified to species level. In this study, two species of Athericidae, four Chaoboridae, five Dixidae, six Sciomyzidae and five Tabanidae were recorded. Distribution maps of all the recorded species are given and their ecology is briefly discussed.

Keywords: water snipe-flies, phantom midges, meniscus midges, snail killing flies, horseflies.

Samenvatting

Macroinvertebraten werden verzameld door de Vlaamse Milieumaatschappij (VMM) om de ecologische waterkwaliteit te bepalen in Vlaanderen. Specimens van verschillende families aquatische Diptera, die werden gevangen tussen 1997 en 2009, werden gedetermineerd tot op soortniveau. Tijdens deze studie werden twee soorten Athericidae, vier Chaoboridae, vijf Dixidae, zes Sciomyzidae en vijf Tabanidae gevonden. Verspreidingskaartjes van alle aangetroffen soorten werden opgegeven en hun ecologie werd kort bediscussieerd.

Résumé

Des Macroinvertébrés ont été récoltés par la Société flamande de l'Environnement (VMM) pour déterminer la qualité écologique des eaux superficielles en Flandre. Des spécimens de différentes familles de diptères aquatiques, capturés entre 1997 et 2009, ont été identifiés jusqu'au niveau de l'espèce. Pendant cette étude, deux espèces d'Athericidae, quatre de Chaoboridae, cinq de Dixidae, six de Sciomyzidae et cinq de Tabanidae ont été trouvées. Des cartes de distribution de toutes les espèces rencontrées sont données et leur écologie est brièvement discutée.

Introduction

Biotic indicators (macrophytes, phytoplankton, phytobenthos, fish fauna and macrobenthic fauna) are used to assess the ecological water quality as required by the European Union water framework directive (WFD). The Multimetric Macroinvertebrate Index Flanders (MMIF) has been developed to meet the requirements of the WFD (GABRIELS *et al.*, 2010). The MMIF is a type-specific multimetric index consisting of five equally weighted metrics: taxa richness, the number of EPT-taxa (Ephemeroptera, Plecoptera and Trichoptera), the number of other sensitive taxa, the Shannon-Wiener diversity index and the mean tolerance score. The Flemish Environment Agency monitors the water quality in Flanders. However, they identify Diptera only to family level, which is the level required to calculate the MMIF (GABRIELS *et al.*, 2010). During the present study, the aquatic larvae of the Diptera families Athericidae, Chaoboridae, Dixidae, Sciomyzidae and Tabanidae, that were collected by the Flemish Environment Agency, were identified to species level and their presence was linked to

the measured environmental parameters. The larvae of mosquitoes (Culicidae), soldier flies (Stratiomyidae), blackflies (Simuliidae) and trickle midges (Thaumaleidae) have also been identified, but these data were published elsewhere (LOCK *et al.*, 2012, 2013, 2014; LOCK, 2013). Also phantom crane flies (Ptychopteridae) were studied, however, we could not agree on the identification of the different species. The midges (Chironomidae) will be studied in the future. Biting midges (Ceratopogonidae), long-legged flies (Dolichopodidae), dance flies (Empididae), shore flies (Ephydridae), limoniid crane flies (Limoniidae), hairy-eyed craneflies (Pediciidae), house flies (Muscidae), moth flies (Psychodidae), snipe flies (Rhagionidae) and dung flies (Scathophagidae) were also present in the macroinvertebrate samples of the Flemish Environment Agency, however, larvae of these families generally cannot be identified to species level. Adults of the hoverflies (Syrphidae) and crane flies (Tipulidae) have already been intensively investigated (VAN DE MEUTTER, 2011; www.waarnemingen.be) and because only a small part of their larvae is aquatic, these families were not investigated during the present study.

Larvae of water snipe-flies (Athericidae) are piercing and sucking predators, the most common prey include mayflies, caddisflies and midges. The body is tapering anteriorly and pairs of highly contractile prolegs are present on abdominal segments 1-7. Either two dorsal and two lateral short tracheal projections are located on segments 2-7 or these projections are very long and conspicuous, but only present on segments 6-7. Larvae of phantom midges (Chaoboridae) are predacious (feeding mainly on copepods), with strong mandibels and prehensile antennae. Living larvae are almost transparent and thus hard to see. The thorax is swollen and the end of the abdomen bears a fan-like row of setae ventrally, which allows them to swim rapidly. The larvae of meniscus midge (Dixidae) can often be found on the surface film of stagnant or slow-moving water. They feed on micro-organisms or particles of decaying organic matter suspended in the water column or trapped in the surface film. A pair of posterior paddles with floating hairs is used for swimming. Two or three abdominal segments bear ventral combs and the abdomen ends in a tapering caudal appendage. Snail killing flies (Sciomyzidae) live in marshes and other damp habitats, but only a few species are truly aquatic. All species predate on molluscs or their eggs and most truly aquatic larvae attack Lymnaeidae, Planorbidae and Physidae. Each larva can kill 8-30 snails during its development. The elongated body is spindle-shaped, tapering anteriorly, with a spiracular disc surrounded by fleshy lobes posteriorly. The integument is wrinkled and folded, often with transverse rows of tubercles. The well-developed mandibles are visible through the integument. Larvae of horseflies (Tabanidae) have a long body covered with longitudinal stripes. The abdomen bears three or four pairs of pseudopodia per segment. The last segment ends in a vertical stigmata opening. The chinitised head can be retracted into the thorax. Some horsefly larvae feed on detritus, while others are predators.

Material and methods

The Flemish Environment Agency sampled macroinvertebrates at several thousand locations in the context of water quality monitoring. The sampling locations are evenly spread and nearly all 5x5km UTM squares in Flanders have been sampled. A standard handnet was used to sample macroinvertebrates over a stretch of 10-20 m for approximately five minutes (GABRIELS *et al.*, 2010). During each sampling event, conductivity, dissolved oxygen and pH were measured. During the present study, all larvae of the studied families of aquatic Diptera were identified to species level. The larvae were identified using the following literature: Athericidae (THOMAS, 1997), Chaoboridae (SÆTHER, 1997), Dixidae (DISNEY, 1999), Sciomyzidae (VALA, 1989) and Tabanidae (ZEEGERS & VAN HAAREN, 2000).

Table 1. Sampled aquatic Diptera, with indication of the number of samples per water type where each species was found.

River type:	Large river	Small river	Large brook	Large Campine brook	Small brook	Small Campine brook	Polder watercourse	Lake	Total
Catchment area:	600-10000 km²	300-600 km²	50-300 km²	50-300 km²	< 50 km²	< 50 km²	Not applicable	Not applicable	
Athericidae									
Atherix ibis (Fabricus, 1798)		5		16		19			40
Atrichops crassipes (Meigen, 1820)				4		4			8
Chaoboridae									
Chaoborus (*Chaoborus*) *crystallinus* (De Geer, 1776)					2	1		1	4
Chaoborus (*Chaoborus*) *flavicans* (Meigen, 1830)	2				5	4	2	10	23
Chaoborus (*Chaoborus*) *obscuripes* (van der Wulp, 1859)						1		1	2
Chaoborus (*Peusomyia*) *pallidus* (Fabricius, 1794)					1				1
Dixidae									
Dixa nebulosa Meigen, 1830								5	5
Dixa submaculata Edwards, 1920			1		12	19			32
Dixella aestivalis (Meigen, 1818)					3	11			14
Dixella amphibia (De Geer, 1776)					5	2			7
Dixella autumnalis (Meigen, 1838)		2	2		7	5	2		18
Sciomyzidae									
Elgiva solicita (Harris, 1780)							1	1	2
Ilione (*Knutsonia*) *albiseta* (Scopoli, 1763)					2				2
Sepedon (*Sepedon*) *sphegea* (Fabricius, 1775)					4			1	5
Tetanocera arrogans Meigen, 1830							1		1
Tetanocera ferruginea Fallen, 1820	1			1	25	4	3	2	36
Tetanocera hyalipennis von Roser, 1840					1				1
Tabanidae									
Chrysops (*Chrysops*) *caecutiens* (Linnaeus, 1758)			2	2	31	39			74
Chrysops (*Chrysops*) *relictus* Meigen, 1820	7	3			6	5	5	8	34
Heptatoma pellucens (Fabricius, 1776)			2		3	3			8
Tabanus autumnalis Linnaeus, 1761	1	1	1		3	2	5	1	14
Tabanus bromius Linnaeus, 1758						2			2
Number of species:	4	4	5	4	15	15	7	9	22

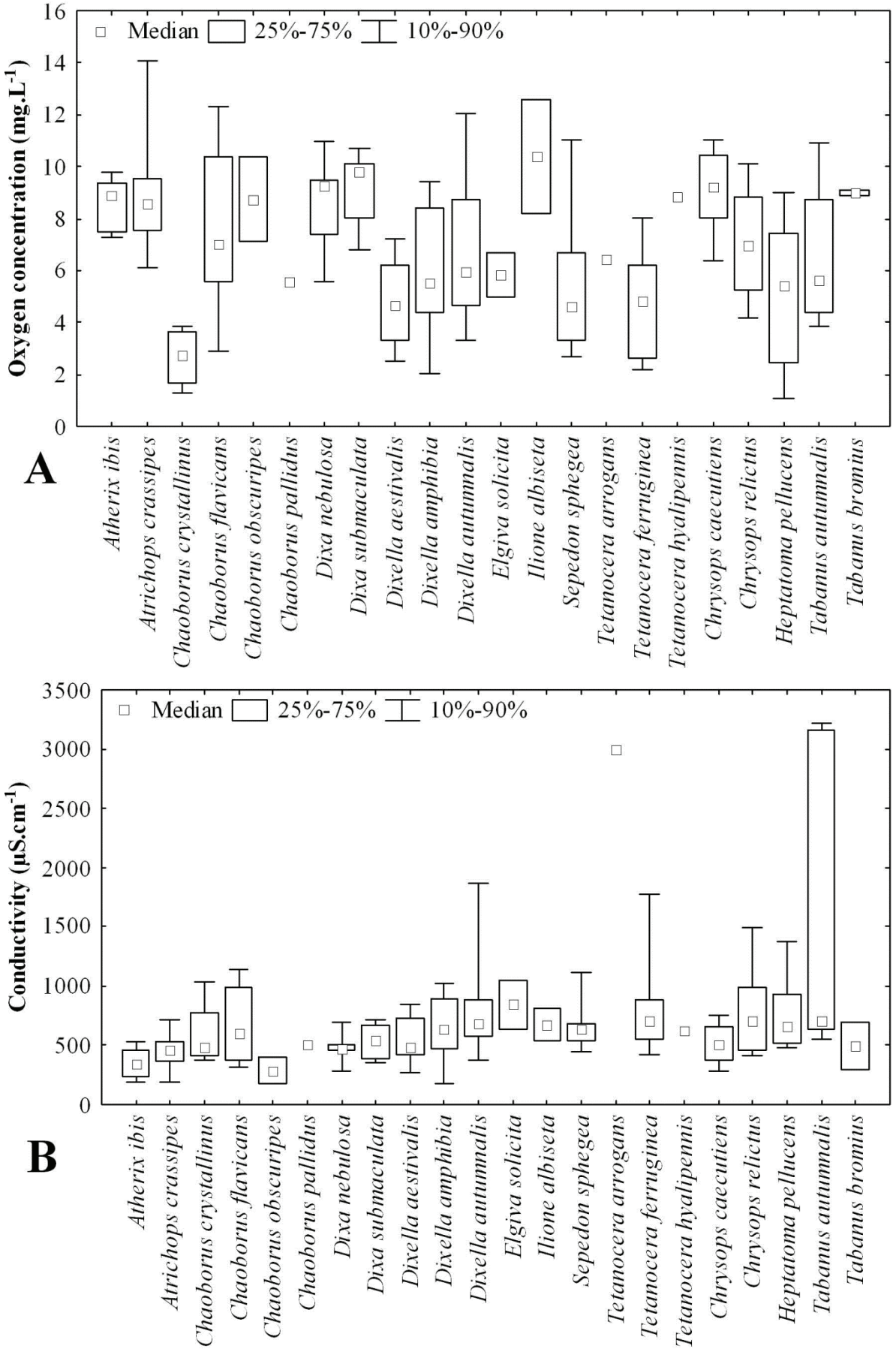

Fig. 1. Box & Whisker plots of the oxygen concentration (A) and the conductivity (B) for the encountered aquatic flies.

Results

ATHERICIDAE

Atherix ibis and *Atrichops crassipes* were only found in watercourses with high oxygen concentrations and a low conductivity (Fig. 1). Both water snipe-flies were only captured in the Campine region (Table 1, Fig. 2).

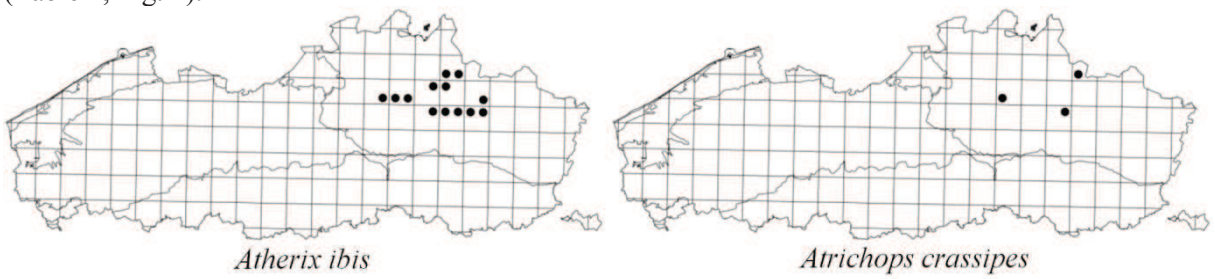

Fig. 2. Distribution of the recorded water snipe-flies (Athericidae) in Flanders.

CHAOBORIDAE

Four species of phantom midges were observed. *Chaoborus crystallinus* was found in water with a low oxygen content, whereas the other species preferred water with high oxygen levels (Fig. 1). All species were found in waters with a relatively low conductivity. All species occurred in all types of waters (Table 1). *Chaoborus flavicans* was quite common, however, the other species were rarely found (Fig. 3).

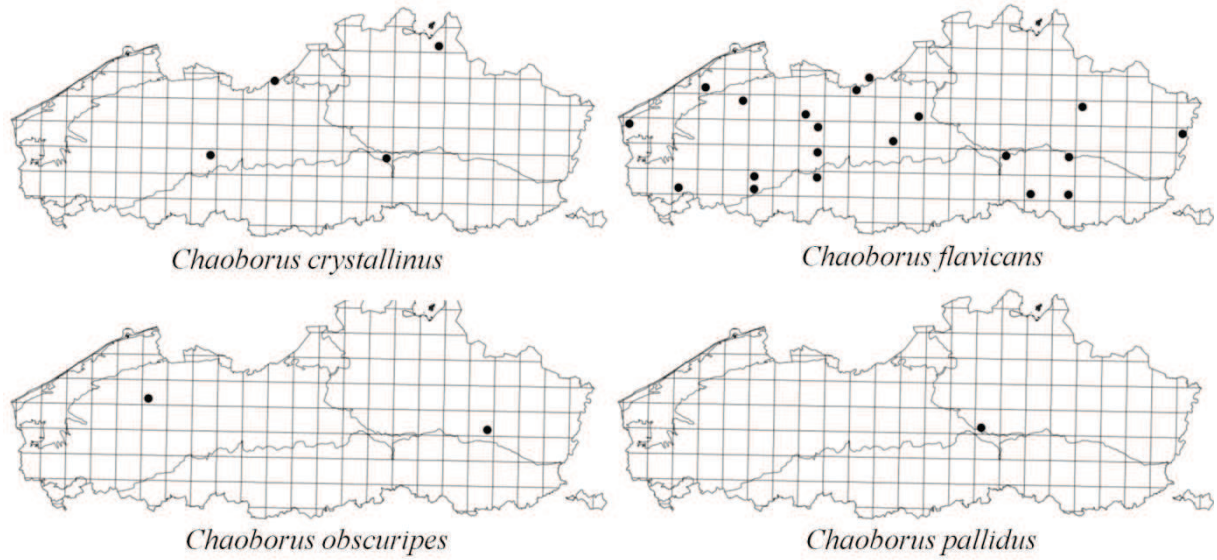

Fig. 3. Distribution of the recorded phantom midges (Chaoboridae) in Flanders.

DIXIDAE

The meniscus midges were all quite rare (Fig. 4). Both species of the genus *Dixa* preferred water with a high oxygen content, while the species of the genus *Dixella* also occurred in waters with lower oxygen concentrations (Fig. 1). Dixidae were rarely found in waters with a high conductivity. *Dixa nebulosa* was only found in lakes, whereas the other species almost exclusively occurred in brooks (Table 1).

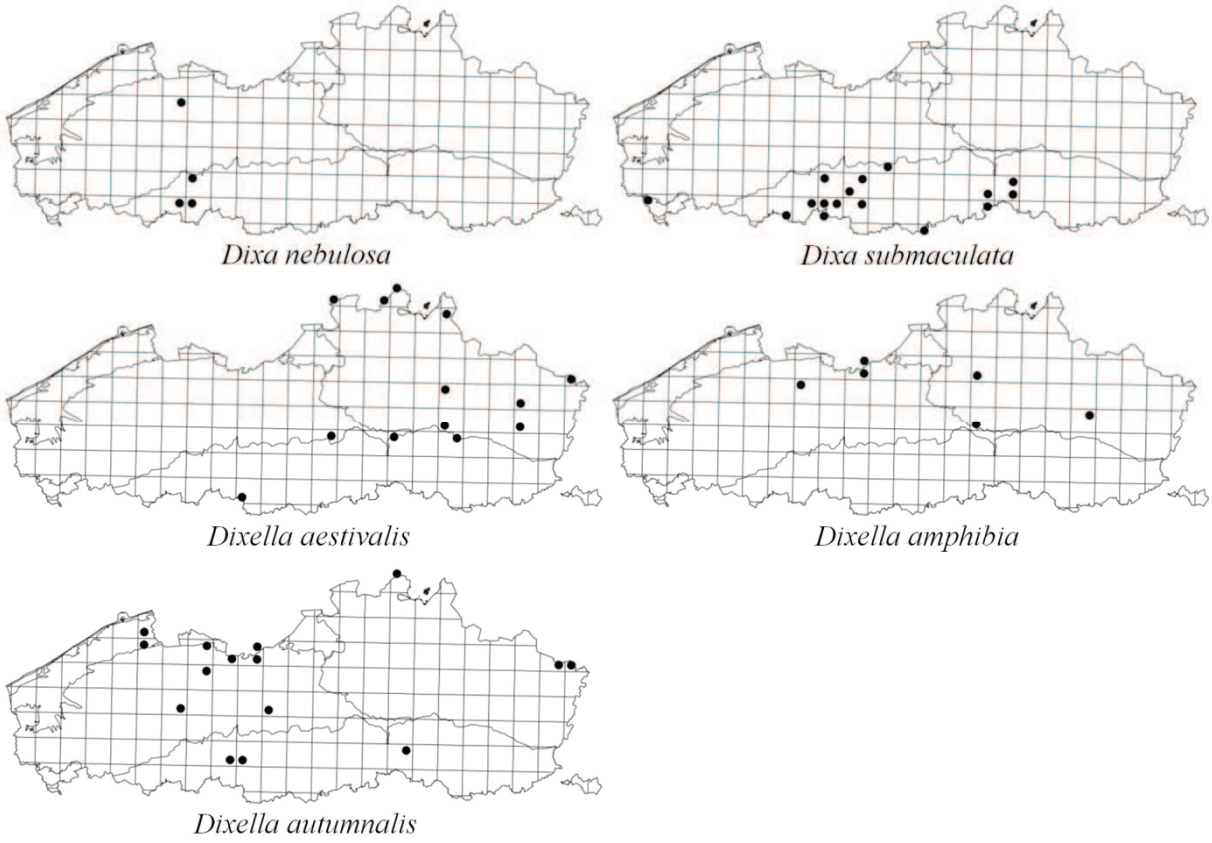

Fig. 4. Distribution of the recorded meniscus midges (Dixidae) in Flanders.

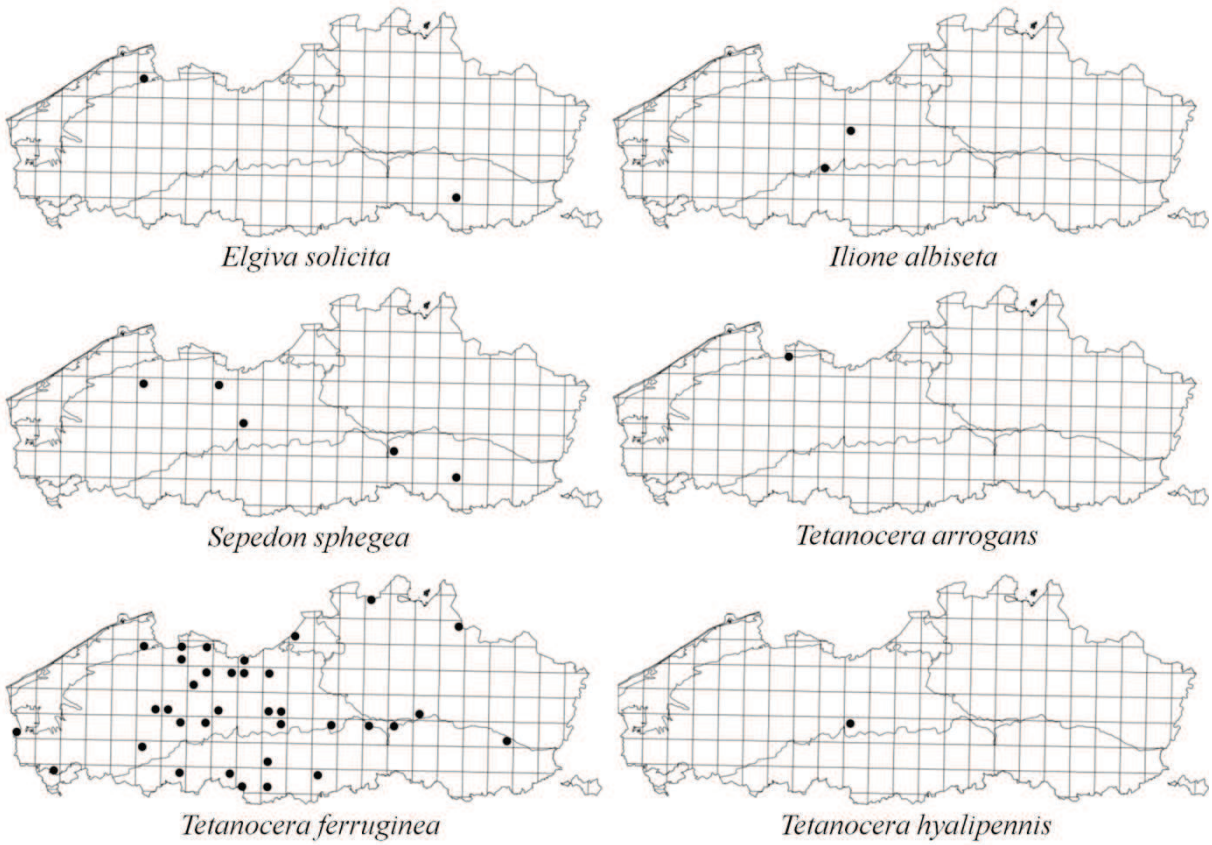

Fig. 5. Distribution of the recorded snail killing flies (Sciomyzidae) in Flanders.

SCIOMYZIDAE

Ilione albiseta preferred high oxygen concentrations, while the other species were mainly found in waters with a lower oxygen level (Fig. 1). *Tetanocera ferruginea* was regularly encountered, but the other species were only found on a few occasions (Fig. 5). *Tetanocera arrogans* was only found on one occasion in the Roeselarekreek in Sint-Laureins, a slightly brackish creek. The other species were found in waters with a lower conductivity. The snake killing flies were found in all sampled types of water (Table 1).

TABANIDAE

Chrysops caecutiens and *Chrysops relictus* were quite common, but the other three encountered horseflies were rare (Fig. 6). *C. caecutiens* was mainly sampled in small brooks, but the other species occurred in all types of waters (Table 1). *C. caecutiens* and *Tabanus bromius* preferred waters with a high oxygen content and a low conductivity, however, the other horseflies also tolerated lower oxygen concentrations and higher conductivities (Fig. 1).

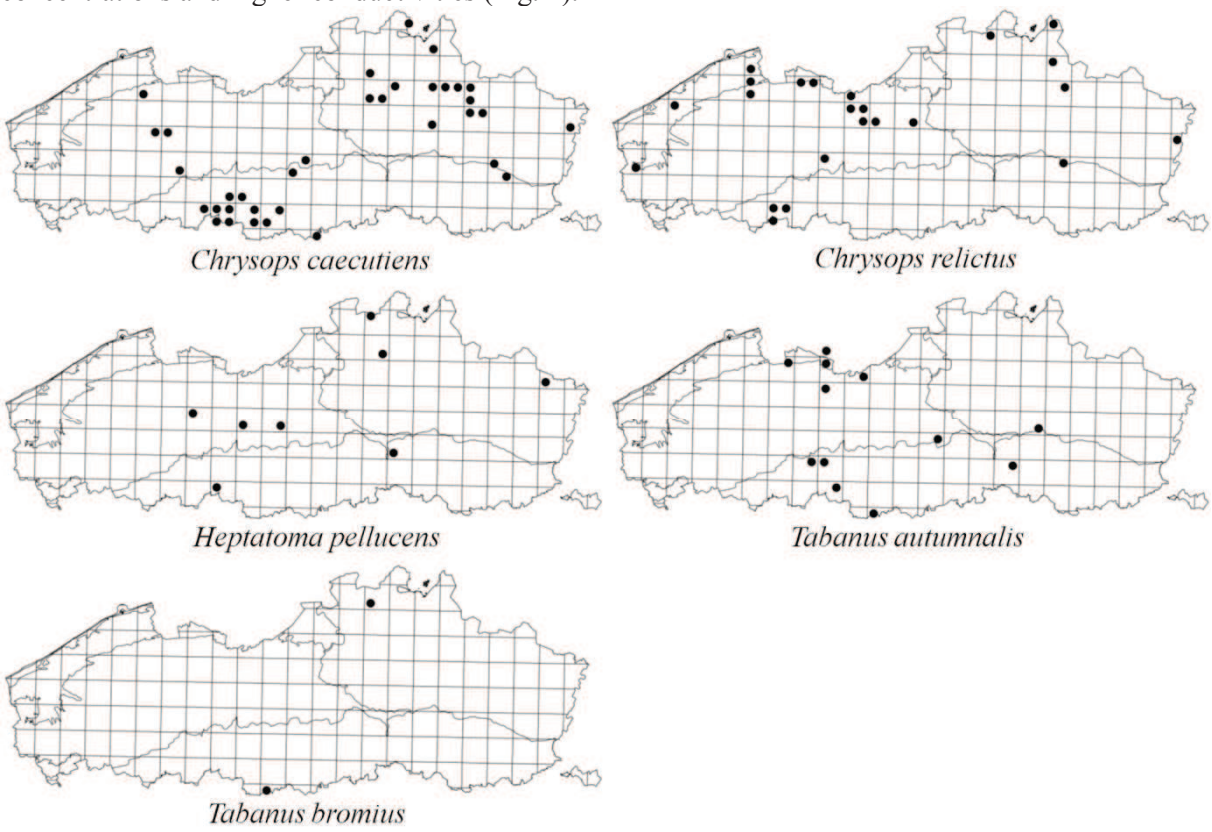

Fig. 6. Distribution of the recorded horseflies (Tabanidae) in Flanders.

Discussion

Two species of water snipe-flies (Athericidae) were observed here. Also *Ibisia marginata* (Fabricius 1781) has been reported for Belgium (GOSSERIES, 1991), but that species is limited to Wallonia. All four species of *Chaoborus*, that are present in Belgium (GOSSERIES & GODDEERIS, 1991b), were collected by the Flemish Environment Agency. The only additional genus of phantom midges (Chaoboridae) that occurs in Belgium, *Mochlonyx*, lives mainly in temporary waters such as tree cavities and was not encountered here. Five of the 11 species of meniscus midges (Dixidae) that have been reported from Belgium (GOSSERIES & GODDEERIS, 1991a) were found during the present study. As this family has hardly been studied in Belgium, it is unclear how many species occur in Flanders. LECLERCQ (1991a) mentioned 66 species of snake killing flies (Sciomyzidae) from Belgium. Here, only six species were identified, which are all common species that feed on aquatic gastropods (REVIER & VAN DER GOOT, 1989). This low species richness can partly be explained by the fact that

not all species are aquatic. In addition, the larvae of several species live inside their hosts and these were not encountered during the present study as no dissections were carried out. Only five species of the 39 horseflies (Tabanidae) that occur in Belgium (LECLERCQ, 1991b) were sampled. As the larvae of most horsefly species are not aquatic, only a limited number of species was expected. Four of the encountered species are common in Belgium, while *Chrysops caecutiens* was considered rare in Flanders (ZEEGERS & VAN HAAREN, 2000), however, during the present study, this was the most frequently encountered horsefly. The species was especially common in the basin of the river Nete and in the Vlaamse Ardennen region.

For the calculation of the Multimetric Macroinvertebrate Index Flanders (MMIF), tolerance scores ranging from 1 (indicator of a bad water quality) to 10 (indicator of a very good water quality) were assigned to all macroinvertebrate taxa and taxa with a score of at least 6 were considered to be sensitive (GABRIELS *et al.*, 2010). Athericidae and Dixidae were considered sensitive taxa and received a tolerance score of 7 and 6, respectively, while the other studied families were considered as tolerant taxa and these received a tolerance score of only 3 (GABRIELS *et al.*, 2010). These scores could generally be confirmed during the present study.

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