ON THE BIOLOGY OF *SIMULIUM ORNATUM* GROUP (DIPTERA: SIMULIIDAE)

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Abstract. Black flies of the *Simulium ornatum* group are very common in the East Baltic region. Four species of the *S. ornatum* group are known in the fauna of Lithuania: *S. intermedium* Roubaud, 1906; *S. ornatum* Meigen, 1818; *S. trifasciatum* Curtis, 1839; *S. frigidum* Rubtsov, 1940. Different species of this group are very similar morphologically, especially in larval stage. Several morphological characters recommended by different authors for the identification of *S. ornatum* larvae, as well as some morphometrical characters of the *S. ornatum* group are analysed. Some data on the distribution and seasonal activity of these species in Lithuania are given.

Key words: *Simulium ornatum*, distribution, seasonal activity, variability.

Introduction

The species *Simulium ornatum* seems to be one of those most widespread in Central Europe (Jedlička, 1978). Black flies of the *S. ornatum* group are very common in Lithuania and in Latvia. Larvae and pupae of *S. ornatum* group can be found in very different types of running water. *S. ornatum* is a pest species in Lithuania, attacking both humans and livestock. The *S. ornatum* group is known to have five species in the East Baltic area. Four species of this group are known in the fauna of Lithuania (Pakalniškis *et al*., 2006).

Different species of this group are very similar morphologically, especially in larval stage. On the other hand, larvae are the easiest to collect, because larvae of different instars can be found almost all year round in Lithuania. Some morphological characters recommended by different authors for the identification of *S. ornatum* larvae, as well as some morphometrical characters of the *S. ornatum* group are analysed in this paper.

Material and Methods

We collected larvae and pupae of the *Simulium ornatum* group in 27 different rivers in Lithuania (the Elmė, the Grūda, the Išrūginis, the Merkys, the Mūšia, the Nemėža, the Riešė, the Rudamina, the Skroblus, the Stangė, the Strauja, the Susiena, the Šventoji, the Ula, the Vilnia) and in Latvia (the Abuls, the Briede, the Brasla, the Dzelda, the Grīva, the Iecava, the Jaunpalsa, the Lāčupīte, the Koja, the Krāčupe, the Mutulīte, the Sutasgrāvis) from April to September 2007–2008 (the material from Latvia was collected by M. Kalniņš and R. Bernotienė). Nine morphological-morphometrical parameters of larvae (head width, postgenal cleft width, postgenal cleft length, head length, hypostomium width, frons-clypeus width, width and length ratio of head and postgenal cleft, marks of apotome) and four parameters of pupae (cocoon, the structure

of common gills, the corner between gills and thoracic tubercles) were checked, measured and analysed. All parameters were measured using an MBS-9 microscope, and thoracic tubercles were checked using PZO optical microscope (Poland).

All statistical calculations were made using the STATISTICA 6 package for Microsoft Windows 2000.

Data on the distribution and seasonal activity of *S. ornatum* group are based also on the data collected by the author in 1999–2004 in 44 Lithuanian rivers.

Results and Discussion

Four species of *Simulium ornatum* group are known in the fauna of Lithuania (Pakalniškis *et al.,* 2006): S*imulium (Odagmia) intermedium* Roubaud, 1906; *Simulium (Odagmia) ornatum* Meigen, 1818; *Simulium (Odagmia) trifasciatum* Curtis, 1839; *Simulium (Odagmia) frigidum* Rubtsov, 1940.

S. frigidum was not found during our investigations. This species was found in 1999–2001 in the Grėva and the Skroblus rivers in Lithuania. The identification of this species in larval stage is not so problematic, because larvae of this species can be defined by anal gills, so this species will not be analysed in this paper.

Larvae and pupae of *Simulium ornatum* group were found in 93% of investigated rivers in Lithuania. During our study, we found *S. intermedium* in five rivers out of 27 rivers investigated (the Elmė, the Merkys, the Skroblus, the Strauja and the Ūla). Black flies of this species were not very abundant in Lithuania. Larvae and pupae of this species were found in small rivers and rivers of medium size with cold (up to 15 ^{o}C) and clean water, with hard substrates (stones, gravel), in spite of the fact that larvae were found only on water plants. Black flies of *S. intermedium* overwinter as larvae, so larvae can be found from October till April. Pupae can be found twice a year in April–May and in August–September.

Black flies of *S. trifasciatum* were not abundant, either; they were found in ten rivers out of 27 rivers investigated in Lithuania (the Elmė, the Riešė, the Skroblus, the Stangė, the Susiena, the Ūla) and in Latvia (the Abuls, the Briede, the Dzelda, the Sutasgrāvis). It is known that larvae of *S. trifasciatum* are found more often and more abundantly in sandy, small (discharge 0.2–7 m^3/s), clean rivers with low pH (<8) and with different temperature regimes (6.5 to 24^{o}C) in Lithuania (Bernotienė, 2006). Data from Slovakia have shown that *S. trifasciatum* preferred minor brooks (larvae of this species were found in brooks up to 5 m wide) with gravel and stones (Jedlička, 1978). The new data from Lithuania show that at least five rivers out of 10 where *S. trifasciatum* larvae and pupae were found were characterised by a gravel or stone bottom. *S. trifasciatum* overwinter as larvae; larvae can be found from October till April. Pupae can be found twice a year in April–May and in August–September. So, larvae of this species can be found almost during all the year.

Black flies of *S. ornatum* were very abundant; they were found in all 27 rivers in Lithuania and in Latvia and were collected from April till September; however it is known that this species overwinters as larvae (Sprangauskaitė, 1998), so larvae can be found during all the year. Pupae of *S. ornatum* can be found in April–May, in July–August and September–October. Sometimes some pupae of *S. ornatum* can be found in June, but this depends on the river and on the temperature regime of a certain year. The larvae of *S. ornatum* were found more often and more abundantly in small rivers with

hard, clean water, but some larvae were found in rivers of different size and discharge (0.2–250 m^3/s), with different water temperature (6.5 to 24°C) and on different substrates.

It is very difficult to separate *S. intermedium*, *S. trifasciatum* and *S. ornatum* species by the characters of larvae. Some authors thought that these three species could not be separated in the larval stages owing to the high degree of variability, particularly in *S. ornatum* (Bass, 1998). Jensen (1997) also maintained that these species were very difficult to separate, and there were probably additional species present in North Europe. Authors, especially from East Europe, used some larval characters such as marks of apotome, for the identification of species within the *S. ornatum* group. It is thought that larvae of *S. ornatum* and *S. intermedium* have very distinct apotome marks, and the marks of *S. trifasciatum* are pale, with little pigmentation (Kaplich *et al.,* 1990; Kaplich & Skulovec, 2000). The shape of postgenal cleft was also used for species identification within the *S. ornatum* group. The postgenal cleft is round (Kaplich & Skulovec, 2000; Yankovsky, 2002; Rubzov, 1956), varying from a straight line to an inverted "V" (Davies, 1968) or square (Rubzov, 1956) in *S. ornatum.* It is oval (Kaplich & Skulovec, 2000), relatively deep (Yankovsky, 2002), extending about half the distance from the posterior tentorial pits to the base of the hypostomium, its anterior edge is rounded (Davies, 1968) in *S. intermedium.* It is shallow (Davies, 1968; Jensen, 1997) or square with a distinct anterior edge (Kaplich & Skulovec, 2000; Davies, 1968; Jensen, 1997) in *S. trifasciatum.* The number of radiuses in great fan (45–54 in *ornatum,* 49–58 in *intermedium* and 45–49 in *frigidum*) and the number of hook rows in the anal segment (60–74 or 74–80 in *ornatum,* 80–84 in *intermedium* and 66–76 in *frigidum*) were also used by some authors (Rubzov, 1956; Yankovsky, 2002) for the identification of these species, but we did not use these characters because they are overlapping between the species.

Characters of pupae are used for the identification of species by both East and West European scientists. The weaving of pupal cocoon can help to differenciate *S. intermedium* from other species of the *S. ornatum* group, as it is loosely woven within *S. intermedium* (Davies, 1968) and closely woven in other species. The shape of thoracic tubercles can help to differeciate *S. trifasciatum* from other species of the *S. ornatum* group, as they are round, hemispherical for *S. ornatum* and *S. intermedium* and some have a terminal spike in *S. trifasciatum* (Jedlicka *et al.,* 2004). Common stalks of pupal gills and the corner between border gills sometimes were used for the identification also. Every two gills have visible common stalks in *S. ornatum* and *S. trifasciatum* (Kaplich & Skulovec, 2000), but the fourth (Rubtsov, 1956) or the first and the fourth stalks are longer (Yankovsky, 2002) in *S. ornatum.* On the other hand, every two gills have very short common stalks (Kaplich & Skulovec, 2000) in *S. intermedium*, and the second stalk is especially short (Rubtsov, 1956); the first to fourth gills are two times thicker than the fifth to eighth (Yankovsky, 2002). The corner between the border gills can varry from 60° in *S. ornatum* (Yankovsky, 2002), 120° (Yankovsky, 2002) or 180° (Kaplich & Skulovec, 2000) in *S. intermedium* and about 180° (Kaplich & Skulovec, 2000) in *S. trifasciatum.* We identified collected pupae using thoracic tubercles, the structure of common gills, weaving of pupal cocoons and some other parameters.

We noticed that the corner between gills varied in the same species and could not be used as the character for the species identification. The corner between gills was similar (about 120°) in *S. ornatum* and *S. trifasciatum* in figures in some keys for the

identification of black flies (Lechthaler & Car, 2005). In many cases pupae of *S. ornatum* had a gill structure that can be determined as 2+2+4, and *S. trifasciatum* had a 2+2+2+2 gill structure. The structure of *S. intermedium* was 2+2+4 (64%) or 2+2+2+2 (36%) as well.

The analysis of the morphometric parameters of larvae of different species showed that there were no statistically reliable differences among three species of the *S. ornatum* group (Table 1). Differences in head length and hypostomium width between *S. intermedium* and *S. trifasciatum* were statistically reliable.

Table 1. Morphometric parameters of different species of *Simulium ornatum g*roup (mean ± SD, statistically reliable differences are underlined)

Characters	*S. intermedium* n = 12	*S. trifasciatum* n = 34	*S. ornatum* n = 92
Head width (mm)	0.72±0.04	0.66±0.08	0.68±0.05
Head length (mm)	0.94 ± 0.02	0.85 ± 0.1	0.89±0.08
Width and length ratio of head	1.31 ± 0.07	1.30 ± 0.09	1.30 ± 0.1
Clypeus width (mm)	0.52 ± 0.04	0.51 ± 0.45	0.52 ± 0.05
Hypostomium width (mm)	0.59 ± 0.02	0.51 ± 0.05	0.56 ± 0.06
Postgenal cleft width (mm)	0.42 ± 0.04	0.38 ± 0.04	0.41 ± 0.06
Postgenal cleft length (mm)	0.28 ± 0.03	0.26 ± 0.04	0.28 ± 0.04
Width and length ratio of postgenal cleft	1.52 ± 0.07	1.5 ± 0.2	1.55 ± 0.36
Apotome marks	Distinct (67%)	Pale (77%)	Distinct (57%)

The investigated morphological-morphometrical parameters varied within one species during the season. Larvae collected in spring were always larger in all measured parameters than larvae collected in the second part of summer (Table 2). Only few larvae of *S. intermedium* were collected, so data only on two species - *S. ornatum* and *S. trifasciatum* - are shown in Table 2.

Table 2. Morphometric parameters of larvae from different (spring and summer) generations of *Simulium ornatum* and *Simulium trifasciatum* (mean ± SD, statistically reliable differences are underlined)

Characters	*S. ornatum*		*S. trifasciatum*	
	April–May	July–August	April–May	July–August
Head width (mm)	0.71 ± 0.05	0.67 ± 0.05	0.75 ± 0.04	0.63 ± 0.08
Head length (mm)	0.90 ± 0.08	0.88 ± 0.07	0.95 ± 0.05	0.82 ± 0.08
Width and length ratio of head	1.26 ± 0.11	1.32 ± 0.1	1.30 ± 0.09	1.30 ± 0.1
Clypeus width (mm)	0.53 ± 0.06	0.52 ± 0.04	0.57 ± 0.05	0.49 ± 0.04
Hypostomium width (mm)	0.58 ± 0.06	0.55 ± 0.06	0.60 ± 0.04	0.48 ± 0.03
Postgenal cleft width (mm)	0.42 ± 0.03	0.41 ± 0.07	0.43 ± 0.02	0.36 ± 0.02
Postgenal cleft length (mm)	0.30 ± 0.03	0.26 ± 0.04	0.25 ± 0.04	0.25 ± 0.04
Width and length ratio of postgenal cleft	1.39 ± 0.2	1.60 ± 0.39	1.78 ± 0.3	1.45 ± 0.17
Apotome marks	distinct (82%)	Pale (53%)	Pale (67%)	Pale (70%)

Several authors pointed to a decrease of the total length of both imagos and larvae of a summer generation as compared with a spring generation (Jedlička, 1978). It is known that temperature is very important for the development of black flies, so the temperature is thought to be the main factor provoking the variability of the measured parameters. Their seasonal as well as geographical variability are also known, but both variabilities of black flies depend on different thermal regimes. So, morphometric parameters should be used in the taxonomy of black flies with a particular caution.

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Kai kurie *Simulium ornatum* grupės upinių mašalų (Diptera: Simuliidae) biologijos bruožai

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Santrauka

Simulium ornatum grupės upiniai mašalai yra dažnai aptinkami Rytų Baltijos regione. Lietuvoje žinomos keturios šiai upinių mašalų grupei priklausančios rūšys: S. *intermedium* Roubaud, 1906; *S. ornatum* Meigen, 1818; *S. trifasciatum* Curtis, 1839; *S. frigidum* Rubtsov, 1940. Šiai rūšių grupei priklausančios skirtingos rūšys yra labai panašios savo morfologija, ypač lervos stadijoje. Keletas morfologinių požymių, įvairių autorių nurodyti kaip tinkami rūšių nustatymui, o taip pat keli morfometriniai požymiai yra analizuojami šiame darbe. Pateikiami duomenys apie *S. ornatum* grupės upinių mašalų paplitimą bei sezoninį aktyvumą Lietuvoje.

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