Notes on *Lasioptera rubi* (Schrank) (Diptera: Cecidomyiidae) and its larval parasitoids (Hymenoptera) on raspberries in Russia

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In this paper, larva and pupa of *Lasioptera rubi* (Schrank) infected by hymenopteran parasitoids are illustrated. For the first time it is found that *Platygaster pelias* Walker is a solitary parasite and winters at the embryonal stage inside host larva of *L. rubi* reared from galls on *Rubus idaeus* stems in Russia. *Lasioptera rubi*, *Torymus eadyi* Graham & Gijswijt and *Platygaster pelias* Walker are recorded from Russia for the first time.

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1. Introduction

The raspberry stem gall midge *Lasioptera rubi* (Schrank, 1803) (Diptera, Cecidomyiidae) occurs from Western Europe to the Far East of Russia and Japan (Yukawa et al. 2014). In Russia, it is widely distributed in the middle and southern parts. It has also been recorded in western Siberia (the Yenisei Siberia) (Kolomoets et al. 1989, Gerasimchuk 2008) and near Krasnoyarsk (Gagne 2004).

The damage inflicted on raspberry (*Rubus idaeus* Linnaeus) by galls of *L. rubi* (Fig. 1a) inhibits the growth of plants and causes partial desiccation of stems, which may break due to strong winds. Galls may also reduce crop yields in raspberry. The raspberry stem gall midge (Fig. 2b) can fly for considerable distances (own unpublished data). The orange-red larvae (Fig. 3c) reside under the bark of young stems, creating fusiform or irregularly globular swellings. Larvae cocoon, pupate and overwinter in the galls on the stems of raspberries and blackberries. In central Russia, the lengths of gall midge larvae observed by Batysheva (1982) are equal to 2.0–3.0 mm in 56.3–86.3% of cases and to 0.7–1.6 mm in others.

In Europe, the complex of parasitoids reared from *L. rubi* comprises 16 species of Chalcidoidea and one species of Platygastridae (Table 1). The assemblage includes four species of *Aprostocetus* and *Sigmophora brevicornis* (Eulophidae: Tetrastichiniae), three species of *Eupelmus*, *Eurytoma* and *Torymus* each, one species of Pteromalidae and one of *Platygaster* (Platygastridae).

Here we illustrate the larval instars of *L. rubi*, report the development of its parasitoids, and pro-
Table 1. Hymenopterous parasitoid species reared from *Lasioptera rubi* mines by different authors during 1966–2006.

| Parasitoid family and species | Authors | Country                          |
|------------------------------|---------|----------------------------------|
| **Eulophidae**               |         |                                  |
| *Aprostocetus roesellae* Nees, 1834 | Domenichini 1966, Herting 1978 | Italy, Great Britain, Russia (Far East of Russia) |
| *A. rubi* Graham, 1987        | Graham 1987, Jennings 2005     | Russia (the Czech Republic), Finland, France, Germany, Sweden, Yugoslavia (Serbia) |
| *A. rubicola* Graham, 1987    | Graham 1987                        | Germany                              |
| *A. tymber* Walker, 1839      | Domenichini 1966, Simova-Tosic & Dobrivojevic 1966, Bouek 1977, Viggiani & Mazzone 1978 | Austria, Czechoslovakia (the Czech Republic), France, Germany, Great Britain, Hungary, Netherlands, Sweden |
| **Sigmophora brevicornis** (Panzer, 1804) | Thompson 1955 | Germany, France                  |
| **Eupelmidae**               |         |                                  |
| *Eupelmus fulvipes* Förster, 1860 | Bouček 1977, Herting 1978         | Yugoslavia (Serbia) |
| *E. urozonus* Dalman, 1820    | Simova-Tosic & Dobrivojevic 1966, Tudor & Neacsu 1983 | Yugoslavia (Serbia) |
| **E. vesicularis** (Retzius, 1783) | Thompson 1955, Herting 1978, Viggiani & Mazzone 1978, Tudor & Neacsu 1983 | Germany, France, Italy, Romania |
| **Eurytomidae**              |         |                                  |
| *Eurytoma aterrima* (Schrank, 1781) | Thompson, 1955 | Germany, France |
| *E. curculionum* Mayr, 1878   | Bouček 1977                        | Yugoslavia (Serbia) |
| *E. roae* Nees, 1834          | Bouček 1977, Popescu 2006          | Yugoslavia (Serbia), Romania |
| **Sycophila submutica** (Thomson, 1876) | Herting 1978 | Great Britain |
| **Pteromalidae**             |         |                                  |
| *Mesopolobus rhabdophagae* (Graham, 1957) | Herting 1978 | Great Britain |
| **Torymidae**                |         |                                  |
| *Torymus chloromerus* (Walker, 1833) | Herting 1978, Stenseth 1978       | Norway                              |
| *Torymus eadyi* Graham & Gijswijt, 1998 | Graham & Gijswijt 1998, Popescu 2003, Zerova & Seryogina 2003 | Great Britain, Ukraine |
| **T. rubi** (Schrank, 1781)   | Bouček 1977, Herting 1978         | Yugoslavia (Serbia) |
| **Platygastridae**           |         |                                  |
| *Platygaster pelias* Walker, 1836 | Vlug 1995 | England, Sweden, Spain, Norway, Finland, Estonia, Denmark |

provide new ecological and faunistic data on parasitoids associated with this gall midge. Although *Platygaster pelias* Walker is well-known as a parasitoid of *L. rubi*, its life history has not been described in details.

2. Materials and methods

The study was carried out in June 2009–July 2010 in two localities of the Ulyanovsk Region: the village of Staraya Mayna (68 km E from
Ulyanovsk, 54°36' N, 48°55' E) and the city of Ulyanovsk (the western bank of the river Volga, 54°19' N, 48°22' E). Altogether 530 galls of L. rubi were collected on raspberries from these localities.

Part of the stem, together with a gall, comprising 5–7 cm on either side of the gall, was cut from the lower and middle parts of the stem. After cutting the stems, galls of L. rubi were placed in plastic vials (80×15 mm) with filter paper and were kept in the laboratory at a temperature of +20–22 °C and shaded from direct sunlight. Selected emergent adults were killed in 75% ethanol for identification.

A total of 153 galls were dissected to determine the number of larvae of L. rubi per gall. The
remaining 377 galls were kept in containers for further rearing: 20% of them became moldy (76 galls), and the rest yielded a total of 582 *L. rubi* adults, 178 specimens of *Platygaster pelias* (Proctotrupoidae: Platygastriidae), 28 specimens of *Aprostocetus rubi* (Chalcidoidea: Eulophidae) and 17 specimens of *Torymus eadyi* (Chalcidoidea: Torymidae). The parasitoids were identified using the keys provided by Trjapitzin (1978), Storozhueva et al. (1995) and Buhl (2006). Voucher specimens are deposited in the Zoological Institution of Russian Academy of Sciences (ZISP), St.-Petersburg, Russia.

### 3. Larval and pupal stages of *Lasioptera rubi*

Dissected galls revealed different numbers of the raspberry stem gall midge larvae (3–5 larvae in 32 cases, 6–8 in 61 cases, 9–11 in 45 cases and 13–14 in 15 cases). Most galls (69%) contained from 6 to 11 larvae (average = 7.91, S. D. = 3.15, n = 153).

The third instar larva of *L. rubi* is initially orange-yellow (Fig. 1c). At 3.0–3.5 mm length it begins to pupate and young pupa is still orange-yellow dorsally and ventrally (Fig. 1d, e). The pupa is subsequently turning dark-brown and matures (Fig. 1f).

### 4. Hymenopteran parasitoids infecting larvae of *L. rubi*

No hymenopterous pupal parasitoids were found in this study.

#### 4.1. *Platygaster pelias* Walker, 1836 (*Platygastridae*)

**Material.** The species was represented by 178 specimens: 110♀, 10♂, reared from galls of *L. rubi* on stems of *R. idaeus* 15.7.2009, Ulyanovsk, 6.6.2009 E. N. Yegorenkova leg.; 50♀, 8♂, reared from galls of *L. rubi* on stems of *R. idaeus* 20.7.2010, Staraya Mayna, Ulyanovsk province, 14.VI.2010 E. N. Yegorenkova leg.

**Comments.** This species is distributed in England, Sweden, Spain, Norway, Finland, Estonia and Denmark (Vlug 1995, Austin et al. 2005, Buhl 2006), and in this study as a new record in Russia.

**Biology.** The species is a larval parasitoid of Orthoptera, Hemiptera, Neuroptera, Coleoptera, Diptera and Lepidoptera. Among Cecidomyiidae (Diptera), *L. rubi* has also been mentioned (Vlug 1995).

*Platygaster pelias*, an egg-larval parasitoid, has never been mentioned from Russia (Buhl 2006). We observed the eggs and larvae of *L. rubi* infected by *P. pelias* (Fig. 2a). It means that the parasitoids overwinter as embryos. In spring of the following year, the parasitoids develop and emerge in July. Sex ratio (males: females) for adults of *P. pelias* reared in laboratory was 18:160. A dark yellow-brownish pre-pupa of *P. pelias* is clearly visible inside the *L. rubi* larva, to which it is attached by a filament (Fig. 2b). The sternal spatula of *L. rubi* is also visible in ventral view. The adult of *P. pelias* breaks through the head of the *L. rubi* larva using its mandibles to make a hole (Fig. 2c). In all cases there was one *P. pelias* pupa per prepupal larva of the host that formed a single parasitoid (Fig. 2b, c). This suggests that only one parasitoid larva develops in each host, and therefore it is a solitary parasitoid. Several larvae of *L. rubi* were found with *P. pelias* that had reached the adult stage. So this species of *Platygaster* is monembryonic as for example *Platygaster matsutama* Yoshida & Hirashima that has been reared from *Thecodiplosis japonensis* (Diptera: Cecidomyiidae) (Jeon et al. 1985). We establish solitary parasitism of *P. pelias* in *L. rubi* for the first time.

#### 4.2. *Torymus eadyi* Graham & Gijswijt, 1998 (*Torymidae*)

**Material.** The species (Fig. 2f) was represented by 21 specimens: 14♀, 3♂, reared from galls of *L. rubi* on *R. idaeus* stems, 15.VII.2009, Ulyanovsk, 6.VI.2009 E. N. Yegorenkova leg.; 1♀, 3♂, reared from galls of *L. rubi* on *R. idaeus* stems, 20.VII.2010, Staraya Mayna, Ulyanovsk province, 14.VI.2010 E. N. Yegorenkova leg.

**Comments.** The species is distributed in Bulgaria, France, Netherlands, Romania, Ukraine,
and England (Graham & Gijswijt 1998, Zerova & Seryogina 2003), and in this study as a new record in Russia as it has not been recorded from the Middle Volga Region and Russia earlier (Zerova & Seryogina 2003).

Lasioptera rubi has always been mentioned as the only host of *T. eadyi* (Graham & Gijswijt 1998, Popescu 2003, Zerova & Seryogina 2003). Female:male ratio for reared adults was 15:6.
4.3. *Aprostocetus rubi* Graham, 1987 (Eulophidae)

*Material.* Only females were reared: 28 ♀, reared from galls of *L. rubi* on *R. idaeus* stems, 10.–12.VIII.2009, Ulyanovsk, 6.VI.2009 E. N. Yegorenkova leg.

*Other material examined.* 1♀, Germany Baden, Wurttembert, Heilbronn, 3.V.2006 ex *Lasioptera rubi*, K. Schrameyer leg., S. Schmidt det. 2007.

*Additions to original description* (Graham 1987). Female (Fig. 2d) (length 1.3–1.9 mm) (1.8–2.5 mm in Graham 1987). Body black. Antennae fuscous. Legs yellowish with black coxae. POL (The minimum distance between the posterior ocelli) 2.0 times as OOL (The minimum distance between the eye margin and the nearest posterior ocellus). Antenna with 3 anellii (Fig. 3a).

Propodeum 3.1–3.2 times as broad as long, strongly reticulate with median carina, callus with 1 seta. Distance between submedian lines 1.4 times that between submedian and lateral lines. Dorsellum 1.25 times as long as propodeum Forewing (Fig. 3b): Marginal vein of forewing with 10–11 setae (10–15 in Graham 1987). Last tergite as long as broad (1.0–1.4 in Graham 1987). Ovipositor sheaths projecting by 0.26 × length of last tergite (0.2–0.5 in Graham 1987).

Genitalia (Fig. 3c): outer plates of ovipositor (T9+T10) 3.1 times as long as broad, 1.3 times as long as inner plates of ovipositor, and 3.3 times as long as ovipositor sheaths. First and second valvulae 1.1 times as long as projecting part of sheaths.

*Comments.* The species is distributed in the Czech Republic, Finland, France, Germany, Netherlands, Sweden, United Kingdom, Yugo-
slavia (Serbia) (Graham 1987)) and Far East of Russia (Storozheva et al. 1995, Yefremova 2002) and has been mentioned as a host of *L. rubi* (Graham 1987, Jennings 2005) and *Dias tropus rubi* (Bouché 1834) (Hymenoptera: Cynipidae) (Askew et al. 2006). *Aprosti cetus rubi* has not been reared from galls in the Middle Volga Region earlier, it had been collected only by sweeping (Yegorenkova et al. 2007). In some cases the prepupa of *A. rubi* may occupy almost 90% of the volume of the host body (Fig. 2e). It means that it is a solitary endoparasitoid. In Fig. 2e, a well-developed head of a parasitoid is adjacent to the head of the host larva, whose dark-coloured eyes are clearly visible.

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