

Phenology of some chironomid species (Diptera, Chironomidae) of the Middle Urals

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Krashennnikov AB. 2012. Phenology of some chironomid species (Diptera, Chironomidae) of the Middle Urals. *Fauna norvegica* 31: 55-63.

Flight period results of chironomid species from the Middle Urals are grouped into eight categories. Six different peaks of chironomid flight activity during the year are established, namely: early-spring, late-spring, July, late-summer, early-autumn and winter. The flight periods of chironomids from the Middle Urals and southern Swedish lakes are compared.

doi: 10.5324/fn.v31i0.1371. Received: 2011-11-02. Accepted: 2012-06-22.

Published on paper and online: 2012-10-17.

Keywords: Chironomidae, phenology, Middle Urals, Russia

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INTRODUCTION

Dynamics of seasonal activity of the imago is an important aspect of insect ecology. Differences in the development cycles of chironomids are observed depending on climatic conditions, geographical location and latitude (Brundin 1949). These differences enable the adults of various non-biting midge species to modify their emergence depending on cyclically varying environmental conditions which occur throughout different periods of the year (or from year to year), such as favorable or adverse weather, fluctuations in food resources for the larvae, etc. Studying the phenology is important for understanding the ecological adaptations of different species to climatic conditions in a region and it enables predictions to be concerning the status of insect's populations. In Russia, detailed data on chironomid phenology is included in the works of Shilova (1976) for the Rybinsk Reservoir and of Yavorskaya (2010) for the Lower Amur River basin.

Data on chironomid phenology is very incomplete because the non-biting midge fauna of the Urals is very poorly studied. Tauson (1947), Gromov (1951, 1953), Aleksevina (1988), Pankov (2004) and Pozdeev (2010) have conducted investigations of the chironomid fauna in this region have, but most of these studies concentrated their attention only on the immature stages.

The main purpose of this work was to investigate chironomid phenology of the subfamilies Diamesinae, Prodiamesinae and Orthoclaadiinae in the Middle Urals.

MATERIAL AND METHODS

The material for this investigation was collected from 2004 to 2011 at 28 sites in the Middle Urals (including lotic and lentic waters). Two sites were studied regularly, the first was located on the Sylva River (between the village of Torgovishche and the town of Suksun) and the second was located at the outflow of the hydrosulphuric spring by the Irgina River near the town of Klyuchi. At these two sites adult male chironomids were collected every 7–10 days from 2009 to 2010 mainly with sweep nets. The material was preserved in Oudemans' solution and later mounted on slides in Berlese's fluid or Euparal.

Publications of Makarchenko (1985, 1998, 2006), Makarchenko and Makarchenko (2005, 2006a, b, 2009a, b, 2010a, b, c), Brundin (1947, 1949, 1956, 1966), Cranston and Sæther (1982), Cranston et al. (1989), Fu et al. (2009, 2010a, 2010b), Hirvenoja (1973); Hirvenoja and Hirvenoja (1988), Langton and Pinder (2007), Lehmann (1969, 1972), Oliver and Roussel (1983), Rossaro and Lencioni (2000), Sæther (1969, 1975, 1976, 1977, 1985a, 1985b, 1989, 1990, 1995, 2004), Sæther and Wang (1995) Sæther et al. (1984), Schlee (1968), Strenzke (1950, 1960), Tuiskunen (1985, 1986), Tuiskunen and Lindeberg (1986) and Willassen et al. (2005) were used for identification. The Sylva River site is hyporhithral and the water chemistry (averaged for 2003) is as follows: pH 8.06; total dissolved solids 0.387 g/l; O_2 10.54 mg/l; $N_{NH_4^+}$ 0.25 mg/l; NO_2^- 0.03 mg/l; NO_3^- 2.24 mg/l; PO_4^{3-} 0.06 mg/l; SO_4^{2-} 73.91 mg/l; Cl^- 4.91 mg/l.

The Irgina River site is metarhithral and the water chemistry (for July 2005) is as follows: pH 8.81; O₂ 11.03 mg/l; total dissolved solids 0.142 g/l; SO₄²⁻ 48.97 mg/l; PO₄³⁻ 0.054 mg/l; N_{NH₄⁺} 168.0 mg/l; NO₂⁻ 0.02 mg/l. Water chemistry of the hydrosulphuric spring (for July 2005) is as follows: pH 7.82; O₂ 11.19 mg/l; H₂S and S²⁻ 0.1 mg/l; total dissolved solids 0.387 g/l; SO₄²⁻ 75.60 mg/l; PO₄³⁻ 0.1 mg/l; N_{NH₄⁺} 307.2 mg/l; NO₂⁻ 0.01 mg/l. One of the interesting features of the microorganisms in the spring is the large number of colorless filamentous sulfur-oxidizing bacteria *Thiothrix* sp. and photoautotrophic purple bacteria *Chromatium* sp.

RESULTS

The results of these studies revealed differences in flight periods for different species: 13 species fly only in spring, 19 species fly from spring to summer, 15 species fly from spring to autumn, 34 species fly only in summer, six species fly from summer to autumn, four species fly in spring and in autumn, three species fly only in autumn and one species flies from autumn to spring including winter.

Fly only in summer: *Acamptocladus reissi* Cranston et Sæther, 1981; *Allocladius nanseni* (Kieffer, 1926); *Bryophaenocladus akiensis* (Sasa, Shimomura et Matsuo, 1991); *B. inconstans* (Brundin, 1947); *Corynoneura aurora* Makarchenko et Makarchenko, 2010; *C. lacustris* Edwards, 1924; *Cricotopus* (s. str.) *albiforceps* (Kieffer, 1916); *C.* (s. str.) *bicinctus* (Meigen, 1818); *C.* (s. str.) *festivellus* (Kieffer, 1906); *C.* (s. str.) *cf. politus*

(Coquillett, 1902); *C.* (s. str.) *similis* Goetghebuer, 1921; *C.* (s. str.) *triannulatus* (Macquart, 1826); *C.* (s. str.) *vierriensis* Goetghebuer, 1935; *C. (Isocladus) laetus* Hirvenoja, 1973; *C. (I.) obnixus* (Walker, 1856); *Doncricotopus dentatus* Tuiskunen, 1985; *Limnophyes angelicae* Sæther, 1990; *L. edwardsi* Sæther, 1990; *Metriocnemus* (s. str.) *atriclava* Kieffer, 1921; *M.* (s. str.) *caudigus* Sæther, 1995; *Nanocladus* (s. str.) *balticus* (Palmén, 1959); *N.* (s. str.) *distinctus* (Malloch, 1915); *Odontomesa fulva* (Kieffer, 1919); *Parakiefferiella smolandica* (Brundin, 1947); *Paratrichocladus goetghebueri* Spies, 2011; *Pseudosmittia danconai* (Marcuzzi, 1947); *Pseudosmittia mathildae* Albu, 1968; *Potthastia longimanus* Kieffer, 1922; *Rheocricotopus (Psilocricotopus) atripes* (Kieffer, 1913); *Rh. (P.) chalybeatus* (Edwards, 1929); *Smittia controversa* Makarchenko et Makarchenko, 2005; *S. nudipennis* (Goetghebuer, 1913); *S. pratorum* (Goetghebuer, 1927); *Thienemanniella oyabedilata* Sasa, Kawai et Ueno, 1988.

Fly from spring to summer: *Acricotopus lucens* (Zetterstedt, 1850); *Bryophaenocladus ictericus* (Meigen, 1830); *B. subparallelus* (Malloch, 1915); *Corynoneura arctica* Kieffer, 1923; *C. carriana* Edwards, 1924; *C. gratias* Schlee, 1968; *C. scutellata* Winnertz, 1846; *Cricotopus (Isocladus) cf. intersectus* (Stæger, 1839); *Limnophyes asquamatus* Søgaard Andersen, 1937; *L. minimus* (Meigen, 1818); *Metriocnemus* (s. str.) *eurynotus* (Holmgren, 1883); *M.* (s. str.) *picipes* (Meigen, 1818); *Nanocladus* (s. str.) *cf. minimus* Sæther, 1977; *Paracladius conversus* (Walker, 1856); *Paratrichocladus rufiventris* (Meigen, 1830); *Prodiamesa olivacea* (Meigen, 1818); *Pseudodiamesa nivosa* (Goetghebuer, 1928); *Rheocricotopus*

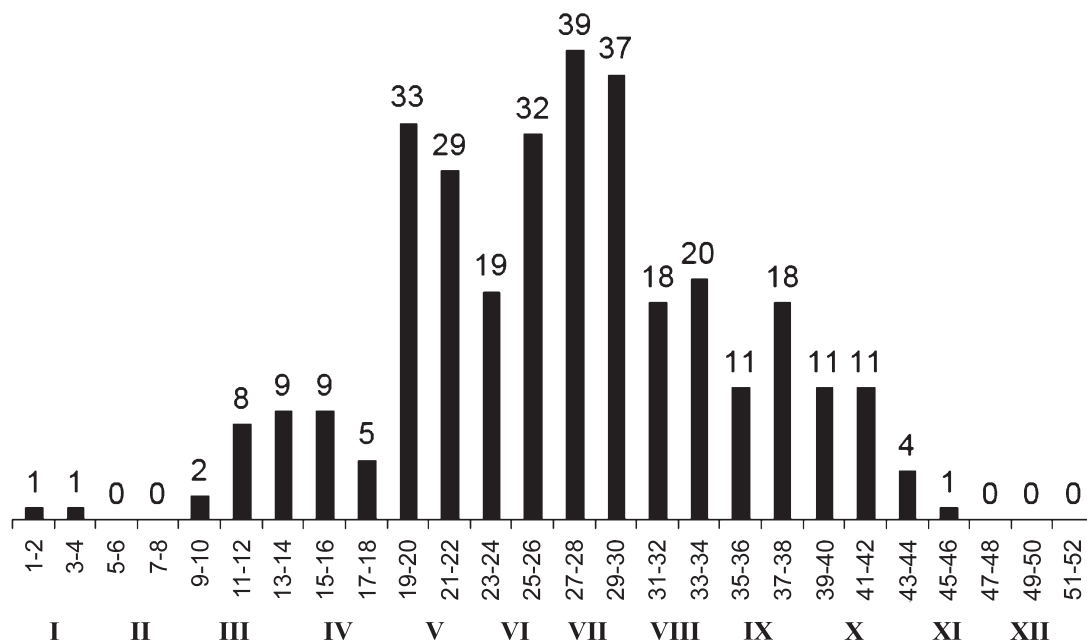


Figure 1. Dynamics of chironomid species diversity in the Middle Urals through the year. Numbers of weeks (Arabic numbering) and months (Roman numbering) are specified.

(*Rheocricotopus*) *effusus* (Walker, 1856); *Tavastia yggdrasilia* Brodin, Lundström and Paasivirta, 2008.

Fly from spring to autumn: *Bryophaenocladus vernalis* (Goetghebuer, 1921); *Camptocladus stercorarius* (De Geer, 1776); *Corynoneura lobata* Edwards, 1924; *Cricotopus* (s. str.) *cf. algarum* (Kieffer, 1911); *C.* (s. str.) *tibialis* (Meigen, 1804); *C. (Isocladus) cf. sylvestris* (Fabricius, 1794); *Eukiefferiella gracei* (Edwards, 1929); *Limnophyes natalensis* (Kieffer, 1914); *Limnophyes pumilio* (Holmgren, 1869); *Metriocnemus* (s. str.) *fuscipes* (Meigen 1818); *Pseudosmittia trilobata* (Edwards, 1929); *Smittia aterrima* (Meigen, 1818); *S. extrema* (Holmgren, 1869); *S. leucopogon* (Meigen, 1804); *Thienemanniella obscura* Brundin, 1947.

Fly only in spring: *Chaetocladus* (s. str.) *piger* (Goetghebuer, 1913); *Ch.* (s. str.) *suecicus* (Kieffer, 1916); *Cricotopus* (s. str.) *flavocinctus* (Kieffer, 1924); *Diamesa parancysta* Serra-Tosio, 1983; *Hydrobaenus cf. maladistinctus* Makarchenko et Makarchenko, 2009; *H. vernus* Krashenninnikov et Makarchenko, 2011; *Metriocnemus* (s. str.) *albolineatus* (Meigen, 1818); *M.* (s. str.) *tristellus* Edwards, 1929; *Paraphaenocladus pseudirritus* Strenzke, 1950; *Pseudodiamesa branickii* (Nowicki, 1873); *Pseudosmittia albipennis* (Goetghebuer, 1921); *Rheocricotopus (Rheocricotopus) fuscipes* (Kieffer, 1909); *Trissocladus heterocerus* Kieffer, 1908.

Fly from summer to autumn: *Corynoneura coronata* Edwards, 1924; *C. edwardsi* Brundin, 1949; *Cricotopus* (s. str.) *trifascia* Edwards, 1929; *Limnophyes pentaplastus* (Kieffer, 1921); *Nanocladus* (s. str.) *rectinervis* (Kieffer, 1911); *Paraphaenocladus impensus* (Walker, 1856).

Fly in spring and in autumn: *Sympothastia cf. macrocera* Serra-Tosio, 1973; *Diplocladius cultriger* Kieffer, 1908; *Eukiefferiella minor* (Edwards, 1929); *Orthocladus* (s. str.) *wetterensis* Brundin, 1956.

Fly only in autumn: *Brillia bifida* (Kieffer, 1909); *Eukiefferiella brevicealcar* (Kieffer, 1911); *Paracladius quadrinodosus* Hirvenoja, 1973.

Fly from autumn to spring including winter: *Diamesa tonsa* (Haliday, 1856).

The flight period of chironomids in the Middle Urals was observed throughout the year. Six peaks of activity were observed during the year: early-spring, late-spring, July, late-summer, early-autumn and winter peaks (Figure 1). The maximum period of activity by chironomids and the greatest diversity was recorded in July whereas minimum activity and lowest diversity occurs in winter.

A comparison of chironomid phenology was carried out for two different types of rivers, the Sylva River and the

Irgina River (with a hydrosulphuric spring). Flight periods of chironomids from the Sylva River (on a site between the village of Torgovishche and the town of Suksun) are given in Table 1 and for the hydrosulphuric spring by the Irgina River (near the town of Klyuchi) are given in Table 2. Differences in the flight periods are noted for three species of the 22 common to both these rivers. On the Sylva River site *Diamesa tonsa* (Haliday) does not fly in autumn but instead flies in the winter there. *Orthocladus* (s. str.) *wetterensis* Brundin and *Sympothastia cf. macrocera* Serra-Tosio fly in the spring on the Sylva River but on the Irgina River site they fly in the autumn.

DISCUSSION

Maximum adult species diversity in the subfamilies Diamesinae, Prodiamesinae and Orthoclaadiinae of the Middle Urals occurs in the summer, in contrast to southern Swedish lakes where it occurs in the spring (Brundin 1949). The same pattern found in the Middle Urals is typical for subarctic Swedish lakes (Brundin 1949) and the Lower Amur River basin (Yavorskaya 2010).

A comparison of the flight periods was carried out for chironomids of the Middle Urals and southern Swedish lakes. *Acricotopus lucens* (Zetterstedt), *Corynoneura carriana* Edwards and *Cricotopus* (s. str.) *tibialis* (Meigen) have a longer flight period in the Middle Urals but for *Corynoneura lacustris* Edwards, *Cricotopus* (s. str.) *albiforceps* (Kieffer), *C.* (s. str.) *bicinctus* (Meigen), *C.* (s. str.) *festivellus* (Kieffer) and *C.* (s. str.) *triannulatus* (Macquart) the flight period is shorter. Flight periods of *Corynoneura scutellata* Winnertz and *Cricotopus (Isocladus) sylvestris* (Fabricius) in the Middle Urals and southern Sweden are similar. *Corynoneura edwardsi* Brundin in the Middle Ural flies from summer to autumn but not in spring as in southern Sweden. In the Middle Urals *Potthastia longimanus* Kieffer flies in summer but not in spring whereas *Diplocladius cultriger* Kieffer flies in both the spring and in the autumn.

The collecting method used in this study was sweep-netting, and there is a fairly high possibility that certain species were not recorded at times where they actually were flying. The presence of fragmented and short flight periods for some of the species in tables 1 and 2 indicate that this is true (e.g. *Metriocnemus* (s. str.) *fuscipes* (Meigen) and *Smittia aterrima* (Meigen) in Table 1) and the flight periods for these species probably are continuous and/or longer. Also, since adult females were not identified, the phenology of the species reported here is based on the recorded males. For less abundant species or species with a female biased sex-ratio, the true flight periods for the species probably are longer. These potential errors may make comparison in phenology of species between sites inaccurate. However, in the case of the species that displayed different phenologies at the Sylva and Irgina Rivers (*Diamesa tonsa* (Haliday), *Orthocladus* (s. str.) *wetterensis* Brundin

Table 1. Periods of sampled adult chironomids on the Sylva River (between the village of Torgovishche and the town of Suksun).

Species	January	February	March	April	May	June	July	August	September	October
<i>Aricotopus lucens</i> (Zetterstedt)					██████████	██████████	██████████	██████████		
<i>Bryophaenocladus akiensis</i> (Sasa, Shimomura et Matsuo)						████				
<i>B. subparallelus</i> (Malloch)					██████████	██████████	██████████			
<i>B. vernalis</i> (Goetghebuer)						████				
<i>Camptocladus stercorarius</i> (De Geer)					██████████	██████████	██████████			
<i>Chaetocladus</i> (s. str.) <i>piger</i> (Goetghebuer)			██████████							
<i>Corynoneura arctica</i> Kieffer					██████████	██████████	██████████			
<i>C. coronata</i> Edwards								██████████	██████████	██████████
<i>C. edwardsi</i> Brundin						████		████		
<i>C. gratias</i> Schlee					████		████			
<i>C. scutellata</i> Winnertz					██████████	██████████				
<i>Cricotopus</i> (s. str.) <i>albiforceps</i> (Kieffer)						██████████	██████████			
<i>C.</i> (s. str.) <i>bicinctus</i> (Meigen)						██████████	██████████			
<i>C.</i> (s. str.) <i>flavocinctus</i> (Kieffer)					████					
<i>C.</i> (s. str.) cf. <i>politus</i> (Coquillett)							████			
<i>C.</i> (s. str.) <i>similis</i> Goetghebuer						████		████		
<i>C.</i> (s. str.) <i>tibialis</i> (Meigen)					██████████					████
<i>C.</i> (s. str.) <i>triannulatus</i> (Macquart)							████			
<i>C.</i> (s. str.) <i>trifascia</i> Edwards							██████████	██████████	██████████	██████████
<i>C.</i> (s. str.) <i>vierriensis</i> Goetghebuer						████				
<i>C. (Isocladus) laetus</i> Hirvenoja								████		
<i>C. (I.)</i> cf. <i>sylvestris</i> (Fabricius)					██████████	██████████	██████████	██████████		████
<i>Diamesa parancysta</i> Serra-Tosio			██████████							
<i>D. tonsa</i> (Haliday)	██████████		██████████	██████████						
<i>Hydrobaenus</i> cf. <i>maladistinctus</i> Makarchenko et Makarchenko					██████████					
<i>H. vernus</i> Krashennikov et Makarchenko					████					
<i>Limnophyes angelicae</i> Sæther						██████████	██████████	██████████		

Continued on next page.

Table 1. Continued.

Species	January	February	March	April	May	June	July	August	September	October
<i>L. asquamatus</i> Søgaard Andersen					■		■			
<i>L. edwardsi</i> Sæther								■		
<i>L. minimus</i> (Meigen)					■	■				
<i>L. natalensis</i> (Kieffer)					■	■	■	■	■	
<i>L. pumilio</i> (Holmgren)							■			
<i>Metricnemus</i> (s. str.) <i>albolineatus</i> (Meigen)					■					
<i>M.</i> (s. str.) <i>fuscipes</i> (Meigen)					■	■		■	■	
<i>M.</i> (s. str.) <i>picipes</i> (Meigen)					■			■		
<i>M.</i> (s. str.) <i>tristellus</i> Edwards					■					
<i>Nanocladius</i> (s.str.) <i>distinctus</i> (Malloch)						■	■			
<i>N.</i> (s.str.) <i>cf. minimus</i> Sæther					■	■	■			
<i>N.</i> (s.str.) <i>rectinervis</i> (Kieffer)									■	
<i>Orthocladius</i> (s. str.) <i>wetterensis</i> Brundin			■	■						
<i>Parakiefferiella smolandica</i> (Brundin)							■	■		
<i>Paraphaenocladius impensus</i> (Walker)							■		■	
<i>Paratrichocladius rufiventris</i> (Meigen)					■					
<i>Pseudodiamesa branickii</i> (Nowicki)			■							
<i>Pseudosmittia danconai</i> (Marcuzzi)						■	■			
<i>P. mathildae</i> Albu						■	■			
<i>P. trilobata</i> (Edwards)					■	■	■	■		
<i>Rheocricotopus</i> (<i>Psilocricotopus</i>) <i>chalybeatus</i> (Edwards)							■	■		
<i>Smittia aterrima</i> (Meigen)					■	■	■			■
<i>S. extrema</i> (Holmgren)						■	■	■		
<i>S. leucopogon</i> (Meigen)						■				
<i>Sympotthastia cf. macrocera</i> Serra-Tosio				■						
<i>Thienemanniella oyabedilata</i> Sasa, Kawai et Ueno							■	■		

Table 2. Periods of sampled adult chironomids in the outflow of the hydrosulphuric spring by the Irgina River (near the town of Klyuchi).

Species	January	February	March	April	May	June	July	August	September	October
<i>Acricotopus lucens</i> (Zetterstedt)							■	■		
<i>Allocladius nanseni</i> (Kieffer)						■				
<i>Brillia bifida</i> (Kieffer)										■
<i>Bryophaenocladus akiensis</i> (Sasa, Shimomura et Matsuo)						■	■			
<i>Chaetocladius</i> (s. str.) <i>piger</i> (Goetghebuer)				■						
<i>Corynoneura arctica</i> Kieffer							■			
<i>C. lobata</i> Edwards				■	■					■
<i>Cricotopus</i> (s. str.) <i>cf. algarum</i> (Kieffer)			■		■	■	■	■	■	■
<i>C.</i> (s. str.) <i>similis</i> Goetghebuer						■				
<i>C.</i> (s. str.) <i>trifascia</i> Edwards									■	
<i>C.</i> (s. str.) <i>vierriensis</i> Goetghebuer						■	■			
<i>C. (l.) cf. sylvestris</i> (Fabricius)						■	■	■		
<i>Diamesa tonsa</i> (Haliday)			■	■						■
<i>Diplocladius cultriger</i> Kieffer			■	■	■				■	
<i>Doncricotopus dentatus</i> Tuiskunen							■	■		
<i>Eukiefferiella gracei</i> (Edwards)					■	■	■	■	■	■
<i>Limnophyes natalensis</i> (Kieffer)					■					
<i>L. pentaplastus</i> (Kieffer)									■	
<i>Metriocnemus</i> (s. str.) <i>albolineatus</i> (Meigen)					■					
<i>M.</i> (s. str.) <i>eurynotus</i> (Holmgren)				■	■		■			
<i>M.</i> (s. str.) <i>fuscipes</i> (Meigen)						■				
<i>Nanocladius</i> (s. str.) <i>balticus</i> (Palmén)							■	■		
<i>N.</i> (s. str.) <i>rectinervis</i> (Kieffer)								■		
<i>Orthocladius</i> (s. str.) <i>wetterensis</i> Brundin										■
<i>Paracladius conversus</i> (Walker)					■	■	■	■		
<i>Paraphaenocladus pseudirritus</i> Strenzke					■					
<i>Paratrichocladius goetghebueri</i> Spies						■				

Continued on next page.

Table 2. Continued.

Species	January	February	March	April	May	June	July	August	September	October
<i>P. rufiventris</i> (Meigen)						■	■	■		
<i>Potthastia longimanus</i> Kieffer							■			
<i>Prodiamesa olivacea</i> (Meigen)				■	■		■			
<i>Pseudodiamesa nivosa</i> (Goetghebuer)			■	■	■		■			
<i>Pseudosmittia danconai</i> (Marcuzzi)						■	■	■		
<i>P. trilobata</i> (Edwards)							■			
<i>Rheocricotopus (Psilocricotopus) atripes</i> (Kieffer)							■			
<i>Rh. (s. str.) effusus</i> (Walker)					■					
<i>Smittia aterrima</i> (Meigen)					■					■
<i>S. extrema</i> (Holmgren)						■				
<i>S. leucopogon</i> (Meigen)									■	
<i>Sympotthastia cf. macrocera</i> Serra-Tosio										■
<i>Thienemanniella obscura</i> Brundin					■	■	■		■	
<i>Th. oyabedilata</i> Sasa, Kawai et Ueno								■		

and *Sympotthastia cf. macrocera* Serra-Tosio) this likely is unimportant since the observed differences in flight periods are so distinct.

ACKNOWLEDGMENTS

I am very grateful to E.A. and M.A. Makarchenko for help with the determination of some chironomid species and for their support in these investigations.

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