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Caddisflies collected using a Malaise trap at a spring-fed brook of Shimauchi-yusui in the Matsumoto Basin, central Japan: fauna and phenology

TAKAO NOZAKI[1,*], TOMIKO ITO[2] & KOJI TOJO[3, 4]
[1]3-16-15, Midorigaoka, Ninomiya-machi, Naka-gun, Kanagawa 259-0132, Japan. E-mail: takao.nozaki@nifty.com
[2]Hokkaido Aquatic Biology, Hakuyo-cho, 3-3-5, Eniwa, Hokkaido 061-1434, Japan
[3]Department of Biology, Faculty of Science, Shinshu University, Asahi 3-1-1, Matsumoto, Nagano 390-8621, Japan
[4]Institute of Mountain Science, Shinshu University, Asahi 3-1-1, Matsumoto, Nagano 390-8621, Japan
**corresponding author*

Abstract

Adult caddisflies were collected weekly from a spring-fed brook of Shimauchi-yusui from 11 April 2013 to 5 June 2014. A total of 11867 specimens belonging to 39 species, 18 genera and 14 families were identified. The most abundant species collected in 1 year (the first 52 weeks) were *Agapetus sibiricus* Martynov 1918 (60%), *Apatania aberrans* (Martynov 1933) (12%) and *Micrasema spinosum* Nozaki and Tanida 2007 (5.4%). The Trichoptera fauna mainly reflected the major larval habitats of this brook, but other factors such as water temperature also probably affect species composition. The most common species (wherein more than 50 individuals were collected) had discrete seasonal flight periods.

Key words: spring-fed stream, adult Trichoptera, species composition, flight period, seasonality

Introduction

Springs and spring-fed brooks are unique freshwater habitats, and their ecology and faunal assemblages, including the Trichoptera, have been studied by many researchers (e.g., Botosaneanu 1998). In Japan, however, investigations on caddisflies in such environments are scarce, although there are plenty of springs. In Hokkaido, northern Japan, the Trichopteran fauna were studied using Malaise traps from three cold spring-fed streams, and flight periods of several species were reported (Ito *et al*. 1998, Ohkawa 1999, Kuhara 2011). Nozaki and Tanida (2007) and Nozaki *et al*. (2016) also reported on the Trichopteran fauna of two spring-fed streams in central Honshu based on Malaise trap collection.

The Matsumoto Basin is situated in central Honshu and is flanked by 2000–3000 m mountain ranges that supply underground water to many springs in the lower fan zone (Fig. 1). Most springs and spring-fed streams are used for domestic water, and some are also used for the cultivation of plants (mainly wasabi) and fish, such as trout. However, knowledge about the fauna, especially the invertebrates, of these spring-fed streams is very poor. The Shimauchi-yusui is a spring-fed stream in this area. It is supplemented with water from two spring-fed brooks that emerge from the left river terrace of the Narai River. It flows for approximately 1 km to its confluence with the Narai River. These brooks are maintained by local residents who keep the water clean. We studied adult caddisflies using a Malaise trap set at one of the brooks for collection. Here we report on the caddisfly fauna of this spring-fed brook and the phenology of their flight period.

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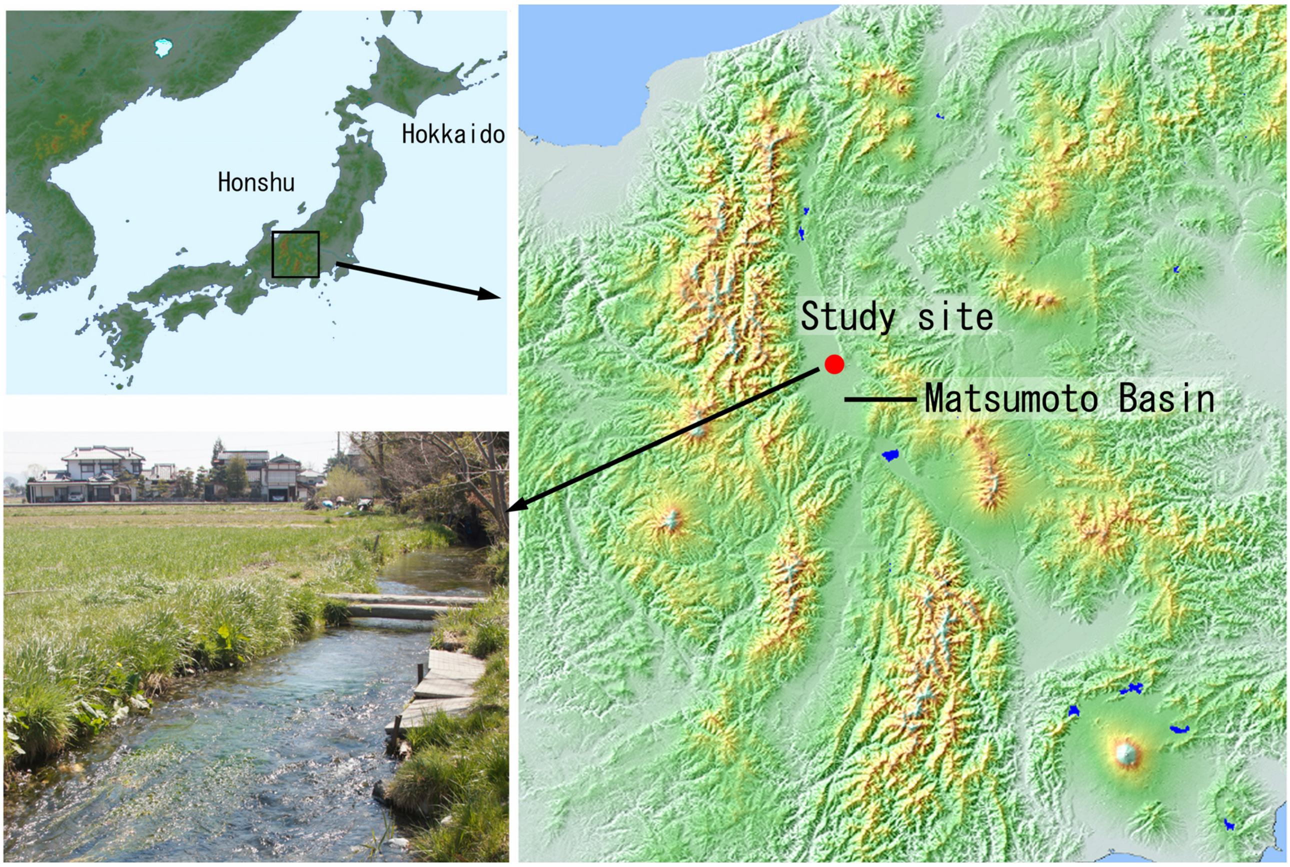

FIGURE 1. Location and photograph of the study site.

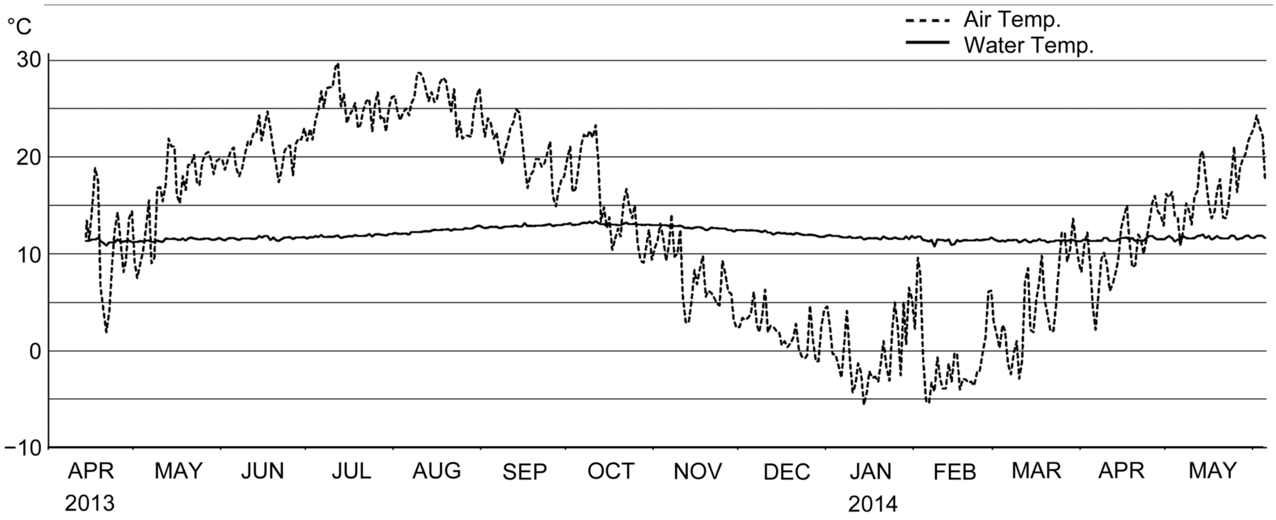

FIGURE 2. Changes in average daily water and air temperatures. Air temperature data were obtained from the Matsumoto meteorological station.

Materials and methods

The study site (36°15′24.6″N, 137°56′42.3″, 570 m a.s.l.) is approximately 300 m from the spring source, and the brook flows between a paddy field and a forested slope (Fig. 1). The width of the channel was approximately 200 cm, the water depth approximately 50 cm, and the current speed approximately 40 cm/s on average. The stream bed was dominated by cobbles and gravels and had a rich assemblage of aquatic plants (*Veronica anagallis-aquatica*, *Ranunculus nipponicus*, and *Potamogeton crispus*) and bryophytes (*Chiloscyphus polyanthos* and *Rhynchostegium riparioides*). The channel side walls were constructed of stone masonry. The annual average water temperature based on daily averages measured using a temperature logger (Hobo TidbiT® v2, Onset Computer cooperation) from 12 April 2013 to 11 April 2014 was 12.0°C (range, 10.8–13.4°C) (Fig. 2). The air temperature recorded at the Matsumoto meteorological station (approximately 2.5 km to the southeast of the study site) during the same period was 12.3°C (range, −5.6–29.7°C) (Japan Meteorological Agency 2014) (Fig. 2).

Adult caddisflies were collected weekly using a Townes-style Malaise trap (Townes 1972) from 11 April 2013 to 5 June 2014. All specimens were preserved in 80% ethyl alcohol and deposited in the personal collections of T. Ito (Hydroptilidae and Lepidostomatidae) and T. Nozaki (others).

List of caddisflies

Rhyacophilidae

Rhyacophila brevicephala Iwata 1927
Materials. 132♂148♀ (2013: 5♂6♀, 11–18.iv; 3♂1♀, 18–25.iv; 3♂1♀, 25.iv–2.v; 1♀, 2–9.v; 2♂3♀, 9–16.v; 1♂, 16–23.v; 2♂1♀, 23–30.v; 2♂1♀, 30.v–6.vi; 1♂1♀, 6–13.vi; 3♂, 13–20.vi; 2♂5♀, 20–27.vi; 2♂3♀, 27.vi–4.vii; 1♂, 4–11.vii; 1♂1♀, 11–18.vii; 2♀, 18–25.vii; 2♀, 25.vii–1.viii; 2♀, 1–8.viii; 1♂1♀, 8–15.viii; 2♂1♀, 12–19.ix; 4♂2♀, 19–26.ix; 5♂5♀, 26.ix–3.x; 1♂, 3–10.x; 1♂3♀, 10–17.x; 2♂8♀, 17–24.x; 2♀, 24–31.x; 2♀, 31.x–7.xi; 1♀, 14–21.xi. 2014: 1♂2♀, 13–20.iii; 1♂3♀, 20–27.iii; 17♂11♀, 27.iii–3.iv; 11♂5♀, 3–10.iv; 11♂10♀, 10–17.iv; 13♂8♀, 17–24.iv; 13♂7♀, 24.iv–1.v; 8♂6♀, 1–8.v; 3♂10♀, 8–15.v; 3♂6♀, 15–22.v; 2♂18♀, 22–29.v; 5♂7♀, 29.v–5.vi).

Rhyacophila kuwayamai Schmid 1970
Materials. 6♂7♀ (2013: 1♂, 16–23.v; 1♂1♀, 23–30.v; 1♀, 30.v–6.vi; 2♂, 6–13.vi; 1♂, 20-27.vi. 2014: 1♂2♀, 22–29.v; 3♀, 29.v–5.vi).

Rhyacophila nigrocephala Iwata 1927
Material. 1♂ (2013: 1♂, 27.vi–4.vii).

Rhyacophila nipponica Navás 1933
Materials. 121♂282♀ (2013: 1♂, 11–18.iv; 1♂2♀, 25.iv–2.v; 3♂7♀, 2–9.v; 6♂20♀, 9–16.v; 3♂10♀, 16–23.v; 4♂6♀, 23–30.v; 6♀, 30.v–6.vi; 3♂8♀, 6–13.vi; 2♂10♀, 13–20.vi; 3♂9♀, 20–27.vi; 3♀, 27.vi–4.vii; 1♂2♀, 4–11.vii; 5♀, 11–18.vii; 1♂, 18–25.vii; 2♀, 25.vii–1.viii; 4♀, 1–8.viii; 1♂3♀, 8–15.viii; 2♂2♀, 29–29.viii; 1♂4♀, 29.viii–5.ix; 1♂, 5–12.ix; 1♂, 12–19.ix; 1♂2♀, 19–26.ix; 1♂2♀, 26.ix–3.x; 1♂10♀, 10–17.x; 4♂12♀, 17–24.x; 4♂6♀, 24–31.x; 1♂10♀, 31.x–7.xi; 2♂2♀, 7–14.xi; 3♂, 14–21.xi; 2♂2♀, 21–28.xi; 1♂, 5–12.xii. 2014: 1♀, 20–27.iii; 2♂, 10–17.iv; 2♀, 17–24.iv; 5♂2♀, 24.iv–1.v; 8♂7♀, 1–8.v; 10♂25♀, 8–15.v; 9♂31♀, 15–22.v; 18♂46♀, 22–29.v; 15♂19♀, 29.v–5.vi).

Rhyacophila yamanakensis Iwata 1927
Materials. 2♂1♀ (2013: 1♀, 6–13.vi. 2014: 2♂, 24.iv–1.v).

Hydroptilidae

Hydroptila botosaneanui Kumanski 1990
Materials. 3♂3♀ (2013: 1♂2♀, 9–16.v; 1♂, 16–23.v; 1♂, 24–31.x. 2014: 1♀, 10–17.iv).

Hydroptila phenianica Botosaneanu 1970

Materials. 7♂14♀ (2013: 1♀, 2–9.v; 1♂, 30.v–6.vi, 1♀, 6–13.vi; 1♂, 12–19.ix; 1♂2♀, 3–10.x; 3♂7♀, 10–17.x; 1♀, 17–24.x. 2014: 1♀, 27.iii–3.iv; 1♂, 3–10.iv; 1♀, 24.iv–1.v).

Oxyethira angustella Martynov, 1933

Matrials. 136♂107♀ (2013: 1♂1♀, 11–18.iv; 1♂, 18–25.iv; 2♀, 25.iv–2.v; 1♂2♀, 2–9.v; 1♀, 9–16.v; 1♀, 23–30.v; 1♀, 27.vi–4.v; 1♂1♀, 18–25.vii; 1♀, 1–8.viii; 1♀, 8–15.viii; 1♀, 15–22.viii; 4♀, 5–12.ix; 1♀, 26.ix–3.x; 3♀, 3–10.x; 1♂5♀, 10–17.x; 1♂8♀, 17–24.x; 8♀, 24–31.x; 2♂2♀, 31.x–7.xi; 3♂5♀, 7–14.xi; 3♂3♀, 14–21.xi; 29♂1♀, 21–28.xi; 2♂, 28.xi–5.xii. 2014: 2♂, 23–30.i; 4♂, 30.i–6.ii; 8♂, 13–20.iii; 25♂18♀, 20–27.iii; 26♂16♀, 27.iii–3.iv; 11♂9♀, 3–10.iv; 9♂, 10–17.iv; 3♂3♀, 17–24.iv; 2♀, 24.iv–1.v; 3♂6♀, 8–15.v; 1♀, 15–22.v).

Glossosomatidae

Agapetus sibiricus Martynov 1918

Materials. 3073♂4028♀ (2013: 90♂71♀, 11–18.iv; 14♂38♀, 18–25.iv; 39♂69♀, 25.iv–2.v; 66♂60♀, 2–9.v; 81♂116♀, 9–16.v; 43♂136♀, 16–23.v; 47♂117♀, 23–30.v; 67♂194♀, 30.v–6.vi; 94♂259♀, 6–13.vi; 89♂217♀, 13–20.vi; 151♂256♀, 20–27.vi; 163♂257♀, 27.vi–4.vii; 162♂173♀, 4–11.vii; 177♂175♀, 11–18.vii; 175♂159♀, 18–25.vii; 90♂81♀, 25.vii–1.viii; 65♂89♀, 1–8.viii; 38♂34♀, 8–15.viii; 19♂52♀, 15–22.viii; 28♂34♀, 22–29.viii; 38♂70♀, 29.viii–5.ix; 59♂74♀, 5–12.ix; 37♂53♀, 12–19.ix; 40♂44♀, 19–26.ix; 26♂39♀, 26.ix–3.x; 27♂42♀, 3–10.x; 31♂45♀, 10–17.x; 39♂57♀, 17–24.x; 30♂42♀, 24–31.x; 25♂36♀, 31.x–7.xi; 22♂23♀, 7–14.xi; 18♂28♀, 24-21.xi; 27♂21♀, 21–28.xi; 11♂7♀, 28.ix–5.x; 19♂4♀, 5–12.xii. 2014: 2♀, 23–30.i; 1♂4♀, 30.i–6.ii; 2♀, 6–13.iii; 19♂15♀, 13–20.iii; 19♂26♀, 20–27, iii; 89♂71♀, 27.iii–3.iv; 61♂31♀, 3–10.iv; 69♂45♀, 10–17.iv; 80♂38♀, 17–24.iv; 122♂41♀, 24.iv–1.v; 75♂41♀, 1–8.v; 76♂84♀, 8–15.v; 93♂82♀, 15–22.v; 88♂195♀, 22–29.v; 134♂179♀, 29.v–5.vi).

Glossosoma altaicum (Martynov 1914)

Materials. 7♂ (2013: 1♂, 11–18.iv; 1♂, 25.iv–2.v; 2♂, 2–9.v; 1♂, 31.x–7.xi; 2♂, 14–21.xi).

Glossosoma ussuricum (Martynov 1934)

Materials. 48♂107♀ (2013: 2♂9♀, 11–18.iv; 1♀, 18–25.iv; 1♂, 9–16.v; 1♀, 13–20.vi; 1♀, 20–27.vi; 1♀, 4–11.vii; 2♂2♀, 18–25.vii; 1♀, 25.vii–1.viii; 1♀, 8–15.viii; 1♀, 15–22.viii; 1♀, 29.viii–5.ix; 1♀, 12–19.ix; 1♂, 19–26.ix; 2♀, 17–24.x; 1♂1♀, 24–31.x; 1♂1♀, 31.x–7.xi; 1♀, 21–28.xi; 1♀, 28.xi–5.xii. 2014: 2♀, 20–27.ii; 2♂, 27.ii–6.iii; 6♂1♀, 6–13.iii; 5♂14♀, 13–20.iii; 14♂13♀, 20–27.iii; 8♂26♀, 27.iii–3.iv; 1♂2♀, 3–10.iv; 3♂15♀, 10–17.iv; 4♀, 17–24.iv; 1♂4♀, 24.iv–1.v).

Stenopsychidae

Stenopsyche marmorata Navás 1920

Materials. 43♂90♀ (2013: 2♀,11–18.iv; 2♀, 2–9.v; 3♀, 9–16.v; 1♂, 16–23.v; 1♂, 13–20.vi; 1♂1♀, 18–25.vii; 1♂, 25.vii–1.viii; 1♂, 1–8.viii; 2♂1♀, 8–15.viii; 1♂1♀, 15–22.viii; 1♂1♀, 22–29.viii; 3♂2♀, 5–12.ix; 1♂2♀, 12–19.ix; 5♂1♀, 19–26.ix; 5♂4♀, 26.ix–3.x; 2♂3♀, 3–10.x; 2♂4♀, 10–17.x; 2♂6♀, 17–24.x; 4♂4♀, 24–31.x; 3♂4♀, 31.x–7.xi; 1♂2♀, 7–14.xi; 8♀, 14–21.xi; 3♀, 21–28.xi; 5♀, 5–12.xii. 2014: 1♀, 2–9.i; 2♀, 23–30.i; 1♀, 30.i–6.ii; 2♀, 27.ii–6.iii; 1♀, 6–13.iii; 4♀, 13–20.iii; 3♀, 20–27.iii; 4♀, 27.iii–3.iv; 1♂, 3–10.iv; 2♂1♀, 10–17.iv; 3♀, 17–24.iv; 1♂4♀, 24.iv–1.v; 1♂1♀, 1–8.v; 1♀, 8–15.v; 1♀, 15–22.v; 1♂, 22–29.v; 2♀, 29.v–5.vi).

Psychomyiidae

Psychomyia acutipennis (Ulmer 1908)

Materials. 1♂3♀ (2013: 1♀, 27.vi–4.vii; 1♀, 15–22.viii; 1♂1♀, 29.viii–5.ix).

Psychomyia armata Schmid 1964
Material. 1♂ (2013: 1♂, 29.viii–5.ix).

Psychomyia morisitai Tsuda 1942
Materials. 9♂14♀ (2013: 1♀, 23–30.v; 1♀, 30.v–6.vi; 4♀, 6–13.vi; 4♀, 13–20.vi. 2014: 4♀, 22–29.v; 9♂, 29.v–5.vi).

Tinodes higashiyamanus Tsuda 1942
Materials. 48♂287♀ (2013: 4♀, 16–23.v; 2♂2♀, 23–30.v; 8♂16♀, 30.v–6.vi; 8♂39♀, 6–13.vi; 3♂57♀, 13–20.vi; 2♂49♀, 20–27.vi; 5♂57♀, 27.vi–4.vii; 4♂19♀, 4–11.vii; 1♂13♀, 11–18.vii; 3♀, 18–25.vii; 2♀, 25.vii–1.viii; 1♀, 1–8.viii; 1♀, 8–15.viii; 3♀, 22–29.viii; 3♀, 29.viii–5.ix; 1♀, 5–12.ix. 2014: 1♂, 22–29.v; 8♂18♀, 29.v–5.vi).

Tinodes sp. (aff. *miyakonis* Tsuda 1942)
Material. 1♂ (2013: 1♂, 6–13.vi).

Hydropsychidae

Cheumatopsyche brevilineata (Iwata 1927)
Materials. 10♂22♀ (2013: 1♂4♀, 30.v–6.vi; 1♂1♀, 6–13.vi; 4♂, 13–20.vi; 1♀, 20–27.vi; 2♂6♀, 27.vi–4.vii; 6♀, 4–11.vii; 2♀, 11–18.vii; 1♀, 15–22.viii; 1♂1♀, 29.viii–5.ix. 2014: 1♂, 29.v–5.vi).

Cheumatopsyche infascia Martynov 1934
Materials. 4♀ (2013: 1♀, 20–27.vi; 2♀, 27.vi–4.vii; 1♀, 4–11.vii).

Hydropsyche orientalis Martynov 1934
Materials. 15♂12♀ (2013: 2♂, 9–16.v; 5♂1♀, 23–30.v; 1♀, 30.v–6.vi; 1♂, 6–13.vi; 1♀, 20–27.vi; 1♀, 4–11.vii; 1♀, 15–22.viii; 1♂, 22–29.viii; 3♀, 29.viii–5.ix; 1♀, 12–19.ix; 1♀, 3–10.x; 1♂, 7–14.xi. 2014: 1♂, 23–30.i; 1♂, 20–27.iii; 1♂, 27.iii–3.iv; 1♂1♀, 17–24.iv; 1♀, 8–15.v; 1♀, 15–22.v).

Hydropsyche setensis Iwata 1927
Material. 1♀ (2013: 1♀, 23–30.v).

Phryganopsychidae

Phryganopsyche latipennis (Banks 1906)
Materials. 71♂83♀ (2013: 10♂6♀, 11–18.iv; 1♂, 18–25.iv; 4♂3♀, 25.iv–2.v; 4♂1♀, 2–9.v; 7♂7♀, 9–16.v; 2♀, 16–23.v; 2♀, 23–30.v; 3♀, 30.v–6.vi; 1♀, 6–13.vi; 1♂, 13–20.vi; 1♀, 20–27.vi; 1♀, 4–11.vii; 4♀, 1–8.viii; 1♀, 8–15.viii; 1♂, 22–29.viii; 4♂5♀, 29.viii–5.ix; 2♂5♀, 5–12.ix; 4♂, 12–19.ix; 2♂1♀, 19–26.ix; 6♀, 26.ix–3.x; 3♀, 3–10.x; 1♀, 10–17.x; 2♂5♀, 17–24.x; 5♂, 24–31.x; 1♂, 31.x–7.xi; 1♂2♀, 14–21.xi; 1♂, 5–12.xii. 2014: 1♂, 13–20. iii; 3♂1♀, 20–27.iii; 3♂4♀, 27.iii–3.iv; 6♂, 3–10.iv; 3♂2♀, 10–17.iv; 2♂2♀, 17–24.iv; 1♂4♀, 24.iv–1.v; 2♀, 1–8.v; 1♂4♀, 8–15.v; 3♀, 15–22.v; 1♂, 22–29.v; 1♀, 29.v–5.vi).

Brachycentridae

Micrasema akagiae Nozaki and Tanida 2007
Materials. 7♂12♀ (2013: 1♀, 23–30.v; 1♀, 30.v–6.vi; 5♀, 6–13.vi; 1♂1♀, 13–20.vi; 1♂1♀, 20–27.vi; 1♂, 27.vi–4.v; 1♂, 4–11.vii; 2♀, 18–25.vii; 1♂, 25.vii–1.viii; 1♂, 8–15.viii; 1♀, 24–31.x. 2014: 1♀, 29.v–5.vi).

Micrasema hanasense Tsuda 1942
Material. 1♀ (2013: 1♀, 20–27.vi).

Micrasema spinosum Nozaki and Tanida 2007

Materials. 470♂320♀ (2013: 12♂21♀, 11–18.iv; 5♂6♀, 18–25.iv; 4♂11♀, 25.iv–2.v; 7♀, 2–9.v; 3♂2♀, 9–16.v; 1♂3♀, 16–23.v; 3♂1♀, 23–30.v; 4♂, 30.v–6.vi; 3♂, 6–13.vi; 2♂1♀, 13–20.vi; 3♂, 20–27.vi; 1♂, 15–22.viii; 4♀, 22–29.viii; 1♂6♀, 29.viii–5.ix; 8♂11♀, 5–12.ix; 16♂6♀, 12–19.ix; 2♂5♀, 19–26.ix; 9♀, 26.ix–3.x; 8♀, 3–10.x; 1♂13♀, 10–17.x; 1♂16♀, 17–24.x; 9♂9♀, 24–31.x; 5♂10♀, 31.x–7.xi; 3♂5♀, 7–14.xi; 2♂9♀, 14–21.xi; 6♂3♀, 21–28.xi; 1♂3♀, 28.xi–5.x; 2♂, 5–12.xii. 2014: 8♂7♀, 13–20.iii; 23♂8♀, 20–27.iii; 77♂42♀, 27.iii–3.iv; 56♂21♀, 3–10.iv; 65♂16♀, 10–17.iv; 68♂23♀, 17–24.iv; 45♂8♀, 24.iv–1.v;16♂4♀, 1–8.v; 7♂12♀, 8–15.v; 2♂3♀, 15–22.v; 4♂5♀, 22–29.v; 1♂2♀, 29.v–5.vi).

Lepidostomatidae

Lepidostoma bipertitum (Kobayashi 1955)

Material. 1♀ (2013: 1♀, 2–9.v).

Lepidostoma japonicum (Tsuda 1936)

Material. 1♀ (2013: 1♀, 24–31.x).

Lepidostoma kojimai (Tani 1971)

Materials. 193♂91♀ (2013: 1♂2♀, 11–18.iv; 2♂, 18–25.iv; 2♂1♀, 25.iv–2.v; 4♂2♀, 2–9.v; 23♂8♀, 9–16.v; 6♂6♀, 16–23.v; 7♂5♀, 23–30.v; 15♂6♀, 30.v–6.vi; 9♂7♀, 6–13.vi; 3♂4♀, 13–20.vi; 5♂3♀, 20–27.vi; 1♂2♀, 27.vi–4.vii; 1♂2♀, 4–11.vii; 4♂, 11–18.vii; 1♂, 1–8.viii; 1♂1♀, 8–15.viii; 3♂2♀, 22–29.viii; 2♂1♀, 29.viii–5.ix; 3♂, 12–19.ix; 7♂3♀, 19–26.ix; 12♂4♀, 26.ix–3.x; 13♂3♀, 3–10.x; 8♂3♀, 10–17.x; 15♂4♀, 17–24.x; 5♂, 24–31.x; 1♂, 31.x–7.xi. 2014: 1♂, 17–24.iv; 2♂, 24.iv–1.v; 1♀, 1–8.v; 1♂2♀, 8–15.v; 1♂3♀, 15–22.v; 9♂4♀, 22–29.v; 25♂12♀, 29.v–5.vi).

Lepidostoma orientale (Tsuda 1942)

Materials. 110♂16♀ (2013: 5♂, 11–18.iv; 1♂, 18–25.iv; 2♂1♀, 25.iv–2.v; 2♂, 2–9.v; 2♀, 9–16.v; 1♀, 16–23.v; 1♀, 6–13.vi; 1♀, 12–19.ix; 1♂2♀, 10–17.x; 1♀, 17–24.x; 2♀, 24–31.x; 6♂, 31.x–7.xi; 3♂, 7–14.xi; 9♂, 14–21.xi; 29♂1♀, 21–28.xi; 2♂, 28.xi–5.xii. 2014: 2♂23–30.i; 4♂, 30.i–6.ii; 8♂, 13–20.iii; 20♂, 20–27.iii; 6♂2♀, 27.iii–3.iv; 4♂, 3–10.iv; 1♀, 10–17.iv; 1♂1♀, 17–24.iv; 2♂, 24.iv–1.v; 1♂, 8–15.v; 1♂, 15–22.v; 1♂, 22–29.v).

Lepidostoma satoi (Kobayashi 1968)

Material. 1♂ (2014: 1♂, 8–15.v).

Limnephilidae

Nothopsyche pallipes Banks 1906

Material. 1♀ (2013: 1♀, 17–24.x).

Nothopsyche ruficollis (Ulmer 1905)

Materials. 5♂16♀ (2013: 1♀, 24–31.x; 1♂4♀, 31.x–7.xi; 1♂1♀, 7–14.xi; 2♂5♀, 14–21.xi; 1♂2♀, 21–28.xi; 2♀, 28.xi-5.xii; 1♀, 5–12.xii).

Nothopsyche ulmeri Schmid 1952

Materials. 127♂55♀ (2013: 2♂, 10–17.x; 3♂2♀, 17–24.x; 14♂6♀, 24–31.x; 26♂13♀, 31.x–7.xi; 36♂14♀, 7–14.xi; 32♂13♀, 14–21.xi; 11♂6♀, 21–28.xi; 1♀, 28.xi–5.xii; 2♂, 19–26.xii; 1♂, 26.xii–2.i).

Apataniidae

Apatania aberrans (Martynov 1933)
Materials. 743♂628♀ (2013: 33♂17♀, 11–18.iv; 3♂11♀, 18–25.iv; 5♂10♀, 25.iv–2.v; 6♂6♀, 2–9.v; 1♂3♀, 9–16.v; 1♂2♀, 16–23.v; 1♂1♀, 23–30.v; 1♂3♀, 30.v–6.vi; 2♀, 6–13vi; 1♂2♀, 20–27.vi; 3♂3♀, 27.vi–4.vii; 1♂3♀, 4–11.vii; 3♀, 11–18.vii; 3♀, 18–25.ii; 1♂2♀, 25.vii–1.viii; 1♂, 22–29.viii; 1♂1♀, 29.viii–5.ix; 1♂2♀, 5–12.ix; 3♂2♀, 12–19.ix; 3♂2♀, 19–26.ix; 5♂5♀, 26.ix–3.x; 3♂9♀, 3–10.x; 5♂3♀, 10–17.x; 10♂13♀, 17–24.x; 13♂21♀, 24–31.x; 8♂27♀, 31.x–7.xi; 12♂17♀, 7–14.xi; 7♂21♀, 14–21.xi; 28♂21♀, 21–28.xi; 19♂11♀, 28.xi–5.xii; 4♂13♀, 5–12.xii; 6♂5♀, 12–19.xii; 6♂3♀, 19–26.xii; 4♂8♀, 26.xii–2.i. 2014: 23♂5♀, 2–9.i; 2♂1♀, 9–16.i; 6♂6♀, 16–23.i; 41♂26♀, 23–30.i; 61♂21♀, 30.i–6.ii; 1♂, 6–13.ii; 2♂4♀, 13–20.ii; 3♂7♀, 20–27.ii; 16♂25♀, 27.ii–6.iii; 34♂27♀, 6–13.iii; 72♂31♀, 13–20.iii; 81♂44♀, 20–27.iii; 63♂43♀, 27.iii–3.iv; 21♂17♀, 3–10.iv; 32♂29♀, 10–17.iv; 26♂20♀, 17–24.iv; 26♂18♀, 24.iv–1.v; 9♂13♀, 1–8.v; 9♂6♀, 8–15.v; 8♂4♀, 15–22.v; 5♂11♀, 22–29.v; 6♂5♀, 29.v–5.vi).

Apatania kyotoensis Tsuda 1939
Materials. 29♂44♀ (2013: 1♂9♀, 11–18.iv; 1♀, 18–25.iv; 1♀, 25.iv–2.v; 2♂1♀, 10–17.x; 13♂8♀, 17–24.x; 8♂6♀, 24–31.x; 2♂2♀, 31.x–7.xi. 2014: 1♂, 27.ii–6.iii; 1♂, 6–13.iii; 1♂, 13–20.iii, 1♀, 20–27.iii; 5♀, 27.iii–3.iv; 4♀, 3–10.iv; 5♀, 10–17.iv; 1♀, 17–24.iv).

Apatania nikkoensis Tsuda 1939
Material. 1♀ (2013: 1♀, 21–28.xi).

Goeridae

Goera japonica Banks 1906
Materials. 9♂8♀ (2013: 1♂1♀, 11–18.iv; 2♂, 2–9.v; 1♂1♀, 23–30.v; 1♂, 30.v–6.vi; 2m1♀, 13–20.vi; 1♀, 4–11.vii; 1♀, 18–25.vii; 1♀, 25.vii–1.viii; 1♀, 8–15.viii. 2014: 1♂, 17–24.iv; 1♂, 8–15.v).

Leptoceridae

Oecetis nigropunctata Ulmer 1908
Materials. 13♂14♀ (2013: 1♂1♀, 6–13.vi; 1♂, 13–20.vi; 3♂1♀, 27.vi–4.vii; 1♂3♀, 4–11.vii; 2♂1♀, 11–18.vii; 2♀, 25.vii–1.viii; 1♀, 1–8.viii; 3♂2♀, 8–15.viii; 2♂2♀, 15–22.viii; 1♀, 29.viii–5.ix).

Sericostomatidae

Gumaga orientalis (Martynov 1935)
Materials. 3♂5♀ (2013: 1♀, 25.vii–1.viii; 1♀, 8–15.viii; 2♂1♀, 29.viii–5.ix; 2♀, 12–19.ix; 1♂, 26.ix–3.x).

Trichoptera fauna of Shimauchi-yusui

A total of 11867 specimens belonging to 39 species, 18 genera and 14 families were recorded from this spring-fed brook. The most abundant species collected in 1 year (the first 52 weeks) were *Agapetus sibiricus* (60%), *Apatania aberrans* (12%), and *Micrasema spinosum* (5.4%) (Table 1). *A. sibiricus* and *A. aberrans* larvae were abundant on stream bed cobbles and stone retaining walls of the channel, whereas *M. spinosum* was more abundant on bryophytes. These abundant species apparently reflect the preferential larval habitats in this stream.

TABLE 1. Comparison between the average water temperatures, major larval habitats, and three abundant species from three spring-fed streams in central Honshu, Japan. The number in parenthesis shows the proportion (%) of each species relative to the total number in 1 year. Data from the Kakida River and Jimoto-yusui were obtained from Nozaki & Tanida (2007) and Nozaki *et al*. (2016), respectively.

	Shimauchi-yusui	Kakida River	Jimoto-yusui
Average water temperature	12ºC	15ºC	11.4ºC
Major larval habitats	Cobbles & gravels, aquatic plants, bryophytes	Sand bed, aquatic plants, mosses	Plant debris, roots of riparian vegetation
Abundant species	*Agapetus sibiricus* (60)	*Micrasema akagiae* (45)	*Lepidostoma kanbaranum* (48)
	Apatania aberrans (12)	*Leptocerus fluminalis** (24)	*Oecetis nigropunctata* (16)
	Micrasema spinosum (5.4)	*Gumaga orientalis* (8)	*Philocentropus shigae* (13)

*: recorded as *Leptocerus* sp. in the original paper.

In central Honshu, the Trichopteran fauna of the Kakida River and Jimoto-yusui using the same method as that in this study has been reported (Nozaki and Tanida 2007 and Nozaki *et al*. 2016). The Trichoptera species composition in the present study differs from these other two spring-fed streams (Tables 1, 2). Considering that the abundant species of the Kakida River and Jimoto-yusui also reflected their larval habitats, these habitats must be an important factor that characterizes the caddisfly fauna of each spring-fed stream. However, although the Shimauchi-yusui is rich in aquatic plants, species associated with this habitat were not abundant. *Leptocerus fluminalis* Ito and Kuhara 2009 inhabit aquatic plant assemblages in the larval stage and was the second most abundant species in the Kakida River (Table 1), but this species was not collected from our study site. Furthermore, although three *Micrasema* species—*M. akagiae*, *M. hanasense*, and *M. spinosum*—were found in both the Shimauchi-yusui and Kakida River, their dominance varied among streams (Table 1). In the Shimauchi-yusui, *M. spinosum* was the most abundant of the three species (96.4%) followed by *M. akagiae* (3.4%), but in the Kakida River, *M. akagiae* was the most abundant species (95.5%) followed by *M. hanasense* (4.2%). These results suggest that other factors, such as the lower water temperature of the Shimauchi-yusui compared with that of the Kakida River, also affect species composition.

TABLE 2. Similarity matrix of Trichoptera communities from three spring-fed streams in central Honshu, Japan [Morishita's Similarity Index Cλ (Morishita 1959)]. Data from the Kakida River and Jimoto-yusui were obtained from Nozaki & Tanida (2007) and Nozaki *et al*. (2016), respectively.

	Kakida River	Jimoto-yusui
Shimauchi-yusui	0.011	0.011
Kakida River	–	0.000

Flight period of Trichoptera adults

Figures 3 and 4 show the seasonal occurrence of 14 species, of which more than 50 individuals of each species were collected. Most species had a discrete seasonal flight period, and these data provide information about their emergence season and voltinism, although precise life cycle studies are needed for confirmation.

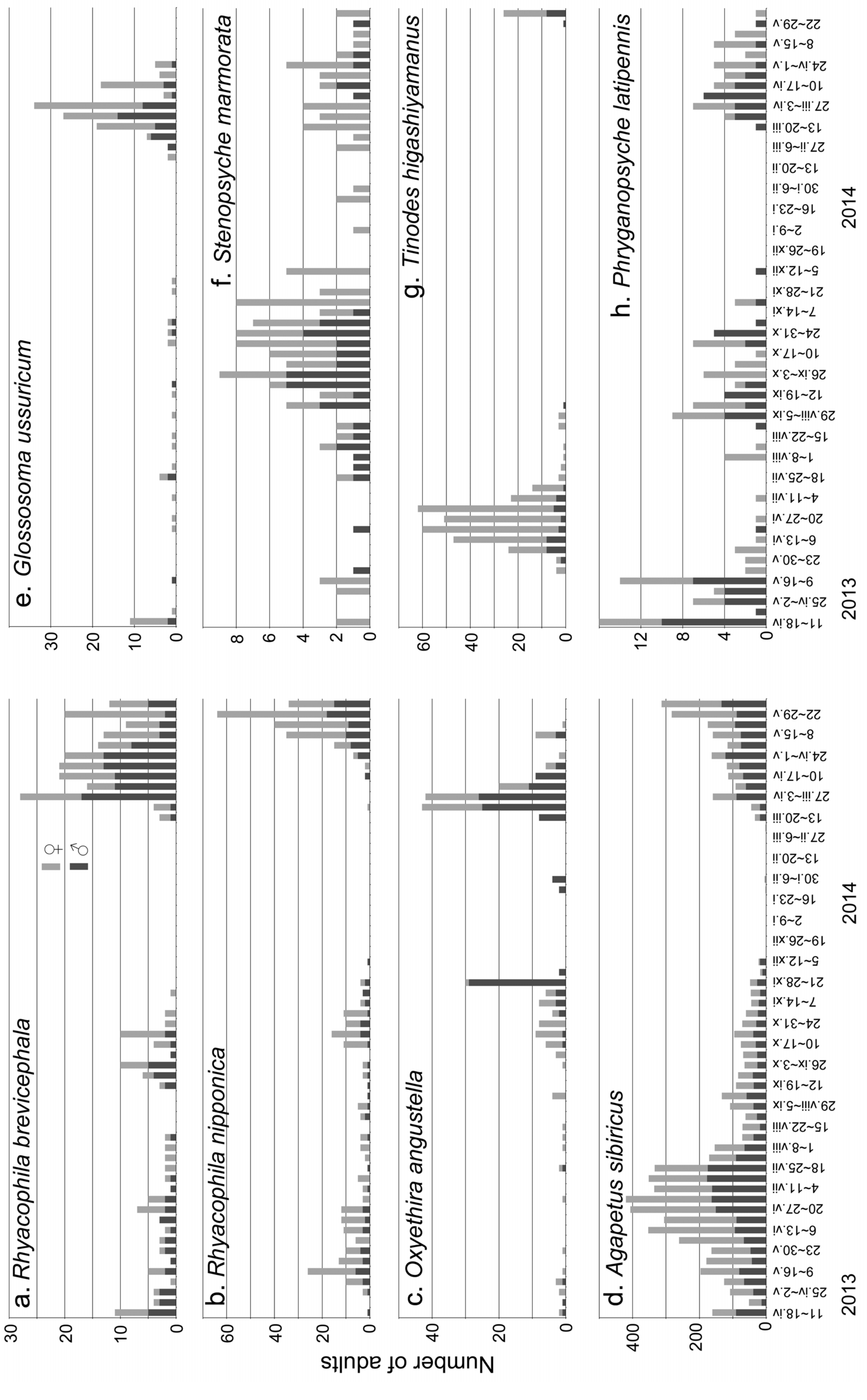

FIGURE 3. Seasonal changes in number of individuals of adult caddisflies captured by a Malaise trap (1).

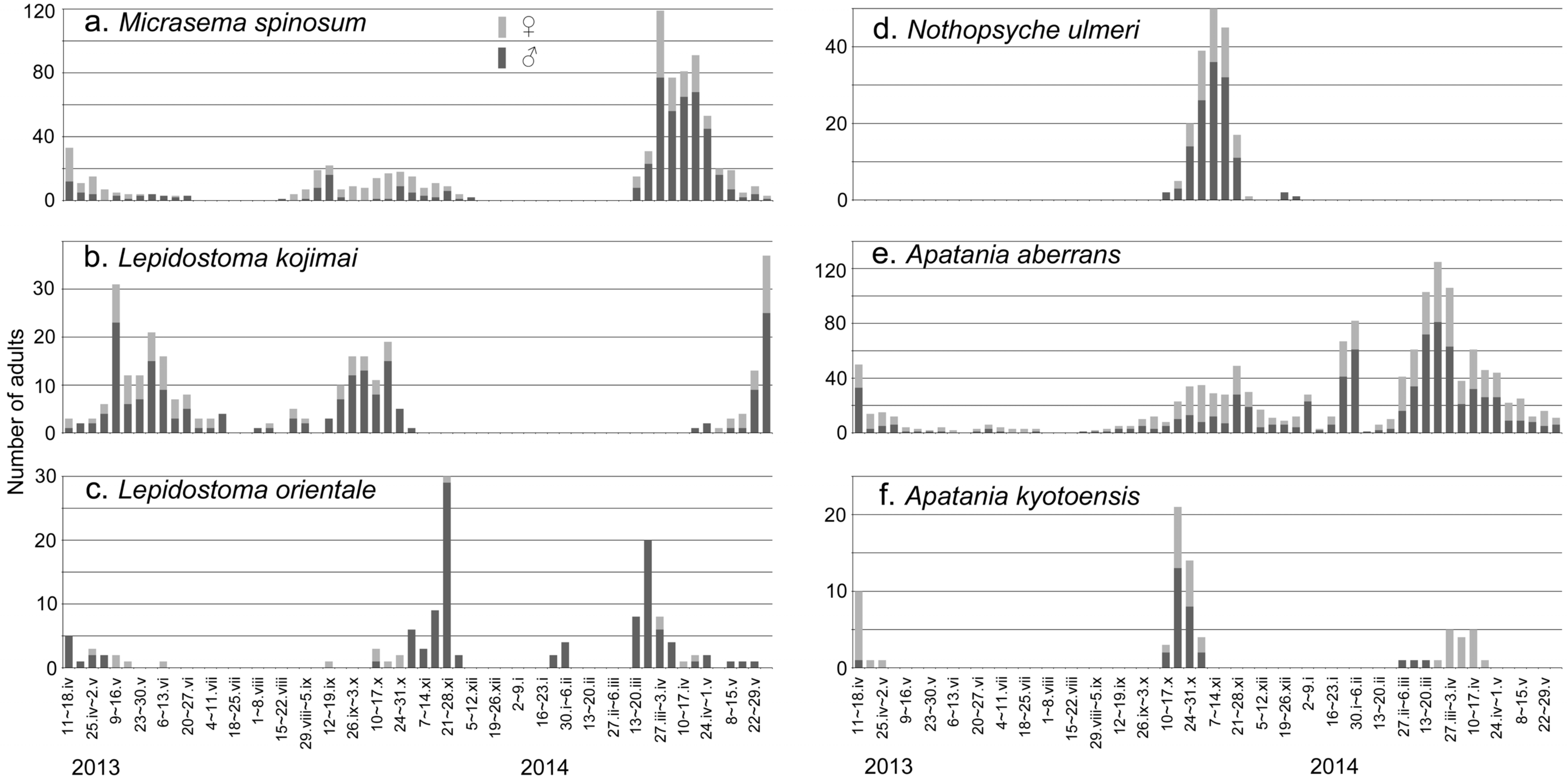

FIGURE 4. Seasonal changes in the number of adult caddisflies captured using a Malaise trap (2).

Tinodes higashiyamanus and *Nothopsyche ulmeri* have one narrow flight peak in early summer and mid-autumn, respectively (Figs. 3g, 4d). One short flight period in a year suggests that these species have a univoltine life cycle at the study site. *N. ulmeri* has a univoltine life cycle with a summer larval aestivation and autumn flight period (Nozaki 1989, as *N. pallipes*). The same autumn flight at the study site with constant water temperature must be regulated by the daily photoperiod.

Six species—*Rhyacophila brevicephala*, *Rhyacophila nipponica*, *A. sibiricus*, *Glossosoma ussuricum*, *M. spinosum*, and *Lepidostoma kojimai*—had one major peak in the spring or early summer (Figs. 3a, b, d, e, 4a, b), but their flight periods were extended throughout much of the year except for the winter. Furthermore, four of them—*R. brevicephala*, *R. nipponica*, *M. spinosum*, and *L. kojimai*—also had small autumn peak (Figs. 3a, b, 4a, b). These species have a univoltine life cycle with a spring or early summer flight period at the study site, but a proportion of the second generation that had rapidly grown probably emerge in autumn.

Apatania kyotoensis had two major peaks in the spring and autumn, and the period between the spring and autumn peak was longer than that between the autumn and spring peak (Fig. 4f). Nishimoto (1989) suggested that Japanese *Apatania* species originally had a univoltine life cycle with an autumn emergence period and that a proportion of the second generation that grew rapidly during winter could also emerge in the spring. He also suggested that they avoid high water temperatures during the summer season as they are at the prepupal stage during this season. The case of *A. kyotoensis* in this study supports his hypothesis. This species must aestivate during the summer, even with a constant water temperature, and has a second generation that emerges in the spring. On the other hand, *Apatania aberrans* had three peaks in the spring, autumn, and mid-winter, and the former two peaks were broader than those of *A. kyotoensis* (Figs. 4e, f). This species probably has a more flexible life cycle and can emerge two or more times between the autumn and spring at the study site. *Oxyethira angustella* and *Lepidostoma orientale* had two major peaks in the spring and autumn, similar to *A. kyotoensis*, and they also had a small peak in the mid-winter (Figs. 3c, 4c). Although they may have a life cycle similar to that of *A. kyotoenisis* or *A. aberrans*, further studies, especially on the development of immature stages, are needed. In the Kakida River, adult *O. angustella* were collected throughout the year (Nozaki & Tanida 2007, as *O. kakida*).

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