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Movements of Adult Aquatic Insects Along a Montana (USA) Springbrook

by

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The occurrence and movement patterns of adult insects along a forested springbrook near Flathead Lake, Montana, USA, were studied during three 15-day periods from 19 June through 9 August 1985, using a two-sided Malaise trap. Of the Plecoptera, numbers of males and gravid females of *Malenka flexura*, gravid females of *Zapada frigida*, and total numbers of *Paraperla wilsoni* were significantly higher for downstream-flying adults during one to three periods. Of the Trichoptera, numbers of males of *Anagepetus debilis* were significantly higher for upstream-flying adults during one period, and males of *Lepidostoma cascadense* and gravid females of *L. spicata* were significantly higher for downstream-flying adults during another period. In none of the 26 species examined in these three orders did females show a statistically significant pattern of upstream flight.

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INTRODUCTION

In his description of the "colonization cycle" of freshwater insects, Müller (1954, 1982) proposed that the downstream drift of immature aquatic insects was compensated for by the upstream flight and oviposition of adults. This upstream flight behavior has been observed for adults of certain species in a number of investigations (e.g., see reviews in Bird and Hynes 1981, and Müller 1982).

The original purpose of this study was to examine the relationship among the direction of aquatic insect flight, direction of stream flow, and meteorological factors such as wind direction and velocity, air temperature, rainfall, and cloud cover. During the period of this study, however, meteorological conditions were atypically constant and the original analysis could not be done. However, because so little is known about the flight activitiy of North American aquatic insects and because our results did not conform to those predicted by the colonization cycle we felt that a description of the movement pattern that we

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observed under these meteorological conditions may be of use to others designing or analyzing such studies.

STUDY SITE

Data were collected from 16 June 1985 to 9 August 1985 on Roy's Creek, a springbrook located at the University of Montana's Flathead Lake Biological Station, Yellow Bay, Montana USA. This springbrook forms at a culvert and flows approximately 240 meters before draining into Flathead Lake; collections were made at two sites approximately 90 m apart: an upper site, located 200 m upstream of Flathead Lake, and a lower site, 110 m upstream of the lake. The surrounding forest type is old growth grand fir (*Abies grandis*).

Inflow from seepages increased discharge from $0.012\,m^3/s$ at the upper collecting site to $0.5\,m^3/s$ at the lower site. At both sites, depth ranged from 10-30 cm and substrate sizes ranged from < 1-20 cm; however, median particle sizes were Φ, -1(2-4 cm) at the upper site and Φ, -2(4-8 cm) at the lower site. The dense forest and mild weather conditions made wind velocities usually too low to be perceptible to human senses or our wind gauge. When it was detectable, wind direction usually was in an upstream direction during the day and a downstream direction at night. For the first two periods, precipitation and cloud cover were absent, but during the third period, temperatures were lower and on some days cloud cover and light rain occurred.

METHODS

Insects were collected using a two-sided malaise trap (as in Fig. 3.29 of Merritt et al. (1984) but with two separate collecting jars) that was placed perpendicularly across Roy's Creek. The trap, 2.2 m wide and from 1.2 m (at one end) to 2.8 m (at the other) high, traversed the stream and included dry portions of the stream bed. Insects were taken at daily or twice-daily intervals from the collecting jars; any insects that had not entered the jars were removed from the net with an aspirator. The Malaise trap was placed at the upper site from 19 June to 4 July (15 days). From 5 July to 20 July (15 days) it was moved to the lower site, and then from 26 July to 9 August (15 days) it was returned to the upper site. All specimens, both terrestrial and aquatic, were collected and counted during the first two periods, but only Plecoptera, Trichoptera, and selected species of Ephemeroptera were collected and counted during the third period. When possible, females were separated into "gravid" and "spent" categories. Collection data were examined using chi-square analysis.

RESULTS AND DISCUSSION

Fauna Collected

Approximately 50% of the 2,367 adults collected in the Malaise trap during the first period (upper site) were taxa with aquatic larvae; this was true for only 16% of the 4,320 insects from the second period (lower site). These differences resulted from significantly higher numbers of terrestrial Hymenoptera, Diptera, and Lepidoptera that were collected at the lower site ($p < 0.01$ for each order). At least 30 taxa were represented in the aquatic insect adults collected (Table 1). Because the phenology of individual species cannot be separated from spatial differences between the sites, each sampling period (and hence site) was treated separately in the upstream/downstream flight analysis.

Upstream and Downstream Flight

Only 6 of 26 aquatic taxa examined at the species level (all taxa in Table 1 through *Psychoda* sp. B) showed a preference for flight direction; most of these taxa flew in the downstream direction (9 of 10 statistically significant comparisons, Table 1). Downstream fliers include males (periods 2-3) and gravid females (periods 1-3) of the stonefly *Malenka flexura*, total numbers of the stonefly *Paraperla wilsoni* (period 1), gravid females of the stonefly *Zapada frigida* (period 1), males of the caddisfly *Lepidostoma cascadense* (period 3), and gravid females of *L. spicata* (period 3). The only species with significantly higher numbers of individuals flying upstream were males of the caddisfly *Anagapetus debilis* (period 2). In none of the 26 species examined did females show a statistically significant pattern of upstream flight (Table 1). Total numbers of Chironomidae showed significant upstream movements in both of the periods (1 and 2) in which they were examined but patterns of individual taxa in this family were not examined.

The above results indicate that in this springbrook adults of Ephemeroptera, Plecoptera, and Trichoptera do not have movement patterns indicative of a colonization cycle. Did the absence of wind on most days of this study influence the patterns that we observed? Brown (1970) found that in calm periods or periods of light wind there was more variation in the flight direction of night-flying insects than under higher wind speeds.

Is upstream flight necessary to maintain headwater faunas that are reduced by drift? Densities could be maintained by higher survivorship of immature stages, which can result from a decrease in intraspecific competition; this has been shown to occur when population densities are experimentally reduced (Lamberti et al., 1987). The applicability of the colonization cycle as a compensatory mechanism for drift loss has been examined for over three decades. Perhaps other mechanisms also deserve attention in future studies.

Table 1. Aquatic insect adults collected in a Malaise trap that was placed perpendicular to Roy's Creek, and the number of individuals of each taxon captured. The first number of each pair is the number of individuals flying upstream, and the second is the number flying downstream. In the final column, characteristics that were significant at the 0.05 significance level or lower are listed, with the period(s) during which this event occurred in parenthesis. Abbreviations: T=Total, i.e., males and females combined; F=female; g=gravid; s=spent; M=male; si-=subimago; Down=flying downstream; Up=flying upstream; blanks=data not collected; NS=no statistically significant difference in upstream- and downstream-flying adults found; no letters after number refer to adults not separated into above categories.

Taxa	Period 1 UPPER SITE Males	Period 1 UPPER SITE Females	Period 1 UPPER SITE Total	Period 2 LOWER SITE Males	Period 2 LOWER SITE Females	Period 2 LOWER SITE Total	Period 3 UPPER SITE Males	Period 3 UPPER SITE Females	Period 3 UPPER SITE Total	Sex, Significant Characteristic, (Period), Significance Level
EPHEMEROPTERA										
Ameletus sp.	30si/19si	36si/33si 6s/1s	72/53	0	1si/3s	1/3	13si/8si	15si/14si	28/22	NS
Baetis tricaudatus (Dodds)	8/7	6si, 3g/ 2si	17/ 9	0	1si/0	1/0	0	0	0	NS
Heptagenia spp.	2/0	3si, 1s/2si	6/ 2	0	0/1si	0/1	0	0	0	NS
Paraleptophlebia debilis (Walker)	1si/2	0	1/2	0	0	0	0	0	0	NS
PLECOPTERA										
Malenka flexura (Claassen)	2/6	10g/50g 1s/2s	13/58	0/6	0/8g	0/14	1/19	1g/22g	2/41	Fg Down (1-3), $p < 0.01$; M Down (2), $p < 0.02$; M Down (3), $p < 0.01$
Paraleuctra sp.	0	1g/4g	1/4	0	0	0	0	0	0	NS
Paraperla wilsoni (Ricker)	0	1g/5g,2s	1/7	0	0/2g	0/2	0	0	0	T Down (1), $p < 0.05$
Sweltza fidelis (Banks)	9/6	16g/29g	25/35	0	0/1g	0/1	0	0	0	NS
Zapada frigida (Claassen)	0	0/6 g	0/6	0	0	0	0	0	0	Fg Down (1), $p < 0.02$

TRICHOPTERA										
Anagapetus debilis (Ross)	3/2	1g/1g	4/3	7/1	2g/2g	9/3	3/3	0/1g	3/4	M Up (2), $p < 0.05$
Apatania barri Smith	0/1	0	0/1	0	0	0	0	0	0	NS
Banksiola crotchi Banks	0	0	0	0/1	0	0/1	0	0	0	NS
Chyrandra centralis (Banks)	0	0	0	0	1g/0	1/0	2/7	4g/4g	6/11	NS
Clistoronia magnifica (Banks)	0	1g/0	1/0	0	0	0	0	1g/0	1/0	NS
Lepidostoma cascadense (Milne)	2/4	0	2/4	0/2	0/1g	0/3	0/5	0	0/5	M Down (3), $p < 0.05$
Lepidostoma sp.	0	1g/0	1/0	0	12g/5g	12/5	0	0	0	NS
Lepidostoma spicata Denning	1/0	6g/14g	7/14	5/2	15g/9g,1s	20/12	5/10	31g/73g,4s	36/87	Fg Down (3), $p < 0.01$
Limnephilus insularis Schmid	1/0	0	1/0	0	0	0	0	0	0	NS
Micrasema nr. *bactro* Ross	0	0	0	0	0	0	0/1	0	0/1	NS
Oecetis ochracea (Curtis)	0	0	0	0	0	0	0	0/1g	0/1	NS
Parapsyche elsis Milne	1/1	0	1/1	5/5	0	5/5	7/4	0	7/4	NS
Polycentropus halidus Milne	0	0	0	1/0	0	1/0	0	0	0	NS
Rhyacophila vao Milne	0	0	0	4/3	4g/0	8/3	11/4	9g/7g	20/11	NS
Wormaldia occidea (Ross)	0	1g/0	1/0	1/0	0	1/0	0	1g/0	1/0	NS
DIPTERA										
Psychoda sp. A.			14/8			45/55				NS
Psychoda sp. B.			1/1			12/10				NS
Chironomidae			419/276			187/112				T Up (1,2), $p < 0.01$
Culicidae			47/30			43/32				NS
Dolichopodidae			1/3			1/4				NS
Tipulidae			7/12			30/35				NS

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