MOVEMENTS OF ADULT AQUATIC INSECTS NEAR STREAMS IN SOUTHERN ONTARIO

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Abstract

Sticky traps placed across a stream in southern Ontario in June and September showed that only females of the mayfly *Baetis intercalaris* and the caddisfly *Lype diversa* were flying upstream and so conforming to the concept of the colonization cycle. Other species, *B. vagans, Cheumatopsyche oxa, C. campyla, Hydroptila consimilis, Chimarra aterrima* and *Polycentropus centralis* seemed to be flying at random along the stream. There was a distinct downstream movement of *Baetis* subimagos near the water surface. It is shown that a series of 4 traps across the stream gives a better indication of directional movement than a single one.

In March the winter stonefly *Allocapnia vivipara* was shown to walk away at approximately right angles to the stream and to ascend trees at the edge of the woods 16 m away.

Introduction

Müller (1954) coined the name 'colonization cycle' for the sequence of downstream drift of larvae and supposed upstream flight of ovigerous adults of lotic insects. His concept has been supported for certain species by direct observation of upstream flight, or by finding more females than males in upstream reaches (Roos, 1957, Nishimura, 1967; Elliott, 1969; Madsen *et al.*, 1973; 1977; Madsen & Butz, 1976; Bengtsson *et al.*, 1972; Gothberg, 1972; Pearson & Kramer, 1972; Lehmann, 1970; Thomas, 1975; Svensson, 1974 and Neves, 1979). Other workers have, however, observed that the direction of flight is governed largely by the wind (Elliott, 1967; Bishop & Hynes, 1969).

The present study compares the catches of several types of insect on the upstream and downstream sides of a series of traps across a stream. It also concerns the pattern of movement of the winter stonefly, *Allocapnia vivipara* Frison, that walks away from the stream after emergence. The somewhat similar European *Capnia atra* has been studied by Thomas (1966, 1969), Butz (1973) and Müller (1973).

Methods

The upstream and downstream flight of adults was studied over a riffle in Salem Creek, near Elmira, Ontario, where it flows past cedar trees *(Thuja occidentalis)* on the left bank with pasture and scattered trees on the right.

Four sticky traps, as described by Bengtsson *et al.* (1972) and Madsen *et al.* (1973), consisting of plastic sheets sprayed with non-drying glue material were suspended right across the stream. Each was 1.4 m high and 3.7 m long; they were placed 6 m apart with their lower edges just above the water surface. They were set out on June 14 and on September 21, 1977, and were left for 72 hours on each occasion.

In June the weather was warm and sunny with light breezes. In September it was cloudy and cool (15°C) with some drizzle that turned to heavy rain on the last day.

Before the traps were sprayed it was observed that some mayflies flew into the plastic sheets, then backed away and flew back at a slightly higher level. They, and stoneflies, seemed to show no avoidance reactions. However, some Trichoptera flew around or over the traps, as did all Odonata. Also some insects were flying too high to be intercepted.

On both sampling occasions mayfly subimagos were seen to emerge and fly directly onto the traps within 30 cm of the water. In June these were mostly *Baetis intercalaris* McDunnough, with some *B. vagans* McDunnough.

The movements of *Allocapnia vivipara* were studied near the east branch of Canagagigue Creek, also near Elmira, on 10 and 14 March, 1977. There the stream passes a cedar woodlot about 16 m from the left bank and then flows on

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across pasture. The stoneflies emerge both opposite and downstream of the woods, onto the snow-covered ground. Observations were made on direction and speed of movement by marking individuals with fluorescein solution applied with a paint brush. The movement of others was monitored by placing sticky traps, made by spraying strips of plastic sheeting tacked onto pieces of wood, parallel to and at right angles to the stream, near to the stream and in the woods, and 1.5 m up two trees at the edge of the woods.

Statistical analysis of all the data was by the chi-squared test.

Results

The results for the sticky traps in June, given in Table 1 show that only *Baetis* female imagos occurred more often on the downstream sides of the traps, the differences on the two sides being significant for the most downstream of the traps (No. 1), and for the total. *Baetis* subimagos, other mayflies, mostly subimagos, and total Ephemeroptera occurred mostly on the upstream sides, often in significantly greater numbers. Similarly, one may conclude for the Trichoptera that while a few collections showed some differences between the two sides of the traps, only females of *Lype diversa* (Banks) were consistently moving upstream. There was, however, a general upstream movement of caddisfly adults, as shown by the figures for total Trichoptera. It should also be noted that where there was significant upstream movement, in *Lype* females, the numbers caught on the downstream sides of the traps decreased from trap 1 to trap 4, as one moved upstream.

The catches in September were low, probably because of the poor weather, but, as in June, significantly greater numbers of *Baetis* subimagos, mostly *B. vagans,* were caught on the upstream sides of the traps. The figures for Trichiptera were low and inconsistent. (Table 2).

The results shown for *Allocapnia vivipara* are given in Table 3. Most specimens upon emerging walked away from the stream at an angle of 75-84°C from the direction of flow. They walked at speeds ranging from 19 to 91 cm per minute, with a mean of 39.4. Those that emerged opposite the woods continued on their general course, but it was noted that specimens which had emerged downstream of the woods turned towards the trees after they had walked some distance from the stream.

The sticky traps (table 3b) caught more specimens moving away from the stream (180°C) than moving parallel to it (90°C) both near the stream and at the edge of the woods. A trap set in the woods caught only two specimens, and, indeed, no others were seen on the ground inside the woods. However, the two traps encircling two trees at the edge of the woods at a height of 1.5 m caught a large number.

Discussion

This study has detected only two clear cases of upstream migration, by females of *Baetis intercalaris* and *Lype diversa* in June. These then are two species to add to Svensson's (1974) type 1 pattern of movement, which includes species that mostly move upstream. They also support the findings of Madsen *et al.* (1977) that *Baetis* move upstream. However, our observations on *B. vagans* in September do not place that species in this category, and are in agreement with the statement of Waters (1969) that this species does not fly upstream to oviposit.

We may note here also that our findings show consistently that there was a downstream displacement of newly emerged subimagos of *Baetis,* and probably of other mayflies also, in both June and September. As noted above, most such specimens were caught near to the water surface.

Apart from *Lype diversa* our data on Trichoptera are not conclusive. In September catches were small, and in June the results show no clear trend. We must conclude therefore that, despite numerous reports of upstream movements of species in this order (e.g. Roos, 1957; Elliott, 1969; Mackay, 1969; Lehmann, 1970; Svensson, 1974 and Neves, 1979), those that we were collecting, *Cheumatopsyche oxa* Ross, *C. campyla* Ross, *Hydroptila consimilis* Morton, *Chimarra aterrima* Hagen and *Polycentropus centralis* Banks, do not display this phenomenon. This is of interest because, as within the genus *Baetis,* related species seem to differ in this respect. For example, Roos (1957) reported upstream movement in *Cheumatopsyche lepida,* and another Hydropsychidae species, *Stenopsyche griseipennis,* has been reported to migrate upstream (Nishimura, 1967).

A final point concerning migration on the wing and the use of sticky traps to measure it, is that doubtless the position of the trap in relation to local air movements must effects results. Some previous studies with these devices (Bengtsson *et al.,* 1972; Madsen *et al.,* 1973; Madsen & Butz, 1976 and Neves, 1979) have used traps that did not stretch right across the stream or did not reach down to the water. Such arrangements can lead to local eddies of air or to avoidance reactions. We feel that our system of four

Table 1. Numbers of mayflies and caddisflies caught on the upstream (up) and downstream (down) sides of the four sticky traps in June. Significant differences between up and downstream sides are shown by ^{x} = $P < 0.05$, ^{xx} $P < 0.005$. Trap 1 was at the downstream end.

	Sex	Trap number 1		2		3		4		Total	
		down	up	down	up	down	up	down	up	down	up
Baetis imagos	M	2	0	2	2	2	1	1	0	7	3
	F	25	10^{x}	19	13	14	6	8	12	66	41^{x}
Baetis subimagos	M	20	76^{x}	22	49^{xx}	4	23^{xx}	2	18^{xx}	48	166^{xx}
	F	71	69	45	145^{xx}	25	39	11	26^{xx}	152	299^{xx}
Other Ephemeroptera		10	6	18	43	28	55	19	49	75	133
Total Ephemeroptera		128	161	106	252^{xx}	73	124^{xx}	41	105^{xx}	348	642^{xx}
Cheumatopsyche	F	24	36	65	23^{xx}	32	19	6	20^{x}	127	98
Hydropsyche	F	7	4	10	5	1	2	9	11	27	22
Hydropsychidae	M	10	8	14	16	12	18	7	10	43	52
Hydroptila consimilis	M	5	12	5	12	8	1^{x}	2	3	20	28
	F	17	32^{x}	23	26	21	5^{xx}	4	5	65	68
Chimarra aterrima	M	1	2	1	2	2	1	4	6	8	11
	F	3	3	1	3	5	2	2	1	11	9
Lype diversa	M	10	8	5	3	14	15	4	18^{xx}	33	44
	F	76	4^{xx}	40	14^{xx}	36	27	9	5	161	50^{xx}
Other Trichoptera		14	18	19	12	10	14	3	4	46	48
Total Trichoptera		167	127^{x}	183	116^{xx}	141	104^{x}	50	83^{xx}	541	430^{xx}

Table 2. Numbers of mayflies and caddisflies caught on the upstream (up) and downstream (down) sides of the four sticky traps in September. Significant differences indicated as in Table 1.

	Sex	Trap number 1		2		3		4		Total	
		down	up	down	up	down	up	down	up	down	up
Baetis imagos	M	0	2	0	2	0	1	1	0	1	5
	F	3	6	2	7	3	5	2	2	10	20
Baetis subimagos	M	4	9	1	11^{x}	0	3	4	2	9	25^{x}
	F	10	24^{x}	10	54^{xx}	4	21^{xx}	6	7	30	106^{xx}
Other Ephemeroptera		3	11	1	9	0	6	3	0	7	26
Total Ephemeroptera		20	52^{xx}	14	83^{xx}	7	36^{xx}	16	11	57	182^{xx}
Total Trichoptera		7	3	3	20^{xx}	3	3	15	0^{xx}	28	26

Table 3. Movements of adults of the winter stonefly, *Allocapnia vivipara* (a) Direction and rate of movement.

Direction from stream (degrees)*	0–24	25–34	35–44	65–74	75–84	85–94	170–180	270
No. of individuals	4	6	1	2	53	4	2	3
Rate of movement ($cm\ min^{-1}$) of several individuals	19.0	28.4	67.0	91.0	24.3	32.3	40.7	12.2

* 0^{o} is upstream, 180^{o} is downstream, while 270^{o} is towards the stream

(b) Numbers caught on sticky traps.

Sex	near stream 90^{o} to stream	near stream 180^{o} to stream	near woods 90^{o} to stream	near woods 180^{o} to stream	in woods	tree 1	tree 2
Male	1	7	3	6	2	63	56
Female	2	0	0	0	0	9	4

traps set right across the stream and down to the water surface removes some of these doubts. Moreover, where there is a clear movement in one direction it is shown not only by the greater catch on one side than on the other, but by the decreasing catch in the direction of movement. This is very clear in Table 1 for females of *Baetis* (25, 19, 14, 8) and *Lype* (76, 40, 36, 9). It is also probably desireable to know where on the trap the catches are made, as shown by the distribution of subimagos near the water, and almost certainly an ideal trap would sample above the 1.4 m level that ours reached.

Finally, our study of *Allocapnia vivipara* shows that its adults move much as has been reported for the European species *Capnia atra* even to its average speed of walking

acoss the snow surface. Butz (1973) reports 30 cm/min for *C. atra* and our mean value was 39.4. Coleman & Hynes (1970) have already recorded a similar march away from the stream by *Allocapnia pygmaea. A. vivipara,* like *C. atra* is also attracted to landmarks, as shown by the change of direction towards the woods of specimens that had emerged downstream. *A. vivipara's* behaviour does, however, differ in one respect from that of *C. atra.* The latter is reported to walk far into the woods on the ground (Thomas, 1969; Müller, 1973). *C. vivipara* does not do this; it climbs up trees at the forest edge, and few penetrate far beneath the trees.

We therefore have in this area species that do migrate upstream and conform to the original idea of the colonization cycle, and others that seem not to move along the stream in their adult stage. These two types have been typified by Müller (1973). We did not detect any that made small but significant movements upstream (Svensson's type 2) nor that move downstream (type 4). But the Capniidae that move so directly away from the water are examples of his type 3, even though that category was originally devised for flying insects.

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