

PHENOLOGY AND DISTRIBUTION OF MAYFLIES IN A SOUTHERN ONTARIO LOWLAND STREAM

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Abstract. Fifteen emergence trap series collected in 1977 in Salem Creek /43°35'N 80°30'W/ in Southern Ontario are used to describe species composition and phenology of the mayfly community. Some 25 species inhabit the short stretch of stream sampled; the dominant species are Baetidae /Baetis flavistriga McD., B. hageni Eaton, B. macdunnoughi Ide, B. tricaudatus Dodds/ and Leptophlebiidae /Paraleptophlebia mollis /Eaton/ and Habrophlebiodes americana /Banks/ /. Phenologies of various species are compared to one another and confronted to previous results from more northerly sites in Quebec; special emphasis is given to the emergence patterns of Baetidae for which there are still few data available in North America. The fifteen sampling stations are compared on the basis of the composition of their emerging mayfly communities and correlations are attempted with habitat parameters.

Emergence traps, Baetidae, habitats

Most of our knowledge of Canadian mayfly communities has been gathered from highland or mountain streams (Harper and Harper 1982). We were thus most interested in studying a series of emergence trap catches gathered in 1977 by Dr. Laurent LeSage in a lowland stream of Southern Ontario.

Besides the phenology of the species, we will stress species composition and community structure over a short section of stream.

THE STUDY AREA

Salem Creek (43° 35'N; 80° 30'W) arises from a cedar swamp and flows into Canagagigue river, a tributary of the Grand River, the major northern tributary of Lake Erie. The study site,a

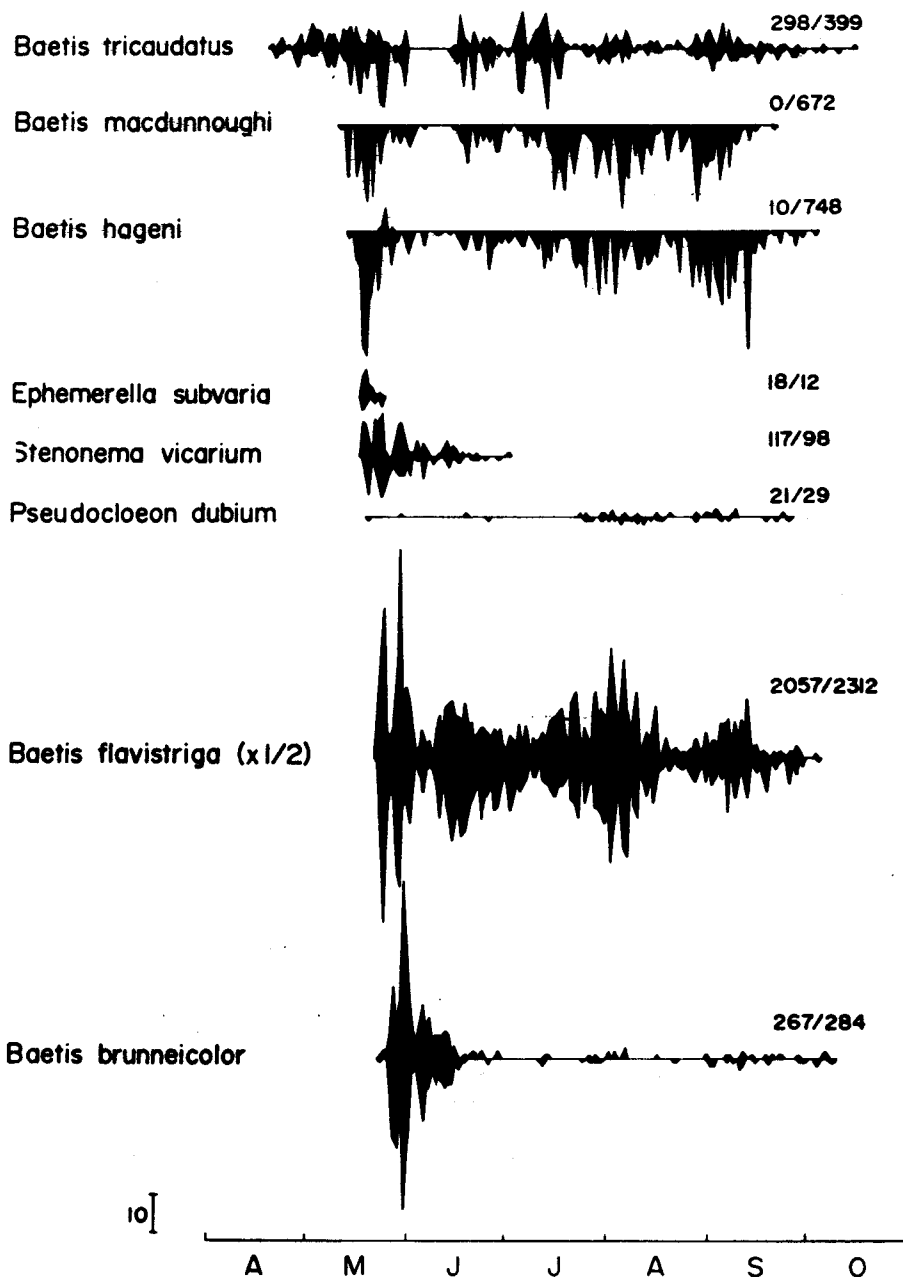


Fig. 1: Seasonal succession of Ephemeroptera collected in 15 emergence traps during the summer of 1977. The upper part of each diagram represents the emergence of males and the lower part, the emergence of females. Total numbers of males/females appear for each species.

100 m stretch at about midlength of the stream, has been described in detail by LeSage and Harrison (1980); it contains the major habitat types of the stream. It can be recalled here, that this section would be qualified as epipotamon; the water has a high pH (8.3), is hard (64 mg/l Ca^{++} ; 23 mg/l Mg^{++}), mineralized (510 $\mu\text{S}/\text{cm}$) and is enriched (45 $\mu\text{g}/\text{l}$ PO_4 ; 0.2 mg/l NO_3) from the cattle and crop industries (maize, hay) in the watershed. Dissolved oxygen remains high throughout the year (95% of saturation).

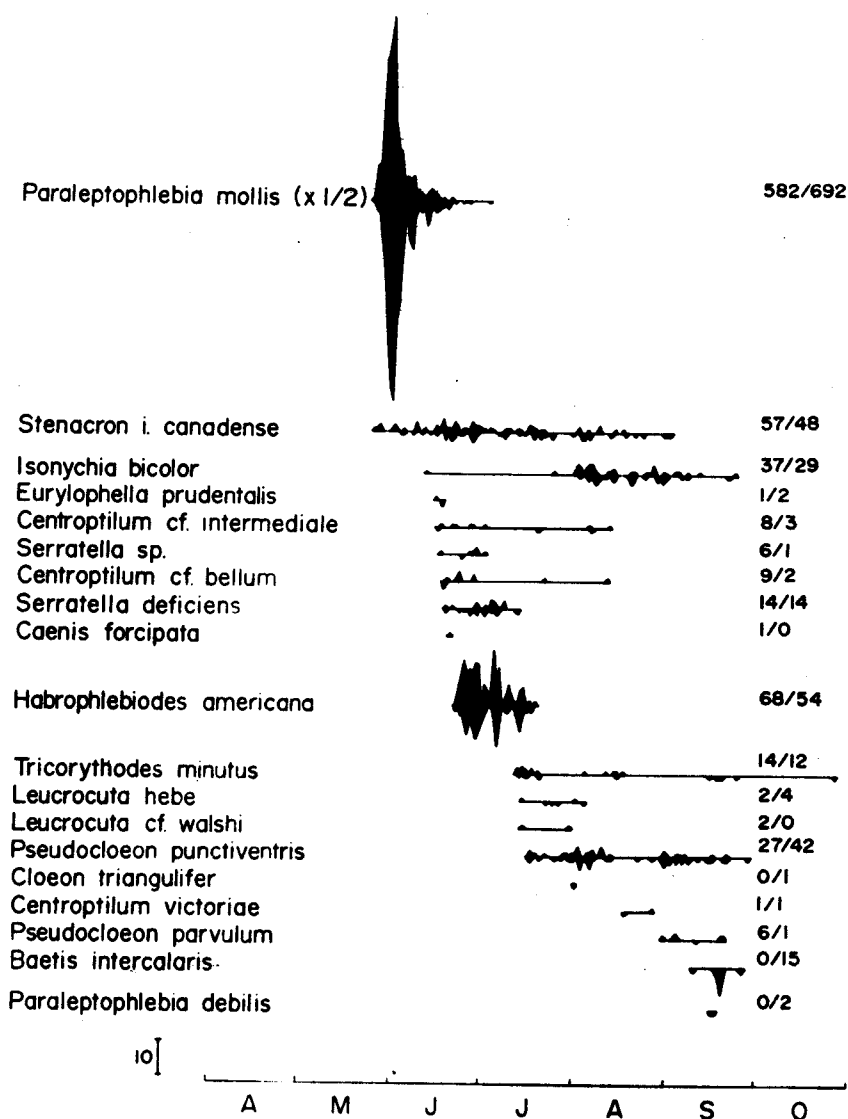


Fig. 2: Seasonal succession of Ephemeroptera collected in 15 emergence traps during the summer of 1977. The upper part of each diagram represents the emergence of males and the lower part, the emergence of females. Total numbers of males/females appear for each species.

MATERIAL AND METHODS

Along a 100 meter section, 15 sampling sections were chosen to reflect the various available combinations of current speed, substrate and cover. A detailed description of the station is available in LeSage and Harrison (1980). In each station, an emergence trap (3716 cm² of trapping surface; LeSage and Harrison 1979) was maintained throughout the emergence season in 1977 (early April to early November) and emptied every day.

Statistical analysis were performed on the Université de Montréal CDC computer using a statistical package (programme "r") developed by Alain Vaudor of our department and following the procedures suggested by Legendre and Legendre (1979).

RESULTS AND DISCUSSION

The species present

The 15 traps yielded some 9230 specimens belonging to 27 species (Figs. 1 and 2). Most of the species are common and widespread, except for Centroptilum victoriae which seldom has been collected.

Sex-ratios are close to one in most abundant species, except in B. macdunnoughi where no males were collected and in B. hageni where only a few males emerged early in the season.

The phenology

Figs. 1 and 2 illustrate the phenology of the species. Most of the Baetidae possess very extended emergence periods in which there are a number of peaks representing 3-4 generations a year (Baetis tricaudatus, B. macdunnoughi, B. hageni, B. flavistriga). In Baetis brunneicolar, more than one generation is involved, but the first cohort to mature in late May is by far the most important. Pseudocloeon punctiventris and dubium probably have two generations a year. This interpretation is however open to doubt, since one should take into account the possibility of overlapping generations as was shown by Humpesch (1979) in European species.

Members of other families appear univoltine, some with a very restricted emergence (e.g. E. subvaria, S. vicarium, S. deficiens, and particularly the Leptophlebiids P. mollis and H. americana), whereas others prolong their emergence over many weeks, without definite peaks (e.g. S. i. canadense, I. bicolor).

The seasonal succession of these Ontario mayflies thus resembles the general patterns observed elsewhere in Canada at more northern latitudes and at higher elevations (Sprules 1947, Harper and Harper 1982, Harper, Magnin and Harper 1983). There are nonetheless some particular features:

The emergence season is much prolonged, starting as early as mid-April and continuing well into September and early October. Even excluding B. tricaudatus which is a very early species appearing well before the others, the overall emergence of mayflies in this stream starts some 10-15 days earlier than in Southern Quebec (Harper and Harper 1982, Harper, Magnin and Harper 1983). This is undoubtedly due to the warmer temperatures of Southern Ontario: early species can appear earlier and late species (e.g. P. debilis) can fly later in the season.

The patterns observed here are similar to those recorded elsewhere, except for one notable exception: B. flavistriga, in the Quebec Laurentians, was clearly shown to be univoltine, with an emergence concentrated in mid-June. Here, it is obviously multivoltine. The temperature differences between the two sites do not explain such differences and doubts must be cast on the identity of the specimens. It will be recalled that

Mohihara and McCafferty (1979) had synonymized a number of species under the name flavistriga (phoebus, pallidulus, cingulatus, levitans ...); perhaps as data accumulate on this groupe, some redivision may be warranted. The emergence of Baetis intercalaris in September only and in such small numbers is a little surprising considering that the species is very common and present throughout most of the summer in Illinois (Burks, 1963) and Wisconsin (Bergman and Hilsenhoff 1978).

Harper and Harper (1982) had observed a very definite temporal segregation between species groups living in a Quebec stream, and this was particularly evident in the Baetids (B. pygmaeus, B. macdunnoughi, B. flavistriga, B. pluto and B. propingus). In this stream, the Baetids are by far the most abundant species and no temporal segregation is evident between them. All peaks coincide more or less which suggests that all species grow at the same time.

Despite the earlier warming in the spring and the more extended warm temperatures in the summer, the synchronized emergence of some species and the extended emergence of others are maintained as clearly as in more northern latitudes which suggests that the emergence pattern is part of the life-history strategy of the species.

Species composition and community structure

Table I shows the distribution of the species in the 15 stations.

Numbers per m^2 differ considerably from a low of 38 individuals/ m^2 in station 5 to a fairly high value of 4992 ind./ m^2 in station 9, for a mean production of 1656 mayflies/ m^2 . These numbers are of the same order of magnitude as those recorded from a Quebec acid stream (mean of 1000-1200 ind./ m^2 , Harper and Harper 1982). Ide (1940) had collected up to 6500 ind./ m^2 in a Southern Ontario stream.

The number of species varies from 4 to 18 in the stations, value much lower than encountered by Harper and Harper (1982) who recorded up to 29 species from a midstream section in Quebec.

Diversity values (nats/ind.) are comprised between 1.67 and 3.19; there is no direct correlation between species numbers, numbers of specimens and diversity: diversity is ordinarily low in stations with few species and specimens (e.g. station 5: $H' = 1.67$, 4 species, 38 ind./ m^2). However, it increases to a higher value with an increase in numbers of species and specimens (e.g. station 12: $H' = 3.14$, 12 species, 121 ind./ m^2); the number of specimens is not particularly high and their distribution into species is even, which accounts for a high diversity. At higher densities, diversity decreases (e.g. station 8, $H' = 2.48$, 17 species, 475 ind./ m^2 ; station 9, $H' = 2.78$, 18 species, 4992 ind./ m^2) mainly because of the dominance of a few species, one of which often makes up to 50% of the community (as B. flavistriga in station 8).

Table I. Distribution of species, number per square meter and diversity at the 15 stations in the summer of 1977.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<i>Isonychia bicolor</i>	3	-	1	14	-	-	3	14	22	-	-	-	1	4	4
<i>Baetis brunneicolor</i>	7	9	10	10	2	2	24	79	232	120	10	4	1	31	10
<i>B. flavistriga</i>	45	54	530	172	7	32	284	857	641	408	18	14	10	955	342
<i>B. hageni</i>	10	8	31	9	1	10	38	142	251	75	-	-	-	121	62
<i>B. intercalaris</i>	9	2	-	-	-	-	1	-	-	-	2	-	-	-	1
<i>B. macdunnoughi</i>	8	19	20	88	-	9	33	54	211	88	15	3	2	80	42
<i>B. tricaudatus</i>	25	2	140	21	-	3	10	249	55	110	2	3	1	54	22
<i>Centroptilum cf. bellum</i>	1	2	-	-	-	-	-	-	-	-	3	5	-	-	-
<i>C. cf. intermediale</i>	1	4	-	2	-	-	-	-	-	-	4	-	-	-	-
<i>C. triangulifer</i>	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
<i>C. victorinae</i>	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-
<i>Pseudocloeon dubium</i>	-	-	2	1	-	-	1	27	1	-	1	1	1	15	-
<i>P. parvulum</i>	-	-	-	2	-	-	-	5	-	-	-	-	-	-	-
<i>P. punctiventris</i>	-	-	4	3	-	-	-	38	1	-	1	-	-	22	-
<i>Leucrocota hebe</i>	-	-	2	-	-	-	1	2	-	-	-	-	-	1	-
<i>L. cf. walshi</i>	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-
<i>Stenacron i. canadense</i>	4	20	6	3	-	2	10	9	21	-	3	3	-	6	13
<i>Stenonema vicarium</i>	24	7	2	1	-	1	9	13	74	33	4	3	14	18	12
<i>Habrophlebiodes americana</i>	4	7	12	4	-	2	6	29	43	7	26	2	-	31	80
<i>Paraleptophlebia mollis</i>	15	82	22	21	4	8	68	237	283	383	7	5	2	88	49
<i>P. debilis</i>	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
<i>Ephemerella subvaria</i>	4	1	-	-	-	-	1	1	6	16	-	1	-	-	-
<i>Eurylophella prudentialis</i>	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-
<i>Serratella sp.</i>	-	3	-	1	-	-	-	-	-	-	-	-	1	3	-
<i>S. deficiens</i>	1	-	2	-	-	-	2	7	7	-	-	-	-	7	2
<i>Tricorythodes minutus</i>	-	-	3	2	-	-	2	3	2	-	-	-	4	9	1
<i>Caenis forcipata</i>	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-

Number / m ²	433	595	2120	953	38	186	1327	4752	4992	3337	261	121	100	3891	1736
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Diversity	3,2	2,8	1,7	2,3	1,7	2,4	2,2	2,5	2,8	2,5	3,1	3,1	2,7	2,0	2,3
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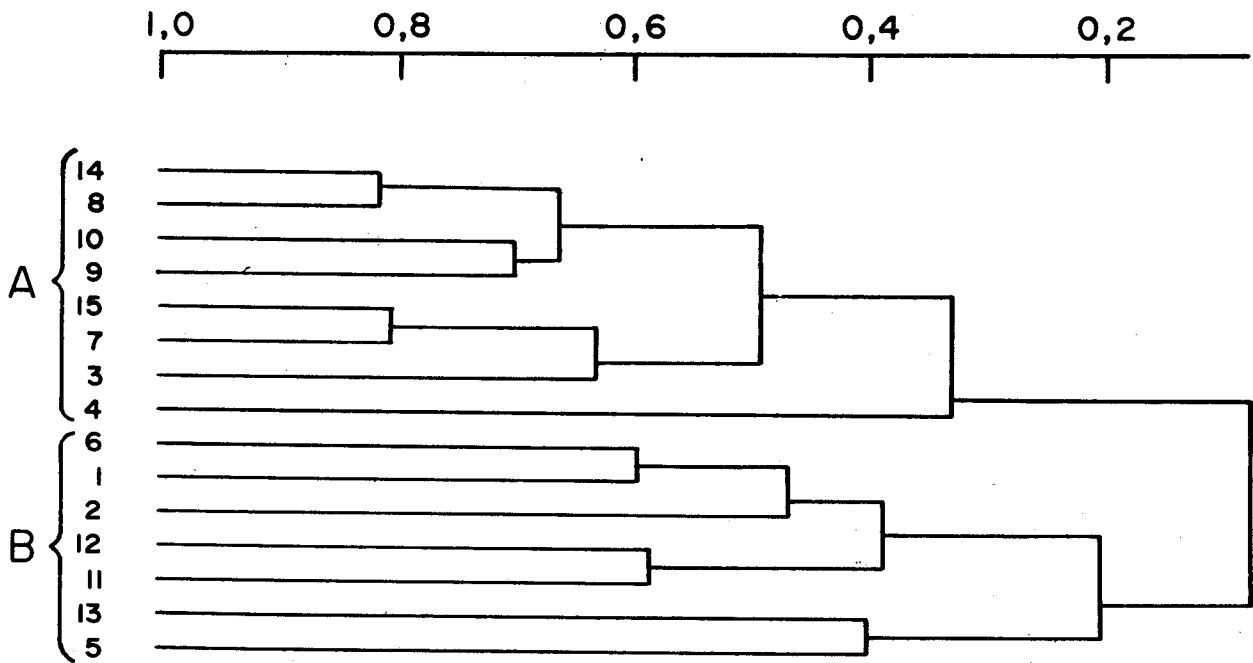


Fig. 3: Clustering of stations based on species composition and abundances at each station using the Steinhaus similarity index.

Species composition is very similar from one station to another and most stations have the same dominant species, B. flavistriga; only three stations are dominated by another species; Station 2 by P. mollis, station 11 by H. americana and station 13 by S. vicarium.

An attempt was made to segregate stations into homogenous groups based on the species composition and the numbers emerged. Species composition and abundances were thus compared at all stations using the Steinhaus similarity index (S_{17} in Legendre and Legendre 1979) which gives high similarity values to lists containing the same species in similar numbers.

When the similarities are extracted on a dendrogram (Fig. 3) based on an intermediate (75%) linkage procedure, two distinct groups of stations become apparent: group A (14, 8, 10, 9, 3, 15, 7 and 4) which comprises stations with a high production of mayflies (953-4992 ind./m²) and group B, which includes stations with a low production of mayflies (38-595 ind. per m²). The mean number of species is 15.2 (9-18) in group A and only 11.3 (4-15) in group B.

When correlations are sought with habitat parameters, a few points can be made:

1) Group A stations on the whole have higher water currents (mean 22.5 cm/s; range 1-40) than group B stations (mean 2.7 cm/s; range 0-12).

2) Group A stations occur generally on $\phi \leq 64$ mm bottom substrates dominated by cobbles or pebbles (ϕ : 16-64 mm); the exception is station 9 where there is a large accumulation of

wood debris on sand. Group B stations have a substrate dominated by silt ($\phi < 0.25$ mm), the main exceptions being stations 12 and 11 where the bottom is composed mainly of cobbles but is silted up during the summer from lack of current.

3) When species lists of both groups are confronted, differences are seen mainly in numbers of individuals present rather than differences in species composition. An attempt was made to establish species associations using the different sites as descriptions in an R-type analysis with a X^2 similarity index (S_{21} in Legendre and Legendre 1979) (clustering based on the nonhierarchical complete linkage procedure of Fager 1957). At a level of similarity of 0.99 B. brunneicolor, B. flavistriga, B. hageni, B. macdunnoughi and P. mollis are clustered. At a level of 0.985, the analysis has grouped I. bicolor, B. brunneicolor, B. flavistriga, B. hageni, B. macdunnoughi, B. tricaudatus, P. mollis and S. deficiens, which indicates that satellite species cluster around a firm nucleus of dominant species as we allow the level of similarity to decrease. No other species group was outlined by the computer analysis, but a look at table I might allow us to distinguish another group of species made up of B. intercalaris, C. bellum, C. intermediale, C. victoriae which are comparatively more abundant in B stations. These species probably represent the slow water element of the community but they are nowhere abundant in this reach of Salem Creek.

CONCLUSION

In conclusion, it can be stressed that in this enriched section of Salem Creek,

- a moderately numerous community of 27 species of mayflies has become established.
- it is dominated essentially by Baetidae and to a lesser extent by Leptophlebiidae.
- Emergence characteristics are classic; the Baetids are mostly multivoltine, while the others are univoltine and exhibit the usual synchronous or extended patterns.
- The most productive stations are those with a cobble or pebble substrate and fast water. They produce large numbers of emerging mayflies, but diversity is low due to the dominance of a few species.
- The stations on fine substrates with slow currents are much less productive; they harbour no specialized community (except for a small group of lentic Baetids), but rather a reduced assemblage of the water community.

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