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The production of two species of Ephemeropters *(Ephemerella ignita* PODA and *Rhithrogena semicolorata* CURTIS) in the upper reaches of the R. Wye, Wales

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Introduction & Methods

As part of a base-line ecological study of the R. Wye related to the construction of an enlarged Craig Goch, a proposed major regulating reservoir in the upper catchment which will be filled from a variety of sources, two sites (W2 and W3) in the headwaters were intensively studied during the period March 1975 – April 1976 and estimates of production made for two species of Ephemeroptera. Both study sites are typical salmon nursery areas with a substrate of cobbles and coarse gravel forming a 'riffle' habitat. The water, similar at both sides, is soft (mean calcium concentration = 4.1 mg/l) and low in inorganic nutrients.

Samples, taken weekly during the summer and less frequently at other times, were collected from each riffle on a stratified random basis using a cylinder sampler (area, $0.05m^2$) modified after Neill (1938). Seven replicate samples were taken with weekly sampling and 14 at other sampling frequencies. The wetted area of each site was measured frequently throughout the study.

Production of *E. ignita* and *R. semicolorata* was estimated from changes in individual weight and population density (Chapman, 1968).

$$P = G.B.$$

Where P is production, B is mean biomass and G is instantaneous growth over a give period. At certain times of year the calculation of instantaneous growth rate was confused by recruitment or by the emergence of adults effectively reducing the mean weight of the population: such apparent negative growth rates are not uncommon. Two methods have been used to estimate production:

A. Negative production (real or apparent) was not included in the final summation (Maitland & Hudspith, 1974).

B. An average instantaneous growth rate was calculated for each species from those periods when recruitment and emergence were unlikely to have influenced the mean weight of the population.

All calculations were carried out using retransformed estimates of numbers (x) after log (x + 1) transformations. Knowing the wetted area of the sites throughout the period, annual production could be expressed per unit site area.

During the period 26th April – 2nd June three basket samplers ($0.028m^2$ x 0.3m) modified after Coleman & Hynes (1970) were buried in the river bed at a nearby and similar site. Total invertebrate density was distributed in the following proportions, 0-10 cm, 71%; 10-

20 cm 16%; 20-30cm, 13%. Both *E. ignite* and *R. semicolorata* were found almost exclusively in the top 10 cm (Table 1).

Results

E. ignita and *R. semicolorata* often formed a substantial proportion of total invertebrate and of ephemeropteran density at both sites (Table 2). Over the period of study *R. semicolorata* reached peak mean (geometric) densities of 470 & 360 m^2 at W2 and W3 respectively (fig. 1). Peak mean densities of E. ignite were recorded in June and July ($440/m^2$ at W2 and $230/m^2$ at W3).

Weight-length relationships for both species were described by the regression equations

$$Log_{10}^{W} = 0.0049 + 2.94\ log_{10}^{L}\ \textit{(R. semicolorata)}$$
$$Log_{10}^{W} = 0.0104 + 2.962\ log_{10}^{L}\ \textit{(E. ignita)}$$

W & L being the dry weight and body weigh in mg and mm respectively.

Table 3 compares production estimates and P:B ratios (cohort turnover) for the two species using both methods of calculation. Although there are differences in production between sites for both species, the most striking difference is associated with the method of calculation of production estimates of *E. ignita*, method B giving values of production and P:B ratios about twice those of method A. In the case of *R. semicolorata* both methods gave similar production values.

Discussion

Early studies of population densities of invertebrates in stone and gravel substrates ignored that part of the population below the sampling depth of conventional surface samplers. The first depth studies which were undertaken greatly emphasised the importance of the hitherto unsampled fractions of populations. Coleman & Hynes (1970), for example, recorded as many as 80% of invertebrates below 7.6cm. Later studies have demonstrated the considerable variation in depth distributions between sites (Poole & Stewart, 1976). In the current study more than 90% of populations of *E. ignite* and *R. semicolorata* occurred within the depth adequately sampled by a conventional surface sampler.

A further difficulty in providing an accurate estimate of animal numbers and size distributions results from losses of small sizes through sampling nets and sieves used in sorting. Although not rigorously examined in the present study, the smallest obtainable head widths of *E. ignite* and *R. semicolorata* were 360 and 460 µ respectively compared with a net aperture dimension of 440 µ in the sampler. Maitland *et al* (1972) indicated an error of only 2.7% in their production estimate of Stictochironomus in Loch Leven caused by using a 500 µ mesh sieve for sorting.

The annual production of both *E. ignite* and *R. semicolorata* in the R. Wye (89-353 mg dry wt/m^2) is much less than that reported by Waters & Crawford (1973), 4000 mg dry wt/m^2, for *Ephemerella subvaria* in a small Minnesota stream. The cohort turnover rate (P:B) of *E. subvaria* (4.2) was similar to ratios reported in this study using method B (table 3). Other production estimates of mayflies, but from lentic waters, are for *Hexagenia limbata*

(450 mg dry wt/m^2) in a reservoir (Horst & Marzolf, 1975) and for *Caenis horaria* (850 mg dry wt/m^2) in the nutrient rich fens of eastern England (Mason, 1977).

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Table 1

Vertical distribution of *Ephemerella ignite* and *Rhithrogena semicolorata* at W5, 2nd June 1976

Species	**Total Density (No/m²)**	**Percentage depth distributions (%)**		
		0-10	**10-20**	**20-30**
E. ignite	670	93	7	0
R. semicolorata	612	98	2	0

Table 2

Relative abundance of *Ephemerella ignite* and *Rhithrogena semicolorata* at sites W2 and W3, March 1975 – April 1976

	E. ignite		***R. semicolorata***	
	W2	**W3**	**W2**	**W3**
% total invertebrate density	(0-24)	4 (0-12)	7 (0-48)	10 (0-38)
% ephemeropteran density	28 (0-80)	17 (0-85)	20 (0-100)	47 (0-94)

Table 3

Production estimates, cohort turnover and estimates of instantaneous growth rates

– 95 % confidence limits in parentheses.

Species	Site	Mean B	Method A		Method B		
			P	P : B	G (per day)	P	P : B
E. ignite	W2	120 (57-133)	344 (186-423)	2.9	0.074	794	6.6
	W3	36 (22-79)	89 (75-124)	2.5	0.065	164	4.5
R. semicolorata	W2	55 (28-98)	216 (83-376)	3.9	0.013	249	4.5
	W3	103 (55-167)	353 (90-611)	3.4	0.012	435	4.2

Figure 1

Seasonal changes in density at W2 and W3 of

a) *Rhithrogena semicolorata*

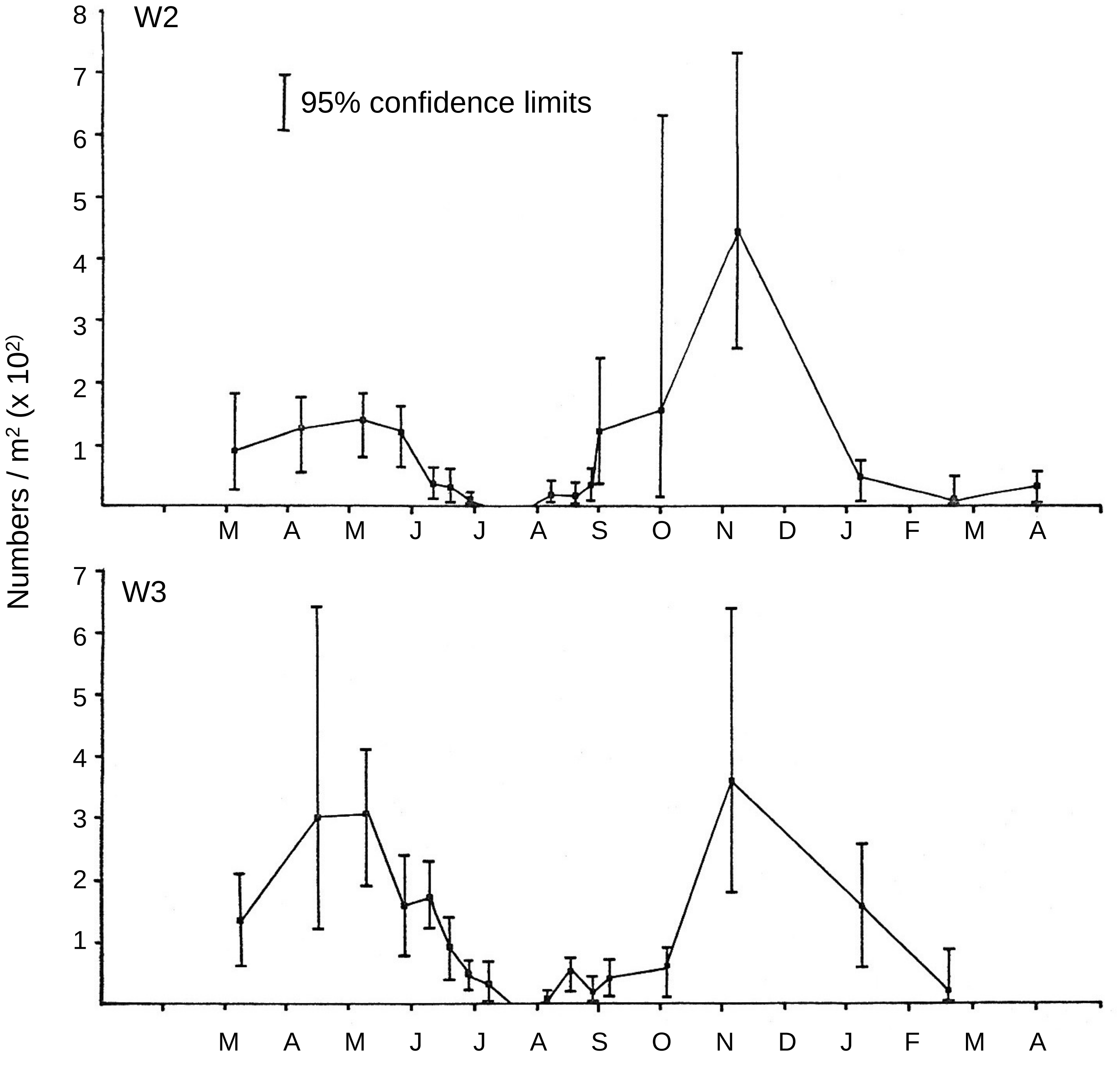

Figure 1 cont.

Seasonal changes in density at W2 and W3 of

b) *Ephemerella ignita*