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Alberto Basset, Loreto Rossi

Factors affecting the habitat choice of Baetis rhodani and Caenis sp. (Ephemeroptera). Note I. Role of three species of leaf detritus

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SEZIONE III

(Botanica, zoologia, fisiologia e patologia)

Ecologia. — *Factors affecting the habitat choice of* Baetis rhodani *and* Caenis sp. (*Ephemeroptera*). Note I. *Role of three species of leaf detritus.* Nota di ALBERTO BASSET (*) e LORETO ROSSI (*), presentata (**) dal Socio G. MONTALENTI.

RIASSUNTO. — È stato studiato in natura il ruolo della qualità del detrito vegetale sulla microdistribuzione di due specie di Efemerotteri detritivori: *Baetis rhodani* e *Caenis sp.*

Pacchi di tre specie fogliari, ontano (*Alnus glutinosa*), cerro (*Quercus cerris*) e salice (*Salix alba*), sono stati immessi in un corso d'acqua del 2° ordine immissario del lago di Bracciano. Prelievi di trentasei pacchi erano effettuati settimanalmente, per otto settimane, e su questi veniva determinata la distribuzione delle due specie animali.

È stato osservato che: 1) La distribuzione intraspecifica presenta notevoli differenze sui tre tipi di foglie; 2) La sovrapposizione di microhabitat tra le due specie è bassa ($0.175 \leq D \leq 0.409$) per la maggior parte del periodo sperimentale.

È sottolineata l'importanza della qualità ed eterogeneità del detrito vegetale per la coesistenza stabile delle due specie nello stesso biotopo.

INTRODUCTION

A habitat and food preference shift is currently considered the earliest identifiable reaction between coexisting similar species (Connell, 1980). When there are competitors, however, a species should specialize in the use of the habitat where it finds its food rather than in its diet (MacArthur and Wilson, 1967). The study of biologic mechanisms allowing a sympatric coexistence of similar species is particularly interesting in communities involved in the demolition processes of plant detritus in waterways. Deposits of allochtonous plant detritus: 1) form an important energy source for aquatic communities; 2) generally consist of a mixture of different leaf species; 3) are colonized by many taxa having, apparently, a total or almost total trophic overlap.

This work aims at verifying the importance of the plant detritus quality to the coexistence in the same biotope of two detritivorous mayflies: *Baetis rhodani* and *Caenis sp.* We therefore studied experimentally in nature the microdistribution of the nymphs of the two species on different leaf substrata.

(*) Centro di Genetica Evoluzionistica c/o Istituto di Genetica dell'Università degli Studi di Roma.

(**) Nella seduta del 21 novembre 1981.

Materials and methods

The study was carried out in a 2nd order tributary of the Bracciano lake (Fosso del Diavolo).

Packs of leaves (5 g dry weight) of three species commonly found in allochtonous detritus deposits of the stream were introduced into the water in February 1979. Leaves collected from single alder (*Alnus glutinosa*), oak (*Quercus cerris*) and willow (*Salix alba*) trees near the study area were used. The packs were prepared with leaves dried in an oven for 72 h at 60 °C, tied together by their stalks. Sixteen rows of packs, each one formed by six packs for each type of leaf (eighteen packs per row) were introduced into the water in a reach of the stream where *Baetis rhodani* and *Caenis sp.* were known to be dominant. In each row the packs were arranged in six identical successions of alder-oak-willow. Each week two rows of packs were collected. Animals of the two species were collected from nine packs for each type of leaf. Each pack was rinsed separately more than once with tap water in a single glass bowl. The leaves were then observed through a stereoscope to make sure that the rinsing had completely removed the animals; any animal still present was removed by hand. Individuals belonging to the two species of Ephemeroptera in each bowl were then separated and counted. The remaining three packs for each species of leaf were used to determine the microbic load. The results of this analysis will form the subject of the next note.

Results

The intraspecific distribution for both species is highly influenced by the type of leaf (Fig. 1, Table I). The microhabitat interspecific overlap, calculated by Schoener's D (1968), was always very low except during the 4th and 5th week (Fig. 2). In fact, the two species have widely differentiated distribution patterns on all types of leaves used, especially on two of them: alder and oak.

In the beginning, *Baetis* shows a strict preference for alder; this leaf collects over 70% of the individuals until the 4th week; later, the percentage decreases and, in the last sampling, is down to little more than 10%; the number of *Baetis* on oak grows in parallel: in the last three samples this leaf always collects over 65% of the individuals. Oppositely, *Caenis* immediately colonizes oak, while, in the last week, it shows a marked preference for alder. Neither species of mayflies seems to be especially attracted by willow (Fig. 1). The total number of individuals of each species throughout the whole period of the experiment, however, is very close: 1656 *Baetis rhodani* nymphs and 1649 *Caenis sp.* nymphs were collected. For both species the greatest number of animals was found on alder and oak packs, while willow packs only collected 22.32% of *Caenis sp.* individuals and 6.64% of *Baetis rhodani.* (Table II).

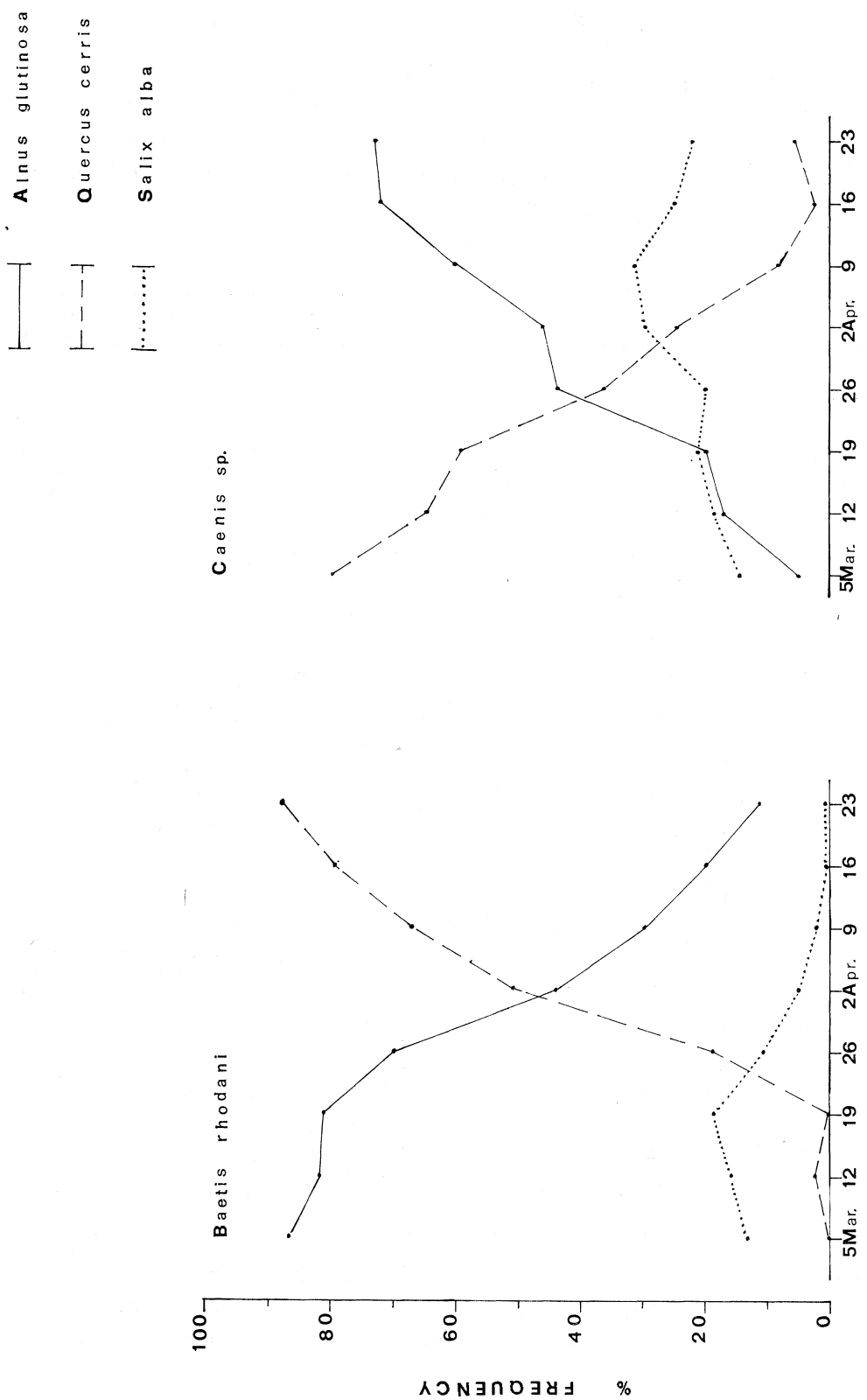

Fig. 1. – Distribution of *Baetis rhodani* and *Caenis sp.* nymphs on different leaf-packs (March 5–April 23).

TABLE I

Significance levels ($p < 0.05$), *at each sample time, in the differences between the number of individuals of the same species found on packs of each leaf species* (*test*, χ^2; *arrows are directed towards higher value*). B.r. = Baetis rhodani; C.sp. = Caenis sp.

Sampling Dates	Leaf species	Alder		Oak		Willow	
		B.r.	C.sp.	B.r.	C.sp.	B.r.	C.sp.
5 March	Alder	—	—				
	Oak	↑	←	—	—		
	Willow	↑	↑	←	↑	—	—
12 March	Alder	—	—				
	Oak	↑	←	—	—		
	Willow	↑	n.s.	←	↑	—	—
19 March	Alder	—	—				
	Oak	↑	←	—	—		
	Willow	↑	n.s.	←	↑	—	—
26 March	Alder	—	—				
	Oak	↑	n.s.	—	—		
	Willow	↑	↑	n.s.	↑	—	—
2 April	Alder	—	—				
	Oak	n.s.	↑	—	—		
	Willow	↑	↑	↑	n.s.	—	—
9 April	Alder	—	—				
	Oak	←	↑	—	—		
	Willow	↑	↑	↑	←	—	—
16 April	Alder	—	—				
	Oak	←	↑	—	—		
	Willow	↑	↑	↑	←	—	—
23 April	Alder	—	—				
	Oak	←	↑	—	—		
	Willow	↑	↑	↑	←	—	—

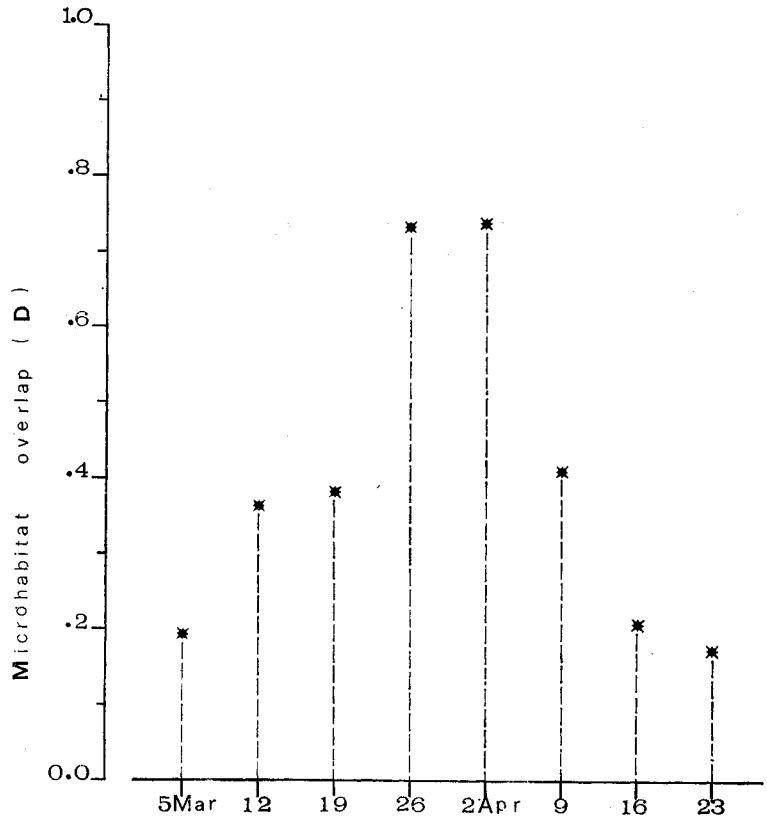

Fig. 2. – Overlap in microhabitat use between *Baetis rhodani* and *Caenis sp.* nymphs.

$$D = 1 - 1/2 \sum_i | p_{ki} - p_{ji} |$$ (Schoener, 1968)

Where p_{ki} is the ratio of *Baetis rhodani* population and p_{ji} of *Caenis sp.* on the ith category of leaves. D varies between 0, no overlap, and 1 when the overlap is complete.

TABLE II

Distribution of each of the two mayfly species on the three types of plant substratum introduced into the stream. Values relate to the whole study period (March 5 – April 23). For each species values not marked by the same line are significantly different (test, χ^2).

Leaf Species	*Baethis rhodani*		*Caenis sp.*	
	n. ind.	%	n. ind.	%
Alnus glutinosa	750	45.29	654	39.66
Quercus cerris	796	48.07	627	38.02
Salix alba	110	6.64	368	22.32
Totals . . .	1656		1649	

Discussion

These results stress the importance of the plant detritus quality in the distribution of nymphs of both species of Ephemeroptera showing different preferences, at the interspecific level, for the various types of leaves used. This is proved, in the first place, by a clear selectivity shown both by *B. rhodani* and by *C.sp.* towards the different plant species.

Experimental methods allow us to exclude that the position of the different leaf packs has affected the two species distribution, although it is possible that willow packs, because of a looser cohesion of the leaves, were more washed off by the current and this may have led us to underestimate the importance of this plant species.

Selectivity of mayflies and their preference shift (*Baetis*: from alder to oak; *Caenis*: from oak to alder) throughout the experiment, however, seem to be connected to the composition and dynamics of the fungus populations of the three types of leaves used. This point will be further discussed in the next note (Basset and Rossi, 1981). The remarkable differences that we found in distribution patterns of both species on oak, alder and willow seem to agree generally with many other Authors' observations: Reice (1978), studying benthic invertebrate colonization of several types of leaves, noticed that many animal species form close animal-leaf associations; similar associations, in different stages of processing of the same leaf, are mentioned by Smock and Stoneburner (1980).

Mackay and Kalff (1973) demonstrated that the size of detritus particles — coarse and fine — greatly affects the distribution of the larvae of two species of caddis fly, genus *Pycnopsiche*. Furthermore, the two species of Ephemeroptera studied show a clear divergence in the use of the microhabitat offered. The overlap D values (Schoener, 1968) are constantly lower than 0.5 for three quarters of the samples. An overlap increase between the two species seems to coincide with a decreased heterogeneity of fungus populations of the various leaves (Basset and Rossi, 1981). A study of the evolutionary basis for the microhabitat shift found in the course of the experiment is beyond the scope of this work. The data collected only allow us to believe that an influence of direct competition on the microhabitat separation of the two species, and therefore on their distribution, is unlikely, since at least on willow, *B. rhodani* and *Caenis sp.* co-occur in statistically equal proportion in half of the samples.

In conclusion, we believe that the selectivity for the various plants used shown by *Baetis rhodani* and *Caenis sp.* and their distribution divergence show the capacity of both species of actively choosing their microhabitat and, therefore, point out the importance of plant detritus quality and heterogeneity for the coexistence of the two species in the same biotope.

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