Atti Accademia Nazionale dei Lincei

Classe Scienze Fisiche Matematiche Naturali

Rendiconti

Alberto Basset, Loreto Rossi

Factors affecting the habitat choice of Baetis rhodani and Caenis sp. (Ephemeroptera). Note II. Role of fungi colonizing different leaf detritus

Atti della Accademia Nazionale dei Lincei. Classe di Scienze Fisiche, Matematiche e Naturali. Rendiconti, Serie 8, Vol. **71** (1981), n.6, p. 214–221.

Accademia Nazionale dei Lincei

<http://www.bdim.eu/item?id=RLINA_1981_8_71_6_214_0>

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

RIASSUNTO. — È stata studiata in natura l'influenza dei popolamenti fungini che colonizzano il detrito vegetale presente nei corsi d'acqua 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 venivano determinati il tipo e grado di colonizzazione microfungina e la distribuzione delle due specie animali.

È stato osservato che: 1) I funghi « Comuni », pur essendo gli stessi sulle tre foglie, presentano modelli distribuzionali nettamente differenziati sui tre substrati vegetali; 2) Esistono correlazioni dirette e significative tra la distribuzione dei funghi « Comuni » e quella delle due specie animali.

Viene suggerita una probabile interconnessione tra selettività del microhabitat e richieste alimentari da parte delle due specie animali.

INTRODUCTION

Allochtonous plant detritus forms an important energy source for benthic species in waterways. After the works by Triska (1970) and especially by Kaushik and Hynes (1968, '71), many authors pointed out, through laboratory studies, the importance of microfungi in the palatability of detritus for their nourishment according to its plant species and above all according to the type of its microfungus colonization. Qualitative and quantitative differences are known to exist in microfungus populations primarily conditioning plant detritus in waterways (Barlocher and Kendrick, 1974; Suberkropp and Klug, 1976).

This work aims at verifying in nature the importance of microfungi conditioning leaves in phenomena of habitat selectivity and separation shown by two detritivorous Ephemeroptera, *Baetis rhodani* and *Caenis sp.*, coexisting in the same biotope (Basset and Rossi, 1981). Two questions are at the basis of this work: 1) Are there differences in the microdistribution of fungus populations on detritus substrata of different plant species? 2) Are there relations between fungus populations of the various plant substrata and the microdistribution of the two animal species?.

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

(**) Nella seduta del 21 novembre 1981.

In order to answer these questions we have studied experimentally in nature the distribution of fungus populations on three types of leaves and compared it with the distribution of two mayfly species described by Basset and Rossi (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. Three packs for each type of leaf were used to determine the fungus microflora, which was isolated from the leaves using the following techniques:

1) By dilution: 100 mg of leaf material were shaken for thirty minutes in Erlenmeyer flasks containing 100 ml of sterilized water from the study site; 10 petri-dishes were then inoculated with 1 ml of this suspension (0.1 ml per petri-dish) containing a medium of Agar-leaves (Barlocher and Kendrick, 1974);

2) by direct observation: forty disks (0.5 cm diam) were cut out from the leaf packs with a fire-sterilized cork-borer. The disks were placed in ten petri-dishes containing Agar-leaves, four disks per petri-dish. The frequencies fungus of each were determined by counting the colonies developed within 30 days, in each 10-dish group, in each sample. The other nine packs were used to collect the animals of the two species.

RESULTS

The fungus strains colonizing the three plant substrata are shown in Table I. They are grouped as follows: " Common " " Rare ", " Sporadic ", according to the frequency with which they are found in isolations during the study period.

Fungus populations of *Alnus glutinosa*, *Quercus cerris* and *Salix alba* are very similar as to the species composition: specific fungus-leaf associations are found only in the " Rare " and " Sporadic " groups. Although " Common " fungi are the same on alder, oak and willow (*Acremonium sp.*, *Alternaria sp.*, *Cladosporium sp.*, *Phoma sp. 1*, *Trichoderma sp. 1* – Table I). their distribution is remarkably different on the three leaves (Fig. 1). Direct correlations have

TABLE I

List of fungi found on the three types of leaves during the experiment. Fungus species are ranked in the following categories: A) " *Common* " (*found in over* 50% *of samples*); B) " *Rare* " (*found in at least* 25% *of samples*); C) " *Sporadic* " (*found in less than* 25% *of samples*).

	LEAF SPECIES		
	Alnus glutinosa	Quercus cerris	Salix alba
" COMMON "	Acremonium sp. Alternaria sp. Cladosporium sp. Phoma sp. 1 Trichoderma sp. 1	Acremonium sp. Alternaria sp. Cladosporium sp. Phoma sp. 1 Trichoderma sp. 1	Acremonium sp. Alternaria sp. Cladosporium sp. Phoma sp. 1 Trichoderma sp. 1
" RARE "	Aspergillus sp. 1 Clavariopsis sp. Humicola sp. Mucor sp. Penicillium sp. Aspergillus sp. 2 Flagellospora sp. Geotrichum sp. Tricladium sp.	Aspergillus sp. 1 Clavariopsis sp. Humicola sp. Mucor sp. Penicillium sp. Aspergillus sp. 2 Pythium sp. Trichothecium sp.	Aspergillus sp. 1 Clavariopsis sp. Humicola sp. Mucor sp. Penicillium sp. Anguillospora sp. Fusarium sp. 1
" SPORADIC "	Aspergillus sp. 3 Fusarium sp. 2 Rhizopus sp. Zygorhyncus sp.	Aspergillus sp. 3 Fusarium sp. 3 Periconia sp. Phoma sp. 2 Trichoderma sp. 2	Aspergillus sp. 3 Chaetomium sp. Phytophthora sp. Phoma sp. 2

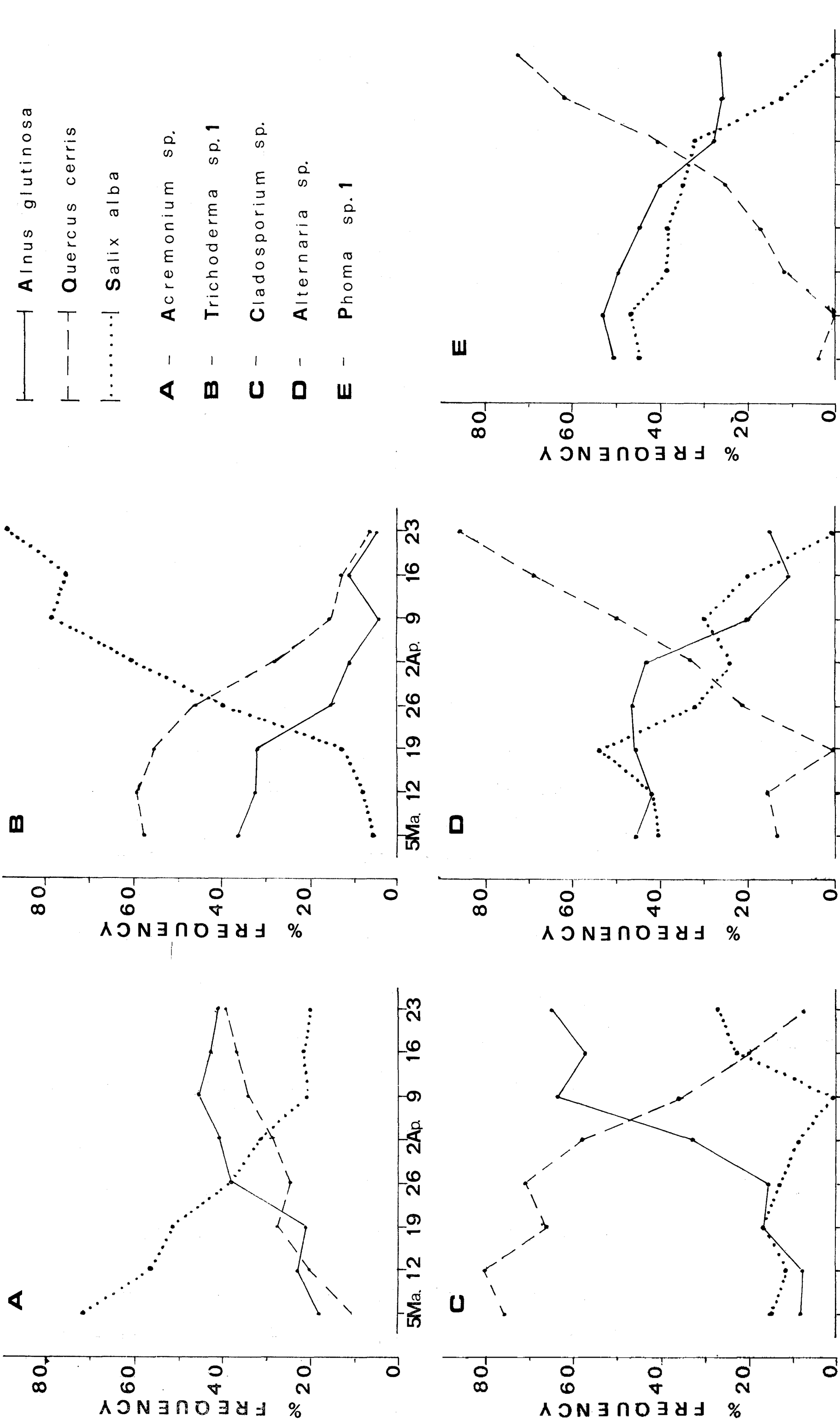

Fig. 1. – Distribution of each of the five " Common " fungus strains on packs of the three types of leaves (March 5–April 23).

been found between the distribution of the two Ephemeroptera species and of the " Common " fungi (Table II). The distribution of *Baetis rhodani* is always correlated with the distribution of *Alternaria sp.* and *Phoma sp.* 1, while the distribution of *Caenis sp.* and of *Cladosporium sp.* are always correlated except on willow. Depending on the leaf substratum the correlation between the distribution of the two mayflies and of the other " Common " fungus species (*Acremonium sp.*, and *Trichoderma sp. 1*) can be direct or inverse; *Baetis rhodani*'s distribution on oak and willow, for example, is directly correlated with *Acremonium sp.*, while on alder there is an inverse correlation. The density and number of fungus species conditioning the different leaves do not seem to directly affect the distribution of the two animal species studied.

TABLE II

Correlations between the distributions of Baetis rhodani *and* Caenis sp. *nymphs and distributions of each of the " Common " fungus strains on each leaf used. The significance of direct and inverse correlations* ($p < 0.05$) *is indicated by* (+) *and* (—) *respectively.*

	Baetis rhodani	*Caenis sp.*
Acremonium sp.	Oak r = .8652 (+)	(—) Oak r = —.9235
	Alder r = —.8684 (—)	(+) Alder r = .9327
	Willow r = .8704 (+)	(—) Willow r = —.7875
Trichoderma sp. 1	Oak r = —.9933 (—)	(+) Oak r = .9606
	Alder r = .9027 (+)	(—) Alder r = —.9436
	Willow r = —.9625 (—)	(+) Willow r = .7290
Cladosporium sp.	Oak r = —.9458 (—)	(+) Oak r = .8778
	Alder r = —.9674 (—)	(+) Alder r = .9154
	Willow r = —.1507 n.s.	n.s. Willow r = —.4346
Alternaria sp.	Oak r = .9582 (+)	(—) Oak r = —.8704
	Alder r = .9044 (+)	(—) Alder r = —.8527
	Willow r = .8891 (+)	n.s. Willow r = —.3541
Phoma sp. 1	Oak r = .9543 (+)	(—) Oak r = —.8977
	Alder r = .9743 (+)	(—) Alder r = —.9544
	Willow r = .7974 (+)	n.s. Willow r = —.3150

DISCUSSION

The interpretation of studies on fungus populations conditioning decaying leaves is restricted by several problems: little is known about the physiology of fungi involved in the detritus processing, even less about their nutritional requirements, especially in a natural environment. Furthermore, works about the chemical modification of leaves during processing, (e.g. Suberkropp *et all.*, 1976; Triska and Seddell, 1976) generally consider the main groups of organic substances (lipids, glucides, proteins, cellulose, lignin, org. N) while the dynamics of single organic substances during the processing is almost unexplored. This forces us to give a mere description without explaining the causes of the fungus strain-distribution found in nature. The results obtained—i.e. fungus population species composition is relatively homogeneous, while " common " strains distribution on the three leaves species is remarkably different—seem, however, to agree in general with other Authors' findings, especially with Suberkropp and Klug (1976). Studying hickory and oak leaf microflora during the processing, these authors found that dominant fungus species are the same on both leaves, but show different distribution patterns on each plant substratum. In our opinion, the features of fungus populations on oak, alder an willow affect leaf palatability for the two animal species. This is suggested by direct correlations between the distribution of more common fungus strains on the three leaves and the distribution of *Baetis rhodani* and *Caenis sp.*

In fact, the microfungi form an important trophic resource for both species (Rossi *et all.*, 1981). Furthermore, great differences between the fractions of individuals colonizing the same leaf in the various samplings seem to indicate that the type and degree of fungus colonization of the various leaves affects the distribution of the two mayfly species. It seems that the distribution patterns of the two species (Fig. 2, from Basset and Rossi, 1981) cannot be directly ascribed to other characteristics of the different leaves, such as their degree of softness (Suberkropp and Klug, 1980) or their demolition rate. Neither factor—nor both factors together—can explain the distribution patterns of *Caenis sp.* nymphs nor plausibly make it clear why willow packs are so scarcely attractive for individuals of both species, and especially for *Baetis*; although some weight difference between alder and oak leaves, and the greater softness of alder—alder is a " fast " leaf according to Petersen and Cummins' classification (1973)—may reasonably, explain the distribution patterns of *Baetis* on these leaves.

The fact that direct (alder and oak) and inverse (willow) correlations exist between the distributions of *Acremonium sp.* and *Baetis rhodani* on the various leaves, and the similar correlation between the distributions of *Trichoderma sp. 1* and *Caenis sp.* (direct on alder and oak, inverse on willow) could be ascribed to a different palatability of these fungi on the different leaves. This opinion is supported by the importance, for some benthic species, of fungus-leaf associations, found through laboratory studies (Barlocher and Kendrick, 1973; Rossi, pers. com.) and, at the same time, could constitute a direct confirmation.

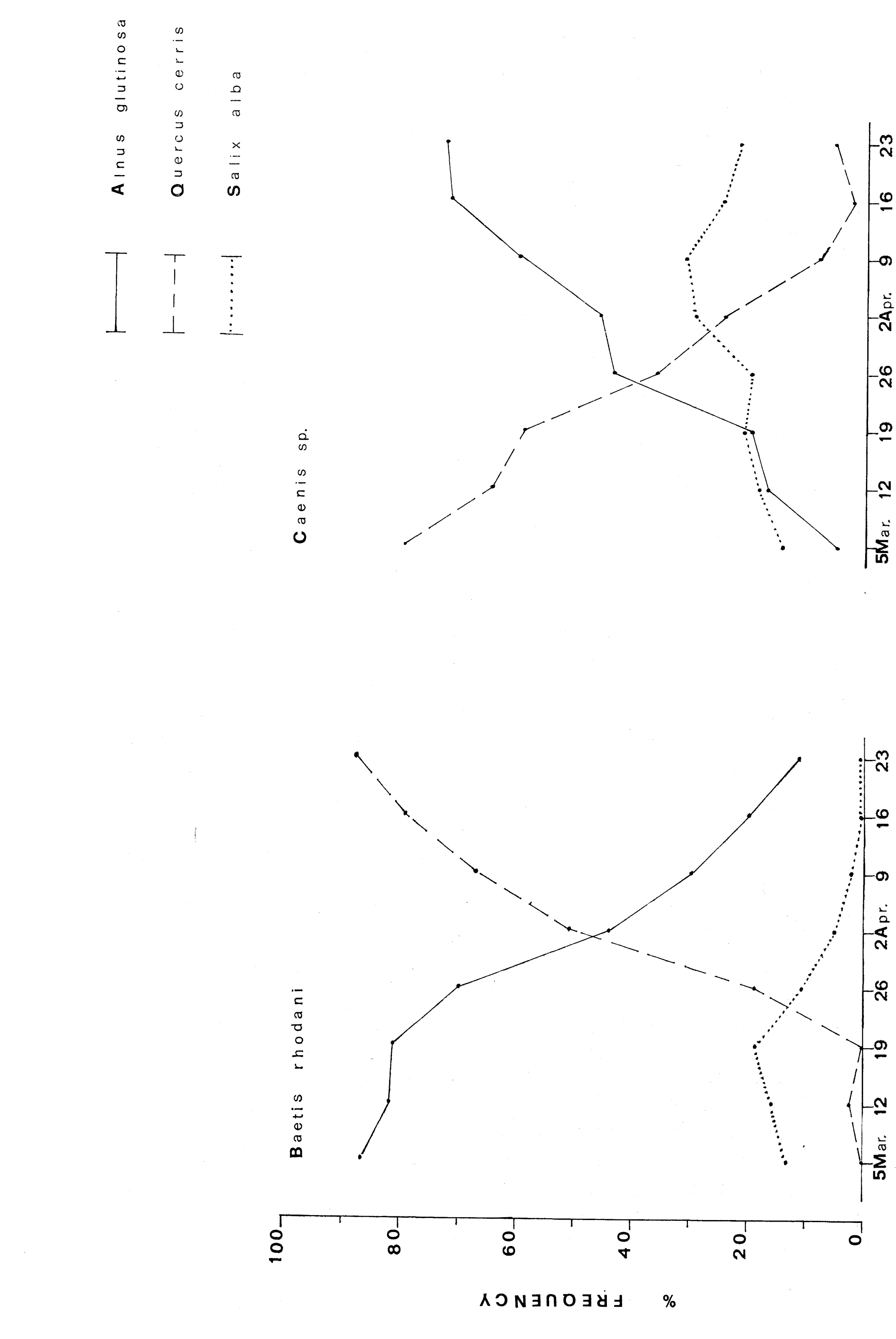

Fig. 2. – Distribution of *Baetis rhodani* and *Caenis sp.* nymphs on different leaf-packs (March 5 – April 23). (Rewritten by Basset and Rossi, 1981).

Therefore, the microhabitat selectivity of *Baetis rhodani* and *Caenis sp.* could be affected by trophic requirements of the two species. A preference for the most common fungi could be interpreted as the nymphs' choice of fungal resouces more constantly present on the detritus during the long time they must spend in the water.

In conclusion, we believe that these results suggest an interconnection between the habitat choice and food preferences in *Baetis rhodani* and *Caenis sp.*, even though we believe it necessary to carry out experimental manipulations in nature in order to obtain a direct proof of this hypothesis.

Acknowledgments. This study was funded by C.N.R. Grant n. 79.00852.06. Dr. Corrado Fanelli provided considerable assistance in the classification of fungus strains.

References

[1] F. Barlocher and B. Kendrick (1973 b) – *Fungi and food preferences of* Gammarus pseudolimneus. « Arch. Hydrobiol. », *72*, 501–516.

[2] F. Barlocher and B. Kendrick (1974) – *Dynamics of the fungal populations of leaves in a stream.* « J. Ecol. », *62*, 761–791.

[3] A. Basset and L. Rossi (1981) – *Factors affecting the habitat choice of* Baetis rhodani *and* Caenis sp. (*Ephemoroptera*): Note I – *Role of three species of leaf detritus.* « Rend. Acc. Naz. Lincei » (in press.).

[4] N. K. Kaushik and H. B. N. Hynes (1968) – *Experimental study on the role of the autumn-shed leaves in aquatic environment.* « J. Ecol. », *56*, 229–243.

[5] N. K. Kaushik and H. B. N. Hynes (1971) – *The fate of dead leaves that fall into streams.* « Arch. Hydrobiol. », *68*, 465–515.

[6] R. C. Petersen and K. W. Cummins (1974) – *Leaf processing in a woodland stream.* « Freshwater biol. », *4*, 343–368.

[7] L. Rossi, A. Basset e E. Marchetti (1981) – *Predazione ed evoluzione della nicchia trofica in cinque specie di detritivori bentonici.* « Atti Congr. U. Z. I., Boll. Zool. », *48* suppl., 97.

[8] K. Suberkropp and M. J. Klug (1976) – *Fungi and bacteria associated with leaves during processing in a woodland stream.* « Ecol. », *57*, 707–719.

[9] K. Suberkropp and M. J. Klug (1980) – *The maceration of deciduous leaf litter by aquatic hyphomycetes.* « Can. J. of Bot. », vol. 58, n. 9, 1025–1031.

[10] K. Suberkropp, Godshalk, G. L. and M. J. Klug (1976) – *Changes in the chemical composition of leaves during processing in a woodland stream.* « Ecol. », *57*, 720–727.

[11] F. J. Triska (1970) – *Seasonal distribution of aquatic hyphomycetes in relation to the disappearance of leaf litter from a woodland stream.* Ph. D. thesis – Univ. Pittsburgh, Pittsburgh.

[12] F. J. Triska and R. Sedell (1976) – *Decomposition of four species of leaf litter in response to nitrate manipulation.* « Ecol. », *57*, 783–792.