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Early stages of leaf detritus processing in the Garigliano river. Note I. Decomposition rate

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Ecologia. — *Early stages of leaf detritus processing in the Garigliano river.* Note I. *Decomposition rate.* Nota di Elisa Anna Fano e Loreto Rossi, presentata (*) dal Socio G. Montalenti.

Riassunto. — Viene studiato il processo di decomposizione del detrito vegetale in una zona del fiume Garigliano in passato soggetta a uno scarico di acqua calda di di una centrale termo-nucleare.

Pacchi di foglie di *Alnus glutinosa* (10 g peso secco) sono stati posti a monte e a valle dello scarico e successivamente raccolti ogni settimana, per un mese.

In laboratorio è stata determinata la perdita in peso e la variazione del contenuto calorico.

I dati raccolti mostrano un rallentamento della velocità del processo di decomposizione a valle dello scarico: oltre il 44% del materiale resta indecomposto. Il medesimo andamento tra le due stazioni, è seguito dalle variazicni del contenuto energetico dei campioni.

Introduction

The lotic communities are basically sustained by allocthonous energy mainly constituted by vascular plant litter (Cummins, 1979). After its entry into a stream the detritus is decomposed by a sequence of events which involve abiotic processes such as leaching, mechanical breakage and biotic processes such as microbial degradation and ingestion by invertebrates (Petersen and Cummins, 1974; Fano *et al.* 1981).

The direct and indirect effects on the decomposition by natural elements such as phosphorus and nitrogen released for various reasons by man into the natural environment have been widely described (Elwood *et al.* 1981). Just as widely described are the effects of temperature increase on animal associations in streams (Fraley, 1979). Little is known, however, of the effects of heated discharges into rivers on the plant detritus processing. Preliminary data (Paul *et al.*, 1978) show faster leaf decomposition in the immediate vicinity of a heated discharge.

The aim of this study was that of determining the decomposition rate in an area of the Garigliano river situated in the vicinity of a nuclear power plant discharge.

Biotope studied

Two sites were selected on the Garigliano river in the vicinity of a nuclear power plant. Station 1 was located 500 m upstream from the discharge and served as the reference station. Station 2 was located just downstream from the heated discharge.

(*) Nella seduta del 13 marzo 1982.

In that area, the river is 40–50 m wide and has a capacity which varies from 50 to 300 m^3/sec and an average annual temperature of 18°–20 °C.

The nuclear power plant operated in the period 1960–1978, the average capacity of the discharge was 12 m^3/sec and the water temperature was 35°–37 °C. At present, even though having the same capacity, the discharge serves only for drainage of water with a temperature only a few degrees greater than that of the river.

METHODS

Alnus glutinosa leaves collected at abscission were dried for 3 days at 60 °C and stored until use. Ten gram dry weight leaf packs were prepared, each bound separately with nylon cord, and placed on the river bed at the two stations, about 2 m from the bank at a depth of 1 m. Ten random packs were collected weekly from 25.9.1980 until 23.10.1980. Each retrieved pack, placed in a plastic bag, was returned to the laboratory. The leaves were washed in running water to remove sediment and colonizing animals, then oven dried at 60 °C for 3 days. Two 500 mg d.w. samples were removed from each pack: the ash content of one was evaluated by placing the sample in a muffle furnace for 6 h at 800 °C and the caloric content of the other by Mahler's microbomb. The same parameters were determined for the packs at the beginning of the experiments.

To analyze the decomposition we used the coefficient K (Petersen and Cummins, 1974):

$$-K = \log_e (\% \, R/100)/t$$

where R is the remaining ash free dry weight (AFDW) and t is experimentation time.

RESULTS AND DISCUSSION

The processing of the leaf packs measured as weekly loss of ash-free dry weight is suited to the negative exponential model in both areas examined (for station 1 $y = 95.0144\, e^{-0.0381x}$; the coefficient r is $= -0.9648$; $p < 0.01$; for station 2 $y = 88.2070\, e^{-0.0238x}$; the coefficient r is $= -0.9496$; $p < 0.01$).

Decomposition of the packs placed at station 1 is more rapid than that of the packs placed at the station downstream from the discharge. In fact after a first period which corresponds to leaching and which is not significantly different in the two sites, at the fourth week of sampling at station 1, 31% of the material remains and at station 2 44% (Fig. 1). Also the pattern of the caloric content per unit weight is different in samples from the two stations. Upstream from the discharge there is a significant caloric increase after a week, after which the values remain constant until the fourth week when there is a sudden and significant decrease (Fig. 2). At station 2 the increase in caloric content remains significant until the second sampling, then the value drops at the third and the fourth week even though not reaching the values found at station 1 (Fig. 2).

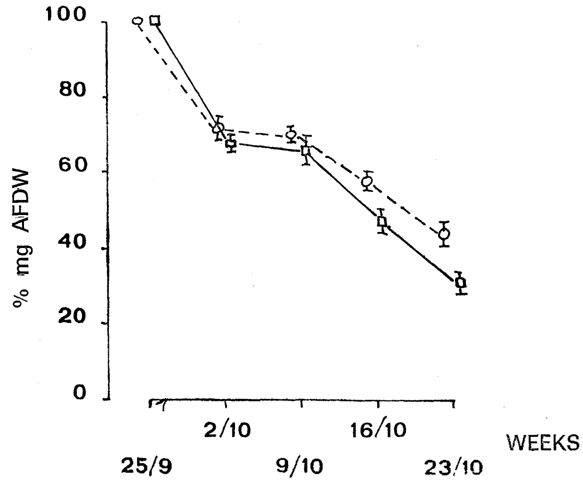

Fig. 1. - Demolition rate (AFDW = ash-free dry weight) of *Alnus glutinosa* leaf packs placed in two sites of Garigliano river.
Station 1 ——— Station 2 - - - -

It is widely demonstrated that after a period of leaching which lasts about 48 h (Petersen and Cummins, 1974) the leaves undergo conditioning by microorganisms which at this stage are basically represented by microfungi rather than bacteria (Bärlocher and Kendrick, 1974; Suberkropp and Klug 1976, 1980). It is also known that detritivorous invertebrates preferentially feed on leaf areas more richly colonized by microfungi and do not feed on non colonized detritus (Cummins and Klug, 1979; Rossi and Fano, 1979; Fano *et al.*, 1982). Therefore,

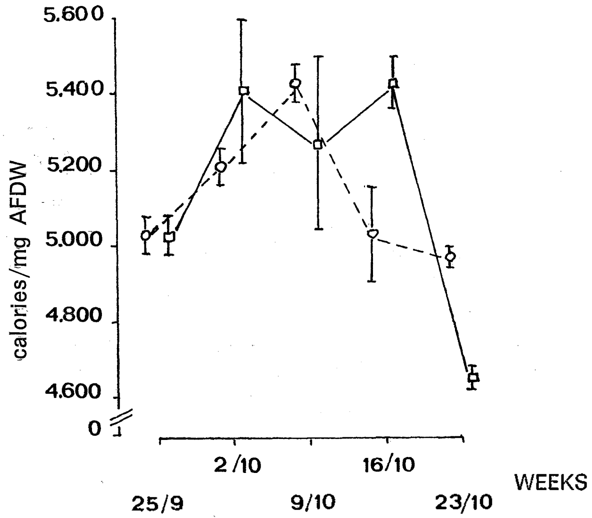

Fig. 2. - Demolition rate (calories/AFDW) of *Alnus glutinosa* leaf packs placed in two sites of Garigliano river.
Station 1 ——— Station 2 - - - -

even if in this study the microbial analyses of the samples are not reported, our previous observations make it possible to claim that the initial increase in caloric content per unit weight was caused by microfungi during the conditioning process (Fano *et al.*, 1981). The decrease in caloric content per unit weight observed after the first weeks at both stations seem to us to be easily explained by the results of the animal associations (Fano and Rossi, 1982). It is in fact known that a large class of detritus feeders skeletonize the leaves by removing the softer parts. This in fact is where the microorganisms are mainly localized (Cummins and Klug, 1979). Our data support this hypothesis. In fact the most conspicuous caloric decrease is found at station 1, where the animals are more numerous and functionally more efficient.

CONCLUSIONS

From our results it seems that the slower decomposition rate found for the material located at station 2 is due to the reduced number of animals. In fact, on comparing the K of leaching (K_1) of the two sites, these are not significantly

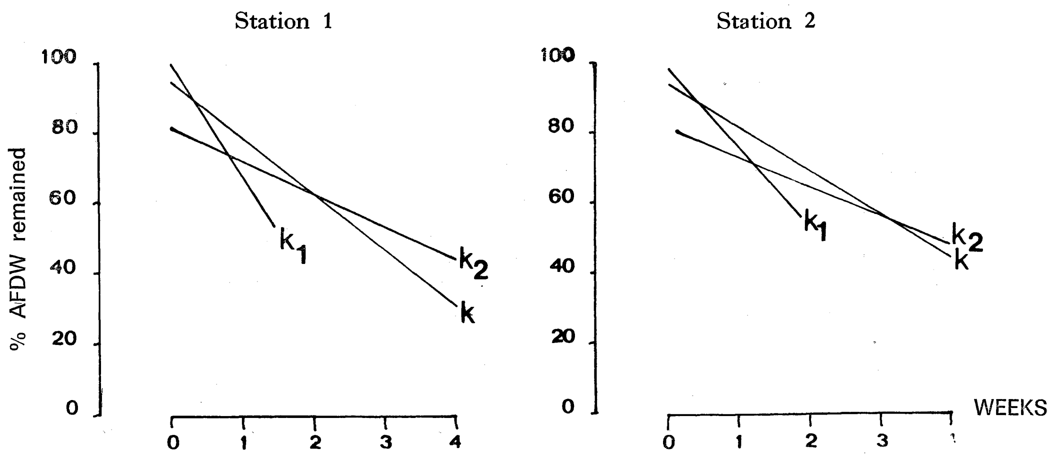

Fig. 3. – Decomposition rate (K = coefficient of decomposition) of *Alnus glutinosa* leaf packs placed in two sites of Garigliano river.

	Station 1	Station 2
K_1 = leaching ($\bar{x}\pm 2$ S.E.)	0.0541±0.0032	0.0495±0.0048
K_2 = demolition ($\bar{x}\pm 2$ S.E.)	0.0359±0.0019	0.0278±0.0009
K = decomposition ($\bar{x}\pm 2$ S.E.)	0.0404±0.0030	0.0328±0.0034

different, whereas there are significant differences between the demolition rates K (K_2) (Fig. 3). Therefore leaching, which is a phenomenon due to the plant nature of the detritus and to the chemical and physical characteristics of the environment, proceeds in an identical way in the two stations, whereas true decomposition, in which the animals play a remarkable role, is slowed down in the site in which they are present to a lesser extent.

In conclusion, we feel that the physical effect of the heated discharge is to be considered, even if indirectly, the cause of the results obtained in the present study. Even if further investigation is necessary for a complete definition of the ecological process under way, at the present stage the processing rate seems to be a good indicator of the functioning of the metabolism of lotic environments.

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