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Elisa Anna Fano, Loreto Rossi

Early stages of leaf detritus processing in the Garigliano river. Note II. Animal associations

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Ecologia. — *Early stages of leaf detritus processing in the Garigliano river.* Note II. *Animal associations.* 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 ad uno scarico di acqua calda 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 sui pacchi veniva valutata l'entità della colonizzazione animale tramite conte numeriche e determinazioni ponderali della biomassa.

Le associazioni macrobentoniche risultano differenziate tra le due stazioni, a valle dello scarico la comunità è meno diversificata che a monte dove sono presenti più animali appartenenti a numerosi taxa.

Si discute un probabile effetto della carenza di cibo derivante dalla azione meccanica e chimico-fisica dello scarico.

INTRODUCTION

Leaf decomposition is one of the basic processes in streams which are essentially heterotrophic systems (Cummins, 1979) and involves both abiotic and biotic factors. In particular the animal associations colonizing the detritus and feeding it in various ways, are very important to decomposition (Cummins and Klug, 1979). It is known that variations in thermic range of a river variously affect the zoobenthic associations present, generally resulting in a decrease in the number of species (Ward and Stanford, 1979).

The aim of this study was to evaluate the effect of a heated discharge from a nuclear power plant in the Garigliano river on macroinvertebrate associations present and therefore the indirect effect of this discharge on the decomposition of monospecific plant detritus.

METHODS

Alnus glutinosa leaf packs prepared and placed *in situ* as previously described (Fano and Rossi, 1982) were retrieved weekly from two sites in the Garigliano river: station 1 situated 500 m upstream from the discharge and station 2 immediately downstream from the nuclear plant discharge. Ten packs per week were returned to the laboratory. The leaves were washed in running water to collect the colonizing animals. These were counted and identified using the

(*) Nella seduta del 13 marzo 1982.

stereomicroscope and then oven dried for three days at 60 °C to calculate the biomass.

For diversity and evenness evaluation were used Shannon's H_s and Pielou's E:

$$H_s = -\sum_{i=1}^{n} p_i \ln p_i \qquad E = H_s/\ln S$$

where $p_i = \%$ frequency of species i; S = total number of species.

Results and Discussion

In both sites the animal associations, though different, show the same model. In fact in both stations there is initially a prevalence of the shredders (Isopods, Amphipods and Gasteropods) whereas at the end of the experiment the collectors (*Diptera larvae*) predominate. The predators constitite an almost negligible fraction and in any case are present only at station 1. Here the number of zoological taxa present is always greater, the minimum number of taxa being present

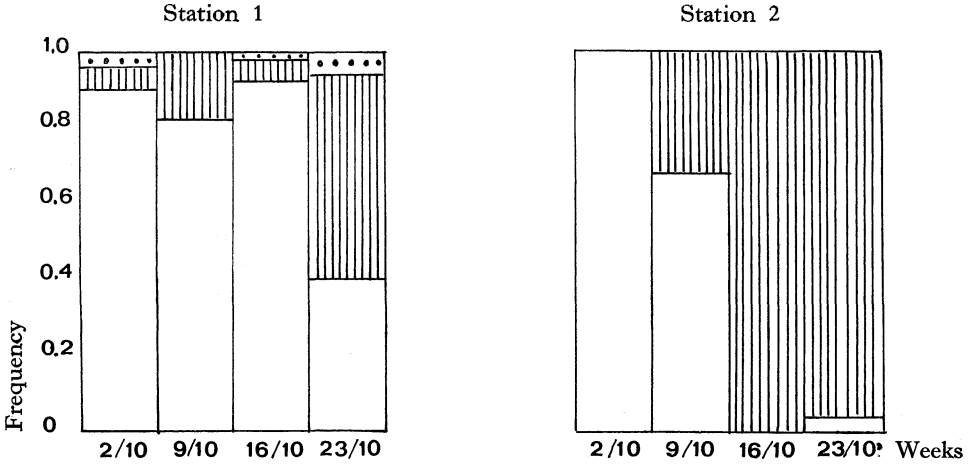

Fig. 1. – Animal associations found on *Alnus glutinosa* leaf packs placed in two sites of Garigliano river.

at the second week. Downstream from the discharge the minimum value is observed at the 3rd week (Fig. 1, Table I). The trend of the biomass is completely irregular at station 1, whereas it is in keeping with the number of taxa present at station 2 (Fig. 2). This fact is certainly influenced by the conspicuous presence at station 1 of Gasteropods which instead are scarce at station 2. These organisms, which have a great shell, can strongly influence the values of the biomass. The diversity trend (Shannon's H_s) and that of evenness (Pielou's E) are in agreement at each station. This means that the diversity variation depends on the number of taxa present and not on their proportions. However, the diversity values are

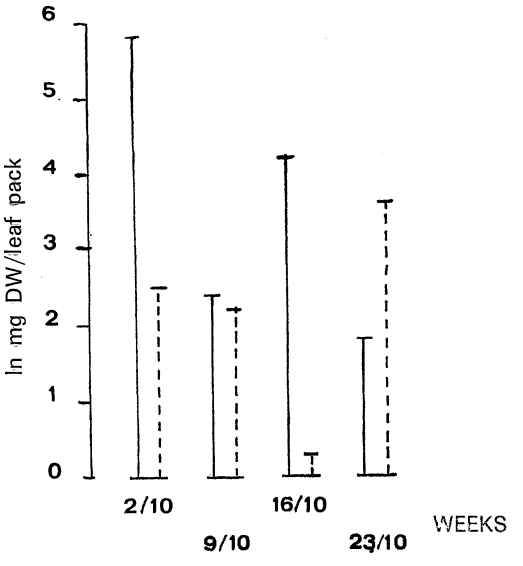

Fig. 2. – Total Biomass (DW = dry weight) of animal associations found on *Alnus glutinosa* leaf packs placed in two sites of Garigliano river.
Station 1 ——— Station 2 - - - -

always greater at station 1 than at station 2, while the evenness is only in one case (second week) greater at the upstream than at the downstream station, this precisely corresponding to the minimum number of species found there (Table I, Fig. 3).

TABLE 1

Animal taxa found weekly on *Alnus glutinosa* leaf packs placed in two sites of Garigliano river (P = predators; C = collectors; S = shredders).

	TAXA	STATION 1				STATION 2			
	Weeks	1	2	3	4	1	2	3	4
P	Turbellaria	+							
C	Tubificida		+	+			+	+	+
S	Isopoda	+	+	+	+	+			
S	Amphipoda	+	+		+	+	+		+
C	Diptera	+	+	+	+				+
S	Coleoptera	+		+	+				
P	Odonata				+				
P	Plecoptera				+				
S	Gastheropoda	+		+	+				+

On the whole the animal associations present downstream from the discharge are in any case composed of a smaller number of individuals and zoological taxa, and therefore show biomass values which are always lower and are less " different " with respect to the associations present in the upstream station.

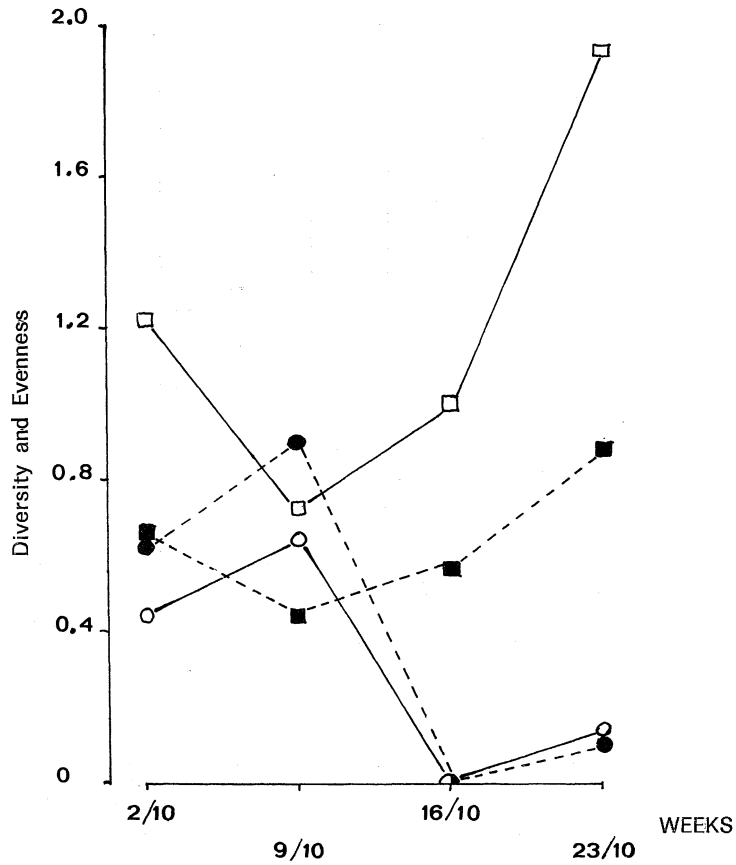

Fig. 3. - Diversity (Hs Shannon) and Evenness (E Pielou) of animal associations found weekly on *Alnus glutinosa* leaf packs placed in two sites of Garigliano river.

Station 1 □ ■ ——— Hs - - - - E
Station 2 ○ ● ——— Hs - - - - E

The reduced presence of animals in the downstream site could be attributed to the absence of heterogeneous detritus suitable to sustain complex animal associations. In fact the absence of plant detritus of various size and origin does not permit the stable co-occurrence of animals with different trophic functions (i.e. shredders and collectors). In fact Benfield *et al.* (1977) have attributed the absence of a conspicuous number of animals to the absence of heterogeneous detritus on the bed of a pastureland stream. All this is in keeping with the "detritus continuum" hypothesis of Petersen and Cummins (1974) who demonstrated the presence of leaves with slow, medium and fast decomposition according

to their plant nature. Since the detritus which falls into a river running in woodland area is of different plant origin, it shows different rates of decomposition. This makes resources always available to the animals since medium decomposing leaves follow in time fast decomposing leaves, and so on. This has been demonstrated also by us in a river of central Italy (Fano *et al.*, 1981).

In this case, whereas in the upstream station on the river bed there is a great amount of coarse polyspecific detritus, fundamentally represented by *Alnus glutinosa* and *Populus alba* leaves (> than 5 cm), in the downstream station the bed is covered exclusively by mud (< 1 mm) with a total absence of leaves or coarse detritus. In fact the associations at the discharge are mainly constituted by collectors which eat fine grained material (< 1 mm) (Cummins and Klug, 1979). This faster decomposition of the material and the formation of sediment on the river bed could have been caused by prolonged action of temperature (Paul *et al.*, 1978), which in this site operated for almost twenty years.

Moreover, it is possible to explain the presence of the animals at the downstream station, where the " continuum detritus " is absent, by passive transport by the current from the upstream area. In fact the taxa represented are too few and furthermore some functional categories are completely absent (i.e. predators) for us to think of a natural recolonization which would have had to begin when heated discharge ceased. Therefore we can envisage a slowing down of the times of recolonization of the area caused by the chemico-physical modifications effected by the discharge which is still present, even though no longer involving thermic variations, and continues to maintain the areas in unnatural conditions.

CONCLUSIONS

From our results it seems evident that the temperature rise due the discharge from the nuclear power plant which took place from 1960–1978 had two effects: a direct effect on the invertebrates, decreasing the number of zoological taxa present, and an indirect effect favouring the formation of fine grained detritus, hence the absence of resources available throughout the whole year to detritivorous species. On the whole the environmental disturbance cause by the discharge results in a qualitative—quantitative decrease in the number of animals which causes a less efficient decomposition of detritus.

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