

INTRODUCTION

Studying the phenomenon of the decomposition of particulate organic matter with all the processes physical chemical and biological and their positive and negative effects on receiving aquatic environments is a complex subject that can be approached from different angles and by different specialists (microbiologists, botanists, pedologists, ecologist, mycologists ...).

The phenomenon of leaf decomposition is one of the main characteristics of the heterotrophic functioning of aquatic environments while integrating the relationship between rivers and terrestrial environments (Naiman et al. 1988) level of land / water interfaces that are summarized in the major stages of the functioning of an ecosystem (Bouraada and Essafi 2016).

Dilatorators play an important role in the process of degrading coarse particles of organic matter and fragmenting them into finer-sized elements generally smaller than millimeters (Cummins et al. 1989). A positive relationship has been noted between the amount of dead leaves present in a stream and the biomass of the invertebrate dilators and collector (Chergui 1989). Complete destruction of leaf material is strongly dependent on the influence of riparian forest (Maamri et al. 1994).

Food ingested by these dilators can reach 60% of the initial mass. A significant portion returns to water as feces and contributes to the stock of fine organic matter; it constitutes an important source of food for the collecting invertebrates.

In an Australian watercourse the study of the decomposition of three species of hardwood litter (*Eucalyptus* Chene and *Nothophagus* Blackburn and Petr 1979) has shown that among the most important detritivorous aquatic invertebrates are dilacerators and collectors. The objective of this work is to quantify the action of the invertebrater *Melanopsis* on the degradation of the dried leaves of *Eucalyptus* and Laurel rose.

DESCRIPTION OF THE STUDY ENVIRONMENT

Aquatic vegetation consists of filamentous green algae. Riparian vegetation consists mainly of *Equisetum fluviatilis*, *Scirpus lacustris* *Salix* sp. and *Typha latifolia*. The slopes of the valley are mainly covered with *Eucalyptus camaldulensis*. The bed of the stream consists mainly of sand and mud and some stones in places (Figure 1).The aquatic fauna is dominated mainly by *Gambusia affinis* (small fish) which plays an important role in the fight against the Anopheles by consuming a large quantity of larvae) and by *Melanopsis*. The Prosobranch Gasteropode is considered as the main dilator of leaf intake in freshwater (Chergui and Patte 1991).

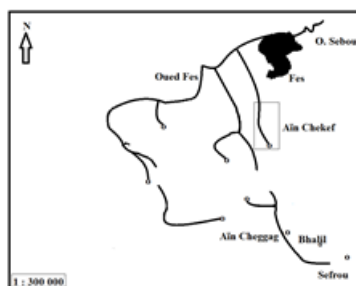


Figure 1, description of the study environment

2.1. Comes and harvesting of leaf material

The leaves of *Eucalyptus camaldulensis* and *Nerium oleander* were selected as foliar material. These grow at the edge of the studied stream and are therefore a very important source of energy for aquatic ecosystems (Webster and Benfield 1986 Boulton and Boon 1991). The leaves were harvested in autumn during their natural fall. The leaves were dried in the oven at 40 °C for 48 hours. Sixty-six batches of leaves of both species (33 batches each) were weighed in batches of about 1g and incubated in water.

After 16 days of immersion in water in order to eliminate toxic water-soluble substances the leaves were recovered and then dried at 40 °C for 48 hours and weighed again. pH electrical conductivity and dissolved oxygen concentrations were measured on the 1st 2 4 8 and 16th days of the experimentation. The other physicochemical parameters (hardness alkalinity calcium chlorides nitrates sulphates orthophosphates) were analyzed only at time 0 (beginning of leaching) and at the time of leaf recovery (16th day end). The optical density of the incubation solutions was measured to estimate the degree of dissolution of the leaf compounds in the water. These measurements were done to determine changes in water quality at the time of leaching and their possible effect on *Melanopsis* survival.

1.2. Choice and harvest

We chose as dilators for this experiment the Gasteropode Prosobranch: *Melanopsis costellata* (Ferussac 1823). This species constitutes the dominant invertebrate fauna in the Ain Chkef stream. The Gasteropode was farmed in the laboratory in a tank containing tap water constantly oxygenated by bubblers. The experience lasted 17 days. The different beds were distributed as follows: 33 beakers filled with 200ml of water each containing dried leaves of *Eucalyptus* and *Melanopsis*. 33 beakers filled with 200ml of water each containing dried leaves of Laurel rose and 5 *Melanopsis*. The biomass used in each batch ranged from about 3 to 5 grams of fresh animal mass per gram of dry leaf mass with the animals being fasted for 48 hours before the start of the experiments.

The mass of plant material per unit of animal biomass was calculated from the approximate relationship between the shell length (L) and the fresh mass of the soft parts (P) of *Melanopsis costellata* (Ferussac 1823) for individuals from 0.9 to 3.5cm ($P = 0.524L - 0.653$ $r = 0.968$) (Chergui and Patte 1991). 2.3. Statistical study We used single-factor analysis of variance (ANOVA). The statistical analysis was carried out by the SYSTAT version 12 program

2. RESULTS AND DISCUSSION

2.1. Physical chemistry

After 16 days of incubation in water there is a loss of mass of the leaves with however a small gap between the two types of leaves. This loss is mainly due to leaf leaching. It is accompanied by numerous physicochemical changes in water.

2.2. Oxygen

In the presence of pink laurel leaves water loses almost all of its oxygen after only four days of incubation (Figure 2a). On the other hand the one containing the leaves of *Eucalyptus* loses only half of it and progressively until the 16th day of experimentation. Both species have a rapid oxygen deoxygenating action for laurel and relatively slow for *Eucalyptus*.

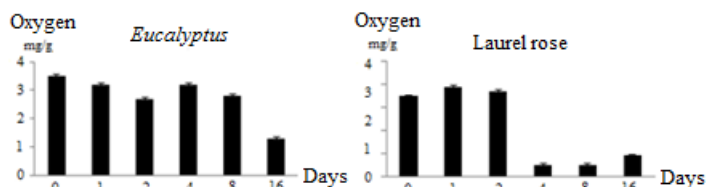


Figure 2c: Variation of the Oxygen

3.1.2. Optical Density

This parameter is related to the degree of leaf leaching and the amount of dissolved and suspended matter in the water. A phenomenon opposite to that of mineralization is observed. Strong leaching occurs on the first day for both species and continues until day 16 for Eucalyptus leaves (Figure 2b).

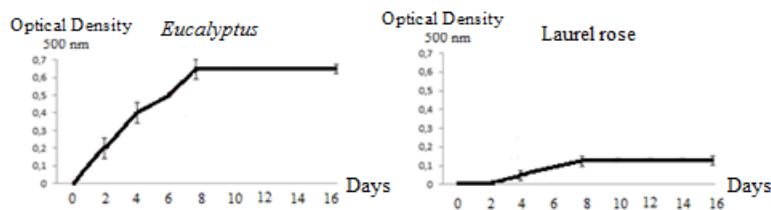


Figure 2c: Variation of the Optical Density

2.3. Conductivity

There is a gradual increase in the mineralization of the water in the presence of the leaves of the oleander and a slight variation of this parameter in the presence of those of Eucalyptus the mineralization of the water remaining approximately the same at the end of the experiment (Figure 2c).

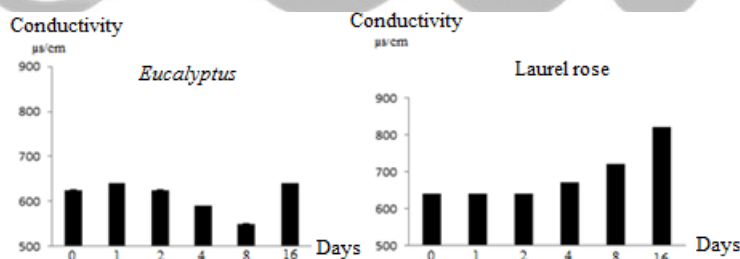


Figure 2c: Variation of the Conductivity

2.4. pH

There is a slight variation in the pH of the water in the presence of Eucalyptus leaves. In the presence of Laurel leaves the pH of the water increases after two days then decreases and returns to its initial value (Figure 2d).

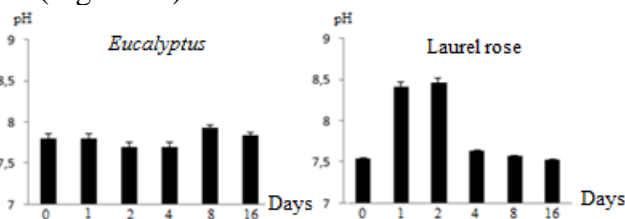


Figure 2d: Variation of the pH

2.5. Hardness, Alkalinity, Calcium, Chlorides, Nitrates, Sulfates and Orthophosphates

After 16 days we noted an increase in alkalinity and hardness which remain relatively modest an increase in the concentration of sulphates a decrease in chloride concentration an increase in orthophosphate concentration and a sharp decrease in nitrate concentration more pronounced in pink Laurel (Figure 2e). This decrease would be related to that of oxygen the nitrates being able to play the role of oxygen donors in condition of anaerobiosis.

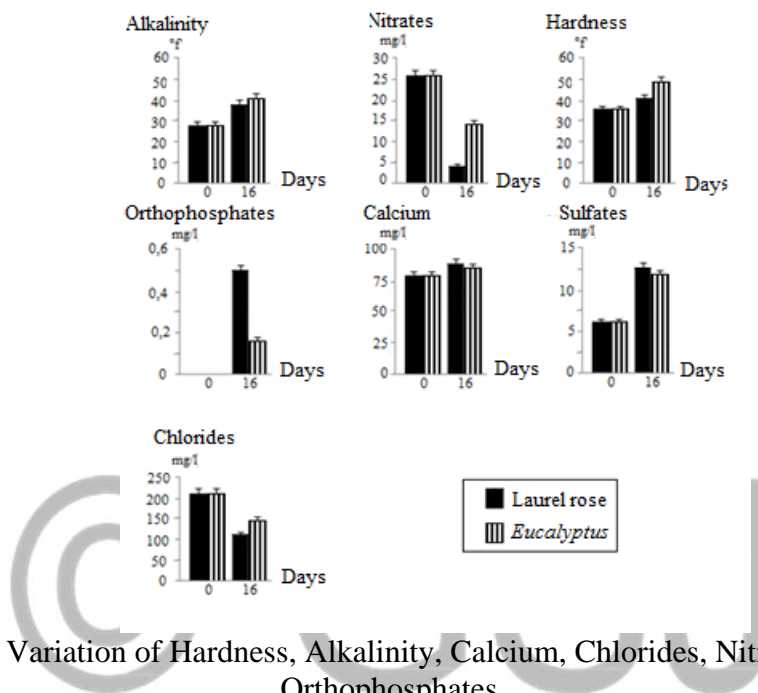


Figure 2, Variation of Hardness, Alkalinity, Calcium, Chlorides, Nitrates, Sulfates and Orthophosphates

3.2. Variation in leaf mass and ingestion by *Melanopsis*

Leaf loss is estimated by determining the residual mass of leaves from the formula: $Pr = 100Pf / Pi$ (Pr: residual mass, Pf: final mass, Pi: initial mass). The residual mass of *Eucalyptus* leaves decreases until the sixth day and then stabilizes (Figure 3). After 16 days of incubation in water the decrease is of the order of 30% of the initial weight of the leaves with a slight difference between the two species. After introduction of *Melanopsis* a new loss of mass is recorded. It is about 25% after 16 days of incubation for *Eucalyptus* leaves and about 30% after only 2 days of incubation for Laurel leaves. This decrease includes: - ingestion of leaves by the *Melanopsis* - the mechanical fragmentation of the leaves by the different biological activities of *Melanopsis* - and eventually the dissolution of some water-soluble compounds. Since the leaves were washed before introducing the *Melanopsis* we considered the leaching as negligible. As well as the mechanical fragmentation of the leaves the loss of which is generally very low compared to that due to the ingestion of the leaf material (Chergui and Pattee 1991b). The ingestion of *Eucalyptus* leaves by *Melanopsis* increases until the fifth day with a consumption of about 25% of the initial mass of the leaves then decreases or even becomes zero during the rest of the experiment.

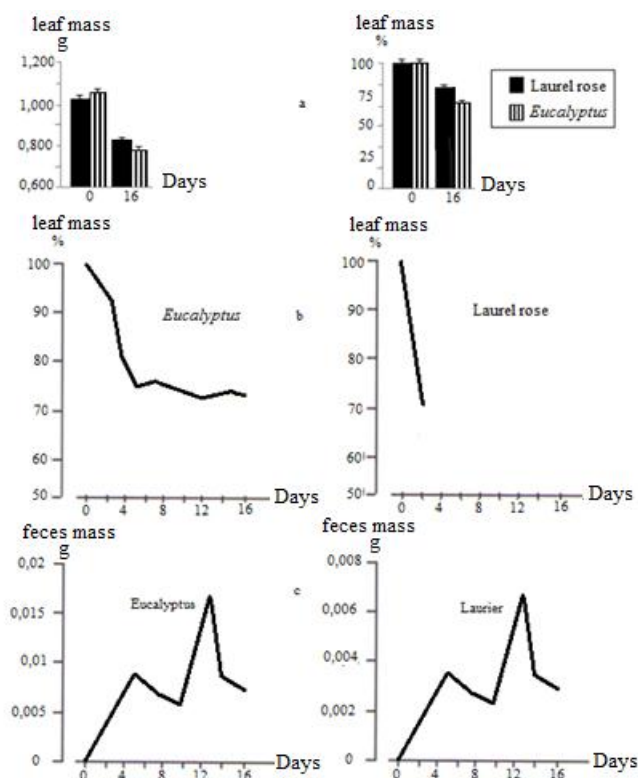


Figure 3, Variation in leaf mass and ingestion by *Melanopsis*

In the presence of Laurel leaves *Melanopsis* consume up to 30% of the initial leaf mass in just two days and die immediately afterwards. In fact Rodin and Basilevitch (1965) have shown that leaves rich in nitrogen have a very important oxygen-scavenging effect. This is consistent with our results: the nitrogen-rich laurel leaves deoxygenate the receptor medium much more than the nitrogen-poor *Eucalyptus* (Pozo 1993 Molinero et al. 1996 .The amount of feces rejected is very low (about 0.004g after two days of incubation in the presence of bay leaves and 0.017g after 16 days of incubation in the presence of *Eucalyptus* leaves) assimilation would evolve in the same direction as ingestion of leaves. Such an assimilation has been observed by Heller and Abotbol (1997) who attribute to the dilators *Melanopsis praemorsa* a consumption of 10mg of litter per animal and per day.

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Egglshaw (1964) observed a significant relationship between the total number of aquatic invertebrates and the amount of plant organic detritus. By analyzing the intestinal contents of different species the author has found that terrestrial plant diseases represent an important source of food for most primary consumers: 90% of the species studied use the detritus as the main source of energy consumes from 96 to 100% of allochthonous leaf material Amphipode *Gammarus minus* up to 90% Decapodes, *Orconectes rusticus* and

Cambarus sp. from 30 to 100%. Insects Ephemeropteres (*Ceanis* sp.) From 50 to 100%. Cummins et al. (1966) estimate that leaf detritus accounts for 20% dry weight of the intestinal contents of Trichoptere *Hydropsyche slossonae* which represents about 17% of the caloric energy consumed. Mackay and Kalf (1973) found that trichopteran larvae can ingest in 24 hours more than 50% of their dry weight as leaf tissue. The same observations were made by Anderson and Grafius (1975). Cummins et al. (1973) attribute 20% of leaf loss to benthic fauna. Similarly Petersen and Cummins (1974) estimate this loss at 24%. According to Chamier and Willoughby (1986) this loss is facilitated by the presence in certain invertebrates of endoenzymes allowing them to digest cellulose.

But to access this source of energy aquatic communities depend on the intervention of microorganisms that possess a great capacity to degrade plant substances such as cellulose and lignin (Barl cher and Kendrick 1978). Many detritivores prefer to feed on leaves with rich microbial growth especially mycelium fungi. Their presence strongly influences the quality of the leaves (Kaushik and Hynes 1968 Barl cher and others 1978 Petersen and Cummins 1974 Rossi and Fano 1979). Cummins et al. (1973) suggested that it was via mechanical and / or chemical stimuli that invertebrates selected leaves that were highly colonized by bacteria and fungi. These are some examples as well as our results that show the role of allochthonic plant inputs in the trophic functioning of aquatic environments. Aquatic invertebrates mainly dilacerators thus occupy a very important place in the phenomena of energy transfer from terrestrial systems to aquatic systems. They play a dual role: on the one hand they participate in the conversion of primary production into animal tissues that will be consumed by predators and on the other hand they increase the rate of degradation of non-native materials for their recycling. The fine organic matter resulting from their activities as well as their feces after being conditioned by bacteria and fungi will be used by scraper and collector invertebrates in another form of energy and nutrients (Gessner and Chauvet 1994 2002).

CONCLUSION

Ingestion of Eucalyptus leaves increases until the fifth day with a consumption of about 25% of the initial mass of leaves then decreases or even vanishes. However in the presence of bay leaves *Melanopis* consume up to 30% of the initial leaf mass in only two days and die immediately probably because of the leaf toxicity of this plant. This phenomenon of the decomposition of the leaves is fundamental for the functioning of the streams but must not mask the potential toxicity of these processes on the receiving aquatic environments especially during the first stages of decomposition of the leaves in the water.

BIBLIOGRAPHIC REFERENCES

- BARLÖCHER F., KENDRICK B. et MICHAELIDE J. (1978). Colonization and conditioning of *Pinus resinosa* needles by aquatic hyphomycetes. Arch. Hydrobiol., 81 : 462-474.
- BOURAADA K. et ESSAFI M. (2016). Study of the biodegradation of *eucalyptus* leaves (*Eucalyptus camaldulensis*) and oleander (*Nerium oleander*) in the water of Oued Ain Chkef in Morocco. Journal of Water Science Quebec (CANADA) 29 (2): 169-176.
- BLACKBURN W.M. and T. PETR (1979). Forest litter decomposition and benthos in Victoria Australia. Arch. Hydrobiol. 86 (4): 453-98.
- BLACKBURN, W.M. et T. PETR, (1979). Forest litter decomposition and benthos in a mountain stream in Victoria, Australia. Arch. Hydrobiol., 86 (4) : 453-98.
- CHAMER A.C. et WILLOUGHBY G.L. (1986). The role of fungi in the diet of the Amphipod *Gammarus pulex* (L.) : an enzymatic study. Freshwat. Biol., 16 : 196-206.
- CHERGUI H. (1989). Flow of coarse particles of allochthonous and indigenous organic matter in a dead arm of the Rhone. Sci Water Review: 565-585.
- CHERGUI H. and PATTEE E. (1991a). Degradation of non-native dead leaves in the Moulouya lowland network in Morocco. Acta oecologica, 12 : 543-560.
- CHAMER A.C. and WILLOUGHBY G.L. (1986). The role of fungi in the diet of the Amphipod *Gammarus pulex* (L.): an enzymatic study. Freshwat. Biol. 16 : 196-206.
- CHERGUI H. et PATTEE E. (1991b). An experimental study of the breakdown of submerged leaves by hyphomycetes and invertebrates in Morocco. Freshwat. Biol., 26 : 97-110
- CUMMINS K. W., KOFFMAN W. P. et ROFF A. (1966). Trophic relationships in small woodland stream, Verh. Internat. Verein. Limnol., 16 : 627-638.
- CUMMINS K.W. (1975). Structure and function of stream ecosystems. Bioscience, 24 :61-64.
- CUMMINS K.W., KLUG M. J., WETZEL R.G, PETERSEN R.C., SUBERKROPP K.F., MANNY B.A., WUYCHECK J.C. et HOWARD F.O. (1972). Organic enrichment with leaf leachate in experimental lotic ecosystems. Bioscience, 22 : 719-722.
- CUMMINS K.W., MINISHALL. G.W., SEDELL J.T., CUSHING C. et PETERSEN R.C. (1984). Stream ecosystem theory. Verh. Internat. Verein. Limnol. 22 : 1818-1827.
- CUMMINS K.W., PETERSEN T.C., HOWARS F.O., WUYCHECK J.C. et HOLT V. (1973). The utilization of leaf litter by stream detritivores. Ecology, 54 : 336- 345.
- CUMMINS K.W., WILZBACH M.A., GATES D.M., Perry J. et TALLIAFERRO W.N. (1989). Shredders and riparian vegetation, Bioscience, 39 : 24-30.
- EGGLISH H.J. (1968). The quantitative relationships between bottom fauna and plant detritus in streams of different calcium concentrations. J. Appl. Ecol., 5 : 731-740.
- ESSAFI M. (2000). Natural degradation process and water contamination by dead leaves of *Eucalyptus camaldulensis* and *Nerium oleander*. National Doct., Fac Sci .Fès, 248p.
- GESSNER M. O. et CHAUVET E. (1994). Importance of stream microfungi in controlling breakdown rates of leaf litter. Ecology, 75, 1807-1817.
- GESSNER M. O. et CHAUVET E. (2002). A case for using litter breakdown to assess functional stream integrity. Ecological Applications, 12, 498-510.
- HELLER J. et ABOTBOL A. (1997). Litter shredding in a desert oasis by the snail *Melanopsis praemorsa*. Hydrobiologia. 344: 65-73.
- KAUSHIK N.K. et HYNES H.B.N. (1968). Experimental study on the role of autumn shed leaves in aquatic environments. J Ecol .56 (1): 229-243.
- MAAMRI A. CHERGUI H. et PATTEE E. (1994a). Allochthonous input of coarse organic matter to a Moroccan mountain stream. Acta oecologia, 15 : 495-508.

- MAAMRI A. CHERGUI H. and PATTEE E. (1994b). The retention of dead leaves in a mountain stream in Morocco seasonal variations *Annls Limnol.* 30 : 323-332.
- MACKAY R. J. et KALFF J. (1973). Ecology of two related species of caddisfly larvae in the organic substrates of a woodland stream. *Ecology*; 54 : 499-511.
- MOLINERO J.n POZO J. et GONZALES R. (1996). Litter breakdown in streams of the Aguera catchment: influence of dissolved nutrients and land use. *Freshwater Biology.*, 36 : 745-75.
- NAIMAN H., Decamps, Pastor J. et Johnston C.A. (1988), The potential importance of boundaries to fluvial ecosystems, *Journal of the North American Benthological Society*, 7(4): 289-306.
- PETERSEN R.C. et CUMMINS K.W. (1974). Leaf processing in a woodland stream. *Freshwater. Biol.*, 4 : 343-368.
- POZO J. (1993). Leaf litter processing of alder and eucalyptus in the Aguera stream system (north Spain). I Chemical changes. *Arch Hydrobiol.*, 127 : 299-317.
- RODIN L.E. et BASILEBITCH E. (1965). Production and mineral cycling terrestrial vegetation. *E Fogg ed.*, 34 : 128-129.
- ROSSI L. et FANO A.E. (1979). Role of fungi in the trophic niche of the congeneric detritivorous *Asellus aquaticus* and *A. coxalis* (Isopoda). *Oikos*, 32 : 380-385.
- WEBSTER J. et BENFIELD E.K. (1986). Vascular Plant Breakdown in freshwater ecosystems. *Ann. Rev. Ecol. Syst.*, 17 : 567-594.

