Belowground Necromass Dynamics in Estuarine Stands of the Seagras *Cymodocea nodosa*

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Introduction

Belowground biomass accounts for a significative part of total biomass and production in seagrass stands (ZIEMAN & WETZEL, 1980). The decay of this biomass occurs within the sediment, leading to a necromass accumulation. This accumulation can be relevant to the nutrient cycling and/or trophic structure of the ecosystem. Nevertheless, data on this topic are relatively scarce (PIRC, 1983; FRANCOUR, 1990; ROMERO et al., in press). The aim of this paper is to make a quantitative approach of these aspects in the Cymodocea nodosa ecosystem focussing on three items: (i) the evaluation of the dead organic matter stock from both roots and rhizomes; (ii) the estimation of its turnover and decomposition rates and (iii) the assessment of the variability of these parameters depending on nutrient availability and stand age.

Methodology

The work was conducted at the Alfacs Bay (Ebro river Delta, NE Spain), a shallow bay with freshwater inputs. Sampling was performed in summer (Agust-September) using a hand-held corer with a 200 cm2 base, pushed into the sediment to a depth of 30 cm. After collection, the samples were rinsed in situ, and sorted into living rhizomes, dead rhizomes, living roots and dead roots. Weight of each fraction is expressed as dry weight.

Samples were taken in (a) a continuous meadow in a nutrient poor zone; (b) patches of different ages in a nutrient poor zone and (c) a continuous meadow in a nutrient rich zone. The age of the patches was estimated using both CAYE & MEINESZ (1985) criteria and plastochrone interval (PEREZ & ROMERO, in press). This method allows also to estimate root and rhizome production (PEREZ & ROMERO, in press).

Table I. Stocks of belowground biomass and necromass (g/m2).

Zone	Rhizomes Living	Rhizomes Dead	Roots Living	Roots Dead
(a)	256	127	105	104
(b)	96	19	48	44
(c)	125	78	38	9

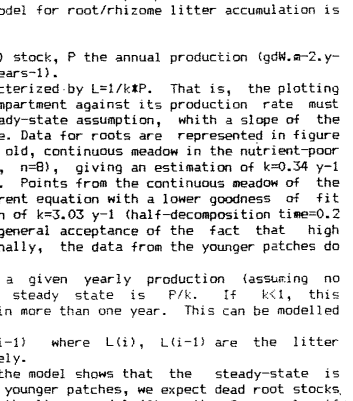

Fig. 1. Root production (x-axis) against root necromass (y-axis). (g/m^2/year and g/m^2.)

Results and discussion

The data are summarized in table I. The main contribution to the belowground biomass corresponds to the living rhizomes. In general, dead stocks are in the same order of the living biomass; its variability depends on the different accumulation rates. The following model for root/rhizome litter accumulation is proposed:

$$dL/dt = P - kL \qquad \text{(eq. 1)}$$

where L is the necromass (litter) stock, P the annual production (gdW.m-2.y-1) and k the decomposition rate (years-1).

The steady-state (dL/dt=0) is characterized by L=1/k*P. That is, the plotting of the litter stock of a given compartment against its production rate must give a straight line under the steady-state assumption, whith a slope of the reciprocal of the decomposition rate. Data for roots are represented in figure 1. The points corresponding to the old, continuous meadow in the nutrient-poor zone fits the linear model (r=0.95, n=8), giving an estimation of k=0.34 y-1 (half-decomposition time= 2 years). Points from the continuous meadow of the nutrient-rich zone follows a different equation with a lower goodness of fit (r=0.55, n=6), giving an estimation of k=3.03 y-1 (half-decomposition time=0.2 years), which agrees with the general acceptance of the fact that high nutrient levels enhances decay. Finally, the data from the younger patches do not fit a linear model.

From eq. 1, the necromass for a given yearly production (assuming no interannual fluctuations) in the steady state is P/k. If k<1, this "equilibrium necromass" is reached in more than one year. This can be modelled in a quite simple way:

$$L(i)=P+(1-k)L(i-1)$$ where L(i), L(i-1) are the litter stocks at time i and i-1, respectively.

For k=0.34 y-1, the running of the model shows that the steady-state is reached after 4-5 years, so for the younger patches, we expect dead root stocks well below the values predicted by the linear model (fig. 1). Conversely, if k>1, the steady state can be reached in less than one year. This implies that one year is an unadequate time basis for the description of this phenomenon, and that seasonal variations can severely affect the results. In the nutrient-rich zone, the fact that root necromass is in all the cases below root producction gives support for a decomposition rate k>1, but the proposed estimation of k=3.03 must be contemplated with caution.

For the rhizomes, only the data from the continuos meadow in the nutrient poor zone conform to the linear model, but with low correlation vales (r=060, n=8), that can be explained by a decay rate (k=2.43) higher than one.

Althought the data presented are preliminary, some provisional conclusions can be drawn. In the nutrient-poor areas, the decomposition rate of belowground material of the Cymodocea stands under study are low relatively to the ones estimated for the aboveground parts (leaves; see HARRISON, 1989). This results in an accumulation of organic matter in the sediment, mostly in the form of dead roots. In more eutrophic areas, the root decay is greatly enhanced, leading to a lower dead matter accumulation and thus a higher recycling rate. In the necromass compartment, equilibrium is reached when inputs (from the death of living parts of the plant) balances outputs (from decomposition). This equilibrium can be shifted by nutrient levels, as stated, but it also takes some time to be achieved. Necromass development to an steady-state value can be interpreted as a succesional process within the plant stand development.

References

CAYE, G. & MEINESZ, A., 1985. Aquatic Botany, 22:277-289.
FRANCOUR, P., 1990. Thèse 3ème cycle, Université Paris VI.
HARRISON, P.G., 1989. Aquatic Botany, 23:263-288.
PEREZ, M. & ROMERO, J. in press. Marine Ecology (submitted)
PIRC, H., 1983. Proc.Int.Symp.Aq.Macrophytes, 177-181
ROMERO, J.; PERGENT, G.; PERGENT-MARTINI, C.; MATEO, M.A. & REGNIER, C., in press. Marine Ecology, submitted.
ZIEMAN, J.C. & WETZEL, R.G., 1980. In PHILIPS & MCROY. Garland, N.Y.