Macrofauna and roots reduce CH_4 production and attenuate nutrient recycling in organic-rich fluvial sediments

Benelli Sara[1*], Bartoli Marco[1&2]

[1]*University of Parma, Italy*
[2]*University of Klaipeda, Lithuania*

* e-mail: sara.benelli@unipr.it

In freshwater ecosystems sediment-water fluxes of chemically reduced gas, as methane, and nutrients increase with organic enrichment, through an array of different mechanisms, which can depend upon benthic biodiversity.

Rooted macrophytes and burrowing macrofauna can act as *ecosystem engineers* and alter sedimentary processes and benthic-pelagic coupling via:

- radial O_2 loss (rooted macrophytes)
- particle reworking and burrow ventilation (macrofauna)

Aim

Evaluate emerging properties from the interaction among macrophytes, macrofauna and microbial communities in organic-rich fluvial sediments

Macrophyte: *Vallisneria spiralis*
&
Oligochaete: *Sparganophilus tamesis*

Working Hypotheses

- The combined action of macrophyte roots and burrowers may stimulate denitrification and depress methane emissions
- Tight coupling between macrofauna-mediated nutrient release and plant uptake may result in benthic retention of N and P

Material & Methods

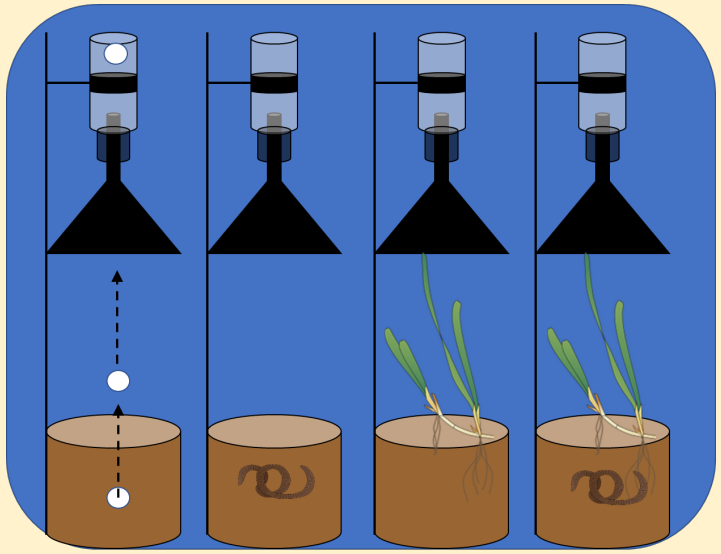
Experimental conditions:

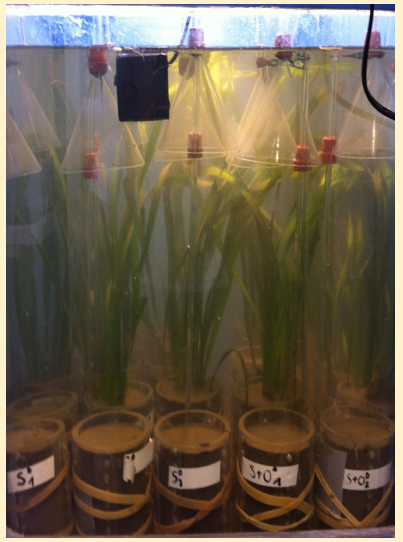
S = bare sediment
SO = sediment + oligochaetes
SV = sediment + *V. spiralis*
SOV = sediment + oligochaetes + *V. spiralis*

12 microcosms for ebullitive fluxes *(n=3 per condition)*

12 microcosms for diffusive fluxes *(n=3 per condition)*

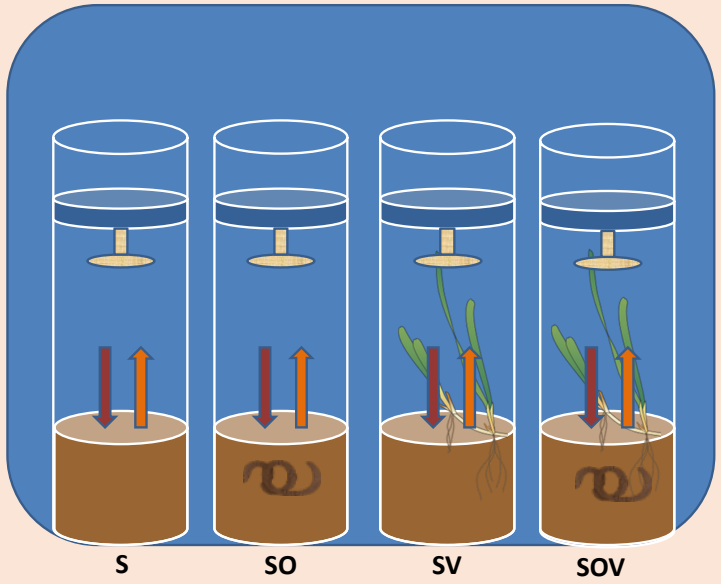
Set up for ebullitive fluxes measurement

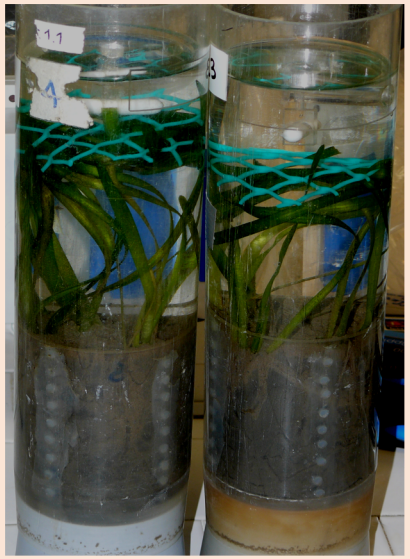




320 h of incubation under a light regime of 12 h dark and 12 h light

Set up for net fluxes measurement

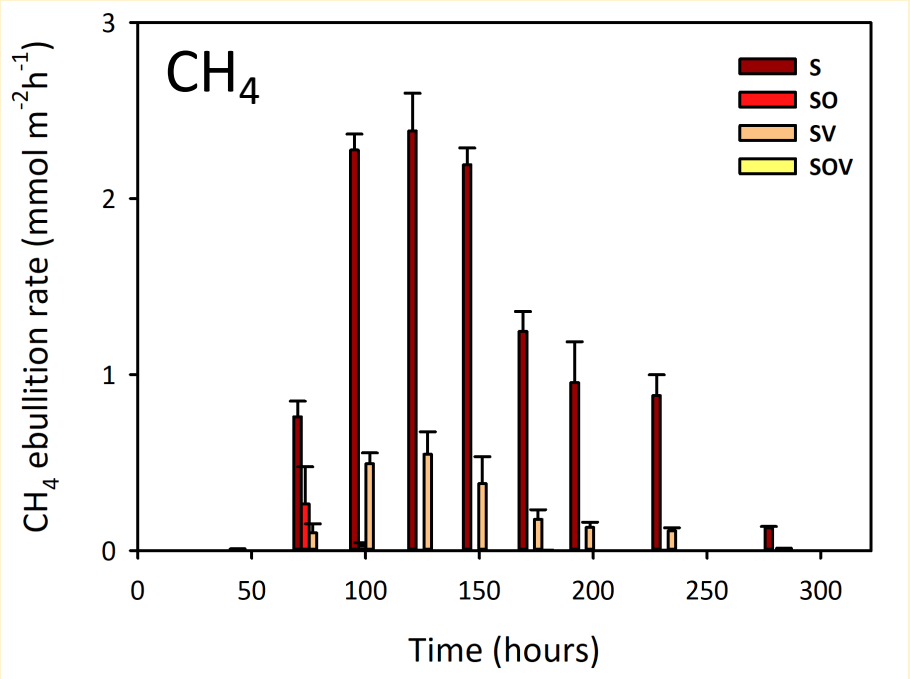


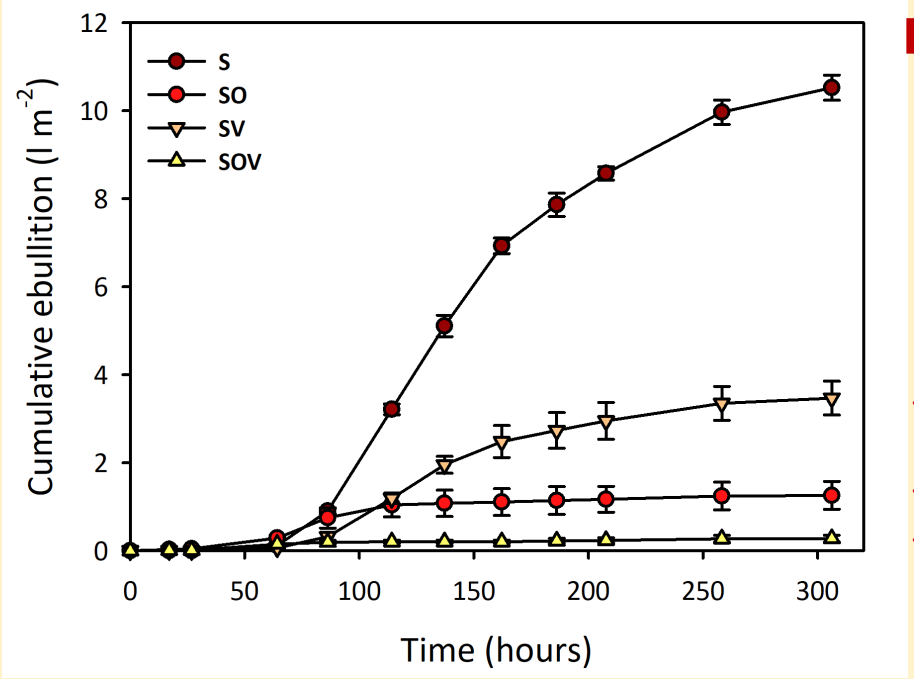


Dark & Light batch incubations*

**light incubations only in SV and SOV conditions*

Results: gas ebullition





Reduction of gas ebullition compared to S:

-60 % in SV

-90 % in SO
-95 % in SOV

CH_4 fluxes via ebullition peak after:

50 h of incubation in SOV

75 h of incubation in SO

125 h of incubation in SV and S

Total gas production during the experiment:

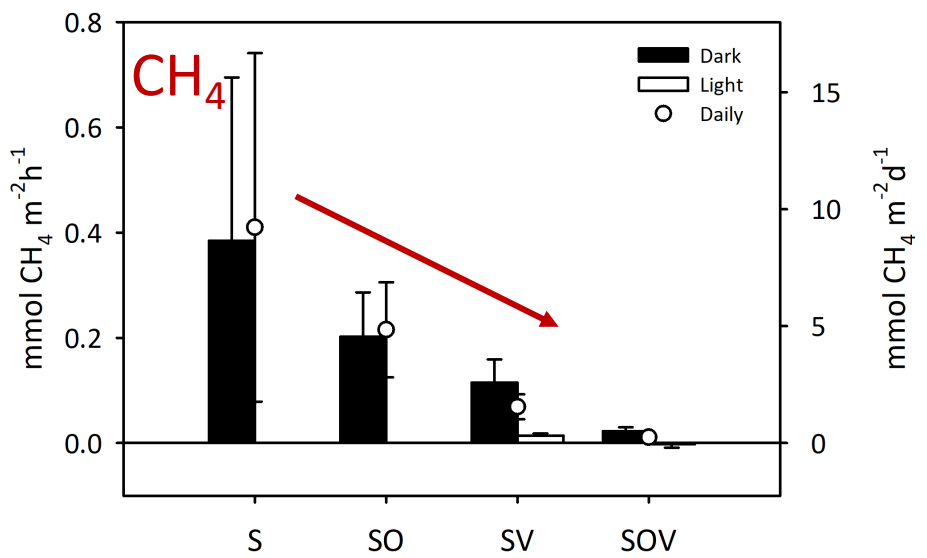
10 l m^{-2} $period^{-1}$ in S

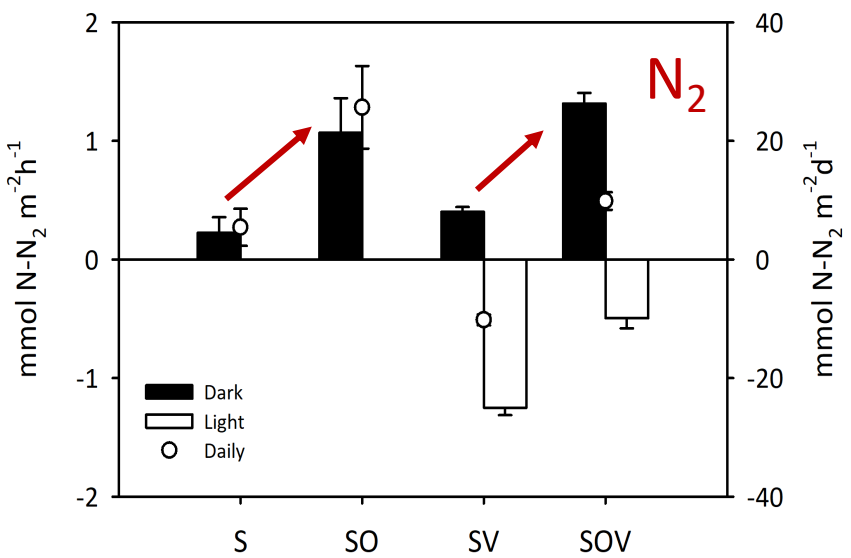
4 l m^{-2} $period^{-1}$ in SV

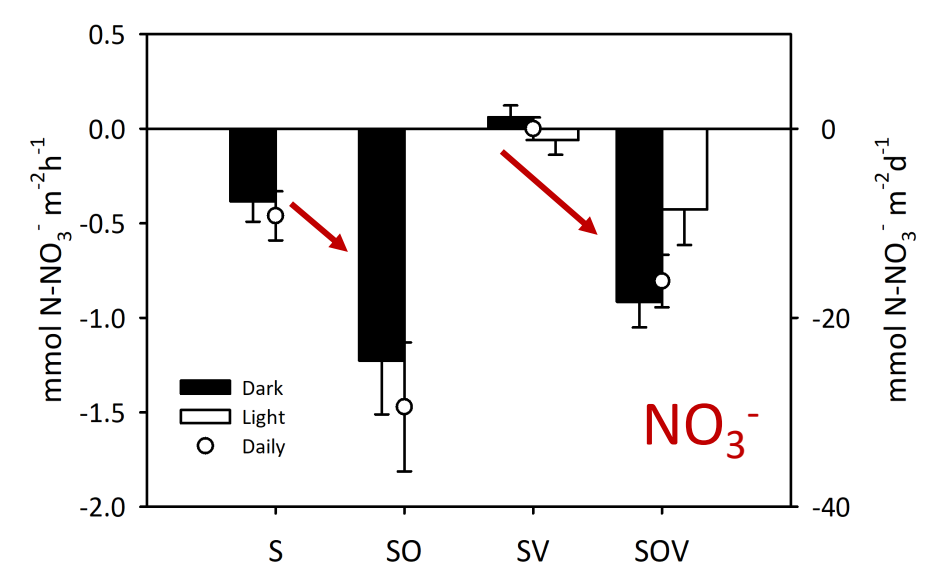
1 l m^{-2} $period^{-1}$ in SO

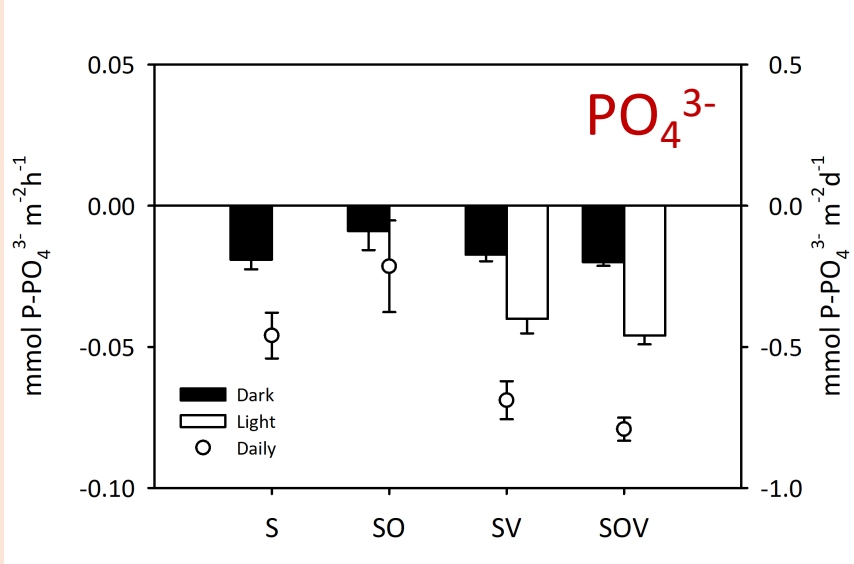
0.5 l m^{-2} $period^{-1}$ in SOV

Results: net fluxes of gas and nutrients









Conclusions

Macrofauna and macrophyte roots **reduce CH_4 emission** in organic-rich fluvial sediments:

- *S. tamesis* by stimulating denitrification and sediment reoxidation
- *V. spiralis* by releasing O_2 via the roots and oxidizing the surrounding sediment

Macrofauna and macrophyte roots **attenuate nutrient recycling** in organic-rich fluvial sediments:

- *S. tamesis* favored inorganic N removal with implications to pelagic primary producers
- *V. spiralis* assimilated N and P reducing their recycling to the water column

The association of *S. tamesis* and *V. spiralis* alters the functioning of the benthic system, by promoting sediment oxidation and favouring O_2 and NO_3^--based respiration at the expenses of methanogenesis and resulting in lower nutrients regeneration.