

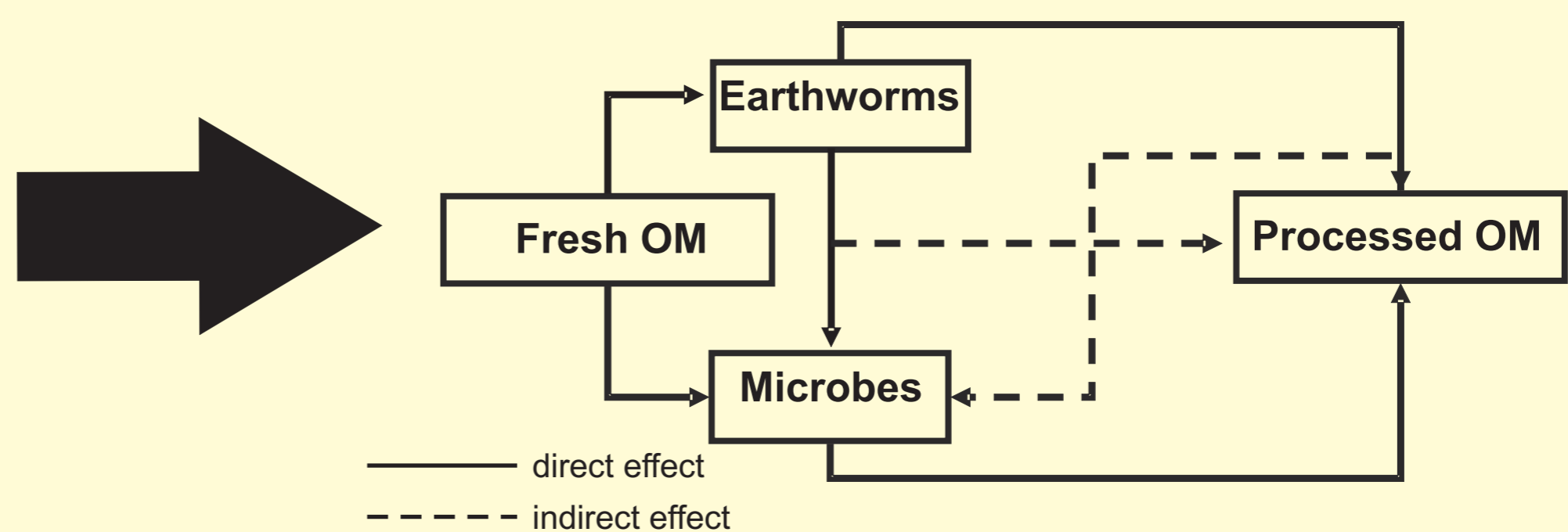


# Earthworms and microorganisms: disentangling the black box of vermicomposting

Manuel Aira, María Gómez-Brandón and Jorge Domínguez  
 Departamento de Ecoloxía e Bioloxía Animal. Universidade de Vigo. Vigo. E-36310. Spain.  
 E-mail: aira@uvigo.es

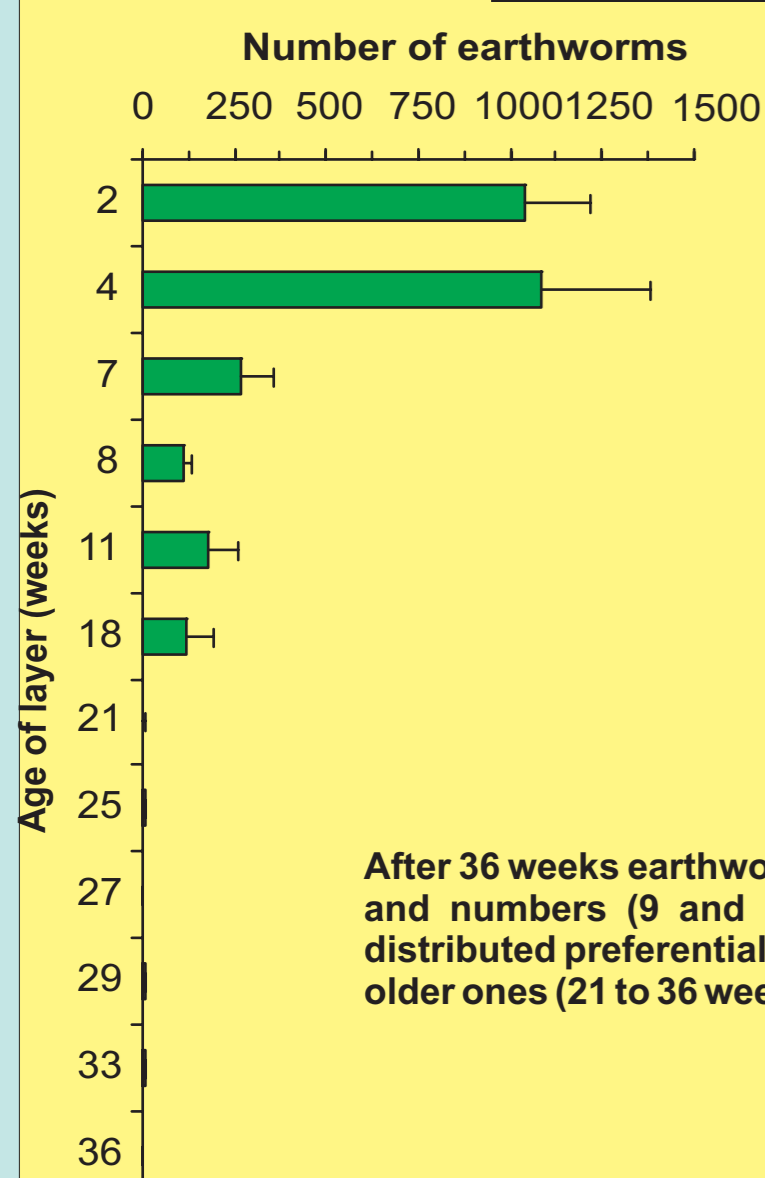
## RATIONALE

Microorganisms are largely responsible of organic matter decomposition, but earthworms may also affect to rates of decomposition directly by feeding on and digesting organic matter, or indirectly affect them through their interactions with the microflora, basically involving stimulation or depression of the microflora biomass and activity. Here we present the results of three experiments which tried to separate between the direct and indirect effects of earthworm on decomposition of organic matter. We used the vermicomposting process as a model to study the relationships of earthworms and microorganisms.

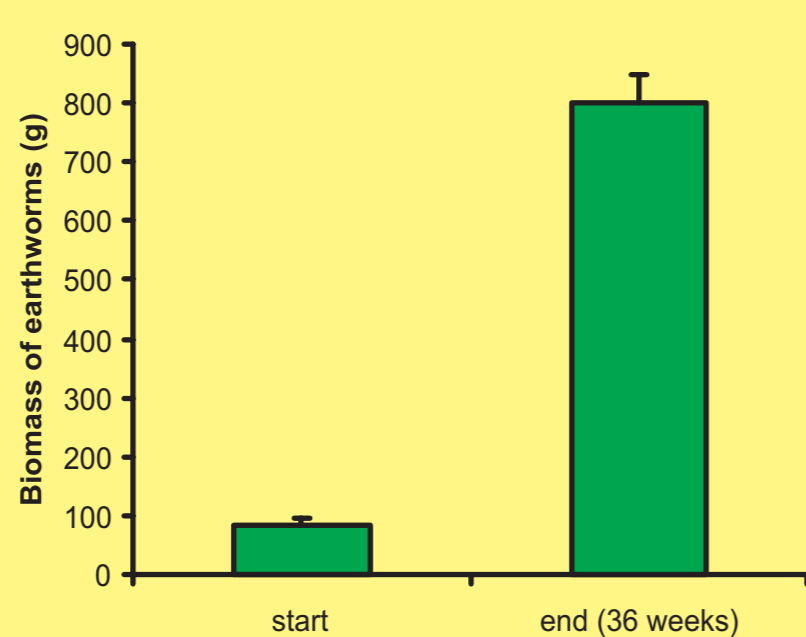


## DIRECT AND INDIRECT EFFECTS OF EARTHWORMS

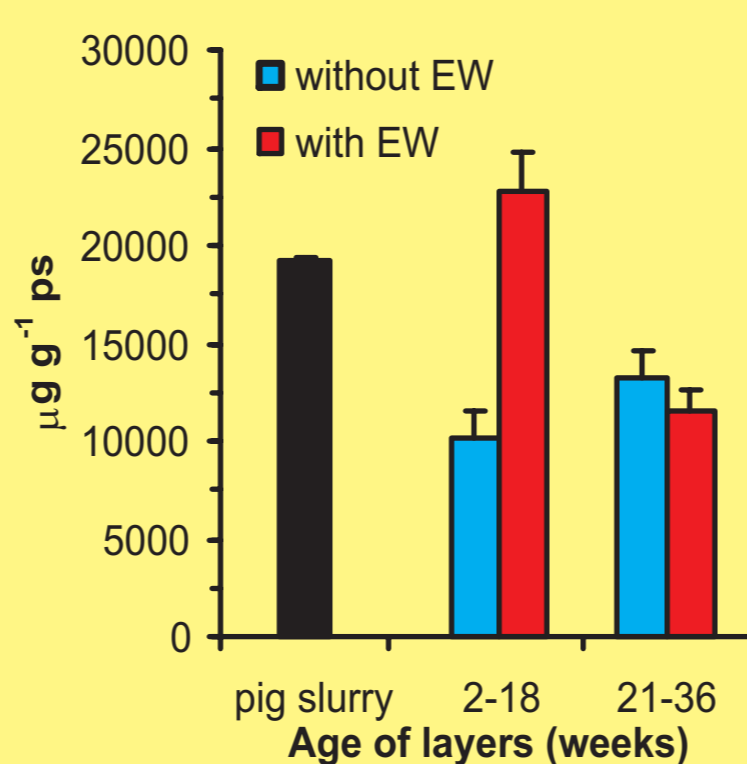
### EARTHWORM POPULATION



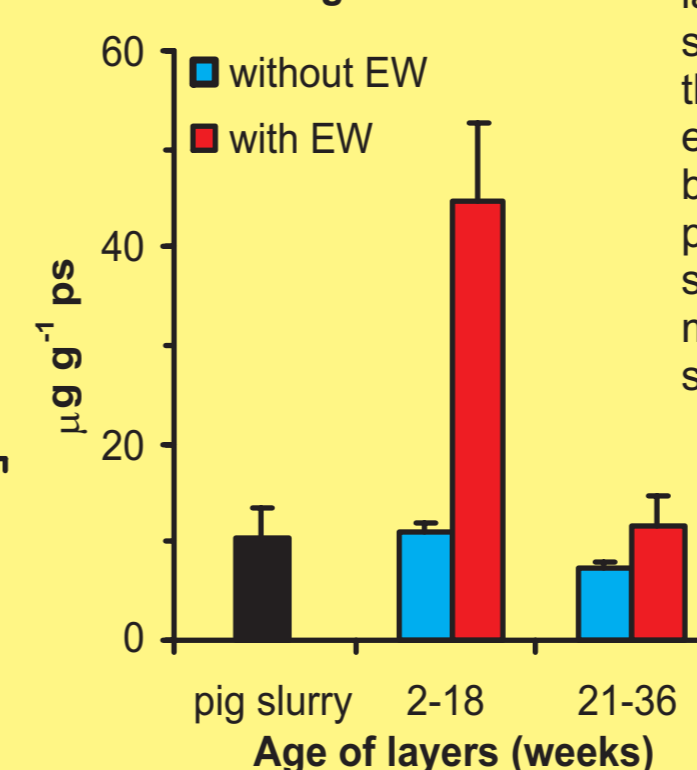
After 36 weeks earthworm population showed a marked increase in biomass and numbers (9 and 6 times respectively). Moreover, earthworms were distributed preferentially in younger layers (2 to 18 weeks-old layers), than in older ones (21 to 36 weeks-old layers).



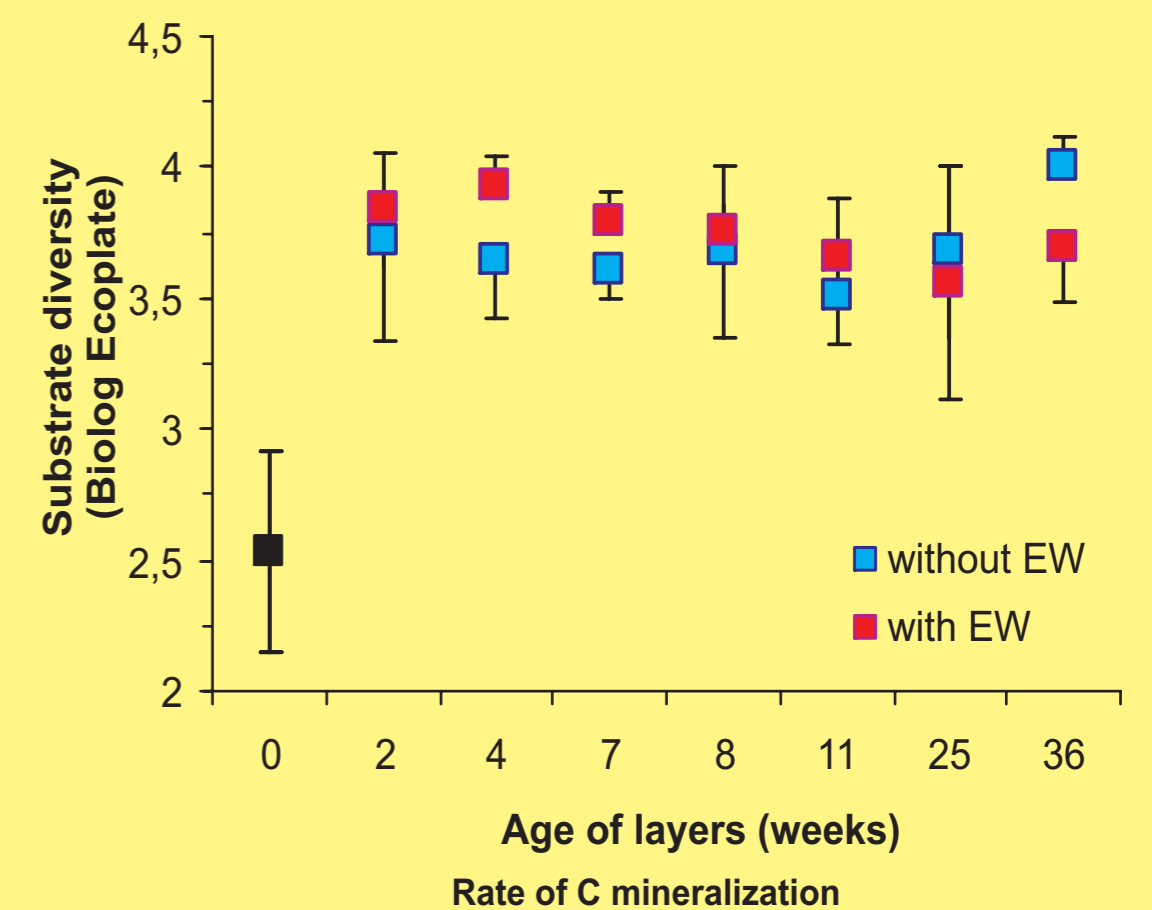
### Microbial biomass-C



### Ergosterol content



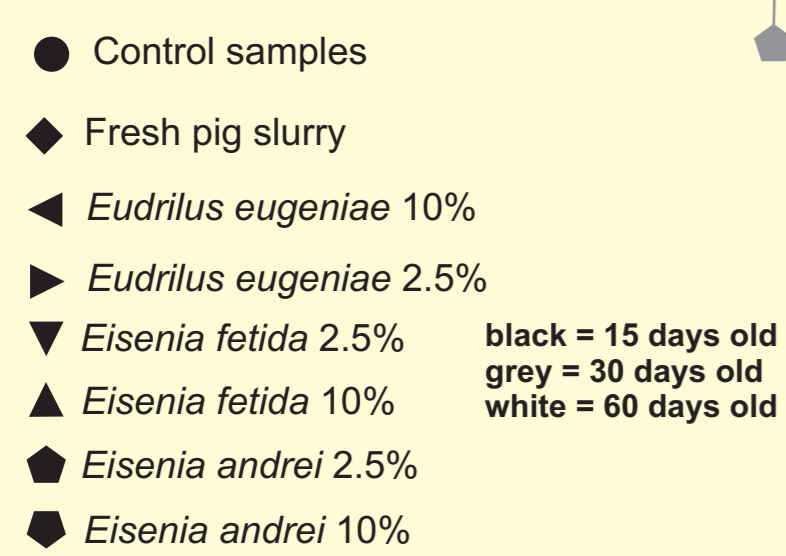
The first experiment studied the whole process of vermicomposting, using *Eisenia fetida* and pig manure in continuous feeding vermireactors; these vermireactors were made of independent layers which allowed us to date them. Earthworms promoted significant increases in both microbial biomass and activity when they were present in the layers, and after that, in aged layers where earthworm were absent, microbial stabilization (i.e. low microbial biomass and activity) occurred. Further, community physiological profiles (Biolog Ecoplate) revealed that earthworms promoted significant alterations in the physiological capabilities of microorganisms. As consequence, carbon mineralization was significantly enhanced.



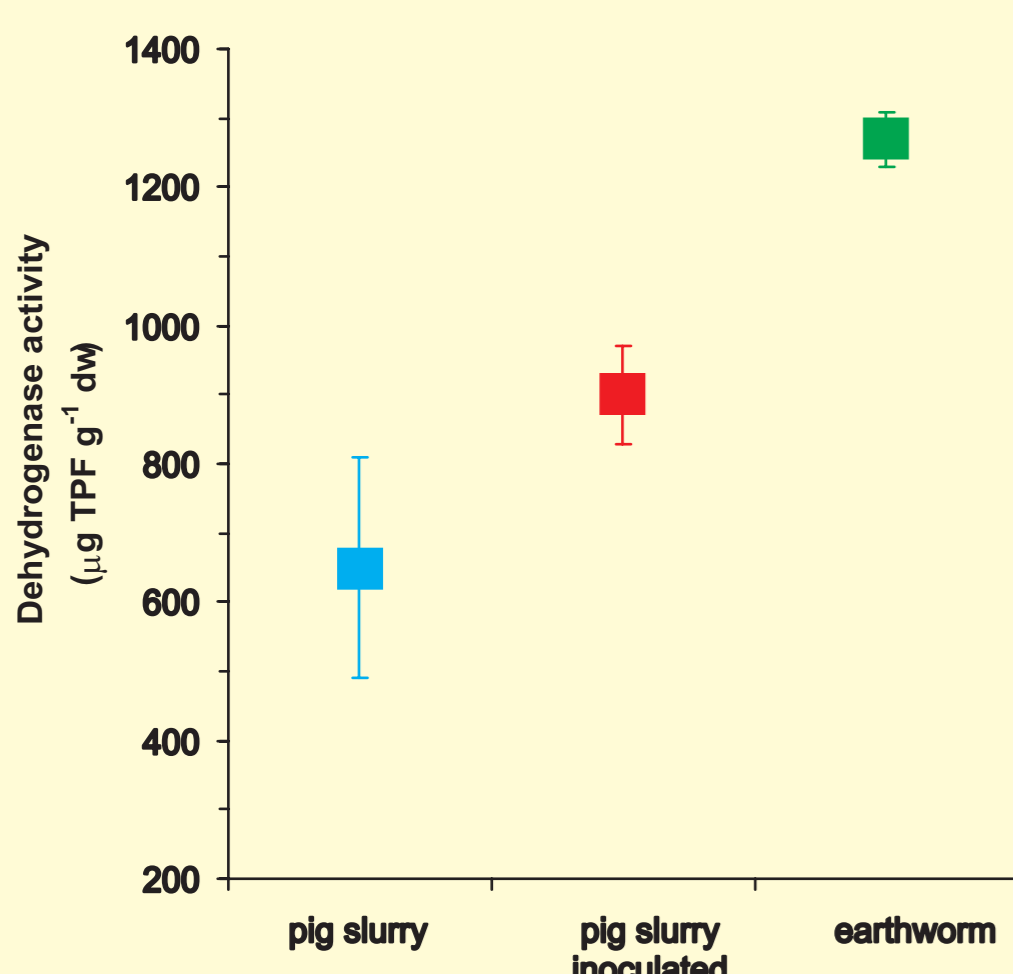
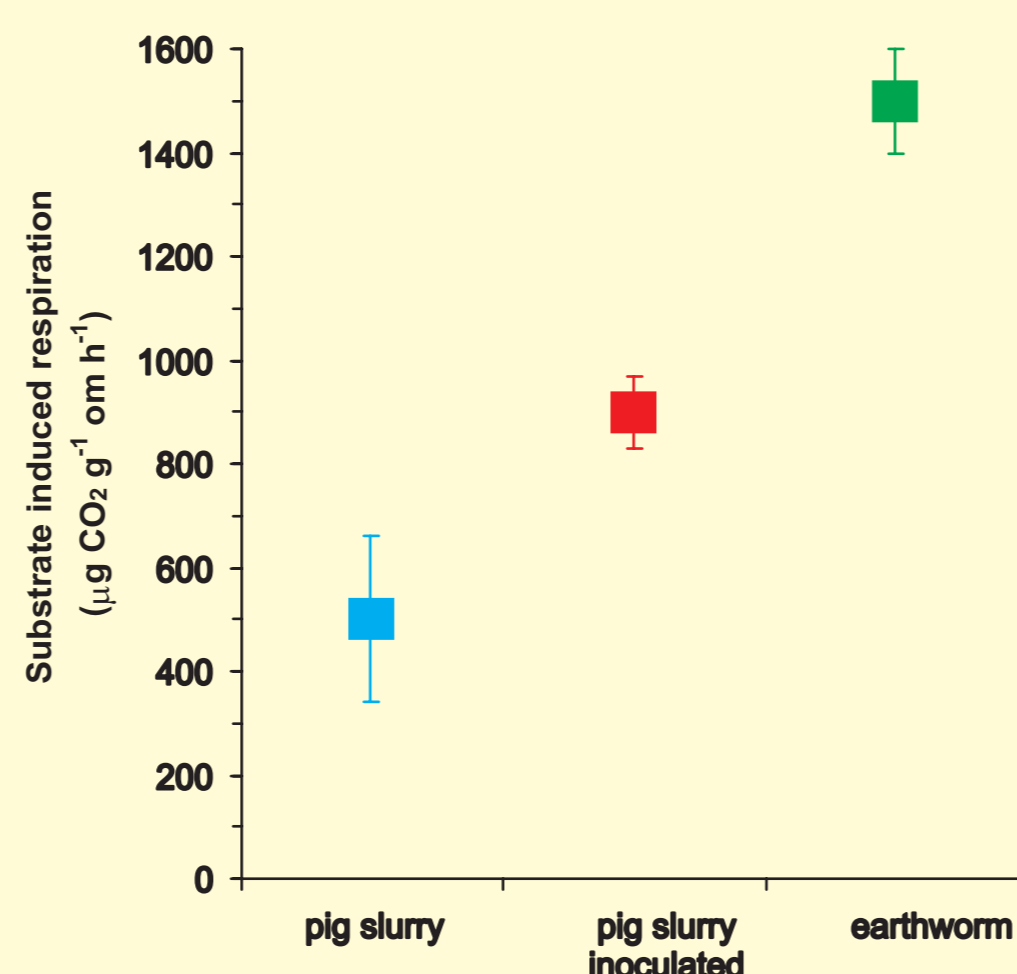
## INDIRECT EFFECTS OF EARTHWORMS

### Factor loadings

	PC1	PC2
Basal respiration	0,60	0,57
b-glucosidase	0,56	-0,71
alkaline phosphatase	0,74	-0,25
cellulase	0,68	-0,45
protease	0,70	0,31
SIR	0,45	0,74

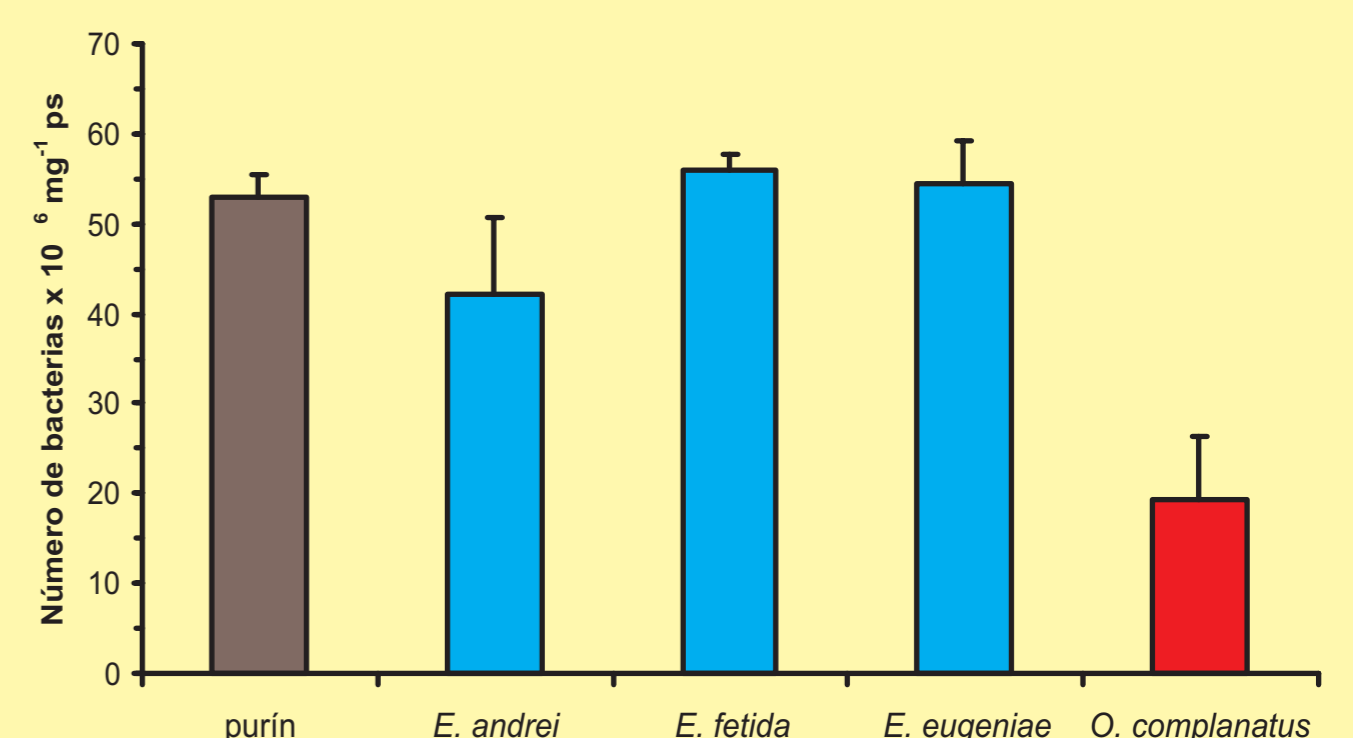


In a second experiment, we inoculated pig manure with two doses of vermicomposts (2.5 and 10%) obtained from laboratory cultures of *E. fetida*, *E. andrei* and *Eudrilus eugeniae*. Samples were incubated and analyzed at 15, 30 and 60 days. By doing this, we were able to test the indirect effect of earthworms, that is, whether an earthworm processed substrate can modify organic matter decomposition or whether it is necessary the earthworm presence to achieve the same results of the first experiment. We found that inoculation of vermicompost produced the same increases in microbial biomass and activity, and although these increments were not as higher as in presence of earthworms, we can state that indirect effects of earthworm are strong enough to alter the dynamics of organic matter decomposition.



## DIRECT EFFECTS OF EARTHWORMS

In the third experiment, we analyzed the gut content of four earthworm species (*E. fetida*, *E. andrei*, *E. eugeniae* and *Octodrilus complanatus*) which were fed with pig slurry. We determined the number of bacterial cells by fluorescence microscopy to understand the direct effect of earthworms on microorganisms. We found that only *O. complanatus* produced a significant decrease in the number of bacterial cells, whereas there were no differences between pig manure and the gut content of the other earthworm species.



## CONCLUSIONS

Earthworms increased microbial biomass and activity; they also modified microbial community composition leading to a more efficient C mineralization.

Microbial communities followed similar dynamics after inoculation of pig slurry with vermicompost, suggesting that indirect effects of earthworms are enough to trigger decomposition.

The transit through the gut of epigeic earthworms did not affect bacterial numbers. This result suggests the existence of external mutualism between earthworms and microorganisms.