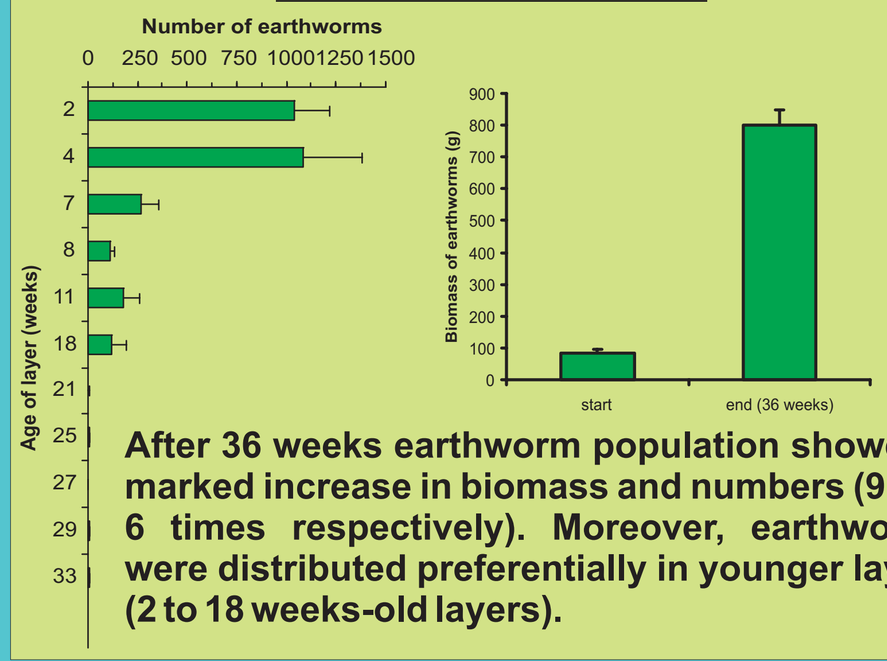
Earthworms accelerates decomposition modifying the structure and function of microbial communities during vermicomposting of pig manure

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

RATIONALE

Although microorganisms are largely responsible of organic matter decomposition during vermicomposting, earthworms may also affect to rates of decomposition directly by feeding on and digesting organic matter and microorganisms, or indirectly affect them through their interactions with the microorganisms, basically involving stimulation or depression of the microbial populations. We tested the general hypothesis that microbial populations, and especially fungi, are enhanced by earthworm activity, and also whether earthworms are able to modify the biodiversity of microbial populations, and its relation with the function of the system. In addition we examined the metabolic quotient and the effect of labile organic C to assess the relationships between earthworm and microbes.

EARTHWORM POPULATION

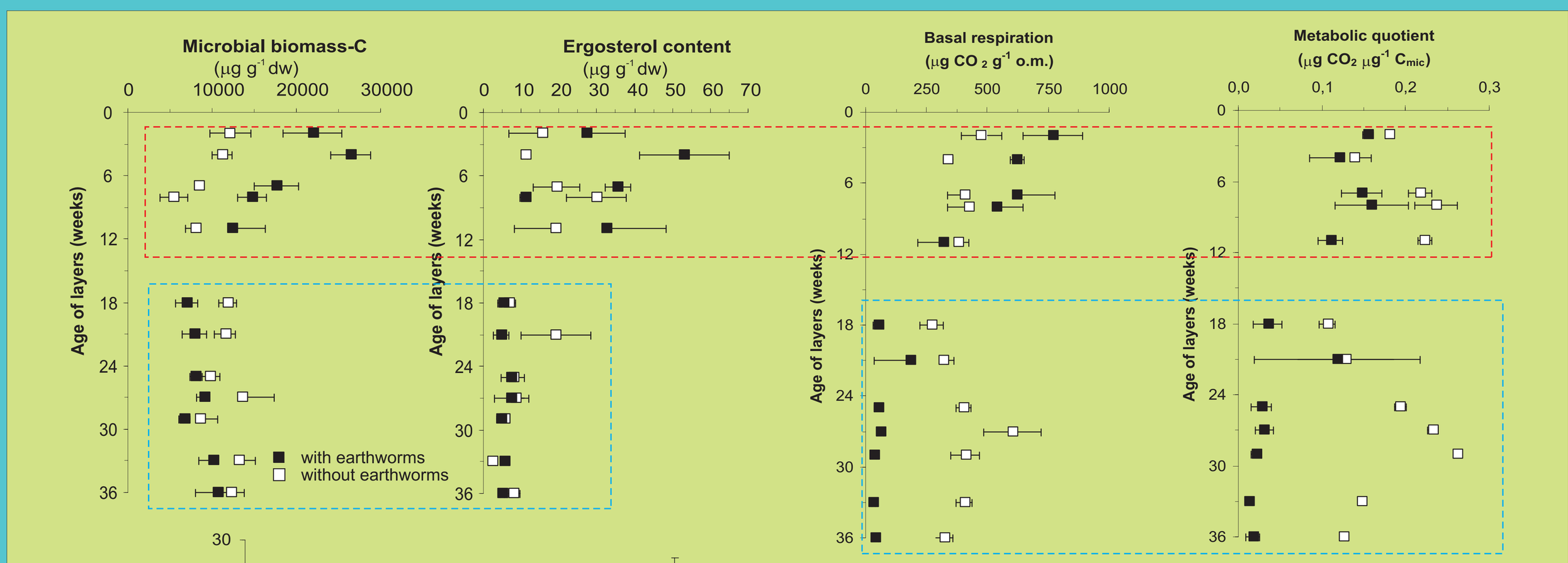


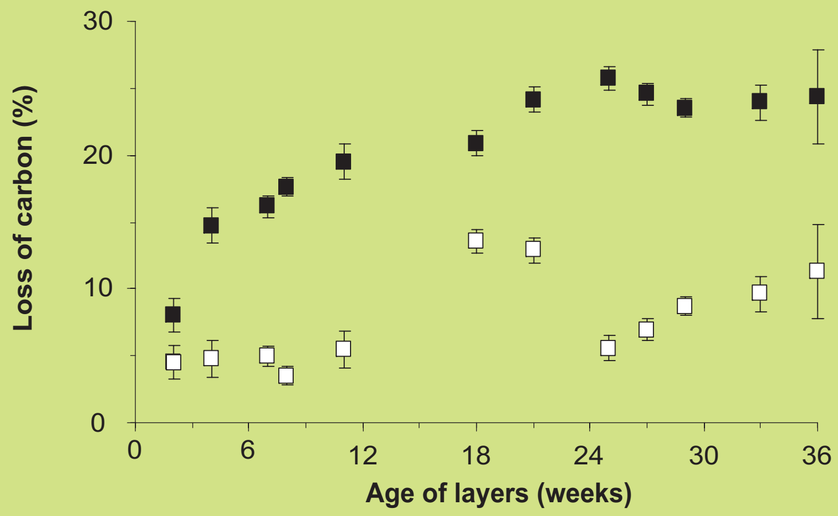
After 36 weeks earthworm population showed a marked increase in biomass and numbers (9 and 6 times respectively). Moreover, earthworms were distributed preferentially in younger layers (2 to 18 weeks-old layers).

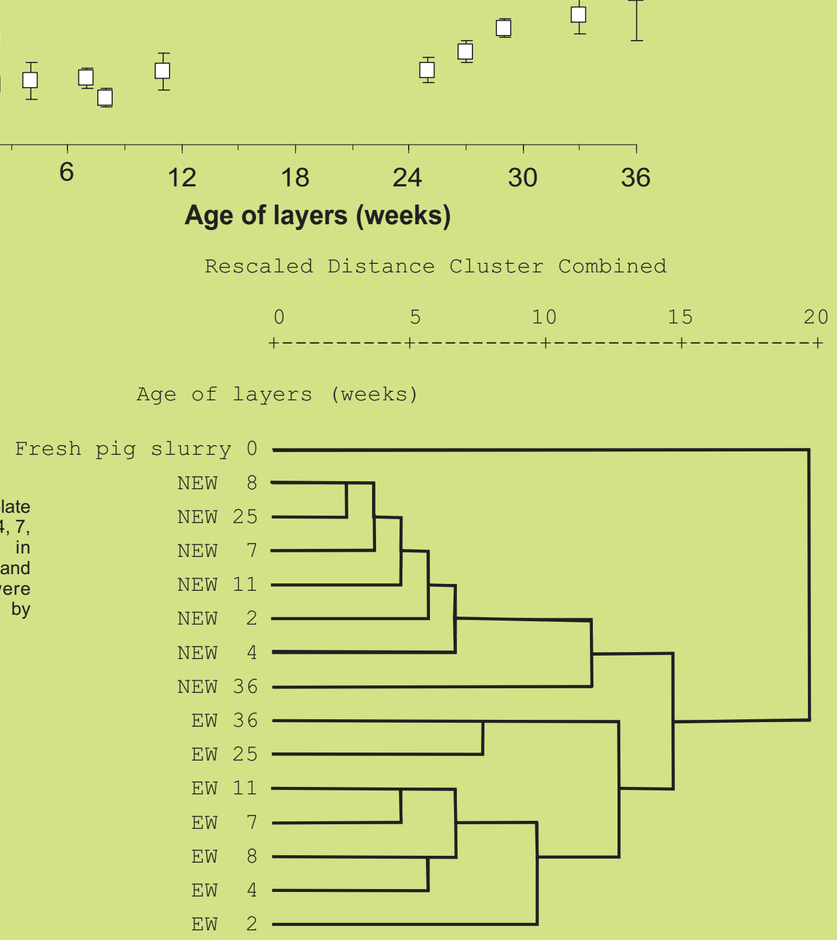
Material and methods

Experimental design

We designed continuous feeding vermireactors with separated layers to date them. We set up three reactors with earthworm (500 mature initial population, ca. 85 g) and three reactors without (control). New layers with fresh pig slurry(1.5 kg fresh weight) were added when the last ones were eaten by the earthworms and the experiment ended after 36 weeks. At the end there were nine layers with an age gradient of 0, 4, 8, 13, 21, 25, 27, 33 and 36 weeks from upper to bottom layers. Five samples of substrate per module were taken at random and gently mixed for biochemical analyses, i.e. total C content, microbial biomass-C (Cmic), ergosterol content, basal and substrate induced respiration and Biolog® Ecoplate analysis. Data were analyzed under a split plot repeated measures ANOVA design.







Cluster analysis of the Biolog Ecoplate physiological profiles from layers of 0, 2, 4, 7, 8, 11, 25, and 36 weeks of age in vermireactors without earthworms (NEW) and with earthworms (EW). Clusters were determined by the Ward method and by Euclidean distance.

CONCLUSIONS

We found that decomposition of pig manure has two stages characterized by the presence or absence of earthworms. Thus, the presence of earthworms was related with increases in overall microbial biomass and activity which decreased when earthworms left the substrate; the same pattern was observed for fungi. Furthermore, earthworms modified the physiological profiles of microbial communities of pig manure, increasing the diversity of substrates utilized. In addition, earthworms promoted a more efficient use of energy of microbial communities as the metabolic quotient showed. The rate of carbon loss was almost twice in the presence of earthworms, revealing faster decomposition. Our data match with the recent findings that for maintaining essential processes the functional properties of present species are at least as important as the number of species per se. This is in accordance with the "insurance hypothesis" which states that a large number of