Higher decomposer functional diversity bolsters ecosystem gross primary productivity resistance under drought: a three-year ecotron study

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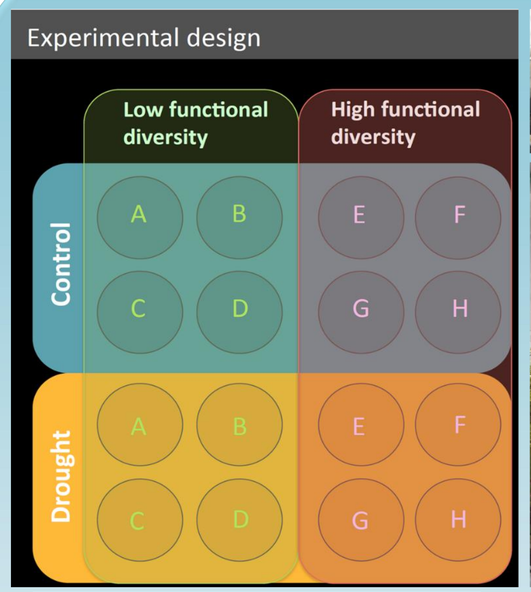
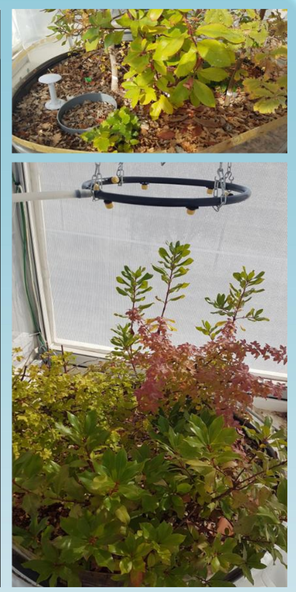
Background and hypotheses

Due to the critical knowledge gap on how soil biodiversity influences ecosystem CO_2 exchange—particularly under increasing drought—we conducted an experiment in the Mesocosms[1] platform of the Montpellier European Ecotron. This setup enabled continuous measurements of gross primary productivity (GPP) in complex ecosystems mimicking natural conditions. Our main objective was to test how soil decomposer functional diversity (low vs. high) and drought (ambient vs. extreme summer drought) affect ecosystem processes in a Mediterranean forest (understory) ecosystem. The model system consisted of four tree species transplanted into 1 m³ lysimeters. The decomposer treatments were established by gamma-irradiating soil (2.5 kGy) followed by controlled soil fauna inoculation (Tables 1 & 2), with 4 replicates per treatment combination. The drought treatment involved a 30% precipitation reduction and 30% longer water stress (tensiometer-monitored). **Hypothesis: Higher soil decomposer functional diversity (FD) enhances the resistance and resilience of ecosystem processes, including GPP**.

Experimental setup & methodology

Setup in the Mesocosms experimental platform





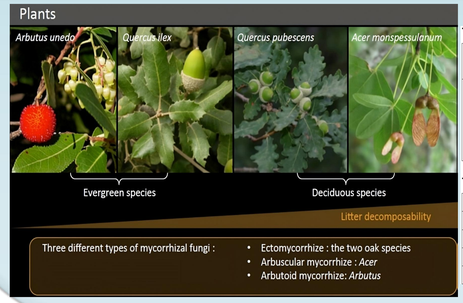


Table 1 | Macrofauna species by functional groups

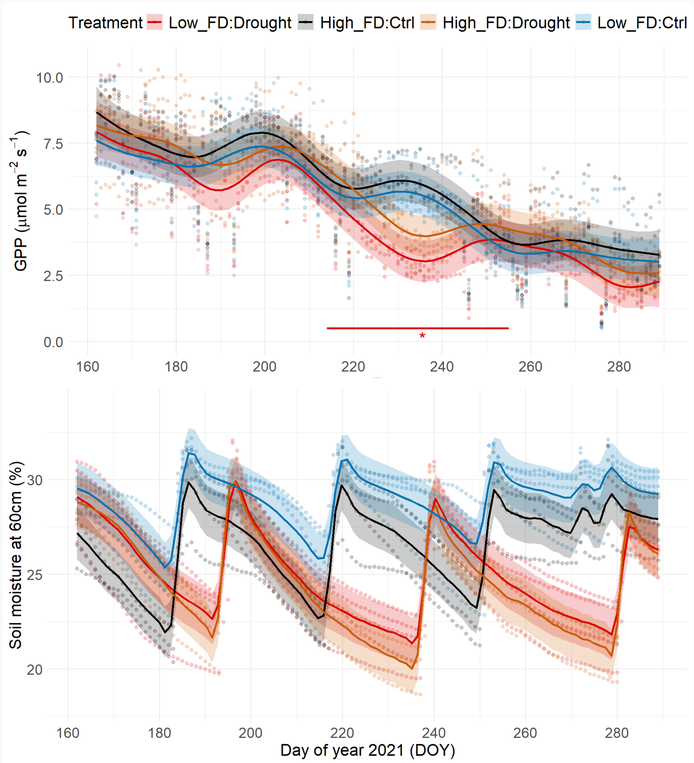
Functional group	Anecic earthworms	Endogeic earthworms	Diplopod s (millipede)	Isopods (woodlouse)
Species	*Lumbricus terrestris* *Aporrectodea noctuna* *Scherotheca gigas*	*Aporrectodea icterica* *Aporrectodea caliginosa* *Allolobophora chlorotica*	*Glomeris marginata* *Ommatoiulus sabulosus* *Cylindroiulus caeruleocinctus*	*Armadillidium vulgare* *Porcellio laevis* *Armadillo officinalis*

Table 2 | Macrofauna assemblages of low and high functional diversity

	Low functional diversity	High functional diversity
Replicate 1	3 species of anecic	1 anecic + 1 diplopod + 1 isopod
Replicate 2	3 species of diplopod	1 endogeic + 1 diplopod + 1 isopod
Replicate 3	3 species of isopod	1 anecic + 1 endogeic + 1 isopod
Replicate 4	3 species of endogeic	1 anecic + 1 endogeic + 1 millipede

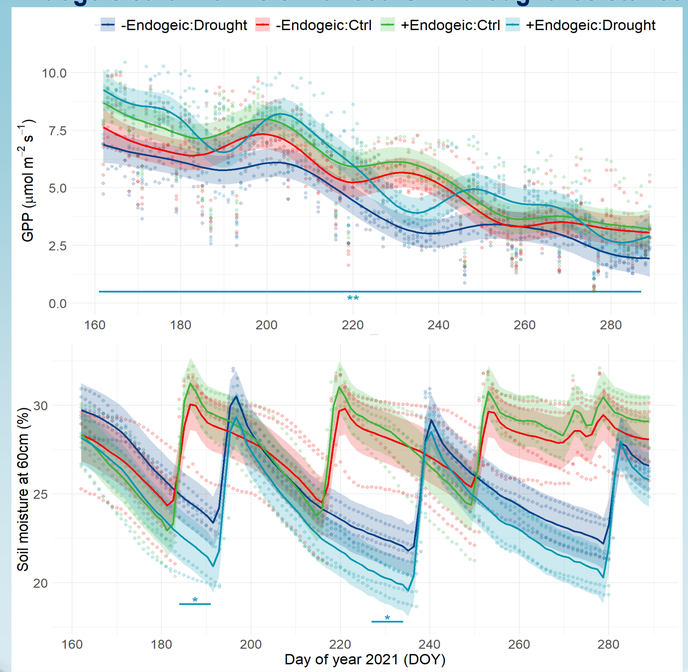
Key results

High decomposer FD increased GPP drought resistance



- Higher FD sustained higher GPP in the extreme summer drought treatment.
- Higher GPP was correlated with lower soil moisture content at 60 cm depth – indicating an enhanced water acquisition capacity. This effect was even stronger if endogeic earthworms were present.
- Overall, decomposer FD enhanced drought resistance but not resilience.

Endogeic earthworms enhanced GPP drought resistance



➢ **Conclusion: Decomposer functional diversity plays a key role in sustaining tree drought resistance in a 3-year, realistic controlled-environment experiment.**

References

Roy J, Rineau F, De Boeck HJ, Nijs I, Pütz T, Abiven S, Arnone JA, Barton CVM, Beenaerts N, Brüggemann N, …A Milcu. 2021. **Ecotrons: powerful and versatile ecosystem analysers for ecology, agronomy and environmental science**. *Global Change Biology* **27**: 1387–1407.

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Facility access: The Montpellier European Ecotron is a user facility available to external research projects. Researchers interested in utilizing advanced controlled-environment facilities for ecosystem studies are encouraged to contact us regarding access opportunities.