Freie Universität Berlin

Zusammenspiel von Biokohle mit arbuskulärer Mykorrhiza

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MARIE CURIE ACTIONS

DBU
Deutsche Bundesstiftung Umwelt

Arbuscular mycorrhizae

AM fungi are in phylum *Glomeromycota*

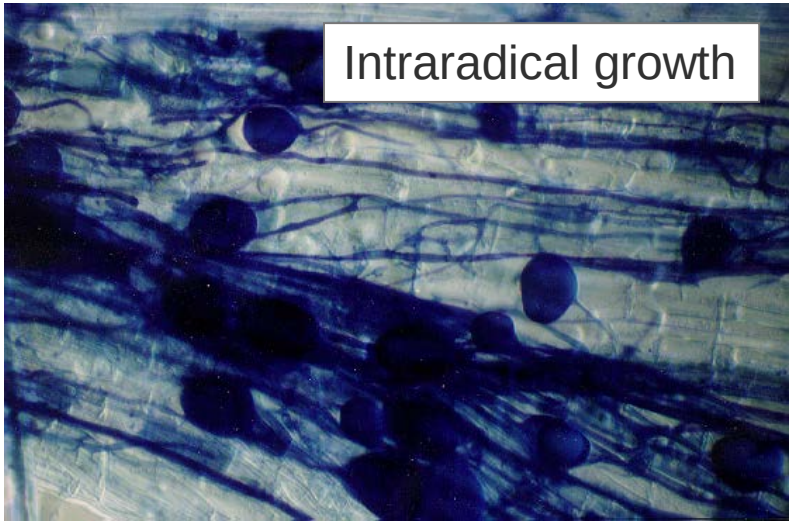
- ~200 known described species; obligate biotrophs

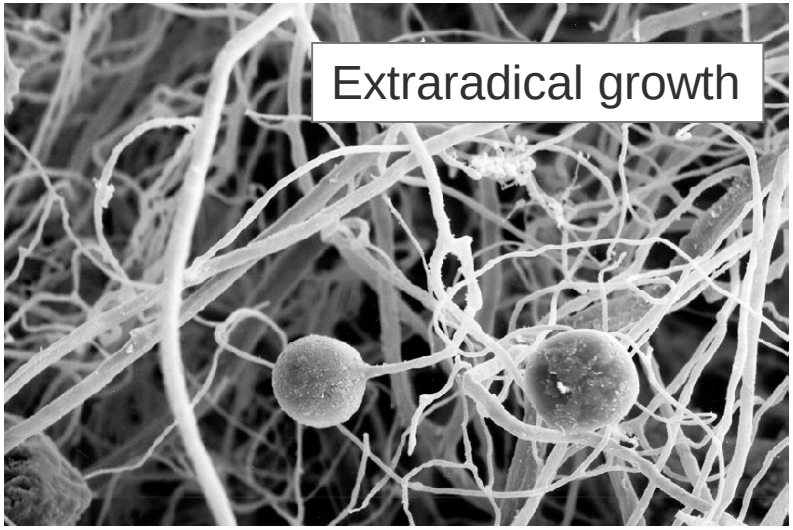
Ubiquitous distribution

- An estimated 2/3 of plant species form this association; most crop plants
- In all biomes (biomass varies 60-fold); ~1.4 Pg dw in roots globally

Ecological importance: multifunctional

- Plants, plant communities
- Soil (Mummey & Rillig 2006 *New Phytol*)
- Ecosystems (Rilig 2004 *Ecol Letters*)





Effects of biochar on arbuscular mycorrhiza

- Mostly examined root colonization: often positive effects on root colonization
- Negative and neutral effects also possible, including on soil hyphae

- Possible mechanisms
  - Nutrient ratios
  - Signalling compounds
  - Refuges from grazers
  - Physico-chemical changes

Reviewed in Warnock et al. (2007); Thies & Rillig (2009); Lehmann et al. (2011); Thies, Rillig & Graber (2015)

So far unknown…

- Do AM fungi colonize biochar particles (surface and interior)?
- Can AM fungi derive nutrients from biochar and deliver it to the host plant?
- Therefore: is there potential to „co-manage“ AM fungi and biochar?

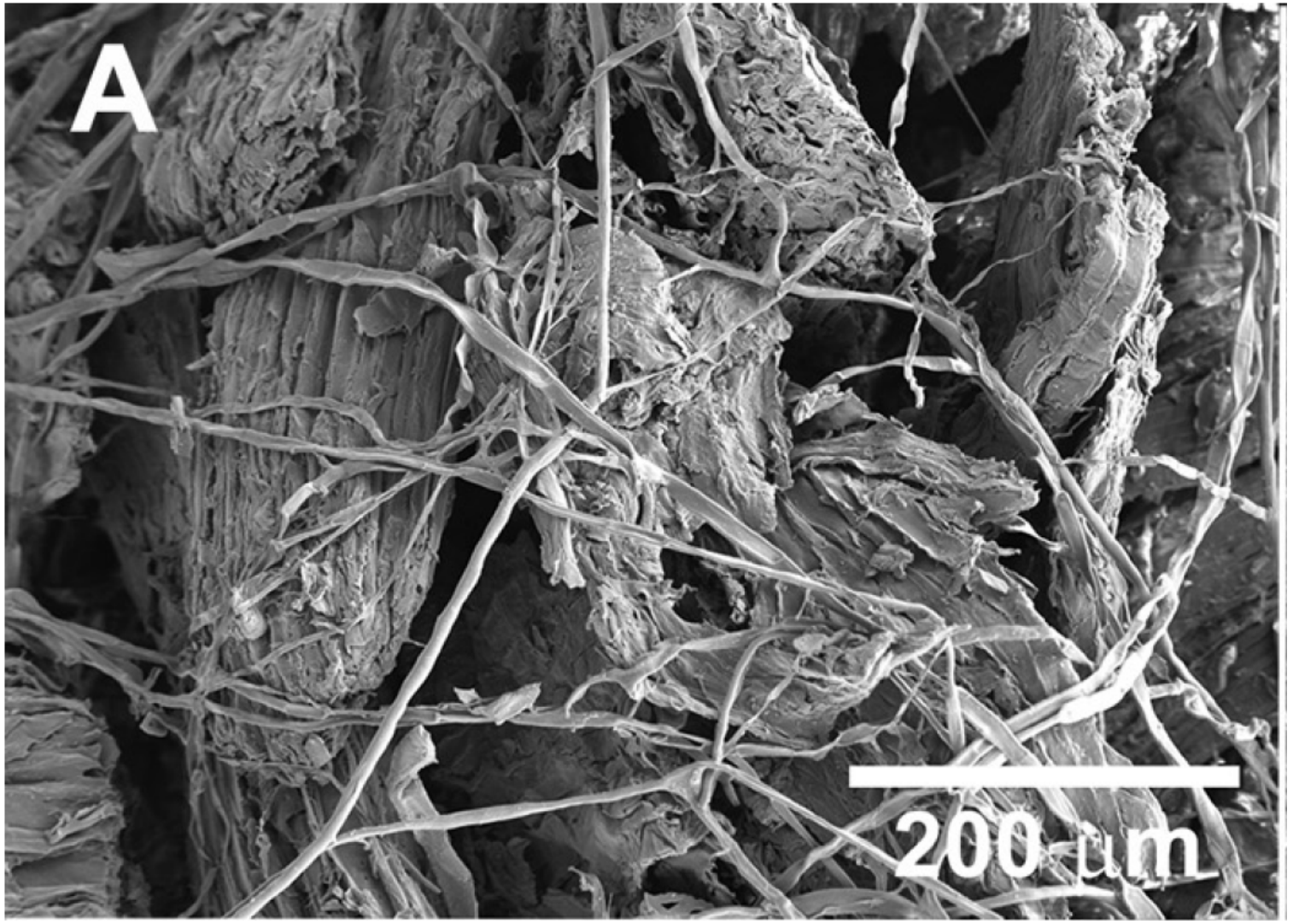
Image: http://pacificbiochar.com

For mechanistic resolution: *in vitro* culture

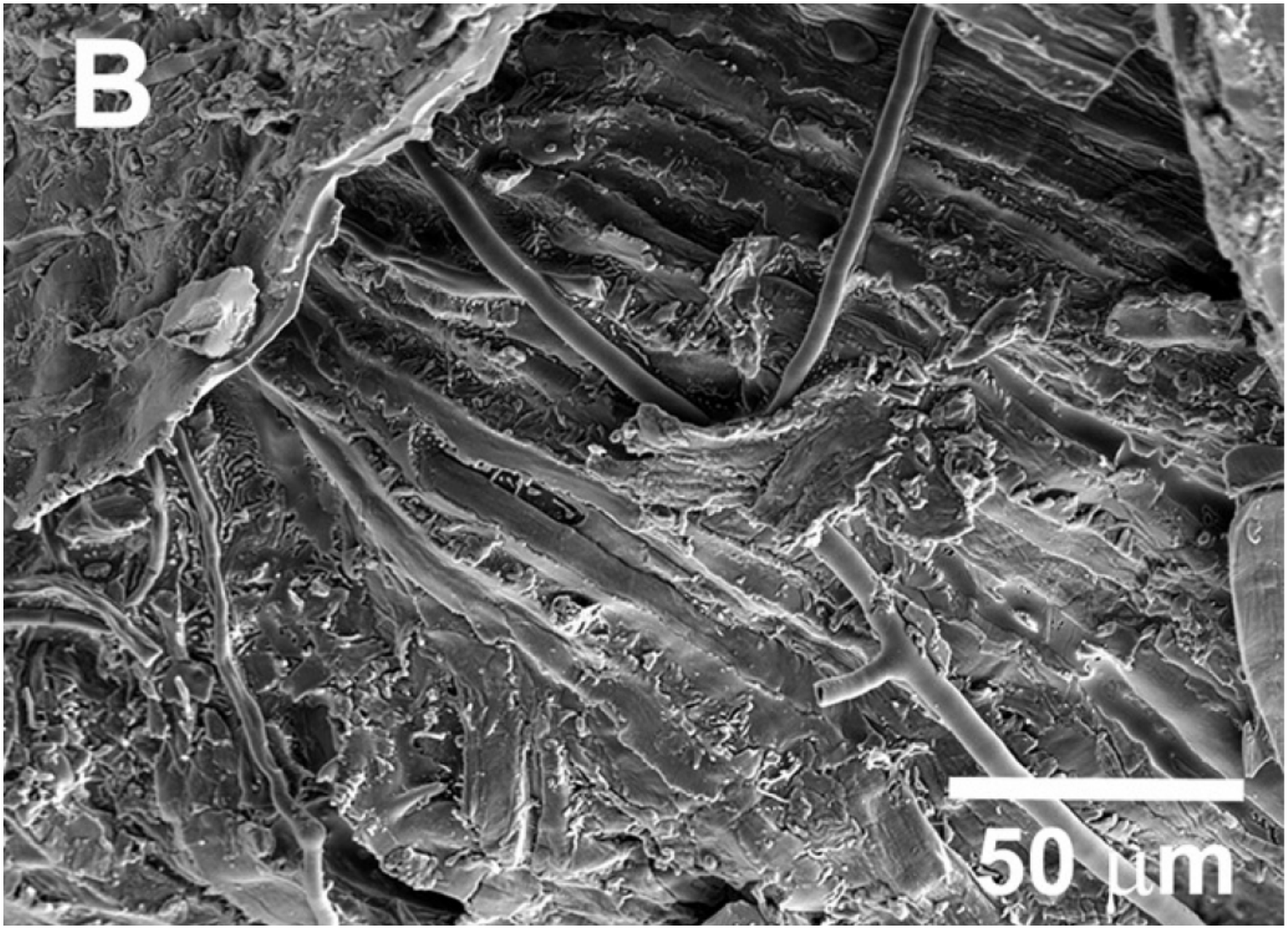
Photo: Prof. Baodong Chen

Hammer E, Balogh-Brunstad Z, Jakobsen I, Olsson PA, Stipp SLS, Rillig MC. 2014. A mycorrhizal fungus grows on biochar and captures phosphorus from its surfaces. *Soil Biology & Biochemistry* **77**: 252-260.

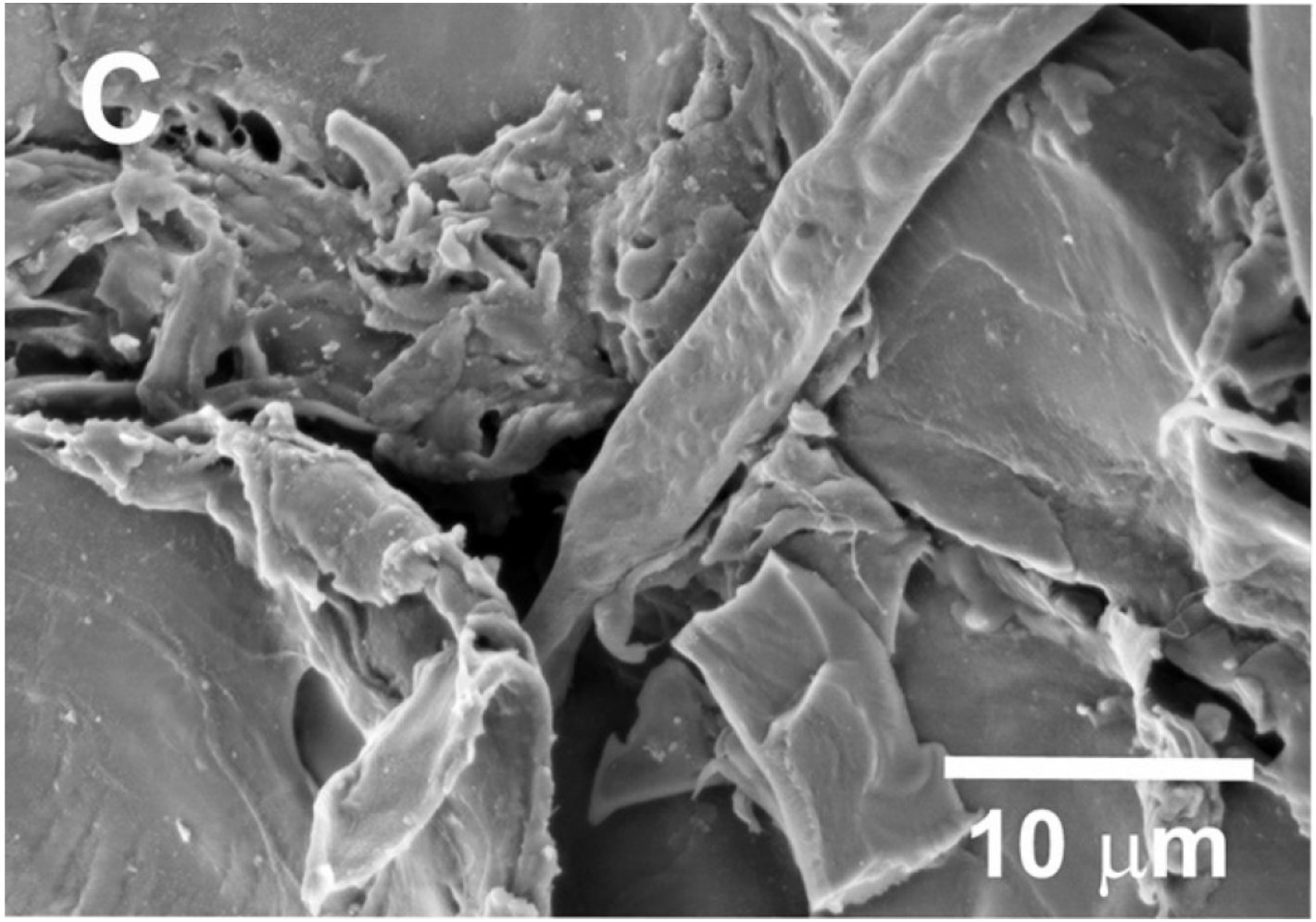
Surface colonization of wood biochar



Hyphae growing inside particles



Hyphae were able to enter pores



Also with chicken manure biochar: colonization

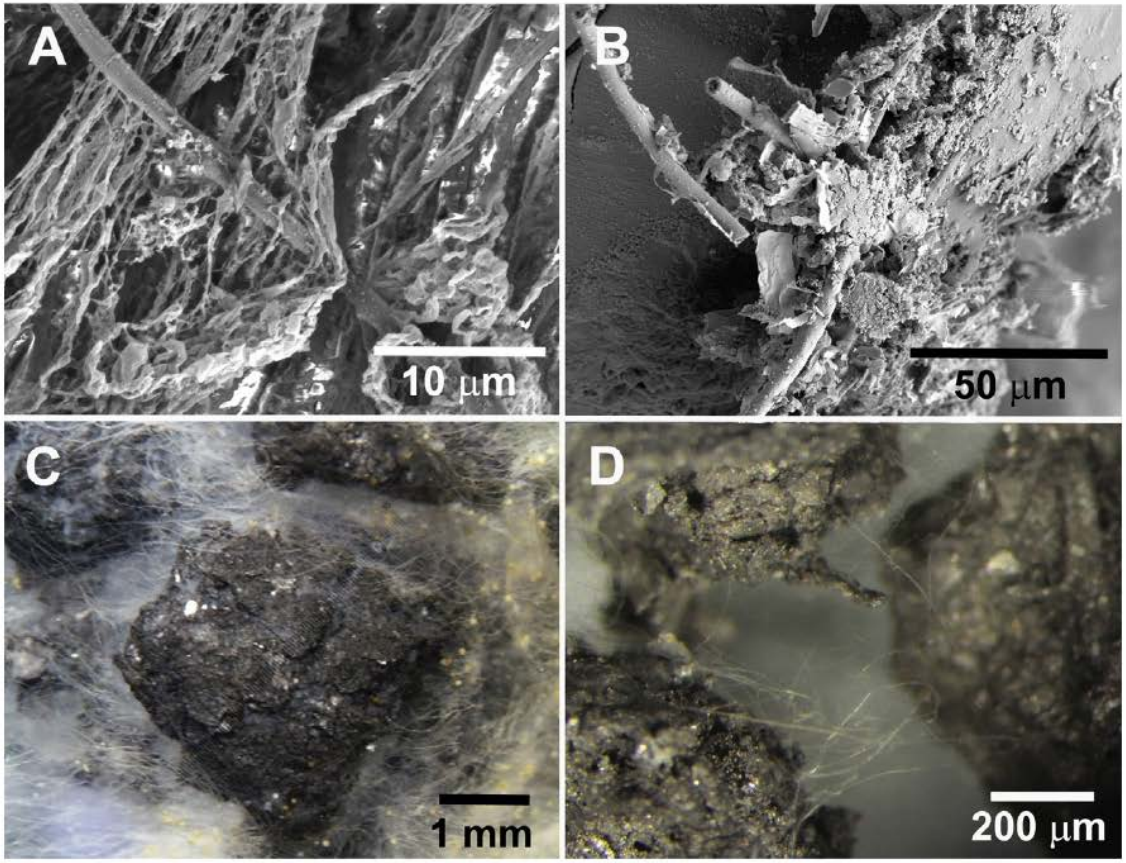


Fig. 3. Microscopy images show the interaction of AM fungal hyphae and chicken manure biochar particles. Chicken manure biochar was successfully colonized by AM fungi (A: surface shot, B: inner part of the biochar) as shown by cryoSEM. *In situ* dissecting microscope images of chicken manure biochar show complete hyphal coverage in M-medium (C) and distinct hyphal connection of particles in MilliQ water (D).

Do AMF preferentially colonize biochar for nutrients?

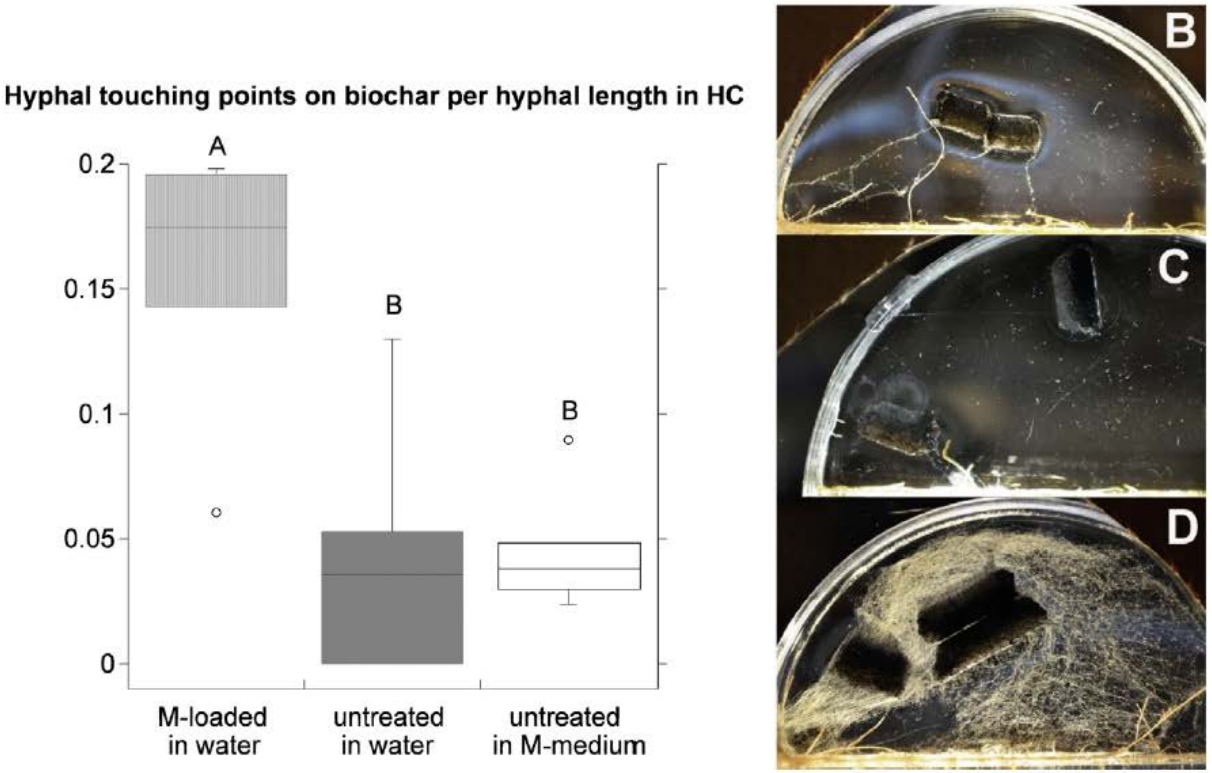
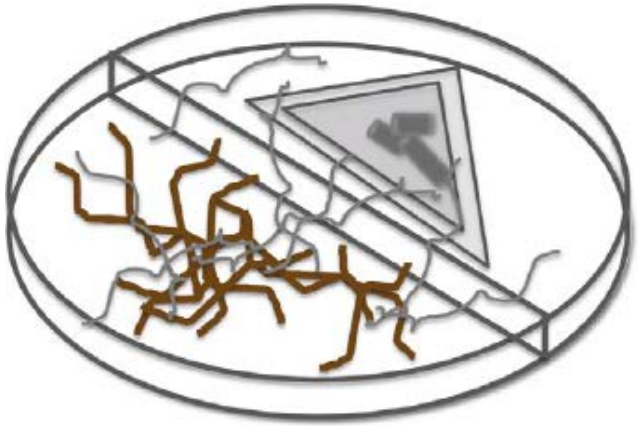


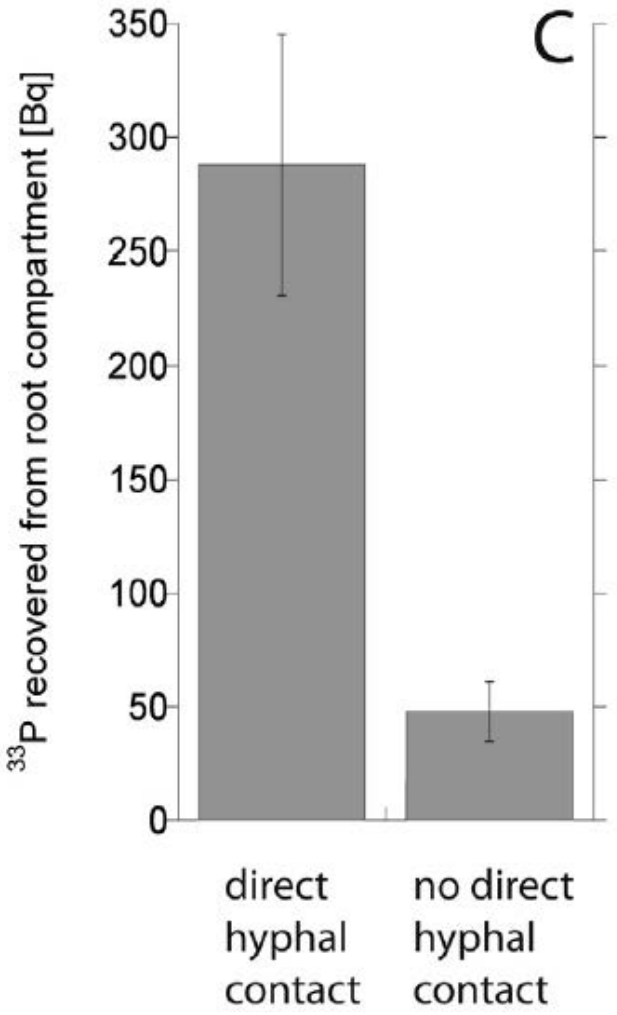
Fig. 4. Relative number of hyphal attachment points on the biochar surfaces in water or M-medium and on M-medium loaded biochar in water, Expt. 2 (A). The data were normalized to the total hyphal length present in the hyphal compartment. Different letters (a, b) denote statistically significant differences, $n = 5$. Photographs of mycelium growing around biochar loaded with M-medium in water (B), untreated biochar in water (C), or in M-medium (D).

Do AM fungi obtain P from biochar particles?

A



B

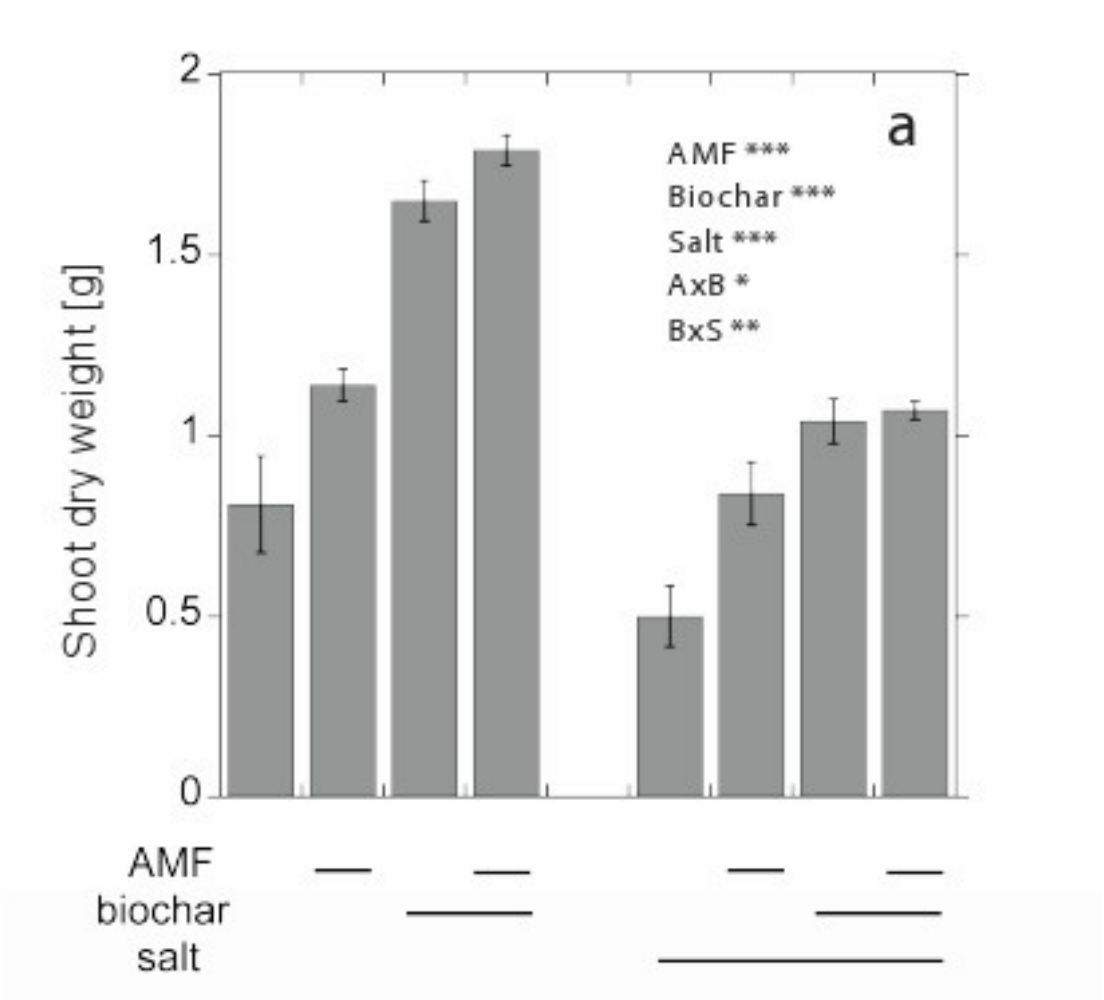


Biochar as AM fungal inoculum

- AM-colonized biochar was dried, stored at room temperature for 6 months
- Used in inoculation with *Lactuca sativa* plants in the greenhouse
- Fungi from biochar particles were able to successfully colonize plants (40% RLC)
- Possible to co-apply AM fungi and biochar as a „package deal“

Hammer & Rillig, unpublished

Pattern in soil (greenhouse experiment, lettuce)



Hammer, Kohler, et al., unpublished

Summary

- In addition to potential positive responses to biochar, AM fungi can intensely interact with biochar
  - Biochar exterior and interior surfaces are colonized
  - Nutrient-loaded biochar particles are preferred
  - P is obtained from biochar and translocated to the plant
  - Biochar is a suitable habitat
- Co-management seems like a viable option to explore

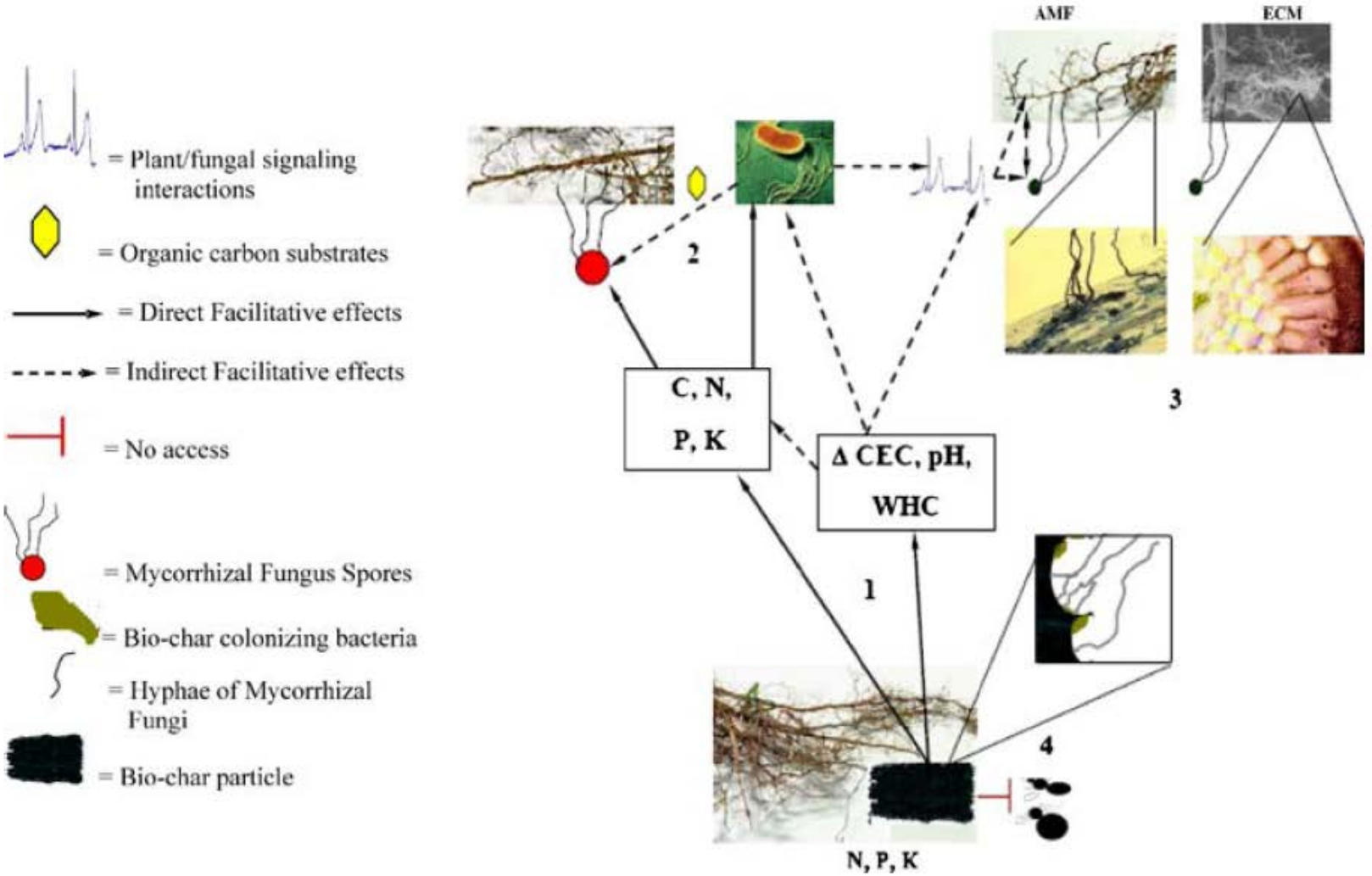
Thanks for your attention!

Photo: Prof. Baodong Chen

Experimental work mainly by: Dr. Edith Hammer, Dr. Josef Kohler

Char palatability

Hypothesized mechanisms



Warnock et al. (2007) Plant and Soil; Thies and Rillig (2009)