Role of fungi in the aggregation of soil

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The current research in my lab is focussed on understanding the role of fungi in aggregation of soil, and the subsequent role in storing organic carbon. The research is built around two major points:
(1) carbon in soil is declining in agricultural areas and has contributed approximately 30% of the atmospheric carbon dioxide. Carbon is critically associated with plant productivity and the sustainable use of soil. As we will require more food as the global population increases, measures to increase stores of soil carbon will contribute to both the sustainable use of agricultural soil and to the reduction of carbon dioxide in the atmosphere.
(2) a model on how carbon is stored in soil by a German research group indicates that long term stores of carbon are held in aggregates. Micro-aggregates are held together by 'glues' of plant and microbial origin, and are the most stable types of aggregate in soil. Macro-aggregates are held together by fine roots and fungal hyphae, and though they hold carbon, their life is measured in months not years.

Thus we wish to more clearly understand how fungi contribute to aggregation of soil. The literature suggests that arbuscular mycorrhizal fungi 'bind' or 'enmesh' smaller aggregates in to macro-aggregates. Leonie Whiffen examined this issue and failed to find any increase in aggregation. Leonie used agricultural soil that was diluted with sand. In other words, the starting carbon content was extremely low. Cathal Daynes used mine spoil which has no carbon and added varying quantities of compost. In this growth medium, he showed increasing aggregation with mycorrhizal fungi provided carbon was present. Our current data supports the importance of AM fungi. We subsequently concentrated on saprotrophic fungi. We have examined two aspects: enmeshment and gluing.

We collected 80 isolates of Trichocomaceae (*Penicillium* and *Aspergillus* species) for other reasons. Cathal Daynes inoculated spoil to which glucose was added. Each fungus was then inoculated to the spoil. Some two thirds of the fungi statistically increased the enmeshment of spoil, so we are now testing compost amended spoil. Interestingly, the culture filtrate from one fungus increased adhesion or gluing by 50%. Thus both mechanisms may be important.

Our current research is examining whether we can increase the storage of carbon. To do this, we need to be able to add complex carbon into the interior of the micro-aggregates. Thus we have isolated endophytic soil fungi that are melanised (black). Melanin is a complex polyphenolic compound which is thought to degrade to 'humus' the recalcitrant organic material in soil. We believe that by adding melanin in to micro-aggregates, and then enmeshing them in hyphae of AM fungi we should be able to place a complex carbon into a protected micro-aggregate, thus increasing the store of carbon in soil. This work is ongoing, and we should be able to tell you the results in three years time.