Theoretical biology

Mushrooms in cyberspace

Mushrooms arise largely from the inflation of pre-existing cells, which in part accounts for the startling speed with which they can appear. But what developmental processes are responsible for shaping those cells first into the primordial mushroom structure and then into the full-grown 'fruiting body' itself? Audrius Meškauskas and colleagues, writing in *Mycological Research* (**108,** 341–353; 2004), provide a new angle on this question. They have grown cyber fungi like the mushroom shown here; as well as creating primordial fruiting bodies whose cell arrangements mimic the real things, the authors' computer models provide predictions that can be tested.

Fungi use a single cell type — the filamentous hypha — to generate mushrooms and other multicellular organs such as the cords and rhizomorphs that function as exploratory devices for colonies once they run out of food. This reliance on hyphae distinguishes fungi from plants and animals, both of which produce a variety of cell types that are specialized for different functions. For this reason, a model of mushroom development need only specify the positions of cells. Unfortunately, simple anatomy has not led to a clear explanation of the processes that make cells that lie parallel to one another in the stem of a mushroom blossom into the bell-shape of the cap.

What Meškauskas *et al.* show is that baby cyber mushrooms develop simply by applying rules of mutual attraction and repulsion to every one of thousands of gravity-sensing hyphae. As long as all of the filaments behave in precisely the same way at the same time, there is no requirement for the exercise of global, or organ-level, control in fabricating the whole structure. This means that the intricate shapes of different mushrooms might be specified in a clockwork fashion, solely by genes activating successive waves of cellular attraction and repulsion. This is good news for mycologists, because the kind of hormone-pumping meristems that are found at the tips of shoots and roots, and that regulate plant development, have not been found in fungi.

With the evidence of the computer animations, experiments on single cells take on new significance. Manipulation of genes that steer fungi in rotting wood, for example, may be likely to change the arrangement of cells in a mushroom and result in some extraordinary fruiting body forms. If more progress can be made in understanding what makes a hypha bend towards or away from its neighbours, mycologists will be closer to solving the mystery of mushroom development. **Nicholas P. Money**

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