'Paternal' and 'maternal' DNA in fungi active at different times

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Credit: Delft University of Technology

Many types of mushroom have two different nuclei in their cells, one from the 'father' and another from the 'mother." Researchers at the universities of Delft, Utrecht and Wageningen have discovered that the

genes from the parental DNAs are expressed at different times in mushroom development. "This means that when genes involved in mushroom formation are identified, we first need to find out whether the paternal or maternal nucleus is active," says TU Delft doctoral candidate Thies Gehrmann. The research results were published in the journal *PNAS* on 11 April 2018.

Fungi, such as mushrooms, play an important role in our ecosystem. In nature, they recycle dead plants and animals. As humans, we not only eat fungi, but also use them in making food, such as bread and beer, and as bioreactors in the manufacture of drugs and other substances. They also play a direct role in human health since they can cause infections. In order to take full advantage of mushrooms (and fungi as a whole) and prevent their undesirable effects, a better understanding of fungi is essential. However, mushrooms are highly complex organisms, as are their genetic processes.

In this study, the researchers from TU Delft, Utrecht and Wageningen investigated gene expression in mushrooms, both in a model mushroom and in the common, edible mushroom. They studied the extraordinary phenomenon discovered by TU Delft doctoral candidate Thies Gehrmann. "Many fungi have two different nuclei in their cells, each with different genetic material. A mushroom inherits DNA from both parents, but this is not mixed in a single nucleus as in humans. We have now seen that genes on both of the parental DNAs are expressed at different times in the development process – something that was not known before."

The impact of this new discovery is that, from now on, it will first be necessary to find out whether the paternal or maternal nucleus is active when studying mushrooms, for example in the quest for genes involved in mushroom formation. This new understanding of the molecular mechanisms in mushroom DNA can be used to breed new strains that

can improve the cultivation of edible mushrooms, such as the common mushroom.

Much of the article in *PNAS* originates from the dissertation by Thies Gehrmann, who has obtained his Ph.D. on Friday 6 April at TU Delft. "For my doctoral research, I developed and applied methods of bioinformatic analysis in order to understand variations within and between mushroom-forming fungi. The phenomenon we are now describing in *PNAS* is an example of that. In addition, I also demonstrate that another process, known as alternative splicing, causes some of the variations. This phenomenon is difficult to study in fungi and so it was generally believed that no splicing took place."

Thousands of cases

Alternative splicing is a process in cells that enables a single gene to produce different proteins, each with its own function. Abnormal alternative splicing and mutations in the products of alternative splicing have been linked to cancer, autism and serious development disorders, both in mice and in humans. Despite these serious consequences for mammals, there has been very little research into alternative splicing in fungi. Thies Gehrmann has now demonstrated that thousands of cases of alternative splicing occur in the fungus S. commune.

More information: Thies Gehrmann et al. Nucleus-specific expression in the multinuclear mushroom-forming fungusAgaricus bisporusreveals different nuclear regulatory programs, *Proceedings of the National Academy of Sciences* (2018). DOI: 10.1073/pnas.1721381115

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