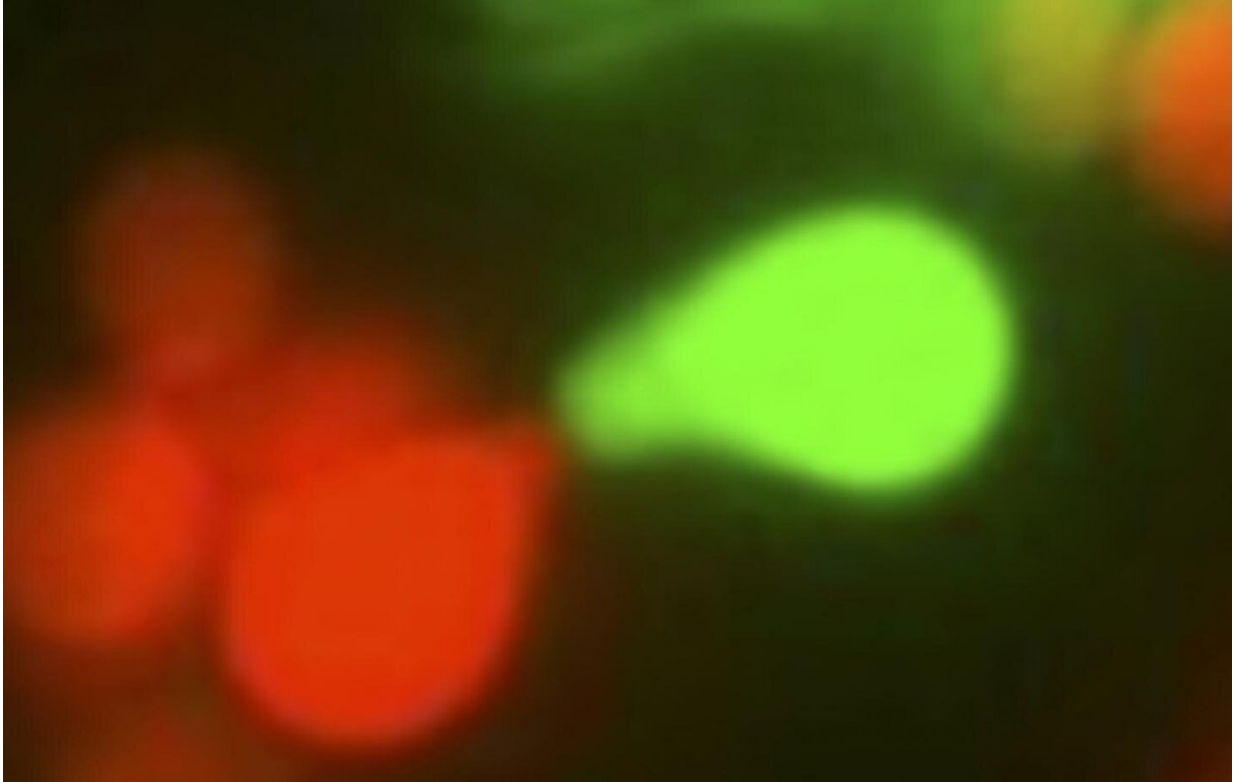


Yeast mating—more than meets the eye

June 16 2021



"When yeast cells kiss": two haploid yeast cells of different mating types approach each other for mating. Credit: Max Planck Institute for Terrestrial Microbiology/Sourjik

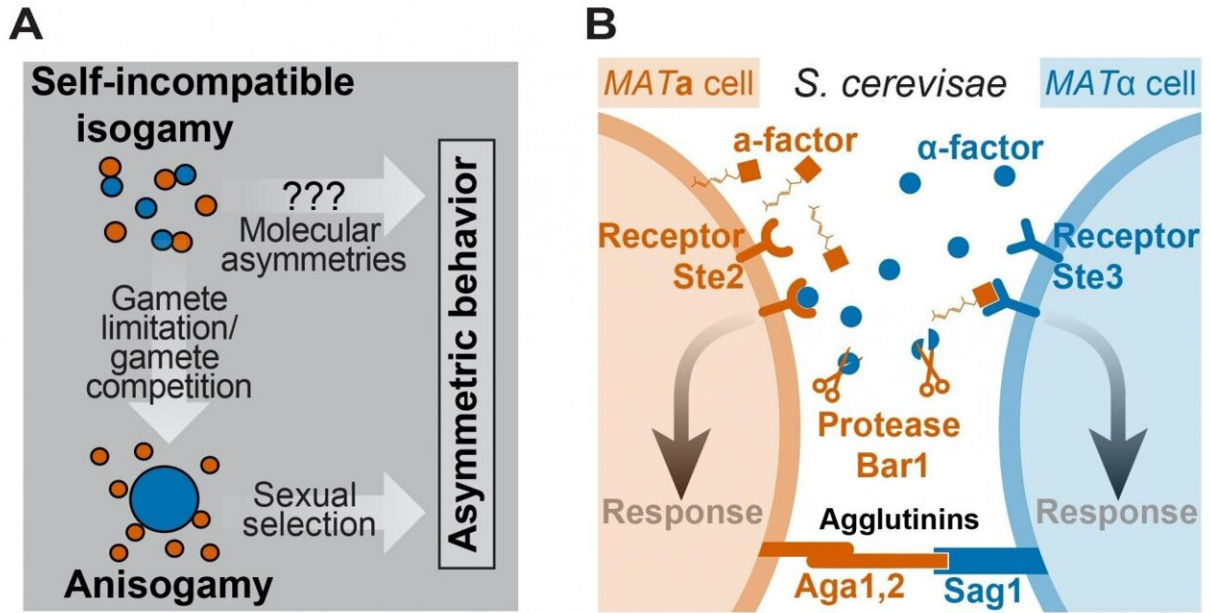
Researchers from the Max-Planck Institute for Terrestrial Microbiology have discovered a surprising asymmetry in the mating behavior of unicellular yeast that emerges solely from molecular differences in pheromone signaling. Their results, published in the current issue of

"*Science Advances*", might shed new light on the evolutionary origins of sexual dimorphism in higher eukaryotes.

Resemblant of higher organisms, yeast gametes communicate during the mating process by secreting and sensing sexual pheromones. However, in contrast to higher eukaryotes, budding yeast is isogamous: seen through a microscope, gametes of both mating types ("sexes"), MAT_a and MAT_α, look exactly the same. Since anisogamy—difference in size between male and female gametes—was considered to be the starting point of sexual selection that drives the evolution of differences in [sexual behavior](#), mating types of *S. cerevisiae* were assumed to be not only morphologically but also behaviorally symmetric.

Now a research team led by Victor Sourjik from the Max-Planck Institute for Terrestrial Microbiology and his former postdoctoral fellow Alvaro Banderas, now at the Institut Curie in Paris, has discovered a hidden behavioral asymmetry that emerges solely from molecular differences in [pheromone signaling](#) between the two mating types, which might have wide-reaching implications for understanding evolution of sexual dimorphism in higher organisms.

Yeast mating involves a- and α-pheromones that trigger the interactions between the two different types, MAT_a and MAT_α. Although the pheromones and their respective receptors are chemically different, the remainder of the pheromone response pathway (one of the best-studied models for eukaryotic signal transduction) is the same for both mating types. It was therefore thought that in yeast, as well as in other isogamous eukaryotic microorganisms, molecular differences between the a- and α-pheromones and their receptors are only required in order to ensure self-incompatibility between the two mating types but have no further functional consequences.



Asymmetric pheromone signaling in *S. cerevisiae* and emergence of asymmetric sexual behavior. (A) Alternative routes of how asymmetry in mating behavior may have originated, starting from mating between morphologically identical (isogamous) gametes/ mating types. Commonly, anisogamy with different sizes of gametes is assumed to be a requirement that allowed for emergence of asymmetric sexual behavior by sexual selection. Alternatively, asymmetric mating behavior might have emerged already in isogamous organisms due to molecular asymmetries between gametes. (B) Asymmetric mating determinants of the mating types in *Saccharomyces cerevisiae*. Molecular components expressed by MATa or MATα cells are shown in red and blue, respectively, and include mating pheromones (a-factor and α-factor), their receptors (Ste2 and Ste3) and a diffusible α-factor protease Bar1 secreted exclusively by MATa cells. Note that a-factor due to its prenylation (indicated by hydrophobic chain) is considerably more hydrophobic than α-factor. Credit: Max Planck Institute for Terrestrial Microbiology/Anders

"As a matter of fact, our original intention was to confirm that the behavior of both mating types is similar. Yet, to our surprise, we found it

to be strikingly different," says Alexander Anders, first author of the manuscript.

Remarkably, the observed differences, with MAT α cells exhibiting exploratory search behavior and MAT α cells showing short-range gradient sensing and polarization towards the proximal mate, resemble well-established asymmetries between gametes in anisogamous organisms. "It turns out that behavioral asymmetry of the gametes is not necessarily a consequence of anisogamy, but could actually have preceded it—this challenges the previous assumptions on evolution by sexual selection as the sole generative mechanism of differences in mating behavior between sexes," says Alvaro Banderas, the co-corresponding author of the manuscript.

Importantly, mathematical modeling and computer simulations suggest that such asymmetric behavior might provide selective fitness advantage by enhancing efficiency of mating over a wide range of environments. "Behavioral asymmetry could maximize frequency of mating encounters under different conditions, meaning that it might be an evolutionary selected emergent property," says Remy Colin, who performed mathematical modeling.

What do these findings tell us about the origins of sexual [behavior](#)?

"Although further [theoretical analysis](#) is clearly required to test our hypothesis," emphasizes Sourjik, "our work on [mating](#) of a model unicellular eukaryote provides a new perspective on what might have been the starting point for the evolution of the amazing diversity of sexual dimorphisms observed today."

More information: Alexander Anders et al, Asymmetric mating behavior of isogamous budding yeast, *Science Advances* (2021). [DOI: 10.1126/sciadv.abf8404](https://doi.org/10.1126/sciadv.abf8404)

Provided by Max Planck Society

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