Willow Bohlen

Honors 302: Plagues in History

Dr. Pruneski

Reader's Choice Report

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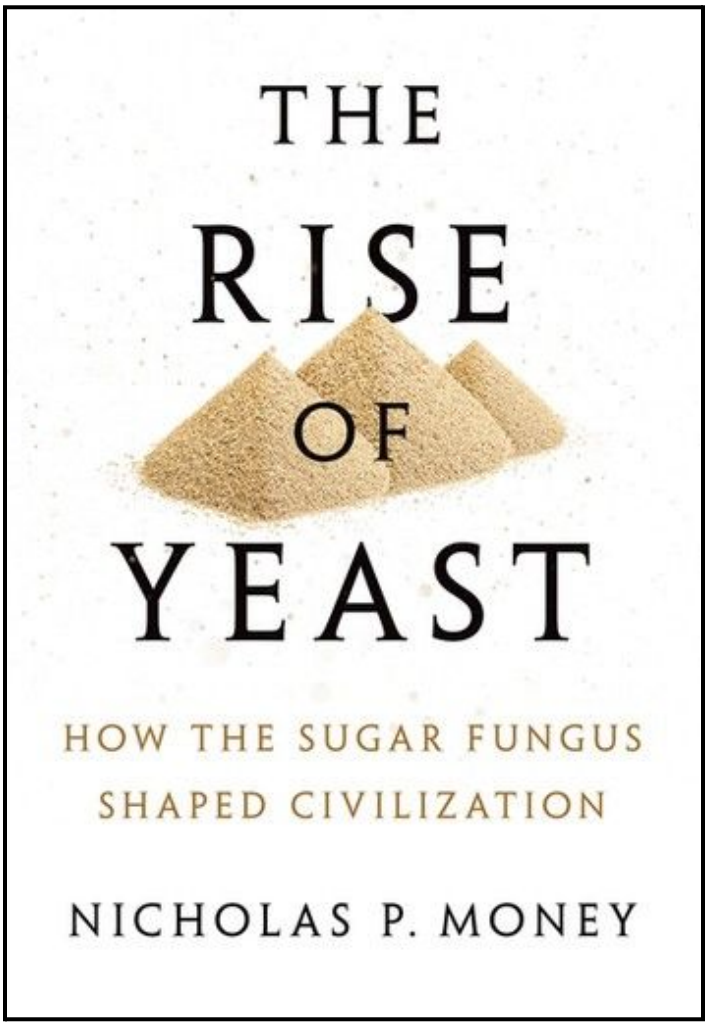
The Rise of Yeast (Nicholas P. Money, 2018)



About the Author

Nicholas P. Money, also known as Nik Money, is a mycologist, author, and professor at Miami University. He is a mycological expert, and has written books on the subject since 2002. He has also written on microbiology, and in recent years has published the books *The Selfish Ape*, which offers a scientific look on human sociology, and *Nature Fast and Nature Slow*, which he describes as "a vision of biology set within the entire timescale of the universe" (Money, 2021). At Miami University, he acts as a professor and the director of the Western Program, and has conducted research using high-speed video to capture the mechanisms of self-launching fungi spores (Miami University, n.d.). Nik Money seems to be fascinated with how humans and fungi interact with each other, and has written on the medicinal and cultural impacts of fungi. This fascination is likely what led him to write on yeast, a microbial fungus which has had an undeniable impact on human civilization.

Critical Summary

From a young age, children are taught the concept of 'germs', invisible specks that can make us sick unless we're careful. The thought can be somewhat of a scary one, that there are things we can't even see, but still pose a threat to people. That sentiment is scarier than ever in the midst of the COVID-19 pandemic, where we've seen first-hand just how dangerous microbes can get. And yet, all of this rhetoric seems to suggest a narrative that all microbes are bad, and should be feared, but that view may be overly simplistic. In truth, there are many microbes that humans are directly dependent on, or are actively beneficial to the environment. Chief among these may be *Saccharomyces cerevisiae*, the sugar fungus; more commonly known as yeast. Yeast is unlike other benevolent microbes, such as those that help us digest food, in that it isn't strictly necessary to the human body, and yet its impact is still undeniable. Yeast is a tool which we have learned how to use to our benefit, and in that regard affects us in a way that is distinctly human. Nik Money discusses humanity's relation to the sugar fungus in his 2018 book *The Rise of Yeast*, subtitled "How the Sugar Fungus Shaped Civilization". In this book, he proposes that the cultivation of yeast has always sat at the forefront of human civilization due to its culinary, scientific, industrial, and medical applications.

The word 'yeast' traces back to the German word 'Gischt', meaning foam or froth (Harper, n.d.). For much of history, yeast was simply known as the froth of beer, which somehow fermented produce into alcohol, and caused bread to rise. The revelation that yeast was a living organism didn't come about until the nineteenth century, and it was subsequently given its Latin name, *Saccharomyces,* which directly translates to 'sugar fungus' (Money, 2018, p. 2-3). Apart from describing its fungal nature, this name also gives a clue as to how yeast functions. It feeds on sugars, such as glucose, and then breaks them down into chemical energy and carbon dioxide.

The process is much more efficient in the presence of oxygen, but can still be performed without. In this latter case, the excess energy that yeast can't harness anaerobically is released in the form of ethanol. Alcohol is famously effective at killing microbes, but the sugar fungus has a natural resistance to it, and it is able to use this to its own advantage as the produced ethanol kills off nearby microbes which might compete for resources. As such, even in an oxygen-rich environment, yeast will typically still produce a small amount of ethanol anyways (Money, 2018, p. 6-8). This basic mechanism is what makes yeast so valuable, and its products have been utilized for millenia.

Thanks to yeast, alcohol occurs naturally in things like overripe fruit, and there are many animals who rely on it as a part of their diet. Humans learned to domesticate the process, and since the early days of civilization, beer, wine, mead, and other beverages have been a staple of human cuisine all across the world. Yeast is not a particularly picky eater as long as it gets its sugar, and many varieties of produce have proven to have interesting and appealing tastes once fermented (Money, 2018, p. 28-30). The sugar fungus also plays a fundamental role in baking, as its release of carbon dioxide is what allows bread to rise as it fills with pockets of gas. This discovery may have been accidental, or perhaps a curious baker experimented with combining dough and beer froth to fluffy results. In any case, leavened bread has been evidenced since as early as the Ancient Egyptians, and has since spread all across the world (Money, 2018, p. 44). Other culinary uses are found in the cases of coffee or chocolate, where yeast plays a crucial role in preparing the produce for consumption, or in marmite, which is made of yeast itself (Money, 2018, p. 63-64, 72). All of these applications created a market for yeast, as brewers and bakers sought for supplies of the lucrative fungus. This led to the development of dedicated ways to cultivate and package yeast, starting with wet blocks or cakes of yeast, and later dry powders

filled with dehydrated yeast. These advances show some of the earliest forms of biotechnology, as yeast production had to constantly innovate to keep up with food demands. In the modern day, yeast is produced on an industrial scale in massive factories, producing both a lot of yeast, and a lot of wastewater (Money, 2018, p. 49-56). Overall, yeast's culinary utility already provides an incentive for more thorough research, but yeast itself may still be worth researching in its own right.

As opposed to the prokaryotic cells of bacteria, fungi are eukaryotic, yeast being no exception. They also differ from bacteria in that they reproduce sexually, exchanging genetic information between cells. These two facts, along with their ease of cultivation, make them a prime candidate for microbiological research, especially considering their similarities to human cells. Yeast research effectively acts as a microcosm of biology as a whole, and studying the sugar fungus can give scientists more insight into how cells work on a broad scale (Money, 2018, p. 75-77). Bioengineering has also been one of yeast's uses, and ventures into creating specially designed strains of yeast may have ramifications towards genetic modification on a broad scale. Even just in yeast, creating specialist strains can open the door for new innovations in yeast cultivation for culinary use, more efficient biofuel production, and medicine production (Money, 2018, p. 100-104). The latter two are examples of just how much yeast has impacted humanity in the modern age, and what the future of yeast may hold.

The biofuel industry rests on the yeasty shoulders of the sugar fungus, with thirty-six million acres of American farmland being used to grow corn specifically for bioethanol production (Money, 2018, p. 106). Bioethanol isn't completely carbon-neutral, as a lot of resources go into growing that much corn, but it is at least somewhat better than fossil fuels such as coal or oil (Money, 2018, p. 111). However, yeast may still become a solution to green energy,

as theoretically a strain of yeast which could process cellulose, much like fungi that grows on trees, could instead feed on compost, wood chips, and recycled paper products. Progress has been made in this direction, but hopes are that further bioengineering breakthroughs will lead to these new yeast-based technologies (Money, 2018, p. 121-122). Bioengineering has already allowed for yeast to make waves in the medical field, where modified strains are used to produce artemisinin, which is an antimalarial drug, along with insulin and vaccine material (Money, 2018, p. 124-125). Further yeast research and development is still an active field, and the uses of the sugar fungus may continue to expand as our understanding of it increases.

While the term 'yeast' tends to apply to *Saccharomyces,* the sugar fungus, in truth there are many variations of microbial fungi which can be considered yeasts. The best known of these is likely *Candida albicans*, also known as 'vaginal yeast', which is the kind generally referred to when speaking about yeast infections. It is often benign, even being the most common fungus in the gut microbiome, but if it breaches the body's defences it can morph itself into an invasive fungus that roots itself into the body, killing the victim if not treated quickly (Money, 2018, p. 172-175). The genus *Cryptococcus* contains an assortment of deadly yeasts, which are able to infect the brain. They are notoriously difficult to treat, some victims having parts of their brains excised in order to save them from certain death. Fortunately for us, these cases are rare and non-contagious, meaning that a worldwide yeast epidemic is highly unlikely (Money, 2018, p. 181). Not all yeasts have much interest in humans, however, and many more varieties exist which have no direct interactions with us at all.

Within all environments on Earth, yeasts can be found. Apart from fermenting fruits, tree sap, or gelatinous mushrooms, some yeasts live underwater, or even float in midair. Some yeasts thrive in the frigid water of melting glaciers, while others happily live in salty brine pools. One

variety even makes its home in the concrete shell surrounding Chernobyl's decaying reactor (Money, 2018, p. 147-148). One class of yeasts are known as 'mirror yeasts', and launch their spores into the air to propagate themselves. The nickname comes from the fact that they can be inoculated into a petri dish by spreading them onto the top lid, and when closed, their spores launch down into the agar, mirroring their orientation from when they were painted on (Money, 2018, p. 130-131). One variety of mirror yeast is known as *Metschnikowia*, a perilous fungus which uses harpoon-like spores to embed itself into the stomachs of beetles and water fleas. In the latter case, it is able to spread so rapidly within the flea's body cavity that the flea literally bursts (Money, 2018, p. 134-137). Yet another type is called *Schizosaccharomyces pombe*, or 'fission yeast'. Unlike the spores or buds of other yeasts, fission yeast stretches itself out until it splits into two cells, in a process very similar to mitosis. Fission yeast is researched for its insights into how cell reproduction works, especially in the case of when that process goes out of control, creating tumors. It can also ferment, much like our beloved sugar fungus, but it isn't much of a rival to its better-known cousin. However, it is part of the group of microorganisms which produce kombucha (Money, 2018, p. 151-155). Our world is a very yeasty one, and nature is filled with various microbial fungi. None of them are as well known as *Saccharomyces*, but are worthy of respect nonetheless.

Nik Money's book touches on all the various ways that yeast has impacted human life, and how it still does today. From the cradle of civilization to the future of biotechnology, he shows how the story of yeast is truly the story of humankind, and the profound impact that the sugar fungus has had on humanity. With the sheer number of applications that it provides, yeast proves to be a constant companion to civilization. In an age filled with fear of the deadly impact of microbes, perhaps it is worth remembering that we still have a tiny fungus on our side.

Personal Review

I greatly enjoyed reading about yeast, and thought that Nik Money did a wonderful job at being both informative and entertaining. The book goes into detail about the scientific elements of yeast and the mechanisms within it, but also includes more practical or even anecdotal elements which describe yeast's cultural impacts. It is written like a story, and is well paced, travelling from topic to topic almost seamlessly. Light quips or comedic tangents are also included, but never to the point of being disruptive. They are sprinkled in perfectly, like a dose of yeast in an uncooked dough. More than anything, you can feel Nik Money's excitement on the subject, and how passionate he is about yeast, as well as mycology as a whole. The book gives a thorough look on all of the various applications of yeast throughout history, and was incredibly informative as to just how much yeast matters. I also enjoyed studying something other than infectious microbes, as it gave me a different perspective towards microbiology and it affects people. Overall, I would highly recommend this book to anyone who wants to know more about one of humanity's smallest and most important allies.

References

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