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The California Drought – Microbial Impact and Potential

It's by now old news that California is suffering from one of the worst droughts in history, prompting concerns about agriculture, the sustainability of the American water infrastructure in the face of anthropogenic environmental change, and making the threat of increasing wildfires horribly real [1]. Generally (and understandably) our focus during this drought has been upon the potential immediate impact it will have upon us, at the top of the food chain. However, as any microbiologist knows, the top of the food chain is only ever as good as the minute life-forms supporting it at the bottom – without which the entire ecosystem is likely to fail [2]. What are the potential impacts of California's historic drought upon microbial processes within the state? Are the things we take for granted – such as rotting and fermentation – ultimately doomed in the case of severe drought? Or could microbial action prove to be part of the solution to our problem?

Human Issues

Drought obviously has already evident impacts upon the human situation in California. Many are concerned about the potential for farms to fail in drought conditions, and about the basic inability of the Californian lifestyle to survive without an awful lot of water. The almond industry has come under fire for using extortionate amounts of water, as has the generally wasteful tendencies of modern America when it comes to water. Social issues related to drought also loom large upon the horizon – the stress and strains of living in environmentally poor conditions has been linked to all kinds of social issues, such as an increased crime rate, mental health problems [3], and a tendency to turn to unwise substances as a coping mechanism [4]. Ecological issues are next down on the list of human concerns – but it stands to reason that if humans, with their dominance and increased share of all available resources, are struggling to cope with the situation, it will be a lot worse for the flora and fauna which also depend upon California having an adequate water supply. At the most intrinsic level, California's microbial activity is likely to be experiencing some profound changes – but quite what form these may take is an area little studied.

Enzyme Inertia

We've known empirically for years that the process of decay is slowed in particularly arid environments. Desiccation, as the Ancient Egyptians and other mummifying cultures knew well [5], is an excellent way in which to preserve the essential structure of soft tissues. More recent studies suggest that this process occurs because a lack of water at least partially immobilizes the microbial enzymes responsible for the breakdown of matter [6]. Decay in itself is vital for preserving the fertility of any given environment – decay aids the return to the earth of all the life-preserving and fueling materials which have gone into something during its lifetime, where they can work to grow new life forms. This drought-induced enzyme inertia also means that certain plants which rely upon microbial action to 'fix' nitrogen around their roots will have a harder time developing root systems and pulling nitric nutrients from the soil. Of course, enzyme inertia is not all bad – the drought is being given credit for slowing the spread of the bacterial spores responsible for rotting living oak trees before their time [7], and for cleaning beaches of waters teeming with human-induced bacteria. However, this offers limited consolation to the farmers and animals which rely on a certain basic level of decay-induced soil fertility.

Natural Processes

The drought in which California is currently struggling is certainly prolonged – but there is a certain amount of evidence to suggest that droughts (and the fires which they bring in their wake) are an essential aspect of the long-term Californian ecosystem. Plant transpiration is reduced after wildfires, allowing the soil to retain more moisture, which in turn awakens the vital microbial enzymes mentioned above. Indeed, microbial levels in the soil after a prolonged drought-and-fire period are often greater than they were before – providing excellent conditions in which to start growing afresh.

Fire also provides a necessary clearing process which is halted during times of enzyme inertia, and kick-starts the germination of seeds from trees like the famed redwoods. However, while the ecosystem as a whole may consider the drought and its resultant fires a time of cleansing and renewal, this is less comforting for the life-forms (humans included) which rely in the immediate short term on a basal amount of water. It has been suggested that microbes could provide part of the solution to our shorter-term water issues. Some companies have begun to experiment [8] with using microbes to clean waste water, allowing it be re-used and reducing our chronic water-wastage. Other nations in more arid areas – Israel, for example – recycle almost 90% of all their water, after putting it through an extensive treatment process. The USA recycles only 1%. The ability of microbes to break down and effectively eliminate 'dirty' compounds within our waste water gives them enormous potential in the water-recycling game. Whether and how this develops is something which remains to be seen, but it's certainly an area of great interest in the current arid climate.

[1] Suzanne Goldberg, "California officials prepare for worst as historic drought deepens wildfire risk", The Guardian, Mar 2014

[2] The National Academies of Science, Engineering, Medicine, "The Vital Role of Microbes on Earth"

[3] SAMHSA, "Drought"

[4] Mental Help, "Outpatient and Inpatient Drug Treatment Centers in California"

[5] Joann Fletcher, "Mummies Around the World", BBC, Feb 2011

[6] Charlotte J Alster, Donovan P German, Ying Lu, Steven D Allison, "Microbial enzymatic responses to drought and nitrogen addition in a southern California grassland", Soil Biology and Biochemistry, Sept 2013

[7] Rory Carroll, "California drought helps state save oak trees from deadly pathogen", The Guardian, Jun 2014

[8] Marco della Cava, "4 tech companies trying to fight California's drought", USA Today, Apr 2015