September 11,, 2018

Microbiology

Consumed to death: bacteria cause their own extinction by over-polluting the environment

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This Break was edited by Max Caine, *Editor-in-chief* - TheScienceBreaker

ABSTRACT

It has been speculated for quite a while if populations – first of all the human population – can drive themselves extinct by over-polluting the environment. We have found such an 'ecological suicide' in microbes, that make their environment so toxic during growth that the whole population dies.

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Living means consuming resources, we buy food to get fed, clothes to stay warm and burn oil and coal to have energy. Where things are consumed waste is produced. However, this waste does not simply disappear but mountains of trash form, plastic covers the ocean and CO_2 accumulates in the atmosphere. Many people are worried about this increased pollution of our planet since it may finally come back to us and threaten our wellbeing if not our existence. In this sense we are all connected, because it does not matter where the CO_2 is blown into the air, it will affect us all.

However, all life depends on the consumption of energy and nutrients and therefore causes the exploitation and pollution of its own environment in some way. The question is if an environment is capable to restore itself and balance these changes. Therefore, can we also find situations in nature where organisms endanger their own existence by over-polluting their environment?

We could indeed find such a behavior in simple soil bacteria. These microbes can grow on sugar as main energy source. However, the digestion of sugar leads to the production of acids that make the

environment of these bacteria acidic – they turn their delicious sugar paradise into an acid bath. Indeed, these bacteria can make their environment that acidic that they cannot survive in it anymore, they start to die and within a few ours go completely extinct. We call this self-inflicted extinction ecological suicide.

By growing these bacteria in the lab we were able to directly observe the acidification of the environment followed by the death of the population. Giving the bacteria less food or slowing down their growth with harming substances like antibiotics, slows also down this acidification and allows them to survive. Interestingly, the barrier towards extinction can obviously be crossed very sudden. A bacterial population can nicely thrive and just minutes later it starts dying. Once the population is on its way towards death, there is no turning back. Before the bacteria realize what is going on, it is already too late.

The more bacteria there are the more waste is produced overall and thus the risk of ecological suicide is higher at high populations densities. Few bacteria can survive over a long time but a dense crowd of bacteria may kill itself very quickly. Therefore, ecological suicide is not only a problem of over-pollution but also of overpopulation.

Although this behavior may seem bizarre in the first moment, it seems not to be very exotic. Indeed we tested a variety of soil microbes for this effect of ecological suicide and found it in around one quarter.

The common appearance of an effect that kills the whole bacterial population lets one wonder, why bacteria would do that. The answer might be the same like the answer why we humans pollute the environment although we know that the consequences will not be good: We care more about our short time benefit than the long time consequences. In similar ways the individual bacterium may prefer to consume as much as possible even if the consequences for the whole population are devastating – egoism simply wins also in bacteria.