Extreme microbes could hold the keys of a greener and healthier world

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To us humans, our planet's most extreme environments often seem to be places to offer great sceneries. For some microbes on the other hand, these places -hot springs, high pressure, cold or hot deserts, radioactive area,…- are their home. These microorganisms are called extremophiles. Since a large portion of the extremophile world is still unknown and that these organisms have surprising adaptation mechanisms, it is thought that this underexplored world may have future applications in health and biotechnology.

Some of the most important compounds in pharmaceutical and biotechnology industries originated as natural products discovered in microbes. Since extreme microbes don't let themselves domesticate easily, scientists are implementing new techniques to unveil the molecular potential of these microorganisms. To find new natural products, some recent strategies used genome mining. By genome mining, we intend looking at genes of particular interest among big datasets of genetic information. Genes that are mostly looked at are the ones belonging to biosynthetic gene clusters (BGCs). BGCs are sets of different grouped genes encoding the biosynthetic pathway to produce a unique natural compound. Two biomolecular families encompass most of bioactive natural products from microbes: polyketides and non-ribosomal peptides. Both have their own enzyme complexes and unique BGCs. New computational tools are under development to analyze BGCs and to find out if they encode unique and interesting compounds. By looking at the genetic diversity of extremophiles, one can discover new BGCs and thus new potentially active natural products.

A first place in which one can look for genetic diversity among microbes is the ocean. Marine and oceanic environments are actually underexplored as bioresource of interesting natural products. In a recent study (1), more than 1,000 samples of sea water from all over the world were analyzed. It allowed scientists to reconstruct more than 25,000 microbial genomes and identify thousands of new species, unveiling more than 7,000 BGC families, half of which are thought to be new. Two new biosynthetic pathways were discovered, one (phospeptin) could produce protease inhibitors while the other one (pythonamide) holds very interesting enzymes on a biotechnological point-of-view.

Hot or thermal springs are also places where to find interesting extreme microbes. Recently (2), microbes from hot springs located on the ocean floor around the Kerguelen Islands were collected and their genomes analyzed. These microbes live with temperatures of more than 80°C and pH ranging up to 9. Preliminary data suggest that they are a source of various biochemical pathways that are still to explore. Indeed, some of them could be able to oxidize carbon monoxide and might thus be used in the future as microbial fuel cells. In addition to this biotechnological role, some hot springs bacteria are already known to produce some bioactive compounds like antibiotics (3).

Extremophiles are also found in cold arid environment like polar deserts. The natural compounds they produce may not only be interesting for us but also play a physiological role for their survival in their habitat. Microbial genes encoding the production of antifungal and biosurfactants were discovered in some Antarctic soil samples (4). These biosurfactants are thought to help these microbes in the uptake of nutrients in their nutrient-poor environment. They have many applications in various industries (food, cosmetics,…) and could replace some toxic surfactants used in the past.

There are many other places in which scientists are looking at for natural product discovery. Our planet's various microbiomes (either extreme or not) show a tremendous genetic diversity, that is still underexplored. Recent developments in genomic and bioinformatic analysis has allowed scientists to extract some of the knowledge of microbes to produce interesting compounds. By replacing toxic or polluting processes and chemicals and by providing us with new drugs, these compounds may help us build a greener and healthier world.

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