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Rounding up the fate of glyphosate

Researchers at the Department of Chemistry, Queen's University, in collaboration with colleagues at Aarhus and Copenhagen Universities, Denmark, have characterized a protein complex which is involved in the catabolism of phosphonic acids. Phosphonic acids contain an exceptionally stable carbon-phosphorus bond, a trait that is prized by the pharmaceutical, chemical, and agricultural industries for applications in medicines, detergents, and herbicides. It has been estimated that more then 20,000 tonnes of phosphonic acids are released into the environment annually in the western hemisphere, and that this release may be harmful to the environment. This has inspired researchers to harness the ability of bacteria to degrade these compounds with the aim of producing a bacterial strain with improved capabilities for this purpose.

A prominent example of a phosphonic acid is glyphosate, the active ingredient in RoundUp. This herbicide is thought to be benign as it quickly disappears from the soil. However, one of the degradation products is aminomethylphosphonate (AMPA), which persists in the soil due to the stable carbon-phosphorus bond. For this reason AMPA constitutes a potential environmental hazard as a pollutant of ground water.

Fortunately, nature may have already derived a solution. Certain bacterial species are able to degrade phosphonic acids, including the well-known *Escherichia coli*. To cope with phosphonate degradation *E. coli* must take advantage of 14 different proteins, encoded by 14 genes arranged in an operon, *phnCDEFGHIJKLMNOP*. Three of these genes (*phnCDE*) encode proteins, which transport the phosphonic acids into the bacterium, while a single gene (*phnF*) encodes a regulatory protein. The remaining 10 genes are expected to encode enzymes and proteins necessary for cleaving the CP-bond of phosphonic acids. Very little is known about these CP-bond cleaving enzymes, collectively called 'CP-lyase', despite half a century of scientific investigation.

By studying the expression of the genes *phnGHIJKLM* the Queen's, Aarhus, and Copenhagen researchers have shown that five proteins, encoded by *phnGHIJK*, remain together as a complex by application of various protein purification techniques. The biochemical function of this complex has yet to be determined in detail, but the results suggest that *phnGHIJK* encodes the long sought CP-lyase.

In the next phase the research team will characterize the CP bond cleaving activity of the protein complex as well as determine its three-dimensional structure.

The research findings will appear this week in the early edition of the *Proceedings of the National Academy of Sciences*.

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