Oxide coating may aid bacteria at mealtime

Why do many different kinds of bacteria living in sediments, soil, and water drape themselves in manganese oxides?

The question has bewildered researchers. After all, "It is a pretty drastic thing to coat yourself with a bunch of rocks," says environmental scientist William G. Sunda of the National Marine Fisheries Service in Beaufort, N.C.

Researchers have proposed many possible explanations. Some researchers say the manganese coat may protect the bacteria against toxic metals or ultraviolet light, while others suggest it may generally strengthen the capsule around the organism, note Sunda and David J. Kieber of the State University of New York in Syracuse in the Jan. 6 NATURE.

But Sunda and Kieber say they have a better hypothesis.

Humic substances, such as the humus gardeners use, abound in the environments where bacteria live. Microorganisms can't directly use these biologically inert, complex materials, considered the dregs of organic matter, Sunda and Kieber write. It would be useful for the bacteria if they could because humics are valuable sources of carbon.

However, the insoluble manganese oxides surrounding some bacteria may oxidize the humics, they argue. This would create low-molecular-weight organic compounds on which the bacteria can thrive. In fact, manganese oxides may be able to break down many types of complex organic compounds into simpler ones. This would make large stores of carbon accessible to the manganese-cloaked organisms, the two scientists contend.

The outer shells of manganese oxide are not impenetrable and thus may allow bacteria to feed off of the carbon, which it needs to grow, Sunda suggests.

Bacteria that don't have manganese coats can't tap into humic sources of carbon. They must use a lot of energy to create enzymes to break down the specific nonhumic organic compounds they feed on, the researchers suggest.

Sunda and Kieber have yet to prove their theory, but they have made an encouraging start, they and others say. To test their hypothesis, they added manganese oxides to filtered estuarine water that had a high concentration of humics. They also added manganese oxides and fulvic acid, a common humic compound, to water from the Gulf of Mexico, which contained a low concentration of humics.

In both cases, within four hours, they detected increased levels of low-molecular-weight carbonyls — organic compounds that the bacteria can tap as food. Only insignificant concentrations of these carbonyls had existed in the water samples prior to the addition of manganese oxides, indicating that the manganese oxides helped produce them, they report. The carbonyls included pyruvate, acetone, formaldehyde, and acetaldehyde.

The idea advanced by Sunda and Kieber "seems so sensible a possibility," and they have "interesting data" to back it up, says James Cowen of the University of Hawaii in Honolulu.

A follow-up experiment planned by Sunda and Kieber will entail more work than the one described in NATURE, which took a mere week and no special funding, they say.

The new study will involve growing bacteria that can use manganese oxides in the presence of manganese and humic compounds containing radioactively labeled carbon. The team hopes to trace the movement of carbon from the humics into the bacteria. This would indicate that the carbon the bacteria grow on comes from the humics, Sunda says.

The oxidation of humics by the manganese may benefit more than just bacteria, Sunda and Kieber say. It may someday prove useful in pollution control efforts. Manganese oxides are not very picky about what they will oxidize, so they may help degrade different types of pollutants, Kieber speculates. *— T. Adler*

Sorting out cancer IQs in browned meat

The same chemical reaction that imparts a desirable flavor to browned meats also produces a host of powerful mutagens known as heterocyclic amines (HCAs). In animals, researchers have linked these food-borne mutagens — especially one known as IQ — to an increased risk of cancers in the colon and other organs. However, a central question remained: How does IQ foster such cancers, since no HCA is carcinogenic without first being metabolized, or transformed — either by intestinal bacteria or mammalian cells.

A new study now all but exonerates what for some six years had been the leading suspect behind cooked meat's colon-cancer risk: 7-OHIQ — a bacterially derived metabolite of IQ.

Commonly found in feces, 7-OHIQ was identified during the 1980s as a direct-acting mutagen in the Ames test, a bacterial assay used to screen for potential carcinogens. However, bacteria lack some DNA-repair mechanisms that mammals possess to detoxify certain mutagens, explains John H. Weisburger of the American Health Foundation (AHF) in Valhalla, N.Y. So his new studies investigated 7-OHIQ not only in an assay using rat-liver cells, but also in chronic feeding tests with rats and mice.

In the Jan. 5 JOURNAL OF THE NATIONAL CANCER INSTITUTE (JNCI), Weisburger's team reports that the additional tests demonstrate beyond a reasonable doubt that 7-OHIQ "is not carcinogenic, in marked contrast to IQ."

The new studies suggest gut bacteria play little if any important role in the carcinogenic transformation of IQ or related HCA's, according to an accompanying editorial in JNCI by Fred F. Kadlubar of the National Center for Toxicological Research in Jefferson, Ark.

In a second JNCI editorial, a trio of researchers at Japan's National Cancer Center in Tokyo argue that "it is time to shift to a strategy of cancer prevention and accept that human carcinogenesis is largely due to an accumulation of many kinds of carcinogenic factors, each of which in itself may have little impact." Toward that end, these scientists recommend that people avoid overcooking meat and fish and that they remove any HCA-rich char that forms during cooking.

However, aficionados of char-broiled meats may one day be able to dine on such fare with relative impunity. Weisburger has identified a combination of amino acids that, when spread on meat prior to cooking, prevents the formation of HCAs (SN: 2/15/92, p.104). Though he holds a patent for this, Weisburger says, "I've been too involved in other work yet to [commercialize] the patent."

In the Sept. 1, 1993 CANCER RESEARCH, AHF researchers reported another tack in fighting HCAs. Their preliminary data show that in male rats fed low doses of IQ for four years, supplementing the diet with a bacterium prevented colon cancer in all animals, inhibited small-intestine tumors in 80 percent, and suppressed liver tumors in almost 40 percent. Data from female rats suggest the bacterial supplement also may cut the incidence of IQ-related breast cancers.

Bandaru S. Reddy of AHF says European and Japanese manufacturers already add this bacterium, *Bifidobacterium longum,* to yogurt and some soft drinks. He suspects *B. longum's* IQ-shielding effects may trace to its ability to suppress certain other bacteria — such as *E. coli* — from transforming bile acids (which the body uses to absorb fats) into "secondary" acids. "Secondary bile acids are strong promoters of colon tumors," Reddy notes.

Finally, Weisburger says preliminary data from his lab indicate that tea or extracts from it may reduce the mutagenicity of IQ. *— J. Raloff*