Metal Meals?

BY JAMES SCHULTZ

Forget peanuts, chips, cheese or the occasional slice of pizza. Snacks of choice should include healthy doses of iron, zinc, manganese, copper, molybdenum, cobalt and nickel. Chemical oceanographer and Old Dominion assistant professor of chemistry and biochemistry John Donat says these metallic treats are essential to the health of the microscopic creatures called phytoplankton that inhabit most natural waters. Though they are individually tiny, collectively phytoplankton are essential, forming the base of the aquatic food chain and exercising influence over Earth's climate.

Photo courtesy of John Donat.

Come to think of it, adds Donat, metals-laden appetizers are just as important for people—if not superficially very appealing to human taste buds.

"Every morning I take a vitamin with metals in it. Maybe you do too," he points out. "Our bodies need trace quantities of these metals for basic biochemistry. So does everything on Earth. The problem comes when organisms get too much of the wrong metals."

Donat has made it his business to figure out how metals appear, move and persist in coastal waters. Depending on their precise chemical form and composition, metals can be either meal or malady. High concentrations can be deadly to living things. Low concentrations of the right metals can lead to biological abundance. The key lies in knowing the difference between too much of one and too little of the other.

"Will a glass of water hurt you or not?" Donat says. "You need to know exactly what the concentrations of the various forms of the metals are if you're trying to understand their toxic effects. The toxic forms can represent a very small fraction of the total."

Doctor of Aquatics

To identify metals' different biochemical and geochemical behaviors, Donat has studied trace concentrations in the waters of the Chesapeake Bay, the coastal western North Atlantic, the western South Atlantic, the North and South Pacific and local Virginia lakes. He compares the effort to medical school studies. To understand human disease, would-be physicians should understand how the body works and how bodily systems interact. The same is true for anyone who studies complex ecosystems.

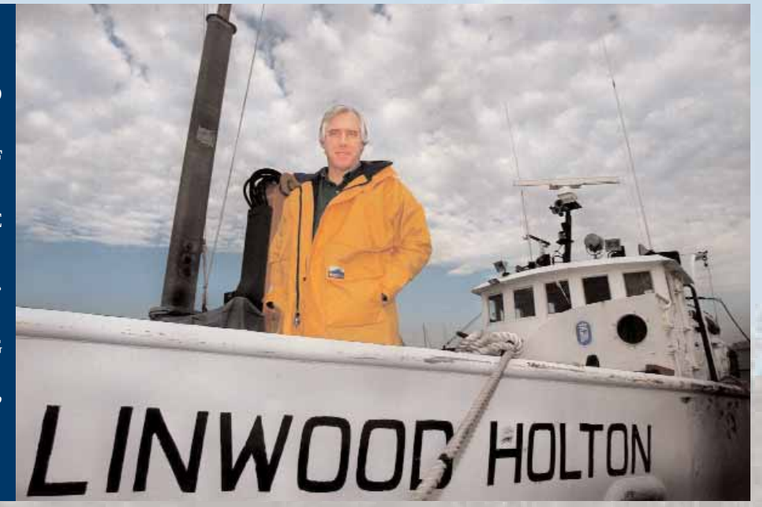
"My philosophy is, if you want to understand human effects on the environment, you need to understand the natural system in the same way a doctor goes to school to learn about anatomy and physiology," Donat avers. "We need to know natural systems in order to know what's unnatural."

According to Donat's analysis, the Chesapeake Bay itself isn't troubled by high concentrations of toxic metals. Overall, sampled amounts of copper, cadmium and zinc are present in very low amounts. But Donat cautions that there are some areas in the Bay where the concentrations are high enough to cause concern. And even low levels may have as-yet-unknown effects in a body of water as large and ecologically varied as the Bay.

"I don't know that the health of the Bay is governed by metals," he says. "There may be other pollutants — nutrients and organics, for example — that play a far greater role."

Despite years of investigations, Donat says that he and his colleagues are only beginning to understand the roles metals play in water. Questions remain. Do seasonal changes affect concentrations of metals? How do geography and location influence distribution? How do metals, trace or otherwise, synergistically interact with living systems? Can the results of investigations in the Chesapeake Bay be applied to other waterways and watersheds?

"Our bodies need trace quantities of metals for basic biochemistry. So does everything on Earth."



Aboard Old Dominion's research vessel the Linwood Holton, John Donat prepares to study trace concentrations of metals found in Hampton Roads waters. The assistant professor of chemistry and biochemistry is exploring how metals appear, move and endure in coastal waters. Left, John Felbinger, a research technician working with professor Donat, analyzes sea water from the Atlantic Ocean for iron complexation using a hanging mercury drop electrode.

Several studies have indicated that some metals can trigger toxic algae blooms. Last summer, Donat traveled to Brazil, Chile and Uruguay to establish collaborations with biological oceanographers working on damaging algal infestations known as "red tides," to see if metals are partly to blame. Thus far, results are inconclusive, although concentrations of copper or iron elsewhere in the Americas have been known to kill beneficial algae, allowing their marine-damaging toxic kin to take hold. With colleagues from the State University of New York at Stony Brook and the University of Delaware, Donat is also studying the influences of trace metal concentrations on so-called brown tides in Long Island Sound.

Waste and Cures

Many, but not all, ills that plague coastal waters can be traced to the development of modern industrial society. Donat concedes that wealth creates waste, especially of the polluting variety, but suggests that environmentally damaging behavior is not limited to humans.

"The Earth has never been a Garden of Eden. When the Earth was first formed it was a pretty nasty place for life as we know it today — poison air, no oxygen," he says. "Natural processes put in metals and harmful organic substances. Even today, natural agents and processes like volcanoes, weathering by rivers, and animals introduce potentially harmful substances into the environment. Humans are not the boogeyman. But we do need to act responsibly and find ways to reduce our wastes and their potential environmental effects."

The key to striking a balance, Donat believes, is to rachet human-discharged metals down to natural concentrations. Environmental regulations should also be rewritten when necessary to direct behavior based on the scientific community's latest, best-validated findings. Manufacturers should be included as partners in the process.

"It's impossible for certain companies to keep metals out of their wastewater," Donat contends. "Metals are a natural component of water everywhere. Bottled water has metals. Tap water has metals. The trick is to reduce them to concentrations low enough so that no one is harmed."

If there is one rule to dealing with the environment, Donat believes, it comes from the ancient healers' code: First, do no harm. And clean up after yourself.

"We all have to drink, sleep and live. Those activities produce waste," Donat says. "We'll never get to the state of producing no waste. The best we can hope for is to get to the stage of recycling most, maybe all, of our waste. And polluting as little as possible, or not at all."