VERMICOMPOSTING

A wormy approach to sludge management is under scrutiny

BY JANET RALOFF

How to safely dispose of the tons of filthy and foul-smelling sewage sludge generated in the United States each year is a serious and growing national problem. One rather unusual proposal under review by the Environmental Protection Agency would harness worms to transform noxious municipal wastes into a salable soil conditioner with properties similar to potting soil. It's called vermicomposting.

While the process of feeding sewage sludge to worms is being investigated, in one form or another, at a half dozen or more sewage-treatment plants around the country, the most scientifically fruitful research is probably generated by work at the State University of New York in Syracuse. Under the direction of Roy Hartenstein and Myron Mitchell, investigators are probing the basic biology of earthworms together with the ecological effects of using vermicomposted sludge on forest and agricultural soils.

Sludge is the solid material removed from wastewater by sewage-treatment plants. EPA estimates that municipal secondary wastewater-treatment plants in the United States will produce 168 million metric tons of wet sewage sludge this year alone.

"The chemical composition of sludge is similar to but richer than that of expensive potting soil," Hartenstein says. The main difference is that sludges also generally contain unstable, foul-smelling materials, heavy metals that could prove toxic and pathogens (disease-producing organisms).

While earthworms tend to ignore heavy metals (although they can accumulate certain of them in their bodies), they can do a lot to mitigate many of the other undesirable sludge-related problems. For instance, recent SUNY experiments demonstrated that by their feeding activity, worms such as the common nightcrawler *(Lumbricus terrestris)* encourage the decrease of *Salmonella typhimurium* bacteria (which produce intestinal disease in humans and some animals) and increase the density of beneficial bacteria that aid in the breakdown of organic matter. "How that occurs, we don't know," Mitchell told SCIENCE NEWS. But it is known, he said, that buffering systems in a worm's gut will actually neutralize acidic materials passing through them to alter their pH.

But the primary role of the worm is to aerate sludge. Its feces, called castings, are much smaller than the chunks produced by sewage-treatment plants. Therefore, by feeding on sludge, a worm increases the surface area of the sludge that will ultimately be exposed to air. That in turn encourages the growth of aerobic organisms (those requiring oxygen to live).

Many microbes are "facultated anaerobes," which means they can grow with or without oxygen, Mitchell said. If they're grown in the absence of oxygen they produce one type of product, he explained; in the presence of oxygen they produce another. And it's the products formed in the absence of oxygen — like mercaptans and hydrogen sulfide — that are so often "stinky," he added.

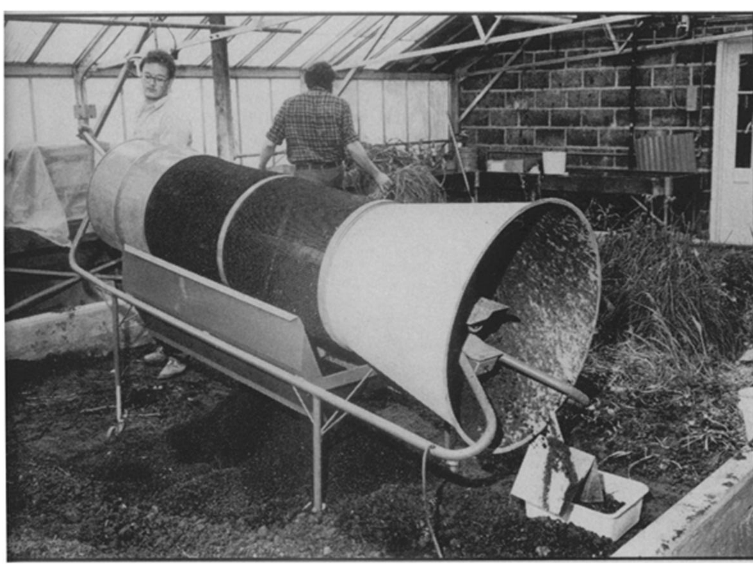
This points to the earthworm's major impact. By physically altering the nature of sludge, it encourages the growth of a suite of symbiotic organisms responsible for carrying out the lion's share of the metabolic and chemical decomposition steps. "It is likely," Hartenstein says, "that earthworms may be able to reduce the time for composting by 50 or even 75 percent of that required when microorganisms alone are present."

Hartenstein believes it is possible that worms and their natural consort of companions — nematodes, bacteria and other microbes — can transform relatively infertile sludges into a product similar to fertile, organic topsoil. He predicts the low-energy process would not only cost less than most current sludge-treatment/disposal options, but could also generate revenues for municipalities through the sale of the converted sludge.

Except for a few current field experiments — such as adding worms to sludge-drying beds at sewage-treatment plants and incorporating wormy sludge into test plots of forest soil — SUNY experiments have been limited to benchtop trials involving less than 100 grams of sludge and worms per experiment.

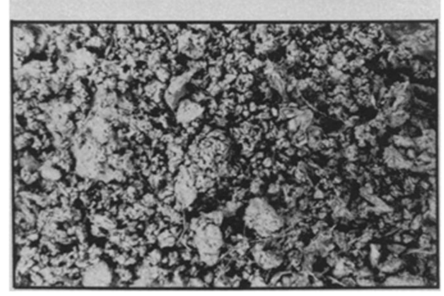
"We do know that the potential exists for the use of certain earthworm species to convert the entire output of municipal sludge into marketable commodities," Hartenstein says. "The critical question is whether [all the necessary steps] can be put together at a wastewater-treatment plant to make it a reliable and economical procedure."

Having doled out an estimated $20 billion during the past eight years for municipal-wastewater cleanup and sludge



Photos: SUNY

Harvesting a new crop of worms (left). Castings of worm-processed sludge shoveled in at left are collected in center; worms exit out right end. Magnified granules of those worm castings (lower right) illustrate the degree to which worms physically break down original chunks of sludge — magnified by same amount (upper right).



removal, EPA also sees cost as one of the most critical issues affecting vermicomposting's future. And "at this point in time, I'm still negative," says Joseph Farrell. Farrell is chief of the Ultimate Disposal Section of the Wastewater Research Division at EPA's Municipal Environmental Research Laboratory in Cincinnati. "I see [vermicomposting] as a costly process," he told SCIENCE NEWS, "and offering very little help for all but the possibly very small cities." But then very small cities — usually rural — often have very easy and inexpensive alternatives to vermicomposting, he added, such as dumping sludge on meadowlands, forests and fields.

Officially, however, EPA has adopted a "wait and see" attitude, Farrell says. Responding to a number of small firms — most of them commercial worm growers hoping to expand a market for their product — EPA has commissioned a survey by the Boston-based firm of Kemp, Dresser and McKee. The survey, a draft report of which is already circulating, was to assess the cost and commercial feasibility of vermicomposting after studying many of the existing research programs, including the one at SUNY. Farrell said that "based on what we see in this report" EPA will decide whether or not to fund vermicomposting research and development.

What many individuals hawking the potential of worms tend to overlook, Farrell says, is that sludge disposal "is not something one can pour a lot of money into. It costs you maybe $100 a dry ton, or five cents a pound to get rid of. Of course, the stuff comes as a wet solid, so you really get five cents to handle five pounds of stuff, to reduce it to one pound and to get rid of it."

Vermicomposting proponents also talk about producing something that can be used in gardens or homes as a potting soil. "Well, my feeling is that anything that goes into a store ... had better be totally pathogen free," Farrell says. Right now vermicomposting appears to reduce pathogens, he says, but does not eliminate them.

What Farrell sees as the greatest factor limiting vermicomposting commercially, however, is something Hartenstein's project identified recently: that anaerobically digested sludges (those worked on by microbes in the absence of oxygen) are toxic — if not lethal — to earthworms. There are already billions of dollars invested in anaerobic digesters, Farrell says, and their output represents well over half of the municipal sludge generated in the United States.

But the SUNY group is already working on the problem. Current experiments are testing the toxicity of worm diets that include a mix of anaerobic and aerobic sludges. And tests expected to begin soon will involve a species of worm different than any yet studied at SUNY — one found in muddy oozes with properties very similar to anaerobic sludge. □