Oysters, Algae & Sewage

Woods Hole scientists are using sewage to grow oysters

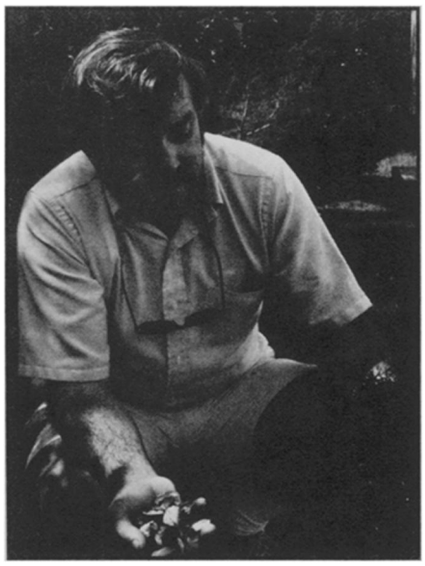
by John H. Douglas

Environmental protection regulations have caused a modification of the old saw, "Necessity is the mother of invention." As more industries must remove bitter pollutants from the fruits of their labor or return to nature something that won't make it choke, a new motto has arisen: "If we'll have to do it anyway, we might as well make it profitable."

Among the environmental protection measures society will probably "have to do anyway" are secondary treatment of sewage, to remove most of the organic matter, and tertiary treatment, to remove most of the dissolved inorganic compounds. The organic and inorganic material left after heavy solid matter is settled out of sewage during primary treatment can upset the balance of nature, acting as fertilizers for the wrong kind of organisms and turning vast bodies of water into great slimy cultures of scum, bereft of oxygen to support other life.

Profitable removal of the organic matter has already been accomplished. The materials are digested by bacteria in special tanks to produce a sludge that can be sold commercially as fertilizer. (In many countries, "night soil collectors" make daily rounds of outhouses to collect valuable fertilizer without benefit of further treatment). But tertiary treatment, to remove inorganic nitrogen and phosphorous compounds, has remained a problem.

Now, scientists at the Woods Hole Oceanographic Institution, working with funds from the National Science Foundation, have pushed through to the pilot plant stage a scheme for removing the inorganic compounds by using them to grow algae to feed oysters, packed together on racks in a tank. During a final stage, tanks of seaweed are used to remove the last traces of nitrogen and phosphorus compounds from the sewage, together with the waste products of the oysters. Water finally dumped into the ocean is about as "clean" as the sea itself.

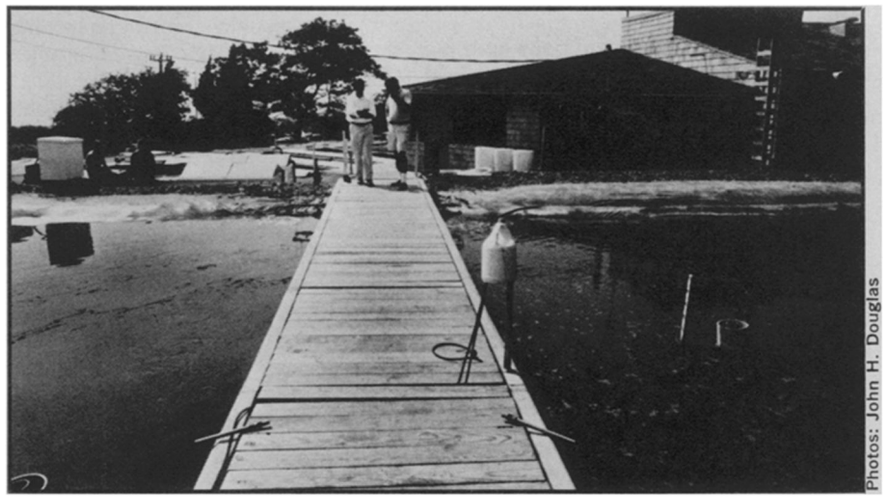


Gifford shows oysters from project.

The project is the brainchild of Woods Hole marine biologist John Ryther, who says he got the idea while studying the natural productivity of the oceans. His studies showed that food production in the sea is nutrient-limited, that most sea life is concentrated near coasts where nutrients from rivers spread and fertilize the growth of plankton that support the oceanic food chain. By artificially providing such resources from treated human waste, he reasoned that productivity could be substantially increased, at least in a small area.

Indeed, it can. A colleague of Ryther's, Cameron Gifford, says the laboratory expects such facilities to produce some 6,000 bushels of oysters per acre of tank each year, at a selling price of about $20 a bushel. The seaweed, "Irish moss," can also bring a handsome price, for it contains carrageenan—a binder used in making ice cream and cosmetics, for which there is no synthetic substitute. Gifford expects a crop of 25 to 50 tons of seaweed, wet-weight, per acre per year, at a selling price of four or five cents a pound. (Thousands of tons of such seaweed are now harvested each year by thrifty New Englanders who comb the beaches to make a little extra money.) A facility large enough to provide tertiary sewage treatment for a coastal town of 50,000, Gifford estimates, might bring in an annual income of $4 million or $5 million, far more than enough for its operation.

At present, the Woods Hole pilot plant has 12,000 square feet of algae ponds and 3,000 square feet of oyster tanks. Treated sewage from Wareham, Mass., is mixed with seawater and



Photos: John H. Douglas

Above: Algae destined to be oyster feed are raised in ponds of seawater and treated sewage. Left: Abalone has also been raised in project.

piped through the system at rates up to 1,000 gallons per minute. Though both the funding agency and various commercial firms are eager to see even larger-scale units put into community use, project scientists warn about potential problems that must still be solved and caution that the system is thus far applicable only to coastal, residential communities.

The first problem is that of viruses, which may persist through all the stages of treatment and might become concentrated in the oysters. A virologist consultant is working with project scientists on the problem. Although they say no one yet knows how serious the viruses may prove to be, they remain confident that the matter can be resolved within the timescale of present pilot plant experiments.

A potentially more serious problem, which seems to inherently limit the process to treatment of residential sewage containing no large industrial effluents, is the difficulty of eliminating heavy metals and other toxic substances. Heavy metals *would* be concentrated in the oyster meat and seaweed, and some toxins that make their way through preliminary treatment might create a health hazard for consumers—if they didn't poison the whole aquaculture unit first. New regulations are likely to lead to further separation of industrial and residential waste treatment systems, with industry bearing an ever-increasing responsibility for removing toxic substances before returning its effluents to public waters. Such regulations would help assure the safety and effectiveness of such aquaculture installations.

If the idea catches on, future developments may lead to wider varieties of marine foods produced by sewage-aquaculture and to application of the technique to freshwater areas. The current pilot plant follows three years of scaled-down experiments, and for the first time, this summer, a few fish are being raised in the outdoor tanks in addition to the oysters. Inside a nearby laboratory building, small tanks are being used to explore the possibility of raising a variety of other aquatic species, including abalone and lobsters. (One immediate problem with trying to mass-produce lobsters: They eat each other.)

Aquaculture has not yet experienced a "green revolution," with intense fertilization, use of genetic engineering to produce high-yield species of both plants and animals, and development of an integrated system of feed production and stock optimization. "We're a hundred years behind agricultural technology," says Gifford.

To catch up, scientists must learn more about the basic oceanic food chain and the life cycles of individual species. By keeping food levels optimal and temperatures even, year-round, researchers at Woods Hole predict they can bring oysters to maturity in 12 to 18 months, compared with the four or five years required in the open sea. By studying which species can be optimized in various climates up and down the coast, aquaculturists may someday be able to install large-scale sewage treatment plants as part of an "open system," increasing the natural productivity of a channel or bay.

The ever-spreading impact of man on the environment and the continually increasing cost of minimizing its harmful effects requires a new generation of ideas that place society working with nature, rather than against it. Sewage-based aquaculture seems to be an imaginative, economical example of such an idea. □

Off the Beat

Late blooming Nobel laureate

A recent behavioral research note told of a counselor in England who gives encouragement to the parents of intelligent children doing badly in school by telling them of noteworthy scientists who had been underachievers in school: Einstein, Mendel, Edison, Darwin (SN: 8/3/74, p. 73). The list could probably go on at great length.

Add another person to the roster of late bloomers in science: Ivar Giaever, who shared the 1973 Nobel Prize in Physics for his work on the quantum-mechanical tunneling effect. In an interview in R&D REVIEW, a publication of the General Electric Co., for which he works, Giaever tells of his days as "a somewhat indifferent" student in his native Norway and his problems getting started in his profession.

"I wasn't really very interested in mechanical engineering, the field in which I majored. . . . I was interested in electrical engineering or electronics at that time, but I couldn't get into either of those fields because my grades weren't good enough. So I applied for chemical engineering and they wouldn't let me in *there* because my grades weren't good enough. Finally I got accepted into mechanical engineering, which was my last choice. I wasn't really very interested in that, but that's the way the ball bounces."

After graduation, marriage and military service, Giaever worked for a time as a patent examiner but could find no apartment for his family in Oslo and finally decided to move to Canada just before Christmas 1954. "When we got to Toronto, I simply could not get a job. My wife knew some people in Toronto, so we weren't going to starve, but there were absolutely no jobs. . . . IBM would not even let me fill out an application form."

He worked for awhile as a draftsman in an architect's firm and finally, with the job market livening up, got a job with Canadian General Electric. There he had the opportunity to take an engineering course that the company offered. That was a turning point.

"As you may have gathered, I had been a somewhat indifferent student in Norway, but in Canada I realized that this was my last chance—if I wanted to get somewhere I would have to buckle down. So I worked hard on the course and learned a lot."

Giaever continued his courses and eventually joined the staff of the General Electric Co. in Schenectady, N.Y., where he was stimulated by his research colleagues. But he had reservations about starting too late. He was already 29. He talked to John C. Fisher, a physicist and prominent member of the research laboratory's staff, about it.

"I told him, I am really too old to do something in physics, because people normally do their best work in physics when they are much younger."

" 'No,' John said, 'that is not the reason. People do their good work when they are learning. You are 29 years old and you are going to learn something and then you'll do good work.' "

The Nobel Prize came just 15 years later. □

How some others see us

Modest as we are here at SCIENCE NEWS, we try not to toot our own horn too much, but we are always happy to share nice comments about us when they appear elsewhere. The following are from a recent column in *The Village Voice* (July 18): "SCIENCE NEWS is one of the most consistently readable magazines on the general sciences that I've come across lately. Not only do they seem to scoop every newspaper in the country with their brightly written weekly, but they have the rare gift of being able to write humorously about rather portentous subjects."

On the same general subject, we belatedly but proudly note that in an article last year on the Washington press corps, WASHINGTONIAN magazine included SN's Dietrick E. Thomsen, senior editor and physical sciences editor, in a listing of four or five of the most important specialty reporters in Washington.

—*K.F.*