Cercetările din ultimele decenii au început să recunoască rolul și importanța ciupercilor din viața noastră, astfel ciupercile sunt tot mai des utilizate în proceduri așa zise de "microremediere", adică în situații în care omul deja a făcut tot ce se putea face iar acum natura este lăsată să termine ce omul nu a reușit. Exemplul cel mai grăitor este cel al [Păstrăvului de fag](http://ciupercomania.blogspot.com/2013/11/pastravul-de-fag-pleurotus-ostreatus.html) care a fost folosit cu succes în catastrofe petroliere, cum este și cel acargobotului *Cosco Busan* eșuat la *Bay Bridge*, unde sau vărsat peste 58,000 de galoane **de țitei**, iar fundația non-profit **Matter of Trust din San Francisco** alături de micologiști din întreaga America printre care micologista [**Lisa Gautier**](http://www.bohemian.com/northbay/mycroremedia-what/Content?oid=2176003)**,** au reușit să demonstreze incredibilul. **Ciuperca Pleurotus poate și asimileaza produsul petrolier într-un ritm de neimaginat, după nici două luni de la deversare această ciupercă își produce deja fructul sănătos.**

**Mycroremedia What?**

Why such low-tech solutions as hair mats and mushrooms may be the answer to oil-spill woes

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**Y**ou are what you eat—unless you're an oyster mushroom.

In that case, you can indulge in some of the most toxic, noxious petroleum products available and turn them into delicious, photogenic morsels that go wonderfully in white wine cream sauces and Japanese stir-fries with not a carcinogen remaining. Called mycoremediation, this impressive skill of the oyster mushroom has gained substantial press in the wake of the Nov. 7*Cosco Busan* oil spill in the San Francisco Bay, and many environmental activists believe that, if pursued by biotechnology developers, mycoremediation could completely rewrite how to handle the aftermath of future spills.

Mycologists have been speculating for years on the possibility of someday employing oyster mushrooms, *Pleurotus ostreatus*, in toxic-waste cleanup projects, and when the freighter *Cosco Busan* scraped the Bay Bridge and spilled 58,000 gallons of sludgy bunker fuel, mushroom biologists from Monterey to Seattle quickly mobilized. They partnered with the San Francisco nonprofit Matter of Trust, secured a small plot of federal land in the Presidio near the Golden Gate Bridge and proceeded to spearhead a historic experiment of oil-hungry mushrooms that has attracted nationwide media scrutiny.

"Nature has all the solutions. We just haven't been paying attention," says Matter of Trust executive director Lisa Gautier, who has been laboring tirelessly since the day of the spill, becoming somewhat of an authority on the arcane subjects of ship fuel and fungi in the process. "In nature, there really isn't any waste. All materials get dealt with, and it's just a matter of harnessing the technology."

Harnessing the powers of oyster mushrooms is exactly what Gautier and a team of mycologists have done. Two months have passed since the oil spill, and there now grows a healthy colony of large and vigorous hand-sized oyster mushrooms at the Presidio project site. Scientists, who plan to run chemical analyses of the substrate beneath the mushrooms and the mushrooms themselves, expect to find few to no hydrocarbons or other trace elements common to petroleum products remaining.

The mushrooms are sprouting from eight experimental 5-by-5-foot cubicles partitioned from each other with bales of hay and rubber pond liners each filled with varying mixtures of straw, sawdust, grain, oil and oyster-mushroom mycelium, the vinous, underground rootlike matter that constitutes the greater mushroom organism. Two control blocks, which were not implanted with any mushroom spores, have shown no notable activity. The experiment demonstrates how simple it could be to implement a brand-new procedure for detoxifying contaminated soil and turning it into harmless compost.

**T**he essence of mycoremediation occurs underground, amid the tangly mycelium. In their day-to-day life, mushrooms eat forest-floor plant matter, and in doing so they break down cellulose and lignin, which occur side by side in the cell walls of plants. This plant matter is composed of hydrogen and carbon, just like petroleum products, and for the oyster mushroom there is little difference on a microscopic level between eating wood and eating nasty, sticky bunker oil; it's all just hydrogen and carbon. Once these atoms are isolated, the fungus reconfigures them into carbohydrates, familiar molecules which many of us either love or hate.

Meanwhile, fruits pop up above ground, and, assuming no heavy metals are present in the soil, the mushrooms are free of toxins. In time, the mushrooms themselves will be eaten or decay, nature will reabsorb them into the food chain, and any oil in the soil will be gone.

Humans, of course, mostly burn oil—but as concern over carbon emissions, air quality and climate change escalates, mycoremediation may begin to look more and more like the perfect alternative.

**S**ecuring oil from the water or beach and transporting it to a controlled environment was among the greater obstacles in the Presidio mycoremediation process, but mats made of human hair have served as a superbly effective material for conducting this task. A barber from Huntsville, Ala., named Phil McCrory conceived of this product with a bit of experimentation in the years following the 1989 Exxon Valdez oil spill in Alaska.

Since 2002, McCrory's garden-supply company Smart Grow has commercially marketed dense pads of human hair as commercial and household horticulture aids. The mats insulate soil, help retain groundwater, discourage weed growth and release essential nutrients into the soil, but in November these hair mats served for the first time ever in a large-scale oil-spill cleanup effort.

When the *Cosco Busan*busted its hull, Matter of Trust—which has worked with McCrory since the late 1990s—had several hundred hair mats on hand, ready for just such an occasion. With several hundred guerrilla volunteers, Lisa Gautier mopped up several thousand pounds of the black tar as it came ashore at Ocean Beach. Dressed in a HazMat suit, Gautier and others wrung the hair mats out into large dumpsters, reusing them multiple times before each was saturated and had to be finally disposed of. Gautier sent the oily refuse away with Unified Command, the government body overseeing the spill's aftermath, intending to subsequently retrieve as much as she needed as fodder for her experimental brood of oyster mushrooms.

***Mushroom Man***

Gautier, meanwhile, made plans to launch the mushroom growing experiment. She has long opposed the standard government-assisted protocols of dumping or incinerating waste oil, and has concurrently admired the work of famed Washington state author, biologist and entrepreneur Paul Stamets, who has experimented with oil and oyster mushrooms in the past.

Stamets happened to be in town at the time of the spill for the annual Green Festival in San Francisco, and Gautier contacted him three days after the spill, by which time she and her volunteers had secured several thousand pounds of *Cosco Busan* fuel. Gautier explained the situation, and the two agreed to partner up, along with Stamets' cohort David Sumerlin and the Mycological Society of San Francisco's Ken Litchfield. Stamets called home and ordered an immediate shipment of several hundred blocks of oyster mushroom mycelium, and so the stage was set for history.

Of course, the mainstream media was there, too. With Stamets ready to be filmed, a KTVU cameraperson prepared him for taping, urging him to speak on topic.

"It's a wonderful quirk of nature," Stamets began, "that oyster mushrooms can break down diesel and many petroleum products, the reason being that oyster mushroom mycelium breaks down straw and wood, and wood and straw are composed, as most plants are, of long chains of carbon and hydrogen strung together to form cellulose and lignin. Well, when mycelium breaks down wood and straw, it cleaves the bonds between carbon and hydrogen, and those same carbon-hydrogen bonds are what hold hydrocarbons together—petroleum products. So the mycelium has already devised a way of breaking down those hydrogen-carbon bonds and in doing so breaks the hydrocarbons apart and remanufactures them into sugars, called carbohydrates."

"I hate to do this to you," the cameraman said. "We need to simplify this a lot, because it's mainstream television." ~

"I thought I did simplify it!" Stamets laughed. "I thought that was very simplified."

He restated the above, using fewer terms from the periodic table and basic chemistry.

Gautier, standing by, suggested that he recite it still again—but without saying "mycelium."

"Say 'mushroom,'" she suggested.

"Yeah," agreed the cameraman. "I don't think everyone has a biology degree."

"It's really simple!" cried Stamets, exasperated to his wits' end. Still, again, he described the experiment in painfully simplified terms. It was just what KTVU needed, and the cameraman packed his gear and departed.

**C**leanup crews only collected about 19,000 gallons of oil, leaving some 39,000 gallons at large. Gautier says that the response could have and should have been much more successful. She insists that, had the Department of Fish and Game (DFG) accepted her immediate advances after the accident, when she was there on the double offering McCrory's human hair mats, the cleanup effort could have secured nearly all the bunker fuel from the water's surface, before it washed out to sea and before it soiled a hundred miles of Bay Area beaches.

"Not only are these hair mats a green method of cleaning up oil, unlike the polypropylene sponges they usually use, but they actually work better," Gautier says. "There's no reason not to use them, and if they'd accepted those hair mats and used them in the beginning, they would have had all that oil cleaned up.

"But the DFG has their own emergency-response system, which they stick to," she says. "Anyway, they're bombarded after every oil spill with green methods that don't work at all, so they just said, 'We'll review your proposal and consider this,' and went away."

Hair-mat inventor McCrory agrees, insisting that his product—of which Smart Grow makes about 4 million each year—could have saved the bay. "If they had contained that oil spill and then put the hair mats down, that water would have been as clean as your dining room table."

The DFG's Yvonne Addassi, who regularly oversees statewide oil-spill cleanups, says that her agency declined to use the hair mats because similar products have in the past been treated with chemicals which, though they facilitate the adsorption of oil, can contaminate water.

"I wasn't familiar with these new hair mats," Addassi admits. "We thought they could pose their own risk of releasing these chemicals into the water."

And so the great mass of freshly dumped *Cosco Busan*bunker oil traveled westward on the outgoing tide. It drifted past the bay's islands and under the Golden Gate Bridge. It split into northward and southward regiments and began a steady assault on popular beaches, while bureaucrats in various buildings shuffled papers, straightened ties and attended meetings, wondering who should do what, where and when. Mainstream media would herald the weeks after the spill as a triumphant time of teamwork and charitable volunteers, but as is now known, most of the oil was not recovered. Dead and dying birds would wash ashore for weeks afterward.

***Fuelhardy***

As the finishing touches were made to the Presidio project site, authorities suddenly revoked their promise to hand over even as little as the 20-gallon sample of fuel which Gautier had collected herself, for the sludge had become potential evidence in the escalating criminal investigation of the incidents just prior to the oil spill.

"I really doubt they're going to bring 18,000 gallons of oil into a courtroom," Gautier charges. "They could spare 20 gallons for our experiment if they really wanted to help."

Gautier, Ken Litchfield and others suspect that various parties have been reluctant to see Matter of Trust gain access to the oil, which is being held in an Alameda shipyard, because of its plans to test it for varying intensities of toxicity. The tests would be for scientific purposes—to see how efficiently oyster mushrooms can metabolize particular molecules—but it's likely, says Gautier, that those responsible for the oil were afraid of legal complications that might arise should the mushroom folks discover a particularly toxic chemical or heavy metal in the *Cosco Busan's* fuel.

"There are millions of dollars of damages at hand," Gautier says, "and we were planning to analyze the oil more than anyone has analyzed it. If we came up with something that hadn't already been seen, it would have opened a whole new can of worms for them."

With no bunker fuel at the ready but with over 1,000 pounds of ravenous mycelium just dying for something poisonous to eat, the mushroom team went to Plan B: used motor oil, donated just before Thanksgiving, care of San Francisco's Department of the Environment.

***Brave New Biology***

Today, the mushrooms are thriving, particularly in the experiment block containing a large addition of grain, and in hindsight, Gautier is perfectly content not to be using any of the*Cosco Busan* fuel anyway. It has been greatly diluted with seawater and is almost certainly not as potent as the fresh product, she says, and if the mushrooms could eat it, big deal; for the fungus to devour pure motor oil would actually be a weightier testament to the possibilities of mycoremediation. After all, the Environmental Protection Agency estimates that over 360 million gallons of motor oil drain into the sea every year. By contrast, large ship accidents spill just 37 million gallons of bunker fuel annually.

And according to the Smithsonian Institution, annual road runoff from a city of 5 million people equals approximately the amount of petroleum involved in some large oil spills, a stat that makes one wonder about a solution as simple as planting beds of oyster mushrooms along the shoulder of every highway in America to catch the toxic runoff.

Indeed, a prosperous future appears to be developing in the realm of hair mats and mycoremediation. Ken Litchfield, who owns and manages an organic farm in the East Bay hills, has high hopes for a world bettered by mushrooms. We are at the beginning of the biological century, he says. The world in the year 2100 will be as different from today as 2000 was from 1900. It was technology that drove the change in the last 100 years, but in this century, Litchfield says, biotechnology, much of it in the form of myco-technology, will change the face of civilization.

"We will not be living in the same world—assuming we make it through—that we're living in now, biologically speaking." [Marker]

He tells of innovative carpenters who have experimented with fungal architecture. These builders grow mycelium in broad flat beds, then kill the organism and dry it so that a thick "board" remains, serving as organic, fungal wall insulation. Even better, says Litchfield, mushrooms may also be used someday to extract heavy metals that contaminate our soil. Theoretically, the mycelium would pick up the atoms and channel the heavy metals upward to the surface, into the mushroom's fruit.

***Oil Over the Place***

But is it science fiction or destiny? Without question, mycelium is running wild just under our feet, and many believe that, if only harnessed and controlled, fungi could help remedy the earth's many problems of environmental contamination. In the Presidio, the alchemy of mushroom biology is at work, and the state-run Department of Toxic Substances Control is watching closely, tentatively interested in adopting mycoremediation technology into standard practice.

A global movement seems already to be underway. The Dec. 7 spill in the Yellow Sea, which discharged a reported 2.7 million gallons of oil just off the coast of South Korea and devastated the local fishing and aquaculture industries, is now being remedied by crews armed with Bay Area hair mats.

Cleanup crews addressing the Nov. 12 oil spill in the Black Sea, which poured a thousand tons of bunker fuel into the water, have also secured hair mats from Matter of Trust and Smart Grow to better mop up the sludge. And in Ecuador, where a 2001 pipeline break on the Toachi River dumped 10,000 barrels of crude oil and left a messy legacy festering on the banks, American volunteers have revived the long-dormant cleanup effort with hair mats in hand and a fresh sense of hope.

There are even stubborn remnants of the memorable 1989 Exxon Valdez oil spill, reported at 11 million gallons, in Alaska's Prince William Sound that still need attention.

"There's a ton of it coming out of the ground," says Riki Ott, a journalist and author with a Ph.D. in oil pollution. "It got buried subsurface and has been preserved."

According to Ott, who has researched the biological and cultural effects of the Valdez spill extensively, only 5 percent of the spill was removed from the water. Ott also accuses Exxon of lying about the volume of the disaster, underestimating in order to lessen the intensity of the legal consequences. She believes 30 million gallons of oil may actually have entered the water, leaving a legacy guaranteed to linger for decades.

Among the most dangerous compounds in petroleum are polycyclic aromatic hydrocarbons (PAHs), and near Valdez, says Ott, those atoms are still "bio-available," meaning that they may be ingested by organisms and dispersed into the food chain, eventually entering humans. She says that thousands of illnesses and maladies among locals in the Prince William Sound area can be attributed to PAHs, which may cause asthma, immune system failure, respiratory problems, reproductive disorders, vertigo, nausea and cancer.

But oyster mushrooms relish the dangerous molecules, and Ott hopes to channel some of Exxon's settlement dollars from the spill—much of it yet to be paid—into hair mats and mycoremediation-development programs. Ott is also coordinating with environmentalists on the devastated West Coast of South Korea, but not without her simmering grievances against oil companies.

"I'm so disappointed that the oil industry continues to operate without a viable plan to clean up their messes, whether it's in a tiny seaport in Alaska or in a big place like San Francisco or South Korea," she says. "It's inexcusable, and it shows a total lack of disrespect for everyone else on the planet."

Ott expects the oil industry to try and block such progress in systemic change. The standard polypropylene oil pads are, in fact, a profitable business product for those invested in petroleum; countless pads are produced annually to aid in cleaning up some 2,500 annual oil spills.

"These people are profiting from their own messes, and they have closed eyes and ears to any suggestion of [cleaning up the oil] in some new way."

***Beauty of Greasy Hair***

According to hair-mat inventor McCrory, synthetic mats hardly even work when compared to his seven-ounce, 10-inch-wide organic products, which are reputed to be able to soak up a quart of oil in less than two minutes. Squeezed and rung out like a wet towel, McCrory says that each mat can be used as many as 100 times, adding that the synthetic pads soak up a blend of approximately half oil, half water. Even less effective, he says, are "skimmers," vessels that enter oil slicks and vacuum the pollutant off the surface at a 9-to-1 ratio of water to oil, fluid far too diluted with water to be recuperated, which usually gets discarded or burned.

Amidst so much oil and interest in hair mats, is there enough human hair in the world to support this new technology? Almost certainly. In the United States alone, some 320,000 hair salons produce an average of a pound of hair every day, most of which currently goes to landfill. McCrory's hair mats are all produced at six locations in China and India, which also have ample hair resources, but Oakland's East Bay Depot of Creative Reuse, an arts and crafts recycling nonprofit, is arranging—with the help of the tireless Gautier, of course—to purchase the required needle-punch machine, arrange a compact with Bay Area barbers and establish the first domestic hair-mat factory.

**C**hange is in the air, and the vision shared by Stamets, McCrory, Ott, Gautier and so many other activists and mushroom fanatics seems to be materializing. The biotechnology of human hair and mushrooms is gaining support and could eventually replace antiquated, dirty methods of toxic-spill management.

"The oil-cleanup business is a hard revenue stream to break into, but there's been such a positive response," Gautier says. "I think this is really the kind of thing that the world can grab on to. We're all familiar with hair, oil and fungus, and this is a cheap and effective and organic system. We're proving that it works, and I think the San Francisco Bay Area, with all that's going on now after the spill, is going to revolutionize oil-spill cleanup."