UTILIZING LOWER LIFE FORMS FOR THE BIOCONVERSION OF PUTRESCENT WASTE *and how this could dramatically reduce carbon emissions*

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Suppose we were asked to imagine the best possible way to dispose of putrescent waste, to imagine a totally natural process that would affect an enormous reduction in the its weight and volume within a matter of just a few hours. Ideally this process should require no oil or natural gas, no gasoline or diesel, no coal or charcoal, no electricity or chemicals, absolutely nothing - not even water. The process should be totally self-contained and not emit a drop of effluent, and aside from a small amount of carbon dioxide, it should not produce methane or any other greenhouse gases.

The unit housing this process should operate with the simplicity of a garbage bin. It should have no moving parts, and it should require very little servicing and maintenance, very little expertise or experience to operate. It should not emit offensive odors, but at the same time, it should drive away houseflies and other filth-bearing flies. Since food waste would be rapidly reduced and recycled at its point of origin, it would eliminate altogether the collection, transport and land-filling of food waste. Similarly the huge problems associated with accumulation of manure at pig parlors, dairies and poultry farms would be solved.

This bioconversion process, however, should not demand the introduction of anything foreign or exotic. It should be powered by a creature commonly found throughout the whole of the Americas, and even though it may have lived alongside humans for thousands of years, it should not be associated in any way with the transmission of disease. In view of the wide variability of putrescent waste presented to it, this benign grub should possess one of the most robust digestive systems within nature. It must have the ability to thrive in the presence of salts, alcohols, ammonia and a variety of food toxins.

Upon reaching maturity, this creature should be rigidly regimented by evolution to migrate out of its feeding chamber and into a collection bucket without any human or mechanical intervention. This self-harvesting grub should represent a bundle of nutrients that should rival in commercial value the finest fish meal. Why not boldly insist upon the reintegration into the food chain of virtually all of the nutrients and energy contained within the waste?

Is the bioconversion process described above nothing but a fanciful leap of the imagination? Hopefully as you read on, it will become clear that this process does, indeed, exist, and that it represents the fastest, cleanest, most efficient, and most economical way to recycle food waste, manure and all other types of putrescent waste.

The agent chosen for this bioconversion process is the larva of the black soldier fly (BSF), *Hermetia illucens*. This species of fly is indigenous to the whole of the Americas, from the southern tip of Argentina to Boston and Seattle.

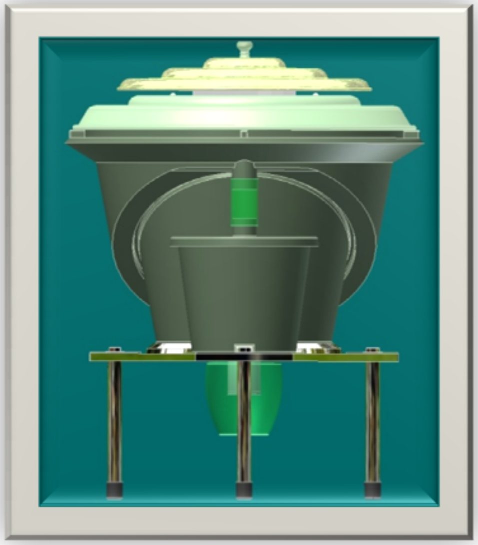
Unlike many other flies, BSF adults do not go into houses, they do not have functional mouth parts, they do not eat waste, they do not come into contact with waste, they do not regurgitate on human food, and consequently, they are not associated in any way with the transmission of disease. They do not bite, bother or pester humans in any way.

The basic bioconversion numbers associated with this process are quite incredible, and they are backed up and confirmed by many decades of intensive research in America, Australia and Asia. Each day BSF larvae can digest over 15 kilograms of putrescent waste per square meter of feeding surface area (3 lbs/ft^2). In the case of putrescent waste of a low cellulosic content, we also witness a reduction in weight and volume that reaches as high as 95%, and under normal conditions, all of this takes place within a period of less than 24 hours. Finally, in the case of rich substrates such as food waste or pig waste, we see that 20% by weight of the fresh waste bio-converts into fresh larvae.

Thousands upon thousands of active larvae can be found in a putrescent waste disposal unit, and in contrast to red worms, these larvae have the ability to eat and digest just about any type of fresh putrescent waste, including meat and dairy products. The moment the waste is deposited into the unit, the larvae begin to eat it long before it begins to rot and smell. But the larvae, nonetheless, do give off a distinctive odor (not offensive to humans) that drives away houseflies and all other flies that are a pest to humans.

After reaching maturity BSF larvae will crawl long distances in search of an ideal pupation site. Prepupal migration initially appears to be a random search for a way out of the waste. If a ramp of an upward inclination lies at the edge of the waste, the larvae will make every effort to climb up this ramp. If, at the summit of the ramp, an exit hole is provided, the larvae will fall neatly and cleanly right into a collection bucket.

Note that BSF larvae are totally self-harvesting. They abandon the waste only when they have reached their final mature prepupal stage, and they crawl out of the waste and into a collection bucket without any mechanical or human intervention.



BSF bioconversion units (called *biopods*) are now being manufactured in a medium density polyethylene that lasts indefinitely. A nominal 2-foot diameter biopod (depicted on the left), weighing only 14 lbs (6.4 kg), can process over a metric ton of putrescent waste per year. A nominal 4-foot diameter biopod, weighing about 40 lbs (18 kg), can process well over five metric tons of putrescent waste per year.

Therefore, why should we go on collecting and land-filling food waste? Why should we allow manure to accumulate on farms in unmanageable proportions? Why do we compromise the health of birds and animals by raising them in close proximity to their waste? Why do we go on pumping these creatures with antibiotics? Why do we eat the flesh of birds and animals grown under such wretched conditions?

All of this becomes even more nonsensical when we consider the value of BSF larvae. BSF larvae have a dry matter content of almost 50%, and this dry matter is incredibly rich in nutrients. It has a protein content of 42% and a fat content of 34%. It has roughly the same value as Menhaden fish meal valued at over $1,200 US dollars per ton.

Of course BSF larvae emit a small amount of CO^2 as they eat and digest putrescent waste, but such an amount of CO^2 is negligible relative to what happens when putrescent waste is dumped in landfills or accumulates in lagoons. BSF larvae begin eating putrescent waste the minute it is made available to them, long before anaerobic or even aerobic bacteria have an opportunity to degrade it.

Not only do BSF larvae prevent anaerobic bacteria from transforming waste into methane, but they also prevent the huge release of CO^2 that mesophilic or thermophilic bacteria would generate if the waste were composted. Furthermore BSF bioconversion generates far less CO^2 than even vermi-composting seen as an isolated process, since red worms do not eat fresh putrescent waste but depend upon bacteria to do an initial breakdown of waste. This initial degradation of waste by bacteria releases large amounts of CO^2 into the environment and consequently is far from ideal.

However when larval bioconversion precedes vermi-composting, nothing could be more efficient. The larvae capture nutrients long before bacteria have had a chance to degrade them, and the non-putrescent BSF residue constitutes an ideal substrate for red worms. Recent studies in Asia indicate that BSF residue allows red worms to grow three to five times faster than when fed fresh putrescent waste. Not only do the proteins and fats made available in the larvae and red worms rival in quality those of the finest fish meal, but they also represent the most efficient extraction and conservation of nutrients and energy to be found anywhere within the natural world.

By allowing BSF larvae and red worms to extract proteins and fats from our waste, we do not have to turn to our oceans and farmlands to obtain these nutrients. When we consider the enormous energy expended in fishing and agriculture, the utilization of these lower life forms becomes an irresistible option to anyone seriously concerned about reducing carbon emissions.

But the story does not end here. When red worm castings are made available to a plant as fertilizer, the plant will require far less nitrogen derived from fossil fuels and far less phosphorous extracted from phosphorous-bearing rocks (an energy intensive process). Most nitrogen fertilizers are derived from natural gas, and world reserves of phosphorous are rapidly dwindling and increasingly contaminated with pollutants such as cadmium.

We talk a lot about sustainability, but we will never relate to nature in a sustainable manner until we give back to nature in a closed loop all of the nutrients that she needs to sustain us. Capturing all of the nutrients in our waste and making these nutrients available to the life processes that support us is surely our first and most important obligation as citizens of plant Earth.

Likewise, we talk a lot about reducing carbon emissions. But until we learn to utilize lower life forms to recycle putrescent waste, any attempt to achieve significant reductions in carbon emissions will always fall short.