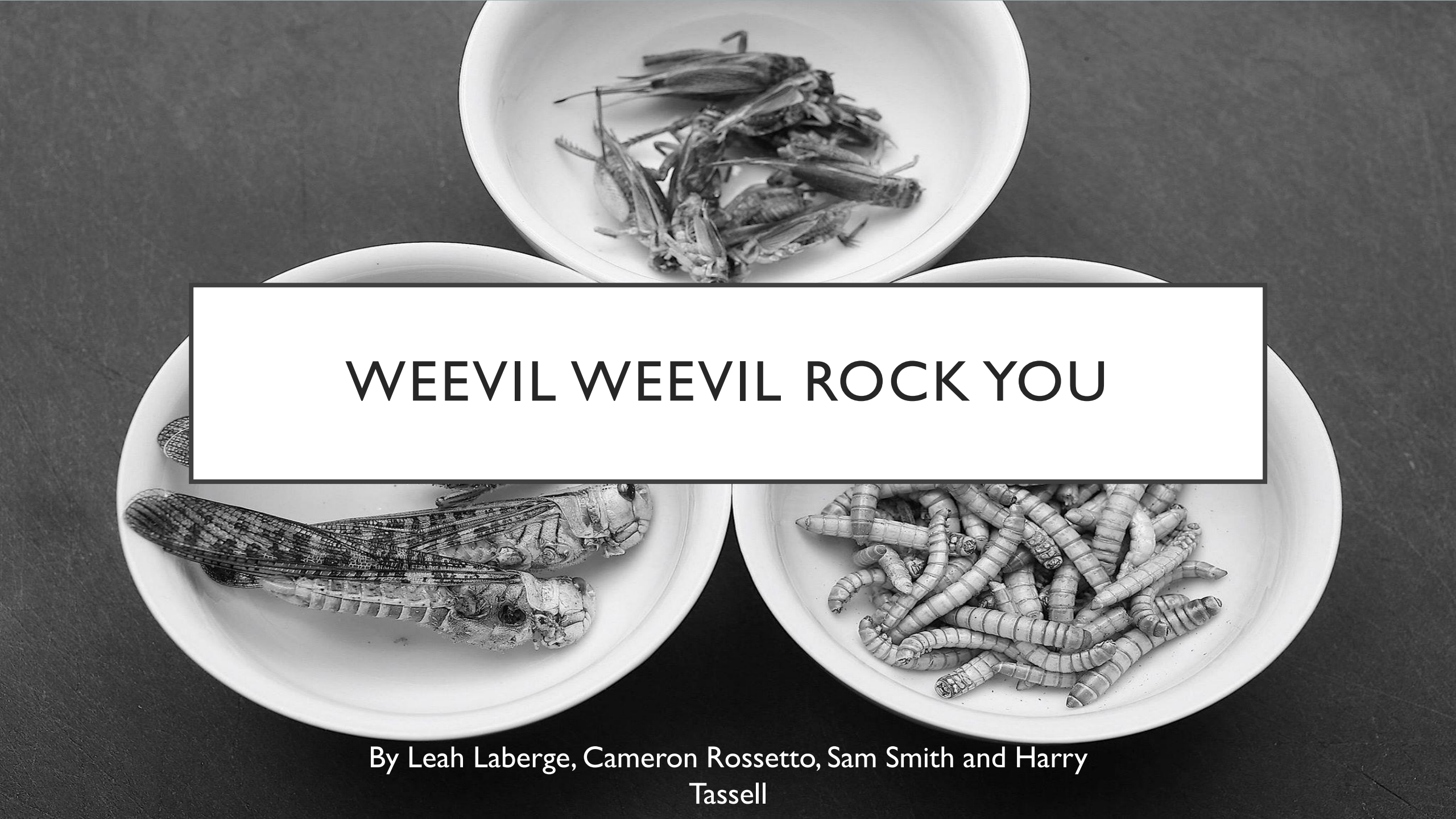


WEEVIL WEEVIL ROCK YOU

By Leah Laberge, Cameron Rossetto, Sam Smith and Harry Tassell

INSECT FARMING

Lets talk about how great shifting to farming insects could be for mitigating climate change!

By Leah LaBerge

Edited by Harry Tassell

SUSTAINABLE INSECT FARMING VS. MODERN LIVESTOCK INDUSTRY

A meat-eating lifestyle has been embraced by most cultures in the world since agriculture became the prominent source of our food supply. Today the meat industry has evolved to one of the highest contributor's to climate change. These unsustainable food production practices have led to huge increase in rates of greenhouse gasses, land overuse, erosion, overconsumption of water, bio waste, toxic runoff, deforestation, and species extinction, people are increasingly questioning how ethical this industry really is. With these current problems in mind, converting to sustainable insect farming may be a right step in mitigation our environmental footprint.

HISTORICAL INSECT CONSUMPTION

- The well-known days of hunting and gathering are often remembered strictly as gathering berries and hunting wild game, however, for many people insects have always been an important source of food. Historically what was brought to the dinner table depended highly on what was in your surrounding area. As human transportation was at one point limited to where an immediate food and water source is. Those living in areas such as South America, Asia, Africa, Australia and New Zealand, there were nearly 1000-2000 species of edible insects available, and would have been more likely to add them into their diets. Here on the coast, living off the land meant utilizing our rivers and coast lines for salmon, sea otters and whales, or foraging our lush forest for plants and fruits. Incorporating insects into this location may of helped relieve some of the stress that had been put on the coast.

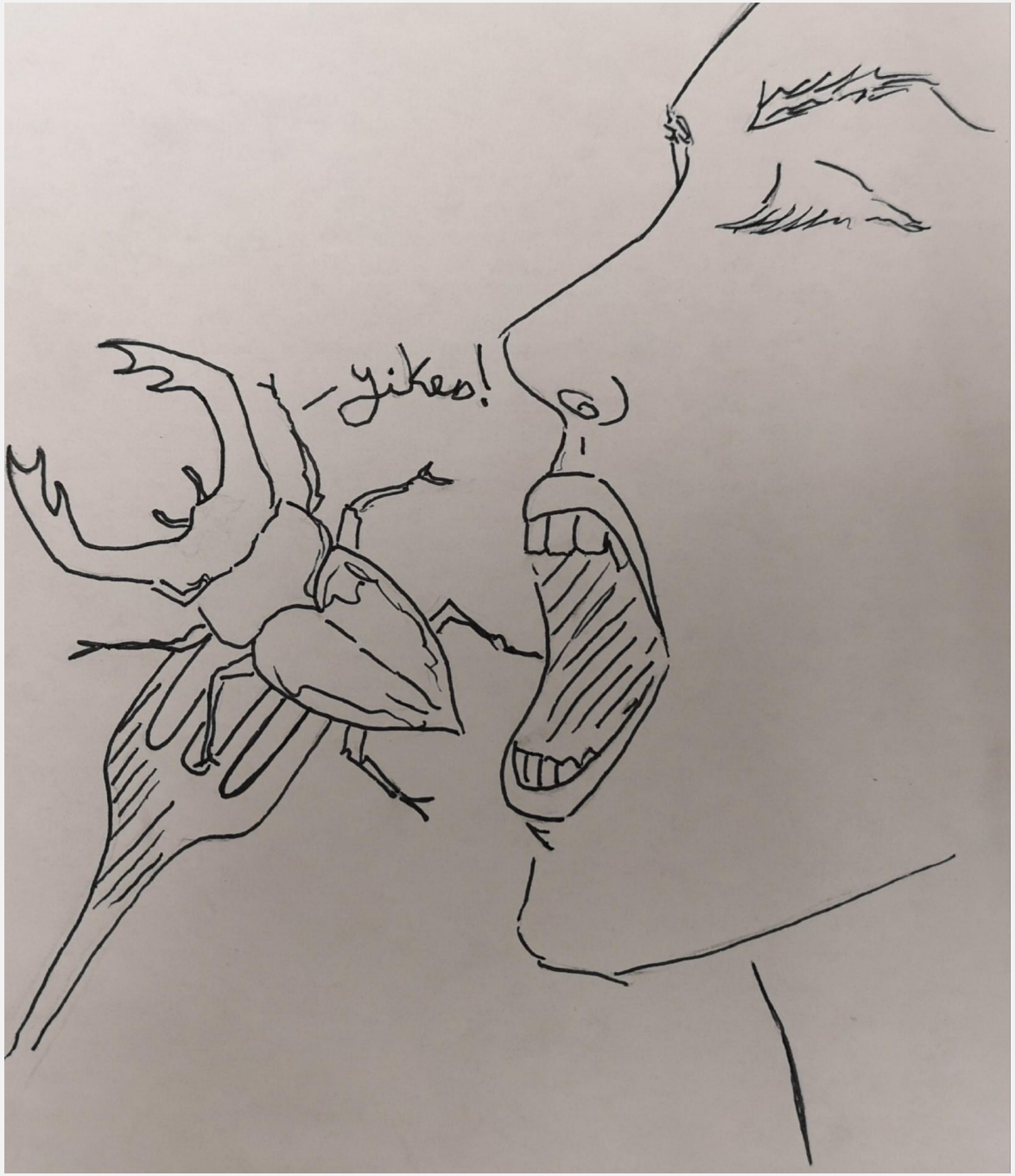
VS.

Thailand, Southeast Asia

West Coast B.C. Canada
North America

STIGMATIZATION OF INSECT FARMING

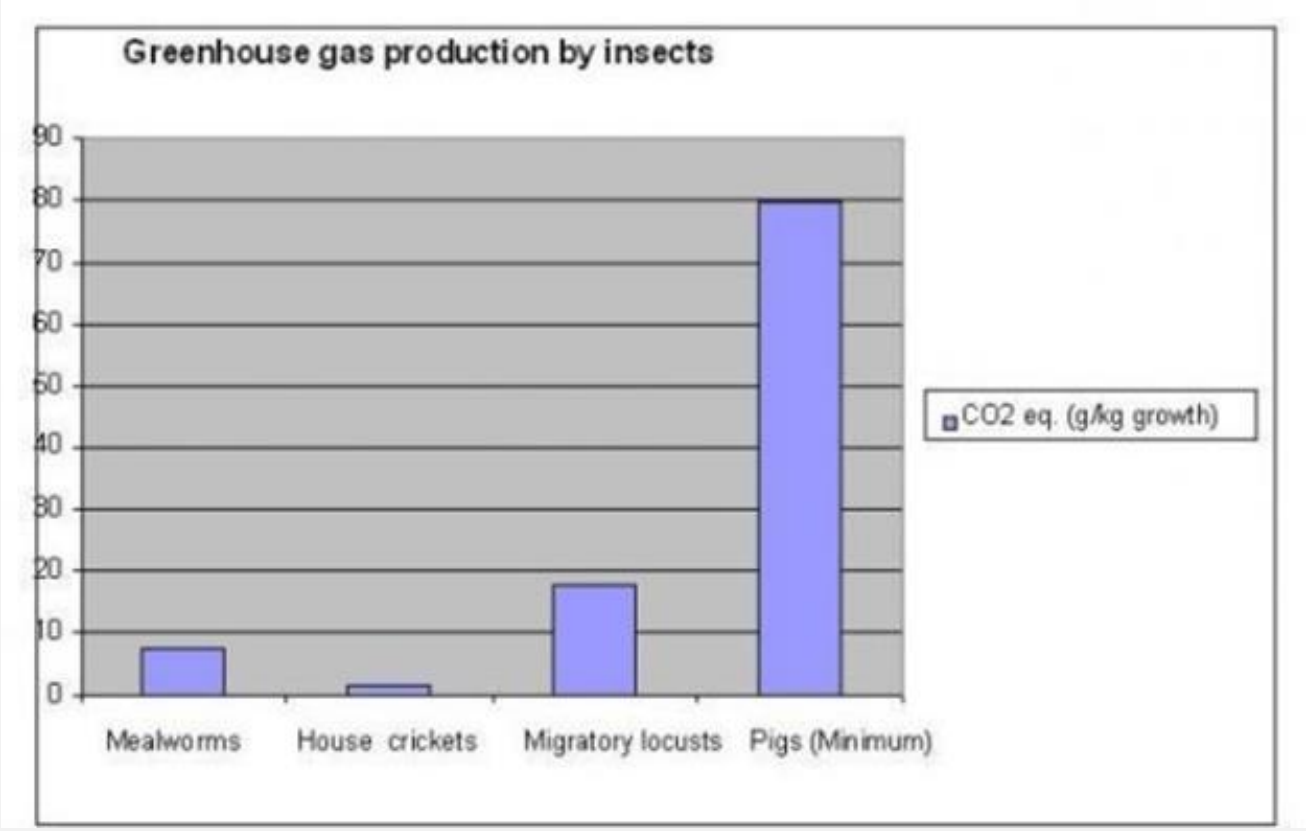
- Introducing an insect farm has its challenges as there is still limited specific education offered in how to start and manage a farm, and there is likely confusion due to the lack of regulations in place. Not to mention convincing people in a culture that does not traditionally incorporate insects in to their diet to buy your product. The western nations have unfortunately mastered the art of masking where and how we get our food, and it has created a discomfort around eating creepy crawly bugs. Working with nations that already farm insects successfully can help in mitigating some of these issues by utilizing their knowledge and experience. Globalization of the world has increased our ability to transport almost any good and service demanded, introducing insect farming around the world can more readily be done and at a lower cost. The needed knowledge for the practice of farming insects can also be passed on, so areas new to this practice can start with some base understanding.


Yikes!

EMISSIONS

Modern farming unfortunately has many environmental impacts in the form of both greenhouse gas emissions and water pollution by pesticides and fertilizer. Methane and CO2 in large quantities dangerously lower the earth's air quality and begin to break down the protective ozone layer. The livestock industry is one of the largest contributors to this problem as the demand for meat proteins increase with our rapidly growing population. Its understandable why the methane levels produced by this industry are hard to control, as most of these animals are very large, and require so much food that they are often fed a poor diet in order to make feeding so many large animals economically feasible. In an effort to find a solution, scientists have compared emissions by livestock and insects using an equal mass of both and discovered that insects emit nearly 80% less methane! Why insects produce less methane can be explained through a case study done by the Department of Microbiology and Evolutionary Biology at the university of Nijmegen. By examining various insect families and recording the chemicals they produced as they digest, scientists discovered that methane emission was restricted to Diplopoda, Blattaria, Isoptera, and Cetonidae and the representatives of the other arthropod taxa proved to be negative. What this means is some insects produce literally no methane at all!

EMISSION CONT.

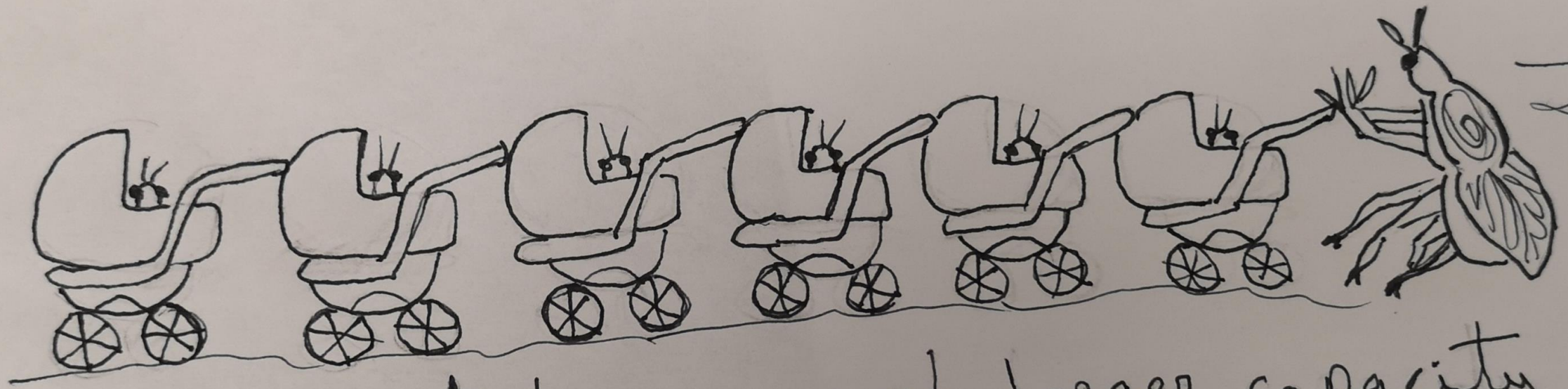


ENVIRONMENT

- Producing livestock is not only hard on our environment but wears on farmer's wallets. From purchasing thousands of acres of land, feeding large animals that constantly must graze, keeping them healthy with vaccines and medications as they are crammed into small dirty spaces for the entirety of their life, to the continued costs of then producing, packaging, and transporting the meat to buyers. Insects are much more sustainable than most other forms of animal farming as insects basically convert their food to body mass that we can eat. Moreover, they eat many different things, so they are not very demanding.

WATER

Water use in the livestock industry is huge. Consider, its needed for watering feed, watering the animal itself, cleaning the living area and processing the protein once its been harvested. Because of the size of livestock, they require a greater amount of water to sustain, as well as millions of acres dedicated to growing feed such as corn and grasses for them. Insects win this round again as even in mass their small compact bodies require significantly less water and feed, plus once harvested, they require very little water for processing, limited to just sanitizing them for wholesale. As mentioned previously, insect's adaptability means they do not require antibiotics, contamination in runoff is lowered and humans will not ingest harmful second-hand hormones and antibiotics. But apart from polluting waterways, lakes, and groundwater with pesticides and sending large amounts of CO2 up into the atmosphere, livestock production requires lots of land, which often requires converting the natural landscape to fields.



Many insects have a much larger capacity to reproduce than large meat raised livestock

LAND

Unlike livestock, Insects do not require mass deforestation for grazing land or livestock feed agriculture. In fact, many edible insect species naturally live as large groups in rather confined spaces, furthermore, may not need to be confined into one space to be farmed if done seasonally. This benefits insect farming as they are less susceptible to suffering stress while confined for farming purposes, and therefore may be farmed in urban settings, lowering transportation costs, and land use.

HIPPO-CRITICAL
BY KIRBTAROOS

FOOD ETHICS

Insects anatomy makes them suitable for todays growing demand in animal protein in that the are highly adaptable to different habitats and resilient to stressors. The silk worm's small size and short metamorphosis allow them to grow quickly using much less food, water and volume of area in the process. Already 70% of agricultural land and 30% of all land on earth are utilized to raise animals. Furthermore, unlike most livestock that produces around 2-12 offspring per year, a single insect can often lay upwards of hundreds of eggs at a time resulting in them multiply extremely fast. The question of whether livestock slaughter is or can be ethically done can be countered with insects' ability to thermoregulate their bodies. They are capable of two different types of dormancy; insects will naturally become dormant in advance of harsh conditions, known as predictive dormancy, and there is consequential dormancy which is an immediate response to harsh conditions. This means that the process of insect farming can be made ethical by triggering consequential dormancy by freezing them, and within a matter of days they will unconsciously die.

REFERENCES

- http://cases.open.ubc.ca/environmental-impact-of-meat-consumption/
- http://sciencenordic.com/how-much-more-environmentally-friendly-it-eat-insects
- https://www.wur.nl/en/show/Edible-insects-produce-smaller-quantities-of-greenhouse-gasses-than-cattle.htm
- https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/insect-farming

WHY EAT INSECTS?

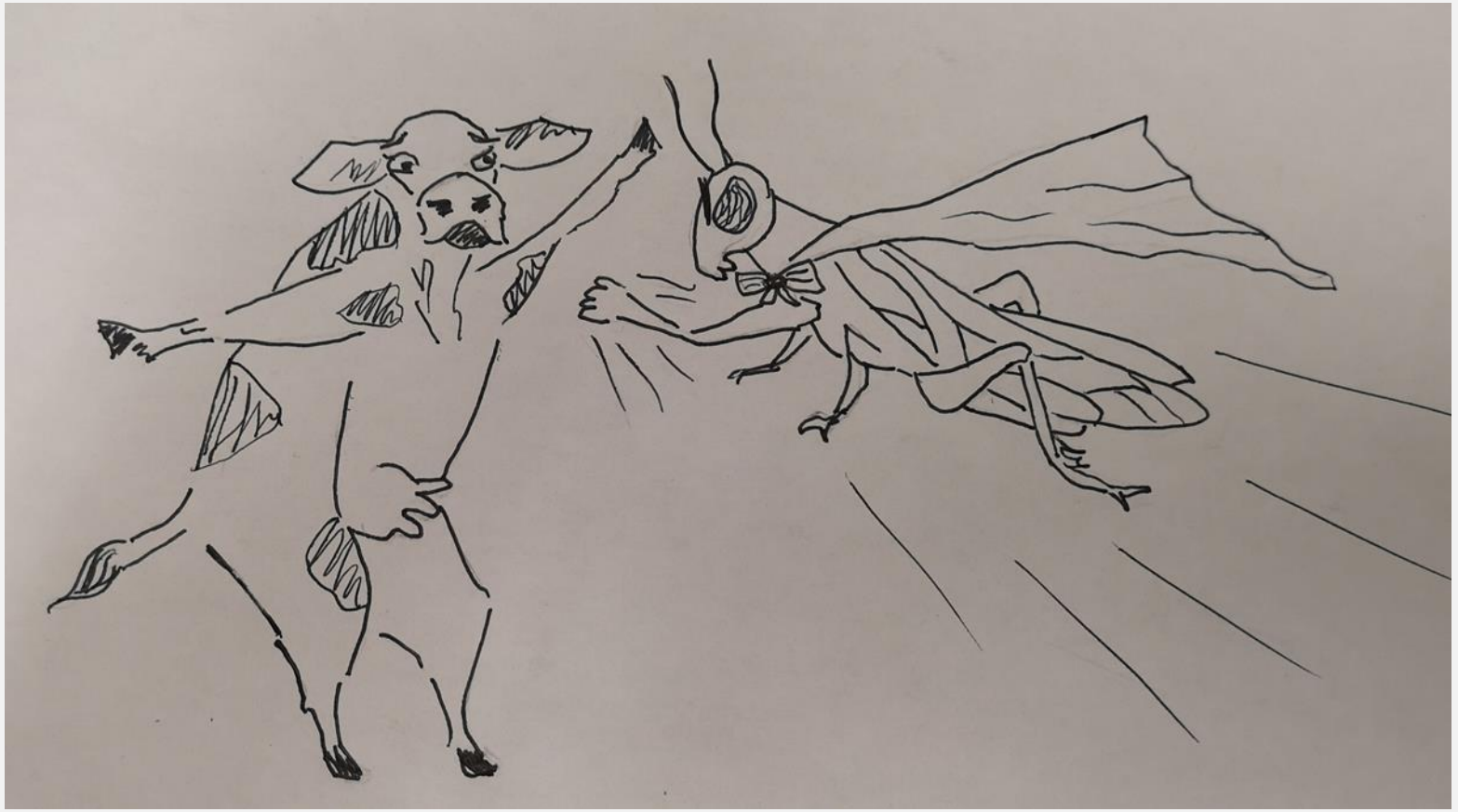
By Harry Tassell

Edited by Leah Laberge

WHY SHOULD WE EAT BUGS?

- As the human population of the world continues to grow at alarming rates, the question many people are asking is, are we going to be able to feed the entire population? With traditional livestock farming practices stressing many of our natural resources for little in return we must turn somewhere else. This is where insects come to play! Since the beginning of human evolution, many cultures have already been utilizing insect protein in their everyday meals. Crickets are just one more popular example among thousands of edible insects available that offer a cheap and sustainable source of complete protein and essential amino acids.

CRICKETS VS BEEF[1]



CRICKETS VS BEEF[1]

Nutrition	Beef	Eggs	Cricket flour
Calories	200	200	200
Protien (g)	22.4	19	31
Fat (g)	11	15	8

- Here we can see a comparison between 200 calories by dry weight, of beef, chicken eggs and cricket flour. The cricket flour absolutely blows the beef and eggs out of the water with its nutritional values! It offers close to 10 grams more protein than beef and a whopping 12 grams of protein more than eggs! As well as offering sustainably less amounts of fat. When considering the environmental foot print left by each individual livestock harvested, in this case beef, the crickets win producing next to no harmful emissions and requiring very little land, feed, and water in comparison. Furthermore, crickets are entirely edible so each single cricket you eat that by dry weight ranges between 65-70 percent pure protein leaves no waste, while beef is only between 17-40 percent protein with carcasses and unfavourable cuts left behind. What's more is, this is simply comparing beef to one of the thousands of edible insects available!

SUSTAINABILITY[1]

- It is estimated that crickets are 20 times more efficient as a source of protein. Its important to considering the masses of feed required to sustain our protein livestock. To produce the our common livestock requires substantially more; cattle require six times more feed than crickets, Sheep require four times the amount as crickets, and pigs require twice as a much feed as crickets. Crickets also require far less water than cattle, to get a pound of dry protein from cattle, it requires between 1,700 – 2,500 gallons of water. Where as to get the same pound of dry protein from crickets the amount of water is only one gallon. That is between on average 2100 times less water needed by crickets! As well as require less food and less water crickets also produce 80 times less methane than cattle making them even more environmentally friendly!

GROWING YOUR OWN INSECTS

- Growing your own insects is an easy hobby to get into, it is relatively cheap to get started as there is no need for any specialized equipment or materials. It can be done as a artisanal farming, this also means that it can be done pretty much anywhere in the world, as well as requiring little space to get going, they also only need minimal amounts of resources such as food and water. Many websites these days are now offering starter batches of bugs, meaning you can get them delivered directly to your doorstep. Furthermore, many of these kits come with instructions on how to get started. www.tiny-farms.com offers a beginner kit for only $22, the basic kit is enough to get started. However, if you really want to get into farming mealworms, they offer a full kit for $154, this includes everything you need to start producing 1kg of mealworms per month. They also offer differing farm plans and how to get started for free on their website, as well as how to build the infrastructure needed.

TIPS FOR EATING INSECTS[1]

- Insects not only bring a higher nutritional value to the table compared to beef. They also bring exciting new flavours and textures to your diet. They enable us to try different regional and ethnic foods, for example in Vietnam fried crickets on a stick with different flavours are a common snack and street food vendor item, fried ant eggs are also a common side dish in Vietnam. In Ghana, they termites are one of the main sources of protein in the spring months when food is short, they can be fried, roasted or even made into a type of bead. Even now in Canada people have been known to partake in the eating of ethnic food and drinks contain insects, one of the most common one that people know about already is the tequila worm. More often than not the hardest bug to eat is also your first one, after the first one it gets easier. If your first bug is the hardest you could try fried or dried flavoured crickets, which come in a variety of flavours like salt and vinegar, sour cream and onion or even chocolate covered.

MORE TIPS[1]

- Here are some quick tips for adding insects to your diet
- Replace 1/3 of the flour that the recipe calls for with cricket flour
- Add cricket flour to smoothies for a boost of protein (think of it like adding chia seeds to the smoothie!)
- You can sprinkle dried crickets into your salads or on your pizza!
- Add dried crickets to your spaghetti sauce

CRICKET CHIP COOKIE RECIPE[2]

- **Ingredients needed**
- ½ cup of soft butter
- ½ cup of white sugar
- ½ cup of brown sugar
- 1 egg
- 1 tsp vanilla
- ½ tsp baking soda
- 1 tsp hot water
- ¼ tsp salt
- 1 ¼ cup of flour
- ¼ cup of cricket flour
- ¾ cup of chocolate chips

Directions

Preheat your oven to 350F

In a large mixing bowl cream together the butter and sugars

While mixing add the egg and vanilla

Dissolve the baking soda in hot water and add to the butter mixture as well as adding the salt

In a second bowl mix together the remaining ingredients, then add to the wet mix and continue to fold until the chocolate chips are well mixed in!

Spread the dough out on a cookie sheet, making sure the cookies are spaced properly

Cook for 10-12 minutes or until the edges are golden brown

Enjoy!

REFERENCES

1) https://draxe.com/cricket-flour/

2) http://entomofarms.com/featured_item/bite-sized-chocolate-chip-cricket-cookies/

3) https://www.tiny-farms.com/

4) https://travel.usnews.com/gallery/countries_that_eat_bugs

BIOCONTROL

The use of Insects as Pest Control

By

Cameron Rossetto

Edited by Sam Smith

WHAT IS BIOCONTROL

- Biocontrol's are the use of the natural enemies of unwanted pest or invasive species to control or diminish its population to a desired level. In the case of insects as the biocontrol, the use of predator/prey relationship can be used to protect a plant by introducing a natural predator insect to attack the population of a plant damaging insect, or to directly attack a plant if it is an unwanted weed or invasive species. This method is known as classical biocontrol because it is an induced change to the population of a natural system already in place. The use of classical controls can have long lasting effects as it responds to growths and reductions in populations. The biocontrol insects' populations will decrease with the loss of prey, where as if the prey species has a population spike there is the sudden availability of food for the predator insect's population to grow. There are also types biocontrol's that use natural pathogens of the pest insects to wipe out entire populations at once but do not have long lasting effects (3).

CLASSICAL CONTROLS

The use of classical controls are the introduction of man-made herbicides and pesticides. These can range from a natural pathogen that is put into a form that is easily dispersed to man made chemicals. Examples of classical controls are:

- **Btk**: Bacillus Thuringiensis Kurstaki (BTK) is a natural bacteria that is found in soil that affects caterpillars only. The product is sprayed on foliage in the form of small crystals that dissolve in the alkaline guts of the caterpillar after they have eaten them. Inside the crystal is an endo toxin that reacts with the alkaline gut to create a toxin that destroys and paralyzes the gut walls. This causes the caterpillar to stop eating and starve to death (4).
- **NVP**: Nucleopolyhedrovirus (NPV) acts similar to BTK in many ways. It is a naturally occurring virus that has been put into a crystal form for the caterpillar to ingest. Once the crystal dissolves in the gut, the virus is released and attaches itself to the gut walls allowing it to replicate and spread throughout the body of the caterpillar. The virus eventually kills the caterpillar and the body will swell and rupture releasing a goop that helps to spread the virus (5).
- **Chemical Pesticides**: Man made chemical products such as Raid or Roundup have been very useful for eliminating unwanted plants and insects. These chemicals however have various unwanted effects that make the use of biocontrol's more appealing. The targeted pests can become resistant to the chemical sprays and become "super pests" causing formulas to change or become stronger. These chemicals can spread all over an environment and into food sources if not properly cleaned off or into water systems. They can adversely affect humans and non targeted species by making them sick or potentially killing them, due to the chemicals not being species specific (6).

TYPES OF BIOCONTROL INSECTS (3)

Biocontrol's can be divided in into several categories based on how they attack the intended target:

- **Predator Insects**: Feeds on pest insects.
- **Gall Producing Insects**: Insects produce galls to divert nutrients to gall instead of plant growth.
- **Defoliators**: Eats leaves and stem tissues to reduce plants ability to create nutrients.
- **Sap Suckers**: Feed on the nutrients produced by the plants weakening them.
- **Flower and Seed Feeders**: Feed on seeds and other reproductive tissue of plants.
- **Stem Miners**: Larvae mine into plants and eats plant tissues impairing nutrient transport, as well as can carry pathogens.
- **Crown Feeders**: Insects feed on plant crown reducing the nutrient transport and reserves.
- **Root Feeders**: Insects that bore into roots disrupting nutrient and water uptake.
- **Parasites/Parasitoids**: Insects that live in or on another organism, at the expense of the other organism.

ADVANTAGES & DISADVANTAGES (1)

The use of insects as a biocontrol has both advantages and disadvantages compared to traditional methods such as herbicides and pesticides.

Advantages:

- Pest control is highly targeted meaning that the introduced control will only attack the desired pest. Traditional herbicide and pesticides are spread throughout an area to be treated and can impact non-targeted species as well as leach into other systems.
- After introduction the insects are fairly self sustaining and require little assistance and upkeep. The population will be controlled based on the availability of the pest as a food source.
- Over a long period, the use of insects is a cost effective due to it usually being a one-time application instead of a seasonal or multi seasonal application with traditional methods.
- Due to the introduced insect being used to target a specific pest they are highly effective.

Disadvantages:

- With the introduction of the biocontrol there is the possibility of unwanted effects. They may switch to a different insect or plant than intended after they have diminished the targeted pest and disrupt natural food chains.
- Pesticides and herbicides act immediately to eliminate the targeted pests, however introduced species will take time to establish a population that has an effect.
- They are not a complete solution as they require something to feed on, so they act only to control the population of the pest not eliminate it.
- It is time and money extensive to set up as there are regulations to acquiring and releasing species into a natural system.

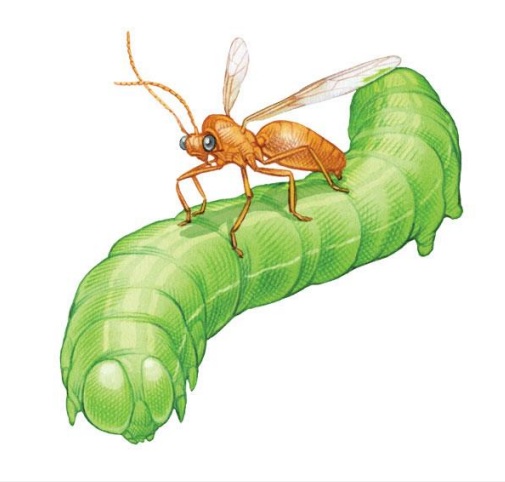
EXAMPLES

- One of the most common examples of biocontrol is the use of ladybugs to reduce the population of aphids. They can be used on various scales from small home gardens to large scale horticulture. Ladybugs are used to target aphids that damage plants through consumption (7).
- The Emerald Ash Borer is the cause of destruction to many of Canadas ash trees, however there are several species of parasitic wasps (Tetrastichus planipennisi, Eulophidae wasp family; Spathius agrili and Spathius galinae, Braconidae wasp family; and Oobius agrili, Encyrtidae wasp family) that lay eggs on or in the larvae of the Emerald Ash Borer making them a good biocontrol (2).

Ladybug eating an aphid, Source: https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=13933

Emerald Ash Borer, Source: http://www.inspection.gc.ca/plants/plant-pests-invasive-species/insects/emerald-ash-borer/eng/1337273882117/1337273975030

Eulophidae Wasp, Source: https://www.forestryimages.org/browse/detail.cfm?imgnum=5402604



Wasp laying eggs in caterpillar with Ovipositor, Source: https://www.motherearthnews.com/organic-gardening/pest-control/beneficial-insects-braconid-wasps-zw0z1301zkin

REFERENCES

1) Csanyi, C. (2019, January 10). Advantages & Disadvantages of Biological Control. Retrieved from https://sciencing.com/advantages-disadvantages-biological-control-8088070.html

2) Government of Canada, Canadian Food Inspection Agency, & Plant Health and Biosecurity Directorate. (2018, January 19). Questions and Answers: Wasps as biological control agents for Emerald Ash Borers. Retrieved from http://www.inspection.gc.ca/plants/plant-pests-invasive-species/insects/emerald-ash-borer/wasps/eng/1371137262586/1371137530758

3) Ministry of Forests. (2007, May 17). Invasive Alien Plant Program. Retrieved from https://www.for.gov.bc.ca/hra/plants/biocontrol/what.htm#What

4) Ministry of Forests Lands and Natural Resource Operations. (2018, November 02). What is BTK? Retrieved from https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our- forest-resources/forest-health/forest-pests/invasive-forest-pests/gypsy-moth/what-is-btk

5) NPV (nucleopolyhedrovirus). (2013, January 01). Retrieved from https://www.daf.qld.gov.au/business-priorities/agriculture/plants/crops-pastures/pest-beneficials/beneficials-a-z/npv-nucleopolyhedrovirus

6) Pros and Cons of Pesticides. (2019, January 05). Retrieved from https://www.prosancons.com/medicine/pros-and-cons-of-pesticides/

7) United States Department of Agriculture - Research, Education and Economics. (2013, January 11). Ladybugs diet influences effectiveness as biocontrol agent. *ScienceDaily*. Retrieved February 19, 2019 from www.sciencedaily.com/releases/2013/01/130111110920.htm

SUSTAINABILITY AND BUG PRODUCTS

By Sam Smith

Edited by Cameron Rossetto

WHY IS THERE A NEED FOR SUSTAINABLE PRODUCTS?

- As previously discussed humanity moves into an era of heightened population, projected at roughly 9 and a half billion by 2050. With this large increase in population all kinds of resources will inevitably become scarce. Food and Water are of the main concerns. Current agricultural practices are resource and land intensive, but bugs offer us a sustainable solution to food and other products. This section will break down specific 'bug alternative' products and explain why they are more sustainable than their counterparts.

WHAT IS SUSTAINABILITY?

Firstly, before we can breakdown a list of products, we must have a basic understanding of sustainability. A product that is considered Sustainable should be able to maintain high levels of production without depletion of resources or be renewable, and should have little to no damage to the environment from production to consumption.

THE PRODUCTS

- Bug products come in a wide rage of shapes of forms and are used in all aspects of humanities lives in the past an in the present day we are still finding uses for them as the tailor to many of our every day need.

- The products:
  - Beeswax
  - Medicinal Uses
  - Silks

Be aware this is only a small window into the things we use bugs for.

BEESWAX

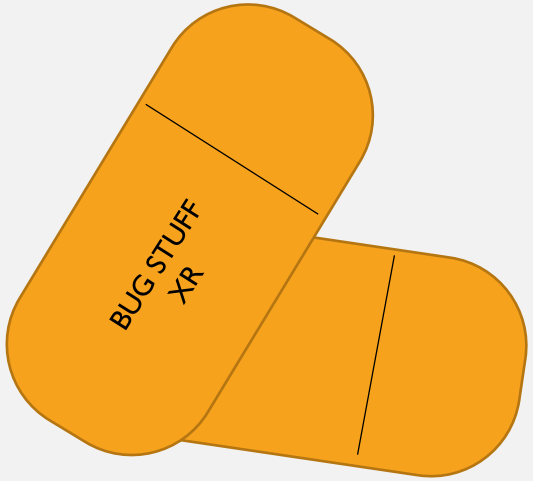
- Beeswax is a sustainable byproduct of honey production from bees. Beeswax comes from honeycomb and what makes this sustainable is that beekeepers are only taking the excess; allowing the bees to generate new comb. This helps the bees as they also prefer to lay eggs and rear their young in fresh honeycomb. Beeswax is a sustainable product if managed right and it has a plethora of uses:
  - Candles that burn longer and slower than paraffin wax
  - Prevents rust on tools and coating nails and screws stops wood from splitting
  - Can be used as hair product
  - Waterproofing and polishing shoes

BEESWAX CONTINUED…

- One thing that beeswax also offers is the potential for a new type of packaging that could replace plastic. With the combination of plant wastes and beeswax there is now a procedure to chemically create a film-like structure that resembles that of a plastic bag. What's more fascinating is that the beeswax addition enhanced the strength and water resistance of the newly formed compound!

MEDICINE

- Insects have been used for thousands of years in traditional medicine, though modern medicine typically does not use insects, this doesn't mean they aren't effective. Maggots are a good example of this, studies have shown that larval therapy on an open wound can be much more effective at healing than a bandaging the wound. The barrier here seems to be stigma surrounding the bugs rather than truly investigating the benefits of them.
- Bugs have other uses in the medical field too, with flu vaccines potentially being created using insect cells. Traditionally the vaccines are grown within chicken eggs however this has led to allergic reactions and this is why there is now looking at the use of insects for these vaccines.



MEDICINE CONTINUED

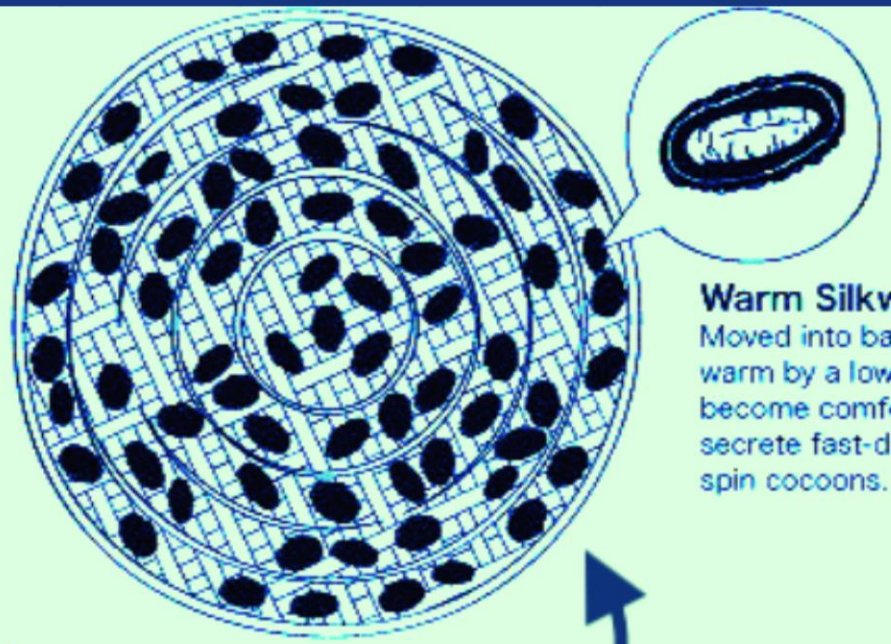
- The *Formicidae* family, or Ants, are also another group of bugs that are showing more and more uses in the medical field, with research showing a variety of uses. The Chinese Black ant (*on the right*), has been used as food and medicine in Asian cultures for year, and is now making its way onto the modern medical scene due to its anti-inflammatory, kidney protective, and immunosuppressive properties. When you consider the differences of farming ants versus industrial drug making processes, you then gain an understanding of how much less resources and money you spend in the long run. Another honorable mention goes to the wasps and the bees as their stings contain a high number of antibiotics and pain reducing chemicals. Bee stings have also been known to help treat rheumatoid arthritis.

SILKS

- Silks like medicine have very old roots in human use. Approximately 90% of today's silk comes from the *Lepidoptera* family of silkworms. Silks are used for textiles and are considered a luxury material because of their high tensile strength and their ability to bind to dyes. Sericulture is the farming of silk. The practice involves feeding the silkworm larvae mulberry leaves and on the 4th molt the larvae spins the cocoon that is made out of silk.

Collect Eggs

Each female moth lays 200-300 eggs onto paper or cloth sheets.



Warm Silkworms

Moved into bamboo trays kept warm by a low flame, silkworms become comfortable and secrete fast-drying liquid silk to spin cocoons.

Collect Cocoons

Silkworms seal themselves inside a cocoon in just two days. The entire process, from egg to complete cocoon, takes 20-25 days.

Extract Thread

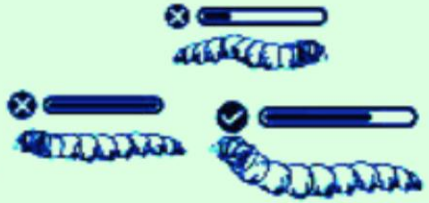
Cocoons are softened in boiling water. Workers locate the end of the thread and unwind the cocoon to 1-1.5 kilometers of continuous thread.

Prep For Sale

Dyeing, weaving & spinning.

Test Readiness

Check between the silkworm's rear pair of legs - if you see a gray mass, it's too early; when the mass turns translucent, the silkworm is ready to cocoon.

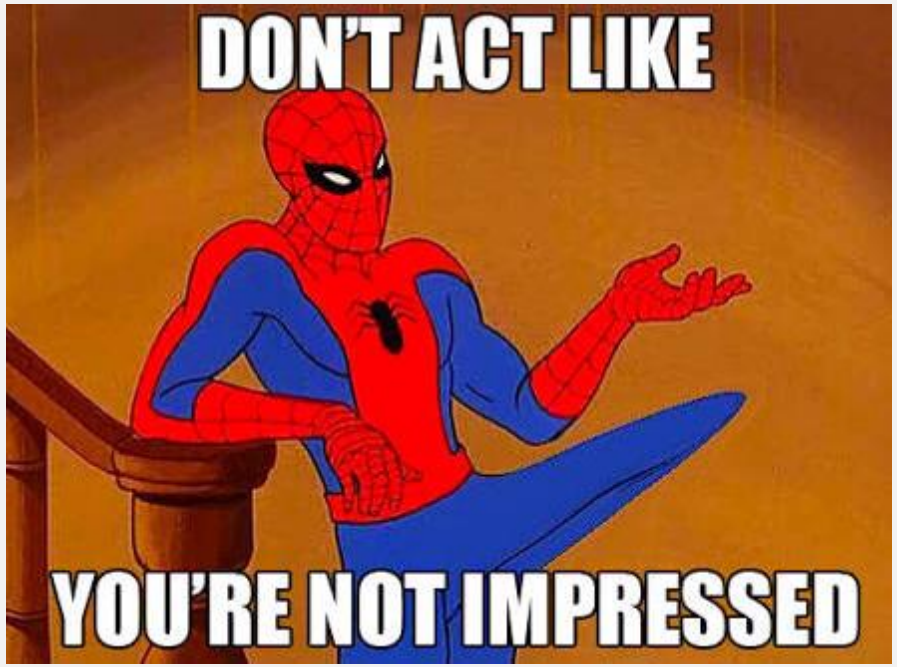


Hatch & Feed

Baby silkworms hatch from the eggs and eat mulberry leaves. Traditionally, the first hatching comes three days after the Tomb Sweeping Day in early April.

OTHER POSSIBILITIES WITH SILK

- Spider silk is also something that people are looking to try and exploit. Pound for pound spider silk is 5 time the strength of steel, meaning that it can be used as replacements for many materials with the benefit of strength and weight savings. Many of the possible uses have being geared to use in tissue engineering. The goal here is to better reproduce ligament or tendon tissues. You could be a real-life spider man!!!



REFERENCES

- https://news.un.org/en/story/2013/06/442212-world-population-projected-reach-96-billion-2050-un-report#.V6or25h97b0
- Bessa, L. W., Pieterse, E., Sigge, G., & Hoffman, L. C. (2017). Insects as human food; from farm to fork. *Journal of the Science of Food and Agriculture*. DOI 10.1002/jsfa.8860
- https://www.thebalancesmb.com/edible-insects-as-sustainable-food-alternatives-4153360
- Tedeschi, G., Benitez, J. J., Ceseracciu, L., Dastmalchi, K., Itin, B., Stark, R. E., . . . Heredia-Guerrero, J. A. (2018). Sustainable fabrication of plant cuticle-like packaging films from tomato pomace agro-waste, beeswax, and alginate. *ACS Sustainable Chemistry & Engineering, 6*(11), 14955-14966. doi:10.1021/acssuschemeng.8b03450
- https://econation.co.nz/beeswax/
- Cherniack, E. P. (2010). Bugs as drugs, part 1: Insects: The "new" alternative medicine for the 21st century? *Alternative Medicine Review : A Journal of Clinical Therapeutic, 15*(2), 124
- Tang, J., Fang, P., Xia, H., Tu, Z., Hou, B., Yan, Y., . . . Cheng, Y. (2015). Constituents from the edible chinese black ants (polyrhachis dives) showing protective effect on rat mesangial cells and anti-inflammatory activity. *Food Research International, 67*, 163-168. doi:10.1016/j.foodres.2014.11.022
- http://www.nursing-school-rankings.com/10-surprising-uses-of-insects-in-medicine/?fbclid=IwAR0abxbkvh_qzNmwqkxBNB4IwVPAhc_6IDXCJi839qatkqBSyxH24nwY6vs
- Giacomin, A. M., Garcia, J. B., Zonatti, W. F., Silva-Santos, M. C., Laktim, M. C., & Baruque-Ramos, J. (2017). Brazilian silk production: Economic and sustainability aspects. *Procedia Engineering, 200*, 89-95. doi:10.1016/j.proeng.2017.07.014
- Kluge, J. A., Rabotyagova, O., Leisk, G. G., & Kaplan, D. L. (2008). Spider silks and their applications. *Trends in Biotechnology, 26*(5), 244-251. doi:10.1016/j.tibtech.2008.02.006