Mushrooms as Reducers of Trash

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Areas of Science: Biology

Executive Summary:

Since the 1960s, over 8.3 billion tons of plastic have been produced. 40% of this production has been for packaging that is used once and discarded. Landfills receive about 27 million tons of plastic every year in the United States alone. To solve the growing problem of plastic pollution, researchers have begun to look for methods by which plastic can be decomposed. This led to the discovery of plastic-eating mushrooms.

Mushrooms can obtain their nutrition from metabolizing nonliving organic matter. They can send little seed-like [the spores are seed-like but not seeds.] "Fungi have a unique propensity for breaking down chemical pollutants (including oil and pesticides) by producing ENZYMES (Ali & Di, 2017)." We need to clean trash because if we don't it will send toxins into the air and we might kill our planet. Mushrooms can help this solution by breaking down chemical pollutants like plastic. For this project, we have decided to focus on mushrooms because they can clean our world by breaking down compounds in plastic. Changing trash into soil takes two weeks to several months and creates new nutrients.

Through research, it has been found that Pestalotiopsis (pes-ta-low-tee-op-sis) fungi can decompose plastic. Most mushrooms are capable of decomposing plastic and they are edible. In our first experiment, we will grow mushrooms and see if plastic will decompose. "PETA turns garbage into food." (Hildebrant, 2020) Microbial life can be used to eat plastic through supercharging bacteria and create mutations by using supercomputers to redesign enzymes.

Research has shown psychedelics can help treat depression, post-traumatic stress disorder, and addiction. Lawmakers passed a memorial in the 2024 legislative session that asks the New Mexico Department of Health and the University of New Mexico Health Sciences Center to study the possible use of psilocybin, a psychoactive compound found in some fungi known as magic mushrooms, for certain therapeutic medical treatments. The Journal toured two mushroom farms potentially interested in changing up the business if mycologists could legally grow psilocybin mushrooms.

Problem Solution:

It is necessary to find the best combination of conditions for fungal growth to decompose pollutants, by coding a new program to tell about these kinds of pollutants and to find more information through the recycling of mushrooms. Astoundingly, these mushrooms can survive on plastic alone. The fungi consume polyurethane and convert it into organic matter. This plastic-eating mushroom can also live without oxygen – making it the perfect candidate for cleaning up landfills. Therefore, we will be researching these mushrooms: Blue Oysters, Black Pearl, and Golden Oysters. We will be adding plastic and managing the watering daily to see which oyster will decompose the plastic the fastest and most economical.

Our Progress:

We took a field trip to the NM Fungi Institute to learn about mushrooms in New Mexico. When we arrived at the Institute-Estevan Hernandez was our guide. He owns and operates the institute on a daily 24/7 basis. We walked around their facility to research how the mushrooms are grown. The institute uses sawdust and rice to grow their mushrooms. They use big batches of soil and other minerals and stuff to create the best product for eating and making tinctures for ailments. He explained how they harvest and regrow mushrooms to sell and recreate products.

The mushrooms we will be researching are: Lennon is growing Golden Oyster mushrooms, and Elias is growing Black Pearl mushrooms. Alexandrea and Zoey are growing Blue Oyster mushrooms. Each mushroom has unique qualities that will encourage decomposition and growth. Each mushroom will exhibit the decomposition of plastic in different ways so we can have a basis for how trash and mushrooms work together to decompose trash through the process of decomposition.

Figure 1. *Pestalotiopsis*, and *Alternaria* Mushroom Species

Coding Plan:

We will build a model where the mushrooms will decompose plastic and grow new crops with mushroom soil. We will manipulate the temperature, humidity, and soil type so we can find the best place for our plastic-decomposing EX: volcanic island. We'll be programming on NetLogo because it's the best language for the coding world.

I, Lennon, had a model that had high Lenard aggression and did not explain enough information. To have a graph to show the mushrooms growing in hours. I learned about linear regression to show the model and how Python helps with the code. Also, have a low p graph and a high p graph. And need a better-explaining code to show linear regression and how Python shows code.

NetLogo and Model Progress:

To construct a dataset to represent mushroom plastic clearance in NetLogo, the clearance rates of *Alternaria* and *Pestalotiopsis* genuses were averaged at an initial volume of 0.05 cubic centimeters after 8 hours at 23 degrees Celsius (Russell et al., 2011). Varying mushroom genus percentages of total volume (in cubic centimeters), time, and degrees Celsius, we produced a data set that reflects the remaining polyester polyurethane (PUR) to construct a Python Scikit-Learn machine learning model. The linear equation is detailed in Figure 3. Despite the simplicity of our equation and limited data, we tested Python machine-learning models that might support highly correlated factors based on the research of Rabinowicz and Rosset (2022). After exploring multiple linear regression which resulted in a low R-squared, we decided to use a gradient boosting regressor model, which after 100 to 1000 iterations, produces an R-squared of 99%. As our predictions are predominantly based on the observed clearance rates of two mushroom genuses, the current model is overfitting.

```
turtles-own [ ate ] ;boolean,true/false
patches-own [ toxic-waste ]

to SETUP
clear-all
 ask patches
  [
  set pcolor lime
  set toxic-waste 0


  ]

  place-plastic ;randomly place plastic
  update-toxic-waste ;update the color on a patch how much plastic is left

  create-turtles 20
  [ set color sky
    set ate false ;the turtle has not eaten plastic yet
    set size 1.5
    setxy random-xcor random-ycor
  ]
  reset-ticks
end


to GO
ask turtles
  [ ifelse toxic-waste > 0 ; thair is plastic on this patch
    [
      set toxic-waste toxic-waste - 0.1
      set ate true
    ]
  [ set toxic-waste 0
     set pcolor lime
    ]
  ]
update-toxic-waste ;update the color in this patch
   tick
end

to place-plastic ;to show the density of plastic on each patch by color scale
  ask patches
  [
  if random 100 < 30 [
  set toxic-waste random 10
    ]
  ]

end


to update-toxic-waste
  ask patches
  [ if toxic-waste > 0
    [set pcolor scale-color brown toxic-waste 10 0.1 ] ;the color reflect the amount of plastic
  ]
end
```

However, in the future, this strategy could be implemented with our experimental data, to provide a true dataset reflecting accurate variability in these factors (and potentially others) to predict PUR clearance adequately. In the NetLogo program, the user can adjust the temperature, milliliters of PUR, time to clear, total mushroom volume, and both percentages of *Alternaria* and *Pestalotiopsis* genuses. Each mushroom turtle represents 10 cubic centimeters and each PUR test tube turtle represents 50 milliliters of PUR. When the user presses the "decompose" button, the remaining PUR milliliters are calculated. While this is not the final model, it can be used with our experimental research data in the future.

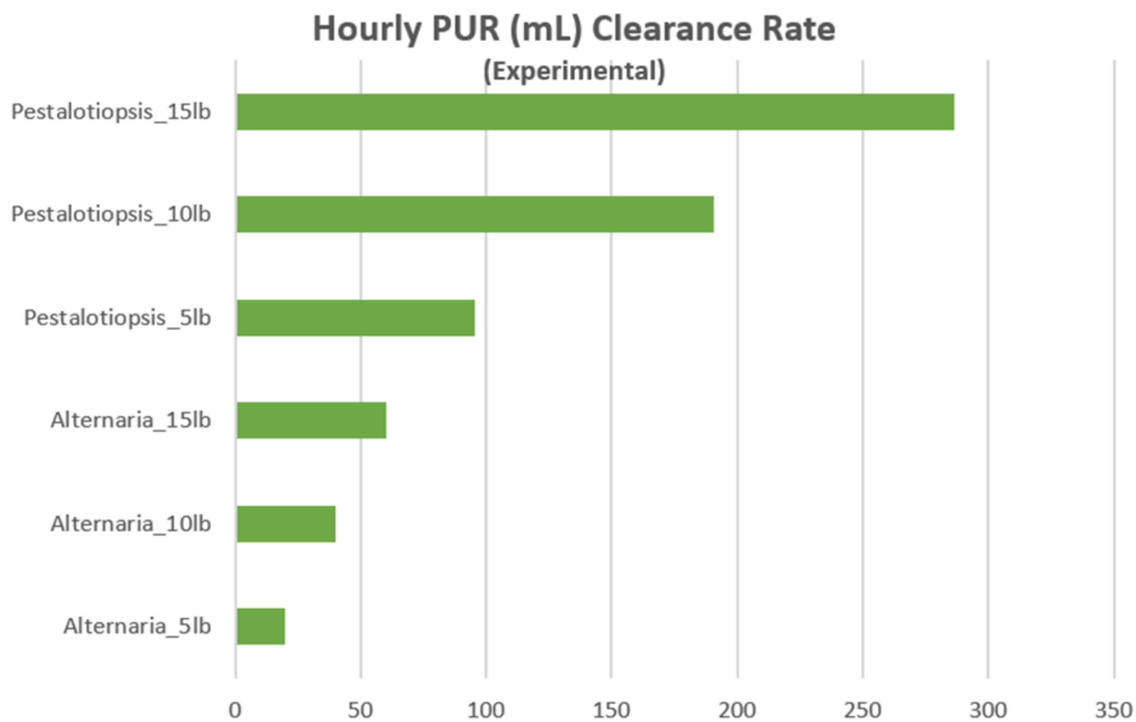

Figure 2. *Pestalotiopsis* and *Alternaria* Genuses, Clearance Rate by Volume in Pounds

Genus	Average Clearance	Initial Volume (cm3)	Initial Volume Pounds	PUR Volume (mL)	Time Hours	PUR Cleared (mL)	PUR Remaining (mL)
Alternaria	0.1488	0.05	0.00011	10	336	1.488	8.512
Pestalotiopsis	0.7054	0.05	0.00011	10	336	7.054	2.946

Expected Results:

The oyster mushroom is capable of decomposing plastic and it’s edible. In our first experiment, we will grow mushrooms and determine if we can dissolve plastic. This experiment will be conducted for several weeks to determine if plastic can be decomposed in mushrooms. I, Lennon, grew an oyster called golden oyster mushroom but they died because they weren't in the sun or had been watered. Elias grew black pearls. One part of the mushroom grew but died due to no water then I started to water it again and a new part of the mushroom grew and started to decompose the dead one and the plastic and about 2 weeks later it got about 4 cm longer. I, Alexandrea, grew blue oysters. My mushroom decomposed the plastic very fast.

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