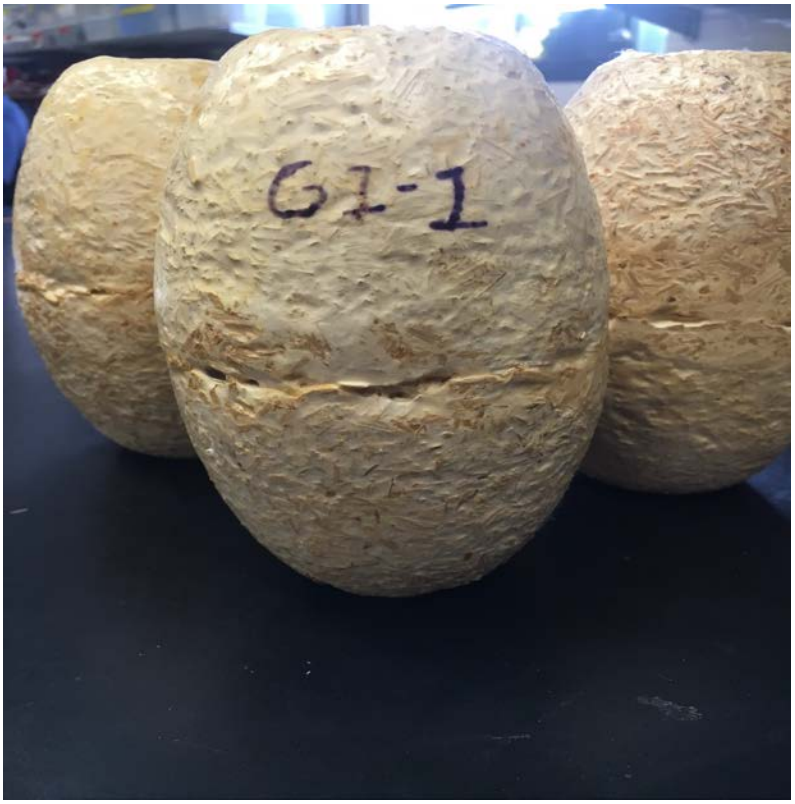
Testing Different Types of Mycelium Buoys' Durability and Longevity



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Introduction

Today people are blind to the impacts that plastics, cardboard, Styrofoam etc. have on the environment. Plastics and Styrofoam don't degrade for up to 500 years, or more. Styrofoam is also harmful to the environment because mercury adheres to the debris not just as a pollutant. This is a bad indication of health for animals since mercury poisons it's carrier. Testing was done on mercury in Styrofoam debris showing that there was mercury inside the styrofoam samples. (Graca,B., et al., 2013). Ecovative, a mycelium biocomposute manufacturing company, has new Mycelium Fungi products can be used as an environmentally beneficial alternative. Myco buoys, Ecovative's 100% renewable buoys, would be a suitable alternative because they would biodegrade over time and the mycelium would be able to recycle nutrients in the environment, instead of becoming a pollutant such as Styrofoam. Hence by testing and observing the performance of a different Myco-buoy composition will be crucial for long term production. With the data it will be easier to determine if the buoys are one step closer and more reliable to use across the world and in real net fisheries scenarios or deployment of the buoys on other objects. The Myco-buoys, made from Ecovative's Mushroom® Material, will be tested while being suspended with rope into water. The purpose of the experiment is to identify, "Which type of buoy will sustain the best durability and longevity while suspended into water?" This is important because the health of the harbor will continue to decline if the amount of pollutants increase.

The buoys are made in the same shape and measurements like a normal plastic in order to replicate a valid alternative. The plastic buoys will all be held the same and the mycelium buoys will have the same dimensions with some different coatings that will specified throughout testing. Overall if the buoys last long enough and withstand the conditions with the cages like the plastic buoys can, there will be a replacement to plastic debris with an environmentally friendly alternative. Plastics and other harmful materials that are littered commercially everyday will have a substitute. Overall testing mycelium will be an innovative step for preserving water conditions and having less pollution.

Background

Mycelium material is a new method for eco-friendly manufacturing, but there have been experiments testing strength of mycelium material different formation methods etc. (Jiang *et al,* 2014+). Jiang (2014) has tested Vacuum Infusion of Mycelium Bound Biocomposite Preforms with Natural Resins. The purpose of the experiment was to test if they could make a 100% renewable brick like structure using mycelium. (The results of the experiment showed that the structure was assembled using bio composite resins and colonized fungi). He also tested a new method of manufacturing bio composite material with mycelium-based cores (2016). The purpose of this was pretty similar to the previous experiment but it was less focused on the steps of infusing the resin and more focused on making different samples of mycelium cores and inserting them into a mycelium manufactured structure. In a third experiment he examined preform shell behaviors with the manufactured biocomposites. This experiment focused on making a sandwich structure but looking more into the shell behavior and strength of the manufactured sample.

Although mycelium is a renewable resource, Styrofoam and other materials like cardboard and plastics are currently harmful to the environmental. Not only by causing pollution but also because of adherent toxic molecules**.** In an experiment, it was shown that Styrofoam debris is a carrier of mercury (Bozena Graca *et al* 2013). Mercury can cause disruption of an ecosystem because when an animal inhales or absorbs mercury, it can severely damage or kill it because of mercury poisoning. When you add this to Styrofoam being a pollutant itself to the environment, the long-term effects could be deadly. This demonstrates why mycelium or other biocomposites shall be used long term. And as tested in an experiment with derivatives biomaterials (Zeller, P. *et al* 2013) mycelium was tested to be used for environment sustainability (Arifin & Yusuf 2013). A recent experiment tested production of advanced products from mycelium focusing on its tuning and physical properties (Haneff, M. *et al* 2017) In a last experiment used testing growth of mycelium's biomass and growth, tested different conditions and locations that produce biomass and seasonal growth of mycelium. (Wallander, H. *et al*)

Project Design

Problem

Which mycelium buoy composition will sustain the best durability and longevity while suspended into water?

Hypothesis

Raw uncoated buoys will be less durable and have a shorter life span then other mycelium buoys with coatings.

Objectives

Gather data on the different buoy composition comparing durability and longevity of composites.

Variables

Dependent Variable	Independent Variable
-Change in height of buoys. -Change in weight of buoys. -Water uptake inside buoys. -% biomass lost total (measure using the dry weights). -Color of buoy(s) -Structure of buoy(s)	Mycelium buoys will be used for the experimental group, while the red plastic buoys will be used as the control group of the experiment. Independent Variable is type of buoy.

Proposed Controls	**Proposed Constants**
• Location of deployment. • How the buoys are suspended into the water	• Water depth at constant locations • Length of rope tied to buoys suspended into water from corresponding locations • Dimensions of buoys (plastic corresponds with plastic mycelium corresponds with mycelium).

Project Scope

Assumptions	Limitations	Risk
-Mycelium buoys can withstand being in normal water conditions.. .-Mycelium buoys may have different data depending on the type of mycelium buoy. Ex: Raw weaker then coated buoys.	-Amount of times a buoy can be used. -Amount of time before certain buoys decompose. -Amount of time for experimentation and collecting data (1 year) -Rate of sampling	-All the buoys will be lost (broken or decomposed) leaving no numerical or heavily quantifiable data. -Factors like the weight of cages may affect buoys durability. -Some of the resources/buoys will be broken. -Keeping track of differently coated buoys may be complicated. (use coding on buoys).

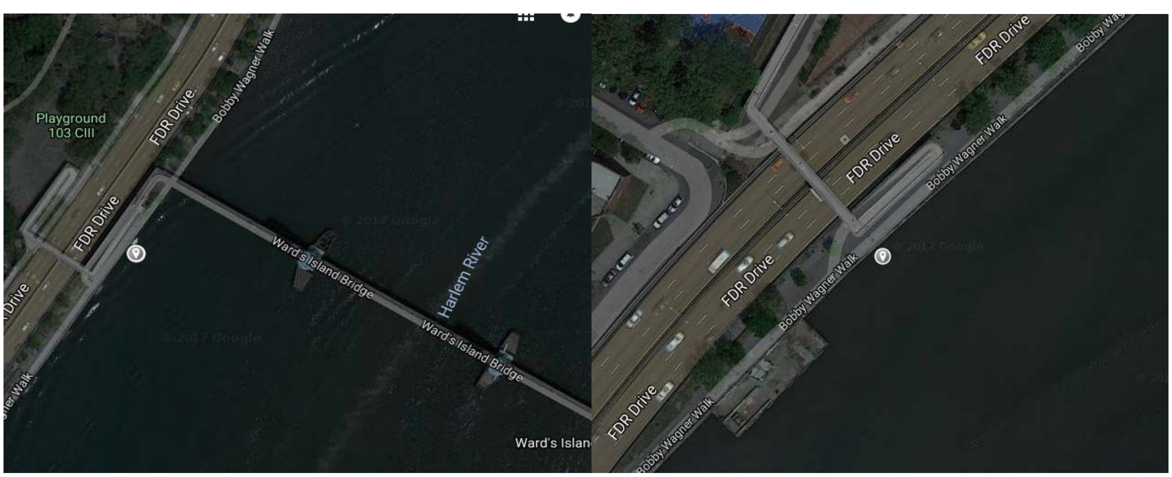
Safety

Safety while conducting this experiment is slipping hazard near the water, you always want to be careful with the water because you could slip and fall when you're near slippery surfaces with the buoys. In this experiment heavy lifting will be a factor when picking up cages or anything else the buoys are attached too. Each station carries two oyster cages, some with concrete and more. This combined with water weight, (water soaks into material) causes a heavy lifting hazard. Another time to take safety during this experiment is man over board, a term for when a person falls into the water. When lifting or deploying the cages you want to make sure not to lean over any edges and fall into the water.

Materials

Name	Quantity	Usage
Mycelium Buoys	12	Used as the experimental buoy.
Plastic buoys (5in x 3in, in diameter, 1/2-inch hole Airhead	12	Used as control buoy.
Rope		To tie buoys and platforms together
Tape Measure	1	Measurements on pier.
Scale	1	Measure the weights of buoys
Camera/Phone	1	For pictures of deployments.

Locality



Picture 01: Deployment location:. The first location is 103rd street on the Harlem River, and the second location is on 116th on the Harlem River.

Buoy Composition

	Buoy Composition			
	Mycelium	Mixture	Coating	
Raw		Hemp fines	N/A	
HK	PC	Hemp/Kenaf	Synthetic Epaint	
G1	GR	Corn/Hemp	Synthetic Epaint	
G2	GR	Corn/Hemp	40% bio-based epoxy	

Fig__: This figure shows the composition of the buoys and their mixtures, coatings, and type of mycelium

Procedures

Data Procedure

1) Obtain Mycelium buoys - gathered from Sue.
2) Obtain Plastic Buoys - purchased online.
3) Deploying Experiments
4) Data Analysis
5) Record data.
6) Analyze data.

Experimental Procedure

1. Obtain oyster cage, mycelium and plastic buoy, and rope.
2. Tie a bowlin knot through the mycelium buoy hole
3. Repeat step 2 for plastic buoy
4. Tye the mycelium buoy a couple squares up from the corner of the cage
5. Repeat step 4 for the plastic buoys
6. Tie cage to wooden post
7. Deploy the post into the water
8. Repeat steps for each deployment.

Sample Dates

	Cages date sampled vs picked up			
	Location #1		Location #2	
Cage 1-3	11/11/2016	03/25/17	12/3/16	03/25/17
Cage 4-6	11/11/2016	03/25/17	12/3/16	03/25/17
Cage 7-9	11/11/2016	03/25/17	12/3/16	03/25/17
Cage 1--12	11/11/2016	03/25/17	12/3/16	03/25/17

Fig 01: This figure shows The locations and there different sampling times. Shows initial dates and end dates of sampling for the cages at the two locations.

Results

Qualitative Data

Set-up ___

The buoy in sampling are tied from the whole onto a cage (Picture 02) . It starts with an oyster cage, with that after the cages are set-up, the buoys are tied. In the experiments some cages had no mycelium buoys, while some had both plastic and mycelium buoys. The buoys were tied to the cages on either right or left side. The buoys were tied to the cage with bowlin knots as well as bowlin knot through the buoy hole. The cages are then connected to wooden pole, which is suspended along the Harlem River sea wall.

Picture 02. This shows how the buoys and cages were set-up and suspended in the water The buoy on the right is a mycelium composite attached to the lower right portion of the cage. To the lower left of the cage is the red plastic control buoys.

Before Deployment

The buoys before deployment are shown below separated by composition in Picture 02. As you can see, all the buoys are in their molded form and coded dependent on which type of buoy. All the buoys were placed in the water at the same deployment sight, on two deployment days. The 6 white buoys are the raw samples, the buoys second from the left are the Hemp/Kenaf samples and the following are the G1 and G2 samples of hemp and corn with different waterproof coatings.

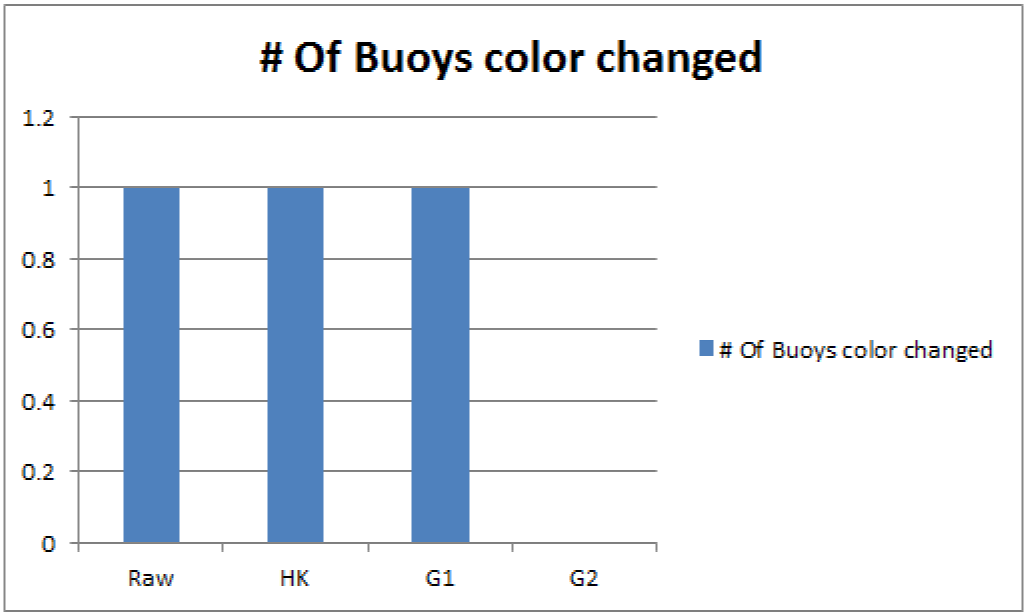
Picture 03: Shows the sample set for the different types of buoys being tested. All of the composed buoys were used during sampling.

After Deployments

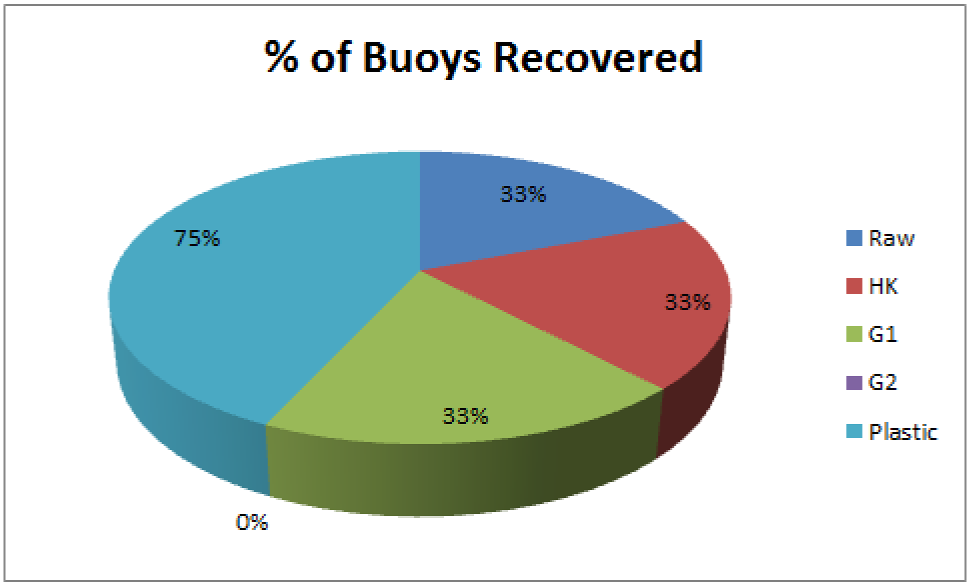
A B C D

Picture 4: (A)Shows a raw uncoated buoy after deployment, (B) Shows a rope with a mycelium buoy that is no longer present on this cage. (C) Image C is showing a G2 sample next to a red plastic buoy. (D) This image shows a KF sample after deployments.

Quantitative Data



Graph 01: This graph represents the types of buoys and the amount of them showing color changed. Each of the buoys that had color change only recovered one buoy.



Graph 02: This shows the % of each buoy composition that was recovered from the sampling dates including the plastic buoys.

Out of the buoys that were deployed the graph above shows the % of buoys that were recovered (Graph 02). The Graph above that shows the number of buoys of each composition that showed discoloration not including the plastic buoys.

Table 02: This figure shows the number of buoys that were present after the last sample date on 3/25/2017, and the amount that decomposed and/or got lost, from original data.

Buoy Type				
As of 03/25/17	Raw	HK	G1	G2
Present	0	1	1	1
Gone	2	2	2	2

Analysis

From the qualitative data, there hasn't been dominant data showing which buoy sustained the best durability within the given time length. All the buoys that withstood condition during deployments were from the Dec 3rd deployment, not the earlier November 11th deployment. The HK (hemp/kenaf) buoy (Picture 3D.) shows the least damage with little to no chipping and some discoloration compared to the rest of the images where buoys were present such as the raw buoy (Picture 3A.) where it's very decomposed and almost fallen apart. The G2 buoy from the Picture 3C also shows more decomposition than the HK sample buoy. The buoy data comes from a sampling date on March 25th 2017. The buoys have been re-deployed since then and the first sight was tested on 11/18/17 and 11/25/17 and no buoys were recovered. The buoys were re-deployed for experimentation so quantitative data is less reliable but due to the qualitative data, the Hemp Kenaf buoy shows as the most reliable alternative.

Conclusion

Mycelium fungi composites are cutting edge, environmentally beneficial projects. Mycelium buoys were used to test which mycelium composite would sustain durability and longevity through qualitative and quantitative data. The 4 samples were one, uncoated mycelium fines with hemp fines, the 2nd and 3rd sample is G1 and G2 which is mycelium fines with hemp and corn, the difference is G1 contains a water proof epoxy, while G2 is specifically as 40% bio based Epoxy. The last buoys composite sample was HK which is mycelium fines with hemp/kenaf substrates and the non-bio-based epoxy. Mycelium fishing net buoys were deployed and tested for around 11-months to 1 year. The buoy deployments took place on 11/11/16 and 12/3/17. The hypothesis of the experiment was the raw buoys would sustain the least durability due to the buoys having no waterproof coating to slow down biodegradation. The first sampling date after around 3-4 months, 03/25/17 show data with various of the given composites still present.

Through qualitative data on the first sampling date, one of each composite was recovered besides a G2 composite was present. Objectives of data measurements was to obtain both quantitative and qualitative data. Through the first sampling date, it was shown through the qualitative data (Picture 04) that the HK sample showed little chipping, no deforming of the buoy shape, and slight discoloration, while other samples were very beaten, disorganized, or just not present. The buoys were re-deployed for further sampling. The next sampling dates have shown no more buoys present. Due to lack of presence quantitative data was only able to go as far as percentage of buoys showing color change, and % of buoy composite recovered (Graph 01 and 02). Overall the HK sample shows the most extensive durability and longevity with the given data. Since the buoys were sampled for an extensive period of time for experimentation, the slight quantitative data was hard to base conclusions on but could also support as evidence saying the HK buoys withheld parameters as well as or better than the other buoy compositions.

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