Investigating the Growth and Oxygen Production of *Lemna minor* in Cytherean, Lunar, and Martian Pressures

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Abstract

This project considers the applications of *Lemna minor* as a tool for human space exploration. A containment unit capable of inducing both high and low pressures was designed. Due to the restrictions during the COVID-19 pandemic, the experiment could not be carried out as planned. To compensate, literature review was performed to investigate applications of *L. minor* for future research.

Introduction

- Study the application of *L. minor* in the production of oxygen as a precursor to terraforming
- Focus on how *L. minor* grows in conditions mimicking Lunar, Martian, and Cytherean environments by recreating atmospheric pressure in a closed system
- *L. minor* chosen due to its low cost, ease of cultivation, and high oxygen transport rates

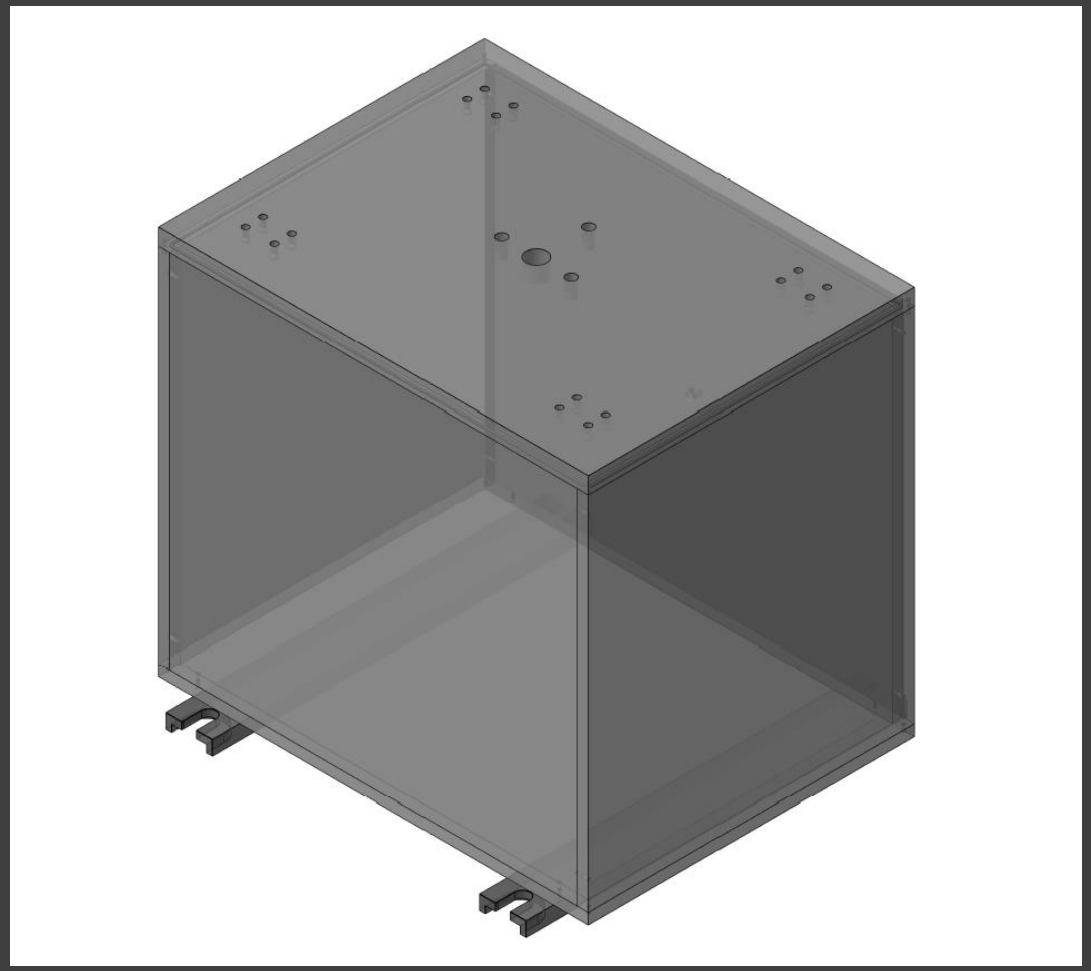
Materials and Methods

- *Lemna minor*, also known as duckweed, purchased from Carolina Biological Supply®
- Cultivated in-house to increase supply

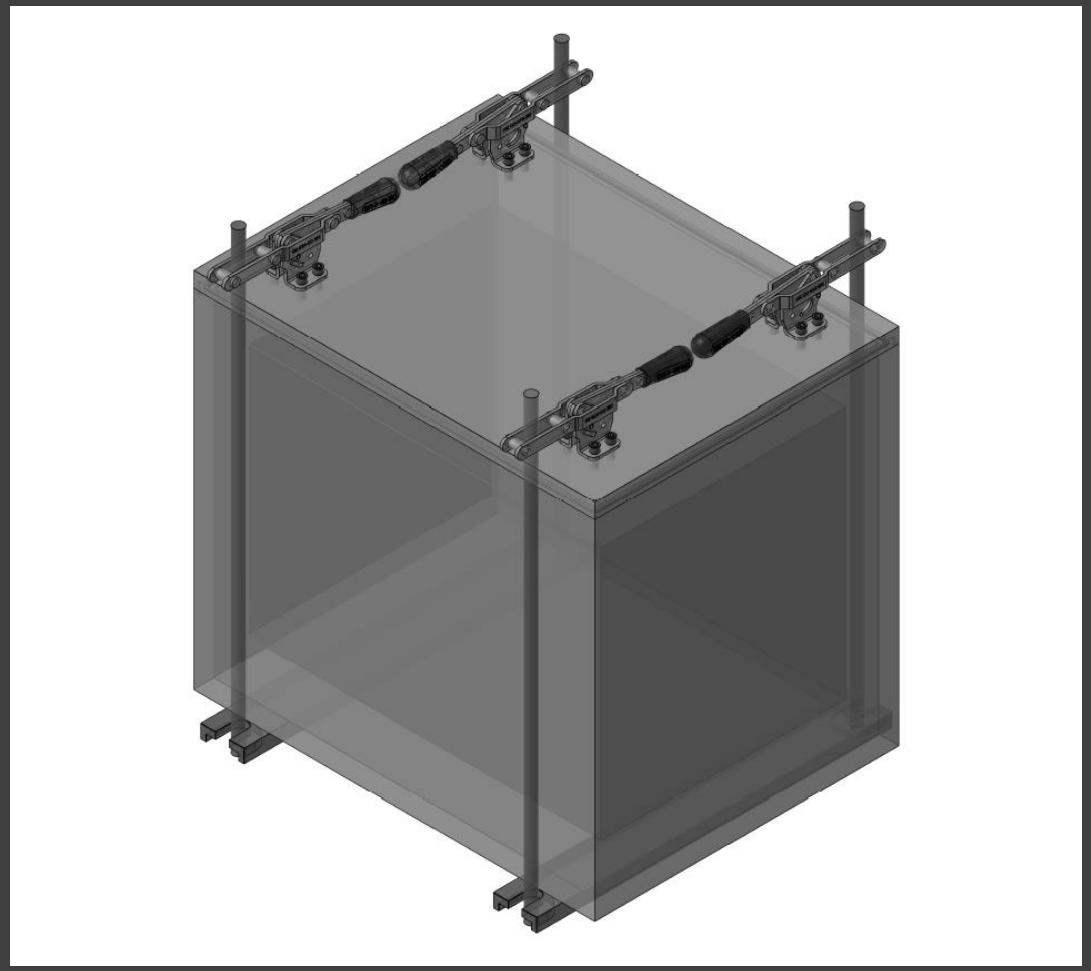
- Cultivated in a container with two liters of tap water
- Water treated with Tetrafauna® AquaSafe® to neutralize chlorine and heavy metals
- Miracle-Gro® potting soil added for nutrient content
- 50-watt LED light put on a timer to allow ten hours of light exposure per day

Containment

- Designed to withstand both high pressure and near vacuum conditions
- Fully transparent to allow the observation of the experiment without disturbing interior environment
- Reusable for future student experiments



- Containment is constructed from 1.27 cm and 1.91 cm thick acrylic sheeting
- Passthrough ports for various sensors and pressure valve
- Rubber tubing around top forms a vacuum seal



- Aluminum frame connected to four heavy-duty clamps to ensure a tight seal
- Shaded area inside denotes usable space for interior *Lemna* containment
- Note top ports are not shown in this view

Experimental Design

- Due to quarantine the experiment was not able to be completed
- The pressure containment would be tested for seal quality and for the maximum pressure it could withstand
- Sensor arrangement would be finalized before first experimental trial

Experiment consists of several trials at three different pressures: near-vacuum, as high as the chamber allows, and standard atmospheric pressure as a control.

The *Lemna is* placed in a smaller container of water and soil. Sensors are set up and the containment is sealed.

Desired pressure is induced, and the air temperature, water temperature and pH are monitored using an Arduino setup. The amount of light is kept consistent at ten hours per day.

At the end of one week, a sample of interior air is taken and analyzed with mass spectrometry.

Discussion

- Because there was no experiment, time was spent investigating other applications for *L. minor* in space travel and exploration

- Used in bioremediation to treat wastewater as a first step in water reclamation
- High starch *L. minor c*an be cultivated for biofuel
- Can be added to the human diet as a good source of protein
- Additional mental health benefits from being in proximity to nature

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