2022

Formicarium

Project Brochure

Class 4G SPF

Fig. 7

Leafcutter ants

Atta sexdens

Contents

1 Introduction

This brochure is to guide anyone interested through this project. Here you will get a representation, biological background-information, and justifications of the project. Furthermore, you will find a list of costs of the resources used and descriptions of the building process. Possible difficulties and problems will be shown, and solutions will be provided.

All sources used for providing the general information are linked in the exponent.

1.1 Leafcutter Ants[(1)]

Leafcutter ants are any of the 47 species of leaf chewing ants belonging to the two genera *Atta* and *Acromyrmex*. They are fungus growing ants and native to South and Central America. They can carry twenty times their own body weight and cut and process fresh vegetation to serve as nutrition of their fungus.

In a mature colony, the leafcutters are divided in different groups, based mostly on size, that perform different functions. This groups are as follow:

- ***Minims***: The smallest workers. They take care of the brood or the fungus gardens
- ***Minors***: Are slightly larger than minims and present in large number. They are the first line of defence and patrol the surrounding terrains.
- ***Mediae***: Are the collectors, who cut leaves and bring the leaf-fragments back to the nest
- ***Major***: The largest worker ants. They act as soldiers, defending the nest from intruders and carrying the larger items like debris. Total body length up to 16 mm and 7 mm head width.

1.2 Fungus[(2)]

The fungus used by leafcutter ants are all members of the family *Lepiotaceae*. The ants are actively farming their fungus, feeding them with freshly cut plant material and keeping them free from pests and other dangers.

They are even able to adapt to the fungus' reaction to different plants. If a plant is toxic to the fungus, the ants will stop collecting it. This happens thanks to chemical signals from the fungus.
The fungi cultivated by the adults is used to feed the larvae. The adults themselves feed on leaf sap.

2 Biological Elements

2.1 Mutualistic Symbiosis[(3)]

An important biological element is the symbiosis.

Symbiosis is any type of a close and usually long-term interaction between two different organisms. It can be mutualistic (both benefit), commensalistic (one benefits) or parasitic (one benefits, the other is harmed). The organisms must be of different species. Symbiosis can be obligatory: the symbionts depend on each other for survival, or facultative: they could live independently but are better off together.

In this case a mutualistic/obligatory symbiosis between the fungus and the ants can be observed.

2.2 Ecology[4]

Ecology is the study of the relationship between living organisms and their non-living (abiotic) physical environment. Ecosystem processes nutrient cycling and regulate the flux of energy and matter through an environment.

A formicarium functions too as an ecosystem. Everything must be regulated and depends on each other. If this doesn't function well, issues can and will occur.

2.3 Genetics of Ants[5]

Leafcutter ants are one of the most important herbivorous insects. They harvest vast quantities of fresh leaf material. The ant-fungus mutualism is one of the few non-human farming occurrences and is likely the reason for the massive size of their colonies. Mature leaf-cutter ant colonies contain millions of workers ranging in size from small garden tenders to large soldiers, resulting in one of the most complex social systems between animals.

3 *Atta sexdens*[6]

The *Atta sexdens* are the ants used for this project. They are the most spread *Atta* species in the world. For their fungus the workers look for suitable grasses, leaves and fruits, cut them with their extraordinarily strong biting tools and transport them over wide distances to their fungus. This fungus grows further by adding the leaves and serves as food for the colony. The Queen also lays her eggs on the fungus, so the brood ca be fed and raised at the same spot.

Atta sexdens divides its colony members into four major castes, each differentiated by a range of head widths

- **Gardener-Nurses** (*minims*): The smallest of the four castes, gardener-nurses have an average head width of 1.0 mm, and range from 0.6 mm to 1.2 mm
- **Nest Generalists** (*minors*): Average head width of 1.4 mm
- **Foragers-Excavators** (*mediae*): Average head width of 2.2 mm
- **Defenders** (*majors*): Average head width of 3.0 mm
- The **Queen** is the largest ant in the colony, often measuring two centimetres or longer

Reproduction

Three to four weeks after being laid, the egg hatches and larvae emerges. In Atta colonies the larvae are fed by secretions from gardener-nurse ants and the fungus. The larvae, after an additional 3-4 weeks, spin cocoons around themselves and pupate. After 3-4 more weeks, the pupae hatch into adult workers, ready to serve the queen and colony.

Breeding interval
Queens and males breed only during one mating season of their lives.
Non-queen females cannot breed.

Breeding season: October to December

4 Project

4.1 Organisation

After some thought process, it was agreed to have a building group, a finance group, an organization group, and a brochure group.

The organization group consists of four people. They were responsible to organize the process and the communication between the groups.

The finance/biology group consisted too of four people. This group was responsible for the finances, this refers to all the material that had to be bought and the purchase of the ants themselves. Later they were additionally referred to as the biological specialists and informed themselves and the others about the needs of the ants.

The brochure group consists of three people. They were responsible for communicating with the other groups to have the required information to write the brochure.

The biggest group were the builders. They are separated further in different smaller groups responsible for the different chambers. We have the main chamber group, the fungus chamber group, the craft group and the coordination and planning group.

After the first ant colony died, an additional one was created, the investigation group. Their goal was to find the reasons why the ants didn't survive and possible solutions.

The communication between the groups was very important otherwise the implementation of the project would have been very difficult.

4.2 Planning

To carry out such a large project with many people, there is need of a good organization and a clear structure. In this way, uncertainties can be avoided, and the individual groups can work better with each other. The organization group had the opportunity to try out different concepts.

Concepts

When the first work on the project started, the first concept was introduced. The aim was to get a structure into the lessons and to improve the communication between the groups.

1. Every group has to define one (or two) person who are responsible for the communication. They know what is going on in the group and are their speaker. Their task was to tell the class at the beginning of the lesson what they did last week, what they are working on and what their target for that day is. At the end of a session the organization group is giving a short overview.

2. Groups are working individually on their tasks.

3. At the end the organization group is giving a closing word if it`s necessary.

After a few weeks, the first concept was revised with the experience gained.

1. 5 minutes before the lesson starts, the teacher is asked if there are any news which are important to tell the class.

2. If there was something, it was communicated to the class at the beginning of the lesson.

3. The class meets ten minutes before the lesson ends and one of each group (the speaker) tells what they did today, what the goal for the next week is and inform about problems they`re struggling with.

Instagram account

It was agreed to have an Instagram account for the project. The intention was to reach out to the students of the BKS and introduce them to this project. It was also aimed for people who are in general interested in ants. The account should be informative and enrich knowledge about ants and the formicarium.

4.3 Difficulties & Problems

The project faced a few difficulties and problems. One of which was the death of the first ant colony. It set the operation back some time, but after short investigations, theories could be formed as to why this happened.

Another struggle was obtaining the correct materials and the correct amount. The species of ants wanted was changed a few times so there was some confusion.

The right coordination between groups was also a challenge. Reason for that was that the groups tended to remain only among themselves and didn't communicate enough.

There were also some minor difficulties during the construction of the Formicarium, for example the connecting tube not being held up properly or the chambers not being warm and humid enough.

4.4 Solutions

After the first ant colony died, an additional group was created. Their goal was to find out why the ants didn't survive and possible solutions.

The first assumption was a problem with the humidity. Ants need high humidity in the fungus chamber so the fungus can be cultivated, and it may not have been high enough. Another hypothesis was that the ants were already weak from the transport and didn't have a high chance of survival regardless of how they were managed afterwards.

Without the fungus, the ants would have had no nutrients and would starve to death. Although it was a major setback, also from the financial perspective, a lot of experienced was gained.

Another observation made was that the ants weren't cutting leaves. This may be because the fungus (that arrived with the ants) was taken out of the container by the builders instead of letting the ants take it out independently. So, the second time, the ants were let to take the fungus out themselves.

Because the same ants were purchased the second time, time could be saved because the right construction and materials were already available.

The difficulties of building the formicarium were mostly fixed with some reconstructing or with the use of more supplies.

5 Formicarium

The building group had the task to build the formicarium. The group was split in to four, each subgroup had their own role in planning and building the formicarium.

Group 1 was tasked with the job to build the most complex chamber, the fungus chamber (**Fig. 1**). This group had to make sure that the humidity is optimal for the ants. This turned out to be a very complex job.

Group 2 had to deal with the task of filling the chambers. They had to choose the most suitable layers for the ants. This group also filled the main chamber (**Fig. 2**).

Group 3 was responsible for the manual work on the chambers and corridors. Their task was to drill holes (**Fig. 4**) into the glass walls of the chambers and connect them with pipes.

Group four was responsible for communication and coordination.

Fig. 1: The fungus chamber

Fig. 2: Main chamber with death chamber attached

Group 1 had to decide on a suitable shape for the chamber of the fungus. It was decided to build it rectangular, under the assumption that the fungus will adjust to this form.

After that, they had to work on how to correctly calibrate the desired temperature (ca. 26°) and humidity (min. 97%) in the chambers. This was achieved by layering Seramis, as Seramis retains and releases moisture. The temperature is already convenient because of the outside temperature is similar. But in winter when it will get cold, heat meats will probably be used to bring in the right temperature.

Before the ants arrived, group 1 carried out some tests in which they used measuring devices to determine whether the artificially created climate was suitable for the ants or not.

Group 2 informed themselves at the finance/biology group for the right terrain needed in the different chambers.

- The death chamber must be dry, so no Seramis. Regular stones are suited most for this.
- The fungus chamber needs high humidity, so Seramis is needed (because they retain and release moisture) and a layer of sand to cover the Seramis.
- The main chamber should resemble the ground of a forest, so mostly regular earth and different types of woods, sticks, moss, and some bigger stones were used.

First, the school´s material inventory was checked before the assistant team placed any additional orders.

The various layers should reflect a profile that is as similar to the natural ground as possible. After the individual layers had been filled and moistened, they took care of the decoration. For this purpose, suitable objects from the immediate nature were used, again based on information from the finance/biology team.

Lastly, they introduced a second death chamber (**Fig. 3**) and closed the main chamber with a seal.

Fig. 3: Second death chamber with the fungus chamber in the background

Fig. 4: Builders drilling holes for the tubes

6 Didactical purposes

The didactical purposes refer to the ability of the formicarium to be used as a medium to learn.

First, the formicarium is transparent and accessible. Everybody can see the structures present there and how the ants inhabit it. Further it's possible to install a camera and supervise it around the clock.

The formicarium can be used to do research and answer specific research questions. The future SPF classes can be given a task to develop a research question (example: what leaves do ants prefer?) and answer it with the help of the formicarium.

It can also be used to clarify and show basic biological functions like the symbiosis between the ants and fungi and the hierarchy of the ants (suited for GF Biology).

Additionally, it can serve as a functioning example for classes and people who want to recreate or build an own one.

7 Finances

7.1 Shopping list and costs

These supplies could be collected directly from outside:

- 1 raspberry bush
- 1 bramble
- 1 bush or roses

These supplies had to be purchased

Supply	**Cost in Euros**
5 kg Coal	8.95
3l Orchid substrate	5.95
1 kg oatmeal	4.90
40l Regular earth	19.80
9 kg pumice stones	44.70
8 m^2 weed mat	19.95
30l Seramis	46.75
30l expanded clay	9.90
15l sand	5.95
1l construction silicone	14.90
Sealing ring	5.90
30 ml ant escape protection	17.70
10 m transparent tubes 150mm	109.00
20 m PVC tubes 50mm	21.80
3x basin connector 27mm	53.70
4x water dispenser	379.60
2 ml bowl 360°	3.90
1x fog machine	94.90
Ant colony (**Fig. 5**)	250.00
Total	**1118.20**

The list for the required materials and all information and instructions for the keeping of ants were taken from the website myants.de (references 7 & 8).
The glass walls for the formicarium were already present in the school (**Fig. 6**).

For people who want to replicate the project, it's recommended to use the same materials and follow the provided instructions as they turned out to be right ones.

It is to note that the materials in the table are the ones needed and used. But because of misjudgement, two additional fog machines were purchased (worth 190 Euros) and because of the death of the first ant colony, a second one had to be purchased, costing an additional 250 Euros. Summed up, about 440 Euros were misspend.

Fig. 5: package ants & fungus

Fig. 6: the glass box used for the main chamber

8 References

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Fig. 7: https://www.pinterest.ch/pin/289567451017973406/?mt=login