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I.B Higher Biology
Group lab test
“A comparison of soils (e.g. garden/ school / park / woodland) linked to controlling environmental factors”.

Planning (a)

Introduction and background information

Soil is an abiotic factor when considered as a natural surrounding. Different soil types affects individual species of plants and animals.
A good example of how soil type affects plant life is to compare two different ecosystems with different soil compositions. The desert plains in central Australia consist of mostly sandy soil. The sand does not retain water well and is very dry and arid, but the plants have adapted so that their life cycles are completed in the 30 days that follow a good rainfall. Only some succulent plants which retain water very well manage to survive throughout the whole year.
A comparison may be a peat bog; cold, waterlogged and deficient in nutrients, mosses and plants which obtain minerals through “alternative” methods (carnivorism) thrive here.

Soil supports the basis of the Earth’s ecosystems, and the agriculture and economy of the world. The three main types of soil include:

- **Sandy soils**, which are light, heat up quickly and retain water poorly. Particles are relatively large with relatively big airspaces. A sample with more than 90% sand particles is just called “sand”.
- **Clay soils** and **silty soils**, which tend to be cold, dense, and are often waterlogged. They contain small particles with very small air spaces. A sample with more than 40% clay particles is true clay soil.
- **Loam**, which is an “intermediate” type of soil. It is dark and has a sort of “crumb” structure; it has a mixture of particles of different sizes and usually a fairly high humus content, which consists of nutrient-rich organic matter, good for plants.

The aim of the investigation is to test soils for various different properties, in terms of nutrient content, water content, organic content (living organisms), and find correlations between the results and observations of the individual samples.

Planning (b)

Soil samples
1 cup of each sample is to be collected from each area:

- From homes – Alabang, Magallanes, Merville, Bel-air.
- From school – Area behind basketball hardcover
    - Nature Garden
    - Football field
    - Area next to D-Block

Tests to be carried out:

1. Organism test
2. Geographical tests (observations)
3. Water content
4. Organic matter
5. pH test
6. Nutrient tests – nitrate
    - potassium
    - phosphorous
7. Sedimentation method soil analysis
8. Classify soil types as either clay, loam or sand. (sedimentation of soil analysis)

Apparatus:

- Soil sieves
- Air-tight containers
- Measuring scales
- Measuring cups
- Nutrient soil testing kit
- Bunsen burner
- Tripod stand
- Test tubes
- Wire gauze
- Crucible pot
- Tongs (test-tube holder)
- Forceps
- Ethanol
- Lamps
- Graduated cylinder
- Retort stands
- Timer
- Gloves
- Beaker
- Fireproof slate

Method

1. Organism Test

a.) Set up retort stands and lamp, with sand filter and beaker of ethanol in place. Filter out half a cup of soil, of each sample, separately, and record necessary observations.

Independent variables: Amount of time exposed to lamp; amount of soil tested
Dependant variables: Soil type

Hypothesis – There did not seem to be many organisms in our collective samples at all. Most of the soil also seemed to be rather clay-like, and this type of soil tends to support less life.

2. Geographical Test

a.) For each soil sample, provide a detailed description of the area from which the soil was taken, including details such as plant volume, natural life, shade, sun, average humidity, etc.

Independent variables: Natural condition
Dependant variables: Area chosen for soil excavation

3. Water Content

a.) This test aims to find the water content of soil. Set up Bunsen burner, tripod stand, wire gauze and crucible.
b.) Record the mass of the crucible
c.) Measure out about 10 g of soil and place it in the crucible. Record the mass of the soil and crucible.
d.) Place crucible and soil on wire gauze, and heat over open flame for about ten minutes. Allow to cool, and weigh again. Record any changes in mass. Repeat until no further change in mass is recorded.
e.) Do this for every soil sample.

Independent variables: Soil type
Dependent variables: Amount of time needed for all water content to be lost.
Hypothesis: Most soil samples seem to be clay. I believe that they will all take quite a while to lose all water mass.

4. Organic content
To measure organic content, weigh out a 10g sample of dried soil (that used to determine moisture content). Place this in a crucible, and heat over an open flame, over a tripod stand and wire gauze.

Independent variables: Soil type
Dependent variables: Amount of time needed for all water content to be lost.
Hypothesis: Most soil samples seem to be clay. I believe that they will all take quite a while to lose all water mass.

5. pH test.
a.) This can be tested using a provided kit. Record all observations fully.

Independent variables: Soil type
Dependent variables: None
Hypothesis – the soil samples look quite normal, so I would expect them to be mostly neural.

6. Nutrient Content
a.) Tests for nitrogen, phosphorous and potassium can be carried out using a provided kit. Test each soil sample and record observations carefully.

Independent variables: Soil type
Dependent variables: Section of soil chosen for experiment
Hypothesis – not much organic content can be seen in the samples, but I'm quite sure that some nutrients must be present.

7. Sedimentation of soil
a.) To demonstrate the basic composition of a soil sample, mix about a quarter of a cup of soil with water, in a measuring cylinder, and shake it well. Inorganic contents settle out in order of size, and will soon show neat layers. Sketch and label observations clearly, including things such as humus and organic debris floating on surface, silt, fine sand, coarse sand, gravel and stones.

Independent variables: Soil type
Dependent variables: Section of sample chosen for experiment

8. Classifying soils as loam, clay or sand.
a.) Observe each sample carefully, sketch grain and make notes on composition.

Independent variables: Natural condition
Dependant variables: Area chosen for soil excavation

<u>Data Collection</u>

1. Organism Test

Soil Sample	Results
Alabang	No organisms; possible traces of glass
Magallanes	No organisms
Merville	1 dead mosquito 2 unidentifiable flies

Bel-air	No organisms
Area behind basketball hardcover	No organisms; traces of plastic
Nature Garden	No organisms
Football field	Many roots found within soil
Area next to D-Block	No organisms

2. Geographical Tests

Soil Sample	Observations (Sketches)
Alabang	
Magallanes	
Merville	
Bel-air	

Area behind basketball hardcover	
Nature Garden	
Football field	
Area next to D-Block	

3. Water Content

Soil Sample	Mass After Heating					
	Original Mass (g)	After 10 mins	After 20 mins	After 30 mins		Water content
Alabang	-	-	-	-	-	-
Magallanes	-	-	-	-	-	-
Merville	-	-	-	-	-	-
Bel-air	22.8	21.5	21.8	21.8	21.8	1
Area behind basketball hardcover	24.0	22.4	21.9	21.8	21.8	2.2
Nature Garden	22.8	21.1	20.5	19.9	19.9	2.9
Football field	22.0	20.0	20.0	20.0	19.0	3
Area next to D-Block	21.7	20.6	19.5	19.5	19.5	2.2

4. Organic Content

Soil Sample	Mass After Heating				
	Original Mass (g)	After 10 mins	After 20 mins	After 30 mins	
Alabang					
Magallanes					
Merville					
Bel-air					
Area behind basketball hardcover					
Nature Garden					
Football field					
Area next to D-Block					
Around the Pool					

Not Applicable

5. pH level

Soil Sample	pH Level	Acid/ Base / Neutral
Alabang	7	Neutral
Magallanes	7	Neutral
Merville	7	Neutral
Bel-air	7	Neutral
Area behind basketball hardcover	7	Neutral
Nature Garden	7	Neutral
Football field	7	Neutral
Area next to D-Block	7	Neutral

6. Nutrient Content

a.) Nitrate

Soil Sample	Amount of Nitrate	
Alabang		
Magallanes		
Merville		
Bel-air		
Area behind basketball hardcover		
Nature Garden		
Football field		
Area next to D-Block		

Not Applicable

b.) Phosphorus

Soil Sample	Amount of Phosphorus	
Alabang		
Magallanes		
Merville		
Bel-air		
Area behind basketball hardcover		
Nature Garden		
Football field		
Area next to D-Block		

Not Applicable

c.) Potassium

Soil Sample	Amount of Potassium	
Alabang		
Magallanes		
Merville		
Bel-air		
Area behind basketball hardcover		
Nature Garden		
Football field		
Area next to D-Block		

Not Applicable

7. Sedimentation of Soil

Soil Sample	Results (analysis of layers in ml)					
	Humus	Clay	Coarse sand	Fine sand	Silt	Gravel
Alabang	3	97	4	2		
Magallanes	1	45	34	12	1	
Merville	3	23	5	9	4	30
Bel-air	1	26	6	5		13
Area behind basketball hardcover	2	19	6	6		30
Nature Garden	2		4	3	1	32
Football field	2.5	23	2	6	1	48
Area next to D-Block	4	27	6	6		30

8. Classifying soils as loam, clay or sand

Soil Sample	Observations	Classifications
Alabang	As mentioned in (7)	Thick clay
Magallanes	As mentioned in (7)	Thick clay
Merville	As mentioned in (7)	Less clay – more sandy loam
Bel-air	As mentioned in (7)	Less clay – more loam
Area behind basketball hardcover	As mentioned in (7)	Very little clay – more loam

Nature Garden	As mentioned in (7)	Thick clay – more loam
Football field	As mentioned in (7)	Thick clay – more sandy loam
Area next to D-Block	As mentioned in (7)	Very thick clay

Data Processing and Evaluation

The results obtained from the investigation are, unfortunately, scattered and incomplete. The samples cannot always be directly compared, but theories can be drawn from the observation and classification of the samples (which are complete) compared to the organism test and water content.

As the sedimentation of the soil and the classifications in test 7 and 8 respectively suggest, the soil samples all contain high quantities of clay. In order for a more accurate classification, the soil may be analyzed as percentages of the total composition:

Soil Sample	Results (analysis of layers by %)					
	Humus	Clay	Coarse sand	Fine sand	Silt	Gravel
Alabang	2.8	91.5	3.7	1.9		
Magallanes	1	48.3	36.6	12.9	1.1	
Merville	4.1	31.1	6.8	12.2	5.4	40.5
Bel-air	2	51	11.8	10		25.5
Area behind basketball hardcover	3.2	30.2	9.5	9.5		47.6
Nature Garden	4.8		9.5	7.1	2.4	76.2
Football field	3		2.4	7.3	1.2	58
Area next to D-Block	5.4	36	8.2	8.2		41.1

As the table illustrates, most of the samples from the student's homes are clay soil (with the exception of Merville, which had more gravel), which can probably be expected from a tropical country such as the

Philippines. I would have expected to see more loam, because the environments of most of the excavation sites have green foliage and trees growing nearby, which hints at rich, fertile, loamy soil. The soil samples taken from the school grounds, however, seem to be mostly gravel. This is not really surprising, as the school grounds are literally based on a heap of rubble, with a thin layer of loam soil. Most of the excavation sites are quite barren; grass grows, but surrounding shrubs and trees seem to be rather weak and under-developed.

The pH level remains constantly neutral for all soil types. I did not expect this to change much; the soil samples with more clay may have been a little more acidic, but not by much. However, the test kit used was supposedly quite old, and the method quite simple, so I do question the accuracy of the results.

I regret not having results referring to water content for all the soil samples; we only have soil samples taken from the school grounds and one sample from a student's home.

Soil Sample	Mass After Heating						
	Original Mass (g)	After 10 mins	After 20 mins	After 30 mins		Water content	
Bel-air	22.8	21.5	21.8	21.8	21.8	1	4.4 %
Area behind basketball hardcover	24.0	22.4	21.9	21.8	21.8	2.2	9.2 %
Nature Garden	22.8	21.1	20.5	19.9	19.9	2.9	12.7 %
Football field	22.0	20.0	20.0	20.0	19.0	3	13.6 %
Area next to D-Block	21.7	20.6	19.5	19.5	19.5	2.2	10.1%

I expect that the soil samples from the student's homes would have contained even more water, as they were identified to be made up of more clay than gravel. Gravel is very arable and is less efficient in retaining water than clay is; however, Bel-air, a student's home, actually had the least amount of water present, despite being a predominantly clay substance. However, it was also made up of about a quarter of gravel, so the water loss is still understandable.

The organism test seemed to have little variation in its results; no living organisms were found in any of the soil samples, except for the sample from Merville, which seemed to contain one mosquito and two flies, and predominantly gravel. The soil sample from the football field had a lot of roots, was predominantly gravel and had the highest water content. The presence of the clustered roots may be the reason for this. The two soil samples which showed the highest signs of life had were made up of gravel and were arable, so this suggests that plants and organisms of the Philippines prefer arable yet well-watered soil. Not enough data exist in this investigation to support this, though.
Traces of what appeared to be glass were detected in the soil sample from Alabang, and bits of plastic were found in the soil sample from behind the basketball court. They were clay samples with no organisms detected within; the traces of artificial substance may be an indication of pollution, which could drive organisms away. The area behind the basketball court is secluded and shady, with sparse plant growth, and occasionally has traces of food wrappers – not and ideal, healthy environment.

As has been mentioned before, the results are sparse and incomplete, and it is difficult to draw conclusions. More time would have been useful for this experiment, and fewer tests should have been conducted on fewer samples. The nutrient test, soil sedimentation and classification, water content test and organism tests are probably the most useful and important, and some interesting theories could have been made based on complete results.

I do not really think many modifications to the experiments are necessary. Testing for water content could have been done by baking the samples in an oven, but that would have taken up more time; the pH and nutrient test are standard tests set up by specialized kits, and the organic content test is a simple test which relies on observational skills.

Conclusion

The Alabang soil sample, showing no forms of life, was a predominantly clay sample, and probably would have contained a lot of water.
The Magallanes sample had no signs of life, and was predominantly clay with coarse sand. This may not be a favorable kind of soil for plant growth, as the ground is tough and likely to be water-logged. It also does not have much humus, and is thus not very fertile; this is probably not very good soil for plants.
The Merville sample had three insects within it, and was a predominantly arable gravel sample; this may suggest that life is more likely to thrive is samples which have slightly more gravel and air space within. It consisted of 4 % humus, and was thus fertile ground. With about 12% fine sand (light, airy particles), it seems to be a very favorable biotic factor.
The Bel-air sample was half clay, one quarter gravel and about 10% coarse and fine sand, with a 2%b humus content. This seems to be quite healthy soil, fertile, moderately airy, but despite its high clay content, it does not seem to retain water well, as it only had about 4% water content.
The sample taken from the area behind the basketball court was quite shady, with sparse plant life and some pollution. It consisted mostly of gravel and clay, and had a 9.2% water content. Earlier data suggests that this is quite healthy soil; with a humus percentage of about 3.2, it seems like it should support more life. Perhaps a factor which has not been investigated has influenced this, such as a lack of sunlight.
The nature garden has a 4.8 % humus content, about 12% of its mass was water, and consisted mostly of gravel, coarse sand and fine sand – no clay. The sample did not seem to support much life, but the area around it is quite lush and green; it seems to be a favorable soil sample.
The soil sample taken from the football field had a lot of roots in it, and I believe this is the reason for its very high water content. Mostly gravel and loam, it supported a fair distribution of green grass, and looked healthy; with a humus percentage of 3, it probably is a favorable kind of soil.
The area next to the D-Block had the highest humus percentage, had quite a lot of clay, but just a little more gravel. It did not support much life, and the plant life around it, although plentiful, seemed somewhat strained. It should be a healthy sample; perhaps there is not enough nutrients in the soil to support all the plants.

It would be extremely valuable to this project to know the nutritional value of the soil samples, but from the available data, it seems that the most favorable soil samples are airy, humus, and are capable of retaining quite a lot of water.