LITTLE MISS SHY

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Content

1. Abstract

Mimosa pudica, which is a sensitive plant, is a perennial but is often cultivated as an annual in gardens. When it is being touched or shaken, its leaflets will fold together and the whole leaf will droop downwards temporarily.

In this project, our objectives are to study how variable environmental conditions (light intensity, damp or dry soil, wind speed, temperature) affect the folding time of its leaves. For our investigation, we have prepared eight *Mimosa pudica* and set up a variety of controlled experiments in the school laboratory. In our experiments, the standard of folding up of leaves is set to be distance between less than 1 cm and the concluded results are as followed:

1. The higher the humidity the soil is, the shorter the folding time of leaves
2. The higher the light intensity in the environment, the shorter the folding time of leaves
3. The greater the wind movement, the longer the folding time of leaves
4. Varied temperature does not affect the folding time of leaves.
5. The amount of leaves touched does not affect the folding time of leaves.
6. Given the same level of light intensity, the leaves of *Mimosa pudica* under natural light reopen faster than that under man-made light.

2.Introduction

2.1 Introduction to the research topic

Mimosa pudica is one of the most common plants found in Hong Kong and we can often see them along the streets and railways. Very often, we touch them because of curiosity. However, we seldom notice how much time is needed for the reopening of its leaves and when will it show its shyness for a longer period of time. Therefore, we decided to work on it. Besides, we notice that its leaves are often closed when we see them at night. This raises our interest in the relationship between the environment and the movement of the leaves of *Mimosa pudica.*

In this report, we aim to investigate the environmental factors affecting the folding time of *Mimosa Pudica*, so that we will know more about these "shy" leaves and find out the secrets behind their closings. We will concentrate on investigating the effect of the change in temperature, humidity, wind speed and light intensity ,which are the common factors in the living environment of this sensitive plant. The effect of different number of leaves being touched is also investigated.

2.2 Objectives

1.To study how the folding time of leaves of *Mimosa pudica* is affected by the environment (light intensity/ temperature/ humidity of the soil/ wind speed)
2.To study how the folding time of leaves of *Mimosa pudica* is affected by human actions towards it (the number of leaves being touched)

2.3 Research Questions

1 How ***light intensity*** affect the folding time of the leaves?
2 How ***wind speed*** affect the folding time of the leaves?
3 How ***temperature*** affect the folding time of the leaves?
4 How ***humidity of soil*** affect the folding time of the leaves?
5 How ***amount of leaves touched*** affect the folding time of the leaves?
6How ***natural light*** and ***man made light*** affect the folding time of leaves?

2.4 Background information of *Mimosa pudica*

The origin of *Mimosa pudica* is in north America, also common in tropical area. The leaves are alternate in pattern, which is about is 1.5-5.5 cm long and have 10~26 pair of leaflets. Flowers that are lilac in colour are also commonly found. The leaves of *Mimosa pudica* fold as a result of the internal movement of water.

A stimulus, such as touch or air movement, triggers certain areas of the stem to release chemicals, which causes water to move out of cell vacuoles and the cell collapse. If the touch is strong enough the entire plant ends up folding its leaves together leaving the *Mimosa* almost unrecognizable potentially.

In the pulvini, it consists of two motor cells, divided into flexor and extensor cells on the front and back side of the leaf, respectively. They are for regulating the volume and shape according to their relative turgor pressure. When we touch the leaflet, the water of the extensor cell leave to cell due to the lower water potential. The flaccid extensor and the stretched flexor cell makes the leaf closes. (fig2.4)

This mechanism provides them safety from foragers. For example, it would be beneficial for them to close their leaves if a caterpillar climbed on it. Instead of eating the leaves, the caterpillar might be stuck inside the leaf, or it might fall off the plant. Closing the leaves also makes the plant look less appetizing to passing herbivores and prevents water loss at night.

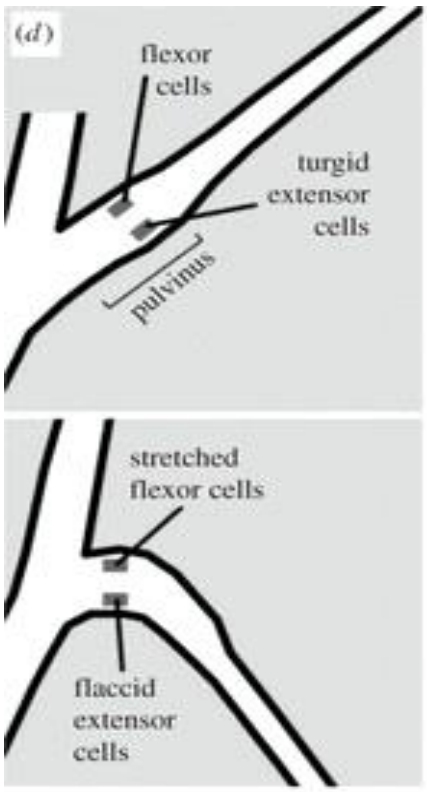


fig 2.4 Mechanism of the Seismonastic Reaction in *Mimosa pudica*

3. Materials and Methods

3.1 Working Schedule

Time	Schedule	Venue
30 December 2015	Field Work 1	Tai Lam Country Park
22 February 2016	Field Work 2	Tsing Chung Koon Road Government Quarters platform
23 February 2016	Field Work 3	School Garden
March 2016	Experiments	School Laboratory

3.2 Field Study 1 - Tai Lam Country Park

In December 2015, we went to Tai Tong Country Park for our first field trip. We walked for very long time but we could not see any *Mimosa pudica.* We thought that it was very easy for us to find them because they were one of the most common plants found in Hong Kong so we were quite disappointed. Therefore, we went back home without any *Mimosa pudica.* After we had done the research, we found that December is not their florescence so we decided not to have another field trip until the weather turns warm. Besides, we saw many *Hypolepis punctata* during the trip. This confused us a lot as they really look alike *Mimosa pudica*. We have to distinguish them from *Mimosa* by touching them.

Later on, we found out that there are small white dots at the base of each leafle of *Mimosa Pudica,* which is different from that of *Hypolepis punctata* and this is the secret as how the *Mimosa*' s tiny leaflets move. These dots are fluid filled, sac-like structures called pulvini that are tiny actuators powered by turgor pressure. This proved the importance of this structure to them.

fig 3.2.1 Tai Lam Country Park

fig 3.2.2 *Hypolepis punctata*

fig 3.2.3 small white dots

3.3 Field Study 2 - Tsing Chung Koon Road Government Quarters platform

The weather turned warmer so we decided to have our another field trip. It was carried out on the platform at Tsing Chung Koon Road Government Quarters, where a lot of *Mimosa pudica* are present. We measured the basic environmental data there so that we get to know more about the habitats of *Mimosa pudica.*

fig 3.3 *Mimosa pudica* found on the platform

fig 3.4 some of our *Mimosa pudica*

3.4 Field Study 3 - School Garden

As found from the internet, it is very difficult for us to transplant *Mimosa pudica.* Therefore, we decided to use those from our school garden for our experiments. We picked eight of them and put them to the school laboratory and we carried out the experiments a few weeks later as we wanted them to adapt the new environment.

3.5 Field site basic information

	Field trip 1	Field trip 2	Field trip 3
Date	30 December 2015	22 February 2016	23 February 2016
Time	10:00-12:00	17:00-18:00	16:30-17:00
Temperature	13.4°C	18.3°C	16.1°C
Wind speed	8m/s	6m/s	6m/s
Humidity	68%	71%	80%
Light intensity	1640lux	910lux	1278lux

3.6 Field trip equipments for measuring abiotic factor:

fig 3.5.1 Equipments

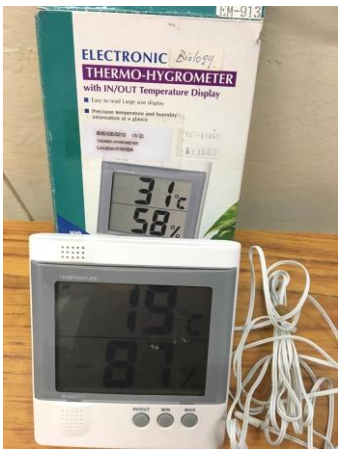


fig 3.5.2 Thermo-hygrometer

fig 3.5.3 Windspeed Meter

fig 3.5.4 Light sensor

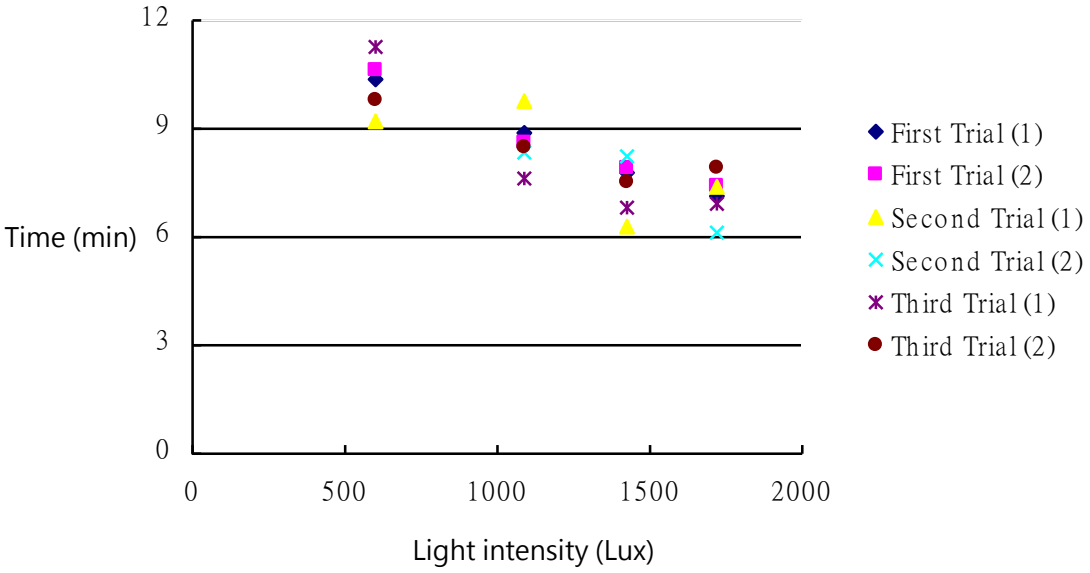
fig 3.5.5 Stopwatch

4. Experiments and Results

In March, we did a total of five experiments for three times in the school laboratory.

In our experiments, the leaves of the *Mimosa pudica* have to be folded and our standard of "folded" is that the distance between each pair of leaves less than 1 cm

4.1 Light intensity



Objective:

Find out the effect of light intensity on the folding time of *Mimosa pudica*' s leaves

Set Up:

Mimosa pudica plants x 8 (A1 A2, B1 B2, C1 C2 and D1 D2)

Camera x 1

Lamp x 3

40×30×30 cm Carton x 1(with a small window for observation)

Lux meter x 1

Variables:

Independent variable: Light intensity (by using lamps of different brightness)

Dependent variable: The time needed for the leaves to open

Controlled variable: humidity, wind speed, temperature ,number of leaves stimulated

Assumption:

All *Mimosa pudica* plants used in the experiment are identical

Procedure:

1. Put A1 A2 in a 40×30×30 cm carton.
2. Put B1 B2 under a 60W lamp.
3. Put C1 C2 under a 80W lamp.
4. Put D1 D2 under a 100W lamp.
5. Use a light sensor to measure the light intensity of the four set-ups.
6. Set cameras for B1 B2, C1 C2 and D1 D2 for observation.

7. Touch all the leaflets fully (distance less than 1cm)
8. Observe the opening time of leaves of B1 B2, C1 C2 and D1 D2 by the videos recorded.
9. Measure the opening time of A1 A2 leaflets by observing them in the small window of the carton at 5 minutes interval, then at 1 minutes interval from 10 minutes onwards.
10. Repeat step 1~7 for three times.

Observation:

The leaves of A1 A2 put inside the dark carton did not open after 20 minutes. For the others put under lamps, the time needed for them to re-open decreases when the ligth intensity increases ,and the difference between various light intensity is significant.

Conclusion:

When light intensity increases, the folding up time of *Mimosa pudica* decreases.

4.1.1 Man-made light and Natural sunlight

	light intensity	Time of Opening(average)
natural sunlight	1623lux	6 min 23s
man-made light(lamp)	1690ux	8 min 34s

Objectives:

We observe that even light is supplied to *Mimosa Pudica at night*, its leaves don' t reopen. In this experiment we will find out the difference of the effect of man made light and natural light towards the plant.

Set up:

Mimosa pudica ×4(A1 A2, B1 B2)
camera ×1
100W table light ×2, 60W table light ×2, 80 W table light ×2
40×30×30 cm carton box × 1
light sensor ×1

Variable:

Independent variable: natural sunlight and man-made light
Dependent variable: The time needed for the leaves to open
Controlled variable: Light intensity, humidity, wind speed, temperature ,number of leaves stimulated

Assumption:

All *Mimosa pudica* plant used in experiment are identical.

Procedure:

1.Put the two 60W table light and plant A1 A2 into the carton box. This is to imitate the dark situation at night with extra light given to plant and block the natural light.

2. Put B1 B2 outdoor under natural sunlight. This is to imitate the outdoor natural environment of the plant.

3. Measure the light intensity of each set up using light sensor. Try to keep the light intensity in both cases constant, by adding or reducing the amount and W of table light.

4. Set camera for the two set up to record accurate reopen time.

5. Repeat step 1~4 for three times.

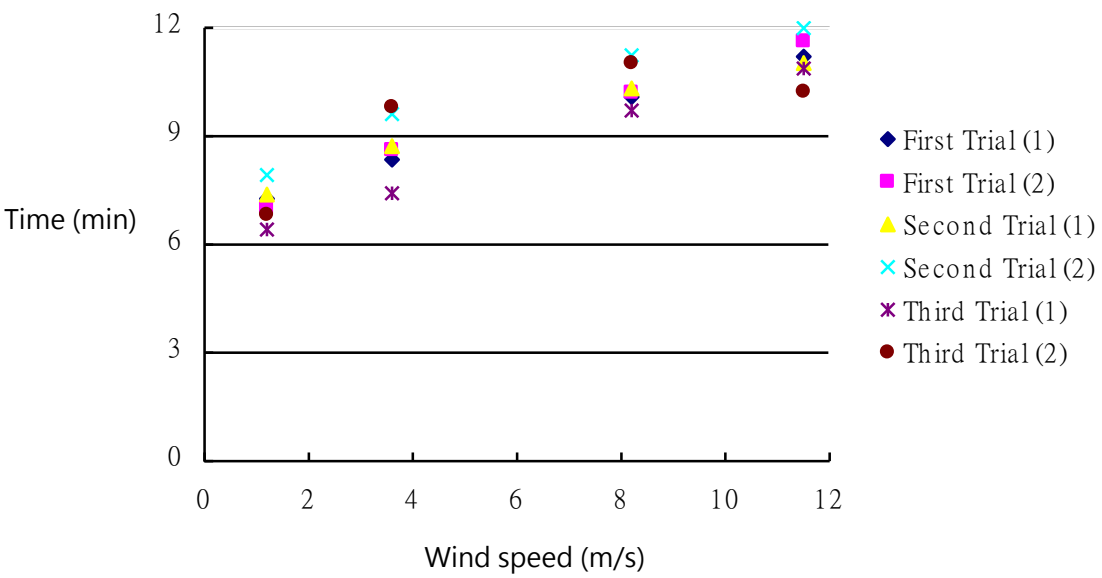
Analysis:

The *Mimosa pudica* under man made table light reopen slower than that of *Mimosa pudica* under natural sunlight for ~ 1 min 30 sec under similar light intensity level. Therefore,we deduce that there are some components in sunlight, which man-made light lacks, help shortening the folding time of *Mimosa*′ s leaves.

Conclusion:

Given the same level of light intensity, the leaves of *Mimosa pudica* under natural light reopen faster than that under man-made light.

4.2 Wind Speed



Objective:

Find out the effect of wind speed on the folding time of the leaves of *Mimosa pudica*

Set Up:

Mimosa Pudica plants x8 (A1 A2, B1 B2, C1 C2 and D1 D2)

Camera x 1

Electrics fans x 3

Windspeed meter x 1

Variables:

Independent variable: wind speed

Dependent variable: The time needed for the leaves to open

Controlled variable: water supply, the environment(except wind speed),number of leaves stimulated

Assumption:

All *Mimosa pudica* plants used in the experiment are identical

Procedure:

1: Put three electrical fans in front of sample A1A2 B1B2 and C1C2 separately and put D1D2 aside.

2. Turn on the three fans with different degrees.

3. Measure the wind speed of the four set ups using a anemometer.

4. Set cameras for the set-ups for observation.

5. Touch all the leaflets fully (distance less than 1cm)

6. Repeat step 1~5 for three times

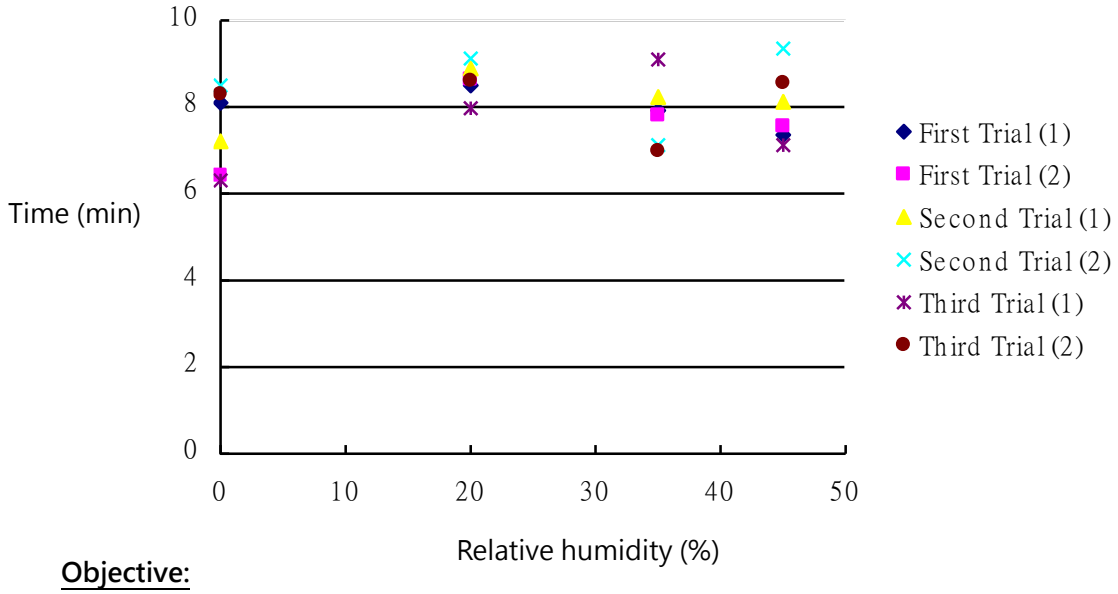
Observation:

There is a gradual change in the folding time of its leaves as the wind speed increases. At moderate wind (0.1m/s), it reopens as normal , which is generally 7 minutes. Then from 10m/s onwards it needs more than 10 minutes to reopen.

Conclusion:

The stronger the wind is, the more time needed for mimosa' s leaves to open.

4.3 Relative Humidity



Objective:

Find out the effect of humidity on the folding time of the leaves of *Mimosa pudica*

Set Up:

Mimosa pudica plants x 8 (A1 A2, B1 B2, C1 C2 and D1 D2)

Camera x 1

Water sprayer x 1

Hygrometer x 1

Variables:

Independent variable: Relative humidity of the soil (by changing the amount of water supplied)

Dependent variable: The time needed for the leaves to open

Controlled variable: The environment (e.g. temperature, light intensity),number of leaves stimulated

Assumption:

All *Mimosa pudica* plants used in the experiment are identical

Procedure:

1. Stop watering D1D2 one day before the experiment.
2. Water A1A2 with 20mL water.
3. Water B1B2 with 10mL water.
4. Measure the humidity of the soil of the eight samples using a thermo-hygrometer.

5. Set cameras for the set-ups for observation.
6. Touch all the leaflets fully (distance less than 1cm)
7. Repeat step 1~6 for three times.

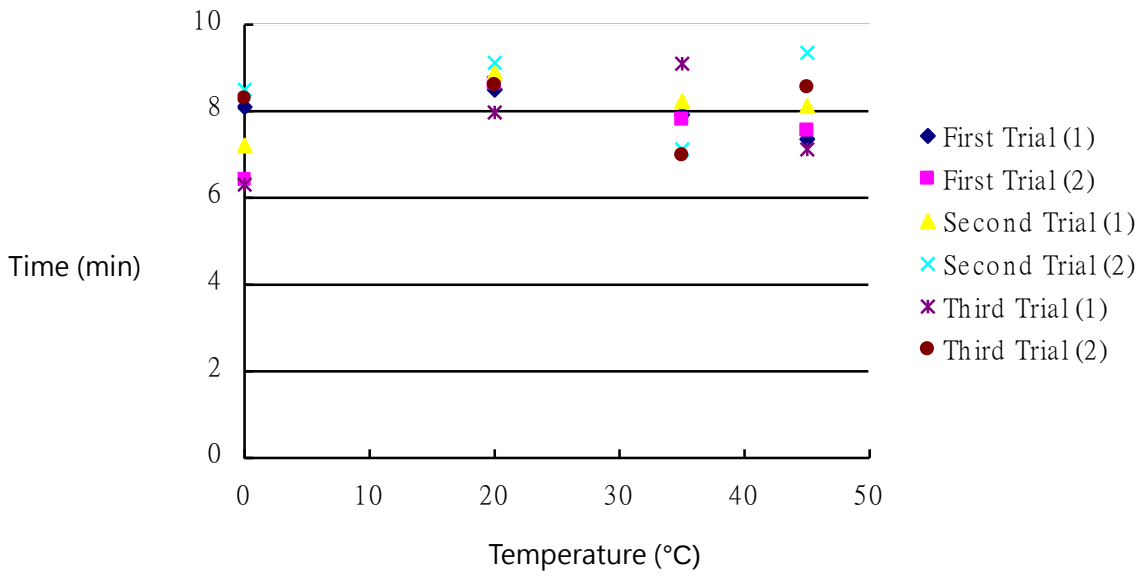
Observation:

The humidity of watered and non watered soil is generally 70~80%.After watering, soil humidity increases for 3~4%; and without watering for a period of time, the humidity of soil also decreases for 3~4%. With more water added, the reopen time of leaflets decreases for ~30sec. Comparing to dry and wet soil, there is a significant difference of the reopening time. Leaflets in wet soil reopens faster than that in dry soil for more than 1 min.

Conclusion:

The wetter the soil is, the quicker the leaves of mimosa open.

4.4 Temperature_



Objective: Light intensity (Lux)

Find out the effect of temperature on the folding time of the leaves of *Mimosa pudica.*

Set Up:

Mimosa Pudica plants x 8 (A1 A2, B1 B2, C1 C2 and D1 D2)
Camera x 4
Thermometer x1
Transparent plastic box x1
Heater x1
Ice

Variables:

Independent variable: temperature

Dependent variable: The time needed for the leaves to open

Controlled variable: water supply, the environment, number of leaves stimulated

Assumption:

All *Mimosa pudica* plants used in the experiment are identical

Procedure:

1. Put ice around A1A2 .
2. Use a transparent plastic box to cover the above items.
3. Place B1B2 away from the heater for 10 cm.
4. Place C1C2 away from the heater for 40cm.
5. Place D1D2 on the bench.
6. Measure the temperature of the four set ups using a thermometer.
7. Set camera for the set ups.
8. Touch all the leaflets fully (distance less than 1cm)
9. Repeat step 1~8 for three times.

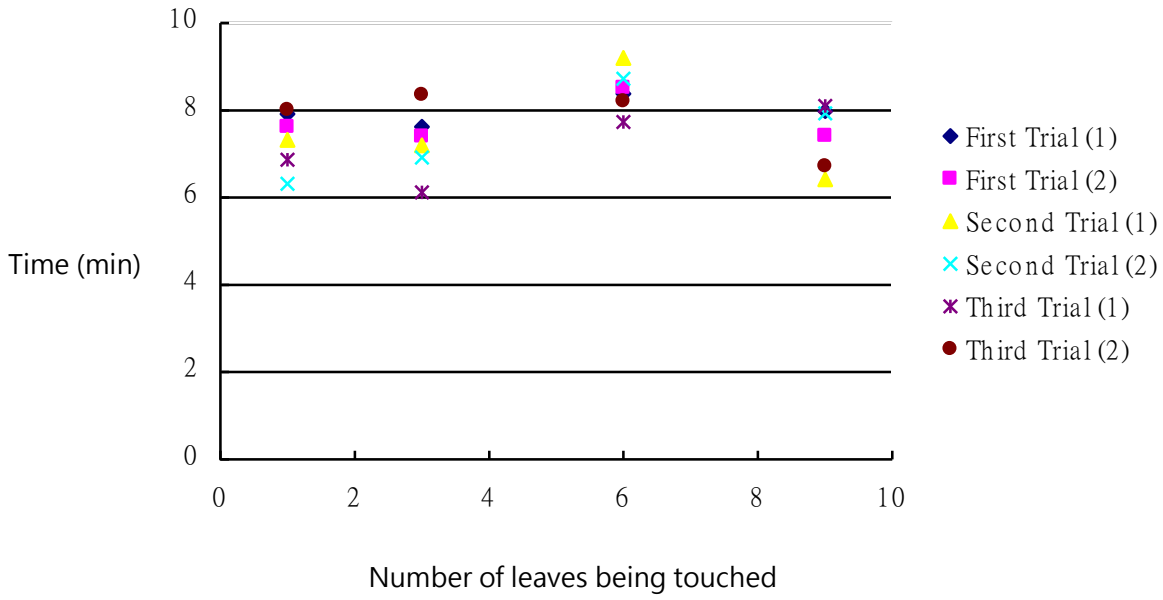
Observation:

The folding time of the leaves of the eight samples doesn' t varied a lot and no regular pattern can be observed. There is no significant changes of folding time when the temperature increases. All of them need around 7-8 minutes for their leaves to open. Therefore, we deduce there is not much relationship between the temperature and the folding time of *Mimosa pudica*' s leaves.

Conclusion:

Varied temperature does not affect the folding time of its leaves much.

4.5 Number of Leaves Being Touched



Objective:

Find out whether the folding time of its leaves will be affected by the numbers of leaves stimulated.

Set Up:

Mimosa pudica plants x 8 (A1 A2, B1 B2, C1 C2 and D1 D2)

Camera x 1

Variables:

Independent variable: numbers of leaves stimulated

Dependent variable: The time needed for the leaves to open

Controlled variable: water supply, the environment (e.g. temperature, light intensity)

Assumption:

All *Mimosa pudica* plants used in the experiment are identical

Procedure:

1. Touch a pair of leaves for A1 A2, 3 pairs for B1 B2, 6 leaves for C1 C2 and all leaves for D1 D2 respectively (the chosen leaflets are scattered on different branches to make result fair)
2. Set camera for each set up for observation .
3. Repeat step 1~2 for three times.

Observation:

The folding up time of various amount of stimulated leaves is 7min 30 sec averagely. There is no significant changes of folding time when the amount of stimulated leaves increases.

Conclusion:

There is no relationship between the folding time of leaves and the amount of stimulated leaves.

5. Discussion

5.1 Analysis of results

Light intensity

From our observation and the above experiments, it can be concluded that the folding time of *Mimosa pudica*' s leaves is closely related to the light intensity .The higher the light intensity is, the shorter the time needed for their leaves to open. This is why when we did the experiments in the late afternoon, when the light wasn' t strong, we have to wait for a very long time until the leaves open.

Besides, when they are placed in the dark, the leaves remain closing .This is called the Nyctinastic movements, which are reactions that happen in the absence of light, causing *Mimosa pudica* to close its leaves at night. Therefore, we can never see them open their leaves when they are placed in the darkness.

Furthermore, compared with natural sunlight, *Mimosa* put under light from lamps, which lacks some of the components of sunlight, need more time to reopen their leaves. So we can see that light intensity is one of the most significant factors affecting the folding time of *Mimosa Pudica.*

Wind speed

By our experiments, we have concluded that there is a positive relationship between wind speed and the folding time of its leaves. The stronger the wind is, the more time needed for their leaves to open.

We deduce that it' s because they are so sensitive that even a gust of wind may cause them to close down. As a result, when the wind is strong, *Mimosa* is kept on stimulating by the wind and therefore, it takes more time for them to recover under such condition. From this , we can also deduce that in a windy and typhoon day, the leaflets of *Mimosa pudica* will always fold up.

Relative humidity

In the experiment, samples with more water supply open their leaves faster. The wetter the soil is, the quicker the leaves open. The time needed for the one of relative humidity of 85% to reopen its leaves are almost 3 minutes faster than that of 68%, which is a significant difference. This shows that the humidity of the soil is quite an important factor affecting the folding time of *Mimosa pudica*' s leaves.

As a result, we can deduce that in the seasons with more precipitation, i.e. spring and summer, *Mimosa pudica* can recover in a shorter time when its leaves are being stimulated, compared with that in autumn and winter.

Temperature

Before doing the experiment, we expected that temperature will be one of the greatest factors affecting the folding time of *Mimosa pudica*' *s* leaves but from our experiments, we can see that varied temperature does not affect it much.

Number of leaves being stimulated

Our experiments show that there is no significant changes of folding time when the amount of stimulated leaves increases. It is rather different from our expected result, which is the more leaves being stimulated, the more time needed for it to recover. No matter how many leaves are stimulated, the mechanism still works the same.

5.2 Limitation

1. As it is very difficult and risky to transplant *Mimosa pudica*, the samples we used in the experiments are from school garden instead. Therefore, the results may not be suitable to apply on all mimosa pudica.

2. In our experiments, it' s assumed that every mimosa are identical but in fact, different Mimosa Pudica has different amount of branches, size of leaves, etc. To solve this , we try to keep the amount and size of leaves stimulated similar.

3 From our experiments, we can only find out the relationship between the environment and the folding time of the leaves of *Mimosa*, we can' t explain how these factors affect the mechanism behind.

5.3 Improvements & further studies

1. In our experiments testing the effect of light intensity, the lamps of different brightness may cause the temperature of the four set-ups slightly different, which may affect the results. Although from our experiments, varied temperatures don' t affect the folding time much, it would be better for us to put transparent heat insulation sheets in front of the lamps next time, so that we can keep other factors constant during the experiment.
2. We have concluded that light intensity is one of the major factors affecting the folding time of *Mimosa pudica*' s leaves. To further investigate the topic, we may try using lights of different colour to test them and see if it will affect the time needed for the leaves to reopen.

3. As found from the experiment 2, given the same level of light intensity, the leaves of *Mimosa pudica* under natural light reopen faster than that under man-made light and we deduced that it' s because of some special components in sunlight. We may try investigating what exactly those components are. For example, using a ultraviolet light lamp in an experiment and see what the result will be.

4. At first, we always did our experiments after school, which is generally 4:30~5:00 pm, the leaves takes quite a long time to recover. Sometimes it may take nearly 40 minutes to reopen fully. Later on, we find out that it' s because of the Nyctinastic movements. Under this condition, the results of the experiments may not be accurate and reliable. To ensure the accuracy of our investigation, we have to prevent doing the experiments in late afternoon or evening.

5.4 Conclusion

After conducting all the experiments, we find out that there is a close relationship between the environment and the folding time of *Mimosa pudica*' s leaves and the following ideas can be concluded.
1. The higher the light intensity in the environment, the shorter the folding time of its leaves.
2. Given the same level of light intensity, the leaves of *Mimosa pudica* under natural light reopen faster than that under man-made light.
3. The greater the wind movement, the longer the folding time of leaves
4. The wetter the soil is, the shorter the folding time of leaves
5.Varied temperature and the amount of leaves stimulated does not affect the folding time of leaves.

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7. Appendix

7.1 Nyctinastic Movement

Plants, unlike animals, are sedentary organisms, but they are capable of some limited movements. These include nastic movements, which enable plants to adapt rapidly to changes in their environment by changing orientation.

The most widely occurring nastic movements are probably *Day-and-Night Movements,* known as *Nyctinastic Movements*. Another important kind is thigmonastic movements, triggered by touch or other mechanical stimuli.

The leaves of many plants respond to the daily alternation between light and darkness by moving up and down. In these nyctinastic, or sleep, movements, the leaves extend horizontally (open) to intercept sunlight during the day and fold together vertically (close) at night.

Leguminous plants exhibiting *Nyctinastic Movements* include the sensitive plant (*Mimosa Pudica*) and the silk tree (*Albizzia Julibrissin*). The movements also occur in some species of oxalis (*Family Oxalidaceae*). In the prayer plant, maranta species (*Family Marantaceae*), the leaves, which are simple, fold at night into a vertical configuration that suggests praying hands.

7.2 Tables

4.1 Light intensity

Light intensity	Time of Opening(average)
25 lux	-
1088 lux	8 min 53 s
1425 lux	7 min 47 s
1720 lux	6 min 10 s

4.1.1 Man-made light and Natural sunlight

	light intensity	Time of Opening(average)
natural sunlight	1623lux	6 min 23s
man-made light(lamp)	1690ux	8 min 34s

4.2 Wind Speed

Wind Speed	Time of Opening(Average)
1.2 m/s	7 min 13 sec
3.6 m/s	8 min 34 sec
8.2 m/s	10 min 5 sec
11.7 m/s	11min 12 sec

4.3 Relative Humidity

Relative Humidity of the soil	Time of Opening(average)
85% (20ml water added before the experiment)	6 min 19 s
81% (10 ml water added before the experiment)	6 min 41 s
72 % (no water added before the experiment)	7 min 37 s
68% (without watering for 1 day)	9 min 02 s

4.4 Temperature

Temperature	Time of Opening(average)
0°C	7 min 55 s
20°C (room temperature)	8 min 31 s
35°C	7 min 56 s
45°C	8 min 20s

4.5 Number Leaves Being Touched

Number of Leaves Being Touched	Time of Opening(average)
1	7 min 55 s
3	7 min 50 s
6	8 min 13 s
All (8-10)	7 min 42 s

6.4 Snapshots

Special Thanks to Mr. Fok Ping Chiu

And

Classmate Edgar Cheung

The End