

Searching For Nature Stories 2012

Title:

Why are the paper bark trees so lonely?

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Content

I.	Abstract	P.3
II.	Introduction	P.4
	<u>1. Reason of investigation</u>	P.4
	<u>2. Objective</u>	P.4
	<u>3. Relevant research on paper bark tree</u>	P.4
	<u>4. Background for site of investigation</u>	P.4
III.	Field Study	P.5
	<u>1. Time and venue</u>	P.5
	<u>2. How paper bark tree affect other species</u>	P.6
	<u>A. Observation on vegetation</u>	P.6
	<u>B. Experiment: Animals trap</u>	P.6
	<u>3. Collect soil sample, leaves and paper barks</u>	P.7
IV.	Methods and materials	P.8
	Hypothesis A: Blockage of sunlight by paper bark tree	P.8
	<u>A1. Observation: Big tree canopy</u>	P.8
	<u>A2. Observation: densely distributed paper bark</u>	P.8
	<u>A3. Observation: Closely grown paper bark tree</u>	P.8
	Hypothesis B: essential oil affects other species	P.9
	<u>B1. Observation: Extent of damage of leaves</u>	P.9
	<u>B2. Experiment: planting green bean seed by soil collected</u>	P.10
	Hypothesis C: Paper barks affect absorption of other plant	P.13
	<u>C1. Experiment: Absorption of water of paper bark</u>	P.13
	<u>C2. Experiment: Permeability of paper bark to water</u>	P.14
V.	Limitation of the investigation	P.14
VI.	Conclusion	P.14
VII.	Question remained	P.15
VIII.	Bibliography	P.15

Abstract

Have you ever noticed that the soil surface around the paper bark trees a bit barren? Some people suspect that the essential oils produced by the paper bark trees are the 'culprits'

In our investigation, we are going to

1. Find out ways that the paper bark trees exert their influence on other species which including both plants and animals.

We had field study at Shing Mun Reservoir on 3 days and made the following observations:

1. only a few grasses scattered around the paper bark trees
2. relatively less animals are present in the studied area with paper bark trees
3. relatively little or no damages done on the leaves of paper bark trees by pests
4. the canopy of the paper bark trees reduces the penetration of light to the ground level
5. Lots of fallen leaves and paper bark litter on the surface of soil.

We proposed the following hypotheses to explain the above observation:

Hypothesis A—the big tree canopy of paper bark tree block the sunlight to the plant on the ground hence limiting the growth of other vegetation.

Hypothesis B—The leaves of paper bark tree contain essential oils which may hinder the growth or existence of plants and animals.

Hypothesis C— Fallen paper bark on soil surface absorbs rainwater thus water is insufficient for plant to absorb for photosynthesis and transpiration.

Samples of soil, leaf litter and the fallen paper bark were collected for further laboratory investigation.

In laboratory, we had done the following experiments:

1. To find out whether the chemical which is released to the soil from the decayed leaves of paper bark tree to the soil inhibit the germination of green bean seed and their further growth.
2. To find out to what extent the paper bark absorbs water and hence limiting the supply of water to the growth of plant.

As a conclusion to our investigation, we can say that the paper bark trees adversely influence the survival of other plants due to

1. insufficient light penetration to ground level due to the thick canopy.
2. inadequate supply of water to soil that is being covered by leaf and bark litter.
3. the layer of leaf and bark litter acts as a physical barrier to prevent any seeds reaching the soil and hence inhibit germination.

Besides, the paper bark trees also adversely influence the survival and existence of animals there by the special odour of essential oils that scares them away or causes death after eating the leaves.

Introduction

A. Reasons and motives of investigation

Although we are living in a concrete jungle, there are still lots of trees around us but we seldom stop and observe the trees carefully. One day, our group members went hiking in Shing Mun Reservoir. We found it eccentric that there are not many species near the paper bark trees. Only the area under the paper bark trees seems a bit barren. This phenomenon intrigued us instantly.

B. Objectives

Find out ways that the paper bark trees exert their influence on other species

C. Information of paper bark trees

Description

Melaleuca quinquenervia, commonly known as Niaouli or Broad-leaved paper bark or the Paper Bark Tea Tree, is a small- to medium-sized tree of the allspice family, Myrtaceae.

The broad-leaved paper bark grows as a spreading tree up to 20 m high, with the trunk covered by a white, beige and grey thick papery bark. The grey-green leaves are ovate and the cream or white bottlebrush-like flowers appear from late spring to autumn.

Distribution and habitat

The plant is native to New Caledonia, Papua New Guinea and coastal Eastern Australia, from Botany Bay in New South Wales northwards, into Queensland and the Northern Territory. It has become naturalised in the Everglades in Florida, where it is considered a serious weed by the USDA.

Paper bark trees in Hong Kong

There are 150 species of *Melaleuca spp.* Yet, there is only one type in Hong Kong, known as *Melaleuca cajuputi subsp. Cumingiana*

D. Background of the study area

The distribution of the paper bark tree in Hong Kong is confined to the roadside, the reservoirs and their catchment areas such as Tai Po Kau and Shing Mun reservoir. The proliferation of paper bark trees in Shing Mun Reservoir is more than natural. Shing Mun reservoir has plentiful supply of water makes it become one of the best species to cope with the environment. There are few species that can proliferate under their crowns now. So we have chosen Pineapple Dam Nature Trail, Upper Shing Mun Reservoir (Labeled as A in the map) as our study area.



Fig.1.1

Field study

1. Time and venue

Date	11-2-2012	26-2-2012	27-2-2012
Time	10:00a.m. To 2:00p.m.	10:00a.m. To 2:00p.m.	11:00a.m. To 3:00p.m.
Weather	Cool with some showers	Cold with some showers	Cold, cloudy with thunderstorm
Temperature	13 degree Celsius in Shing Mun Valley	11 degree Celsius in Shing Mun Valley	11 degree Celsius in Shing Mun Valley
Relative humidity	83%	85%	89%
Wind direction	east to north east	North-east	North

Table.1.1 (*Weather condition was recorded from the daily weather report delivered by the Hong Kong Observatory.)

The environment in Shing Mun Reservoir



Fig.1.2 (A photo taken in our site chosen)

2. How paper bark tree affect other species

A. Observation on vegetation



Fig.1.3



Fig.1.4

Then, we went to the site said in the blog of traveler. There are lots of fallen paper bark and leaves of paper bark tree. Paper bark is large in size. The biggest paper bark we found is measured about 79cm X 42cm in size. According to our observation, there is only tiny little grass besides paper bark tree. The distribution of grass is scattered.

We suggest that near the paper bark tree, there are less other plants. The paper bark tree may affect the growth or existence of other plant species in Hong Kong. Not only in foreign country.

B. Experiment: Animals trap

We do the animal trap to find out if paper bark tree affect the number of species in Shing Mun Reservoir

Apparatus: 250ml beaker

Materials: Sugary solution

Procedures:

1. Pour 100 ml sugary solution to two 250ml beakers
2. Dig the soil under the paper bark tree and other tree species
3. Make a hole under a paper bark tree and other tree respectively.
4. Put a beaker with sugary solution in each hole.
5. Leave it there for 30 minutes.

Result:

Beaker put under other tree which is about 5M away from nearest paper bark tree.	beaker put under paper bark tree
	
A spider, 2 ants.	One ant.

Table.1.2

Limitation: the number of animals may be affected by multiple factors. The result may not be accurate as we only do the experiment for one time.

Interpretation: We think that the region with paper bark tree will have fewer animals. That means the paper bark tree may bring unfavorable effect on ecosystem at local region. There may be fewer animals in the region with paper bark tree.

3. Collect soil sample, leaves and paper barks

We collect the soil sample, leaves of paper bark tree and paper barks to have further investigation. (Note that all the leaves and paper barks collected are naturally fallen on the ground)



Fig.1.5

Material, methods and result

- ✧ **Hypothesis A**—the big tree canopy of paper bark tree block the penetration of sunlight to the plant on the ground.

- **Observation:**

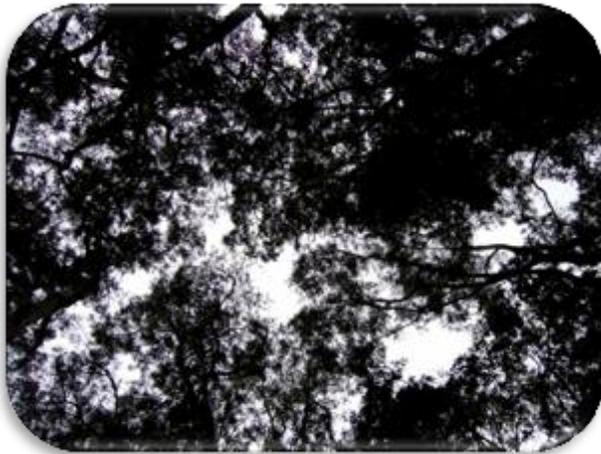


Fig.2.1



Fig.2.2

A1. Photo show the big tree canopy of the paper bark tree.



Fig.2.3

A2. Photo show the shadow made by the paper bark tree. The light intensity is not high. We cannot found sunlight shone on the ground.



Fig.2.4

A3. Photo show the densely populated paper bark on the ground. The whole land surface is covered by plenty of paper bark and leaves.

Possible explanation: Paper bark trees are planted closely. Their large tree crowns are large. The paper bark trees may block the sunlight so the plants on ground may not get enough sunlight to carry photosynthesis.

After we had read some literature, we made hypothesis B.

◆ **Hypothesis B :** The leaves of paper bark tree contain essential oils¹ which may hinder the growth or existence of plants and animals.

➤ **B1.By observation** Date of observe: 27/02/2012

Procedures:

We observed and took some photos of the leaves on the paper bark trees and other trees. This is to compare the number of holes made by herbivorous animals.

Results:



Fig.2.5

Photo of leaves of paper bark tree. We can find holes on one leaf.

Remark 1: According to Doran and Turnball(1997). Essential oils are extracted from leaves of paper bark tree, twigs and seeds by hydro-distillation from plantations in New Caledonia.



Fig.2.6

Photo show another tree at Shing Mun Reservoir. Nearly all leaves of the tree have little holes on it.



Fig.2.7

Photo show leaves of other trees in the Shing Mun Reservoir. There are holes made by herbivorous animals on 11 leaves of a plant.

Possible explanation:

Paper bark tree will not be eaten by some herbivorous animals.

Owing to the unpleasant smell or toxins of the paper bark trees, herbivorous animals and insects are less likely to eat the leaves of paper bark tree..

It may be a reason leading to relatively less animals near the paper bark tree, than other trees in Shing Mun Reservoir.

After our second field study in Shing Mun Reservoir, we collected soil samples near paper bark trees and under other trees. We carried experiments in our school laboratory.

➤ **B2 Experiment**

Aim: to find out if the soil near paper bark tree are not favorable for plant growth

Time: from 12/3/2012 to 19/3/2012

Apparatus: fifteen 250 ml Beakers

We have 3 different set-up.

Set- up group A: 5 soil samples under 5 different paper bark trees (with the top leaves and paper bark **removed**)

Set -up group B: 5 soil samples from 5 other trees

Set-up group C: 5 soil samples under 5 different paper bark tree (with top leaves and paper bark **remained**)

Procedures:

1. Put the soil sample in the beakers.
2. Plant same number of green bean seeds in each beaker.
3. Place Set up A, B, C in same condition
4. Water the plants every morning.
5. Count the number of seeds germinated every day
6. Measure the maximum height of seedlings and the size of leaves after 1 week

By comparing Set-up A and B



Photo of Set A

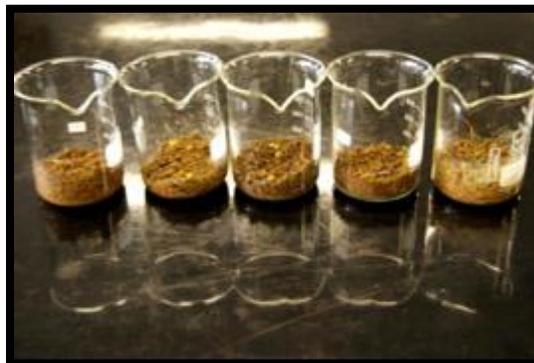


Photo of Set B

Fig.3.1

Fig.3.2

Result:

Date		12/3	13/3	14/3	15/3	16/3	19/3	20/3
Set A1	Experiment started-green bean seeds are planted.		1	2	3	4	4	4
Set A2		1	2	3	4	4	4	
Set A3		1	2	3	4	4	4	
Set A4		1	1	2	3	3	4	
Set A5		0	1	2	3	3	3	
Set B1		0	1	2	3	3	3	
Set B2		0	1	2	3	3	3	
Set B3		0	1	2	3	3	3	
Set B4		0	1	1	3	3	3	
Set B5		0	1	1	2	2	2	

Table show the seed germination of green bean seed for six days.

Table3.1

	Set A	Set B
Percentage of seed germination	76%	56%
Rate of seed germination	Faster	Slower
Height of green bean seeding (on 19/3)	Max : taller than 250mL beaker Mini: not germinated seed	Max: about 4/5 of a 250mL beaker Mini: not germinated seed
Size of leaves	No big difference	
Color of the leaves	Green/ Pale green	
Texture of leaves	Presence of hairs	
Root	White or milky	

Table compare set-up A and B on 19/3.

Table3.2

Significant result: For set up A, soil collect under paper bark trees with top leaves and paper bark removed, have a higher percentage of seed germination and rate of seed germination than set up B.

Interpretation: the essential oil in leaves may not change the soil condition of soil near paper bark tree. According to our experimental result, we can even deduce that the soil around paper bark tree is relatively fertile. Our hypothesis may not be correct.

But the other set up shows a surprising result.

By comparing set-up A and C

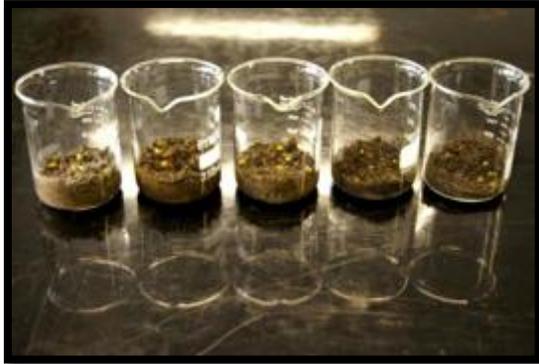


Fig.3.3



Fig.3.4

Photo of Set A

Photo of Set C

Result:

Date	12/3	13/3	14/3	15/3	16/3	19/3	20/3
Set A1	Experiment started-green bean seeds are planted.	1	2	3	4	4	4
Set A2		1	2	3	4	4	4
Set A3		1	2	3	4	4	4
Set A4		1	1	2	3	3	4
Set A5		0	1	2	3	3	3
Set C1		0	0	0	0	0	0
Set C2		0	0	0	0	0	0
Set C3		0	0	0	0	0	0
Set C4		0	0	0	0	0	0
Set C5		0	0	0	0	0	0

Table show the seed germination of green bean seed five days.

Table3.3

	Set A	Set B
Percentage of seed germination	76%	0%

Table compare set-up A and C after one week.

Table3.4

Significant result: soil of paper bark trees which removed the paper bark and leaves have 76% seed germinated. While none of the seed germinated in soil of paper bark tree which do not remove the paper bark and leaves on top of it.

Possible explanation: The leaves and paper bark continuously falling from the paper bark trees will not be decomposed in the soil. They act as a physical barrier to block the seeds from reaching the soil and absorbing water for germination Thus the germination of seed is hindered.

Limitation: In each beaker, we have put 5 green bean seed. It may be too little so that we should put more, at least 20 or even 50 in each beaker to have a more accurate result.

Base on the result of experiment of green bean seed comparing setupA and setupB, we have made hypothesis C

- ◆ **Hypothesis C**—Paper bark trees absorb rainwater thus water in soil is insufficient for plant to absorb to do photosynthesis and transpiration. Texture of paper is just like paper. Paper on top of the soil may absorb water so water cannot reach the soil.

In order to find out the effect of how paper bark affects the absorption of water for other plant, we carry out two experiments.

➤ **C1: Experiment -absorption of water for paper bark**

Aim: To find out to what extent the paper bark absorb water.

Apparatus: 250 ml Beaker, 300 ml Beaker, Electronic balance, Calculator

Materials: Water, Paper bark (collected from the field)

Procedures:

1. Cut the paper bark into small pieces
2. Put an empty 250ml beaker on the electronic balance and set zero.
3. Put the paper bark in beaker and record the initial weight (g)
4. Put the paper bark in a 400ml beaker and add in 250ml water.
5. Wait for 5 minutes.
6. Use a forceps to pick up the paper bark and place them on the tray
7. Record the new weight (g) of paper bark using the 250ml beaker on the electronic balance.
8. Calculate the water absorbed by the paper bark

Limitation1: the paper bark may only trap the water between its gaps but not absorb the water.

Improvement: Use a tissue paper to absorb the water on the paper bark’s surface slightly to ensure no excess weight measured. This procedure is processed before step 7.

Limitation2: To have a convenient experiment, we use a large paper bark to cut into pieces. However, it may not the same in real life.

Results:

		Water absorbed: $20.23\text{g} - 10.20\text{g}$
Initial weight of paper bark used=10.20g	Final weight of paper bark=20.23g	$=10.03\text{g}$

Table3.5

Result:

The new weight of the paper bark is about 2 times that of its original mass.

Interpretation: The paper barks absorb lots of water. The paper bark absorbs nearly the same weight of water of its original weight.

➤ **C2—permeability of the paper bark to water**

Aim: To find out the permeability of the paper bark to water penetration under imitate situation of raining

Apparatus: Tray, 250 ml Beaker, 400 ml Beaker, Electronic balance, watering can

Materials: Cotton wool, paper bark

Procedures:

1. Place a layer of cotton wool in the tray. The cotton wool acts as the soil as it absorbs water quickly.
2. Cover the surface of cotton wool with paper bark in the central part of the tray.
3. Use a watering can to pour 200mL colored water on top of the set up. (The water is colored by red poster color)
4. Pour the water in a circular movement to ensure an even distribution of water until the watering can is empty.
5. Observe the distribution of red colour on the cotton wool after picking up the leaves and paper bark from the tray.

Results:

The distribution of coloured water on the cotton wool is intense at positions which have less or no coverage of paper bark and leaves. The cotton wool under the paper bark is dyed with lighter colour than other region. There seems a hard layer of the paper bark prevents the water to diffuse in cotton wool.

Limitation: The distribution of paper bark and its leaves in real situation may be different from our experiment. The smaller the tray used, the bigger the error of experiment.

Possible explanation: Paper bark absorbs water which is nearly as same as its weight. Their presence on soil surface may affect the infiltration of rainwater. Plants growing nearby the paper bark tree may not absorb sufficient water if there is a thick layer of paper bark on the soil surface.

Limitation of the investigation

The Shing Mun Reservoir has lots of people to visit every day. The scattered grasses near the paper bark tree maybe also caused by trampling by picnicker.

Conclusion

In the urban district, we seldom find that there are fallen tree barks all around the paper bark trees and not many species near the paper bark trees due to the regular management of the trees by the government Department.

The paper bark trees in Shing Mun Reservoir are different from those in the urban district in Hong Kong. We had field study at Shing Mun Reservoir on 3 days, we found that only a few grasses scattered around the paper bark trees. There are relatively less animals are present in the studied area with paper bark trees. After discussion, we have made a conclusion together to explain this bizarre phenomenon. There are multiple ways that the paper bark trees exert their influence on other species.

Possible reasons to explain the barren land near the paper bark tree:

- ✚ The canopy of the paper bark trees, densely distributed paper bark tree and large coverage of paper bark over the land surface reduces the penetration of light to the ground level.
- ✚ paper bark absorbs water and hence limiting the supply of water to the growth of plant.
- ✚ The paper barks act as an physical barriers to avoid the seed from reaching the soil and germinate

Possible reasons to explain relatively less animals are present in the studied area with paper bark trees:

- ✚ The essential oil in the leaves may scare away the herbivorous animals.
- ✚ There are less plant thus providing less food and shelter for the animals.

Question remains:

Since the paper bark trees have multiple ways that the paper bark trees exert their influence on other species. We can only know parts of them. The other factors are still needed to be found.

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