Ecological Survey report for Bukit Kerajaan (Botanical Garden Area)

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Avifauna Report

Introduction

Natural disturbances have contributed to the high biological diversity found in many tropical ecosystems (Restrepo & Gomez 1998). Such natural disturbances are thought to promote species diversity by preventing competitive exclusion and creating habitat heterogeneity, thereby allowing specialization and resource partitioning (Levey 1988). Much of the recent interest in tropical forest dynamics has centered on the relationship between naturally occurring disturbances and species diversity (Lawton & Putz 1988). One of the main examples of natural disturbances that promote diversity is natural or man-made treefall forest gaps.

Gaps are termed as a vertical hole in the forest extending through all levels down to an average height of 2 m above the ground (Brokaw 1982). Studies conducted by Levey (1988), Schemske&Brokaw (1981) and Willson *et al* (1982) had shown that there is a certain pattern of relationship between the distribution of trees and the diversity of understory birds at the gap area. Gaps offer a concentration of resources that may attract numerous individuals from many different species. This paper presents data of avian census conducted at 2 closed canopy forest area and 2 man-made gap areas.

Site Description

Bukit Kerajaan Forest Reserve, Pulau Pinang. Bukit Kerajaan Forest Reserve is considered as one of the most important forest reserves in Penang, due to its function of supplying water to part of the Penang State. The forest is also part of the tourist attraction to the State, whereby most of the pristine hill and lowland forest with native species are still intact and relatively in good condition. The reserve forest also offers a suitable habitat for many kinds of bird species. For example, The Botanical Garden (which is a part of Bukit Kerajaan) is a well known spot for bird watching activities. The actual sampling site is actually by following a man-made trail starting from the base of the Bukit Kerajaan (from the Botanical Garden). According to Brokaw (personal comm.) a gap may also be created by trails/development that is made by humans. The matter of importance is the definition of a gap area which is a vertical hole, its edge lies along the line directly beneath the edge of the surrounding foliage, the cause of the gap is not considered a priority (to the definition of gap) but it does contribute to the heterogeneity of the gaps. I classify the trail at Bukit Kerajaan as a man-made gap because of the whole trail has been paved with rock slabs and cement. There is also evidence of water pipes/waterworks running along this trail. This prohibits the emergence of any seedlings along the trail. Such situation presents a chance to study the effects towards the flora and fauna along the trail. To fulfill the requirements towards the meaning of gap, caution must be taken when selecting the study plot. As there are bordering plants along the trail, there is chance for the canopy layer of the trail to be closed thus preventing a gap. The plot chosen must not be closed by connecting canopy layers of the bordering plants along the trail. 4 plots are chosen which consists of 2 closed canopy area and 2 man-made gap area.

Methods

Mist Netting

Mist-netting is an effective method in obtaining quantitative data for avian studies. The mist-nets are 9 meters x 4 meters in size with mesh size is about 2.5 centimeters. The nets were opened during early morning (0800) and closed before dusk (1830). After a month of

field test, taking into account the capture rate of all the sites, the nets are then left opened for 24 hours. During the field test, I have found that almost all of the captured birds and observed are caught/sighted during morning (9 am up to 11 am). The diurnal cycles of the bird community are fairly consistent which is highly active during the morning and declining steadily towards noon time in accordance to the rising temperature, the catch rate is also high during morning compared to the evening time (Habebah 1999, Fazlina 2001, N, Fadzly 2002). The mist nets are left opened for 24 hours in hopes of capturing nocturnal birds and other creatures that frequents the area.

The nets will be placed in an intact forest and also in gap area. Using Levey (1988) description of an intact forest site "a site with a dense upper canopy and little evidence of recent disturbances", mist nets are placed 200 meters from a gap area and an intact forest area. Mist nets placed inside gap area are placed carefully to minimize visibility. The birds that are captured through mist-netting are photographed, recorded, tagged and then set free.

Fixed point/point counts

Another type of method is by performing a fixed point observation/point counts. Fixed point observation will require a certain fixed point at an area. I will remain still at the spot at about 5 to 15 minutes starting from the time I reached the point, observing the birds with a 10 X 25 binocular. Birds that are sighted or heard in the area are recorded. As suggested by Shankar Raman (2003) each of the points established must be at least 100 m apart to avoid overlap (in this case, the chosen distance is 200 m apart). This method, even though it is easier to be applied, does have its own weakness. First of all the data collection is mainly based on the experience and the capability of the researcher. The researcher must be able to distinguish and quickly identify the birds merely by looking with binoculars or just by the sound of the birds. Trying to rectify and compensate this problem, I have resolved in using a tape recorder to record the bird sounds. These recordings can be play back later on for confirmation of identification. For sound identification purposes, I refer to the recordings made by Scharringa (2001) in Birds of Tropical Asia 2.

Results

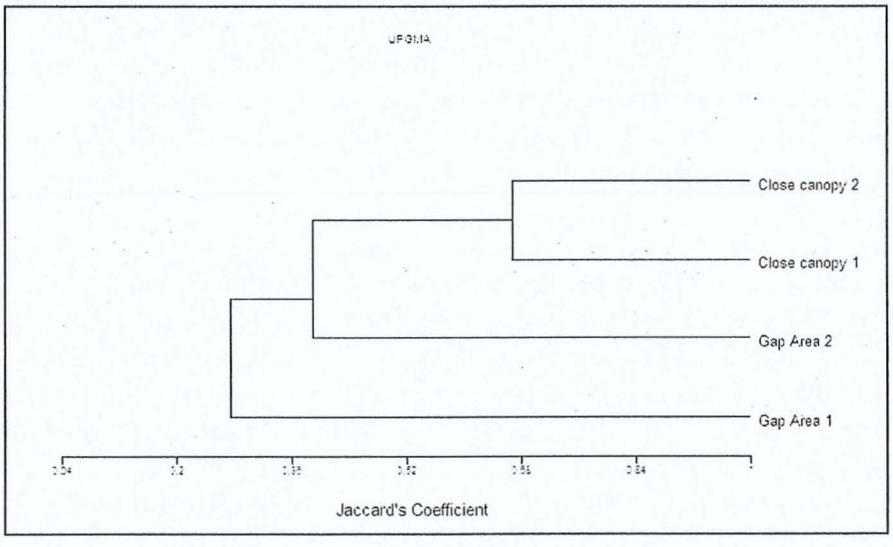


Figure 1: Cluster analysis of the similarities between sites

Table 1: Diversity Index count (Shannon's with Log base e)

Sample	Index	Evenness	Num.Spec.
Gap Area 1	2.527	0.911	16.000
Gap Area 2	2.422	0.894	15.000

Close canopy 1	2.322	0.968	11.000
Close canopy 2	2.099	0.955	9.000

Discussion

A total of 92 individual comprising of 27 species from 11 families was detected (Table 2). 18 individuals were caught while the remaining 74 individuals were identified through observation and voice recording. The most frequent species that is detected is the Little Spiderhunter (*Arachnothera longirostra*).

Based on the list, a diversity index calculation was conducted using the Multivariate Statistical Programme. Table 1 shows the results of the calculation. The man-made gap areas (Gap area 1 and Gap area 2) shows the highest diversity index count compared to the closed canopy areas. Gap areas also show the highest number of species count (16 species for gap 1 and 15 species for gap 2) compared to closed canopy areas (11 species for close canopy 1 and 9 species for close canopy 2). It seems that man-made gap areas attract more birds compared to closed canopy forest. The man-made gap areas, where the ground areas are paved with rock slabs (the main purpose of the trail doubles as a walking trail and underwater piping system). These rock slabs prevents any regrowth of the trees at the gap areas, the only chance for the gap areas to close up is through the branching of the neighboring trees surrounding the gap area. This in turn creates a rather unique situation in which we can postulate that human intrusion either creates a chance for species population development or rather further more damages the ecosystem. In this situation, it might be that the rock slabs and water holes along the trail create a niche for insects which attracts insectivorous birds to the area. This statement is also backed by the fact that of the 31 species that are detected at man-made gap areas, all of them, with the exception of the Barred Cuckoo Dove (*Macropygia unchall*) which is considered as terrestrial frugivore (Wong 1986), other species are considered as insectivorous birds.

A similarity matrix was also calculated using the same multivariate program. Similarity matrix or cluster analysis is a type of multivariate analysis that describes the similar traits among the cases; in this case it describes whether each of the study sites has any connection with each other. Using the UPGMA variant (Unweighted Pair Group Average, because the data are expected to have some clusters that are much smaller than others) and Jaccard's Index as the coefficient, Figure 1 shows that there exists a specialized cluster for the close canopy birds and the gap area birds. There are 3 nodes of cluster that can be observed. The first node which is the similarity between close canopy 1 and close canopy 2 shows the value of 0.667. The second node is between the first node and gap area 2 shows the value of 0.390. The last node is the similarity between the second node and gap area 1 has the value of 0.276. This shows that the gap areas are unique in each of their own cluster, compared to the close canopy area.

In conclusion, we can summarize that there is an apparent specialization of birds concerning areas that they frequent, either for food, shelter or just flying through. Man-made gap areas seem to offer a much better opportunity compared to closed canopy areas.

Table 2 : Total species list

Family	Scientific name	Species list	Gap Area 1	Gap Area 2	Close canopy 1	Close canopy 2
Columbidae	*Macropygia unchall*	Barred cuckoo dove	0	1	0	0
Cuculidae	*Eudynamys scolopacea*	Asian Koel	1	0	0	0
Cuculidae	*Centropus bengalensis*	Lesser Coucal	1	0	0	0
Dicruridae	*Dicrurus leucophaeus*	Ashy Drongo	0	1	1	1
Dicruridae	*Dicrurus paradiseus*	Greater Racquet Tailed Drongo	1	0	1	0
Meropidae	*Merops leschenaulti*	Chestnut headed Bee eater	1	0	0	0
Muscicapidae	*Ficedula westermanni (melanoleuca)*	Little Pied Flycatcher	0	1	0	0
Nectariniidae	*Aethopyga siparaja*	Crimson sunbird	3	1	2	2
Nectariniidae	*Arachnothera longirostra*	Little Spiderhunter	2	8	2	1
Nectariniidae	*Nectarinia jugularis*	Olive-backed Sunbird	0	2	0	0
Nectariniidae	*Hypogramma hypogrammicum*	Purple naped sunbird	1	1	2	2
Nectariniidae	*Arachnothera flavigaster*	Spectacled spiderhunter	2	0	2	2
Pycnonotidae	*Hypsipetes mcclellandii*	Mountain bulbul	0	0	1	1
Pycnonotidae	*Criniger ochraceus*	Ochraceous bulbul	1	1	0	0
Pycnonotidae	*Hypsipetes malaccensis*	Streaked bulbul	0	0	1	0
Pycnonotidae	*Pycononotus goiavier*	Yellow vented Bulbul	0	2	1	2
Strigidae	*Ninox scutulata*	Brown Hawk Owl	3	1	0	0
Sylviidae	*Phylloscopus borealis*	Artic Warbler	0	1	0	0
Sylviidae	*Orthotomus sutorius*	Common Tailor Bird	0	3	3	0
Sylviidae	*Orthotomus atrogularis*	Dark necked tailorbird	1	0	0	0
Sylviidae	*Orthotomus cuclatus*	Mountain Tailorbird	7	2	0	0
Timalidae	*Alcippe brunneicauda*	Brown Fulvetta	1	0	0	0
Timalidae	*Trichastoma sepiarium*	Horsfield Babbler	0	1	0	2
Timalidae	*Macronous gularis*	Striped tit babbler	1	0	0	0
Turdidae	*Copsychus saularis*	Magpie robin	2	0	0	0
Turdidae	*Copsychus malabaricus*	White rumped shama	1	2	2	4
			29	28	18	17

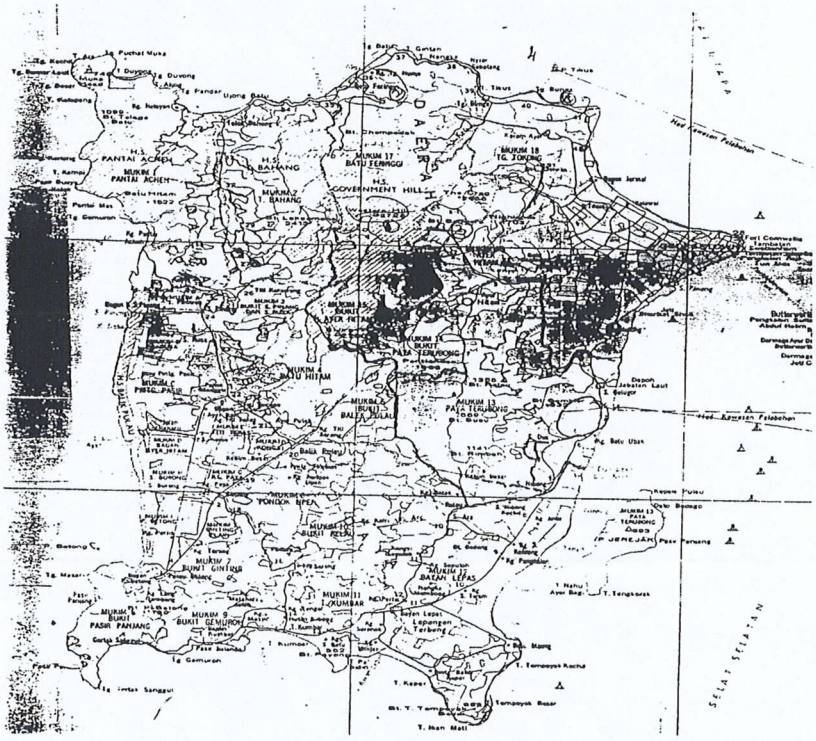
Tree Species List in Botanical Gardens

SITE LOCATION AND METHOD

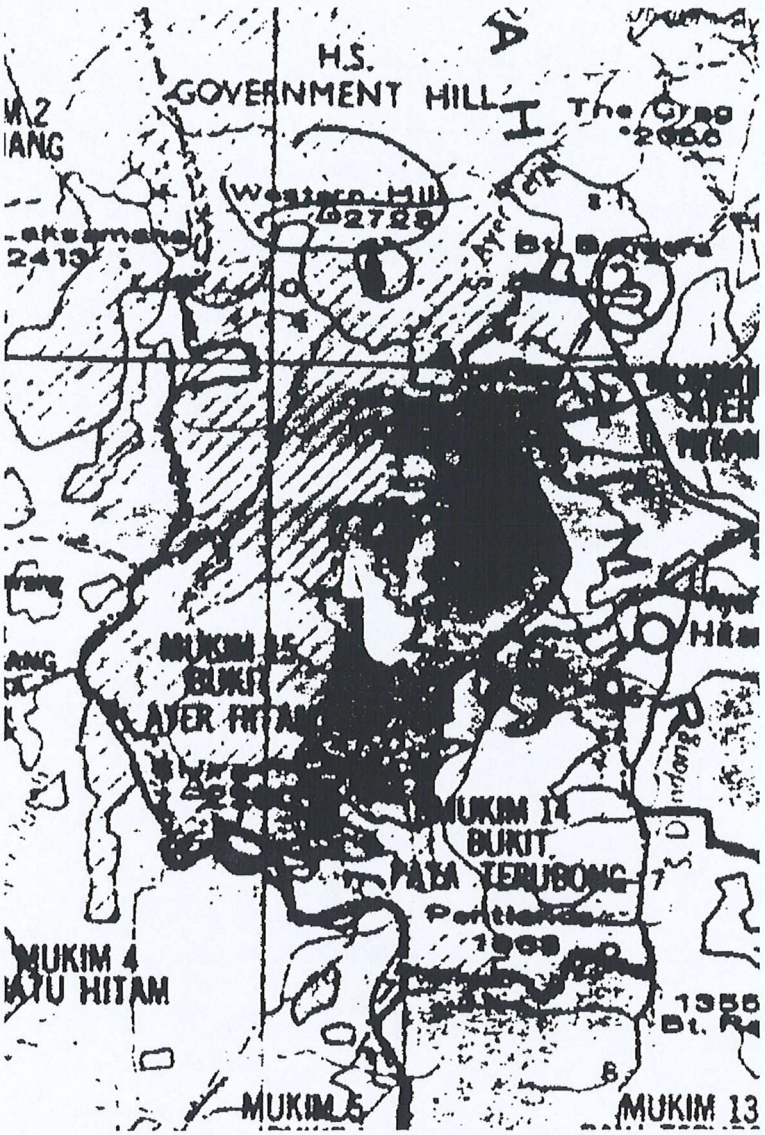
Penang Botanical Garden is situated in Penang Island. It is surrounded by Government Hill. Air Terjun river flows through the garden. Research sites are held in the garden of Penang Botanical Garden and the surrounding forests. There are 15 sites, five are located along Air Terjun River which passes through the garden, and another five sites are located exactly at the border of garden and the surrounding forest while the remaining five sites are located a little deeper than sites at the border. These remaining five sites are in the secondary forests.

The five sites in the garden are referred as Site 1, 2, 3, 4 and 5, border sites are referred as Intermediate 1, 2, 3, 4 and 5 while for secondary sites are referred as Middle 1, 2, 3, 4 and 5.

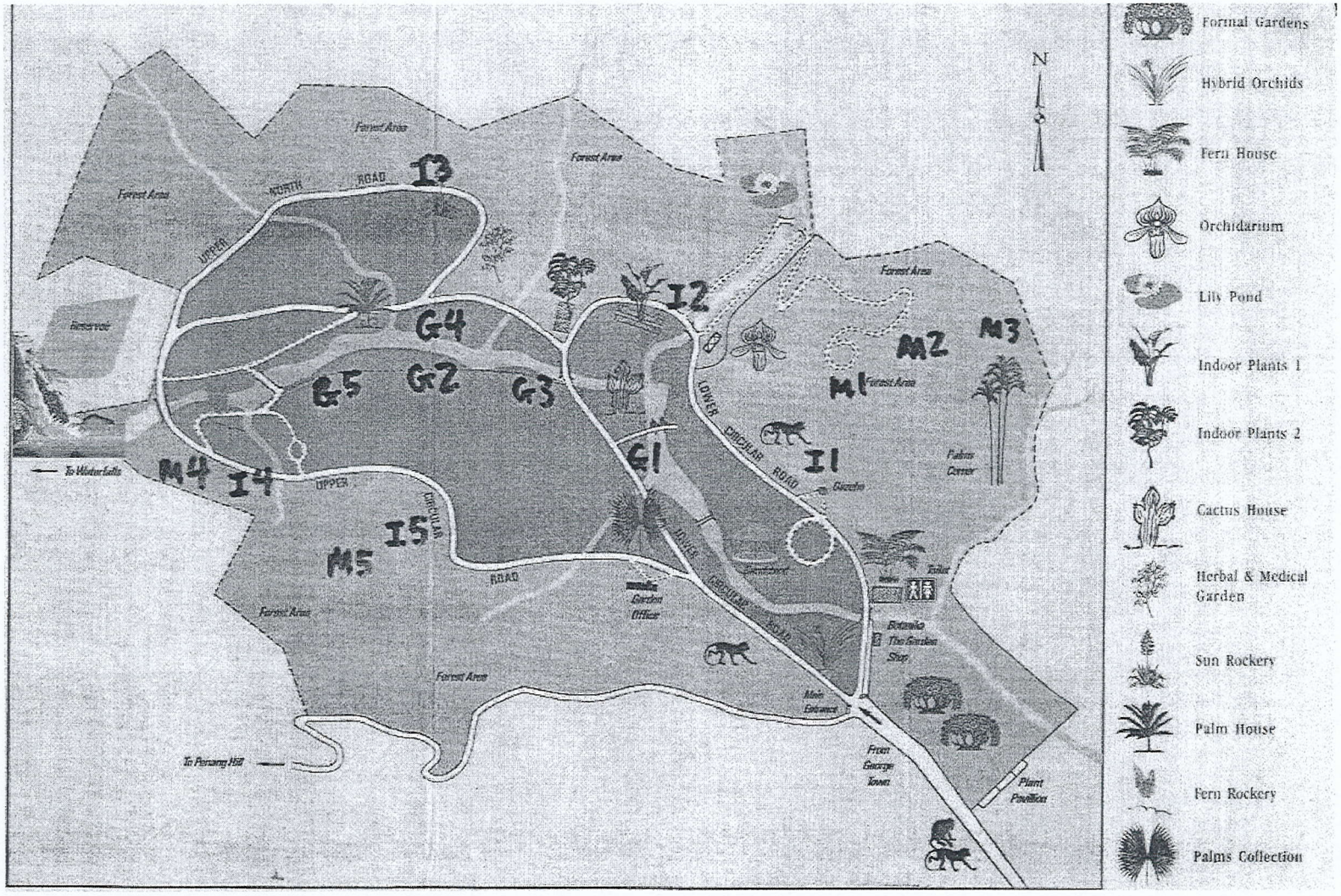
20m X 20m quadrats were used at every site. These quadrats were divided into 16 boxes with the measurement of 5m X 5m per box in order to make it easier for trees mapping.



Penang Botanical Garden in Penang Island



The area near Government Hill and Air Terjun River is Penang Botanical Garden



Locations of sites (G-garden, I-intermediate, M-middle)

Results

TREES SPECIES

Around 80 species, 40 genuses and 20 families of higher plants are found. Some species could be found in all sites – Garden, Intermediate and Middle. For example, *Syzygium spp.* (Kelat). *Couroupita guinensis* (Canon ball tree) can only be found in garden sites because it was grown by man.

Garden species list:

	Scientific Name	Family	Local Name
1	*Adirachta excelsa*		Sentang
2	*Antidesma spp.*	Euphorbiaceae	None
3	*Aquilaria malaccensis*	Thymelaeaceae	Karas
4	*Artocarpus elasticus*	Moraceae	Terap nasi
5	*Artocarpus heterophyllus*	Moraceae	Nangka
6	*Cinnamomum iners*	Lauraceae	Medang
7	*Cinnamomum spp.*	Lauraceae	Medang
8	*Couroupita guinensis*		Canon ball tree
9	*Crypteronia paniculata*		Bekoi bulu
10	*D.* suffruticosa		Simpoh Air
11	*Fagraea wallichiana* Benth.	Loganiaceae	Tembusu padang
12	*Macaranga spp.*	Euphorbiaceae	Mahang
13	*Microcos tomentosa*	Tiliaceae	Cenderai
14	*Palaquium spp.*	Sapotaceae	Nyatoh
15	*Pterocarpus indicus*		Angsana
16	*Sandoricum koetjape*	Meliaceae	Sentul
17	*Sandoricum radiatum*	Meliaceae	Sentul
18	*Sandoricum spp.*	Meliaceae	Sentul
19	*Syzygium pseudosubtilis*	Myrtaceae	Keriang
20	*Syzygium spp.*	Myrtaceae	Kelat

Intermediate species list:

	Scientific Name	Family	Local Name
1	*Acronychia peduncalata* (L.) Miq.	Rutaceae	Limau hutan
2	*Actinodaphne pruinosa* Nees	Lauraceae	None
3	*Alseodaphne foxiana* (Gamble) Kosterm.	Lauraceae	None
4	*Anisophyllea curtisii* king	Anisophylleaceae	Delek
5	*Antidesma cuspidatum* Mull. Arg.	Euphorbiaceae	Kenidai punai
6	*Antidesma tomentosum* Blume	Euphorbiaceae	None
7	*Aporusa confusa* Gage	Euphorbiaceae	None
8	*Aquilaria malaccensis* Lam.	Thymelaeaceae	Karas
9	*Artocarpus hispidus* Jarrett	Moraceae	Temponek
10	*Baccaurea motleyana* (Mull. Arg.) Mull. Arg.	Euphorbiaceae	Rambai
11	*Baccaurea parviflora* (Mull. Arg.) Mull.	Euphorbiaceae	Asam tambun

12	*Buchanania sessifolia* Blume	Anacardiaceae	Otak udang
13	*Callerya atropurpurea* (Wall.) Schot	Leguminosae	Tulang daing
14	*Calophyllum canum* Hook.*f.*	Guttiferae	Bintangor
15	*Canthium confertum* Korth.	Rubiaceae	Kemuning jantan
16	*Canthium glabrum* Blume	Rubiaceae	Kenanga samak
17	*Cinnamomum porrectum* (Roxb.) Kosterm.	Lauraceae	Medang wangi
18	*Cratoxylum formosum* (Jack) Dyer	Hypericaceae	Geronggang
19	*Cynometra malaccensis* Meeuwen	Leguminosae	Kekatong
20	*Deehasia pauciflora* Blume	Lauraceae	None
21	*Dehaasia polyneura* (Miq.) Kosterm.	Lauraceae	None
22	*Diospyros areolata* King & Gamble	Ebenaceae	Kayu malam
23	*Diospyros hasseltii* Zoll.	Ebenaceae	Kayu malam
24	*Diplospora malaccensis* Hook.*f.*	Rubiaceae	Gading-gading
25	*Drypetes pendula* Ridl.	Euphorbiaceae	Gelugor salah
26	*Dysoxylum excelsum* Blume	Meliaceae	None
27	*Elaeocarpus polystachyus* Wall. *ex* C. Muell.	Elaeocarpaceae	Mendong
28	*Eugenia* sp. 38	Myrtaceae	Kelat
29	*Euonymus javanicus* Blume	Celastraceae	None
30	*Fagraea wallichiana* Benth.	Loganiaceae	Tembusu padang
31	*Flacourtia rukam* Zoll. & Moritzi	Flacourtiaceae	Rukam
32	*Garcinia rostrata* (Hassk.) Miq.	Guttiferae	Kandis
33	*Gironniera subaequalis* Planch	Ulmaceae	Hampas tebu
34	*Gluta curtisii* (Oliv.) Ding Hou	Anacardiaceae	Rengas
35	*Gluta wrayi* King	Anacardiaceae	Rengas
36	*Greenea corymbosa* (Jack) K. Schum.	Rubiaceae	Sekam bulan
37	*Greenea corymbosa* (Jack) K. Schum.	Rubiaceae	Sekam bulan
38	*Ixora grandifolia* Zoll. & mor.	Rubiaceae	Pecah periuk
39	*Knema laurina* (Bl.) Warb.	Myristicaceae	Penarahan
40	*Madhuca malaccensis* (Clarke) Lam.	Sapotaceae	Bitis
41	*Mallotus penangensis* Mull. Arg.	Euphorbiaceae	Merepoh
42	*Meliosma sumatrana* (Jack) Walp.	Meliosmaceae	None
43	*Memecylon dichotomum* (C B. Clarke) King var. *dichotomum*	Melastomataceae	Nipis kulit
44	*Microcos tomentosa* Sm.	Tiliaceae	Cenderai
45	*Monocarpia marginalis* (Scheff.) J. Sinclair	Annonaceae	Mempisang
46	*Palaquium gutta* (Hook.*f.*) Baill.	Sapotaceae	Nyatoh taban merah
47	*Palaquium maingayi* (C.B. Clarke) King & Gamble	Sapotaceae	Nyatoh tembaga
48	*Polyalthia hypoleuca* Hook.*f.* & thomson	Annonaceae	Melian
49	*Popowia* sp.	Annonaceae	Mempisang
50	*Porterandia anisophyllea* (Jack *ex* Roxb.) Ridl.	Rubiaceae	Tinjau belukar
51	*Prunus arborea* (Blume) Kalkman var. *arborea*	Rosaceae	None
52	*Pseduvaria macrophylla* (Oliv.) Merr. var. *macrophylla*	Annonaceae	Mempisang
53	*Psydrax* sp.1	Rubiaceae	Tulang-tulang
54	*Pternandra coerulescens* Jack	Melastomataceae	Bunut paya/sial menahon

55	*Rhodamnia cinerea* Jack	Myrtaceae	Mempoyan
56	*Sandoricum koetjape* (Burm.*f.*) Merr.	Meliaceae	Sentul
57	*Santiria conferta* Bennett.	Burseraceae	Kedondong kerantai
58	*Shima wallichii* (DC.) Korth.	Theaceae	Gegatal
59	*Syzygium dyerianum* (King) P. Chantaranothai & J. Parn.	Myrtaceae	Kelat
60	*Syzygium filiforme* (Wall. *ex* Duthie) P. Chantaranothai & J. Parn. var. *filiforme*	Myrtaceae	Kelat
61	*Syzygium hoseanum* (King) Merr. & L. M. Perry	Myrtaceae	Kelat
62	*Tarrena mollis* (Wall. *ex* Hook.*f.*) B. L. Rob.	Rubiaceae	None
63	*Timonius wallichianus* (Korth.) Valeton	Rubiaceae	Mentiong
64	*Urophyllum blumeanum* (Wight) Hook.*f.*	Rubiaceae	None
65	*Vitex pinnata* L.	Verbenaceae	Halban
66	*Xanthophyllum pulchrum* King	Polygalaceae	Minyak beruk
67	*Xerospermum laevigatum* Radlk.	Sapindaceae	Rambutan pacat

Middle species list:

	Scientific Name	**Family**	**Local Name**
1	*Adinandra dumosa*		Tetiup
2	*Aquilaria malaccensis* Lam.	Thymelaeaceae	Karas
3	*Calophyllum inophyllum*	Guttiferae	Bintangor laut
4	*Gironniera subaequalis* Planch	Ulmaceae	Hampas tebu
5	*Gynotroches axillaris*		Mata keli
6	*Palaquium spp.*	Sapotaceae	Nyatoh
7	*Pternandra coerulescens* Jack	Melastomataceae	Bunut paya/sial menahon
8	*Rhodamnia cinerea*		Mempoyan
9	*Syzygium grandis*	Myrtaceae	Kelat
10	*Syzygium spicata*	Myrtaceae	Kelat nenasi
11	*Xanthophyllum pulchrum* King	Polygalaceae	Minyak beruk

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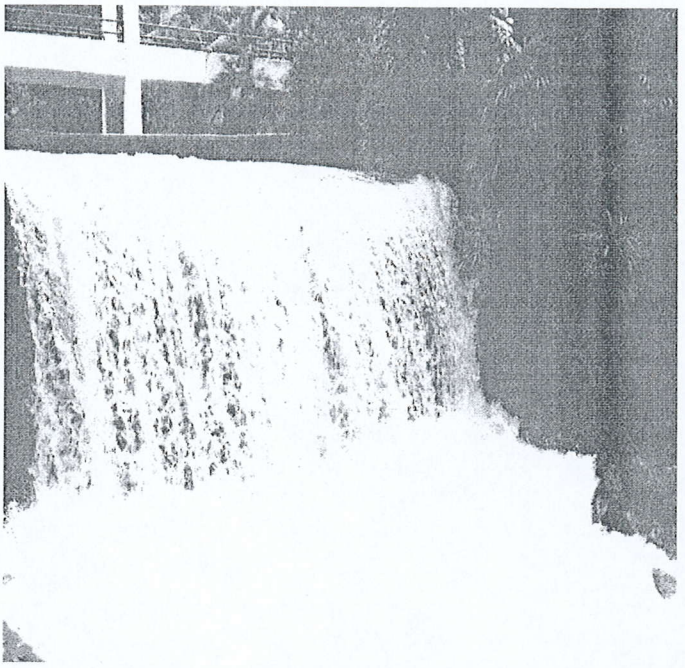
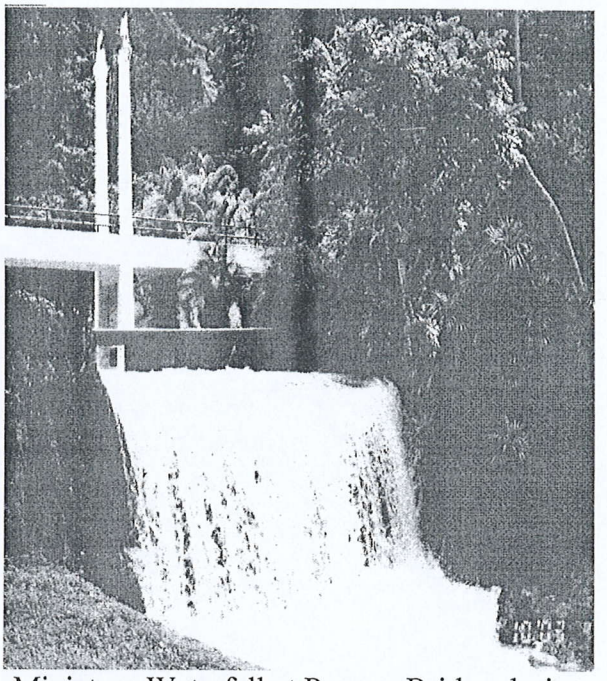
Pictures from sites

River beside PBA during wet season

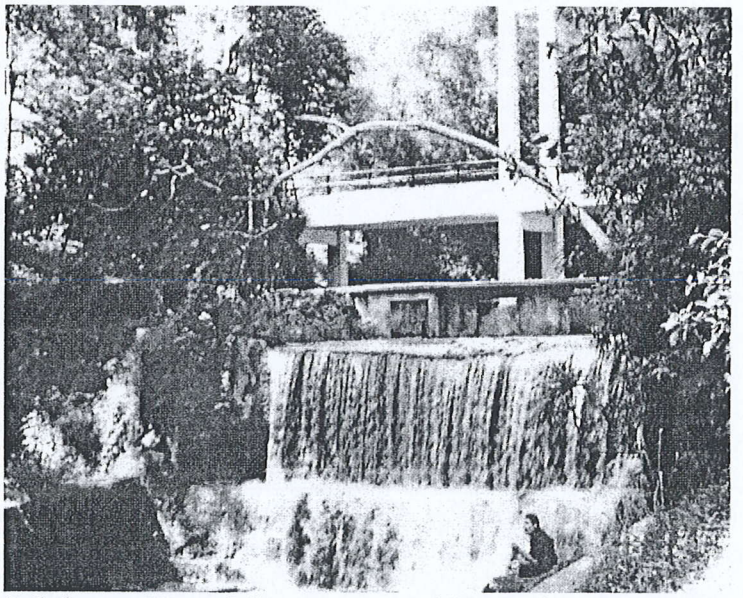
River beside PBA during dry season



Miniature Waterfall at Penang Bridge during wet season



Miniature Waterfall at Penang Bridge during wet season

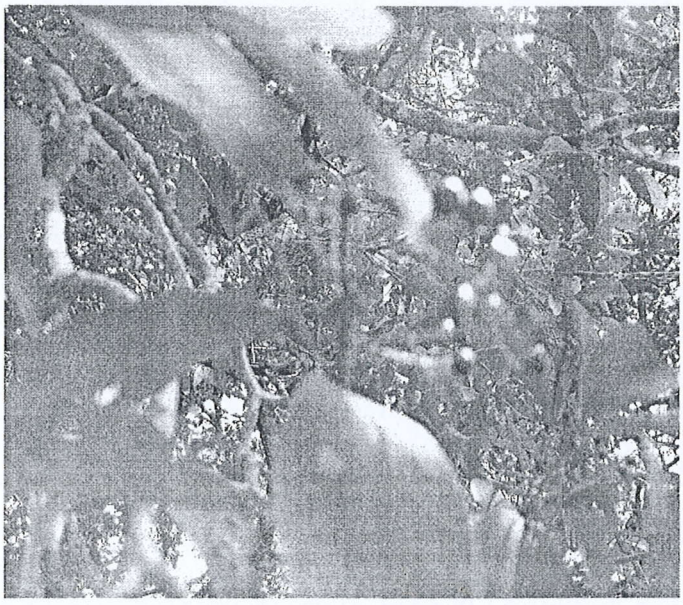


Miniature Waterfall at Penang Bridge during dry season

Fruiting after wet season

'Tapak Itik' fruits

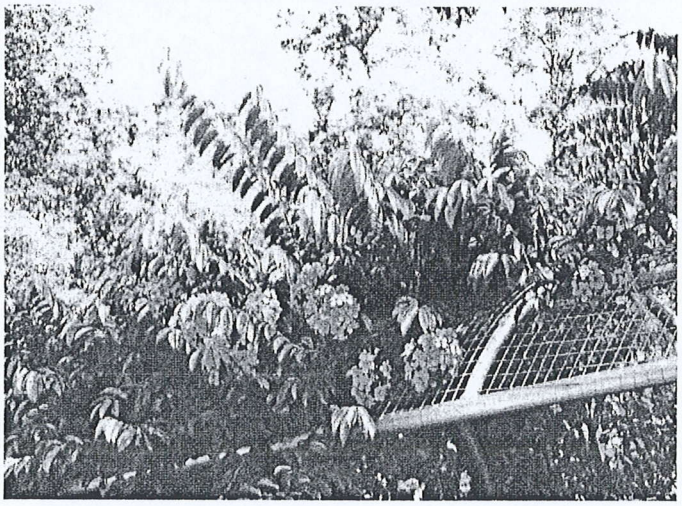
unidentified



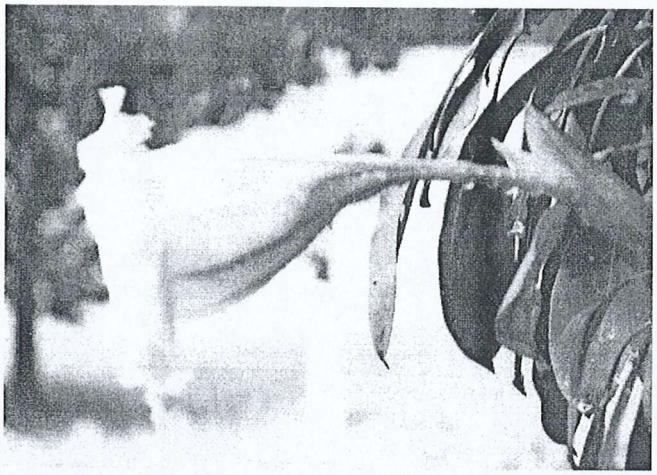
Flacourtia rukam fruits

Flacourtia rukam fruits

Located beside orchid shop



Flowers on rooftop of Perdana House



Bell flowers

Cannon Ball Tree's flowers

Pink flowers outside Begonia House

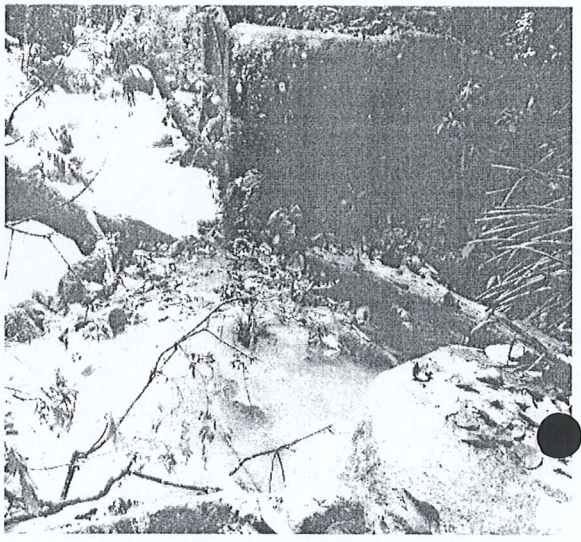
Flowering season

Main Garden

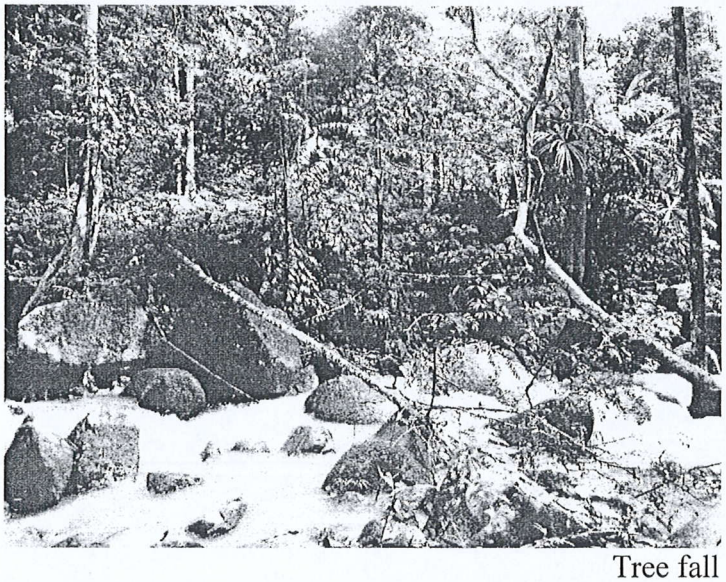
Circular Garden

Wet season

Bamboo fall



Water poodles

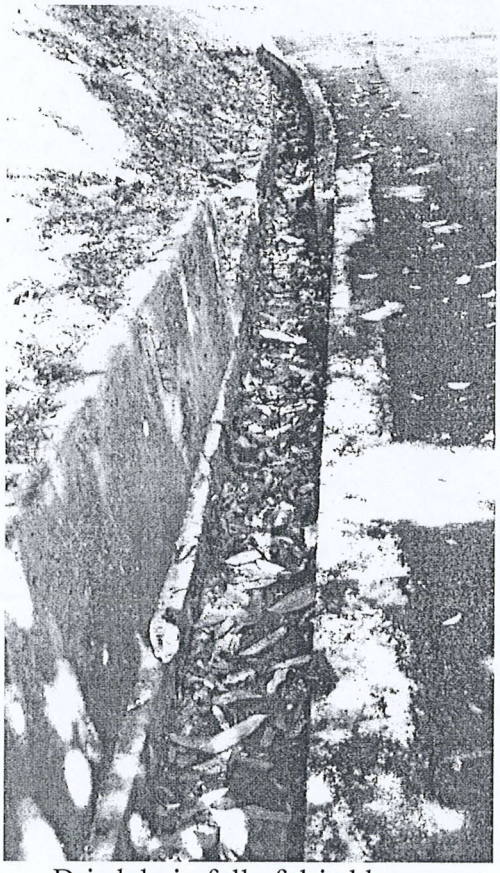


Tree fall

Dry season

Carpets of dried leaves

Tree of dried leaves



Dried drain full of dried leaves