

Nature Contained

Environmental Histories of Singapore

Edited by

Timothy P. Barnard



NUS PRESS
SINGAPORE

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Bib. 600006718
Item 100009024
Barcode 6000010009807
Call no. GF13.3.555
..... T46
..... 2014
Date 15 พ.ค. 2567



NUS PRESS
SINGAPORE

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Published by:

NUS Press
National University of Singapore
AS3-01-02, 3 Arts Link
Singapore 117569

Fax: (65) 6774-0652

E-mail: nusbooks@nus.edu.sg

Website: <http://www.nus.edu.sg/nuspress>

ISBN 978-9971-69-790-7 (Paper)

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National Library Board, Singapore Cataloguing-in-Publication Data

Nature contained : environmental histories of Singapore / edited by Timothy P. Barnard. – Singapore : NUS Press, 2014.
pages cm
ISBN : 978-9971-69-790-7 (paperback)

1. Human ecology – History – Singapore. 2. Singapore – History – Environmental aspects. I. Barnard, Timothy P., 1963–

GF13

304.2095957 -- dc23 OCN859513265

Front cover: A supertree, and trees, at Gardens by the Bay, Singapore (Courtesy of Christopher Yong).

Back cover: Poster for the special stamp collection “Wayside Trees of Singapore”, 1976 (Courtesy of the Postal Services Department, Singapore, and the National Archives of Singapore).

Typeset by: Forum, Kuala Lumpur, Malaysia
Printed by: Mainland Press Pte Ltd

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Acknowledgements

Any book, particularly an edited volume, requires the unseen efforts of many people. The editor and all of the authors wish to express our appreciation to the numerous staff in libraries, archives and other depositories for their help in gathering materials. The institutions consulted for this book range from the Natural History Museum in London to the National Archives of Singapore, as well as libraries throughout the world. The tireless efforts of these curators make visits not only productive, but also pleasant. Among the people that we would like to specifically acknowledge from these institutions are Christina Soh from the Library of Botany and Horticulture at the Singapore Botanic Gardens and Kelvin Lim from the Raffles Museum of Biodiversity Research.

Other individuals, by generously giving their time for interviews and explanations, also greatly influenced the research in this book. They include Leo Tan, Peter Ng and Ilsa Sharp, as well as Richard Corlett, P.N. Avadhani, Michael Daly, Christopher Yong, Kevin Khoo, Vidya Murthy and Puah You Kai, who described their experiences and provided advice on facts and figures that helped shape this work. In addition, institutions such as the Nature Society of both Singapore and Malaysia have been generous in their support. Without the help of all of these friends and colleagues, and we apologize for those left unmentioned, this volume would not have been the rewarding experience it has turned out to be. To all, we would like to express our thanks for their support.

Timothy P. Barnard
Singapore, April 2014

An Introduction

Timothy P. Barnard

Singapore is a small nation-state, an island, at the tip of the Malay Peninsula. Located at the southern end of the Melaka Straits, it has always been a strategically located entrepôt for funnelling goods between South and East Asia as well as within Southeast Asia. The trade that flows past Singapore, and the economic and political control over it, has often been the cornerstone of studies of the Singaporean past.¹ The development of trade, politics and economics, however, has taken place within an environment that is part of a larger tropical zone of incredible biodiversity. This book is an attempt at understanding how this environment has influenced the history of Singapore since the early 19th century.

Modern Singapore reflects much of this tropical biodiversity through governmental efforts to create a "Garden City," making it one of the greenest urban centers in Asia. This designation originated in efforts that began in the early 1960s, when Lee Kuan Yew proposed a tree-planting program to ensure that Singapore would become an "oasis in Southeast Asia."² Government agencies, including the Singapore Botanic Gardens, were enlisted in this effort, which, despite constant economic development and change, has resulted in a city that is "clean and green." In the 1970s, Lee took great pride when visitors would compliment the city-state he ruled for its greenery, as occurred when he met a visiting French minister. As recounted in his autobiography, Lee could not understand the full content of the praise from the visiting official, as he did not understand French.

¹ Hong Lysa and Huang Jianli, *The Scripting of a National History: Singapore and Its Past* (Singapore: NUS Press, 2008).

² Lee Kuan Yew, *From Third World to First—The Singapore Story: 1965–2000* (Singapore: Singapore Press Holdings, 2000), p. 199.

The one word he could make out in the European language, however, was “verdure,” conveying not only the idea of a city that was green, but one flush in environmental assets.³

A description of Singapore as a site of flourishing, vibrant vegetation did not solely come out of government campaigns in the late 20th century. As early as 1856, John Crawfurd—the British Resident of Singapore from 1823–26—described Singapore as an island wrapped in “continual verdure.”⁴ This picture of Singapore as a place of tropical fecundity, however, is a complicated one. The natural environment in Singapore has constantly undergone change. When Crawfurd oversaw the administration of Singapore in the 1820s, it was mainly an island covered in tropical rainforest. By the mid-19th century, the spread of gambier and pepper plantations led to an almost complete deforestation of the island, except on hilltops and the steepest of slopes. Replacing much of this primeval vegetation, as well as gambier and pepper, was *lalang*, a common blade grass (*Imperata cylindrica*), which is difficult to remove from the soil due to its root structure. This transformation in the floral cover of Singapore also led to a vast change in the types of fauna present in the forest. Large jungle animals, such as tigers, soon found little cover or useable habitat. This change was drastic, leading biologist Richard Corlett to estimate that up to 50 percent of the species native to Singapore have disappeared since the mid-19th century.⁵

Into the ecological system of Singapore, new flora and fauna also were introduced. Many of the early transplants, such as gambier and pepper, or nutmeg, were planted in the hope of developing viable export crops. The result was numerous, often small, plantations stretching into the interior that fed into global industries. The initial crops of spices were replaced in the early 20th century with the expansion of rubber plantations, which quickly

³ Lee, *From Third World to First*, p. 203; Harvey Neo, “Challenging the Developmental State: Nature Conservation in Singapore,” *Asia Pacific Viewpoint* 48, 2 (Aug. 2007): 186–99.

⁴ See the first excerpt, following this chapter, in this collection. John Crawfurd, *A Descriptive Dictionary of the Indian Islands and Adjacent Countries* (London: Bradbury and Evans, 1856), p. 396.

⁵ Richard Corlett, “Vegetation,” in *The Biophysical Environment of Singapore*, ed. Chia Lin Sien, Ausafur Rahman, and Dorothy Tay B.H. (Singapore: Singapore University Press, 1991), pp. 134–54. See also the notes on this in John van Wyhe’s contribution to this volume.

came to dominate the non-urban landscape of Singapore up to the Japanese occupation. To feed the growing population, there were also farms providing vegetables and meat, particularly the domesticated pig (*Sus domesticus*), for local consumption. These new products transformed our understanding of what was possible from the local environment as well as the appearance of the landscape. For example, the agricultural development that these pigs represent led to a focused program of food production following the Second World War in which Singapore became self-sufficient (or extremely close to it) in pork, eggs, and poultry until the 1980s, something that seems unimaginable in the 21st century.

All of these various flora and fauna are part of an environmental history of Singapore, in which plants and animals are as important as any human that shaped the nation-state, pointing to alternatives for understanding and appreciating the past of the island. History goes beyond the (often air conditioned) offices of government officials, or stevedores of the port. The history of Singapore, thus, is more than a story of trade, immigration and nation-building. While these are important factors in the development of the island, they all occurred in a natural environment in which the interaction of humans with the flora and fauna determined how we understand a small state in Southeast Asia. This book is an attempt to begin an exploration of this aspect of its past. Each of the chapters examines the interaction of humans with the Singaporean environment, often focusing on how it has influenced our understandings of events in the larger economic, political, social, and intellectual history of the island. In this regard, this book reflects much of the diversity, and dynamism, of environmental history globally.

Environmental History and Singapore

Environmental history is the study of how the environment has influenced humans, and humans the environment. It arose as a subfield within historical studies in the 1960s, as part of larger global social movements that opened the investigation of a variety of social and cultural fields. As a subject of research, it draws upon the humanities and natural sciences to investigate, and better understand, the past. In the United States, scholars such as Donald Worster led the early development of the field through their studies of the American frontier and national parks. Currently the field is quite broad in scope, and has become influential in historical studies of agriculture, exploration, imperialism, technology, and urban areas. Environmental history

has also become popular among those interested in issues such as global sustainability, climate change, and urban development.⁶

While environmental history is a field of growing importance globally, in Southeast Asia it is still in its infancy. Many works on Southeast Asian history do have an environmental component, however, as factors such as shifting trade winds and expansion of rice fields often played a role in the regional past. In addition, in an area in which works of anthropologists and other scholars often filter over into the historical, it is common for researchers to reach across artificial disciplinary divides that often separate research in other areas of the world. Works, such as Clifford Geertz's *Agricultural Involution*, or Michael Adas' *The Burma Delta*, while not written specifically with an environmental history background, can easily be interpreted within the subfield and greatly influence our understanding of the interaction of humans and the environment over time.⁷ The cross-fertilization of different academic disciplines continues into the 21st century, and external influence of global studies of the environment and Southeast Asian approaches continue to influence studies of the region.

Despite the role that environmental studies of the past can play in our understanding of Southeast Asia, there have been few important figures and works. One exception is the role that Peter Boomgaard has played in the development of the study of environmental history in Indonesia. While acting as the Director of the Royal Netherlands Institute of Southeast Asian and Caribbean Studies (KITLV) in Leiden, the Netherlands in the 1990s, Boomgaard oversaw the EDEN (Ecology, Demography and Economics in Nusantara) project, which resulted in numerous monographs, edited works and articles that focus on the Indonesian environment in historical perspective.⁸ With his focus on the largest nation in Southeast Asia, and

⁶ Donald Worster, *The Wealth of Nature: Environmental History and the Ecological Imagination* (Oxford: Oxford University Press, 1993); Donald Worster, ed., *The Ends of the Earth: Perspectives on Modern Environmental History* (Cambridge: Cambridge University Press, 1988); Richard White, "Environmental History: The Development of a New Historical Field," *Pacific Historical Review* 54 (1985): 297–335.

⁷ Clifford Geertz, *Agricultural Involution: The Process of Ecological Change in Indonesia* (Berkeley, CA: University of California Press, 1963); Michael Adas, *The Burma Delta: Economic Development and Social Change on an Asian Rice Frontier, 1852–1941* (Madison, WI: University of Wisconsin Press, 1974).

⁸ There are numerous works, although a good starting point would be *Paper Landscapes: Explorations in the Environmental History of Indonesia*, ed. Peter Boomgaard, Freek Colombijn, and David Henley (Leiden: KITLV, 1997).

access to research funds, Boomgaard was influential in developing a group of researchers that considered how the environment has influenced, and been influenced by, humans. Much of this work, however, has not spilled across national boundaries into other areas of Southeast Asia. It is with this work that initial steps are taken in a path that Worster, Boomgaard, and others have cut in the historical relationship between humans and nature that this work hopes to emulate.

While there are a number of excellent works on the Singaporean environment, as well as the political and social history of the nation-state, this volume is an introduction to the possibilities of combining these environmental studies and the Singaporean past. The authors come from a wide range of backgrounds, from botanists to historians. The chapters roughly follow a chronological order. In between each of these essays are short excerpts from documents, interviews, and accounts of the events that influenced the chapters. These "sources" provide a brief taste of the wealth of accounts and documents available for the study of the environmental history of Singapore. Beyond this chronological order, the chapters focus on two major aspects of the Singaporean past: how a consideration of plants and animals allow us to better understand larger issues in studying the history of Singaporean society.

The first of these chapters, by Tony O'Dempsey, focuses on the broad changes in the Singaporean ecological landscape over the past 200 years, and provides a survey of many of the developments that the subsequent chapters will examine in greater detail. Through his study of how an island transformed from one covered in tropical rainforest and swamps to gambier and pepper and then rubber plantations before transitioning into the secondary forest cover of a "green" Singapore, he explains how larger economic policies and products have influenced the environment surrounding Singaporeans.

The effects of rapid gambier and pepper plantation growth influenced the plant and animal ecology of Singapore, and this is the focus of the next two chapters in this book. With regard to animal life, Timothy P. Barnard and Mark Emmanuel survey the role that tigers played in changing 19th-century ecological landscape. As gambier and pepper proliferated, the disturbance to the forest provided an ideal habitat for tigers, which attacked Singaporeans—mostly Chinese agriculturalists—living in the frontier between the town and forest for the first half century of the existence of colonial Singapore. On the edge of these plantations, the British scientist Alfred Russel Wallace also began his exploration of nature in Southeast Asia. John van Wyhe provides an examination of Wallace and his time in

Singapore, and the role that it played in the development of his theories of natural selection in the next chapter in this book.

Singapore was a key location for scientific research on the environment, as can be seen in the work of Wallace. This theme continues in Nigel P. Taylor's discussion of the role that the Singapore Botanic Gardens have played in this development of economic botany in the region. This contribution can be most famously seen in the development of techniques for the processing of rubber and oil palm, two products that transformed the landscape of Singapore and the Malay Peninsula for over a century, as well as the transformation of "green" Singapore under the post-1965 government. As the Director of the Singapore Botanic Gardens, Taylor provides the insight of both a botanist as well as an administrator who has to oversee the creation of functional green space in the heart of the island, and is able to place the development over a century and half in a historical perspective.

Although tigers haunted Singapore in its first few decades, deforestation and the expansion of the municipality led to a distancing of the links between animals and the larger society as much of the island's flora and fauna was "tamed." This distancing between humans and nature, and the control of the environment, becomes the focus of several later chapters. Singapore's role as an *entrepôt* not only involved the export of rubber; it also included the export of exotic animals. Fiona Tan turns her attention to the links between the port and animals from the larger Malay World during the late colonial period by focusing on legislative attempts to control the animal trade flowing through the harbor. The inability, or lack of desire, of the colonial government to handle the issue, helps provide insight into the role of personalities in environmental matters, as well as the role that trade played in the development of public policy, as her chapter ventures into the city, with a particular focus on bird shops located along Rochor Road in the 1930s.

The role of animals such as birds, and how a modern, urban populace can understand them, is the focus of the next chapter, which follows the development of the Raffles Museum natural history collection, and its fate following Singaporean independence in 1965. Natural history museums, much like Botanic Gardens, allowed for research into the environment of the region. The discovery and collection of new species, as well as their presentation to the public, helped the colonizer visualize its empire at the level of nature. As science and empire changed in the second half of the 20th century, however, the issue of what to do with the massive collection of preserved animals in the Raffles Museum became a concern for government

officials and scientists in Singapore. As this colonial era collection did not fit into understandings of a modernizing and technologically advanced nation-state, the fate of all of these animals, as well as Singaporeans relationship with the natural world, came into question. Through the dedicated efforts of a handful of scientists, they were able to preserve the collection, while continuing to try and make it relevant to young Singaporeans who were growing more distant from their natural surroundings.

These natural surroundings included a vast number of farms up until the 1980s. Agricultural food production in Singapore was one of the early triumphs of the independent government, and from the 1960s until the 1980s Singapore experienced a high level of food security. A number of key products that the citizens consumed, ranging from pork to eggs, were produced on the island. Cynthia Chou, a Singaporean anthropologist living in Europe, explored many of these farms in the 1980s, and discusses the relationship between farmers and government officials, and changing understandings of what the former can contribute to society, in Chapter 8. When government policy called for the closing of these farms in the mid-1980s, and began to focus on agro-technology, it was the end of an era of food self-sufficiency in the nation, pointing to the role that government officials also played in the long-term relationship between the population and the natural environment.

The role of these government officials, and their relationship to nature and civil society, in a global context is the focus of the final two chapters in this book. Goh Hong Yi examines the often-contentious relationship between members of the Nature Society and government officials in the early 1980s with regard to the exotic animal trade, which also harks back to Tan's earlier chapter, and culminated in Singapore joining the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1986. The process, however, was one in which the loyalty of civil society activists to the state was often called into question, and even resulted in a diplomatic row with the United States. Goh argues that this was a key early moment in not only the development of civil society in Singapore, as well as environmental activism, laying the foundation for the future relationship between the government and activists that has resulted in a number of green spaces being designated reserves and national parks.

In the final chapter, Timothy Barnard and Corinne Heng place the efforts of the modern Singaporean government to promote a "clean and green" environment in historical perspective. While the results of this program have been extraordinary, they also reflect a growing technocratic

approach to the environment. Singaporean nature, much like its political, economic, and social policies, was to be controlled and quantified. While this led to a much greener environment, it has also led to calls from various environmental groups, including the Nature Society, to allow for more "natural" growth. These developments, however, are the culmination of over 200 years of interaction between humans and the natural environment in a small port in Southeast Asia. They are part of its environmental history.

While this volume covers the past 200 years of Singaporean environmental history, it is an introductory work. There are still many other areas that other scholars could explore in much greater detail. The urban environment, and even medicine and health, for example, provide a richness of resources that wait for the curious. Hopefully, this work will spur others to look into alternative approaches to examining Singaporean history, and its environment. This is a first step, and, beyond any enjoyment and insight the chapters provide, may it allow others to ask different questions of, and view from different perspectives, the Singaporean past.

SOURCE 1

John Crawford's Singapore: An Excerpt from *A Descriptive Dictionary of the Indian Islands and Adjacent Countries* (1856)¹

John Crawford

SINGAPORE, correctly SINGAPURA, from the Sanscrit singa, lion, and pura city. This is the name of an island, which with the exception of a single village of poor and predatory Malay fishermen, and that only formed in 1811, was covered in a primeval forest down to the 6th day of February, 1819, and is now the fourth in rank of the European emporia of India, ranking after Batavia. De Barros gives a whimsical etymology of the name "Anciently," says he, "the most celebrated city which existed in the land of Malacca, was called Cingapura, which in the language of the country signifies 'false delay' (falsa demora)." This derivation must have come through the Malays who, no doubt were then, as they now are, ignorant of the true meaning of the name, and indeed, even of the fact that it is derived from the sacred language of the Hindus.

Singapore is the most northerly of the large islands of the almost countless group that in a great measure blocks up the eastern end of the strait which divides the Peninsula from Sumatra, leaving but narrow channels for navigation, and forming as it were, a region of straits. It is about thirty miles distant from the southern extremity of the Asiatic continent, and separated from the mainland by a strait generally about a mile broad, but in some parts little more than three furlongs. This is the Sâlat tambrau (strait of the tambrau fish), of the Malays and the "old Straits of Singapore" of European navigators. It was the old passage into the China Sea, but has long been abandoned for that by the southern side of Singapore. I went through it in a ship of 400 tons, and found the passage tedious but safe. Singapore in its greatest length

¹ John Crawford, *A Descriptive Dictionary of the Indian Islands and Adjacent Countries* (London: Bradbury and Evans, 1856), pp. 395–400.

from east to west, is 25 miles long, and in its greatest breadth 14, having an area of 206 square geographical miles, which will make it 70 miles larger than the Isle of Wight. To the north, it is bounded by the territory of Jehore, the limit between being the continental shore of the narrow strait already mentioned. Everywhere else, the British settlement extend to 10 miles from the shore of the main land, and within this distance are contained no fewer than 75 islets of various sizes, embracing an area of 17 square miles, so that the superficies of the entire British settlement amounted to 223 square miles.

Viewed from a distance, Singapore presents no marked elevations, but has the unvarying aspect of one continuous forest. The surface, however, is undulating; consisting, generally, of rounded hills of 80 to 120 feet high, with narrow valleys not above 15 or 20 feet above the sea level. A chain of rather higher hills runs through the island from east to west, making the water-shed in one direction to the north, and in the other to the south. The culminating point of the land is a hill, nearly in the centre of the island, called Bukit-timah, that is, "tin-hill", and this rises to the height of 519 feet above the low water-mark spring tides.

The geological formation of Singapore consists of the same rocks as the Peninsula generally, and is plutonic and sedimentary; the first consisting of granite, and the last, which embraces the greater portion of the island, of sand-stone, slate, and clay iron-ore. The only metallic ore that exists in abundance, and this is very rich, is that of iron. The island lies also in the formation most favourable for the existence of tin, namely, between the junction of granite and sand-stone, but no ore of it has as yet been discovered. The blue clays furnish an excellent material for bricks and tiles; and the decomposed feldspar of granite the finest kaolin which has yet been seen in India, but it has not been applied to the manufacture of porcelain. Some portion of the island, as that which is the site of the town, is of alluvial formation, chiefly sand with a very thin covering of vegetable mould.

The climate of the island is well described by Mr. Thomson, in the *Journal of the Indian Archipelago*. "Singapore," says he, "though within 80 miles of the equator, has an abundance of moisture, either deposited by the dews or gentle refreshing showers, which keeps its atmosphere cool, prevents the parching effects of the sun, and promotes continual verdure. It never experiences gales. If more than ordinary heat has accumulated moisture and electricity, a squall generally sets in, followed by a heavy shower of rain; such squalls seldom exceeding one or two hours in duration. According as the monsoon blows, you will have the squalls coming from that direction. But the most severe and numerous are from the south-west, called 'Sumatras,' and these occur, most frequently, between 1 and 5 o'clock in the morning. The north-east monsoon blows from November to March; after which the wind veers round to the south-east and gradually sets in the south-west, at which point it continues to September. The north-east blows more steadily than the south-west monsoon. The temperature is by one or two degrees cooler in the first than in the last." The average fall of rain is found, from the observation of a series of years, to be 92.697 inches;

and the average number of days a year in which rain falls is found to be 180, thus dividing the year almost equally between wet and dry; the rain not being continuous but pretty equally distributed through the whole year, January, however, being the month in which the greatest quantity falls. The mean temperature of Singapore is, at present, $81^{\circ}.247$, the lowest being $79^{\circ}.55$ and the highest being $82^{\circ}.31$, so that the range is no more than $2^{\circ}.76$. It would appear from this that the temperature on the island is by $9^{\circ} 90'$ lower than that of many other localities at the same latitudes. Comparing the temperature now stated with that which was ascertained 20 years earlier, and in the infancy of the settlement, it would appear that it had increased by $2^{\circ} 48'$; a fact ascribable, no doubt, to the increase in buildings, and to the country having been cleared of forest for three miles inland from the town, the site of the observations. The general character of the climate as to temperature is, that the heat is great and continuous, but never excessive, and that there is little distinction of seasons; summer and winter differing from each other only by one or two degrees of the thermometer. Thunder showers are of frequent occurrence, but the thunder is by no means so severe as I have experienced in Java, and seldom destructive to life or property. "That interesting and wonder phenomenon, called a water-spout," says Mr. Thomson, "is often to be seen in the seas and straits adjacent. They ought more properly to be called whirlwinds charged with vapour. They occur, generally, in the morning between the hours of eight and twelve, and rise to the height of half a mile, appearing in the distance like large columns supporting the heavy masses of cumuli above them. I noticed in October, 1841, six of these attached to one cloud, under action at the same time. In August, 1838, one passed over the harbor and town of Singapore, devastating one ship and sinking another; and carrying off the corner of the roof of a house in its course landward. No other atmospheric disturbances of any moment occur. The typhoons of the China Sea and Bay of Bengal do not reach those parts, nor are there hot winds to parch the land. The equable and quiet state of the atmosphere and seasons of these regions, consequently create analogous properties in the face of indigenous vegetation. Evergreens abound; few trees shed all their leaves at the same time; and many of the fruit trees produce all year round. Such as have their seasons of fruit will produce crops out of season, bearing small irregular ones at intervening times. This continual verdure is, perhaps more grateful to the stranger than to those who have been accustomed to it. To the former it bears the pleasant appearance of exuberance and fecundity—of a region where the lofty forest not only hangs over the beach, but clothes the mountains to their tops, so unlike the sterile barrenness of higher latitudes. To the latter, the continual sameness palls the senses. They want variety, and call for a sterile winter, only that they may renew, with doubly keen perception, their acquaintance with the beauties of returning summer, a season that always here reigns."

Notwithstanding its heat and its monotony, the climate of Singapore is even remarkable for its salubrity; and with, perhaps, the exception of a few little-frequented spots in the interior, it is certainly free from the malaria which often infects countries,

apparently more favourably circumstanced. This advantage it seems to owe to its perfect ventilation by the monsoons—by land and sea-breezes—and by frequent squalls. That this is the main cause is proved by the eminently pestiferous air of the land-locked harbor at the western end of the island, and not above two miles distant from the town.

A popular view of the botany of Singapore has been given by Dr. Oxley, a man of science, and long familiar with the place. "If nature," says he, "has been frugal in her gifts of the higher orders of the animal kingdom in Singapore, she has lavished with unsparing prodigality, the riches of the vegetable one. Notwithstanding the infertility of the soil, climate more than compensates for the loss: heat and moisture cover the lean earth with unceasing verdure; and we realize, what fancy paints as the most desirable of all climates—an eternal spring. But independently of its position, the botany of this place possesses several other interesting considerations. Being a connecting link between the Indian and Australian forms, we have types of both, and many genera of either region. We observe the Indian forms in the natural families Palmae, Scitamineae, Aroideae, Artocarpeae, Euphorbiaceae, Apocynaceae, Guttiferae, Convolvulaceae, Leguminosae, all numerous. The natural families Casuarinaceae, Myrtaceae, particularly Melaleucae, and Proteaceae, connect us with Australia."

"The plants," he observes, "which usually spring up when the primeval forest has been cut down; and where the bane of all the rest of the vegetable kingdom—the *Andropogon caricosum*, or Lalang grass, has not taken possession, belong to the following genera: *Melastoma*, *Myrtus*, *Morinda*, *Solanum*, *Rubus*, *Rottlera*, *Clerodendrum*, *Commersonia*, *Ficus*, and *Passiflora*. The jungle, with the exception of its outskirts is unexplorable, without great risk, from the number of tigers; but we have collected between forty and fifty orchideous plants, including epiphytal and terrestrial, and about the same number of ferns. Fici are extremely numerous. Of palms, I have not seen more than twenty species, although, I believe, there are a much greater number. The most interesting of these in an economic point of view are the coco-nut, the *Areca catechu* or pinang, the *Areca sigillaria* or nibung, the *Sagus laevis* or rambuja, the *Nipa fruticans*, or nipa, and the *Gomutus* or iju. Of the natural families which most abound, the *Asclepiadeae*, *Euphorbiceae*, *Scitamineae* and *Urticaceae* are the chief." The forest contains an immense number of species of timber trees, most of them of great height and growth. Above two hundred have been collected, and of these about half-a-dozen afford good timber for house and boat building. The teak is not of the number. The forest, also, produces the two species which yield the useful gutta-percha, and a fig which affords an elastic gum. But for use these articles, as well as timber, are not obtained from Singapore itself, but from the wider and more accessible forests of the neighboring continent.

The zoology of Singapore is that of the neighboring continent, to the exclusion of some of the larger animals, as the elephant, the rhinoceros, the tapir, and the ox. The largest feline animal indigenous to the island is a small leopard, called by the Malays *arimau-dään*, that is the "the branch" of climbing tiger. But the tiger, and

animal unknown to the island in the earlier years of British settlement, made its first appearance five or six years after it was formed, and is now too abundant. It seems to have crossed over from the continent, attracted no doubt by the sound of human voices and lowing of cattle. It has multiplied greatly, and is supposed to destroy, yearly, from two to three hundred persons, proving the greatest bane of the settlement. Large rewards have been offered for the destruction of tigers, and a good number have been captured in pitfalls, but all attempts at their extermination have been unsuccessful and are likely long to prove so in this still forest-clad island, parted from a region in which the tiger is abundant by a channel of no more than few furlongs broad. The channel between Penang and the main is two miles broad, and this has been sufficient to exclude the tiger, for although there have been examples of individuals having crossed over, it has been in an exhausted state, and they have been immediately destroyed.

Of the natural family of Mustelidae, there are two in Singapore, the musang of the Malays, *Paradoxus musanga*, and the binturang, *Ictides ater*, of the size of a badger. Otters are occasionally seen along the coasts, but are rare. The wild hog is frequent, and there are five species of deer, the usual ones of the Peninsula and Sumatra, from the *Rusa* of the size of a heifer to the *kanchil*, which is hardly as large as a rabbit. Among mammals, one species of bat is often to be seen, the same which is so frequent in almost all parts of the Archipelago, the *kalong* or *Pteropus javanicus*. This is about the size of a raven, and a troop of them in flight has very much the look of a flock of crows, and by a stranger may be easily mistaken for one. "I may add," says Dr. Oxley, "In rendering a sketch of the zoology of Singapore, several species of the bat tribe, and among them that most destructive one to all fruits, the flying fox or *Pteropus*. Fortunately, however, they are at yet scarce, but at no distance from us they are numerous beyond count. I have seen a flock of them while anchored in the Straits of Malacca, so large as to take several hours in passing. A colony is at present located in a mangrove creek at the head of the estuary of the Jehore river. In the day they are seen asleep hanging in millions from the branches of the mangrove. At sunset they begin to stir, and presently they ascend into the air and wing their way to the south-east in one vast uninterrupted cloud. They pass the whole night in the jungle and plantations devouring fruit, and as soon as dawn begins to appear, they mount the air again and return to their roosting-place at the head of the estuary. Their flesh is eaten by the natives, but no real fox smells to my mind half so rank as they do. Methinks a rat would be palatable food compared with them." These bats, in so far as the orchard is concerned, are the locust of the country, in which flights of the insect itself as far as I am aware are unknown. The *Ptermonys*, or flying squirrel, the *krawak* of the Malays, is very frequent in Singapore, and so are three different species of monkey.

As with the larger quadrupeds, the larger birds of the Peninsula and Sumatra are not found in Singapore. It has neither their peacocks nor their pheasants, and the only birds of the *Rasorial* family which exist in it are two species of quail. Nearly all the web-footed birds, whether indigenous or of passage, are not to be seen. There are six different species of pigeon, from the size of our wood-pigeon to that of a thrush.

Parrots are frequent, but the species only two or three. The only bird that can be called game is the snipe, which seems a stranger to no country in the world that has marshes. The birds of prey of four different genera are sufficiently numerous, and Dr. Oxley remarks that among birds of this family, is "that perfect type of true falcons, the beautiful little *Falco caerulescens*, which, although not much larger than a sparrow, will kill and carry off a bird the size of a thrush."

Among reptiles, alligators are common in the salt water creeks, and along the shores of the island, but having an abundant supply of fish, are not troublesome to man. The Iguana lizard, the bewak of the Malays, is not unfrequent, but the noisy house lizard or tokay, the tâké of the Malays, so common in Penang and so much more so in Siam, is not found in Singapore. The esculent turtle is very abundant along the shores of Singapore and the neighboring islands, and being, as food, restricted to the European and Chinese population, is the cheapest animal food in the market, one of the largest weighing several hundred weights selling for six or seven shillings. "Snakes," says Dr. Oxley, "are not numerous. The most common is the dark cobra. I believe this with a *trigonocephalus* are the only well-authenticated venomous species on the island. The first possesses the peculiar property of ejecting venom from its mouth. The Malays say there is no cure for its bite. I have seen it prove fatal to a fowl in two or three minutes, but have not observed its effects on large animals. Those I have killed have measured from $4\frac{1}{2}$ and $5\frac{1}{4}$ feet in length. This reptile being slow and sluggish is easily overtaken and killed. When attacked, it erects the body and dilates the skin on either side of the head, uttering a noise like that of an irritated cat. If attacked it throws, to the distance of six to eight feet, a venomous fluid or a most poisonous quality." Fish and crustaceans are in great plenty, and Dr. Oxley has enumerated forty species of them as seen by himself. About half-a-dozen of these are excellent for the table, fully equal to the best fish of our own coasts. Among these the best is the white pomfret of Europeans, the bawal-puteh of the Malays, of richer flavor than our soles and less luscious than the turbot.

The agriculture of Singapore, although conducted with sufficient spirit and activity, is limited to a small number of objects, and nearly excludes all the cereal grasses and pulses constituting the staple articles of human food. The soil of the island, with very few exceptions, is like that of the adjoining peninsula, unfertile—and there is no natural, and therefore no cheap source of irrigation, and hence the land is incapable of furnishing a cheap supply of the main necessities of life, which are yielded only within the Archipelago by rich volcanic or alluvial soils, assisted by a copious perennial irrigation. For such plants as rice, the sugar-cane, the indigo-plant, pulses, maize, tobacco, cotton, the soil must be considered as ill-suited. Besides want of fertility of soil, Singapore wants sufficient elevation to give a climate fit for the production of coffee. Even the nutmeg thrives only when forced by rich dressings, and the clove does not succeed at all. On the other hand, all plants which depend on heat and moisture than on soil, flourish luxuriantly, such as the coco and areca palms, with the *Uncaria gambir*, which is indigenous. Black pepper, which is a long-naturalised

exotic, although it answer well, yet even it requires some manuring. In 1854, the quantity of pepper produced amounted to 3,116,533 pounds, and the betel or areca nuts to above 40,000 cwts. Among the plants congenial to both soil and climate are most of the intertropical fruits, whether indigenous or exotic. Among these the most easily reared, and even cheaper than the banana is the pine-apple, equaling in size and flavor the finest productions of our hot-houses. Besides fruits, the soil and climate are well adapted to the production of the yam and igname, and to that of the coarse pot-herbs which belong to the latitude.

The following judicious remarks are made by Mr. Logan on the soil of Singapore: "The soil is much more varied than it was supposed to be in former years, and so far from consisting entirely of decomposed sandstone and clay-iron ore, it contains a plutonic (granitic) tract of about sixty square miles, and another in which shales predominate. Although the soils have not the fertility of the volcanic and calcareous ones which occur in many parts of the Indian Archipelago, they are covered with an indigenous vegetation of great vigour and luxuriance, supporting numbers of animals of different species. The hills of plutonic rock support dense and continuous forests composed of more than 200 species of trees, many of which are of great size. So long as the iron is not in such excess as to recompose the clay into stone, or render it hard, those soils which contain most iron are most fertile. The purely, or highly felspathic are the worst. But even felspathic soils, when intermixed with a sufficient proportion of quartz, are, in this estimate, capable of producing an abundant vegetation. Although it is obvious to every observer that there is no kind of soil in the island for which nature has not provided plants, that flourish luxuriantly in it, yet it must not be hastily concluded, as some have done, that this exuberant vegetation indicates a general fertility in the soil. It is found, on the contrary, that there are very few soils in which cultivated plants not indigenous to the region, but whose climatic range embraces it, will flourish spontaneously. While the coco-nut, areca, sago, gomuti, and the numerous Malayan fruits succeed with little care, the nutmeg and clove are stunted, and almost unproductive, unless carefully cultivated and highly manured. Yet the climate is perfectly adapted to them. Place them in the rare spots where there is naturally a fertile soil, or create one artificially, and the produce is equal to that of trees in the Molucca plantations. With respect to indigenous plants, gambier, pepper, and all the fruits flourish on the Plutonic hills, provided they are not too deficient in iron and quartz. The hills of violet shale, where they are not too sandy, are equal to the best Plutonic soils, — those, namely, in which there is a sufficient proportion of hard granules to render them friable, and sufficient iron to render them highly absorptive to water, without becoming plastic. Of all the sedimentary soils, the sandstone and very arenaceous shales are the worst. Of the alluvial soils, the sand, particularly when it contains a mixture of vegetable matter, or triturated shells, is the proper soil of the coco-nut and the vegetable mud of the sago. When the country has been better and longer drained and cultivated, the latter soil will become a rich mould. At present it is too wet and sour to make fertile soil. Rice is grown on some patches of it. The bluish

sea mud contains good ingredients, but the clay is in excess, and the animal matter in it appears to assist in rendering it hard and intractable, when it is not saturated with water. Even for such soils, however, nature has provided plants useful to man, for the area and some of the indigenous fruit trees grow well in it with little cultivation. Although there are cultivated plants adapted to every kind of soil in the island, and it has indigenous tribes of man who can live exclusively on its yams, sago, fish, and wild animals, it is incapable of feeding a population of the more civilised races, and the latter must always be dependent on other countries for the great necessary of life—rice."

In the husbandry of Singapore, neither plough, harrow, nor spade are employed. All is done with the hoe and mattock. The whole is, in fact, a garden culture, in which no great crop is cultivated giving scope for the plough, and which is perhaps best performed by the hoe, the congenial and habitual implement, for this purpose, of all Asiatic nations. With respect to tenures, wild lands, when alienated by the government, are granted in fee simple, on payment of thirty shillings an acre, if within two miles of the town, and of one-half that amount, if beyond this distance. At this simple arrangement the government arrived at last, after the higgling and blundering of a quarter of a century, and the expenditure of vast quantities of ink and paper.

The only manufacture deserving this name that is carried on in Singapore, is that of sago, and for this, it is a workshop of nearly all that at present appears in commerce. This amounts to about 8000 tons yearly, of the value of about 30,000£. Great quantities of tools, implements, swords, and wall-pieces are manufactured by the Chinese, and there is some manufacture of furniture, with some boat and shipbuilding, but not to any great extent, for wet and dry docks remain yet to be constructed, although there be localities well adapted to them.

But ever branch of industry is merely subsidiary to trade. Singapore is, in fact, a great commercial emporium, in which are warehoused for future distribution, the staple products of Europe, Asia, and America. The town, the seat of this commerce, lies in the north latitude $1^{\circ} 17'$, or only seventy-seven miles from the equator, and in east longitude $103^{\circ} 50' 47''$. Its locality on the southern side of the island, on a salt creek, into which falls the brook called the river of Singapore; the commercial part of it being on the western bank, and the public buildings and private houses on the eastern, which spreads into a sandy plain, a little above the level of the sea. There is properly, no harbour, but the bay which fronts the town, and which is also the highway through the Straits of Malacca, is a roadstead equivalent to a harbour in a region never vexed by storms. Ships of the largest burdens lie in good anchoring-ground at the distance of two miles from the shore, those of moderate draught of water, within a mile, and small craft close to it. The salt creek, which has a quay on the commercial side, is navigable at all times for lighters up to the warehouses of the merchants.

In 1826 ...

CHAPTER 1

Singapore's Changing Landscape since c. 1800

Tony O'Dempsey

At the time of Sir Thomas Stamford Raffles arrival in 1819, the island of Singapore was not totally pristine. Although there had been a significant trade port in Singapore in the 14th century, over the subsequent 400 years small groups of *orang laut* (sea people), who occupied the coastal and mangrove river inlets, became the main occupants of the island. Their settlement on the land is thought to have been limited in extent and mainly at the mouth of the Singapore River. Elsewhere, on the southern part of the island *orang Kalang* lived at the mouth of the Kalang River, while in the north *orang Johor* and *orang Selat* lived in the estuaries of the Ponggol River and Seletar River, where the remnants of their communities remained into the 19th century. As fishing was the main occupation of these groups, their impact on the landscape would have been marginal. They certainly utilized mangrove timbers and Nipah palms in the construction of their abodes and possibly utilized some of the lowland rainforest trees in boat-building. Beyond the harvesting of timber for construction, it is thought that they did not venture inland further than the need for fresh water, medicinal plants, and forest fruits required.¹

In a pristine state, Singapore featured three significant ecological habitats (see Figure 1.1). The first of these was lowland dipterocarp forest, which T.C. Whitmore defines as a type of forest within the lowland rainforest formation

¹ John N. Miksic and Cheryl Ann Low Mei Gek, eds., *Early Singapore 1300s–1819: Evidence in Maps, Texts and Artifacts* (Singapore: Singapore History Museum, 2004); Kwa Chong Guan, Derek Heng, and Tan Tai Yong, *Singapore: A 700-Year History: From Early Emporium to World City* (Singapore: National Archives of Singapore, 2009).

on dry lands up to 1,200 meters in which the family Dipterocarpaceae dominates the upper and emergent canopy; it was the most extensive forest type in Singapore.² These dipterocarp forests vanished fairly quickly during the first hundred years of colonial rule due to uncontrolled harvesting of timber as well as destructive agricultural practices. The influence of tides and water characterized the second and third major habitats in Singapore. The first of these habitats was the freshwater swamp forest, which is typically found on the low lying coastal alluvial plains and associated with river and stream systems, and mangrove forest, which occurred within the areas of tidal influence. Freshwater swamp forests originally covered a significant portion (approximately 65 square kilometers) of Singapore and have since suffered significant depletion through land conversions. Freshwater swamp forests come about due to flat low-lying land close to the coast and above the limit of the spring high tide becoming inundated due to rainfall runoff, inflow from surrounding elevated terrain, and the tidal effects restricting outflow of water from the streams. This periodic inundation gives rise to a habitat that is floristically distinct from the surrounding lowland dipterocarp forest. The alluvial soils, upon which this forest type grew, however, would become highly desired agricultural land during the colonial period in Singapore, when most of it was converted for the growing of vegetables. Mangrove forests are the third ecological habitat in Singapore. These forests formed within the intertidal zone. During colonial times, these forests were valued for firewood and charcoal production, poles for fishing platforms (*kelongs*), and timber for boat-building.³ As will be seen, during the first hundred years of colonial rule, poor land administrative practices led to the destruction of most of these forest habitats along with the dependent fauna.

In the late 18th century Chinese clan wars in the Riau Islands forced some Teochew planters to flee to Singapore Island. They most likely settled in remote river estuaries, such as that of Sungei Seletar as well as close to the mouth of the Singapore River, which was nothing more than a primitive trading post at the time. These Teochew planters continued the only occupation they knew—gambier and pepper planting. As such, 20 gambier plantations existed in Singapore at the time of Raffles arrival in 1819. This

² T.C. Whitmore, *Tropical Rain Forests of the Far East* (New York: Oxford University Press, 1984).

³ *Sonneratia* species were sought after for use in struts in boat construction, while *Rhizophora apiculata* is preferred for charcoal production.

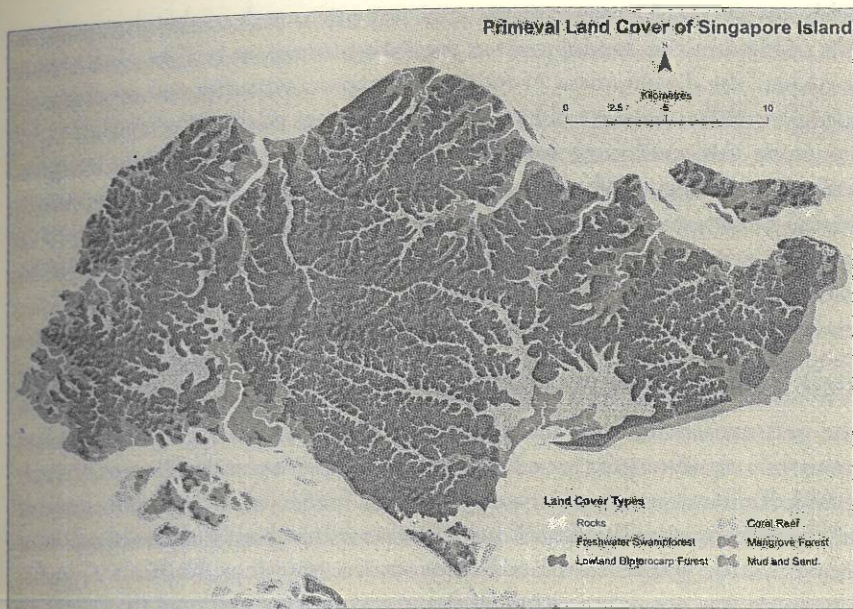


Figure 1.1 Primeval vegetation of Singapore

number is unlikely to have included plantations in remote parts of the island that escaped official attention until as late as 1846, when one such plantation was discovered accidentally along a branch of the Sungei Seletar.⁴

The presence of small settlements in the swampy coastal areas of an island largely covered in dipterocarp forest, however, caused little change in the vegetative cover of Singapore. This would largely occur with the arrival of British imperial rule in the early 19th century. This chapter will trace the changes that Singaporean vegetation has undergone since approximately 1800. The massive deforestation of the landscape for plantations characterizes the first of these periods. This was followed in the late 19th century by a period during which the colonial government attempted to develop

⁴ James C. Jackson, "Chinese Agricultural Pioneering in Singapore and Johore, 1800–1917," *Journal of the Malayan Branch of the Royal Asiatic Society* 38 (1965): 77–82; K.W. Pitt, "From Plantations to New Town: The Story of Nee Soon," in *The Development of the Nee Soon Community*, ed. L.G. Lim How Seng (Singapore: The Grassroots Organisations of Nee Soon Community and National Archives, Oral History Department, 1987), pp. 193–225.

nature reserves and water reservoirs to counteract much of this destruction. This resulted in the development of secondary forests, as well as plantations of rubber. The development of modern Singapore, with the construction of high-rise public housing and movement into former plantations lands, simply represents the continuing transformation of the landscape. The common theme for the past 200 years, thus, is constant change. The Singaporean natural environment has been both preserved and transformed, and will continue to transform, from an imagined pristine state through the efforts of man.

Early Colonial Influence on Vegetation

The well-documented arrival of Sir Stamford Raffles arrival in 1819 set the scene for a significant increase in the rate at which the landscape was altered. It was Raffles himself who performed the first land reclamation project on the island, when he decided that potentially valuable agricultural land should not be wasted in the construction of a township. Raffles' vision for Singapore was not only as a tax free port and establishment of the island as a trading hub. He was also interested in developing other economic activities as were already in progress in Penang where sugar cane and other crops were established and considered successful. He ordered that excavated soil from a nearby hill be used to fill nearby mangrove swamps.⁵

Spices, particularly nutmeg and mace, cloves, and pepper, had been the cornerstone of most European trade in Southeast Asia up to that time, and had fueled much of the British-Dutch rivalry in the region over the previous two centuries.⁶ Merchants and administrators in the English East India Company in the early 19th century were keen to establish commercial plantations within their holdings to gain better control over the trade. As part of these efforts, Raffles established experimental botanical gardens of nutmeg and cloves next to his residence at Fort Canning in 1819. Subsequently, well-off British and Chinese residents planted nutmeg plantations near the town. These plantations thrived for the next 40 years, until an infestation of parasites wiped them out in the 1850s and 1860s. The early failure of the

⁵ Munshi Abdullah, *The Autobiography of Munshi Abdullah*, trans. W.G. Shellabear (Singapore: Methodist Publishing House, 1918), pp. 142-3.

⁶ For an accessible history of this period, see Giles Milton, *Nathaniel's Nutmeg: How One Man's Courage Changed the Course of History* (London: Hodder and Stoughton, 1999).

nutmeg crop meant that it did not have a substantial impact on the total native vegetation coverage of the island, as the plantations were within the extent of the municipality.⁷

The early Teochew immigrants (Chaozhou people, a dialect group originating from Chaoshan in eastern Guangdong Province, southern China) not only brought their agricultural practices to Singapore in the late 1700s, but also their "*kangchu*" system of social organization, which would influence how the landscape was exploited over the first century of colonial rule. The fundamental unit of organization was the "*kangkar*," the riverine village headquarters for the *kangchu* (head man). The typical *kangkar* village consisted of substantial central buildings essentially comprising the *kangchu*'s residence and operational center, around which were scattered shops and stores, often including an opium den and gambling house. Radiating out from these villages were pigsties, vegetable farms, and orchards. Traces of this land tenure system remain to this day in the names of various localities in Singapore. Places such as Lim Chu Kang, Yio Chu Kang, and Choa Chu Kang ("*chu kang*" meaning "river owner" in Teochew) are geographic markers for these gambier production centers of the 1800s.

The *kangkar* contained a number of *bangsals*, which were areas cleared and usually cultivated with gambier and pepper, and also included the processing facilities and "coolie lines" (accommodation). Typically, nine or ten men would work a single *bangsals* in what we might today call a share-farming arrangement. As *bangsals* became depleted after 15–25 years, the planters moved outward within the *kangkar* to establish new *bangsals*, leaving the abandoned areas to revert to *belukar* (secondary forest) and *lalang* grass.⁸

Rivers and streams were the main avenues for moving into interior Singapore in the early decades of colonial rule, as roads to Bukit Timah, Kranji, Serangoon, and Seletar were only established several decades after 1819. Reliance on river transport meant *kangkars* were close to navigable river systems and were typically located at the point of tidal influence. This inevitably meant that the development of these remote areas began along the rivers, expanding outward from the central village. An added advantage of these intertidal locations would have been the ready supply of

⁷ Thomas Oxley, "Some Account of the Nutmeg and its Cultivation," *Journal of the Indian Archipelago and Eastern Asia* 2, 10 (1848): 641–60.

⁸ James C. Jackson, "Chinese Agricultural Pioneering in Singapore and Johore, 1800–1917," *Journal of the Malayan Branch of the Royal Asiatic Society* 38 (1965): 77–82.

the back mangrove palm *Nypa fruticans*, the Nipah palm, fronds of which were commonly used for roof thatching, while other parts of the palm were harvested for other domestic uses. Hence, for many years after the arrival of the Raffles, remote areas were accessible only via navigable waterways. As the road system became established, *kangkars* were found in inland areas devoid of the opportunity for river navigation. An example of this phenomenon is Bu Ko Kang, which covered an area between the Bukit Timah and Seletar Roads during the latter half of the 19th century.⁹

Gambier and pepper were typically grown together on these *bangsai* for crop management reasons since neither was economically viable in its own right. Although pepper was lucrative, it was seasonal and thus did not require workers to be constantly on hand. In contrast, gambier required almost continuous attention, so this crop ensured that a workforce was onsite when occasionally needed for the harvesting or maintenance of the pepper vines. Additionally, the waste runoff from the gambier-boiling process provided fertilizer for the pepper plants. After a period of 15–20 years, the gambier and the pepper crops would exhaust the nutrients in the soil and would start to decline. At this point, the plantation would be abandoned and fresh land would be cleared to continue the activity. As such, gambier and pepper plantations practiced what we would describe today as methods of shifting agriculture.

By the late 19th century, the great majority of gambier and pepper plantations were concentrated in northern and western Singapore, mainly due to better soil conditions. Neither crop could thrive in ponded water (swampy ground) nor on steep hillsides or at altitudes greater than 200–300 feet (61–91 meters).¹⁰ This explains their relative absence from eastern Singapore as well as the retention of native forest stands on hilltops in the hilly central part of Singapore Island. The crop also would not have been planted within the swampy lands of alluvial streams; for this reason, some retention of riverine and swampy forest along certain streams is evident even today, though some of these were eventually converted for vegetable and fish farming. Further evidence that gambier was not planted within swampy areas

⁹ Shawn Lum and Ilsa Sharp, *A View from the Summit: The Story of Bukit Timah Nature Reserve* (Singapore: Nanyang Technological University and the National University of Singapore, 1996); Peter K.L. Ng and N. Sivasothi, eds., *A Guide to the Mangroves of Singapore, Volume 1: The Ecosystem and Plant Diversity* (Singapore: Singapore Science Centre, 1999).

¹⁰ Henry N. Ridley, *Spices* (London: Macmillan, 1912), pp. 254–7.

is obtained from the *Annual Reports of the Forest Department*, in which H.N. Ridley reports that in 1889 the interior forest reserves, such as Ang Moh Kio and Sembawang, still contained "good swampy forest."¹¹ This also explains the existence of primary forest on hilltops and within many of the swampy streams of the Central Catchment Nature Reserve in modern Singapore.

Both gambier and pepper are destructive in the sense that they require huge amounts of timber to process (see Table 1.1). Gambier involved the constant boiling of the leaves, while pepper required kiln drying; this resulted in the destruction of surrounding forests for firewood. These crops also denuded the ancient and leached soils of their nutrients resulting in the practice of shifting agriculture leaving in its wake total destruction of forest. Timber resources within the confines of any *bangsal* commonly were fully consumed during the time that it was occupied.

In a report submitted in 1883, the Superintendent of the Botanic Gardens, Nathaniel Cantley, reported that a typical *bangsal* consumed approximately 2,500 pounds of timber each day in pepper kilns as well as for boiling gambier. Based on these very approximate calculations, we are able to validate the anecdotal estimate that a *bangsal* consumed an area equal to that planted with gambier and pepper for the purpose of firewood. In fact, this is probably a very forgiving estimate as it is not known if the stakes were obtained from timber originally cleared for the *bangsal* or if that original clearing had been completely burned, and stakes taken from surrounding forest—an even more destructive scenario. Little is known about the fate of the saleable timber felled for gambier plantations. Alfred Russel Wallace mentions the presence of Chinese timber cutters in the Bukit Timah and Bukit Panjang areas when he stayed at the Jesuit mission on Bukit Timah Road, and Ridley mentions in his notes that the timber being cut was sold in China where it was considered scarce.¹² We also learn from the papers of the day that woodcutters were active in whatever jungles remained during the 1800s and that this was a distinct industry from the gambier plantations. It is, therefore, possible that some of the lands cleared for gambier could have been previously logged for valuable timber species within reason of accessibility.¹³ Based on estimates, an original clearing removed approximately 7,000 cu

¹¹ H.N. Ridley, "Annual Report of the Forest Department" (1889).

¹² H.N. Ridley Notebook HNR-3-2-2, p. 187. Much of the material on Ridley in this chapter is taken from his personal notebooks, labeled "HNR," which can be accessed at the Library of the Singapore Botanic Gardens.

¹³ "Decrease of Rigers," *The Straits Times*, 16 Apr. 1864, p. 1.

Table 1.1 Estimates of amount of forest cover needed for gambier and pepper production

Estimate volume of timber in 1 ha of dipterocarp forest	Average tree diameter: 1.5 m DBH Average Tree Height: 20 m $\text{PI} * \text{R} * \text{R} * \text{H} = 11 \text{ cu m / tree}$ Average number of trees per hectare: 20	220 cu meters / hectare
Estimate timber required for stakes in a 30 ha <i>bangsal</i>	1 Stake: 20 cm x 20 cm x 4 m = 0.15 cu m 400 Stakes: @ 5 m spacing over 1 ha = 64 cu m	1,920 cu meters
Estimate timber usage for firewood over 15 years within a 30 ha <i>bangsal</i>	Usage at 2,500 lbs/day = 1.4 cu m / day 15 years * 365 * 1.4 = 7,665 cu meters	7,665 cu meters
Estimate amount of forest required for firewood and stakes	$(7,665 \text{ cu m} + 1,920 \text{ cu m}) / 220 \text{ cu m / ha}$	43.6 ha

meters of timber of which 2,000 cu meters was required for stakes upon which gambier and pepper were grown; the remaining 5,000 cu meters was either sold or burned; and, for the 15 years a gambier and pepper plantation operated, there was a demand for almost 8,000 cu meters of fuel, which the surrounding forest supplied.

The destructive nature of gambier and pepper planting became clear to residents of Singapore by the 1840s. In an article published in 1843 in the *Singapore Free Press and Mercantile Advertiser*, which deserves to be quoted in length, Halbert Eestalrig criticized the government land occupation policy and agricultural system as follows:

... behind Bukit Tassie [Province Wellesley] and at other places great plains covered with lalang and studded at intervals with weather-beaten lifeless trunks of trees exhibit the natural results of free and unconditional occupation. In Singapore the same course has from the first been allowed and is now in operation over a larger surface than was ever abandoned to this destructive system in the northern settlement. The greater part of the lands in the vicinity of the town were, soon after the establishment of Singapore, occupied by Chinese gambier and pepper planters who with an indifference, on the part of the local authorities to a practical evil under their eyes with which is strangely out of keeping

with the industry with which regulations have been coined, clipped, and recast, have been always allowed to take procession of as much forest land as they chose, without the slightest acknowledgment of the proprietary right of the Government. The general mode in which these planters proceed is gradually to withdraw labour from their plantations as the plants from increasing age lose their luxuriance. The lalang which so long as the plantation is in its prime is repressed with some care rapidly gains upon the gambier and is at last suffered to choke it. Before the squatter has ceased to gather the feeble foliage of the worn out plants he has already opened a fresh location in the jungle, and the former scene of his labours is abandoned to the dominion of the lalang which with the old gambier plants forms an excellent tiger cover. Hence when the European capitalists sought localities accessible by public roads for space for plantations they were obliged to be satisfied with the scourged and rejected lalang grounds which marked the wake of the Chinese who made them pay large sums to relinquish their pretended possessory rights. Large tracts of land in this state may be seen to the west of the town [Tanglin]. The interior of the public forests when explored exhibits a succession of gambier and pepper fields scattered throughout the jungle many already abandoned and all progressing to the same useless and noxious condition ... The quantity of ground that has undergone or is undergoing this process cannot be estimated under 50,000 acres. The evil does not simply consist in the exhaustion of the soil but in the serious bar that is placed in the way of really useful planters who are desirous of extending permanent cultivation by the heavy outlay required to extirpate the lalang. This according to the texture of the soil is between thirty and forty dollars an acre and it is an expenditure of absolute necessity for not an inch of lalang root can be safely left.¹⁴

As gambier plantations expanded throughout the island, clearing of forest rapidly reduced the available habitat for native fauna, many of which depended on the forest habitat for survival. As a result, some species became extinct. An example is the Oriental Pied Hornbill (*Anthracoceros albirostris*), which is reliant on native forest fruits such as nutmegs and became extinct in Singapore during the late 19th century. Other species such as deer, colugo, and porcupine managed to hang on in small numbers of remaining small patches of forest. The banded leaf monkey (*Presbytis femoralis femoralis*) is another example where a very small number remained confined within forest reserves that became part of the Central Catchment

¹⁴ Halbert Eestalrig, "Notes in the Straits," *The Singapore Free Press and Mercantile Advertiser*, 28 Sep. 1843, p. 3.