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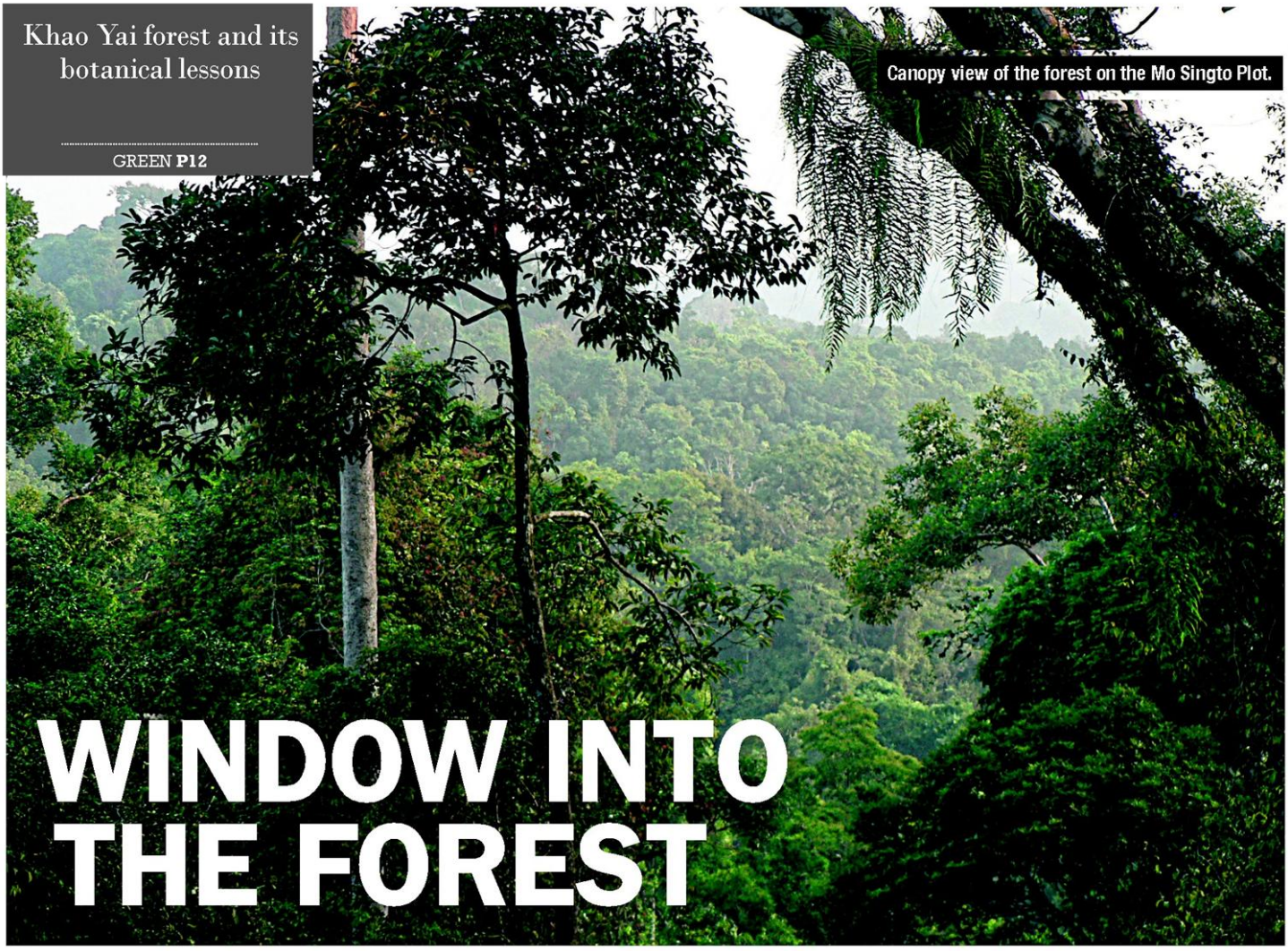
Headline: WINDOW INTO THE FOREST

Khao Yai forest and its botanical lessons

GREEN P12



Canopy view of the forest on the Mo Singto Plot.

WINDOW INTO THE FOREST

The Mo Singto dynamic plot of Khao Yai, home to over 130,000 trees, provides a lens for researchers to delve into the past and future species surviving and dying in its ecosystem

STORY:
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There is an area of forest in the Khao Yai National Park in which every tree — large and small — is being monitored without any respect for their privacy. The trees' permanent locations and other bits of vital personal data are all stored in a computer database and used to probe the trees and their activities.

This area is a rather large plot — 600m by 500m — or 30 hectares. One hectare is an area 100m by 100m in size and here contains, on average, about 4,300 trees and shrubs over 1cm in diameter. The total number of trees over 1cm in diameter on the whole plot is about 131,000. The largest trees on the plot exceed 1.2m in diameter and are over 50m tall.

If you look closely, every tree has a small aluminium tag attached to it (for small trees, the tag is tied loosely around the base and is

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usually hidden in the ground litter). A five- or six-digit number is punched on the tag and you can look the number up in the database and find out its species, its exact co-ordinates on the plot of land, its size at the last tree census and its general health. For each kind of tree, there is also information about how many individuals of each size grow on the plot, when they flower, fruit and grow new leaves every year.

Who would be so ambitious, or so crazy, as to collect so much detailed information about a forest? The answer? A bunch of ecologists who have joined a worldwide network to study the dynamics of forests in all regions of the Earth, especially forests within the tropics where most of the rich biodiversity of Earth resides. This Forest Global Earth Observatory (ForestGEO) network is co-ordinated by the Centre for Tropical Forest Science, or CTFS, which is based in the Smithsonian Institution in Washington, DC.

The plot in Khao Yai is managed by scientists at BIOTEC, an institute that is part of the National Science and Technology Development Agency (NSTDA) located in the Science Park at Pathum Thani, in collaboration with the Department of National Parks, Wildlife and Plant Conservation. Scientists from many other institutions also participate in the research into the plot. In addition to describing and cataloguing the biodiversity of the forest, the major aim of establishing the plot is to study the effects of climate change on the condition of the forest, species by species.

The research therefore must include the study of animals that depend on the forest, such as monkeys, gibbons, squirrels, civets, bears, deer and elephants, plus several hundred species of birds and insects. Furthermore, the study must also include how the plants are affected by these animals as consumers of fruits, seeds and seedlings, etc.

The Mo Singto Plot in Khao Yai is not the only ForestGEO plot in Thailand. There is an even larger (50 hectare) and older plot in the Huai Kha Khaeng Wildlife Sanctuary in Uthai Thani province of western Thailand and one on the top of Doi Inthanon, Thailand's highest mountain in Chiang Mai province, and also one in the more tropical Trang province in the South.

It takes considerable investment and manpower to establish and manage such a large forest plot. Initially, the area must be surveyed into 20m^2 "quadrats", marked with position stakes, and then each tree must be identified, measured and accurately mapped with tapes. The fieldwork takes about a dozen people nearly a year. The identification of all the plant species, however, takes much longer and involves experts in Thailand and institutions abroad. Scientific voucher herbarium specimens are collected and deposited in various herbaria here and abroad.

How many species grow in a 30 hectare area in the moist evergreen forest in Khao Yai? The precise answer, from the last census, is 262 species of trees and shrubs, 204 of which reach a diameter of at least 10cm. There are 16 species of big trees which reach a diameter of 1m. The dominant one is a species of yang tree, *Dipterocarpus gracilis*, which has been measured at 54m in height.

In addition to the trees, it has been found that lianas are also very diverse — at least 120 species — and play important roles in the forest. They connect the tree canopies in a tangled mass of foliage and also produce fruits of great importance for birds, monkeys, gibbons and lots of other wildlife.

These large plots are called "forest dynamics plots" because they provide a window into how the forest is changing. The census data stored in the computer includes the numbers of young trees of each species down to 1cm in diameter, to understand the demography of each species on the plot.

The CTFS protocol requires that all plots are completely re-censused every five years, and all trees remeasured, in order to see how the forest is changing. In addition, studies of phenology and seedling counts are performed on most plots, providing more data on the regeneration capacity of each species.

As is the case on all such large plots, most species of trees are too rare for demographic analysis; many are represented by only one or two individuals. This wide variation in abundance — over five orders of magnitude — has puzzled ecologists since they began studying ecological communities.

Some examples of our findings at Mo Singto illustrate the value of studying tree dynamics. A group of species that reach large size on the plot, including the *Choerospondias axillaris*, whose plumlike fruit is important to many wild animals, was found to not be producing young "recruits"; that is, seedlings and saplings. This indicates that the species just might be dying out in this forest, as the big trees will not be replaced. They will be replaced by other species whose seedlings and saplings are able to survive under the changing conditions.

We know that the seedlings of some of these species grow better in open, disturbed areas where they receive more sunlight and cannot survive in the current shady forest. This suggests that something drastic — even catastrophic — occurred here in the past which opened up the forest. Maybe the forest was destroyed and burnt by nature's forces many years ago, initiating a new process of "succession".

Another study of the dynamics of the kritsana tree that produces agarwood, known in Thai as *mai hom*, has opened a window into the future. The species is *Aquilaria crassna* and it is still a relatively common tree in spite of the fact that its trunks are regularly shaved with knives, or just chopped down, by poachers in all parts of the park (even on our plot) to obtain its valuable resin. Most of the resin, which contains a variety of aromatic compounds, is sold to Arab countries in the Middle East at sky-high prices where it is used in cosmetics such as body oils.

A few years ago a PhD student carried out a demographic analysis of the growth, survival and reproduction of Aquilaria trees on the

An Aquilaria tree recently chopped by poachers in the forest.

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ABOVE
This Gnetum vine offers food to gibbons, monkeys and bears.

RIGHT
A gibbon feeding on figs high in the canopy.

> These large plots are called 'forest dynamics plots' because they provide a window into how the forest is changing

Mo Singto Plot to predict future population changes. The demographic analysis has shown that if the trees are poached in the traditional way, by periodically shaving off the resin-containing wood of living trees, the population can probably sustain itself indefinitely as it has for centuries.

Since the 1997 economic crisis, poachers have become more numerous and more are selfishly chopping down trees to look for the *mai hom* wood. The trees are thus not able to grow to their full size. There is an alarming decline in reproductive-size trees.

Attempts are also being made to obtain evidence for the effects of climate change on forest composition. We know that the average temperature has increased around Khao Yai Park and rainfall patterns may also be affected. El Niño effects can be very severe in the forest in reducing rainfall. Some tree species show signs of lower recruitment of seedlings on drier areas of the plot.

One of the great advantages of having a plot in Khao Yai is the presence of a large variety of wildlife: elephants, deer, wild dogs, gibbons, pigtail monkeys, civets and a great variety of birds that still make the forest their home. They are nonetheless altogether oblivious to the intensive research being carried out on their feeding habits and movements.

A long-term study on gibbons, for example, shows that they are essential to the dispersal

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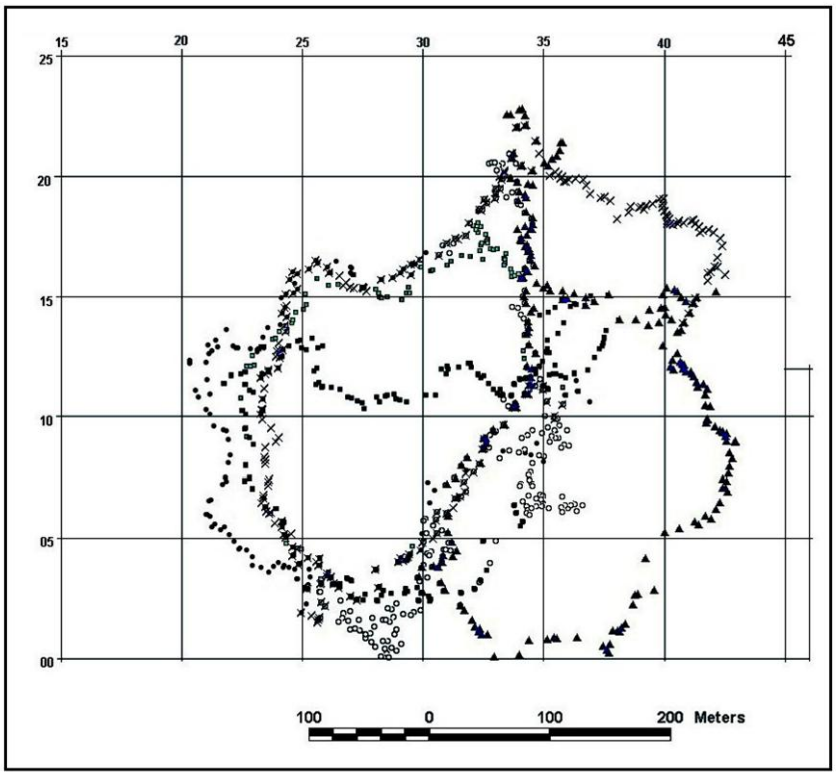

This map shows computer-drawn paths of gibbons foraging on the plot over five days. Each point represents a tree entered.

of seeds of many species of trees and lianas. As the gibbon group that occupies most of the area of the plot has been habituated to the presence of observers, we can follow and map exactly where it harvests fruit and also where it defecates and drops the seeds that germinate into seedlings.

As the number of plant species on the plot and the number of animals that interact with them are so large, the understanding of everything about the forest community becomes a hopelessly complex task. There are not nearly enough researchers and students to even skim over some of the most important research opportunities and questions

How will the changes that are being documented on the plot affect the park as a conservation area in the future, and how will it affect villagers living downstream?

The authors work for BIOTEC, NSTDA, in Science Park, Pathum Thani. Warren Brockelman is a retired biology professor at Mahidol University.