The Conservation Status of Hong Kong's Tree Flora*

ZHUANG XUEYING

Department of Plant Protection, South China Agricultural University, Guangzhou 510642

RICHARD T. CORLETT

Department of Ecology and Biodiversity, University of Hong Kong, Pokfulam Road, Hong Kong

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ABSTRACT

Since 1840, 333 native tree species have been recorded in Hong Kong. However, as a result of past and present land use practices, many forest tree taxa are in danger of extinction. Since the late 1970s, a systematic conservation system has been established in Hong Kong. Most of the forest and many plant species are protected by law. This paper reports the current conservation status of the tree flora of Hong Kong, based on a study of forest ecology and floristics between 1989~1996. The relevance of Hong Kong's experience to the conservation of China's tree flora is also briefly discussed.

Key words Hong Kong, China, trees, diversity, conservation

1 Introduction

Hong Kong lies on the south coast of China between latitudes 22°09'~22°37'N and longitudes 113°52'~114°30'E. It consists of a section of the Chinese mainland (Kowloon and the New Territories, 782 km²) and numerous islands, of which the largest are Lantau Island (142 km²) and Hong Kong Island (78 km²). The total area is 1076 km². The topography is extremely rugged, reaching 957 m at the highest point, Tai Mo Shan, in the New Territories. Hong Kong's population of 6 million people is concentrated on the limited natural flat land, which has been extended by coastal reclamation.

Hong Kong's climate has both tropical and subtropical features, with both temperature and rainfall highly seasonal. The winter, however, is neither very cold nor very dry, so the original forest cover of Hong Kong was probably largely evergreen. There is archaeological evidence of human occupation for at least 6000 years (Meachem 1994) but no direct evidence for when the major deforestation occurred. Both Chinese and European accounts of the region in the 17th century describe or imply a largely deforested landscape but it is possible that considerable clearance occurred much earlier (Dudgeon and Corlett 1994). By 1841, at the start of British administration, there were only two substantial patches of forest on Hong Kong Island, totalling less than 100 hectares, with additional small patches in deep ravines. Subsequent changes have included both the negative impacts of expanding human population and e-

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conomic development, and the positive influence of conservation policies.

In this paper, the conservation status of Hong Kong's tree flora is described and the impact of past and present conservation policies is discussed. Recommendations are then made for enhancing the conservation of native tree diversity in Hong Kong and in those parts of South China which share a similar history of human impact.

2 Conservation history of Hong Kong

There seem to have been few attempts by the colonial administration to protect the existing forest area, either on Hong Kong Island or, later, in the New Territories. The only forest patches which have survived from the nineteenth century are those behind rural villages which are protected by the local inhabitants for reasons of *feng shui*. From the 1870s, however, the Government started large-scale afforestation, initially on Hong Kong Island but extending to the New Territories after 1900. Most trees planted or sown *in-situ* were the native *Pinus massoniana*, but many other species, both native and exotic, were planted on a small scale. By 1938, 70% of Hong Kong Island was covered in Government plantations and there were several large afforested areas in the New Territories. An additional 200 km² was covered in leased forestry lots used for producing firewood. Almost all the plantations were cut down during the Japanese Occupation. Afforestation started again after the war on a smaller scale. Planting was concentrated in the water catchment areas and increasingly relied on exotic species, rather than the native pine.

The Hong Kong Government was very late in setting up a formal protected area system and the first "Country Park" was not established until 1976. Country Parks and Special Areas were established for both conservation and recreation. Today the 21 Country Parks and the 3 Special Areas which are not within Country Parks protect 41 320 hm² of countryside: slightly over 40% of the total land area of the Territory. Outside the Country Park system, a coastal area, Mai Po Marshes in the Northwest New Territories, is protected as a Restricted Area under the Wild Animals Protection Ordinance and a permit is required for entry. In addition, there are 58 Sites of Special Scientific Interest (SSSI), although almost half of these are inside other protected areas. Most SSSIs are small areas which are protected because of their biological or other scientific interest. SSSIs are basically an aid to planning and currently receive no special management. The Town Planning Ordinance also provides for additional landscape protection categories for areas where development should be restricted.

Hong Kong also has legislation which protects named species of plants and animals anywhere in the territory. Protection of plant species started in 1913 with a law to prohibit collecting and selling nine plant taxa with ornamental value, including all species of *Rhododendron*, *Litsea cubeba*, *Enkianthus quinqueflorus* and *Manglietia fordiana* (Dudgeon and Corlett 1994). In 1936, the list of protected plants was extended to include more than 25% of the flora, including all Fagaceae and such widespread species as *Sterculia lanceolata*. The current list of species, protected under the Forestry Regulations of the Forests and Countryside Ordinance, is considerably shorter but includes 27 tree species (Dudgeon and Corlett 1994). This list of protected species is a useful supplement to the protected area system.

In addition to protected areas and species, conservation of the flora and fauna is also promoted by the Environmental Impact Assessments (EIA) required before major developments, even on private land. The presence of rare plant species should be recorded during the

EIA and the developers are required to prevent or minimise damage to all the protected species.

3 Floristic diversity of Hong Kong forest

Today, approximately 14% of Hong Kong (150 km²) is covered in forest: one third plantations and two-thirds natural forest (Ashworth et al. 1993). Although the native *Pinus massoniana* was the most widely-planted species in the past, most trees of this species in Hong Kong have been killed by the introduced Pinewood Nematode (*Bursaphelenchus xylophilus*) and most surviving plantations consist of exotics (Dudgeon and Corlett 1994). The commonest species are *Acacia confusa*, *Lophostemon confertus* (previously called *Tristania conferta*), *Melaleuca quinquenervia* (often confused with *M. leucadendron*) and *P. eliotii*. Most plantations consist initially of a single tree species but diversity increases with age as native species invade and some of the oldest plantations are hard to distinguish from natural secondary forests. Much of the existing natural secondary forest, in fact, consists of trees which became established under a canopy of *P. massoniana*.

Natural forest in Hong Kong can be divided into three major types, although stands with intermediate characteristics do exist (Zhuang 1993). The oldest forests in Hong Kong are *feng shui* woods, protected near villages or temples for the purpose of geomancy by the local residents. Many of these woods are more than 50 years old and some, at least, have existed for several centuries. The origin of *feng shui* woods is uncertain: by protection of existing natural forest, by planting, by succession or, most probably, by a variable combination of these sources. The majority of the natural forest in Hong Kong has developed since 1945 by succession. There is a gradual change in forest floristics around 500 m altitude (Zhuang 1993) so two types are recognised: lowland secondary forest below 500 m and montane forest above.

The floristic diversities of the three forest types have different, but overlapping, ranges (Table 1). In general, *feng shui* woods have the highest species richness, diversity and evenness, presumably as a result of their greater age. The lowland and montane secondary forests have similar ages but montane forest has somewhat higher mean diversity and evenness, possibly because the complex topography and inaccessibility of upland areas allowed more trees to survive during the past centuries of intense human impact.

Table 1 Species richness (*S*), Shannon diversity index (*H*), and equitability (*J*) of three major types of forest in Hong Kong

Forest type	No. of samples ¹	<i>S</i> mean (std ²)	<i>H</i> mean (std)	<i>J</i> mean (std)
FSW ³	13	32(8)	2.99(0.37)	0.84(0.06)
LSF ⁴	25	27(6)	2.53(0.32)	0.77(0.07)
MF ⁵	6	26(4)	2.66(0.14)	0.82(0.05)

1: number of plots sampled of each forest type (plot size = 4 × 100 m²); 2: std = standard deviation; 3. *feng shui* woods; 4: lowland secondary forest; 5: montane forest; *S* = total number of species per plot; $H = - \sum P_i \cdot \ln P_i$, P_i = proportion of total individuals in the *i*th species; $J = H / \ln S$ (Begon et al. 1986)

4 Conservation status of the tree flora

A total of 333 tree species, belonging to 61 families and 162 genera, have been recorded in Hong Kong since 1841 (Zhuang 1993). Of these, 50 species were not seen during the course of a forest survey by Zhuang (1993) while another 47 species were seen at only one site. Among the species seen, 161 were found within the 44 forest plots (each $20 \times 20 \text{ m}^2$) surveyed and an additional 102 species were seen outside the plots. The current secondary forests are mainly dominated by some common pioneer species. Many rare species are confined to a few remote ravine woodlands or those on steep cliffs. Among the 50 species not seen during the course of the study, the family with most species was the Fagaceae. Almost half of the recorded species in this family were not seen and another 25% were seen only at one site.

The status of the rare and endangered plants of Hong Kong varies with the species. Some species are found at only a few sites but are abundant where they occur, such as *Amentotaxus argotaenia*, *Illicium angustisepalum*, *Persea kadooriei*, and *Michelia chapensis*. Such species may not be in immediate danger of extinction but are very vulnerable to habitat destruction. Some other species are widespread but nowhere abundant, such as *Persea grijsii*, *Beilschmiedia tsiangii*, *Sinosideroxylon wightianum*, and *Cinnamomum validinerve*. The most endangered species are those which occur in low numbers at only one or a few sites. Most of the rare and endangered species in Hong Kong belong to this category. A few species are probably extinct, such as *Syzygium odoratum* and *Beilschmiedia fordii*, which were only recorded in the Happy Valley Woods in the nineteenth century. These woods were subsequently cleared some time before 1900.

Considering their distributions as a whole, many of the rare species in Hong Kong are globally rare. Such species include *Amentotaxus argotaenia*, *Camellia crapnelliana*, *C. granthamiana*, *Castanopsis concinna*, *C. kawakamii*, and *Tetrathryrium subcordatum*, which are rare and legally protected in China. However, there are also a few species which are rare in China but common in Hong Kong. The clearest example is *Artocarpus hypargyrea*, which is rare and protected in China, but is quite common in Hong Kong. There are also species which are rare in Hong Kong but abundant elsewhere in China.

Two tree species, *Persea kadooriei* and *Tsiangia hongkongensis*, are apparently endemic to Hong Kong. The distributions of both of them are very restricted. *T. hongkongensis* is possibly extinct because it has not been seen again since two type specimens were collected in the 1850s (But et al. 1986).

Combining information from the forest survey, herbarium specimens, local botanical literature, and personal communications from local botanists, a total of 123 recorded tree species can be considered rare or extinct in Hong Kong (Table 2). This total includes the 50 species not seen during the course of this study, 47 species seen at only one site, and 26 species seen at more than one site but with very few individuals or very vulnerable to destruction of their habitats.

Among the rare or extinct species, the habitat of 15 species is uncertain. Of the others, 90 species are recorded from forest while another 16 species are recorded in thickets or streamsides. Of the species seen in forest, at least 30 species are apparently confined to either montane forest or well-developed *feng shui* woods. The families with most threatened species are Fagaceae (20 spp.), Lauraceae (16 spp.), Theaceae (11 spp.), Magnoliaceae

(8 spp.) and Hamamelidaceae (6 spp.).

Table 2 Rare, threatened or extinct tree species in Hong Kong

Family	Species	Occurrence	Status	Habitat
Aceraceae	<i>Acer reticulatum</i>	I	rare	woodland
	<i>A. sino-oblongum</i>	I	vulnerable	FSW
	<i>A. tutcheri</i>	I	rare	MF
Aquifoliaceae	<i>Ilex dasyphylla</i>	I	rare	MF
	<i>I. graciliflora</i>	II	vulnerable	woodland
	<i>I. kwangtungensis</i>	I	rare	woodland
	<i>I. macrocarpa</i>	O	rare	roadside
Boraginaceae	<i>Cordia dichotoma</i>	O	rare	woodland
	<i>Ehretia thyrsoflora</i>	O	rare	near stream
	<i>E. longifolia</i>	II	vulnerable	woodland
Cornaceae	<i>Dendrobenthamia hongkongensis</i> *	I	rare	woodland
Elaeocarpaceae	<i>Elaeocarpus dubius</i>	II	rare	FSW
	<i>E. japonicus</i>	I	vulnerable	MF
Ericaceae	<i>Lyonia ovalifolia</i>	O	rare	?
	<i>Rhododendron moultmainense</i>	I	rare	woodland
Euphorbiaceae	<i>Antidesma fordii</i>	I	vulnerable	FSW
	<i>Endospermum chinense</i>	II	vulnerable	FSW
	<i>Macaranga sampsonii</i>	II	vulnerable	FSW
Fabaceae	<i>Gleditsea sinensis</i>	O	rare	?
	<i>Millettia pulchra</i>	O	rare	woodland
	<i>Ormosia indurata</i>	O	rare	woodland
Fagaceae	<i>Castanopsis carlesii</i>	O	rare	near catchment
	<i>C. concinna</i>	II	rare	woodland
	<i>C. eyrei</i>	O	rare	?
	<i>C. karwakamii</i>	O	rare	woodland
	<i>C. lamontii</i>	I	vulnerable	woodland
	<i>C. sclerophylla</i>	O	rare	?
	<i>Lithocarpus attenuatus</i>	O	extinct ?	Happy Valley
	<i>L. elizabethae</i>	I	rare	woodland
	<i>L. fenestratus</i>	II	rare	near stream
	<i>L. haipinii</i>	I	rare	woodland
	<i>L. harlandii</i>	O	rare	woodland
	<i>L. irwinii</i>	O	rare	woodland
	<i>L. iteaphylla</i>	O	rare	woodland
	<i>L. konishii</i>	O	rare	?
	<i>L. macilentus</i>	O	rare	?
	<i>L. naindarum</i>	O	rare	?
	<i>L. rhombocarpus</i>	O	rare	?
	<i>Quercus blakei</i>	O	rare	woodland
	<i>Q. fabri</i>	O	rare	woodland
	<i>Q. litseoides</i>	I	rare	thickets
Flacourtiaceae	<i>Casearia villilimba</i>	II	rare	woodland
	<i>Flacourtia rukam</i>	I	rare	FSW
	<i>Xylosma longifolia</i>	I	rare	FSW
Hamamelidaceae	<i>Altingia chinensis</i>	II	vulnerable	woodland
	<i>A. gracilipes</i> var. <i>serrulata</i>	II	rare	near stream
	<i>Corylopsis multiflora</i>	I	rare	MF

Table 2 (Continued)

	<i>Exbucklandia tonkinensis</i>	I	rare	MF
	<i>Sycopsis tutcheri</i>	O	rare	ravine woods
	<i>Tetrathyrum subcordatum</i>	O	rare	thickets
Lauraceae	<i>Beilschmiedia fordii</i>	O	rare	Happy Valley
	<i>B. tsangii</i>	II	rare	ravine woods
	<i>Cinnamomum applianum</i>	I	rare	MF
	<i>C. japonicum</i>	II	rare	thickets
Lauraceae	<i>C. validinerve</i>	II	vulnerable	woodland
	<i>Cryptocarya chinensis</i>	II	vulnerable	woodland
	<i>C. concinna</i>	II	vulnerable	woodland
	<i>Lindera aggregata</i>	I	rare	woodland
	<i>L. megaphylla</i>	O	rare	FSW
	<i>L. metcalifiana</i>	I	rare	MF
	<i>L. nacusua</i>	I	rare	thickets
	<i>Litsea elongata</i>	O	rare	near stream
	<i>L. variabilis</i>	O	rare	woodland
	<i>Neolitsea levinei</i>	I	rare	MF
	<i>Persea grijsii</i>	II	vulnerable	woodland
	<i>P. kadooriei</i>	I	rare	woodland
Lythraceae	<i>Lagerstroemia fordii</i> *	O	rare	woodland
Magnoliaceae	<i>Illicium angustispalum</i> *	I	rare	MF
	<i>I. dunnianum</i> *	II	vulnerable	near stream
	<i>I. micranthum</i> *	I	rare	MF
	<i>Magnolia championii</i> *	II	vulnerable	MF
	<i>M. fistulosa</i> *	I	rare	MF
	<i>Manglietia fordiana</i> *	I	rare	MF
	<i>Michelia chapensis</i> *	I	rare	MF
	<i>M. maudiae</i> *	O	rare	MF
Malvaceae	<i>Thespesia populnea</i>	II	vulnerable	coastal woods
Meliaceae	<i>Dysoxylum hongkongense</i>	II	rare	woodland
Moraceae	<i>Artocarpus styracifolius</i>	II	vulnerable	woodland
	<i>A. tonkinensis</i>	II	rare	FSW
	<i>Cudrania tricuspidata</i>	O	rare	?
	<i>Ficus lankokensis</i>	I	rare	woodland
Myrtaceae	<i>Acmena acuminatissima</i>	O	rare	woodland
	<i>Decaspermum gracilentum</i>	O	rare	?
	<i>Syzygium odoratum</i>	O	extinct ?	Happy Valley
Olacaceae	<i>Schoepfia chinensis</i> *	I	rare	woodland
	<i>S. jasminoides</i>	O	rare	nullah
Oleaceae	<i>Chionanthus retusa</i>	O	rare	?
	<i>Fraxinus griffithii</i>	I	rare	MF
	<i>Olea dioica</i>	I	rare	FSW
	<i>Osmanthus marginatus</i>	I	rare	woodland
	<i>O. matsumuranus</i>	II	rare	woodland
Pinaceae	<i>Keteleeria fortunei</i> *	I	rare	coastal wood
Podocarpaceae	<i>Podocarpus neriifolia</i>	I	rare	thickets
Rhizophoraceae	<i>Carallia pectinifolia</i>	I	rare	FSW
Rosaceae	<i>Laurocerasus marginata</i>	O	rare	woodland
Rubiaceae	<i>Cephalanthus occidentalis</i>	O	rare	near stream
	<i>Randia acuminatissima</i>	I	rare	woodland
	<i>Tsiangia hongkongensis</i>	O	extinct?	?

Table 2 (Continued)

Rutaceae	<i>Skimmia arborescens</i>	I	rare	ravine
	<i>Zanthoxylum ailanthoides</i>	O	rare	near fish pond
	<i>Z. myriacanthum</i>	I	rare	thickets
	<i>Z. ovalifolium</i>	O	rare	?
Sabiaceae	<i>Meliosma fordii</i>	O	rare	woodland
	<i>M. squamulata</i>	I	rare	MF
Sapotaceae	<i>Chrysophyllum lanceolatum</i>	II	vulnerable	FSW
	var. <i>stellatocarpon</i>			
Simarubaceae	<i>Ailanthus fordii</i> *	I	rare	ravine woods
Styracaceae	<i>Alniphyllum fortunei</i>	O	rare	woodland
	<i>Rehderodendron kwangtungense</i> *	I	rare	woodland
Symplocaceae	<i>Symplocos pendula</i> var. <i>hirtistylis</i>	O	rare	woodland
Taxaceae	<i>Amentotaxus argotaenia</i> *	I	rare	MF
Taxodiaceae	<i>Glyptostrobus pensilis</i>	O	rare	?
Theaceae	<i>Adinandra jubata</i>	I	rare	ravine woods
	<i>Camellia assmilis</i> *	II	rare	woodland
	<i>C. crapnelliana</i> *	O	rare	woodland
	<i>C. granthamiana</i> *	O	rare	woodland
	<i>C. hongkongensis</i> *	I	rare	woodland
	<i>Eurya distichophylla</i>	O	rare	woodland
	<i>Hartia sinensis</i>	O	rare	?
	<i>H. villosa</i>	O	rare	woodland
	<i>Ternstroemia microphylla</i>	I	rare	ravine woods
	<i>Tutcheria championii</i> *	II	rare	woodland
	<i>T. microcarpa</i> *	I	rare	woodland
Verbenaceae	<i>Callicarpa longissima</i>	O	rare	thickets

1. Occurrence: O = not seen, I = seen at one site, II = seen at more than one site;

2. Habitat: FSW = feng shui wood, MF = montane forest, Happy Valley = Happy Valley Wood, ? = unknown. * species is protected in Hong Kong.

5 Major problems, recommendations and implication of this study

The conservation of nature in Hong Kong has improved considerably since the late 1970s, but there are still many problems. The principal threat to *feng shui* woods is the increasing development of previously remote rural areas. Most other forest areas are within Country Parks but hill fires are still a threat, particularly to isolated forest fragments. The widespread planting of exotic, fast-growing species in plantations is also an adverse factor for the conservation of the native tree flora. Most of current plantations in Hong Kong consist of exotic species, such as *Acacia* spp., *Pinus* spp. and *Lophostemon confertus*. These plantations have a purely ecological function as timber production in Hong Kong is uneconomic. However, they are unfavourable for restoration of native biodiversity because of their low tree diversity and simple structure. The use of exotic species may be necessary on the most degraded sites but very little research has been done on the potential of the native tree flora in such situations. Further research on the silvicultural characteristics of native species is urgently required.

In addition, although many rare plant species and their habitats are legally protected in Hong Kong, others are not. Among these 123 rare and threatened tree species, only 21 species are under protection of the Hong Kong Forestry Regulation (Dudgeon and Corlett

1994). Many really rare and endangered species have not been included in the list of protected plants of Hong Kong because of the lack of detailed knowledge of the distribution status of the local flora. The most conspicuous case is the Fagaceae. More than half the species in this family are threatened but none are on the protected species list. Existing protected areas include most of the lowland secondary forest and almost all the montane forest. *Feng shui* woods, however, are poorly represented in the protected area system and many of the best examples currently receive no legal protection at all. A comprehensive biodiversity survey of Hong Kong, which is being conducted by the Department of Ecology and Biodiversity of the University of Hong Kong, aims to fill some of these gaps by identifying species and habitats in need of protection.

Experience from Hong Kong is most easily applied in those areas of Southern China which share both a similar physical environment and a similar history of human impact. Despite the differences in scale and in economic factors between Hong Kong and southern China, two conclusions from this study in Hong Kong are probably of general application in the region. Firstly, this study has shown that a very diverse tree flora can persist, apparently for hundreds of years, in tiny forest fragments. Similar forest fragments in largely deforested areas of Southern China should be given a high priority for conservation. Secondly, the study has demonstrated that even badly degraded hill slopes can develop forest in 30~40 years by natural succession if they are protected from fire and cutting. Although this process is slower than active planting of trees, the resulting forest has greater structural and floristic diversity than most plantations. As a result, it is better for supporting wildlife and is likely to be more stable in the long-term. Plantations in many areas of China suffer serious problems from insect pests, a fact which has been attributed to their very low bird populations (Richardson 1990). Indeed, the positive influence of insectivorous birds on tree growth has been shown experimentally in the United States (Marquis and Whelan 1994). It may be possible to combine the advantages of high-yielding plantations with those of diverse, natural secondary forests, by planting a mixture of native and exotic species. However, for this to be possible, it is essential that conservation of China's rich, native tree flora is given a high priority.

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