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Chapter 1

Introduction

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1.1 Introduction: China – garden of the world

The flora of China is astonishing in its diversity. With 32 500 species of vascular plants, over 50% of them endemic, it has more plant species and more botanical variety than any other temperate country, and more than all but a few tropical countries.

Just why the flora of China is so diverse is a complex issue: many historical factors can account for the degree of richness of plant life found in different places on Earth, including the changing face of the Earth itself. Some 180 million years ago, before vascular plants had evolved, the continents were gathered together as a gigantic land mass known as Pangaea. The movement of basaltic plates across the surface of the globe caused the continents to separate, at different rates in different regions, sometimes colliding with others. Mountain ranges were forced upwards at regions of continental collision, such as the Himalaya Shan, or separation, such as the Appalachian Mountains of North America. At the same time, oceans changed in outline and extent, and regional climates developed and changed, particularly as a result of changing oceanic currents. For example, the formation of the Circum-Antarctic current followed the separation of Tierra del Fuego from Antarctica about 49 million years ago, which in turn accelerated Antarctic glaciation, eventually leading to the formation of Arctic continental glaciers, and driving the formation of sharpening contrasts between world climatic zones over the past 15 million years. Eventually, in the past three million years or so, the Arctic ice sheets moved to lower latitudes, with the formation of a cyclical series of expansions and contractions of the glaciers (Axelrod *et al.*, 1996).

In general, the flora of China is more numerous and diverse than that of other temperate areas because, firstly, China extends into the tropics, which neither Europe nor the USA (the other major temperate landmasses); secondly, 40% of the landmass of China lies at an elevation of over 2 000 m, including many isolated mountain ranges on which distinct species have developed relatively recently in geological time; and thirdly, from the Mid Miocene Period onwards (the past 15 million years), a time when the climate of the Northern Hemisphere is considered to have become less favorable for plants, and during ice ages of the Pleistocene Epoch, China's land connections to the south provided areas of refuge for many kinds of plants that disappeared from other northern Temperate areas (Axelrod *et al.*, 1996).

At the time the first humans (the genus *Homo*) first appeared on Earth, about 2.3 million years ago, the climates thus cycled between cold and warm, depending on the position of the ice sheets. The vegetation of the planet reflected these climatic and physical factors, with lush equatorial rainforests, prairies and savannas, alpine meadows extending to their vertical limits, boreal forests and arctic tundra. Until around 11 200 years ago, when agriculture was first developed, humans lived in bands of ca. 30–45 people that rarely came into contact with one another; it is estimated that the total global human population on all continents amounted to perhaps three million people. As human numbers increased, at first slowly and then with increasing rapidity, to perhaps 300 million 2 000 years ago, one billion by the early nineteenth century, and 7.1 billion today, we became a major force in shaping the Earth's vegetation. In the plants of China we clearly can see the legacy of this interplay between earth history—mountain-building, glaciation, continental shift and climatic change—and human history, in one of the world's most ancient and continuous civilizations.

China is not only vast, extending over some 9 600 000 km^2, but also has a great latitudinal range, from 18° N in the south, to 53.5° N in the north. Within this territory lie examples of almost every form of landscape, from the shores of the Nan Hai (South China Sea) to tropical and subtropical forests, deserts, the enormous elevated Qinghai-Xizang Plateau, and some of the world's highest mountains. Each of these ecosystems has its own distinctive plant community, some found nowhere else on earth. However, many are surprisingly familiar to those outside China: hundreds of China's more than 31 000 flowering plant species are now grown in gardens around the world. China is, quite literally, the garden of the world—as Ernest H. Wilson put it, "the mother of gardens" (Wilson, 1929).

This book tells the story of the plants of China, a story all the more remarkable in the context of China's recent rapid development into an economic powerhouse and the second largest economy in the world. China is changing rapidly in terms of economics, politics, science, technology, industry, culture and not least demography: by 2025, its urban population is expected almost to double, to one billion people. But underlying these dramatic developments, seen most clearly in the cities, is the natural economy of China: its green resources that are now recognized by the Chinese government as the essential foundation of a sustainable future.

1.2 The flora of China

China has the richest northern temperate flora in the world – containing approximately 31 500 native species of vascular plants, around 8% of the world's estimated total, or 1.5 times as many species as the USA and Canada combined. Around 15,750 species (over 50%) are endemic to the country. China is also notable for the presence of many taxa with origins far back in geological time, once common in North America and Europe but now surviving only in China, particularly gymnosperms such as *Cathaya* and *Pseudolarix* (both Pinaceae), *Ginkgo* (Ginkgoaceae) and *Metasequoia* (Taxodiaceae). This makes an understanding of the flora of China crucial to interpreting plant evolution and fossil history elsewhere in the world.

Furthermore, China is famed for its variety of habitats and for the continuity it provides between them: it is the only country in the world with unbroken connections from tropical to subtropical, temperate and boreal forests. This has contributed to the formation of rich plant assemblages and vegetation types rarely seen elsewhere. Certain regions of China deserve special mention for the richness and uniqueness of their flora, among them Yunnan, with an astonishing 15 000 species, half the total species in the country. Other Chinese "hotspots" of plant diversity are described in Chapter 2. Like elsewhere in the world, some of the China's richest areas of biodiversity are threatened, by various factors including habitat destruction, over-harvesting and global climate change. Chapter 22 to 24 describe some of these threats, and what we might be able to do to protect the flora of China for future generations.

It is not only the size, diversity and uniqueness of the Chinese flora that makes it such a fascinating subject for study, but also the individual features of the plant species themselves. From ancient seed plant lineages to stunning orchids, rapidly-radiating groups to complex taxonomic conundrums and intricate ecological networks, all can be found among the plants of China. To give just one example, China's most speciose genus is *Rhododendron* (Ericaceae), with 571 species, more than half the world total. Over 400 (72%) of these are found nowhere else in the world. Concentrated in the mountainous southwestern of China (Yunnan and Sichuan), many of these species are now cultivated throughout the world for their glossy foliage and showy spring flowers. Natural and artificial hybrids are common, producing more than 25 000 varieties now available to the grower.

1.3 Plants and people in China

China, perhaps more than any other country, has made extensive use of its natural plant resources for food, forestry, horticulture and medicine (see Chapters 15–21). Over 10 000 species have been employed in one or more of these fields, the vast majority in traditional medicinal systems. Many Chinese plant species have also been widely exported and introduced throughout the world. The orange (*Citrus ×aurantium*) and lemon (*C. ×limon*; both Rutaceae), peach (*Amygdalus persica*) and rose (*Rosa* spp.; both Rosaceae), ginger (*Zingiber officinale;* Zingiberaceae), soybean (*Glycine max;* Fabaceae), magnolia (Magnoliaceae), rice (*Oryza sativa;* Poaceae) and, of course, tea (*Camellia sinensis;* Theaceae), all originated in China.

Plants are also highly significant in Chinese culture, being used as symbols in art, architecture and religion. In her beautiful book, *Hidden Meanings in Chinese Art* (Bartholomew, 2006), Terese Tse Bartholomew highlights two main ways in which plants are used symbolically in China: firstly, by association, such as using a long-lived plant to symbolize longevity; secondly (and uniquely to China), through puns based on their Chinese names. Hence, the lotus (*Nelumbo nucifera,* Nelumbonaceae) can symbolize harmony (he, described by a different Chinese character, 和). Most plant symbols can have many meanings depending on their interpretation and the circumstance. *Bambusa* spp. (bamboo, zhu; Poaceae), with their straight, hollow and strong stems, symbolize humility, fidelity and integrity, while a stalk of *Oryza sativa* (rice) with many branches and multiple seeds symbolizes a good harvest. The paeony (mudan; *Paeonia* spp.; Paeoniaceae) is the most popular botanical image in China and, through its beauty, symbolizes wealth, honor and rank. The blossoms of plum (meihua; *Prunus domestica*; Rosaceae), which are said to occur even on withered old branches, symbolize perseverance and vigor in old age; as one of the earliest plants to flower each year, they also symbolize renewal and purity; and the five petals on each flower are used to represent China's traditional five blessings (old age, wealth, health, love of virtue and a peaceful death).

China is justly famed for its knowledge and use of plant species in medicine. As described in Chapter 14, over 10 000 species are reported to be used medicinally in China (He & Gu, 1997; Xiao & Yong, 1998; Pei, 2002; Hamilton, 2004) and, increasingly, the chemical basis and efficacy of these traditional uses is being investigated and the active compounds identified. Perhaps one of the most significant medicinal plants to come out of China in recent years is *Artemisia annua* (sweet wormwood; Asteraceae), used since ancient times in the treatment of fever. In the 1970s, *A. annua* was identified as a possible treatment for malaria, one of the most deadly tropical diseases worldwide, affecting some 300 million people at any one time and killing around 2.5 million each year, based on information in a 1 600-year old herbal. The active chemical component, artemisin (which is stored by the plant in specialized hairs, has now been isolated, described, and shown to have antimalarial activity. In fact it is considered the only effective treatment against many strains of the disease, including drug-resistant *Plasmodium falciparum*. *Artemisia annua* is now grown for artemisin production in several countries worldwide, across a total of over 11 000 ha; this is still only about half of what would be required to meet world demand (Heemskerk *et al.*, 2006).

1.4 The *Flora of China*: a golden age of Chinese botany

As the remarkable scholar Joseph Needham demonstrated so well in his monumental series *Science and Civilisation in China* (*Volume 6. Biology and Biological Technology*), detailed knowledge of Chinese plants and their uses extends into antiquity; such knowledge always being an integral part of Chinese culture, art and medicine (Various authors, 1984–2000). Nonetheless, the twentieth century in particular goes down as a time of great expansion in our knowledge of the plants of China. From the middle of the nineteenth century, first French missionaries and later British and American plant explorers began to make the botanical riches of China known scientifically and to the horticultural public in Europe and North America (see Chapter 12). It was not until the 1920s, however, that Chinese botanists, at first mostly trained in the west or in one of the colleges in China run by westerners for Chinese students, took on such explorations using international standards for naming plants. From 1949 onwards, the Chinese began to pursue the production of a national flora, the *Flora Reipublicae Popularis Sinicae* (*FRPS*), and between 1959 and 2004 this mammoth project, interrupted by the Cultural Revolution, but involving three generations of Chinese botanists, documented 31 180 species of vascular plants in a series of 80 volumes and 126 books (Ma & Clemants, 2006).

In 1979, the idea of translating the *FRPS* into English, the international language of science, was first mooted at a joint meeting of Chinese and American botanists in Berkeley, California, USA. At this point it was recognized that the Chinese authors of the *FRPS* had not had adequate access to the literature and specimens held in western countries, which was seen as necessary to improve this great work. Thus, in 1989 work officially began on the *Flora of China,* a major international project to produce a fully revised and updated work in which the account of each plant group was to be prepared jointly by at least one Chinese and at least one non-Chinese co-author. The first volume (*Volume 17: Verbenaceae through Solanaceae*) was published in 1994, with the first accompanying illustration volume following in 1998. In 2013, the final text volumes of the *Flora of China* were published. The completion of this entire series in just 24 years makes it one of the most successful Flora projects ever undertaken. Much of this success relates to the friendly, scholarly and cooperative relationships generated through the project, relationships that will, we hope, last for many years to come.

The *Flora of China* covers the vascular plant species of China in 25 volumes. *Volume 1* comprises the indices, summary, classifications, and statistics. *Volumes 2–3* cover the ferns. *Volume 4* includes the gymnosperms and some angiosperms, and *Volumes 5–25* incorporate all the remaining angiosperms. Asteraceae (the largest family) are treated in two volumes (20 and 21). *Plants of China* acts as a companion volume to the series, accessible both to users of the Flora and to a wider audience interested in the flora of China. A complementary project, the *Moss Flora of China*, has also been published in eight volumes by Missouri Botanical Garden Press (Moss Flora of China Editorial Committee, 1999–2011).

Botany in China has seen many changes since the inception of the *Flora of China* project in 1979. As described in Chapter 12, in 1980, Chinese and American botanists joined together for the first joint field expedition involving scientists from a non-Communist country (the Sino-American Sennongjia Expedition). The 1980s and 1990s saw increasing numbers of Chinese and Chinese-International collecting expeditions to many under-explored regions including the Hengduan Shan (Yunnan, Sichuan and Xizang), Wulin Shan (Hubei, Sichuan Hunan and Guizhou), upper reaches of the Hongshui (Guangxi), and Dulongjiang and Gaoligongshan (Yunnan), as well as numerous provincial expeditions.

State support and encouragement for botany, along with other sciences, is today at an all-time high in China. Today, Botanic Gardens Conservation International (BGCI) lists 148 botanical gardens in China, of which three (South China Botanical Garden, Wuhan Botanical Garden and Xishuangbanna Tropical Botanical Garden) are operated under the Chinese Academy of Sciences (CAS). Two Botanical Institutes (Beijing and Kunming) also belong to the CAS, and continue to play a very important role in the development of botany in the country. Botanical research is also conducted in life sciences laboratories, 52 of which hold the prestigious title of State Key Laboratory. Public interest in botany is also growing in China. The Beijing Botanical Garden attracts over 1.4 million visitors per year, almost as many as the Royal Botanic Gardens, Kew, London (1.6 million in 2011). The 2011 International Horticultural Expo at Xi'an Shi, Shaanxi attracted over 15 million visitors during its six-month show.

Botany is an ever-changing science; the *Flora of China* represents only the current state of taxonomic knowledge about the plants of China. Indeed, the rate of taxonomic progress in China is growing at an ever-increasing rate (see Figure 1.1). Take, for example, *Volume 25* (*Orchidaceae*): this volume was published in 2009 and followed a 2003 classification (Chase *et al.*, 2003). However, a detailed new classification of the orchids—*Genera Orchidacearum* (Pridgeon *et al.*, 1999–2009)—is also nearing completion and is expected to provide a revised, contemporary taxonomy of the Chinese species (among others) of this enormous family. The authors of *Volume 25* of the *Flora of China* take care to note in their introduction that "Even when this work [*Genera Orchidacearum*] is completed, such is the speed with which new information and techniques are being developed and published, it will almost certainly require revision" (Chen *et al.*, 2009: 1). Taxonomic interest in the plants of China, from both within and outside the country, shows no sign of slowing down. With the

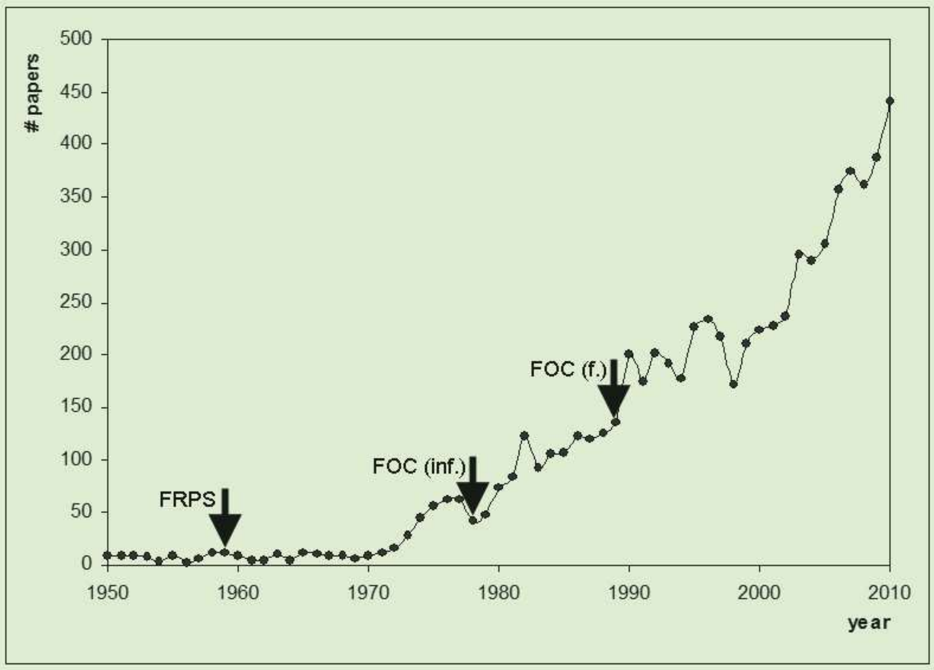

Figure 1.1 Published papers on Chinese plant taxonomy abstracted in Thomson-Reuters Web of Knowledge[SM] since 1950. Arrows indicate the initiation of *FRPS* in 1959 ("FRPS"), the informal inception of the *Flora of China* in 1979 ("FOC (inf.)") and the formal start of the *Flora of China* project in 1989 ("FOC (f.)").

completion of the *Flora of China*, Chinese scientists are now taking the lead in a new, fifty-volume *Flora of the Pan-Himalayas*, working alongside botanists from India, Japan, Nepal, the UK and USA.

1.5 *Plants of China*

Unlike the rest of the *Flora of China*, *Plants of China* was not formally co-authored by Chinese and non-Chinese authors, but was written largely by Chinese experts. It tells the story of the Chinese flora, beginning with its global significance (Chapter 2, by HUANG Hong-Wen, Director of South China Botanical Garden (SCBG), Sara Oldfield, Secretary General of BGCI and Hong Qian, Curator of Botany and Illinois State Museum). The features underlying the country's characteristic and diverse vegetation are outlined in Chapters 3 to 5: Chapter 3, by ZHENG Du of the Institute of Geographic Sciences and Natural Resources Research, CAS, covers the physical geography of this immense and varied landscape including topography, water features, and of course the enormous impact of the orogeny of the Himalaya Shan and uplift of the Qinghai-Xizang Plateau. It concludes with a new classification of China's geography–a physico-geographical regionalization. Chapter 4, by the same author, details the country's equally diverse climate including the important effect of the monsoon, and also ends with a regionalization of China on the basis of its climate. The soils of China are a product of both its geography and climate, among other factors. Their formation, classification and distribution are explained in Chapter 5, also by ZHENG Du, which concludes with a division of the country's landmass according to soil type.

Chapters 6 and 7 explain the complex and fascinating history of the Chinese flora, while Chapters 8--10 explain the nature of the present-day flora from three different viewpoints. Chapter 6, authored by ZHOU Zhe-Kun, Professor of Botany and Paleobotany at Kunming Institute of Botany (KIB), CAS, explains the origin of the Chinese flora from the very first angiosperms, detailing our knowledge of the history of all major groups of Chinese plants from the fossil record, with an interesting discussion of "living fossils" and endemic taxa. Chapter 7, by the same author, takes a detailed chronological look at the history of China's plants from the early Cretaceous Period (150 million years ago) to the present day. This brings us neatly to Chapter 8, by CHEN Ling-Zhi of the Institute of Botany, CAS (IBCAS), which gives a comprehensive description of the myriad vegetation types found in China today. Chapter 9, by PENG Hua, Professor of Botany and Curator of the Herbarium at KIB, and the late WU Cheng-Yih (WU Zheng-Yi), also of KIB, describes how the flora of China may be partitioned into elements based on distribution and affinities, while Chapter 10 by SUN Hang, Professor of Botany at KIB, outlines a classification for regions of China based on the present flora.

Chapters 11 to 14 delve into the fascinating history of botanical study in China. Chapter 11, again by PENG Hua, charts the development of indigenous knowledge about Chinese plants, over more than two millennia. Chapter 12, by HU Chi-Ming (HU Qi-Ming) of SCBG and Mark F. Watson of the Royal Botanic Garden Edinburgh, describes the history of botanical expeditions and exploration, from the foreign travelers of the eighteenth century, through the era of Chinese exploration, to recent international collaborations. Chapter 13, by HU Zong-Gang of Lushan Botanical Garden, MA Hai-Ying of KIB, MA Jin-Shuang, Professor at Shanghai Chenshan Plant Science Research Center, and HONG De-Yuan, Academician of CAS at IBCAS, charts the particular history of botanical institutions in China, and Chapter 14, by ZHANG Yu-Xiao, KIB, and LI De-Zhu, Director of KIB, explains the growth of floristic, taxonomic and systematic studies of Chinese plants, into today's molecular-phylogenetic era.

Chapters 15 to 21 give a flavor of the amazing range of uses to which the plants of China may be–and have been–put. Chapter 15, by PEI Sheng-Ji, Professor at KIB, provides an overview of the history, diversity and importance of economic plants in China. Chapter 16, by HE Shan-An of Nanjing Botanical Garden, YI Ting-Shuang of KIB, PEI Sheng-Ji and HUANG Hong-Wen, details important crop plants with an emphasis on their wild relatives still found in China, and Chapters 17 to 19 give an interesting insight into the range of plants used in forestry (by PEI Sheng-Ji, YANG Yu-Ming and WANG Juan, both of the Southwest Forestry University, Kunming Shi), medicine (by PEI Sheng-Ji and HUAI Hu-Yin of KIB's department of ethnobotany), and horticulture (by HE Shan-An and SCBG's XING Fu-Wu). Chapter 20, by YI Ting-Shuang, Peter L. Morrell of the University of Minnesota, PEI Sheng-Ji and HE Shan-An, shows us the incredible range of non-native plants that have been adopted for use by the Chinese, including many staple foods and other important species, while Chapter 21, by PEI Sheng-Ji and HU Guang-Wan from KIB, demonstrates just how widely plants are used in China–as beverages, dyes, aromatic oils, rubber, fibers and of course animal feed and forage. This chapter also touches upon novel approaches to using plants as a source of energy, a growing field in today's climate-changing world.

Around 3 000 (almost 10%) of China's plant species are endangered. The final four chapters of *Plants of China* look at some of the problems facing the flora of China, strategies that may be used to solve these, and how the future of the flora might look. Chapter 22, by LI Zhen-Yu of IBCAS, FAN Xiao-Hong of the Institute of Animal and Plant Quarantine, Chinese Academy of Inspection and Quarantine, and David E. Boufford, Senior Research Scientist at the Harvard University Herbaria, looks at the impact of non-native plants in the Chinese flora, many of which have become naturalized and in some cases invasive. Chapter 23, by HUANG Hong-Wen and Sara Oldfield, explores the potential crisis faced by extinction in the flora of China, detailing the threats to a range of plant groups from a variety of human-induced sources. Chapter 24, by HUANG Hong-Wen, Peter S. Wyse Jackson and CHEN Ling-Zhi, looks at the range of national and international strategies that have been implemented to conserve this invaluable resource, and Chapter 25, again by HUANG Hong-Wen, provides a rational but positive glimpse of how the future might pan out, providing case study examples of where the flora of China has been successfully protected for generations to come. This will be facilitated by the new *Red List of China's Plants*, the result of a major national effort headed by QIN Hai-Ning of IBCAS.

The names of the many Chinese botanists featured in this book are written in English notation using both the Hanyu Pinyin and Wade-Giles systems, depending on which has been more commonly used for each individual. Family names are capitalized to avoid confusion. Alternative transliterations for the names of many Chinese botanists are provided in Table 12.1 on pages 213–214. As much of the information in this book is historical, we hope the reader will also find it useful to refer to the Appendix showing Chinese dynasties presented on page 473. To assist with finding the geographic locations mentioned in the text, a map of Chinese provinces may be found on endpaper.

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References

Axelrod, D. I., Al-Shehbaz, I. A. & Raven, P. H. (1996). History of the modern flora of China. In: Zhang, A. L. & Wu, S. G. (eds.) *Floristic Characteristics and Diversity of East Asian Plants*. pp. 43-55. Beijing, China and Berlin, Germany: China Higher Education Press and Springer-Verlag.

Bartholomew, T. T. (2006). *Hidden Meanings in Chinese Art*. San Francisco, CA: Asian Art Museum.

Chase, M. W., Cameron, K. M., Barrett, R. L. & Freudenstein, J. V. (2003). DNA data and Orchidaceae systematics: a new phylogenetic classification. In: Dixon, K. M., Kell, S. P., Barrett, R. L. & Cribb, P. J. (eds.) *Orchid Conservation*. pp. 69-89. Kota Kinabalu: Natural History Publications.

Chen, X. Q., Liu, Z. J., Zhu, G. H., Lang, K. Y., Ji, Z. H., Luo, Y. B., Jin, X. H., Cribb, P. J., Wood, J. J., Gale, S. W., Ormerod, P., Vermeulen, J. J., Wood, H. P., Clayton, D. & Bell, A. (2009). Orchidaceae. In: Wu, Z. Y. & Raven, P. H. (eds.) *Flora of China*. St Louis, MO and Beijing, China: Missouri Botanical Garden Press and Science Press.

Hamilton, A. C. (2004). Medicinal plants, conservation and livelihoods. *Biodiversity and Conservation* 13: 1477-1517.

He, S. A. & Gu, Y. (1997). The challenge for the 21st Century for Chinese botanic gardens. In: Touchell, D. H. & Dixon, K. W. (eds.) *Conservation into the 21st Century. Proceedings of the 4th International Botanic Gardens Conservation Congress (Perth, 1995)*. pp. 21-27. Perth, Australia: Kings Park and Botanic Garden.

Heemskerk, W., Schallig, H. & de Steenhuijsen Piters, B. (2006). *The world of Artemisia in 44 questions*. Amsterdam, The Netherlands: Koninklijk Instituut voor de Tropen.

Ma, J. S. & Clemants, S. (2006). A history and overview of the *Flora Reipublicae Popularis Sinicae* (FRPS, Flora of China, Chinese Edition, 1959-2004). *Taxon* 55(2): 451-460.

Moss Flora of China Editorial Committee (1999-2011). *Moss Flora of China*. St Louis, MO and Beijing, China: Missouri Botanical Garden Press and Science Press.

Pei, S. J. (2002). A brief review of ethnobotany and its curriculum development in China. In: Shinwari, Z. K., Hamilton, A. & Khan, A. A. (eds.) *Proceedings of a Workshop on Curriculum Development in Applied Ethnobotany, Nathiagali, 2-4 May 2002*. p. 41. Lahore, Pakistan: WWF-Pakistan.

Pridgeon, A. M., Cribb, P. J., Chase, M. W. & Rasmussen, F. N. (1999-2009). *Genera Orchidacearum*. New York: Oxford University Press.

Various authors (1984-2000). *Biology and Biological Technology*. Cambridge, UK: Cambridge University Press.

Wilson, E. H. (1929). *China: Mother of Gardens*. Boston, Massachusetts: The Stratford Company.

Xiao, P. G. & Yong, P. (1998). Ethnopharmacology and research on medicinal plants in China. In: Prendergast, H. D. V., Etkin, N. L., Harris, D. R. & Houghton, P. J. (eds.) *Plants for Food and Medicine. Proceedings from a Joint Conference of the Society for Economic Botany and the International Society for Ethnopharmacology, London, 1-6 July 1996*. pp. 31-39. London, UK: Royal Botanic Gardens, Kew.

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Chapter 2

Global Significance of Plant Diversity in China

HUANG Hong-Wen
Sara Oldfield and Hong Qian

2.1 Introduction

China is ranked in the top six megadiverse countries of the world (Mittermeier *et al.*), with approximately 32 096 vascular plants (Table 2.1), more than half of these species being endemic (Liu *et al.*, 2003; eFloras, 2008). This tremendous plant diversity comprises pteridophytes (2 278 species), gymnosperms (207 species) and angiosperms (29 611 species), accounting respectively for about 17%, 21% and 10% of the world total (Table 2.1). Amongst the higher plants, 256 endemic genera and 15 000–18 000 endemic species have been recorded (Liu *et al.*, 2003; eFloras, 2008). This rich plant diversity is evolutionarily associated with an ancient geological history, complex and diverse topography and climatic variation, as shall be seen in later chapters.

The flora of China comprises living remnants of the Early Miocene flora of the entire North Temperate Region. As one of the most important centers of diversity of seed plants, China inherited components from ancient northern, Mediterranean and southern continental floras (Ministry of Environmental Protection of the People's Republic of China, 1998). This richness has also given rise to many relict lineages or "living fossils," such as *Metasequoia glyptostroboides* (Taxodiaceae), *Ginkgo biloba* (Ginkgoaceae) and *Cathaya argyrophylla* (Pinaceae).

China's flora is also renowned as the source of numerous food crops, medicinal plants and plants for ornamental horticulture. Furthermore, a long history of agriculture and crop domestication has generated an enormous amount of cultivated germplasm of useful species. This plant diversity has the potential to be of crucial importance to the whole world population, serving as a primary bioresource for livelihoods and sustainable development, as well providing the environmental services on which we depend (China's Strategy Plant Conservation Editorial Committee, 2008). However, the plant diversity of China is increasingly threatened, with an estimated 4 000–5 000 plant species categorized as threatened or endangered (Wang & Xie, 2004), a proportion ranking it as one of the highest priorities for global biodiversity conservation. Conservation of its rich and diverse flora is one of the greatest challenges facing China today.

Table 2.1 The rich diversity of vascular plants in China, dividing according to plant groups. Data for pteridophytes compiled from an updated version of the checklist *Phylum Pteridophyta* in the 2012 edition of the *Species 2000 China Node* (http://www.sp2000.cn); data for seed plants compiled from a database based on the published volumes 4-25 of the *Flora of China* (Wu *et al.*, 1994-2011), plus species that missing from the *Flora of China* or published after the relevant family treatment. Infraspecific taxa were merged into species; exotic species were excluded. Data for the world flora obtained from, but not limited to, Mabberley (2008).

Group	Number of families			Number of genera			Number of species		
	China	World	China %	China	World	China %	China	World	China %
Pteridophytes	64	71	90	221	381	58	2 278	13 025	17
Gymnosperms	10	15	66	36	79	46	207	980	21
Angiosperms	249	ca. 400	62	2 899	ca. 10 000	29	29 611	ca. 300 000	10

2.1.1 Species richness (see Table 2.1)

Pteridophytes.—The pteridophyte flora of China is impressive in terms of the number of both families (64 recorded, ca. 90% of the world total) and genera (221, 58%; Table 2.1). In terms of species, China boasts 2 278, 17% of the world total, the richest diversity of any country (see Table 2.2). In addition, six endemic genera and 500–600 endemic species have been identified in the country (Ministry of Environmental Protection of the People's Republic of China, 1998). Southwestern China is a recognized center of distribution for Asian, and world pteridophytes (Lu, 2004). As many as 2 000 species have been recorded in the four provinces of Sichuan, Guizhou, Yunnan and Guangxi, with approximately 1 500 species in Yunnan alone. This region probably serves as a center for radiative dispersal, with the number of taxa decreasing in all directions from this point. For instance, only 700 species occur on the Indochinese peninsula (Vietnam, Lao PDR and Cambodia), fewer than 640 species in Thailand, 550 species in Malaysia, 1 000 in the Philippines, 452 in Hainan, 639 in Japan, 600 in India, 430 in Australia and 420 in North America (Lu, 2004). Three pteridophyte families in China contain more than 300 species: Dryopteridaceae (13 genera and 700 species), Athyriaceae (20 genera and ca. 400 species) and Thelypteridaceae (20 genera and 300 species; Wu & Chen, 2004).

Table 2.2 Pteridophyte families with more than 50 species in China (Data from Lu, 2004; Wu & Chen, 2004).

Family	Number of species (China/World)	Number of genera (China/World)
Dryopteridaceae	700/1 000	13/14
Athyriaceae	400/500	20/20
Thelypteridaceae	300/600	20/25
Polypodiaceae	250/500	27/40
Aspleniaceae	150/700	8/10
Pteridaceae	100/400	2/11
Aspidiaceae	90/400	8/20
Hymenophyllaceae	80/700	14/34
Dennstaedtiaceae	70/150	4/9
Sinopteridaceae	60/300	9/14
Hemionitidaceae	50/110	5/17
Selaginellaceae	50/700	1/1
Total	2 300/6 060	129/215

Human disturbance, ecosystem degradation and habitat loss caused by the rapid industrialization and urbanization of China have severely threatened natural populations of many pteridophytes species over the past 30 years. Some species are in critical danger or on the brink of extinction. For example *Cystoathyrium chinense* (Cystopteridaceae), *Cyrtomium hemionitis* (Dryopteridaceae; Figure 2.1), *Trichoneuron microlepioides* (Thelypteridaceae) and *Isoetes sinensis* (Isoetaceae; Figure 2.2) are all considered extinct or possibly extinct in the wild.

Figure 2.1 *Cyrtomium hemionitis* (image courtesy YANG Ke-Ming, South China Botanical Garden).

Gymnosperms.—As a group, gymnosperms probably emerged in the Paleozoic Era and thrived during the Mesozoic and Cenozoic Eras. Today there are an estimated 17 families, 86 genera and 840 species worldwide, grouped into the four classes Cycadopsida, Ginkgoopsida, Gnetopsida and Pinopsida (Wang, 2004). Although gymnosperms account for less than 1% of seed plants, they have a wide distribution and are major components of boreal and alpine forests in the Northern Hemisphere. The gymnosperm flora of China is one of the richest in the world, including 10 families, 36 genera and 207 species (Table 2.1). Here also they make up less than 1% of the higher plant flora, but are of great ecological importance, with coniferous forests accounting for over 50% of total forest cover in China. The warm climate that persisted from the Mesozoic Era to the Cenozoic Era, and the lower impact of Quaternary glaciations here than elsewhere resulted in China being a favorable refugium, retaining a large number of ancient lineages, relict and endemic taxa that disappeared in other parts of the world. Examples include the monotypic family Ginkgoaceae and monotypic genera *Metasequoia*, *Cathaya*, *Pseudolarix* (Pinaceae), *Pseudotaxus* (Taxaceae), and many relict species of *Cycas* (Cycadaceae; Ministry of Environmental Protection of the People's

Figure 2.2 *Isoetes sinensis*. A, *I. sinensis* in natural habitat (image courtesy KANG Ming, South China Botanical Garden); B, individual *I. sinensis* (image courtesy XU Ke-Xue).

Republic of China, 1998).

Angiosperms.—There are an estimated 400 families, 10 000 genera and 300 000 species of angiosperms worldwide; China has 249 families, 2 899 genera, and 29 611 species, representing about 60%, 31% and 10%, respectively, of the world total (see Table 2.1). In the world's four largest families (Orchidaceae, Asteraceae, Fabaceae and Poaceae), each with more than 10 000 species, 7–10% occur in China. In addition, China has 60 families containing more than 100 species. These 60 largest families are widespread throughout the country, representing basic components of its flora, and encompass 19 700 species, approximately 80% of China's total seed plants (see Table 2.3). Furthermore, many genera with worldwide distributions include a large proportion of species in China (see 2.3.3, below).

Table 2.3 Angiosperm families with more than 400 species in China (eFloras, 2008).

Family	Number of Species					
	>2 000	1 500-2 000	1 000-1 500	800-1 000	500-800	400-500
Asteraceae	Y					
Fabaceae		Y				
Poaceae		Y				
Orchidaceae			Y			
Rosaceae				Y		
Lamiaceae				Y		
Ranunculaceae				Y		
Cyperaceae				Y		
Ericaceae				Y		
Scrophulariaceae					Y	
Apiaceae					Y	
Primulaceae					Y	
Rubiaceae					Y	
Saxifragaceae					Y	
Brassicaceae						Y
Euphorbiaceae						Y
Gentianaceae						Y
Gesneriaceae						Y
Lauraceae						Y

The angiosperm flora in China is renowned for three significant characteristics: the richness of vegetation and forest types, paleofloristic origin, and high endemism. These characteristics are underlined by the tremendous geographical complexity and range of climate zones (see Chapters 3 and 4), in turn responsible for a huge diversity of habitats and ecosystems supporting plant diversity. Thus China's plants range from alpine permafrost species such as *Phyllodoce caerulea* (Ericaceae) to tropical rainforest plants such as *Parashorea chinensis* (Dipterocarpaceae), from extreme xerophytes such as *Reaumuria soongarica* (Tamaricaceae) to marsh and wetland plants such as *Potamogeton* (Potamogetonaceae), from Himalayan cushion plants such as *Androsace* and *Pomatosace* (Primulaceae) to tropical mangroves such as *Bruguiera gymnorhiza* (Rhizophoraceae) from the coast of southern China. The widest spectrum of angiosperm plants is found across China's unique continuous geographic cline from tropical, subtropical and temperate to boreal forests. Each climatic zone harbors its own representative families and genera. For example, deciduous broad-leaved forests are typically represented by Betulaceae; *Quercus* (Fagaceae) mixed with Salicaceae, Caprifoliaceae and Berberidaceae is typically representative of the temperate zone; whereas evergreen forests with Lauraceae, Magnoliaceae, Theaceae and Fagaceae mixed with Hamamelidaceae, Aquifoliaceae, Araliaceae, Nyssaceae and the monotypic Cercidiphyllaceae and Tetracentraceae are typical of the subtropical zone. Similarly, tropical forests in southern China are well represented by many families including Dipterocarpaceae, Annonaceae, Burseraceae, Sapotaceae, Meliaceae, Clusiaceae, Combretaceae, Euphorbiaceae and Datiscaceae.

The richness and phylogenetic significance of the paleofloristic or primitive components of angiosperm groups–such as Magnoliaceae, Ranunculaceae, Tetracentraceae, Cercidiphyllaceae, Saururaceae, Chloranthaceae, Hamamelidaceae and Lardizabalaceae—are well accepted by the botanical community worldwide, particularly the few relict groups that are only found in China.

A high level of endemism is one of the most significant features of the angiosperm flora of China. There are estimated to be approximately 250 genera and 15 000–

18 000 species endemic to China, including many well-known plants such as *Actinidia chinensis* (Actinidiaceae), *Bretschneidera sinensis* (Bretschneideraceae)., *Cercidiphyllum japonicum* (Cercidiphyllaceae), *Helianthemum songaricum* (Cistaceae), *Euptelea pleiosperma* (Eupteleaceae), *Liriodendron chinense* (Magnoliaceae), *Tetracentron sinense* (Tetracentraceae), *Trochodendron aralioides* (Trochodendraceae), *Tetraena mongolica* (Zygophyllaceae) and *Davidia involucrata* (Nyssaceae).

Davidia involucrata (also known as the dove or handkerchief tree; Figure 2.3) is an endemic, monotypic genus, naturally occuring in central and western China. The plant was first discovered by the French missionary Père David, and named after him by the botanist Henri Ernest Baillon. It is probably the most famous of the introductions made by Ernest Wilson to the western world. The nurseryman Henry Veitch expressed an interest in obtaining seeds of the tree and commissioned the young Wilson to go to China and find it. In 1900, at Yichang, Wilson purchased a native houseboat and engaged a crew for an expedition aimed at finding *D. involucrata*. They sailed through the three gorges of the Chang Jiang to arrive in Badong, from where Wilson pursued his journey on foot through the mountains. In May 1900, while collecting in the countryside southwest of Yichang, Wilson suddenly stumbled across a *Davidia* in full flower. With its large snow-white bracts fluttering in the wind, it must have made a dramatic sight. He later wrote that it was, "the most interesting and most beautiful of the trees which grow in the North temperate regions," and described how when the flowers are "stirred by the slightest breeze they resemble huge butterflies or small doves hovering amongst the trees" (Briggs, 1993).

Figure 2.3 Flowers of *Davidia involucrata* (image courtesy HUANG Hong-Wen, South China Botanical Garden).

In China the genus *Actinidia* Lindl. is known by the name "mihoutao" (monkey peach). Throughout the rest of the world it is commonly known as the kiwifruit. *Actinidia* belongs to Actinidiaceae and contains a total of about 75 described taxa (54 species and 21 varieties). *Actinidia* is naturally centered in China but very widespread over eastern Asia, from just south of the equator to cold regions as far as 50° N, making it a constituent of both Holoarctic and Paleotropical floras. Its general pattern of distribution is typical of many Chinese genera: great diversity within China itself with outlier taxa extending to adjoining countries. Thus most *Actinidia* taxa are endemic to China. The two species found in adjoining countries are *A. strigosa* (restricted to Nepal) and *A. hypoleuca* (endemic to Japan).

Currently, commercial cultivation is based on two Chinese endemics, *A. chinensis* var. *deliciosa* and *A. chinensis* var. *chinensis*. The kiwifruit has been domesticated since only the beginning of the last century, when in 1904 *A. chinensis* (Figure 2.4) was introduced to New Zealand, and in 1930 the first kiwifruit orchard was established there. The fruit is widely favored for its unique flavor, rich vitamin C content, high levels of dietary fiber, the variety of minerals it contains, and its alternative medicinal function as an antioxidant and treatment for gastrointestinal complaints. Domestication and commercial cultivation of kiwifruit is considered one of the most successful examples of plant domestication of endemic Chinese plants in the twentieth century.

Figure 2.4 Fruits of *Actinidia* (image courtesy New Zealand Institute for Plant and Food Research Ltd).

In China, three regions have been recognized as centers of distribution for endemic genera: eastern Sichuan (including Chongqing Shi), western Hubei and northwestern Hunan; western Sichuan and northwestern Yunnan; and southeastern Yunnan and western Guizhou. The area of eastern Sichuan, western Hubei and northwestern Hunan harbors 82 endemic genera in 46 families, including 39 monotypic genera, 31 oligotypic genera and 12 larger genera. The most impressive center is that of western Sichuan and northwestern Yunnan, with a total of 101 endemic genera in 47 families, including 51 monotypic, 35 oligotypic and 15 larger genera. Southeastern Yunnan and western Guizhou contains 56 endemic genera in 36 families, with 32 monotypic, 17 oligotypic and seven larger genera. Although some of the endemic genera overlap in distribution across two or three of these centers, each center contains 23–30 genera unique only to that area.