



中国柑橘产业

CITRUS INDUSTRY IN CHINA

中国柑橘学会 编著



Compiled by the Chinese Society of Citriculture

中国农业出版社

China Agriculture Press

中国柑橘产业

Citrus Industry in China

中国柑橘学会 编著

Compiled by the Chinese Society of Citriculture



中国农业出版社
China Agriculture Press

图书在版编目 (CIP) 数据

中国柑橘产业/中国柑橘学会编著. —北京: 中国农业出版社, 2008.9

ISBN 978-7-109-12882-8

I. 中… II. 中… III. ①柑桔类果树-农业经济-经济发展-研究-中国 ②柑桔类果树-果树园艺-中国
IV. F326.13 S 666

中国版本图书馆CIP数据核字 (2008) 第123779号

中国农业出版社出版
(北京市朝阳区农展馆北路2号)
(邮政编码 100125)
责任编辑 张 利

中国农业出版社印刷厂印刷 新华书店北京发行所发行
2008年10月第1版 2008年10月北京第1次印刷

开本: 787mm×1092mm 1/16 印张: 6

字数: 143千字

定价: 60.00元

(凡本版图书出现印刷、装订错误, 请向出版社发行部调换)

编写牵头人员 徐建国 陈力耕 邓秀新

Coordinators XU Jianguo, CHEN Ligeng and DENG Xiuxin

编写人员 (按姓氏拼音排序)

Contributors (List alphabetically)

陈力耕 浙江杭州, 浙江大学农业与生物技术学院

CHEN Ligeng College of Agriculture and Biotechnology,
Zhejiang University, Hangzhou, Zhejiang

邓秀新 湖北武汉, 华中农业大学园艺林学学院

DENG Xiuxin College of Horticulture and Forestry,
Huazhong Agricultural University, Wuhan, Hubei

邓子牛 湖南长沙, 湖南农业大学园艺园林学院

DENG Ziniu Horticulture and Landscape College, Hunan
Agricultural University, Changsha, Hunan

雷慧德 重庆北碚, 中国农业科学院柑橘研究所

LEI Huide Citrus Research Institute, CAAS, Beibei,
Chongqing

龙桂友 湖南长沙, 湖南农业大学园艺园林学院

LONG Guiyou Horticulture and Landscape College, Hunan
Agricultural University, Changsha, Hunan

彭良志 重庆北碚, 中国农业科学院柑橘研究所

PENG Liangzhi Citrus Research Institute, CAAS, Beibei,
Chongqing

祁春节 湖北武汉, 华中农业大学经济管理学院

QI Chunjie College of Economy Management, Huazhong
Agricultural University, Wuhan, Hubei

吴厚玖 重庆北碚, 中国农业科学院柑橘研究所

WU Houjiu Citrus Research Institute, CAAS, Beibei,
Chongqing





徐建国 浙江黄岩, 浙江省柑橘研究所

XU Jianguo Citrus Research Institute of Zhejiang Province, Huangyan, Zhejiang

赵学源 重庆北碚, 中国农业科学院柑橘研究所

ZHAO Xueyuan Citrus Research Institute, CAAS, Beibei, Chongqing

钟广炎 重庆北碚, 中国农业科学院柑橘研究所

ZHONG Guangyan Citrus Research Institute, CAAS, Beibei, Chongqing

周常勇 重庆北碚, 中国农业科学院柑橘研究所

ZHOU Changyong Citrus Research Institute, CAAS, Beibei, Chongqing

翻译 管睿 湖北武汉, 华中农业大学园艺林学学院

Translation **GUAN Rui** College of Horticulture and Forestry, Huazhong Agricultural University, Wuhan, Hubei

校对 徐强 邓秀新 湖北武汉, 华中农业大学园艺林学学院

Translation Correction **XU Qiang and DENG Xiuxin** College of Horticulture and Forestry, Huazhong Agricultural University, Wuhan, Hubei

目 录

Contents

- 1 中国柑橘栽培历史和起源 (钟广炎) 7
Cultivation History and Origin of Citrus in China
(by Zhong Guangyan)
- 2 柑橘产业现状 (徐建国, 邓秀新) 17
Current Status of Citrus Industry in China (by Xu Jianguo and Deng Xiuxin)
- 3 柑橘品种、砧木与遗传育种 (陈力耕, 徐建国) 25
Citrus Cultivars, Rootstocks and Genetic Breeding
(by Chen Ligeng and Xu Jianguo)
- 4 栽培措施 (彭良志) 37
Cultivation Practices for Citrus (by Peng Liangzhi)
- 5 病虫害及防治 (周常勇, 赵学源, 雷慧德) 47
Diseases, Pests and Their Control (by Zhou Changyong, Zhao Xueyuan and Lei Huide)
- 6 采后处理与加工利用 (吴厚玖) 59
Postharvest, Processing and Utilization (by Wu Houjiu)
- 7 市场与贸易 (祁春节) 65
Citrus Marketing and Trade (by Qi Chunjie)
- 8 产业组织和管理 (徐建国) 75
Organizations and Management of Citrus Industry
(by Xu Jianguo)
- 9 柑橘科学研究与推广 (邓子牛, 龙桂友) 81
Citrus Scientific Researches and Extension
(by Deng Ziniu and Long Guiyou)
- 10 展望 (邓秀新) 93
Prospects of Citrus Industry in China (by Deng Xiuxin)



CONTENTS



1 中国柑橘栽培历史和起源

Cultivation History and Origin of Citrus in China



1.1 中国柑橘栽培历史

History of Citriculture in China



橘柚锡贡图

Mandarins and pummelos as tributes to the Emperor

中国柑橘栽培历史有文献记载的可追溯到4 000多年前,柑橘最早出现在《禹贡》一书中,书载“橘”和“柚”被列为夏代(约公元前21世纪)大禹王的贡品。在记载公元前2000—前1000年我国古代地理、历史和神话传说的《山海经》中提到了荆山地区(可能是现在的湖北和湖南北部地区)产橘柚。成书于公元前500—前300年间的《周书》记载了秋食橘柚的习俗。公元前400年庄周所写的《庄子》赞誉了橘柚的美味。韩非在《韩非子》(公元前300年)中说,“夫树橘柚者,食之则甘,嗅之则香;树枳棘者,成而刺人。故君子慎所树。”公元前300年吕不韦在《吕氏春秋》中载“果之美者……江浦之橘,云梦之柚。”让人感兴趣的是公元前3世纪《周礼》记有:“橘逾淮而北为枳,此地气然也”。屈原在他年轻时的作品《九章》中花了一章写就“橘颂”来歌颂柑橘,首创借物咏志之写作手法。自此之后,柑橘就被识作高雅之象征,时常在诗歌和散文中成为歌咏对象。

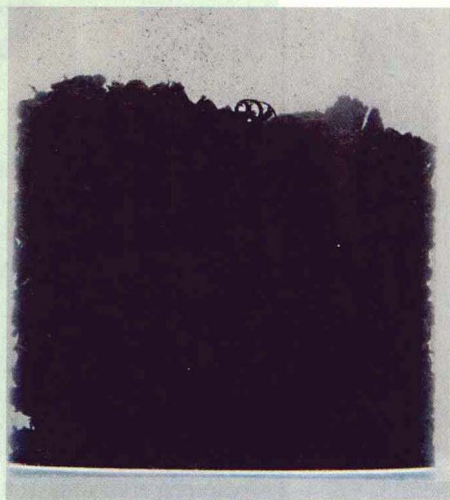
The history of citriculture in China could trace back to 4 000 years ago when citrus fruit first appeared in the book of “Yu Gong” in which mandarins and pummelos were listed as tributes to the Emperor Da Yu who ruled the country in the Xia Dynasty (about 21st century B.C.). Mandarins and pummelos were mentioned as characteristic plants growing in Jingshan region (probably nowadays Hubei and northern Hunan) in “Shan Hai Jing”, a book recording the geography, history and legends of ancient China between 1000 B.C. and 2000 B.C.. It was also recorded in “Zhou Shu”, a historical book written between 500 B.C. and 300 B.C., that people have a custom of eating mandarins and pummelos in autumn season. The delicious taste of mandarins and pummelos was appreciated in “Zhuang Zi”, written by Zhuang Zhou in 400 B.C. Han Fei (300 B.C.), in his book “Han Fei Zi”, wrote, “A gentleman must be prudent in choosing what kind of trees to grow; Mandarins and pummelos will taste sweet and

smell fragrant while trifoliate orange will develop harmful thorns". Lu Buwei said in his book "Lu Shi Chun Qiu" (300 B.C.) that "the best fruits were mandarins from Jiangpu (place name) and pummelos from Yunmeng (place name)". Interestingly, the book called "Zhou Li", written in 300 B.C., noted that the mandarins grown in the South of Huai river were mandarins while those grown in the North of this river turned out to be trifoliate orange, and the differences were due to the different soil and climate conditions. Qu Yuan, a famous poet of 339 B.C.–278 B.C., dedicated a whole chapter called "Ju Song" in the poetry "Jiu Zhang" to eulogize citrus, and created a literary style of using plants or other objects to express the author's inner most emotion. Since then, citrus plants have been considered as the symbol of elegance and praised frequently in poem and prose.

从上述古文献中，我们得知中国商业栽培柑橘始于 2 500 年前，这是因为柑橘的经济价值在那时已广为人知。著名的历史学家司马迁在他的巨著《史记》中记载“……蜀汉江陵千树橘……此其人皆与千户侯等”以及“楚必致橘柚之园”。据载，汉末丹阳太守李衡遗留家人千株橘树并嘱儿曰：“吾州里有千头木奴……亦当足用尔。”

From the above cited ancient literatures, we know that the commercial citrus production began in China at least 2 500 years ago, because the economic value of citrus was widely recognized at that time. The famous historian Sima Qian in his masterpiece book "Shi Ji" recorded that the farmers who grew a thousand orange trees were as rich as the officials who governed one thousand families, and that the citrus production would develop quickly in Hubei and Hunan provinces. It was written that in the late Han dynasty, Li Heng, the Mayor of Danyang county, left his family with more than 1 000 citrus trees and told his son that "the 1 000 trees should be enough for you to make a living" before his death.

马王堆发现的柑橘种子
Citrus seeds were found at "Ma Wang Dui Tomb"



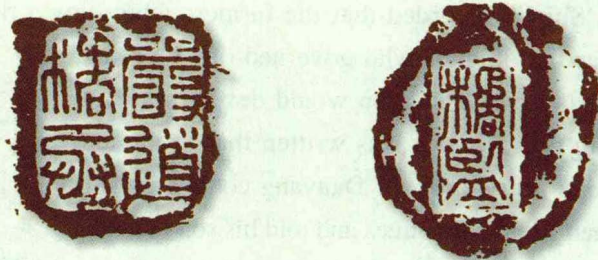
有关 2 000 多年前作为主要作物的柑橘果树的重要性的文献记载，在 1970 年代意外获得了考古学证据的支持。考古学家在湖南长沙市深埋的墓冢（马王堆汉墓）中发现了一具保存完好的贵族女尸，并在她大量的陪葬品中发现了柑橘种子。在湖北出土的另一具男性尸体的汉墓中发现了干香橙皮。

The literature description on the importance of citrus fruit as a major crop 2 000 years ago was supported by two

pieces of archeological evidence obtained accidentally in 1970s. In a deeply buried tomb called “Ma Wang Dui Tomb of Han Dynasty (200 B.C.)” which located in Changsha, Hunan Province, archeologists found that a female body from a noble family remained intact like the freshly deceased inside the coffin, and that there were citrus seeds among her numerous funeral objects. In another Han Dynasty tomb with an un-rotten male body, excavated in Hubei Province, dried Xiangcheng (*Citrus junos*) peel was also found.

随着时间推移到汉晋，柑橘的经济栽培发展到了一个新的水平。东汉时期还设置了橘官来管理贡橘事宜，一本描述公元 300—400 年间四川繁荣景象的古书中载“户有橘柚之园”。在《晋令》(300 年)中记载阆中有专收橘税的税官。南朝梁任昉在《述异记》还述及有称为“橘籍”的专门种植橘树的农户。

As time passed by, citrus cultivation gradually reached a higher level in the Han and Jin Dynasties. During the East Han Dynasty, the government even appointed citrus official to be in charge of tribute of citrus fruit to the emperor. The statement in an ancient book describing the prosperity of Sichuan at the time of 300—400 A.D. was “every family has citrus orchard”. Even revenueur was appointed specially to collect citrus tax as recorded in book “Jin Ling”(300 A.D.). In Nan Chao Dynasty Liang Renfang recorded in his book “Shu Yi Ji” that there were farmers called “Citrus growers” who grew only citrus.



汉代橘官封泥——严道橘丞、橘监
Official sealing clay of citrus manager in the Han Dynasty

《南方草木状》(304 年)中有商业性柑橘害虫生物防治的记载，说的是交趾有人连巢将黄猄蚁卖给橘农，并强调说“若无此蚁，则其(柑橘)实皆为群蠹所伤，无复一完者矣。”看来此法被一直有效的沿用下来，因为后世许多书如清初《广东新语》等中有同样的描述。

The first record on the commercial use of biological control of citrus pests appeared in “Nan Fang Cao Mu Zhuang” (304 A.D.), where the author described that the red tree ants (*Oecophylla smaragdina*) were sold with their nest to control citrus

pests in Jiao Zhi (nowadays Guangdong) and stressed that all citrus fruit would be destroyed by pests without such ants. It seems that the method has been effectively used since that time because many later books such as “Guangdong Xin Yu” (early Qing Dynasty) described the same method.

唐宋时期，许多省份出现了大橘园，柑橘已成为极其重要的商品。橘园管理方法、品种等在诸如《新唐书》、《图经本草》、《橘录》等书籍中大量记载。三卷本巨著《橘录》是韩彦直在 1178 年所著的世界第一本柑橘专著，其第一和第二卷描述了 27 个柑、橘、橙、酸橙、枸橼、枳、金柑品种，第三卷共 9 章分别描述了砧木、嫁接、土壤和水管理、病虫害以及采后处理等栽培方法，此书证明了宋朝的柑橘栽培已达到很高的技术水平。

During the Tang and Song Dynasties, large citrus orchards appeared in many provinces, and citrus fruits became very important commodities. Orchard management measures were recorded and cultivars were documented in many books such as “Xin Tang Shu” (1060 A.D.), “Tu Jing Ben Cao” or flora of herbs (1061 A.D.), and “Ju Lu”. The three-volume book “Ju Lu” was the first monograph on citrus and was written by Han Yanzhi in 1178 A.D. The first and the second volume of the book described 27 citrus cultivars of mandarins, oranges, sour oranges, citron, trifoliolate orange, and kumquats. The third volume with 9 chapters described the cultivation methods including rootstock preparation, scion grafting, soil and water management, pest and disease control and postharvest handling etc. This book demonstrated that the citrus cultivation in the Song Dynasty reached a very high technical level.

宋朝以后，柑橘栽培著作越来越多，反映了柑橘栽培获得了更进一步的发展。然而，过去的数百年间，柑橘发展总体上步履缓慢。虽然现在中国的柑橘生产位居世界第二位，但中国柑橘业的真正快速发展尚不过 30 年。

More and more books on citriculture appeared after the Song Dynasty, reflecting the fact that citrus cultivation had achieved further development. However, the citrus production did not grow too much during the past several hundred years. Although China is the second largest citrus producer in the world today, the truly rapid development of citrus industry in China has lasted no more than 30 years.

1.2 柑橘的起源

Origin of Citrus in China

无疑具有 4 000 余年栽培史的橘柚起源于中国，因为古人不太可能在





江西省崇义野橘
Wild mandarin at Chongyi,
Jiangxi Province

交通原始、地理隔离的情况下从国外引进它们。但是，原始立花橘 (*Citrus tachibana*) 和印度酸橘 (*C. cleopatra*) 分别源自中国台湾和印度的事实对宽皮橘起源于中国大陆的论点提出了疑问，直到 1970 年代，此疑问才因在湖南发现了非常原始的野生宽皮橘而得以澄清。此后，江西、广东等省也发现了原始的宽皮橘。据我们的调查和 DNA 标记分析，来自中国各地的宽皮橘资源中存在着广泛的遗传多样性。可以推断在湘西、黔东及重庆等地仍然存在着大量未发现的宽皮橘资源。根据这些事实，我们可以有把握地认为中国是宽皮柑橘最重要的起源和进化中心。

Undoubtedly, mandarins and pummelos with a 4 000-year history of cultivation were originated in China since it was unlikely that the ancient Chinese introduced them from abroad considering the primitive transportation tools and geological isolation. However, the fact that the primitive mandarins *C. tachibana* and *C. cleopatra* were originally found in Taiwan Province, China, and India, respectively, cast doubt on the assumption that China was the origin center of mandarins. The doubt was not cleared until 1970s when very primitive wild mandarin communities were found in Hunan Province. Later on, different primitive mandarins were also discovered in Jiangxi and Guangdong. Based on our investigation and DNA marker analysis, genetic diversities among mandarin germplasms from various regions of

China are tremendous. We estimate that there are still many undiscovered mandarin germplasm in areas of western Hunan, eastern Guizhou and Chongqing. Taken these together, we can conclude with confidence that China is the most important origin and evolution center for mandarins.

汉字“甘（柑）”（甜橙及其与宽皮橘的杂种）和“橙（甜橙）”首见于《上林赋》（司马相如，公元前179—前117）中，表明甜橙在中国的栽培历史已逾2100年。有意思的是包括司马相如在内的几位作者均提到了“栌橘（甘栌）”，其果实在早春返青，夏季成熟，有些作者描述其果大如拳、皮厚、成熟后味极美，很像现今的伏令夏橙，但也有作者说其果很小，9月结果，表明可能是金柑。更有可能是古人把返青夏熟的柑橘都叫栌橘。

The Chinese character “Gan” (means sweet orange or its hybrids with mandarins) and “Cheng” (means sweet oranges) appeared in “Shang Lin Fu” (author: Sima Xiangru, 179 B.C.–117 B.C.), indicating that the sweet oranges have been cultivated in China for more than 2100 years. Interestingly, a summer orange called “Lu Ju”, whose fruits re-greened in early spring and matured in summer, was referred by several authors including



300 多年生野生橘柚
More than 300 years old wild tangelo



Sima Xiangru; of them some described that its fruits were fist-sized, with thick peel and very delicious after maturation which sounded like nowadays Valencia orange, whereas some others said that its fruits were very small and sour and set fruit in lunar September, indicating it was a kind of kumquats. Most probably, the ancients named all summer maturing citrus as “Lu Ju” to indicate the re-greening of the fruit.

尽管“柚”自夏以来就已为人所知，但迄今未有野生柚存在于中国的证据。中国人都对柚子有由衷的喜爱，尽管柚子果实剥皮困难，这也许反映了中国传统饮食文化的长期影响。从中国各地收集的柚子资源中观察到的广泛的遗传多样性似乎表明，除了单胚特性，它们经历了漫长的进化历程。

Although the pummelo has been famous since Xia Dynasty, no evidence for the existence of wild pummelo in China has been found so far. Interestingly, most Chinese have a warmly love for pummelos despite of the difficulty in peeling the fruit, which may reflect a long-term influence of Chinese dietary tradition and food culture. The extensive genetic diversities observed among the pummelo germplasm collected from China may indicate that they have had a long journey of evolution in addition to its mono-embryonic nature.

香橙仍然可在长江流域发现。虽然有些香橙被引到日本并在那里作为香料原料和食品风味剂使用，但在中国基本没有香橙的商业化栽培。古代中国人也用香橙皮制酱（见《风俗通》，2世纪末）、用香橙果作香料（见《橘录》）。最近发现一个叫“软枝香橙”的香橙品种高度耐碱，已成为土壤pH较高时的备选柑橘砧木。

Xiangcheng (*C. junos*) can still be found along the Yangtze River. Although some Xiangcheng varieties were introduced to Japan and used there as ingredients of perfumes and food additive, they have few commercial cultivation in China. The ancient Chinese also used Xiangcheng peel to make sauce as recorded in “Feng Su Tong” (late of the 2nd century) and the fruit as spice as recorded in “Ju Lu”. Recently, a Xiangcheng variety called “soft branch Xiangcheng” has been found to be highly tolerant to alkaline soils and has been chosen as an candidate rootstock where high soil pH is a problem for growing citrus.

枸橼最早出现在东汉杨孚（约公元50—150年）所著文献《异物志》中。嵇含于304年所著《南方草木状》中有女工用枸橼果实竞雕镂花鸟，渍以蜂蜜，点燕坛，巧丽妙绝，无与为比；以及在太康五年（284年），大秦贡十缶枸橼果实等描述。大秦应该是靠近地中海的国家，但确切位置不可考。佛手的文献见



于晚唐。由此看来，古文献中的枸橼不属中国起源。但是在云南我们已经发现了野生枸橼的广泛分布。

The earliest appearance of Citron (*C. medica*) in Chinese literature was in the book “Yi Wu Zhi” written by Yang Fu in the East Han Dynasty (50–150 A.D.). The book “Nan Fang Cao Mu Zhuang”(The flora in the south), written by Ji Han in the year 304, described that the citron fruit was carved with graph of flowers and birds by female workers and then pickled in honey before being consumed, and Da Qin brought 10 fu (probably around 1 200 liters) of citron fruit as tribute to the emperor in year of 284. Da Qin should be a foreign country somewhere close to the Mediterranean Sea but its exact location is unclear. Fingered citron (*C. medica* var. *sarcodactylus*) appeared in literature in the late Tang Dynasty (about 1 100 years ago). It appears that the citrons described in the literatures were not originated in China, although we have found that wild citron and citron-like fruits distribute widely in Yunnan Province.

有关金柑的首次描述出现在张华 1 700 年前所著的《博物志》中，书中载成都、广都、郫、繁、江原、临邛六县生金橘，……夏秋冬或华或实，大如櫻桃，小者或如弹丸。更翔实的记载出现在韩彦直 1178 年所撰的《橘录》中。无疑，金柑各种均起源于中国，因为直到现在仍然能在江西、浙江、湖南和海南各省野外发现所有已知金柑种类。

The first description about kumquats was found in the book “Bo Wu Zhi” written by Zhang Hua 1 700 years ago, where he claimed that the golden oranges growing in the counties of Chengdu, Guangdu, Pi, Fan, Jiangyuan, Linqiong, and etc. in Sichuan province blossomed or fruited in summer, autumn and winter, and that the big fruit was as big as a cherry fruit while the small one was similar to a pellet. More detailed description were made by Han Yanzhi in his “Ju Lu” in 1178 A.D. Doubtlessly, kumquat species are all native to China since wild kumquats of almost all known species can be found today in Jiangxi, Zhejiang, Hunan and Hainan provinces.

枳实被中医广泛用来作药，这得归因于其果实的随手可得，因为枳广泛分布于华中和华南地区。汉字“枳”首先出现在《山海经》中。从前述可知古人显然知道枳是一种柑橘类植物。枳是唯一落叶、抗寒性强的柑橘。由于具有抗寒、抗衰老和其他人们非常期望的优异园艺学性状，枳现在是非常重要的砧木和砧木育种亲本。野生的枳仍在其大部分原生地存在，在生长习性、植物学性状和抗性上表现出高度的变异性。枳资源中的一个极端例子是新近在云南发现的具有常绿叶片的富民枳，富民枳是真种还是杂种仍有争论。



The fruit of trifoliolate orange was extensively used as an ingredient of herb medicine by traditional Chinese medical practitioner owing to its high availability, and widely distribution in almost everywhere in central and southern China. The Chinese character “Zhi” for trifoliolate orange first appeared in the book “Shan Hai Jing”. Apparently the ancient Chinese knew that the trifoliolate orange was a kind of citrus plants as mentioned above. Trifoliolate orange is the only deciduous and the most cold-hardy citrus. It is now not only a very important rootstock but also a breeding parent for hybrid rootstock varieties due to its highly appreciated and most desirable traits such as cold-tolerance, citrus tristeza virus resistance and excellent horticultural traits. Wild trifoliolate oranges are still growing mostly in places of its origin and exhibit a very high degree of variations in growth habit, botanical characteristics and stress resistance. One extreme instance among the trifoliolate orange germplasm is the relatively newly found trifoliolate orange, Fuminzhi, which was firstly discovered in Yunnan Province for its ever-green trait. Whether Fuminzhi is a genuine trifoliolate orange or just a hybrid is still disputable.

一些大翼橙原产中国。分布最广泛的大翼橙是宜昌橙，见于甘肃、湖北、湖南、广西、贵州、四川、云南等地，已发现宜昌橙在果实、种子、叶片的大小、花色及其他形态特征方面存在着变异。红河大翼橙是1970年代在云南红河发现的，其分布区域狭窄，他省尚未见到。马蜂柑在云南省也有野生分布。

Some papeda oranges are also native to China. The most widely distributed papeda oranges are Yichang Cheng (*C. ichangensis*), which can be found in Gansu, Hubei, Hunan, Guangxi, Guizhou, Sichuan and Yunnan provinces. Variations in fruit, seed, leaf size, flower color and other morphological traits have been observed. Honghe papeda (*C. hongheensis*) was found in Honghe, Yunnan Province in 1970s, which is a narrowly distributed citrus species and has not been found in other provinces. Mafeng Gan (*C. hystrix*) is also distributed wildly in Yunnan Province.