外来杂草薇甘菊的入侵生态及其治理

THE INVASION ECOLOGY AND MANAGEMENT OF ALIEN WEED *MIKANIA MICRANTHA* H.B.K.

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内 容 简 介

薇甘菊于1884年以前就已被引入香港动植物公园，后于20世纪80年代在华南沿海地区广泛而迅速地扩散，对农林业生态系统造成了极大破坏。本书作者对薇甘菊的生态生物学特性、分布、扩散、危害及治理等方面进行了深入研究，提出并应用森草净化学防除薇甘菊，通过群落改造以及用菟丝子控制薇甘菊，引进艳阿珍蝶和筛选出紫红短须螨治理薇甘菊等技术，提出了薇甘菊化学防除、生物防治、生态控制的新理论和新方法，并对生物入侵、生态安全、外来种综合治理等相关问题进行了探讨。本书作为研究治理外来入侵种的个案，将为我国其它外来入侵种的综合治理提供重要依据。

本书可供生态学、植物学、林学和环境科学等相关科技人员、高等院校师生参考，亦可供农林、自然保护、政府机构等有关管理人员以及生态学爱好者参阅。

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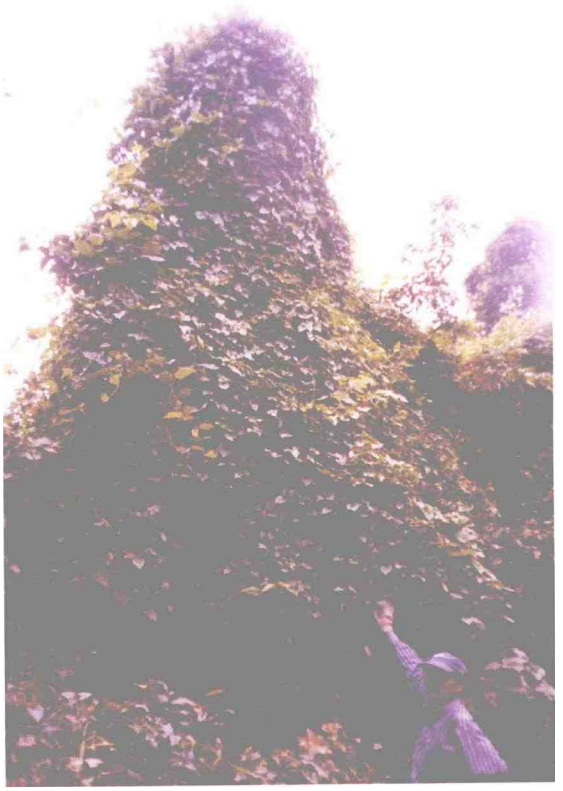

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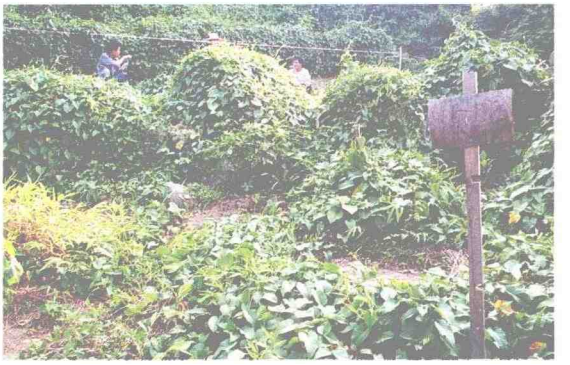

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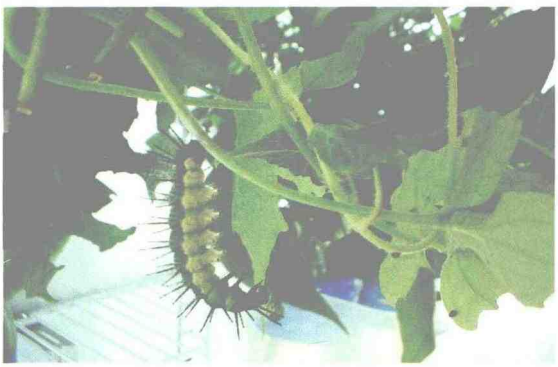

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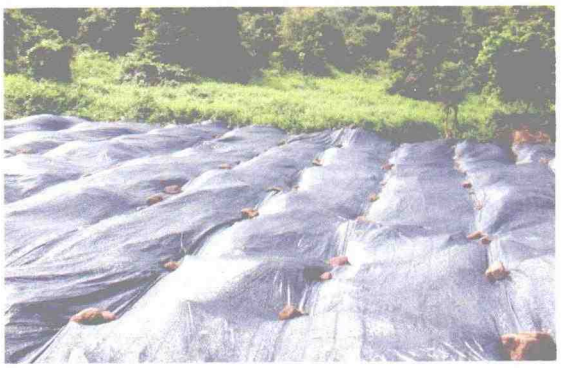

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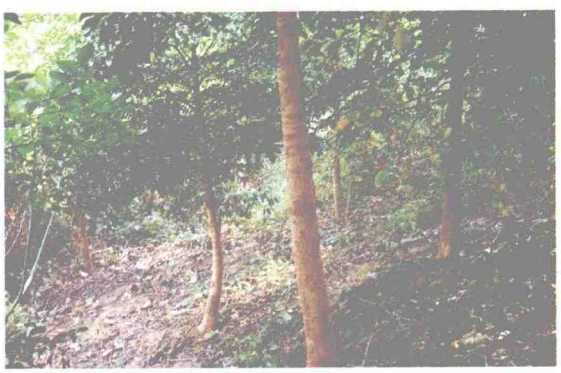

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前　言

外来种与生物入侵已是一种普遍现象，古生态学证据阐明，外来种入侵本质上与本地植物的集合和迁移没有什么不同，二者都在持续地流通。入侵在进化和生态时间上始终存在着，自然入侵的历史与地球上的第一生命同源，对地球的生物分布与进化产生深远影响。但近代的外来种和生物入侵却大都源于人类活动，现今科技的发展和交通的便利，使得人为的外来种和生物入侵在数量和范围上更为空前。生物入侵所造成的巨大经济损失以及对生态系统稳定性和物种生存的自然平衡造成的破坏和长期威胁，成为越来越引起政界、科学界及社会公众所关注的生态学问题。

20 世纪 50 年代，人们意识到化学污染对环境和生物的巨大影响，以及对人类健康的巨大威胁，而 90 年代生物入侵成为人们所要面对的另一巨大威胁，入侵外来种的传播、定居、适应新环境后的增殖、扩散、暴发和危害，构成了比化学污染更具威胁的生物污染。

现在，世界各地植物外来种入侵已成为十分普遍的现象，如美国已有 2000 多种外来种，每天有 66600 英亩（1 英亩=4047m^2）的土地受到外来植物的入侵。据不完全统计，我国已列入的外来植物已近千余种，其中构成生物入侵的就达 80 余种，每年平均发现一种病虫或杂草从国外传入。植物外来种中入侵性最强的物种就像野火一样，既可侵入受干扰的生态系统，也可以入侵自然生态系统，由于受干扰的生态系统里竞争减少，外来种更加容易入侵成功。薇甘菊 *Mikania micrantha* 即是一典型事例。

薇甘菊属菊科植物，原产于中、南美洲，在原产地并非有害生物，在其他地区则成为入侵性极强的外来种。它繁殖力强，尤其是营养繁殖，其茎节能够发根，每节叶腋都可以生长出一个新枝，而侧枝与主枝一样，生命力强，可以扩展出新根的枝叶系统，形成新的植株；它适应性强，生长迅速，故有

“一分钟一英里杂草（mile-a-minute-weed）”之称。它攀援和缠绕在其他植物体上，覆盖重压在植冠层上，影响其下被覆盖植物的生长发育，甚至导致死亡，被认为是世界十大有害杂草之一，或被称为“植物杀手”。

薇甘菊在我国最早的记录是1884年采自香港动植物公园作为观赏植物而栽培的植物标本。20世纪初期逸生于该公园附近，60年代初期已扩散远至香港大屿山等地，80年代扩散至广东深圳，90年代末蔓延到珠江三角洲地区，并继续向周边地区扩展、暴发而成为外来入侵种，严重危害本地种及生态环境，引起政府、学者和民众的极度关注，从而掀起薇甘菊研究和防治的热潮。

为此，广东省和深圳市有关部门先后立题“外来恶草薇甘菊的综合防治”和“农林杂草薇甘菊的生物学特性及防治对策”，对薇甘菊的生物学特性及其综合防治进行研究，由广东内伶仃福田国家级自然保护区管理局、中山大学生命科学学院及生物防治国家重点实验室、广东省昆虫研究所、广东省林业科学研究院等单位的科学工作者组成课题组承担该项任务，经过两年多的努力已取得丰硕成果，在此基础上出版《外来杂草薇甘菊的入侵生态及其治理》专著。

本专著是依据生态学原理，从种群学入手深入全面地研究了薇甘菊的生物学和生态学特性、入侵的生态进程和入侵机理，揭示其动态规律和调控机制；应用森草净防除、菟丝子控制、引进和筛选天敌以及生态恢复等综合治理薇甘菊的新途径和新理论。探讨外来种、入侵种、生物入侵、生态安全和综合防治等相关的概念和内涵，提出了新的见解和观点。进而定义了入侵生物学和入侵生态学，提出了学科体系的框架。本专著难免有不足之处，而一些新的方法和新的论点也不一定完全确切或尚待进一步论证和探讨。然而，专著的出版旨在抛砖引玉，以期深化对外来种与生物入侵的研究。

著者

2004年3月12日

Abstract

Alien species and their invasion occur worldwide and become one of the most serious ecological and economical problems. As international trade and travel increase, more alien species had been brought into China. Based on the statistic up to 1970 there were 837 alien plant species belonging to 267 families had been introduced to China. Among them, more than 120 species had caused negative impacts. No exact data on how many alien animal species were in China so far. It was estimated that every year one pathogen or weed entered China from abroad since 1985.

An invasive species is certainly an alien species. It should be noted, however, an alien species becomes an invasive one only when the alien species aggregates, propagates, out competes other species and exerts damaging impacts on economy, environmental, and or human health.

Scientists defined *biological invasion* somewhat differently. We defined it *alien species establishes, propagates, spreads and causes damages.* The ecological process of biological invasion includes: introduction, dissemination, establishment, aggregation, expansion, and finally occupying a large area in high density. And we defined *Invasion Ecology "a scientific discipline of studying the ecological characteristic of invasive species and its relationship to native species and native community and habitat".*

Biological invasion changed the original geographical distribution of species and the structure and function of natural ecosystem. Thus posed severe impacts on environment, biodiversity and the stability of nature balance. It was estimated that biological invasion had caused several hundred billions US dollars loss every year globally.

It was believed that predicting and preventing invasion were far more efficient than controlling after damages occurred. Some frameworks, hypothesis and models had been proposed in this regard. Synthetic control or integrated pest management aimed to take advantage of nature processes to manage invasive species. A systematic measure of cross disciplines is certainly needed to effectively manage invasive species.

The invasion of a species might bring environmental catastrophic. Therefore, it is crucial to manage the problem at national ecological security level. To stop the chance of invasion from its source, it is necessary to establish related regulations and laws, arise public awareness and strengthen quarantine.

Mikania micrantha H. B. K. is a slightly woody vine species of Asteraceae, native to tropical America. In China, *M. micrantha* flowers in autumn and winter. The capitulum of *M. micrantha* is only 5.3—6.0 mm long with a diameter of 1.3—2.0 mm. Each capitulum usually has 4 florets. In 0.25m^2, there are 34137—50297 capitulums with 136584—201188 florets. The seed was only 1.2—2.2 mm long and 0.2—0.5 mm wide.

In Neilingding Island, *M. micrantha* had a fast vegetative grow from March to August, flowering from September to October, and fruiting from November to February in the following year. The production of seed closely related to the environment. Production was higher where light was stronger. With plenty of sunlight, water and fertile soil, *M. micrantha* that grew from a seed would be able to flower at the end of the year.

Laboratory experiment indicated that seed germinated best, 83.3%, at 25—30 ℃, decline to 42.3% at 15℃ and 1.0% at 40℃. Seedling grew slowly at the beginning, only 1.1cm for 30d after germination. Investigation showed that vegetative propagation grew much faster than growing from seedling.

Climbing stems grew faster than creeping stems, indicating the light demanding of *M. micrantha.* And creeping stem would start to climb when there was a support. At the time when *M. micrantha* grew fast, the growing main stems extended 3—4 cm a day, and develop a new node every 2 days. The fast growing of climbing stems is one of the characteristics that caused a lot of damage. Each node had two bud primodiums. The primodiums are able to develop into either adventitious root, shoot or florecense. The net photosysthesis rate is 21.56 ± 13.2 μ mol CO_2 $m^{-2}s^{-1}$, less than *Miscanthus floridulus* (33.77 ± 6.4) and *Bidens bipinnata* (24.32 ± 0.9) but much higher than *Pueraria lobata* (16.97 ± 3.00) and *Ipomoea cairica* (14.55 ± 2.57) . The net photosysthesis rate of leave decreased from the far end of the shoot toward the root. Shaded leaves were easy to fall off instead of wasting a lot of resources for respiration. In the shade, however, when light intensity was as low as 35 μ mol $m^{-2}s^{-1}$, the leave still had net photosysthesis rate of 0.8 μ mol $m^{-2}s^{-1}$, indicating that *M. micrantha* was able to utilize weak light. Data indicated that under strong light condition more substance was used in root structure while more substance was use in above ground structure under low light condition. The height of seedlings, length of nodes are significantly different under strong and low light condition, while no significant different between ratio of stem/stem biomass and ratio of leaf area/leaf biomass, respectively.

Seed bank investigation indicated that the seed of *M. micrantha* distributed with in 0—3cm depth of soil. The viability of seed decreased from surface to

bottom. 6 months after initial germination experiment, no new seedlings appeared. In the field, no seedlings appeared from June to February of the following year.

The branching pattern and the population distribution pattern of *M. micrantha* differed under different condition.

Investigation and analysis showed that the growth of *M. micrantha* was deterred where water content was insufficient, and consitently, it did not cause great damage under relatively closed forest. The most affected ones are small trees and light demanding shrubs. In addition, other vines climbing on top of affected trees and shrub will further strengthen the negative affect of *M. micrantha.*

Research revealed that the water and organic solvent extracts of above and below ground of *M. micrantha* significantly deterred the germination, stem and root growth of at least one species of *Raphanus sativus, Lolium multiforum* and *Trifolium repens* seedlings, respectively, showing strong allelophathy effect. It suggested that the allelochemic might help *M. micrantha* to suppress the growth of other species. Further research found the allelochemic concentrated in water and ethyl acetate solvents. 49 of volatile oil found in *M. micrantha.* Some of the oils are known to be insecticide.

In an effort to identify the alllochemic, β-sitosterol ($C_{29}H_{50}O$, M=414), dihymikanolide, deoxymikanolide and Mikanin were separated from *M. micrantha.* In addition 2,3-Epoxy-l-hydroxy-4,9-germacradiene-12,8:15,6-diolide was found, being a new compound never reported before. Further research discovered that deoxymikanolide strongly suppressed the growth of many plant species, suggesting it be a potential herbicide.

M. micrantha is native to tropical America, mainly distributes in Mexico, Brazil, Ecuador, Peru, Colombia, Argentina, Bolivia and Florida of USA. The earliest specimen found in the Old World was collected in Zoological and Botanical Garden, Hong Kong in 1884 as a cultivated plant. Specimen collected from sites outside the Garden were also found since then, indicating the escaping process of *M. micrantha.* In 1950s—1960s. *M. micrantha* had been spread in Hong Kong. The first specimen in Guangdong was collected in 1984 in Silver Lake of Shenzhen, a city neighboring Hong Kong. Currently, *M. micrantha* had been found in 35 cities and counties in Guangdong Province. Among them, Shenzhen, Zhuhai, Dongguan, Huizhou and Zhongshan were the center of distribution. The first specimen in Taiwan was collected in 1986. Now it can be found in many counties, especially in the central and southern part of the island.

In Shenzhen, 3000 hm^2 were affected by *M. micrantha.* Among them, 243 hm^2 of forest die. One of the most serious affected area was Neilingding Island, offshore of Hong Kong and Shenzhen. 300 hm^2 were affected: 50 hm^2 of forest