

Management of the pine wood
nematode by Biocontrol of its vector
Monochamus alternatus (Coleoptera:
Cerambycidae) in China

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1. Occurrence and damages of the pine wood nematode in China

The Pine wood nematode was first found in 1982 in China. Since then it has spread in 17 provinces mainly in southern China and has killed 500 millions pine trees and 333,333.3 ha. of pine tree forests were destroyed, which values over 100 billion RMB for economic losses.

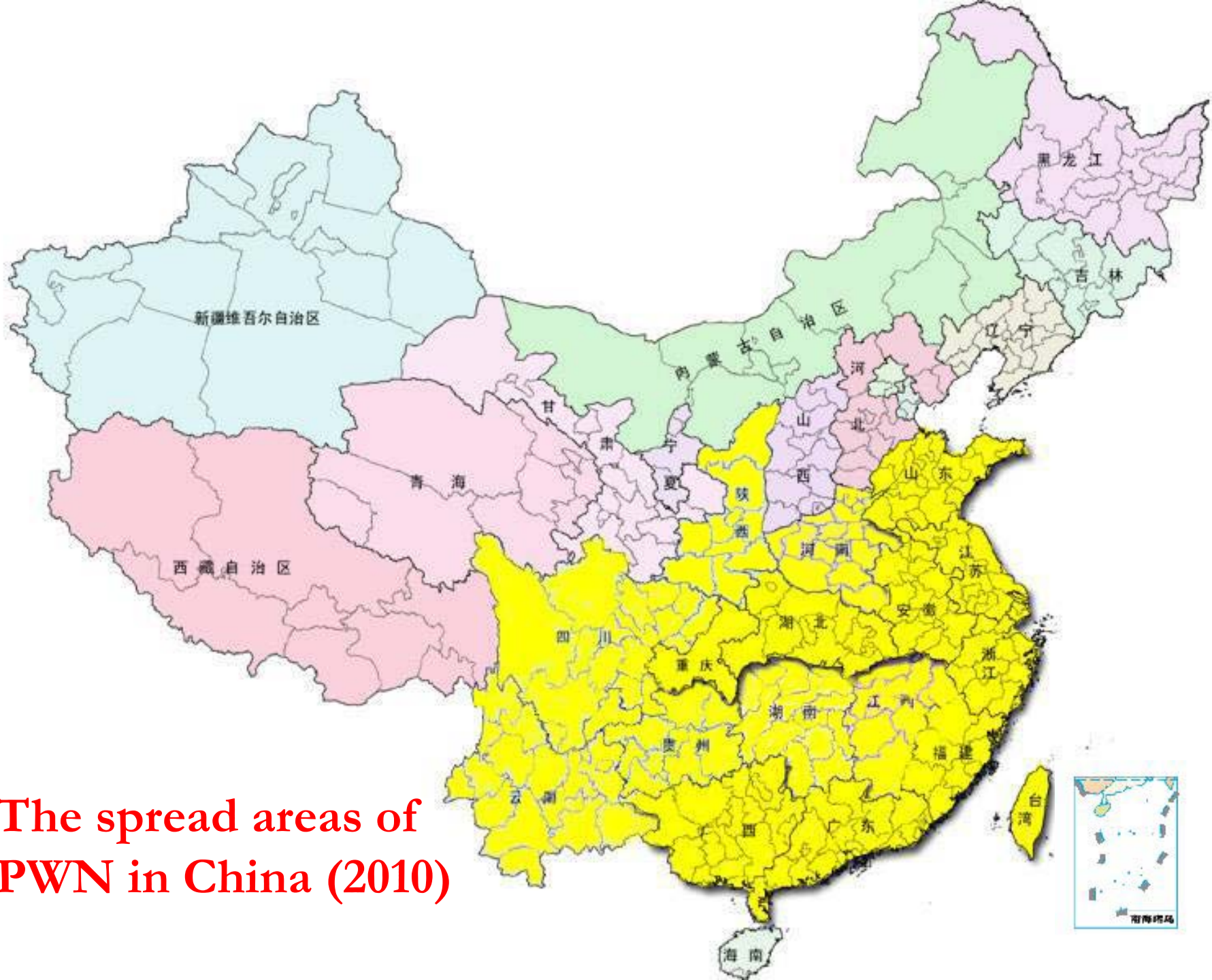
The pine wood nematode right now threatens the sceneries of many China famous mountains and great rivers, as well as many places of historic figures and cultural heritage, e.g., Huangshan, Lushan, Zhangjiajie Mountains, and the ecological environment of Three Gorges Dam areas were also imperiled.



**A large areas of
pine stands were
killed by PWN**



**The spread areas of
PWN in China (2010)**



2. The current situation on studies and control techniques of PWN

1. Study results

- 1) The pathogenic mechanism of PWN;
- 2) The mode transmission of PWN;
- 3) The early detection, rapid testing, quarantine techniques of
- 4) The compound several nematicides.

2. The control techniques

- 1) Quarantine;
- 2) Cleaning up woods infested by PWN;
- 3) The attraction lures for vector longhorn beetles;
- 4) The injection of nematicides;
- 5) Spray insecticides for killing adults of pine sawyer beetle.

For protection of Ancient and rare trees by injection nematicides (for one tree 60 bottles were injected, 5100RMB=\$761.2 US Dollars)

It can not be used in large areas of pine forests!



1) The key technique is to control its vector, the pine sawyer beetle *Monochamus alternatus*

2) Cultivation of health pine stands by making the vector's population under control by biocontrol techniques and other grow methods to reduce the opportunity of PWN disperse.

(Combining methods of treatment of traditional Chinese and Western medicines)



PWN cann'n transfer and disperse themselves and must attach on the longhorn beetle, transmitting and inoculated on health trees by the vector.



The adjustment management strategy, primarily to control the vector, pine sawyer beetle

Although the pathogenicity of the PWN is very strong, it has not migrated the dissemination ability, and must depend upon the vector — *M. alternatus* to carry and proliferate. Therefore, if the vector is controlled, PWN dissemination chain link could be broken, blocking its dissemination way, PWN will be unable to infect the healthy pine tree. Thus, the principal contradiction could be singled out and tackled, and the passive control has been transferred to the active prevention. Therefore, the pine wilt diseases looks like a plant disease question, but materially is an insect pest control problem.

In the management strategy the synthetic techniques should be carry out mainly by biological control of the pine sawyer

Because the pine sawyer's emergency period is different and lasts longtime in a year from late April to early October in the forests. In the such long time, spraying chemicals to control its adults, injecting nematicides are difficult to carry out for many times. Moreover, implement these methods in the most of China mountain forests is impossible besides the high cost.

But the above problems may be overcome by development of biological control techniques of using insect natural enemies. For example, the effective parasitoid of the pine sawyer, *Dastarcus helophoroides* (Coleoptera: Bothrideridae) could be used for biocontrol of the longhorn beetle. The parasitoid developed 3-5 generations in a year compared with one generation of the longhorn beetle. Thus, it could parasitize the PWN vector larvae generation after generation (a pair of the parasitoid could produced 220,000 individual offspring). Because its high reproductive ability the parasitoid could reach high population to make the longhorn beetle under control and thus finally control the PWN.

4. Main Techniques on biological control of *M. alternatus* for suppression of PWN

1. Setting up lure tree for attraction of *M. alternatus* adults to collectively attack, and avoid other trees to be harmed.

2. In the small larval stage (2-3rd instar) of *M. alternatus*, release the parasitoid, *Sclerodermus* sp. (Hymenoptera: Bethyridae).

3. In the middle to old larva stage (over 3rd instar) and pupa stage, release the parasitoid, *Dastarcus helophoroides* (Coleoptera: bethrideridae).

1) Setting up lure trees



**“Lure tree + attractant”
generally setting 1 lure
tree in half ha. of pine
stands**



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产品特点

● 本产品是一种施于松树活立木或濒死木上，由松树吸收后，刺激松树产生对松褐天牛有引诱活性的化学物质，达到吸引松褐天牛成虫到诱木上产卵的目的。

防治对象及使用方法

防治植物	防治对象	施药时期	用量(稀释倍数)	使用方法
马尾松 等松树	松褐天牛 及其传播 的松材线 虫病	松褐天牛 成虫活动 期	按原药：清水=1:3 的比例稀释；每株 树的施药的ml数同 胸径的cm数。诱木 密度为15株/hm ² 。	在诱木基部离地面30~50cm 处的三个侧面，各斜砍2~3 个30°角的刀槽，深入木质 部1cm。用注射器将稀释液滴 于刀槽内。

注意事项

- 本产品如不慎溅入眼睛，应用及时用清水冲洗；施药后，及时用肥皂洗手；
- 诱虫木应在松褐天牛成虫羽化前彻底清除出林地，并按松材线虫病疫木灭疫。

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Usually there are over 850 of *M. alternatus* larvae on a lure tree produced depending on the tree diameter and height, as well as population of the longhorn beetle. The larvae can be used to mass produce its parasitoid, *D. helophoroides* by putting the parasitoid's egg on the trunk after cutting. Thus it will be a mass rearing plot of the natural enemy in forest.





The lure tree was cut with 3 meter long. after the parasitoid's eggs were put on the trunk, they were covered with wire gauze which allow the parasitoid adults go out and not the longhorn beetle.



2) Release young larval
parasitoid, *Sclerodermus* sp. in 2-3rd
instar of *D. alternatus*



The eggs on longhorn larva laid by *Sclerodermus* sp.



Larvae of *Sclerodermus* sp. parasitized on
M. alternatus larva



Sclerodermus sp.
Develop a generation
need 30-40 days





Release the
bethylid parasitoid



3) Release parasitoid, *Dastarcus helophoroides* to control middle-aged and old larva, as well as pupa of *M. alternatus*

老茧



新茧



成虫



卵块



卵块放大



大龄幼虫寄生状



一龄幼虫



花绒寄甲 (*Dastarcus helophoroides*) 生活史图



Pupa of *D.*
helophoroides inside the
cocoon in the gallery of *M.*
alternatus



**Mature larvae of
*D. helophoroides***



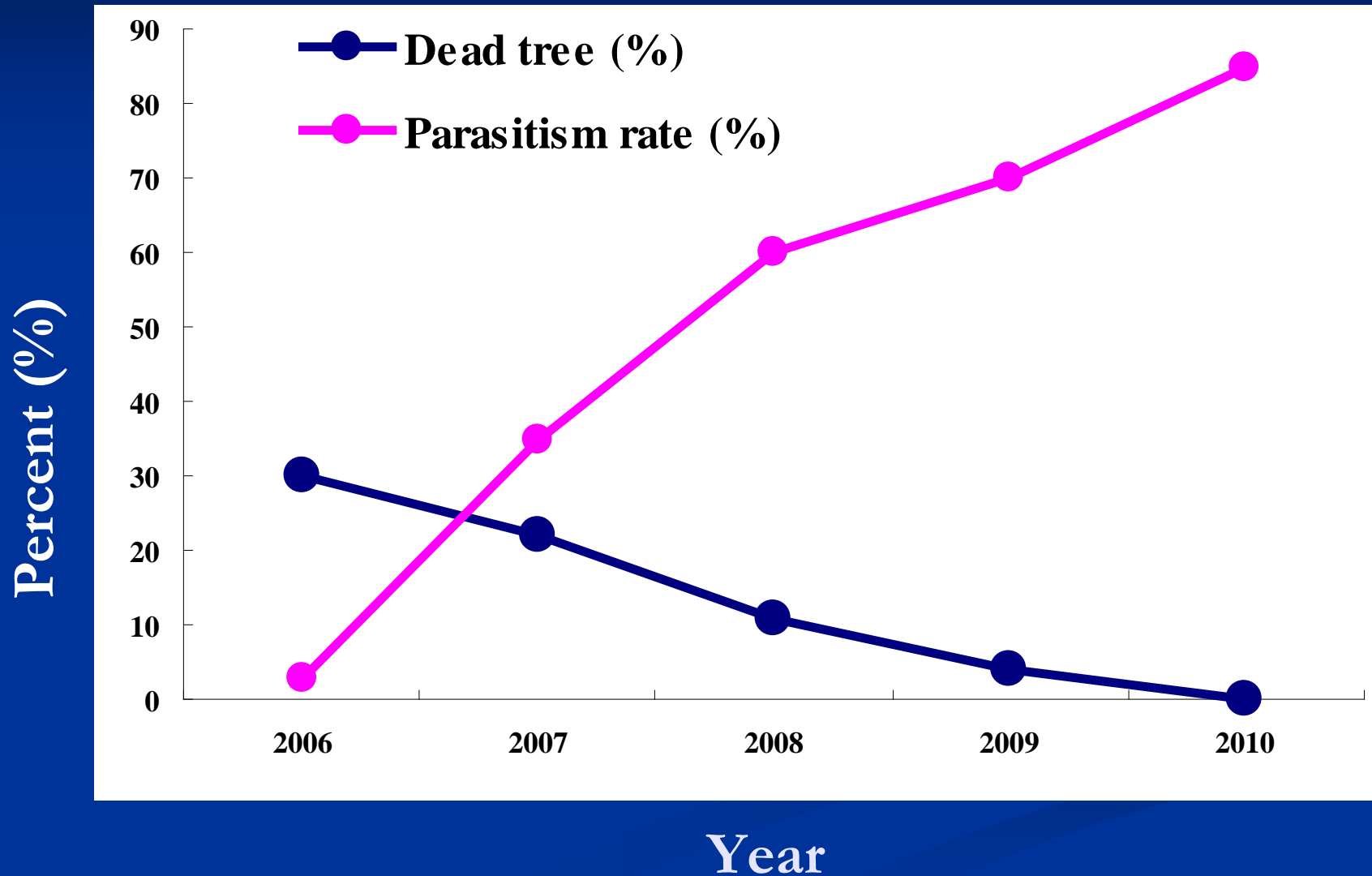
Mass rearing the parasitoids *D. helophorides* and *Sclerodermus* sp. have been successful and the biocontrol techniques were carried out

Successfully settle the problem of mass rearing *D. helophoroides*:

- Inducing one female produce 9860 eggs per year compared only 135 eggs in natural (73X);
- The eggs could conserve 7 months without influence on hatching;
- Long time for the adults live and produce eggs (6 years);
- High parasitism rate with average 86%, and some stands reached 97% and the longhorn beetle were put under control.

In Zunyi, Guizhou Province, the experimental sites with total 140 ha. of *Pinus massiana* were infested severely by PWN and implement of the techniques were carried out for two years there were no dead trees found. It showed that the biocontrol techniques are excellent in suppression the PWN under control.

Results of biocontrol techniques performance





Artificial diet for
rearing larva and
substitute host for
mass rearing *D.*
helophoroides



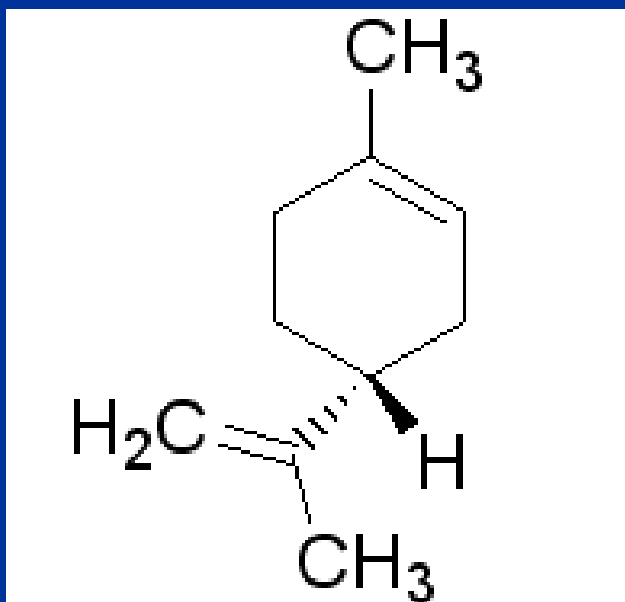
(R)-(+)- limonene was found to be a attractant for *D. helophoroides* to find its host in our study

Agricultural and Forest Entomology (2008), DOI: 10.1111/j.1461-9563.2008.00384.x

(R)-(+)- limonene, kairomone for *Dastarcus helophoroides*, a natural enemy of longhorned beetles

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Mass rearing *D. helophoroides*





Release parasitoid





Cocoons of *D. helophoroides* in the pine sawyer's gallery after consumed its host larva



国家林业局九华山生物防治松材线虫病 试点示范区启动仪式



On 8.18.2009, China National Forestry Administration held the opening ceremony of the program for biocontrol of *M. alternatus* to suppression PWN in Jiuhuashan Mountains, Anhui Province, to promote and extend our biocontrol program.



After the ceremony,
Vice Minister Li Yu-
cai released the
parasitoids in the
infested pine stand
by PWN.





In 2009, the China National Forestry Administration decided that this project carried first on in Anhui Jiuhua Mountain and Zhangjiajie Forest Park in Hunan, to protect our country's World Natural Heritage and the Cultural Heritage.



5. Three predator species were found to prey on larvae of *M. alternatus*

By investigations in the PWN infested areas (Anhui, Jiangsu, Zhejiang, Guangdong, Guizhou provinces), we also found three elaterid species (Coleoptera: Elateridae) preying upon larvae of *M. alternatus*, in which *Cryptalaus berus* (Candeze) is predominant. They could be used as biological control agents.



A larva of *Cryptalaus berus* can prey 38~45 individuals of *M. lternatus* larvae

6. Development of a special black light to attract and kill adults of *M. alternatus*

According to the weak photoaxis characteristics of *M. alternatus* adult, we have begun to develop a special black light to attract and kill adults of *the* longhorn beetle by designed 10 different wave length to select the proper one. Hopefully it could be finished to be one of synthetic control techniques.



**In Jinlin Province in 2008
the black light attracted and
killed 24.15 tons of the
adults of the longhorn beetle**



**We have invented a special black light to attract and kill oak
longhorn beetle with excellent control results in 2008**



The special black light to attract and kill adults of oak longhorn beetle



Thank You

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