Forest Invasive Species: Country Report- P.R. China

I. Basic forestry information

In China, total forest land covers 263.2947 million hm2, from which national forest accounts for 105.902 million hm^2 while collective ownership at 151.1453 hm^2. Among 158.9409 million hm^2 forest, there are 99,395 million hm^2 of timber forest, 21.3847 million hm^2 of various shelter protection forests, 4.4517 million hm^2 of firewood and 3.968 million hm^2 are for multiple special purposes. There are 69.8579 million hm^2 coniferous forest with 39.7483 million hm^2 is pine trees. Broadleaved trees are around 64.4978 million hm^2. Natural forests are 106.9654 million hm^2 nationally and plantation is at 46.6669 million hm^2. Forest land area covers 16.55% of national land area with stocking volume at 12.4878639 billion $m^{3.}$

Overall China is a country in short of supply of forest resources, especially with low stocking volume for most of its forests and large portion of pure plantations. The average forestland and stocking volume/per person are only 0.12hm2 and 8.6m3 respectively, which is about 21% and 12% of the world average respectively. The forestland cover of the national land is also 10% less than the world average of 26.6%. The forest distribution is also not even with 30.9% of forestland cover in 11 eastern provinces which is 1.9 times higher than the national average. While 12 provinces in the western region only has average 11.99% of forestland cover, 5% less than the national average. Meanwhile pure single species plantations account for 90% of the national forests which resulted in may ecological and economic potentials of a forest.

The implementation of six major forestry construction projects since 1998 marks the new phases of China's efforts to eco-environment development, those projects include: natural forest projection project, conversion of some cropland to forest project, Three-North and Yangtze River shelterbelt protection forest project, desertification control around Beijing area project, wildlife

conservation and natural reserve construction project, and fast-growing timber plantation project. Over 10.5396 million hm^2 of trees have been planted so far. 173,400 hm^2 of forest were put under the strict protection program while the number of natural reserves has reached to 1405. In addition, over 95 million hm^2 of forests were protected to some degree as a result of this natural forest protection project and logging was reduced to a reasonable level.

II. Status of the forest pest in China

Forest diseases and insect pests is one of important disasters. People think it as non-smoking forest fire. There are complex climates, various locations and abundant vegetations in China. All of these constitute diverse forest ecological environments. And because diverse environments may produce sorts of germs, insects and rats, they are harmful to people's survival. According to the results of the National Forest Disease and Insect Pests Inventory, there are over 8000 known forest pest insects, disease and rodents in the country, among which there are 5020 species of forest pests, 2918 species of diseases and about 160 species of rats respectively. For the time being, there are about 100 species of plant disease and insects pests leading to disasters in the whole China. According to statistics, the damaged area of forest pests has increased several-fold every 10 years from 1950's to 1980's. Forest diseases and insect pests annually occurred in an area about one million ha in 1950's. Since1980's, the damaged area was not less than 6.67 million ha, and the largest damaged area was up to 11 million ha. In recent decade, forest diseases and insect pests also occurred above 8 million ha every year.

Bursaphelenchus xylophilus, pine wood nematode (PWN), is the most serious pest of pine forests in China. The following are also important pests that cause significant damage to our forest resources. They are pine caterpillar (*Dendrolimus tabulaeformis* Tsai et Liu), pine bark beetle (*Matsucoccus matsumurae* (Kuwana)), pine sawfly and popular longhorn beetles, red turpentine beetle (Dendroctonus valens LeConte), pine shoot beetle(Tomicus piniperda Linnaeus), pine needle scale (Hemiberlesia pitysophila Takagi),

fall webworm (Hyphantria cunea (Drury)), popular defoliators such as Apochema cinerarius Erschoff, Clostera anachoreta Fabricius and Micromelalopha troglodyta (Graeser), forest rats such as Clethrionomys rutilus, Clethrionomys rufocanus and Myospalax frontanieri, etc.

III General Overview of forest invasive species in the country

China is a vast country with rich biodiversity in various forest ecosystems and large single species of plantations which make the country especially vulnerable to invasive species and is truly one of the most severely affected countries. As China's economy keeps rapidly growing with trade becoming more global, the incidence of invasions has greatly increased. There are invasive pest damages in almost all forest types in China and is increasingly becoming a serious threat to forest resources and the country's effort to improve the eco-environment and the developing –west program. After the founding of P.R. China, especially since the opening-up policy in late 1970s, alien species has become widespread in the country, occur in many forest ecosystems and caused or are causing tremendous loss or damage in terms of economic and ecological values, such as pinewood nematode, fall webworm, Japanese pine scale, loblolly pine mealybug, red turpentine beetle, brown spot needle blight of pine, crofton weed, mile-a-minute weed, etc. Among the most damaging forest pest in the country, half of them are exotic pests with occurring area at 1.3 million hm^2 per year and killing over 10 million trees. A rough estimate of losses caused by those exotic pests is around 56 billion RMB in economic, ecological and social impacts. Because of the threat or damage caused by forest exotic pests to China's forest ecosystem, biodiversity and international trade, not only among the relevant government agencies but also the public are also much concerned with those "unwelcome guests" problem, it is commonly recognized the magnitude of this problem necessitates increased efforts to reduce the incidence and impact of forest pest invasions.

IV Strategies and policies for management of forest pest invasions

1. Plant quarantine is the first line of defense against introduction and managing of exotic or invasive pests and diseases by regulating the flow of plant materials.
2. Quarantine controls on the entry of plants and plant products at the border, and quarantine policy based on risk assessment, are designed to identify and minimize the threats to China forests and forest industries from incursions of exotic pests.
3. Develop, strengthen or introduce new legislations or regulatory procedures regarding quarantine, inspection, intentional introduction of plants or animals with more attention to risk assessment before approval and follow-up monitoring after introduction.
4. Carry out monitoring survey for early detection of dangerous pest, and develop early-warning and response systems for invasive species.
5. Strengthen both basic and applied research on invasive species.
6. Raise public awareness of invasive species threats to conservation.

V Measures and other related activities implemented in managing against forest invasive species

1. Given the tremendous potential impact of forest invasions and current forest programs in China, the main theme for tackling this problem is on prevention and early detection backed by integrated management against individual invader which entirely depends on the phases of the invasion. This is in line with the national eco-environment development programs including those six major forestry projects to support the country's sustainable development. Great attention has been attached to manage forest exotic pest invasion by all levels of governments with emphasis on cooperation between relevant agencies and international collaboration, establishing an

efficient early warning and detection program to actively pursue exclusion with legal and regulatory support as inspection and quarantine. Extensive monitoring is also our priority as it is essential in any program where objective is to prevent establishment of new invaders.

2. Intensity basic research in exotic pest such as good biological information of the concerned pest that can be used to guide decision-making, monitoring and detection techniques need to be developed which including new advances in biotechnology. The goal is to build an efficient and broad early warning and detection system with those technologies to achieve exclusion or early detection leading to timely eradication to most potential invaders. In collaboration with Chinese Academy of Sciences and other research institutions, a comprehensive database on forest exotics is in the progress.

3. In order to regulate the introduction more scientifically and accurately, we have compiled a database of potential forest exotic pests to China which included 400 species so far. Meanwhile we also strengthen on-site quarantine inspection and domestic quarantine for established exotic pest in order to prevent their further spread. However, new legislations are also needed to better combat exotic pest such as restricting use of alien species protected areas while promote use of native soecies in reforestation programs, mandatory requirement for scientific trails and risk assessment before large planting of introduced exotic tree plants.

4. One thousand standard forest pest monitoring and detection centers have been established at country level and another 8000 various monitoring stations were set up across the country. Those centers and stations can monitor both native and extic pest year around to achieve early detection.

5. Infrastructures regarding management of forest exotic pests are also being upgraded with national debt investment by setting up new quarantine nurseries and quarantine facilities at some key protected site such as Huangshan National Park to prevent new invasions.

6. To those established exotic pests who caused severe damage in their economic or ecological terms or both, we initiated national control program to manage them such as pinewood nematode, red turpentine beetle and fall webworm while others whose impact were regional or less severe were put in provincial control projects including Japaese pine needle scale, pine bark scale and loblolly pine mealybug. All those projects achieved desired results.

7. To better coordinate work on forest exotics, a National Forest Exotics Office was set up early this year in the State Forestry Administration and Identification and Inspection Center for Forest Exotics was established with appropriate authority and clearly defined function.

It is also recognized that public awareness plays a key role in combating invasive species, TV, newspapers, internets and other forms of media are utilized to inform and educate the general public on impact of invasive species, general diagnostic characteristic, pathways and preventative measures to prevent or reduce human introductions of exotic pests. Strengthening the coordination and information sharing between the relevant government agencies from forestry, agricultural, trade, environmental protection and research institutions in dealing with forest invasive species. It is particularly important to strengthen regional and international cooperations in sharing, linking and integrating forest invasive species database and information system, and in carrying out research to support effective prevention and control programs.

VI Legislation and regulations on forest invasive species

A series of laws and regulations has been enacted regarding forest invasive species, these include:"Forestry Law of the P.R. China" (1991), "Plant Quarantine Regulations" (1992, revised), Regulations of Forest Pest Insect and Disease Control" (1998), "Notice on the pinewood nematode control by the State Council" (2000). The State Forestry Administration also issued total 70 of regulations associated with forest invasive species. For example, "Temporary Management Tactics for Pinewood Nematode" issued by jiangsu Province in 1989, similar regulations or acts were also issued by Anhui Province in 2001 and Guangdong Province in 2002.

VII Cases of major exotic forest pests

- ***Pinewood nematode, Bursaphelenchus xylophilus(Stenier et Buhrer)***

Pinewood nematode (PWN) is native to North America and has distributions in Japan, South Korea, United States, Canada, Mexico and Portugal. PWN was firstly found in Nanjiang in 1982 and expanded its range since then. Currently it is reported in some counties from Jiangsu, Guangdong, Hubei and Shandong provinces besides its known distributions in Hongkong and Taiwan. It is a good example of how an exotic pest can prove costly to the exporting country (the United States in this case), as well as the importing countries. Although PWN is causing destructive damages to forests in China including Taiwan, Japan and South Korea, the damages it has caused in the United States has been in lost export and quarantine cost.

PWN generally does no damage to pines native to North America but has very wide range host in China, mainly pines but including others in family Pinaceae. It has been reported PWN has been isolated from 49 species of host trees in nature and another 21 species can be isolated after artificial inoculation which make 70 species as its potential hosts. PWN is also called "pine cancer" in China because there is basically no cure for infected trees, thus it poses a destructive threat to most of pines in its range. Infected pines can

be killed in 40 days and most die in 2-3 years or the following year. The first signs of attack are the red needles and thinning of the crown appears in fall after infested in summer. The pinewood nematode is not able to move from tree to tree on its own. The main pathway is by transporting infested wood materials or SWPM while the natural spread and main vector in China is the sawyer beetle *Monochamus alternatus*. This beetle is widely distributed in regions south from Hebei Province. The presence of this vector beetle in those regions greatly increased the likelihood of its natural spread. The PWN range has spread steadily and reached to 87,000 hm^2 and over 40 million pines have been killed so far with a direct economic loss at 25 billion RMB.

Control of PWN is high on Chinese government due to its destructive nature and its forest pest status is ranked as number one in the country. A national control project on PWN started 5 years ago with direct involvement of the State Forestry Administration and relevant provincial forestry department in all aspects of the project including general project objectives, annual plan and implementation process. The funding for the project mainly comes from the State Forestry Administration but with certain match fund from the local treasured as well to ensure the sufficient fund to get the project objectives achieved which will be evaluated and inspected by a term of experts periodically. The main measures we used in those projects are: 1. Timely removal of PWN killed trees by a designated well-trained PWN control team; 2. Effective chemical treatment of PWN infected logs as well as stumps, other treatments include: cover scattered individual PWN diseased tree and fumigating, Fumigate felled PWN log piles with methyl bromide or heat treatment of those logs including by microwave treatment; burning or by chipping, processing, for plywood, pulpwood, fireboard and charcoal wood; 3. Control its vector beetle by baited trapping use traps or bundle trap of logs, biological control by parasite (*Sclerodema guani* Wu et Xiao), chemical control including spraying crowns of trees with pesticides at the time of adult flight in an effort to kill the beetles before they can infest more trees or injection of trunk. Another major strategic measures taken by us is to replant those PWN infected stand with non-PWN host trees after cutting. Our experience demonstrated those measures can effective bring PWN under control.

Strict quarantine is proven to be another effective tool to contain its spread, especially regarding transporting of wood materials out from PWN infested region. We set up many quarantine check points at outlets of PWN quarantine regions to stop any illegal or unprocessed pine wood materials leaving. Immediate on-site quarantine and treatment measure will be taken once they are found. Any logs or wood materials resulted from PWN control project can only be utilized locally after effective PWN treatment, mostly by heat or fumigation. If logs or chips from the quarantine region need to be transported out for production of fireboard, only the State Forestry Administration is authorized to issue such special permit which also requires a special truck with designated inspector to go through a designated route to the SFA designated fireboard production plant. Those measures will ensure no loss or spread of PWN during the Transporting presses.

Application of those tactics in an integrated pest management strategy has brought PWN under the control and reduced the further spread and loss of pines. We effectively reduced 6000 hm2 of PWN infected forests in 2002 comparing to 2001, as a result, 700,000 trees were saved. Again those data support the effectiveness of our national control project initiated for PWN.

- **Red turpentine beetle, *Dendroctonus valens* (LeConte)**

Red turpentine beetle(RTB), is a common pest in North America, yet, despite the abundance and wide distribution of this beetle, outbreaks have not been extensive or serve. However, since its first outbreak in 1999 in Shanxi Province, China this exotic beetle has spread rapidly from Shanxi Province to other adjacent provinces of Hebei, Henan and Shaanxi, and infested over 400,000 hm2 of Chinese pine stand (*Pinus tabulaeformis*, usually over 30 years old) with severe mortality. Nearly 10 million of oines have been killed so far. It also attacks other pine as well. Several consecutive years of drought have severely stressed its primary host and contributed greatly to the sudden outbreak. The historical record has shown that the RTB was introduced into China in early 1980s when unprocessed logs were imported from the west coat of the United States. This is also being verified by a collaborative study between

the Cinese Academy of Sciences and the USDA, Forest Service and Texas A&M University. With pines as a major reforestation species in China, and Chinese pine widely planted across a large portion of the country, the potential range and damage by this exotic beetle is overwhelming.

There is one generation per year for RTB in China, female usually first bore into tree bark onto phloem feeding. Its population size depends on the number of previously RTB infested standing tree and untreated stumps in the stand. Generally untreated stumps, tree wounds, logging or oleoresin collection will increase RTB attack. The mechanism of beetle attack is different in China than in the United States where the attacks by this beetle frequency occur on injured or stressed trees. Also it usually initiate attack at the ground line and then colonize a short distance both up and down the bark, i.e. to the upper roots and lower bole. However, in China RTB attack healthy tree and it has also been found colonizing roots extensively and it overwinters inside roots. Because of this and its overlapping generation naturally make it hard to control RTB effectively with pesticides.

RTB received high attention from the State Forestry Administration After its first outbreak, several teams were sent immediately to its native country, the United States and invited teams from the USDA Forest Service to China to exchange information and conducted joint research o this beetle. As a result of those activities, an effective action plan was implanted timely. The measures taken to contain this beetle includes silvicultural measures to improve stand health such as timely removal of fire burned and stressed trees, thinning and precaution to prevent wounding trees during logging. Timing of these operations is also important, removal of stressed or infested trees are usually conducted during RTB dormancy in winter or before adult emergence. Trapping by traps baited with host semiochemicals or bait logs are also experimented on large scale and proven to be effective in reducing RTB population and consequently tree damage. This is practically feasible since the semiochemical based baits attract both male and female, plus we locally developed release device and traps with an effective lures, which make large scale controls use possible. In 2003, 8000 traps are put out in all RTB infested stands and preliminary results are encouraging. First field release was conducted in 2002 and more are

being released this year from a laboratory colony while local natural enemies are also being investigated. In regard of chemical control, Fumigation of boles with aluminum phosphide under plastic cover, DDVP or Omethoate injection into newly initiated galleries, and spraying insecticides (Phorate , Monocrotophos, Cypermethrin, and Phoxime etc.) onto boles during the flight period are direct control methods that all have been shown to be effective at killing beetles but labor cost and side effects are prohibitive to large scale use.

In retrospect, we felt the international with its native country no doubtingly contributed much to the reason we can effectively brought this invasive and destructive RTB under control, especially the work on RTB trapping program with baited traps with the USDA Forest Service. By this cooperation, we developed a very efficient and economic semiochemically based Iure which is proven to be effective in both monitoring and control. Above all, this is done in close conjunction with the national control project initiated by the State Forestry Administration for RTB and results from those researches being immediately tested and applied in the project. Currently joint researches on RTB DNA analysis to pinpoint to the origin of RTB in China and its evolution, regional variation of RTB to host semiochemicals from coevolution point of view between RTB and its new host, pathogenic of RTB associated fungi are being conducted in both US and China. We hope those works will be able to address many basic questions related to the mechanism of invasive species' successful establishment and outbreak.

- **Fall webworm, *Hyphantria cunea* (Drury)**

Fall webworm, *Hyphantria cunea* (Drury**),** native to North America with range between north latitude $19^{o} \sim 55^{o}$. It spread into many countries by human activities through all pathways for exotic species introduction. First recorded in Liaoning Province, China in 1970's, then spread to east coastal provinces and part of Shaanxi Province. It has become a serious invasive pest to agricultural crop, forests and urban ornamental trees due to its wide range of hosts.

Fall webworm is a typical polyphagous defoliator, its host plants include shrubs, crops, vegetables, orchard trees, conifers and broafleave trees, but with preference to broadleave trees. Total 175 species of plants in 108 genera of 29 families are recorded on its host list in China.

All of its distribution areas in China experienced outbreak of this moth, which had subsequently caused serious harm to local forests including some valuable ornamental trees. The web formed by its larvae during feeding is very much a nuisance, especially on city ornamental trees. In most cases during outbreak, the larvae feeding usually defoliate all leaves on a tree which damage its aesthetic value in cities while its larvae also crawl around, sometime into building becoming a noxious disturbance to people's life besides the harm or mortality caused by defoliation. Cost in controlling the moth is steadily increasing, 20 million RMB were spent in control in Liaoning Province alone in 1998. Half million RMB direct loss is tallied in seedling export due to quarantine restriction in Benxi City, liaoning Province.

The moth can complete 2 generations per year, sometime three in some range, but has overlapping generations. It overwinters as pupae and adult appears in late April. Adult moths very strongly attract to light and can fly about 100m, during which it also pre-select its host plant for mating and oviposition. Fecundity is very high for this moth with average 800-900 eggs per female, highest reached 1800 eggs in egg mass. The larval stage last about 40 days and has aggregation phenomena. Pupating usually occurs under the roof, in crevice, corner of wall, rubbles, crevice of tree trunk. Overwintering generation usually sustains high mortality due low temperature, disease, predators and parasites. 70-80 % of mortality has been reported.

There are several ways in damage survey and detection for the moth including surveying the webs which is the simplest. Population monitoring is mainly by black light trapping or pheromone trapping.

An effective and cost-efficient management has been developed over the last 20 years since its establishment in China. Those measures employed in this management plan include: 1. Strict quarantine procedures specially targeted at late instar larvae and pupae stage to prevent long distance spread by human activities, to encourage planting more mixed stand to restructure the current plantation where it is possible or has th opportunity. 2. Manual removal of webs during 3-4th instars larvae stage. 3. Spray NPV virus during larvae stage, release the parasite *Chouioia cunea* Yang during pupae stage, sex hormone, light lure, bioincticide, etc. The parasite *Chouioia cunea* is proven to be very effective and has been applied in several epidemic areas.

In 1999, a national control project for the moth was initiated by the State Forestry Administration to control its further spread and reduce its population in around, Beijing, Tianjing and Hebei provinces. Priority of the project is to prevent its expansion into Beijing. The project covers 35,700 hm^2 fall webworm infested area. The tactics mainly used are black light trapping and pheromone trapping to timely detection and eradication in some isolated stand or outlying infestations by the methods listed above. No chemical pesticide is allowed in this project. We are able to reduce the infestation significantly in the project. The fall webworm infestation area has declined from the initial 33,000 hm^2 to 7000 hm^2 now while the heavily infested stands are also being greatly reduced. The expansion of the fall webworm infestation to Beijing is pushed back with 20km distance back in east to Tianjin.

As an early established forest exotic pest, its arrival, establishment, spread and gradually adapted into various local ecosystems were well documented and studied together with impact on environment, social and economic damage to forestry. More importantly we developed an effective and comprehensive tactics to manage this moth. Those experiences could serve well as reference to manage other similar forest exotic pests.

- **Japanese pine needle scale, *Hemiberlesia pitysophila* Takagi**

Japanese pine needle scale belongs to the family Diaspididae, first reported in Taiwan, and then in Macao, from there spread into Guangdong, China in 1982. Fujian Province recorded this pest in 2001. This scale is native to Japan.

Pines are the host for Japanese pine needle scale is pine, especially mason pine (*Pinus massanonia)* being its primary host. It could attack sapling and 20-30 years old tree and cause mortality of most infested pines. The volume loss resulted from attack by this scale averages about 2.7 cubic meters per hectare and reduction of oleoresin production at 900kg per hectare. Two-three years consecutive attack usually can cause large scale pine death. In Guangdong Province alone, accumulatively 180,000hm^2 of pines have been killed by this scale so far. Currently 1.23 million hm2 of stand is infested in both Guangdong and Fujian provinces.

Japanese pine needle scale mainly feeds on the basal sheath of old needles, also attacks tender terminal's middle and bottom, as well as fresh cone and young needles. Generally only minority of the nymphae hatched in the spring feed on the base of needles while majority move to last year old terminal's sheath. The nymphae hatched after July feed on current year's terminal. Japanese pine needle scale has five generations per year, female is metamorphosis dimidito while male is metamorphosis perfecta. After settled a suitable habitat, immature nymphae live a fixed life on host. Male can mate several times, oviposition last long time but the egg stage is very short, so there is generation overlapping. The scale population is positively related with temperature, with mean temperature at 22.5, the population increases significantly, it is the highest point of reproduction. When temperature is over 28, it usually resulted in high mortality of nymphae.

Monitoring of this scale is mainly relying on random survey and shoots sampling. Usually we select the wind-direction side of the pine, check the bottom branches to looking for dead branches, check the top needles to see whether it is yellow or not, looking for the scale at base of current year's needle, sheath or out side of sheath, base of current year's terminal and fresh cone scales.

Guangdong and Fujian provincial governments pay high attention to the scale control work and have set up a Japanese pine scale control office to coordinate various control works. Funding for researches on this scale was secured from both central and provincial governments which involved over 100 researchers including international cooperative projects. A comprehensive control action plan was implanted with measure including: strengthen quarantine, stop importation of pine seedlings; stop transporting of pine seedlings, branches, logs from epidemic area; plant broadleaf trees in order to mitigation spread; introduce parasite, *Coccobius azumai* Tachikawa from Japan as well as utilize native natural enemies such as *Prospaltella beriosei* How, *Encarsia Formosa*, ladybug, thrips, and etc.; remove dying or heavy infested pine and replant with broadleave tree to restructure the stand for long term solution; strengthen oleoresin collection management in order to prevent excessive collection resulting in over-stressed trees. All of the above measures have made great success.

Overall in our experience with this scale control, using nature enemy *Coccobius azumai* Tachikawa is considered to be the most effective and environment-friendly method. This wasp can propagate rapidly with nine to ten generations per year. The parasitism can be 20-30% high. The density of female Japanese pine needle scale could be brought to below 0.3-0.6 per branch of needles by this parasite, effectively reduce its damage to pine stand or mortality. The total released area with this parasite has reached to 1.032 million hectares by 1998 with satifactory result. However, the scale population resurged again recently due to a let-up on continuous work on the parasite, part of this is because of shortage of the parasite supply. The governments of Guangdong and Fujian provinces immediately organize a team to Japan in May 2002, to reintroduced *Coccobius azumai* Tachikawa to reinforce the field parasite population. Currently related work in both laboratory and field are progressing well.

- **Loblolly pine mealybug, *Oracella acuta* (Lobdell)**

The loblolly pine mealybug, *Oracella acuta* (Lobdell) (Homoptera: Pseudococcidae) is native to the southeastern United States. This insect usually only an occasional pest in its natural range in the southeastern USA. Since its accidental introduction with scion material into Guangdong Province, China in 1988, *Oracella acuta* has spread rapidly and the damage caused by this pest is increasing. Its distribution increased from 53145 km^2 in 1990 to 355 200 km^2 in 2001 (Guangdong Forestry Pest Control Station Internal Report). It is estimated that the pest is currently spreading at the rate of 70,000 hm^2 a year. Loblolly pine mealybug infests many species of pines, including *Pinus taeda*, *P. elliottii*, *P. palustris*, *P. echina* and *P. virginiana*. During the past 30 years, China has introduced many pine species from the USA, among which *P.elliottii*, *P.taeda* and *P. caribaea* are widely planted. These species and many endemic pine species are now threatened by the pest.

- **Pine bark scale, *Matsucoccus matsumurae* (Kuwana)**

Matsucoccus matsumurae (Kuwana) was firest found in Liaoning province in 1942, and it was probably introduced to China on seedlings from Japan. Since, its introduction, this pest has spread to more than 80 countries in Liaoning, Jilin, Shangdong, Zhejiang, Shanghai and Anhui provinces. The infected area of pines is about 200000 hm^2. This scale attacks many species of pines, including *Pinus densiflora, P.tabulaeformis, P.massoniana, P.thunbergii.*

- **Plam leaf beetle, *Brontispa longissima* (Gestro)**

Palm leaf beetle, Brontispa longissima (Gestro), origin from the Pacific islands, is a newly invasive pest in China. The coconut leaf beetle was found in Hainan, Guangdong and Taiwan provinces, but the worse affected areas are in Hainan province. In December of 2004, the infected counties increased to 16 in Hainan, the epidemic area was 390,000ha, 1,820,000, coconut palms were infected. In Hainan province, 11 species of host palm trees such as *Cocos nucifera, Areca catechu, Archontophoenix alexandrae, Roystonea regia,*

Washingtonia fllifera, Hyophorbe lagenicaulis, Washingtonia robusta, Liviston chinensis and Chrysalidocarpus lutescens were recorded. The major host plant is *Cocos nucifer*. Dry periods favour the development of Brontispa populations. The long distance spread is aided by human activities. This insect is a threat to palm industry, and cause extensive damage to coconut production.

- **Banana moth, *Opogona sacchari* (Bojer)**

The banana moth, Opogona sacchari (Bojer) is an important invasive pest in China and has introduced more than 20 provinces. This moth might be introduced into China with the importation of some tropic ornamental plants, such as *Dracaena fragrans*. Fragrant dracaena (*Dracaena fragrans*) from Guiena was introduced as an ornamental plant to Guangdong Province in the early 1980s and was widely planted in the northern part of China, including Beijing, in the 1990s. In the middle 1990s, the first banana moth infestations in Asia were reported on fragment dracaena in Beijing, where many trees were killed. The moth has a wide global distribution. It was reported from the Mascarene Islands in the Indian Ocean in 1856, and subsequently from many regions in Africa and Europe, and later from South America and the West Indies, finally invading Florida in the 1980s. Widespread on foliage-plants and other crops in the Tropics and Subtropics, this insect is becoming an increasingly important pest of landscape plants and ornamentals. The range of its host plants has now expanded to 87 species and 8 varieties of 28 families, including 46 species and 4 varieties of 24 overseas families as well as 55 species and 2 varieties of 14 Chinese plant families. More attention needs to be paid to detecting and controlling this pest to ensure it does not impact on agriculture, forestry and horticulture.

- **Red palm weevil, *Rhynchorus ferrugineus* (Olivier)**

Originating in southern Asia and Melanesia, Red palm weevil, Rhynchophorus ferrugineus (Olivier), has become the most important pest of the date palm in the world. The cause of the high rate of spread of this pest is human intervention, by transporting infested

young or adult date palm trees and offshoots from contaminated to uninfected areas. Since its accidental introduction to China in 1998, this weevil has spread to 5 provinces. It is dangerous and has caused serious damage to the palm plants in South China. Many palm tree species e.g. *Phoenix canariensis*, *Areca catechu, Sabalumbraculifera, Trachycarpus fortunei, Washingtonia* sp., are its host plants. The infected area of palms was about 10000hm^2

- **Nipa palm hispid beetle, *Octodonta nipae* (Maulik)**

Native to Malaysia, Nipa palm hispid beetle, Octodonta nipae (Maulik), is an important pest on palms and poses great threat to palm industry. This beetle was introduced into Hainan province through shipments of ornamental palms in 2002. It attacks Coconut palm (*Cocos* spp.), Nypa Palm (Nypa fruticans), California fan palm (Washingtonia filifera) and other palms. Up to now this insect was only found in Hainan.

- **Asiatic palm weevil, *Rhabdoscelus lineaticollis* (Heller)**

Rhabdoscelus lineaticollis (Heller) (Coleoptera: Curculionnidae), a dangerous insect pest, which had cause serious damage to the palm plants and sugarcane *Saccharum sinensis* in several other countries and districts, had invaded Taiwan in 1997 and Guangdong in 2002. The Asiatic palm weevil is native to Philippines.

- **Western dry-wood termite, *Incisitermes minor* (Hagen)**

The western drywood termite, Incisiterms minor (Hagen), is the most common structure-infesting drywood termite in the southwestern United States. *Incisiterms minor* is found in the coastal and lower montane region of southern California. Its range extends up the

coast to northern California and onward in a discontinuous distribution along the coasts of Oregon and Washington. The western drywood termite can attack woodland, river washes and canyons with trees. It infests sound, dry wood in human-made structures, as well as furniture and other wooden items. Infestations had been found in Haining city of Zhejiang province in 1937. After that this termite had spread to Shanghai and Jiangsu provinces. Infected wood, furniture and other wooden items may serve as vectors of introducing *I. minor* to a new region.

- **Red imported fire ant, *Solenopsis invicta* Buren**

The red imported fire ant is a newly invasive pest in China, which is native to South America. It has been introduced into parts of Asia, Australia and North America. It has also been introduced onto some vulnerable is island ecosystems including islands in the Caribbean (Puerto Rico and the Virgin Islands) and the Pacifice (New Zeland). *Solenopsis invicta* disperses using several methods, including mating flights, dispersal through infested agricultural goods, and by floating on the surface of water.

S. invicta workers are aggressive, mobilize quickly, and sting relentlessly when their mound isdisturbed. They are aggressive and effective at foraging and recruitment. They use their against colony intruders, and to subdue prey. These attributes make them very effective at resource defense, and hence highly competitive. They are omnivourous and opportunistic feeders. Though they prefer insects and arthropods, they preate invertebrates, vertebrates, and plants, scavange, and tend honeydew secreting invertebrates. *S. invica* also causes economic losses by feeding on agricultural crops. *S. invicta* is a serious seed feeder and attacks sunflowers, okra, cucumbers, soybeans, corn and eggplant. It also damage irrigation systems and their mounds disrupt harvesting operations. *S. invicta* causes the death of livestock such as calves, small pigs, and domestic animals. The red imported fire ant colonies often infest electrical equipment such as air conditioners, traffic signal boxes, electrical and utility units. Telephone junctions, airport landing lights, electric pumps for oil and water wells, computers, and even car electrical systems have been affected. The ants chew on the insulation or carry soil into these areas and cause short circuits.

- **Brown spot needle blight of pine, *Mycosphaerella dearnessii* Barr**

Brown spot needle blight is a worldwide pine disease nowadays. This pine disease is caused by *Mycosphaerella dearnessii* Barr, a fungus appearing to be of American origin. It was accidentally introduced to China in 1970s. *Mycosphaerella dearnessii* is an important pine foliage disease in South Chaina. Potentially all species of *Pinus* are its hosts. Of most importantance in China are: *Pinus elliottii, Pinus taeda* and other exotic pines.

This fungus overwinters as mycelium, acervuli, and perithecia in infected needles. Beginning in early April, the fungus produces two types of spores in abundance during moist periodes. They include greenish-brown, curved, one-to three-celled conidia from acervuli that are disseminated by splashing rain, and oblong, bicellular ascospores from perithecia, which are disseminated by wind. Hyphal strands from germinated spores penetrate needle tissues by growing through open stomata. Subsequent growth and development of the brown spot needle blight fungus in needle tissues cause death of mesophyll cells, resulting in characteristic symptoms. Infected areas on needles initially appear as Brown Spot surrounded by yellow bands. Fungal growth in infected tissuses is accompanied by enlargement of spots that frequently merge, resulting in death or blight of entire needles. Within 2 to 8 weeks after infection, the fungus produces acervuli and perithecia within infected tissues, which provide secondary inoculum throughout the year.

- **Red spot needle blight of pine,** Dothistroma pini **Hulbary**

Red spot needle disease is also known as Dothistroma needle blight, which is a worldwide devastating foliar disease of a wide range of pine species. The causal fungus, *Dothistroma pinni* Hulbart, infects and kills needles. Where environmental conditions favour infection, this disease can spread rapidly and cause siginificant damage. Trees can be defoliated within weeks, and mortality is common with repeated attacks. More than 30 species of pines (*Pinus*), including *Pinus sylvestris* var. *monogolica, P. elliottii, P. yunnanensis, P. taeda, P. koraiensis and P. tabulaeformis,* server as hosts.

The fungus has both a sexual stage (*Scirrhia pini*) and an asexual stage (*Dothistroma pini*). The meas of movement and dispersal is similar to *M. dearnessii*, but the hyaline conidia are less adapted to exposure and thus less likely to be transported by methods other than rain-splash. Mist and low cloud may be involved in long-distance dispersal. The rapid intercontinental spread of M.pini was the result of man's movement of live plants or contaminated seed stocks.

- **Knot disease of olive, *Pseudomonas syringae pv. Savastanoi* (Smith) Young, Dea & Wikie**

Olive Knot Disease is caused by the bacteria, *Pseudomonas syringae pv. Savastanoi* (Smith) Young, Dea & Wikie. The pathogen appears to be of European origin and have been spread to many regions in the world. This disease was found in China in 1964. The bacteria is spread about by wind and rain gaining access to the tree throught openings such as leaf scars, pruning wounds and frost cracks. Infections can occur at any time, but gall development is dependant on tree growth. The galls are disorganized plant tissue incapable of conducting water ornutrients. When the galls girdle twigs and branches, they can be killed. Up to now no new outbreak was detected in China, and the disease was under eradication.

- **Mile-a-minute weed, *Mikania micrantha* H.B.K**

Mikania micrantha is a fast growing, perennial, creeping and twining plant, commonly called mile-a-minute because of its vigorous and rampant growth habit. It grows best where fertility, organic matter, soil moisture, and humidity are all high and damages or kills other plants by cutting out the light and smothering them.

Mikania micrantha is native to tropical Central and South America, where it grows in and near forests, along rivers and streams and in disturbed areas such as roadsides. In the end of 19th century, this weed was introduced to China. Now it has dispersed to South China, including Guangdong province, Hong Kong and Taiwan. It has become a serous weed in these regions and disturbed mainly in forests,

plantation crops, horticulture and coastal vegetation. Many trees and shrubs, such as *Macaranga tanarius*, *Lantana camara* and *Litchi chinensis* were smothered and killed by this weed.

This Mile-a-minute weed is a branched, slender-stemmed perennial vine. The leaves are arranged in opposite pairs along the stems and are heart-shaped or triangular with an acute tip and a broad base. Leave may be 4-13 cm long. The flowers, each 3-5 mm long, are arranged in dense terminal or axillary corymbs. Individual florets are white to greenish-white. The seed is black, linear-oblong, five-angled and about 2 mm long. Each seed has a terminal pappus of white bristles that facilitates dispersal by wind or on the hair of animals.

Once established, M. micrantha spreads at an alarming rate, readily climbing and twining on any vertical support, including crops, bushes, trees, walls and fences. Its shoots have been reported to grow up to 27 mm a day. Vegetative reproduction is also efficient and vigorous. Although intolerant of heavy shade it readily colonies gaps. *Maikania micrantha* damages or kills other plants by cutting out the light and smothering them. In this respects it is especially damaging in young plantations and nurseries. It also competes for water and nutrients, but perhaps even more importantly, it is believed that the plant releases substances that inhibit the growth of other plants.

- **Crofton weed, *Eupatorium adenophorum* Spreng (Compositae)**

Eupatorium adenophorum Spreng (Compositae) is perennial tufty semi-shrubby herbaceous plants. It is also called “Liberation weed”, “Black head Weed”, and “Evil weed” by Chinese locals. Crofton weed is a cosmopolitan harmful weed. It capacity of reproduction and ecological adaptation is strong, and grows very fast. It distributes originally in Central America, mainly in Mexico. Now it distributes widely in the United States, Austalia, New Zeland, and many countries of southeastern Asia. *E. adenophorum* was introduced to southern Yunnan province from Burma in 1940s, and keep spreading from southwest to northeast at rate about 20

kilometers per year. Now it distributes diffusely in Yunnaan, Guizhou, Sichuan, Guangxi and Tibet, and spreads further toward north and east of China.

This exotic weed prefers warm and wet environment but its ability of acclimation to environment is very strong. It can grow in the environment at temperature ranged from 5^0C to 42^0C. It can grow at dry and barren wild hill, and even can grow among the aperture of stone at the top of wall and house. But it grows more vigorously in a fecund soil. Its height is about 1 to 2 m. Its shallow root system spread in top soil surface horizontally. In general there are about 30~45 thousand seeds per plant, and sometimes even more than about 100 thousand. *E. adenophorum* maintain and spread its population along river and livestock are mediums for *E. adenophorum* spreading. *E. adenophorum* propagates mainly by seed. Its seed germination needs light absolutely, but its seedlings can grow at shady environment, which is advantage to its invasiveness into other plants community. It can reproduce asexually too. Its root and stem can differentiate adventitious root, and the root can grow into soil, then new plant appears. The root system of *E.adenophorum* can excret allelopathic substance to restrain growth and development of other plants around it. Allelopathy is one of the important cases that *E. adenophroum* possesses high ability of competition and invasiveness, and can form monodominant community.

E.adenphorum can invade pasture and wild land suitable for forest. It can impact greatly on forest generation and growth. It poses an increasing threat to livestock, forest regeneration and ecosystem in its range. Its pollen and pappus also cause allergic (Anaphylaxis) to some people.

This exotic weed received high attention from the government; several research and control projects are under the way on this weed while a comprehensive action plan is currently being implemented in Yunnan with aim to contain its spread and eradicated it in some areas. The approach taken in this program is still based on integrated management with measures including: mechanical and chemical eradication, substitute and biological control. Those are still the main measures to prevent *E.adenophorum* in China. 1. Mechanical

measure; we can eradicate *E.adenophorum* in some area by means of machine or other simple tools. The weed can also be burned after being uprooted and sundried. This is the most simple and efficient method, but an arduous and labor intensive task. 2. Chemicals: Glyphosate, Dicamba and 2, 4-D butyl have been proved to be affective to *E.adenophorum*. This method is very affective and fast to see results, expensive, and contaminate environment. 3. Vegetation substitution; We can use other plant species with strong vitality and high growth rate to restrain *E.adenophorum*. We plant generally crops, pasture, or fast- growing tree species densely after *E.adenophorum* being pulled up by the roots. Because its seedlings like shade environment, and the shade; tolerant ability of big plant is strong too, we can plant both pasture and tree species to substitute *E.adenophrum. E.adenophorum* can not invade dense forest, shrub, plantation, well managed pasture and plantation. 4. Biological control: commonly used natural enemies at present include *Procecidochares utilis* Stone, *Dihammus argentatus*, and *Cercospora eupatorii*. However, it is highly recommended to jointly use those three natural enemies against this weed is more effective. In China, *P.utilis* can oviposit on growing point of *E.adenophorum.* The eggs develop and hatch there, and then gall appears. This usually results in death of the part above gall, and influences plant growth potential and seed production.

In general, *E. adenophorum* is harmful weed, but it can be utilized for our benefits in some area as well when control or eradication is too costive or not practical. Currently there are researches going on about utilization of this weed including raw material for panel board, bio-insecticide extraction and forage after detoxifying, producing gas by fermentation, culture for mushrooms, essential oil extraction, etc. Progress has been made in some of those areas.

VI. List of forest invasive species

See Checklist of forest invasive species present in China

Checklist of forest invasive species present in China

Scientific name	Common name	Origin	Introduction		Likely pathways of spread	Vectors	Distribution patterns	Rate of change	Major hosts	Threat level
			Method	Year						
Hemiberlesia pitysophila Takagi	Pine needle scale	Japan	Accidentally introduced from Japan on live seedlings	c.1982	Nursery trade	Commercial nurseries	Affecting pines, especially mason pine(Pinus massanonia) in both Guangdong and Fujian provinces	Currently 1.23 million hm^2 of stand is infested	pines, especially mason pine(*Pinus massanonia*)	National
Hyphantria cunea (Drury)	Fall webworm	native to North America	Introduced unintentional ly through goods shipment, passengers or transportation and other human activities	c.1970's	It spread to many countries by human activities through all pathways for exotic species introductions	Transport networks	Fall webworm is a serious pest to agricultural crop, forests, city ornamental trees. Now spread to east coastal provinces and part of Shaanxi Province.		Total 175 species of plants in 108 genera of 29 families are recorded on its host list in China.	National
Dendroctonus valens LeConte	Red turpentine beetle	North America	accidentally introduced on imported unprocessed logs from the west coat of the United States	in early 1980's	unprocessed logs	Wood transportation	Affecting northern provinces(now spread in Shanxi, Hebei, Henan and Shaanxi province), natural forest, planted forests, urban areas	Infested over 400,000 hm^2 of Chinese pine stand	Chinese pine stand (*Pinus tabulaeformis*) and other pines	
Brusaphelenchus xylophilus (Steiner et Buhrer)	Pinewood nematode	native to North America	probably was introduced in infested wood or live seedlings	in 1982	The main pathway is by transporting infested wood materials and the movement of vector –the sawyer beetle Monochamus alternatus	The vector in China is the sawyer beetle *Monochamus alternatus*	Bursaphelenchus xylophilus poses great threat to the forestry resources and plantation cause of China, and poses long-term and great impact upon the city plantation and ecological system	The range has spread steadily and reached to 87,000 hm^2 and over 40 million pines have been killed	Has a very wide range host in China, mainly pines but including others in family Pinaceae	National

Oracella acuta (Lobdell)	Loblolly pine mealybug	Native to the south-eastern United States	introduced with scion material into southern China from its natural range in the southern USA	in 1988	spread through plantations of exotic slash pines	Infested wood and other materials of host plans	Affecting conifer forest	Since its introduction into China, Oracella acuta has spread rapidly. Its distribution increased from 53145 km^2 in 1990 to 355200km^2 in 2001	slash pine (Pinus elliottii and other exotic pines like *Pinus taeda* L.and *Pinus echinata*	
Matsucoccus matsumurae(Kuwann)	Pine bark scale	Native to Japan	Accidentally introduced to China on seedlings	In 1940's	Transportation of seedlings and infested wood materials	Infested wood and other materials of host plants	Affecting conifer forest	This pest has spread to 7 provinces in China. The infected area of pines was about 200000hm^2	*Pinus densiflora, P. Tabulaeformis, P. Massoniana, P.thunbergii* and others in this genus	National
Brontispa longissima Gestro	palm leaf beetle or coconut leaf beetle	Native to Indonesia, possibly to Irian Java, and also to Papua new Guinea	Introduced into Hainan island through shipments of ornamental palms	Introduced to Taiwan in 1970's, and to Hainan island around 2001 or 2002	Palm leaf beetles spread mostly through the movement of infested palms	Infested host plants	This insect is threat to palm industry and cause extensive damage to coconut production	In December of 2004, the infected counties increased to 16 in Hainan, the epidemic area was 390, 000 ha 1,820, 000 coconut palms were infected	It attacks more than 20 palm species with the coconut (*Cocus nucifera*) being a favored host.	
Opogona sacchari (Bojer)	Banana moth	Native to Africa	introduced on tropic plant seedlings, such as *Dracaena fragrans*	In early 1990's	Over long distances, movement of infested host plants can ensure pest dissemination.	Host plants	Affecting the tropic ornamental plants and plants in green house	Since its introduction into China, Opogonasacchari has rapidly spread into many areas.	the range of its host plants has now expanded to 87 species and 8 varieties of 28 families, including banana (*Musanana*), Palms (*Cocosnucifera*) and many other tropic plants.	National

Rhynchophorus ferrugineus (Olivier)	red palm weevil	Native to south-eastern Asia	probably was introduced on infested palm plants	In 1998	Plants for planting of Palmae (including date palm, ornamental palm) from infested countries	Infected plants	Affecting ornamental palms	This pest has spread to 5 provinces in China. The infected area of palms was about 10,000 hm^2 .About 20000 coconut palm trees were dead.	Mini palm tree species (*Phoenixcanariensis, Areca catechu, Sabanumbraculifera, Trachycarpusfortunei, Washingtonia* sp. etc.).	
Octodontanipae(Maulik)	Nipa palm hispid beetle	Native to Malaysia	Introduced into Hainal island through shipmens of ornamental palm	In 2001	This beetle spreads mostly through the movement of infested palms	Infected palms	Being an important on palms, this insect poses great threat to palm industry	Up to now this insect was found only in Hainan island.	Coconut plum (Cocos spp.), Nypa palm (Nypa fruticans), California fan palm (Washingtonia filifera) and other palms	Regional
Rhabdoscelus lineaticollis(Heller)	Asiatic palm weevil	Native to Philippines	Introduced into China through shipments of palm plants	Introduced to Taiwan in 1997 and to Guangdong in 2002	This beetle spreads through the movement of palm seedlings	Infected palms	Affecting palm industry	This insect was found only in Taiwan and Guangdong up to now.	Palms including Chrysalidocarpus lutescens, Mascarena verschaffeltii, Areca catechu	Regional
Incisitermes minor (Hagen)	western dry-wood termite	native to the south western United	Probably introduced into China through shipments of	Introduced from Hong-Kong to	This termite spreads through the movement of infected plants,	Infected plants, wood, ect.	The western dry wood termite can attack woodland, river washes and canyons with trees. It infests	This insect was found in Zhejiang, Shanghai, Jiangsu.	Many plants	Regional

		States	infected wood, furniture and other wooden items	Zhe-jiang in 1937	wood, furniture and other wooden items		sound, dry wood in human-made structures, as well as furniture and other wooden items			
Solenopsis invicta Buren	red imported fire ant	origin from Latin America including Brazil, Paraguay and Argentina	Probably introduced to Guangzhou China through transportation of habitat materials.	In 2004	Solenopis invicta disperses using several methods including mating flights, dispersal through infested agricultural goods, and by floating on the surface of water.		Agricultural areas, coastland, desert, disturbed areas, natural forest, planted forests, range/ grasslands, riparian zones, scrub/ shrub lands, urban areas, water courses	This ant was found only several sites in Guangdong, Hong Kong and Taiwan.	Fire ants are omnivorous	Regional
Mycosphaerella dearnessii Barr	Brown spot needle blight of pine	The fungus appears to be of American origin and has spread to other continents	Accidentally introduced into China on infected host plants	c.1970	The fungus spreads through dispersal of conidiophores and the movement infected plants		planted forests, urban areas	South China	Potentially all species of *Pinus* are hosts. Of most importance in China are :*Pinus elliottii, Pinus taeda* and other exotic pins	Regional
*Dothistroma pini*Hulbary	Red spot needle blight of pine		Probably introduced to China on infected plant materials.	c.1984	The fungus spreads through rain-splash, man's movement of live plants or contaminated seed stocks		natural forests, planted forests and nurseries	Since its introduction into China, *Dothistroma pini* has spread into many areas.	The principal hosts are *Pinus* spp.	

*Pseudomonas syringaepv.savastanoi (*Smith*)*Young,Dea&Wikie	Knot disease of olive	The pathogen appears to be of European origin and have been spread to many regions in the world	Probably introduced to China on olive plants	In 1964	The bacteria are spread about by wind and rain gaining access to the tree through openings such as leaf scars, Pruning wounds and frost cracks. And long distance dispersal is by infected plant material.	Olive plants	Olive cultivars, some landscaping plants in nurseries and urban areas	Up to now no new out break was detected, the disease was under eradication.	Some cultivated olives, wild olives and oleander	
Poplar Moseic Virus	Poplar Mosaic Virus disease	First reported from Bulgaria	Introduced to China by infected poplars	In 1972	Virus transmitted by mechanical inoculation, grafting, and by pollen to the pollinated plant	Infected plant material	planted forests, nurseries and urban areas	Now only occurred in a few areas	Poplars, such as populus deltoids, P.nigra, P. x Canadensis, etc.	
Mikania Micrantha H.B.K	Mile-a-minute weed	native to Central and South America	Intentionally introduced for cultivation	In the end of 19th century	Seed dispersed by wind or animals.	Animals, wind, stream and human beings	orchards, forests, disturbed areas	The weed has caused significant damage to mini ecosystems in Macao, Hong Kong and Guangdong province	Many trees and shrub such as Macaranga tanarius, Lantana camara and Litchi chinensis were smoothed and killed by this weed	
Eupatorium adenophorum L	Croftonweed	Native to Central America	This weed entered China either naturally or through human activity from Southeastern Asia	Crofton weed came into Yunnan from Burma in !935	Seeds carried by water and by strong wind. Transported in hay, machinery, vehicles, clothing and mud.	wind stream, animals and human beings	forests shrub land, grass lands, crop lands	Cofton weed is currently spreading from south to north at a rate of 35 km a year and now is widely distributed in southeast China	E. adenophorum can invade pasture and wild land suitable for forest. It can impact greatly on forest regeneration and growth.	

Eupatorium catarium Veldkamp	Praxelis	South America	Introduced for cultivation	c.1980	Nursery trade; Animal	wind, stream, animals, insects and human beings, etc.	forests, orchids, grasslands	Now spread to many areas in Guangdong province	It impacts greatly on forest growth	Regional
Salidago Canadensis L.	Canadian golden rod	North America	Introduced for cultivation	c.1970	Nursery trade; Animal	wind, stream, animals and human beings, etc.	roadsides and fence lines, in dry open fields, and in open woods or orchards	It is currently spreading to many areas in the south of China	It impacts greatly on the growth of shrubs and crops	Regional

*Leave unknown item blanks