Why Do IAS “Walking” Like “Crabs"?

——Take vital Forest Insect Pests IAS as example

为什么IAS都像“螃蟹”横着走？

——以国内外重要林业入侵害虫为例

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   林业入侵害虫区域预警的启示

1. Introduction

(1) 入侵昆虫的危害

- In recent years, invasive insects have posed great threats to world agriculture, forestry, ecology and human health. 近年来，入侵昆虫给世界农业、林业和人类健康均带来了巨大的威胁。

Agriculture

加剧了入侵地农业生物灾害的损失，严重威胁了农作物的生产安全，导致作物减产，经济损失达上亿元。

如*Bactrocera dorsalis*、 *Leptinotarsa decemlineata* 、 *Phenacoccus solenopsis*等。


桔小实蝇

Forestry

造成林木大面积死亡，破坏森林生态系统，轻则造成巨大的经济损失，重则危害整个生态环境。

如*Anoplophora glabripennis* 、 *Hyphantria cunea* 、 *Dendroctonus valens*等。


红脂大小蠹

Human health

某些入侵昆虫作为登革热等传染病等的重要媒介昆虫加速了疾病的流行，给人类带来了恐慌。

如*Aedes albopictus* 、 *Solenopsis invicta*等。


白纹伊蚊

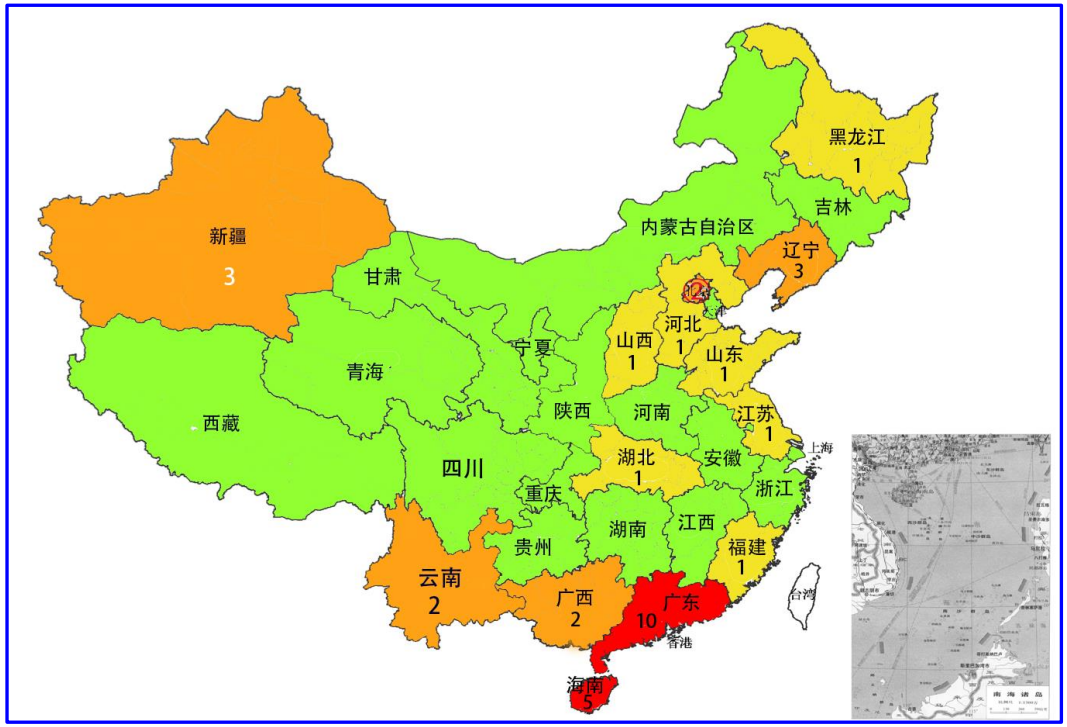

红火蚁

1. Introduction

(2) 中国林业外来入侵生物的发生

① Statistics of the first-discovered Province of the 38 major forest IAS.

中国38种主要林业入侵生物的首次发现省份统计。



- **Regional patterns of the first-discovered locations of the forest IAS**

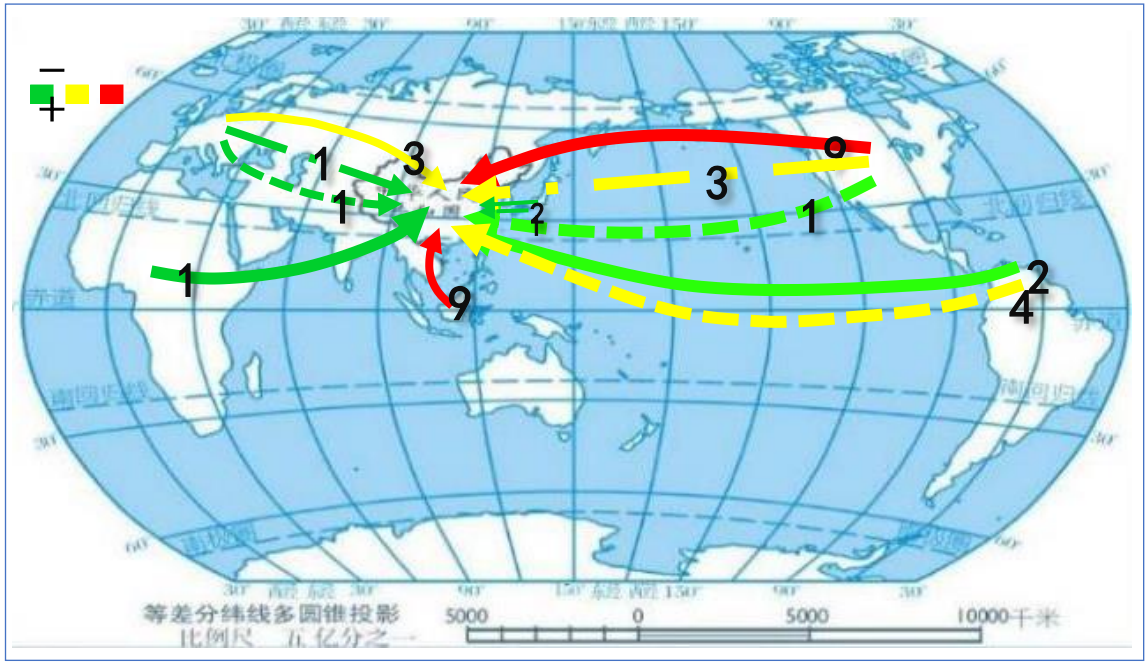
  林业外来入侵生物首次发现地的区域性规律

  - **Among China: centralizing along coastal areas ； 从中国看----沿海一带较集中**
  - **Among coastal areas: most frequently found in Guangdong (10 species), then Hainan (5 species); 从沿海一带看----广东最多（10种）其次为海南（5种）**

1. Introduction

② Native distribution of the 38 major forest IAS

中国38种林业入侵生物的原产地分布示意图



Invasive insects
入侵虫害

Invasive plant diseases
入侵病害

Invasive weeds
入侵杂草

- The native habitats of major forest IAS introduced to China are mainly distributed at the northern hemisphere, especially North America and Europe;我国的林业入侵生物的原产地主要在北半球，并以北美与欧洲为主；
- Although Russia is close to China, and the border is long, there is no forest IAS introduced to China.我国与俄罗斯邻近，且国境接壤线很长，却没有林业入侵生物传入我国。

1. Introduction

We found that the introduced pathways of them are almost **transverse, like crab moving sidewards.**

我们发现，中国林业外来生物的入侵路径以“横行霸道”为主，像螃蟹横行！

2. “Walking”of Vital Forest IAS in China and other countries

Therefore, in order to figure out why IAS all spread like "crabs", we want to explore mainly forest insect pests IAS.

以林业入侵害虫为例，探讨为什么林业外来入侵生物都像“螃蟹”横着走。

Why do we choose forest insect pests IAS?

我们为什么要选取林业入侵害虫？

- Living in the wild under natural conditions, rather than agriculture, flowers and other facilities (greenhouse) crops, under non-natural conditions;自然条件下生存，而非农业、花卉等设施（温室）作物，处于非自然条件下；
- The current distribution range is wide, and most of them are global quarantine pests;目前分布范围较广，且大多为全球性检疫性害虫；
- Host plants are more widespread;寄主植物较广泛；
- They cover a wide range of species, including wood borer, defoliator and sucking.类群覆盖全面，包括钻蛀、食叶、刺吸害虫类型。

2. “Walking”of Vital Forest IAS in China and other countries

(1) Introduced to China 传入中国

① ***Dendroctonus valens***（红脂大小蠹，**RTB, red turpentine bark beetle**）

② ***Hyphantria cunea***（美国白蛾，**mulberry moth**）

③ *Oracella acuta*（湿地松粉蚧，loblolly pine mealybug）

④ *Corythucha ciliata*（悬铃木方翅网蝽，sycamore lace bug）

red turpentine bark beetle

mulberry moth

loblolly pine mealybug

sycamore lace bug

2. “Walking”of Vital Forest IAS in China and other countries

① 红脂大小蠹 (*Dendroctonus valens*) red turpentine bark beetle

- Order: Coleoptera； Family: Scolytidae

Wood borer

D. valens is considered to be **a secondary pest** and is often associated with other, more aggressive bark beetle species. Tree mortality and outbreaks attributed to *D. valens* alone are rare in its native range.

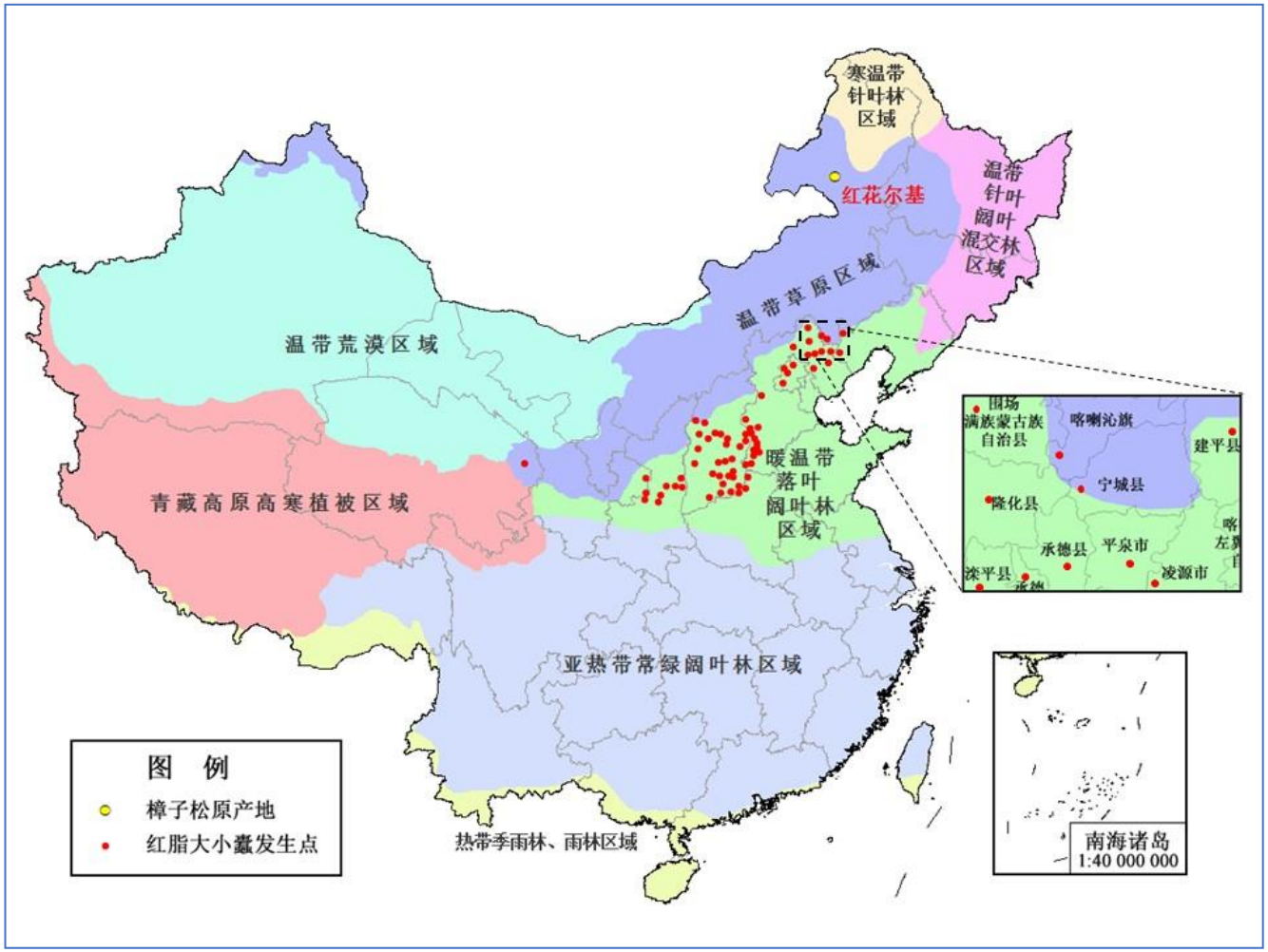
As **pines** are a major reforestation species in **China**, and ***P. tabuliformis*** is widely planted across a large portion of the country, damaged by this invasive bark beetle is **overwhelming**.

Native range

China

2. “Walking”of Vital Forest IAS in China and other countries

Current distribution of RTB in China

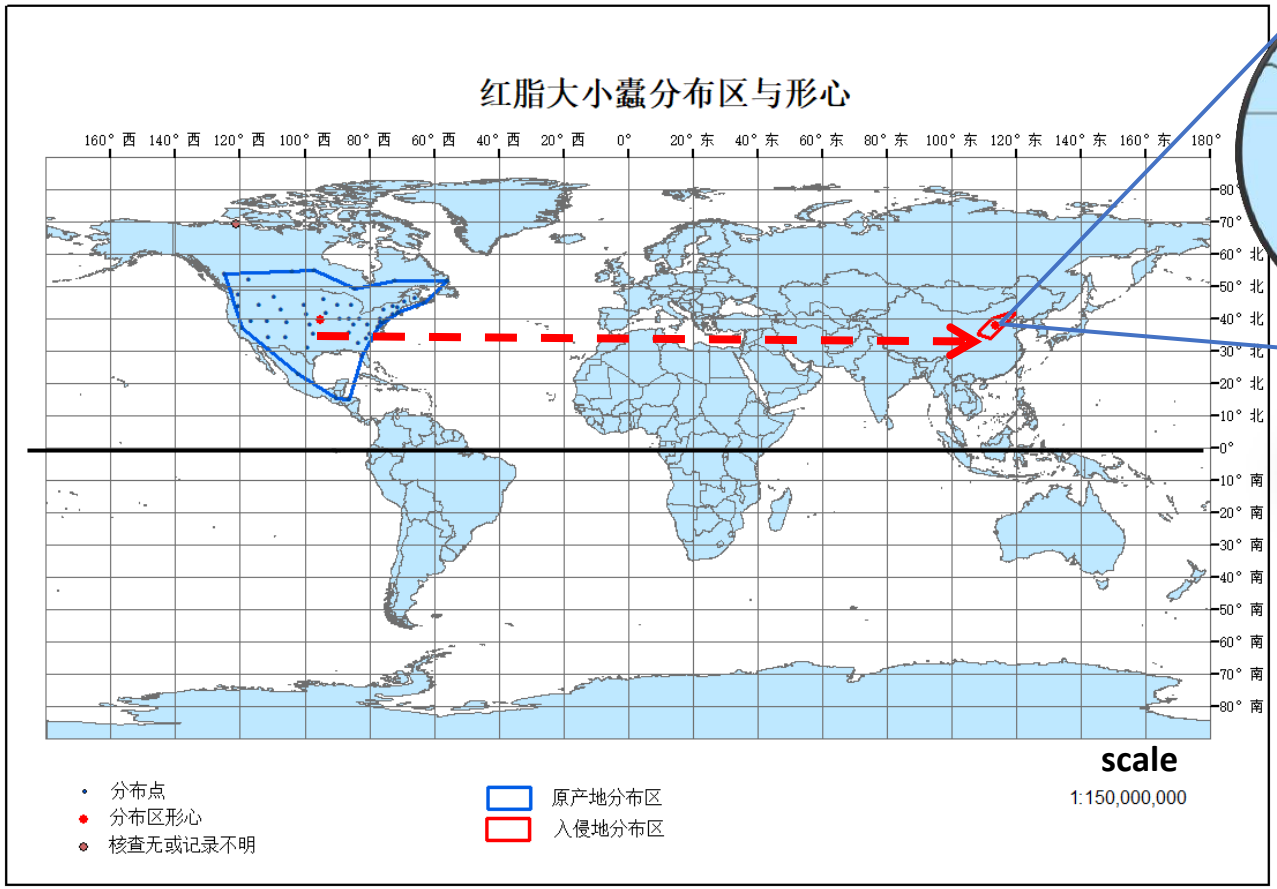


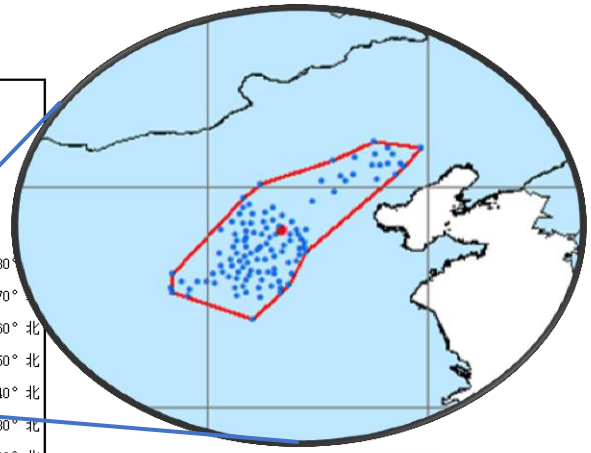
Vegetation area map of China and the occurrence point of RTB

中国植被区划图与红脂大小蠹发生点

2. “Walking”of Vital Forest IAS in China and other countries

Distribution region and geometric center of RTB





Equator
赤道

	Region	Longitude	Latitude	Latitude difference
Native range	North America	95.3778° W	39.8001° N	1.7296°
Invasive range	China	113.4033° E	38.0705° N	

2. “Walking”of Vital Forest IAS in China and other countries

② 美国白蛾 (*Hyphantria cunea*) mulberry moth

- Order: Lepidoptera； Family: Arctiidae

Defoliator

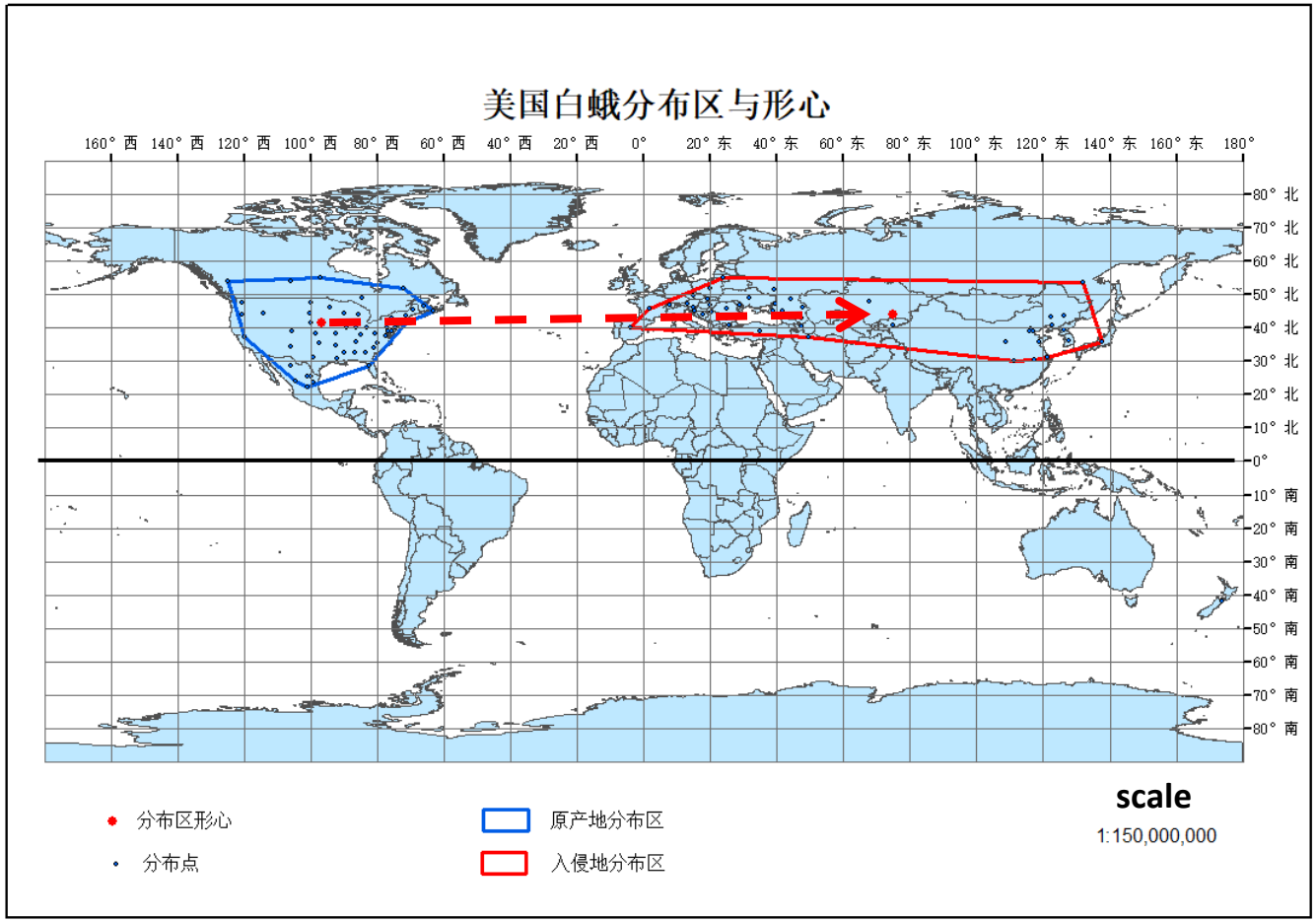
- *H. cunea* is native to North America, where it is widespread. Now, 40 years after its first introduction, it has probably reached the limits of its geographical range in Europe. Also now present in eastern Asia.
- For other parts of the world with a warm temperate climate (parts of South America, Australasia or Asia), *H. cunea* could be a quarantine pest. **It is listed as a quarantine pest by IAPSC**, probably in relation to North Africa.

Native range

China

2. “Walking”of Vital Forest IAS in China and other countries

Distribution region and geometric center of ***Hyphantria cunea***



Equator
赤道

	Region	Longitude	Latitude	Latitude difference
Native range	North America	96.6498° W	41.4697° N	
Invasive range	Eurasia	76.9402° E	42.3566° N	0.8869°

2. “Walking”of Vital Forest IAS in China and other countries

(2) Outgoing abroad 传出国外

- ***Anoplophora glabripennis***（光肩星天牛，Asian longhorned beetle）
- ***Agrilus planipennis***（白蜡窄吉丁，emerald ash borer ）
- ***Scolytus schevyrewi***（脐腹小蠹，banded elm bark beetle）
- ***Adelges tsugae***（铁杉球蚜，hemlock woolly adelgid ）
- ***Lycorma delicatula***（斑衣蜡蝉，spotted laternfly）

Asian longhorned beetle

emerald ash borer

banded elm bark beetle

hemlock woolly adelgid

spotted laternfly

2. “Walking”of Vital Forest IAS in China and other countries

① 光肩星天牛(*Anoplophora glabripennis*) Asian longhorned beetle

Wood borer

- Order: Coleoptera； Family: Cerambycidae

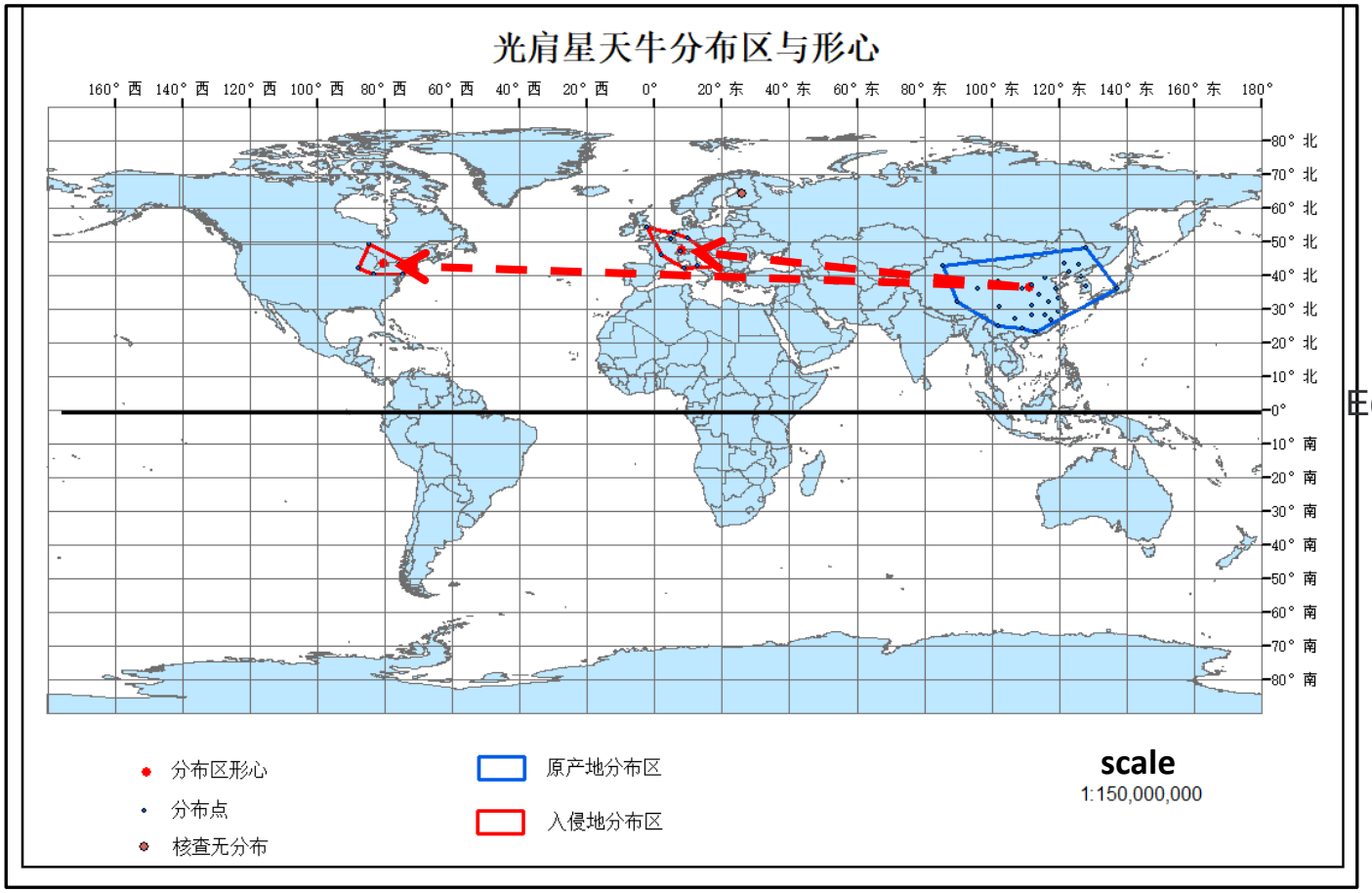
- Widespread planting of **susceptible poplars** in China led quite rapidly to the build-up and spread of *A. glabripennis.*
- In North America, the pest is actively spreading **in urban environments**. Attention was drawn to *A. glabripennis* by its introduction into the USA, where a major **eradication programme** is underway, and strong measures have been taken to reduce the risk of further introduction with **wood packing** from China.

China

Invasive range

2. “Walking”of Vital Forest IAS in China and other countries

Distribution region and geometric center of ***Anoplophora glabripennis***



Equator
赤道

	Region	Longitude	Latitude	Latitude difference
Native range	Asia	111.4667° E	36.2915° N	
Invasive range	North America	80.4205° W	43.5496° N	7.2581°
	Europe	8.0611° E	47.3050° N	11.0135°

2. “Walking”of Vital Forest IAS in China and other countries

② 白蜡窄吉丁(*Agrilus planipennis*) emerald ash borer

- Order: Coleoptera； Family: Buprestidae

Wood borer

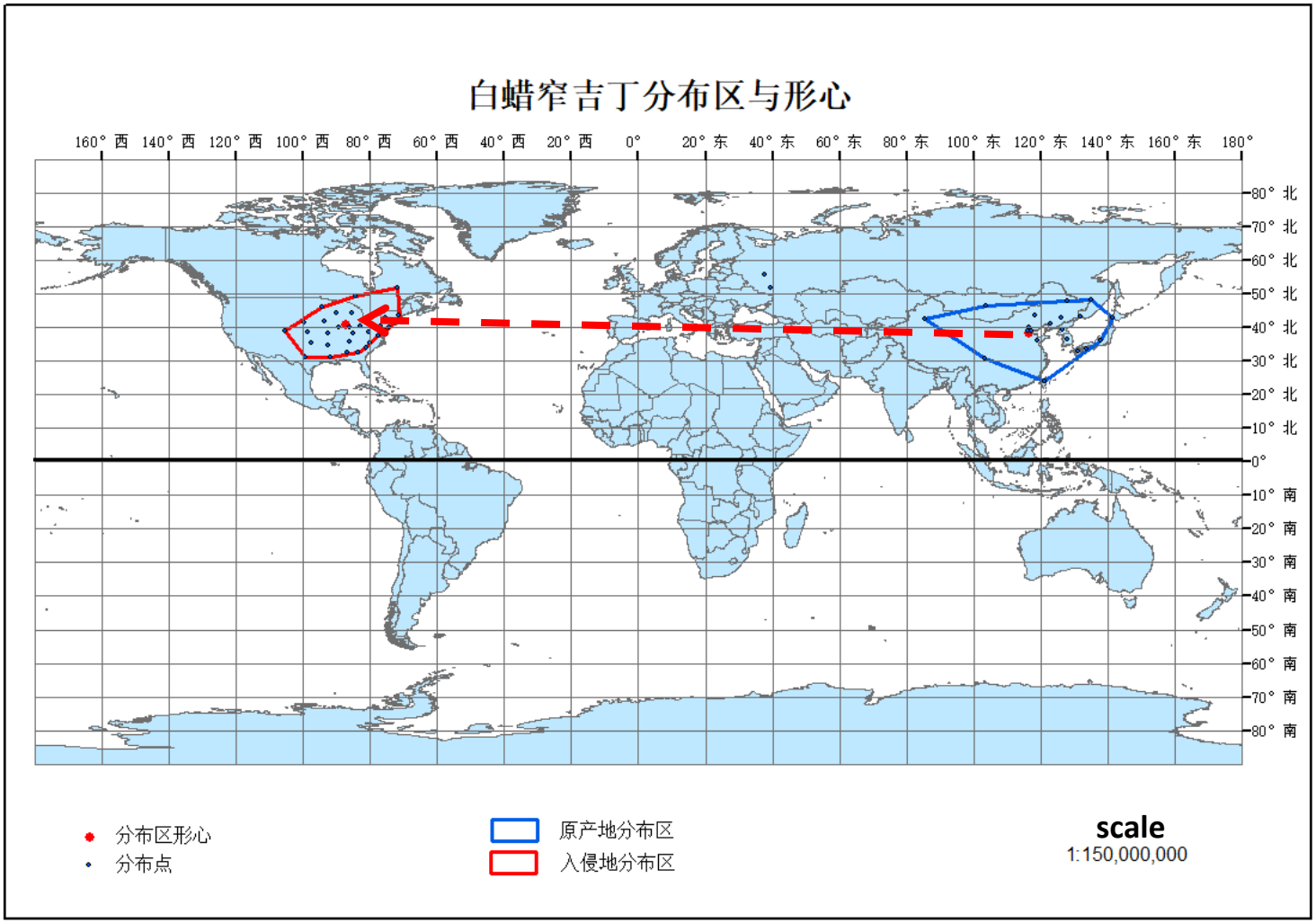
- *A. planipennis* is an East Asian wood-boring beetle that is presently causing dramatic damage to ash (***Fraxinus* spp.**) in the USA and Canada, mainly through the transport of infested **firewood** and other **wood products**.
- In about 10 years, it is estimated that the beetle has killed over 30 million **forest and ornamental trees**, causing significant **economic damage** as well as serious concern for the survival of several **ash species** and related **biodiversity and ecosystems** in North America.

China

Invasive range

2. “Walking”of Vital Forest IAS in China and other countries

Distribution region and geometric center of ***Agrilus planipennis***



Equator
赤道

	Region	Longitude	Latitude	Latitude difference
Native range	Asia	116.5116° E	38.2242° N	2.5570°
Invasive range	North America	87.1330° W	40.7812° N	

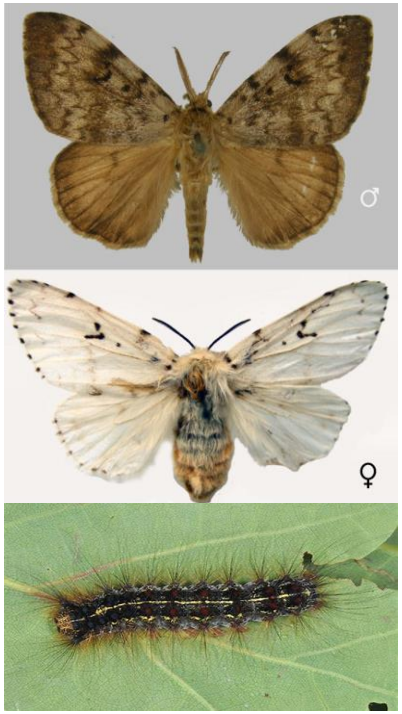
2. “Walking”of Vital Forest IAS in China and other countries

(3) Other special cases 其他特殊事例

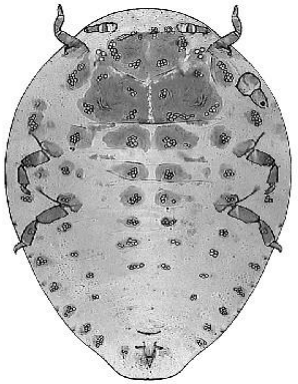
- ***Sirex noctilio*（松树蜂，European woodwasp ）**
- ***Lymantria dispar*（舞毒蛾，gypsy moth ）**
- ***Brontispa longissima*（椰心叶甲，coconut hispine beetle）**
- ***Adelges piceae*（冷杉球蚜，balsam woolly adelgid）**

European woodwasp

coconut hispine beetle



gypsy moth



balsam woolly adelgid

2. “Walking”of Vital Forest IAS in China and other countries

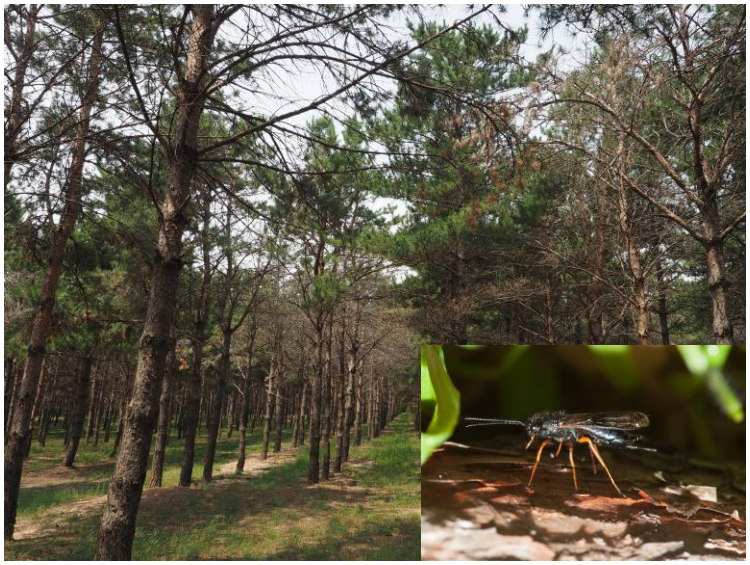
① 松树蜂(*Sirex noctilio*) European woodwasp

- Order: Hymenoptera； Family: Siricidae

Wood borer

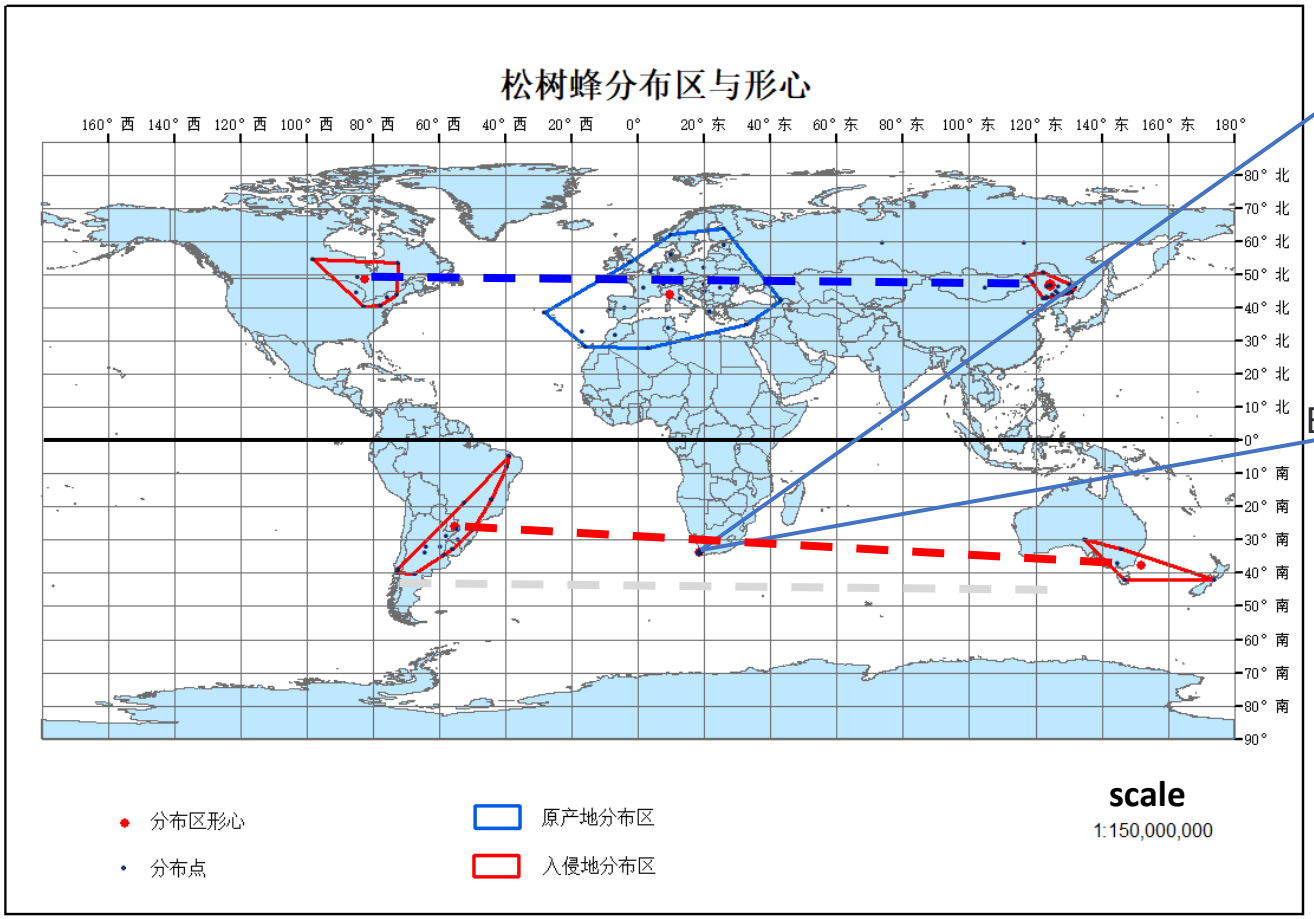
- *S. noctilio* probably entered New Zealand and Australia from Europe via **sea ports**, in cargo heavily infested with larvae and adults of siricid species. In South Africa and South America, it could have been introduced in **solid wood packing material (SWPM)**.
- This pest is an **A1 quarantine pest** for several areas: for example, USA, Japan and Canada.

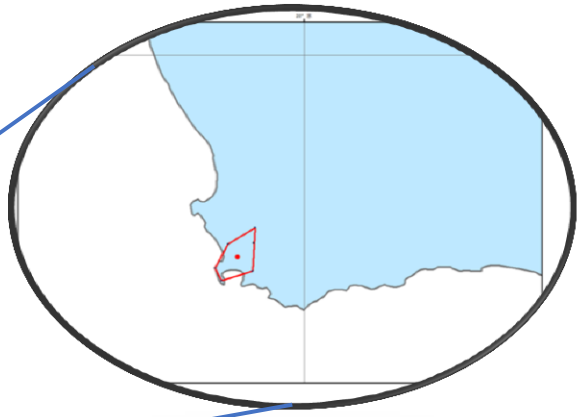
Native range



China

Distribution region and geometric center of ***Sirex noctilio***





Equator
赤道

- 北半球：原产地域入侵的横向一致性
- 南半球：入侵地的横向一致性

“南半球无松树”

	Region	Longitude	Latitude	Latitude difference
Native range	Europe and North Africa	9.5533° E	43.8086° N	
Invasive range	China	124.5564° E	46.6519° N	
2.8433°				
	North America	82.4408° W	48.4240° N	4.6154°
	Oceania	151.9853° E	37.8673° S	
5.9413°				

2. “Walking”of Vital Forest IAS in China and other countries

② 舞毒蛾(*Lymantria dispar*) gypsy moth

- Order: Lepidoptera； Family: Erebidae

Defoliator

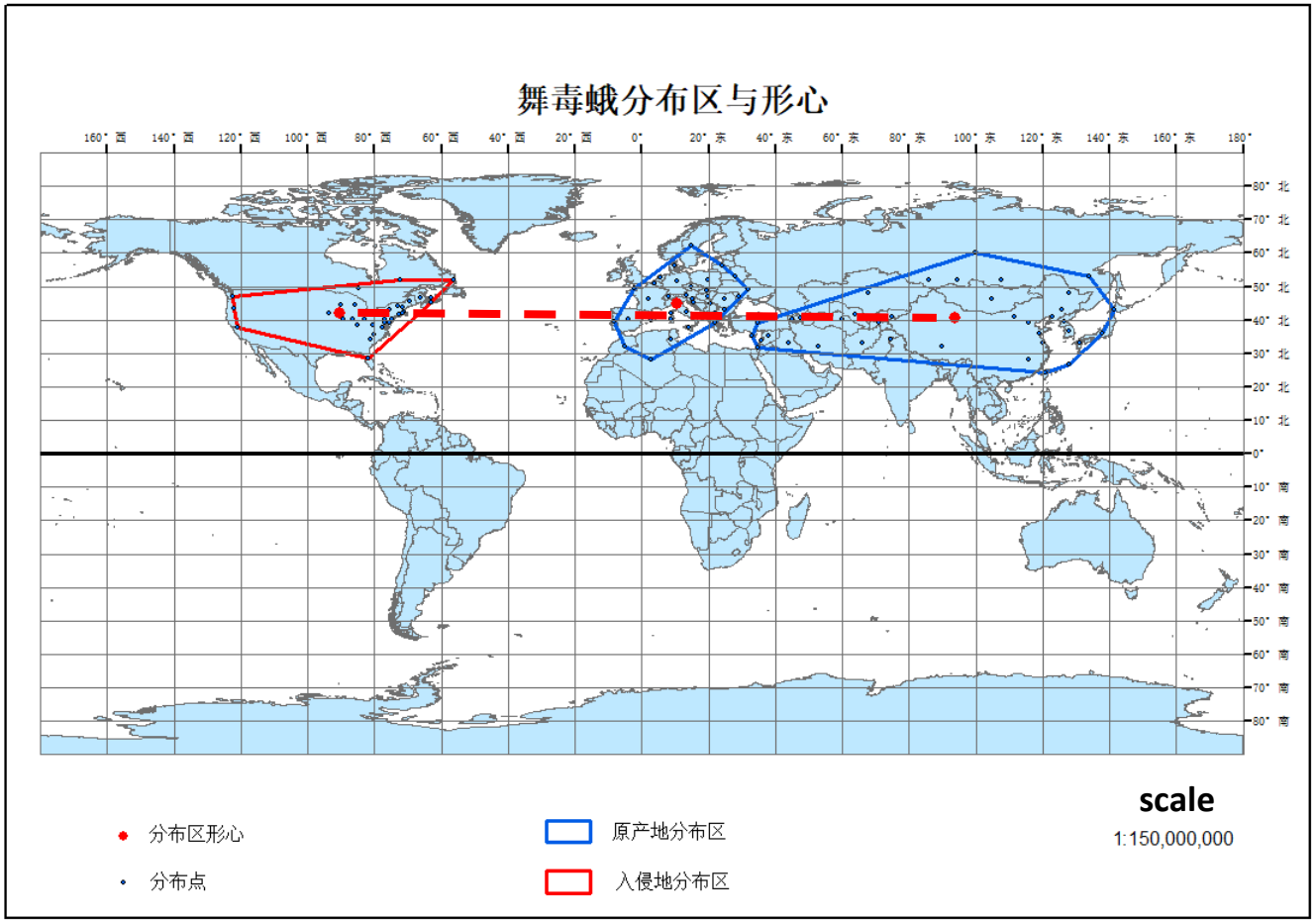
➢ The gypsy moth is likely to ultimately occupy virtually **all portions of the temperate world where oaks and other suitable host plants occur**. The broad range of host plants that it utilizes (Liebhold et al. 1995), along with its **high reproductive rate** combine to make this insect a very successful invader of many types of forest and urban landscapes.

Europe/**China**

North America

2. “Walking”of Vital Forest IAS in China and other countries

Distribution region and geometric center of ***Lymantria dispar***



Equator
赤道

	Region	Longitude	Latitude	Latitude difference
Native range	Europe	10.7312° E	44.7480° N	
	Asia	93.8263° E	40.5009° N	
Invasive range	North America	90.4607° W	41.9109° N	2.8371°

Summary of geometric center latitude differences between major IAS native and invasive range

主要IAS原产地与入侵地形心纬度差汇总表

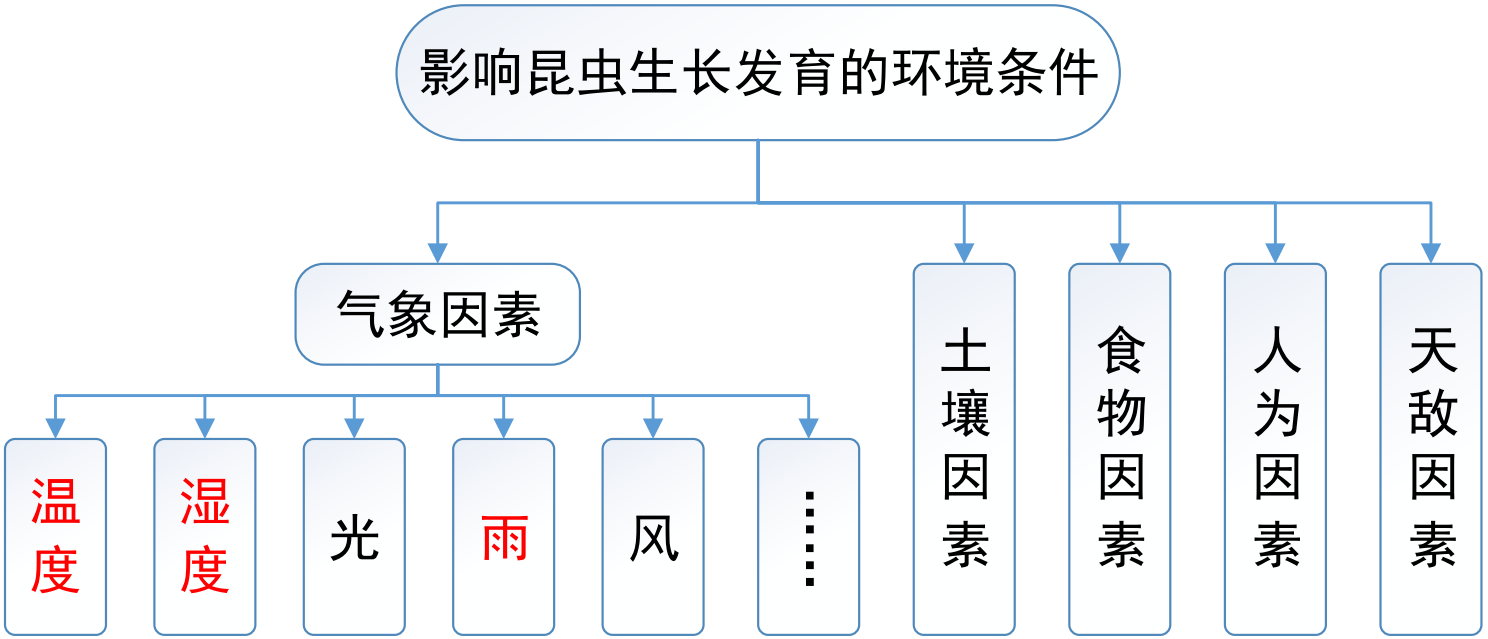
Species	Native range			Invasive range			Latitude difference
	Region	Geometric center		Region	Geometric center		
		Longitude	Latitude		Longitude	Latitude	
Hyphantria cunea	North America	96.6498° W	41.4697° N	Eurasia	76.9402° E	42.3566° N	0.8869°
Dendroctonus valens	North America	95.3778° W	39.8001° N	China	113.4033° E	38.0705° N	1.7296°
Corythucha ciliata	North America	86.1318° W	39.8935° N	Europe	14.6557° E	44.6395° N	4.7460°
				Asia	127.5837° E	35.0876° N	4.8059°
Oracella acuta	North America	88.3097° W	36.8100° N	China	113.7553° E	24.5518° N	12.2582°
Agrilus planipennis	Asia	116.5116° E	38.2242° N	North America	87.1330° W	40.7812° N	2.5570°
Scolytus schevyrewi	Asia	100.3924° E	45.2556° N	North America	100.8293° W	41.5297° N	3.7259°
Anoplophora glabripennis	Asia	111.4667° E	36.2915° N	North America	80.4205° W	43.5496° N	7.2581°
				Europe	8.0611° E	47.3050° N	11.0135°
Lycorma delicatula	Asia	110.2413° E	32.7013° N	America	76.0745° W	40.9312° N	8.2299°
Adelges tsugae	Asia	109.7393° E	28.5178° N	North America	107.1365° W	46.2661° N	17.7483°
Adelges piceae	Europe	11.3392° E	48.1610° N	North America	97.9481° W	48.1734° N	0.0124°
Brontispa longissima	Southern Hemisphere	142.3726° E	15.0519° S	Northern Hemisphere	104.0322° E	13.5925° N	1.4594°
Lymantria dispar	Europe	10.7312° E	44.7480° N	North America	90.4607° W	41.9109° N	2.8371°
	Asia（亚洲型）	93.8263° E	40.5009°				

3. The Enlightenment of Regional Warning of Forest IAS

(1) Why Forest Insect Pests IAS spread like "crabs"?
那么，为什么林业入侵害虫会出现“横着走”？

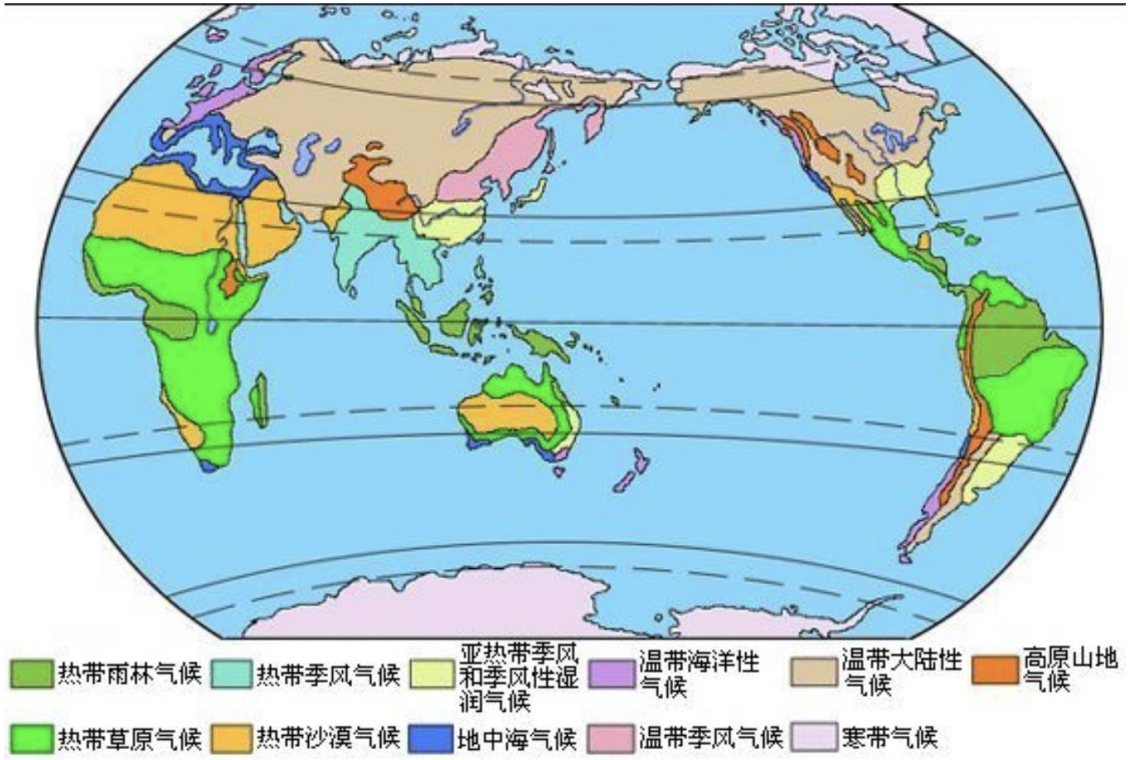
- Climate affects insect distribution, growth and development, phenological synchronicity, interspecies relations, and community structure……

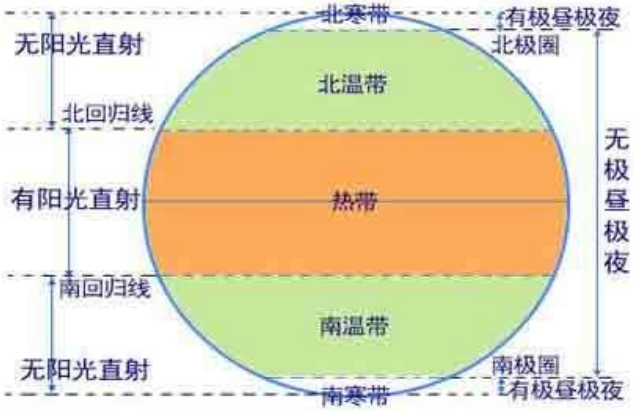
气候会影响昆虫的分布，生长发育，物候同步性，种间关系和群落结构等方面…



➢ Biogeography-the similarity of climate

生物地理——气候的相似性





五带的划分

3. The Enlightenment of Regional Warning of Forest IAS

- In the northern hemisphere, the higher the latitude, that is, the farther north the geographical climate, the lower the diversity of species in plants -- Finland, for example, has few invasive species.在北半球，纬度越高，即越往北的地理气候带，植被的物种多样性越低——例如：芬兰少有外来入侵种
- The species diversity in the forest types of the mountain ranges in different latitudes represented the species diversity in the latitudes, and the statistical comparison was conducted.

Vegetation diversity in typical mountain areas of different latitudes in China

中国不同纬度典型山区植被多样性比较

纬度（° N）	山	基部植被带类型	基带乔木	基带灌木	基带草本	基带总植被	备注（参考文献等）
19	五指山	雨林带	54科123属221种	----	----	----	海南岛五指山的森林植被
27	武夷山	常绿阔叶林	134种	82种	----	191科780属1815种	武夷山自然保护区维管束植物名录
30	峨眉山	常绿阔叶林	36科113属211种	27科70属	30科66属	72科130属	四川省峨眉山森林植被垂直分布的初步研究`
33	伏牛山	常绿阔叶林	31科47属106种	----	----	37科87属298种	河南伏牛山常绿阔叶植物及垂直分布规律初步研究
34	秦岭太白山北坡	落叶阔叶林	29科44属69种	----	----	----	太白山北坡植物物种多样性及其垂直分布格局研究
35	中条山	落叶阔叶林	----	----	----	108科356属612种	中条山植被垂直带谱再分析*
40	雾灵山	落叶阔叶林	----	----	----	101科362属702种	雾灵山主要植被类型及垂直分布规律
42	长白山	阔叶红松林	12科19属33种	----	----	132科480属1189种	中国长白山植物区系的垂直分布格局

3. The Enlightenment of Regional Warning of Forest IAS

(2) Future enlightment for global Forestry Insects Pests IAS warning:今后对全球林业入侵害虫预警的启示：

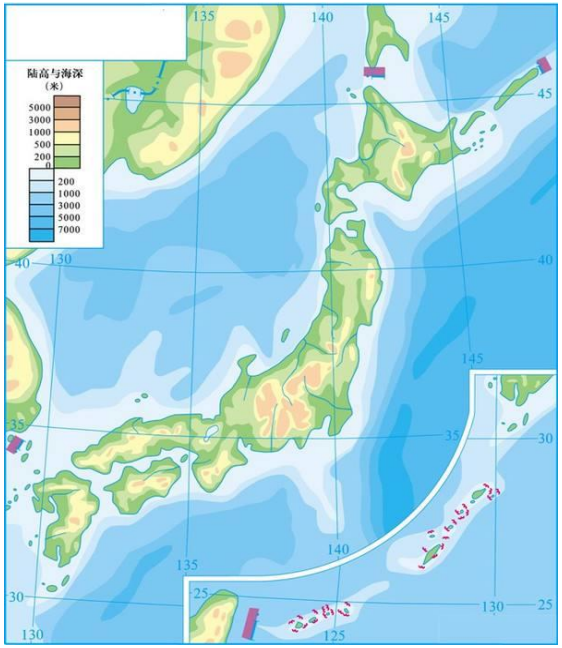
- **Pay attention to the similar law of biogeographic climatic belts.**注意把握生物地理气候带相似的规律。
- **In general, the spread of invasion pests in forestry conforms to the rule of "walking sideways", so it is necessary to focus on the right and left "neighbors" rather than up and down.**大体上，林业入侵害虫传播符合"横着走"的规律，因而须重点提防左右"邻居"，而非上下邻居。

- For example - reports of rare invasive creatures **in China and Russia.**

例如—— **中国和俄罗斯**少见入侵生物的报道。

3. The Enlightenment of Regional Warning of Forest IAS

- **Large span of northern and southern latitudes: countries with rich biogeographic belts have high invasive risks, and should carry out a transversely targeted** regional early warning according to the characteristics of biogeographic belts. 南北纬度跨度大：生物地理带多样的国家入侵风险大，应根据生物地理带特性进行横向针对性的区域预警。如**Japan, Chile, etc.** 如日本、智利等。



Japan

24° 2′-45° 31′ N，纬度差21° 11′

Invasive insects: *Aedes albopictus, Bemisia tabaci,*

Chile

18° -57° S，纬度差39°

Invasive insects: *Hylastes ater, Sirex noctilio, Linepithema humile*

etc. （7 specie

Source： GISD CHINESE

3. The Enlightenment of Regional Warning of Forest IAS

- **Low-latitude countries or regions with large east-west spans (Indonesia) have low invasive risk.** 低纬度东西跨度大的国家或地区（印度尼西亚）入侵风险小。

Indonesia

12°S-7°N，纬度差19°；

96°-140°E，经度差44°

Invasive insects: *Solenopsis geminate, Diaphorina citri* etc. （5 species）

3. The Enlightenment of Regional Warning of Forest IAS

- **Large land area: like China and the United States have highest risk.** 国土面积大：中国、美国等风险最高。

the United States

25°-49° N，纬度差24°；

70°- 130° W，经度差60°

Invasive insects:

Anoplophora chinensis,
Apis mellifera scutellata，
Ceratitis capitata，
Diaphorina citri，
Linepithema humile，
Myrmica rubra，
Ochlerotatus japonicus japonicus，
Quadrastichus erythrinae
etc……（44 species）

Source： GISD CHINESE


Thank you !
感谢聆听
祝工作顺利