Why introductions are so devastating;
Importance of "naive hosts" and effect on resistance

loss of natural enemies (mostly for introduced insects)

**Introduced Pathogens:**

**White pine blister rust** *Cronartium ribicola*

Life cycle review

appears to have come from Northern Asia where *Pinus cembra* is its main pine host

First recorded in Europe from the Baltic region in 1854
by 1900 widespread across Europe - rapid spread by forest tree nurseries

Introduced in North America probably by 1898 on nursery stock from Europe, definitively recorded in Geneva New York and seven other states by 1900

Discovered in Vancouver BC in 1921 on *Ribes nigra* and young exotic pines. - by 1922 it was found widely in BC and the Northern Cascades of Washington state; entire epidemic appears to have originated from a single batch of 1,000 seedling imported from France.

Other "strains" of rust are known from Asia some with different alternate hosts and one with no alternate host.

**Control efforts** - elimination of Ribes, impossible on large scale

**Selection for resistance** in sugar pine - based on single gene trait
Horizontal traits are also being selected

Fate of North American White pines?
- Impact on Sugar pine
- impact on Western White Pine
- impact on high elevation white bark pine

**Dutch Elm disease** *Ophiostoma (Ceratocystis) ulmi*

Life cycle of disease: Pathogenic versus Saprophytic stages,; transmission via root graphs,
- pathogenic phase - tree still living, most inoculum is mitotic
Saprophytic state - tree is dead or nearly dead, multiple beetles arrive and bring in additional strains and mating types, meiotic state occurs

Beetle vectors; European elm bark beetle (*Scolytus multistriatus*) and the Native elm bark beetle (*Hylurgopinus rufipes*)

History of epidemic
Appears in France, Belgium, and Germany between 1918-1921
origin of disease remains unknown
Arrival in Eastern US in late 20s, established in New York and effecting 5500 sq miles by 1940
strain transported to Ohio 1928 via diseased logs
New epidemics in Europe, Aggressive strains recognized in Europe 1971
Differences in aggressive and non-aggressive strains – now recognized as different species (*O. nova-ulmi* & *O. ulmi*)
- arrival from two sources (Brazier's map)

Control efforts: "sanitation" for management within cities; chemical treatment of specimen trees, breeding for resistance

Importance of elm prior to disease, and predictions about its future
5 spp in eastern forest - major upper floodplain dominant

 mass blight *Cryphonectria (Endothia) parasitica*
Life cycle of pathogen, both asexual (orange pycnidia) transmitted by animal vectors and wind borne sexual reproduction (ascospores) are common, wounds are necessary for entry, but many are so small that they are hardly recognizable as wounds

First seen at Bronx Zoo in 1904 may have been introduced by seed or more likely seedlings. By 1940 it had spread throughout the natural range and destroyed and estimated 4 billion trees.

Chestnut's position prior to blight: 1/4 of trees in Appalachian forests. Human and wildlife food, Tanning industry, highly rot resistant wood.

Hypovirulence discovered in Italy in 1950, trees recovering
Later found to be a double-stranded RNA mycovirus

Transfer of DS- RNA naturally through hyphal anastomosus

Genetic engineering of fungus - Nuss
insertion of viral genome into Chryphonectria nuclear genome
Test release in New England forest  
Further modifications of viral genome - decoupling of sporulation & virulence

Other examples

**Fusarium circinatum** (= subglutinans f.sp. pini)- Pitch Canker  
first seen in California in 1986, simple population-genetic structure  
host range - primarily Pinus spp. esp. the coastal pines,  
Douglas-fir too?  
Vectored by lots of insects: twig beetles (*Pityophthorus* spp., *Ernobius punctulatus*) Cone beetle (*Conophthorus radiatae*), engraver beetles (*Ips spp*),

This last year it has become a problem at Pt. Reyes

**Phytophthora cinnamomi** Australian forests (you read about this in Dickman's chapter)  
in dry sclerophyll forests & heathlands

**Phytophthora lateralis** on Port Orford Cedar (*Chamaecyparis lawsoniana*) first  
seen in nursery stock in 1923 Asian *Chamaecyparis* resist it.

**Phytophthora ramorum** sudden oak death  
Kills large number of oaks in Marin county in 1995 (probably arrived earlier); identified in Europe earlier  
Currently coastal California forests up to Oregon; symptomatic trees in the Sierra (e.g. Blodgett)  
Moved by Nursey stock to East Coast of US April 2004

Dogwood Anthracnose - *Discula destructiva*  
pacific northwest then Eastern US mid 1970s  
Japanese dogwood is resistant  
projections for East coast

Butternut canker - *Sirococcus clavigignenti-juglandacearum*; origin unknown,  
discovered in Wisconsin 1967, butternut is now an endangered species

Beech bark disease - interaction between a scale insect *Cryptococcus fagi* and a  
canker fungus *Nectria coccinea* var. *faginata*; first seen in North America in 1920, imported with European beech - now spread throughout the the Northeast.
Guava rust - *Puccinia psidii* -, broad host range in Myrtaceae, native to South America, **kills all species of Eucalyptus tested**. S. American origin, already transported to Taiwan and S. Africa

**Some general rules:**

1) **The problem is clear international and growing**

2) **Consequences of introductions can be catastrophic**, and at least some of these have been avoidable.

3) **Once an introduction happens little can be done** - things that have been tried include: eradication of alternate host (white pine blister rust), breeding for resistance (white pine blister rust), Hybrids with non-native related species (chestnut blight, dutch elm disease); mycoviruses (chestnut blight); other biocontrol (gypsy moth). **On the pathogen side there are no success stories.**

4) **The diseases are often unknown or of minor importance in their native range;** therefore predicting risk of importation is not possible.

5) **Scientific names of pathogens are deceiving.** Frequently cryptic species, varieties, or strains vary significantly in host range or virulences (e.g. dutch elm disease)

**References**

**General**
Your book deals with most of the individual pathogens (Chestnut blight, White pine blister rust, dutch elm disease, pitch canker, Phytophthora, Beech bark disease), but does not have a general section on introductions.

**Specific (in case you want more information)**