**Figure 1.2** Gross Primary Productivity of terrestrial ecosystems. The major vegetational systems of the world may be relatively simply characterized with reference to two main environmental variables: mean annual temperature and mean annual precipitation (after Whittaker, 1970); superimposed on the diagram are representative values for the gross primary production (kJ m$^{-2}$ yr$^{-1}$) for a number of such systems (values derived from McNaughton *et al.* (1989)).
Present Potential Vegetation

- Closed Forest (>70% canopy cover)
- Extreme Desert (<2% vegetation cover)

Last Glacial Maximum (18,000 $^{14}$C years ago)

- Closed Forest
- Extreme Desert
- Glacial Ice

Jonathan Adams, Environmental Sciences, Oak Ridge Natl. Lab
Figure 17-1. Diagrammatic relationships of major vegetation types in the southern Sierra (~37°N) in relation to elevation and moisture.
Figure 2-12. Changes with altitude of mean annual temperatures and precipitation over the Sierra Nevada along the transect of Fig. 2-11. Temperatures on west slope O, on east slope ●. Precipitation on west slope Δ, on east slope △.
"Profile of the Southern Sierra Nevada showing a typical distribution of the tree species."

increasing shade tolerance

- giant sequoia
- most pines
- most oaks
- Douglas-fir
- sugar pine
- true firs
- incense cedars
- hemlock
Problems with a climax view

• Long-lived pioneers can prevent climax from occurring (e.g. redwood)
• Disturbance is inevitable
• The view of communities as real entities is erroneous
“the Modern view”

- Communities are human constructs
- Equilibrium is seldom, if ever, reached
- Plant diversity results from a patchy distribution of disturbance in time and space (its chaotic)
Figure 2.9
A, In the absence of disturbance, shade-tolerant species B increases first in the understory, and slowly replaces species A in the overstory as older trees die. B, In the presence of frequent, low-intensity fires, which thin the stands from below, both species A and B coexist on the site, as growing space is periodically opened for the less shade-tolerant species A, and smaller size classes of species B are selectively removed from the stand by fire.

Figure 2.10
A, In the absence of disturbance, shade-tolerant species D increases first in the understory, and slowly replaces species C in the overstory as older trees die. B, In the presence of periodic windthrows, which thin the stands from above (e.g., take larger trees), enough understory openings exist that both species codominate the site.
Problems with modern view

- Although the importance of disturbance is realized the agents involved in it are often misunderstood, ignored, and underestimated.
- Insects and pathogens are seldom mentioned, even though "gaps" in the forest are frequently caused by them.
- The importance of density dependent selection is appreciated but the roles of disease and to a lesser extent insects are grossly understudied.
- Trees do not die of old age - they are actively killed either by abiotic or biotic agents or a combination of both. Predisposition is important.
- Although fire has been recognized as a significant disturbance agent it is often taught as an all or nothing phenomena - the differential effects of various fire regimes and their specific interactions with plants, plant diseases, and insects are not commonly taught.
- The role of human actions are usually ignored or viewed as unnatural intrusions into a natural system, but today these are some of the dominant influences.
Descriptors of Disturbance Regimes from Edmond et al 2000

- Type (e.g., fire, insect, disease, etc.)
- Frequency (mean number of event/time)
- Predictability (variance in frequency)
- Severity (Effect on ecosystem, mortality of dominants)
- Magnitude (intensity of event, best with physical disturbances)
- Extent (area covered)
- Timing (season)
- Synergy (interaction between disturbances)
Effects of Compound Disturbances - Paine et al.  
1998  Ecosystems 1:535-545
With a single R gene in the plant, the loss of the avr gene in the fungus will overcome resistance.
In a three gene system, loss of any two avr genes still results in resistance.
Models for interactions between products of R genes and Avr genes.

## Gene for Gene (vertical) resistance
### Single factor model

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<th>Pathogen genotypes</th>
<th>RR</th>
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<th>rr</th>
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<tr>
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<table>
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Gene for gene model
2 factors

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<th>R1- r2r2</th>
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<tbody>
<tr>
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<tr>
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<tr>
<td>a1a1 a2a2</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>
Model of Nucleotide Binding Sequence NBS
Leucine Rich Repeat genes.
What are the community-level effects of disease (and insects) on plant communities?

- Selection of species best suited for a site (maintenance of geographic range)
- Maintenance of diversity (selects against monocultures)
- Selects for genetic diversity within species
- Driving forest in succession
Sulfur dioxide source and foliar damage
Photochemical smog

light

$O_2 + NO_3 \rightleftharpoons O_3 + NO$

$O_3 + NO + \text{hydrocarbons} \rightleftharpoons \text{PAN (peroxyacetyl nitrate)}$
Ozone damage on Ponderosa pine
Dodder - *Cuscuta* sp. a parasitic plant
Dodder - a close-up
Mistletoes

Dwarf Mistletoe on pine

Leafy Mistletoe on oak
Bacterial scorch of red oak

Bacterial scorch-like symptoms of California buckeye

Images from Diseases of Trees and Shrubs
Sinclair et al. 1989
Elm Yellows - caused by a “MLO”

Bacteria in vessel

Images from Diseases of Trees and Shrubs. Sinclair et al. 1989
Blackline disease of walnut, cause by Cherry leafroll virus

Images from Diseases of Trees and Shrubs. Sinclair et al. 1989