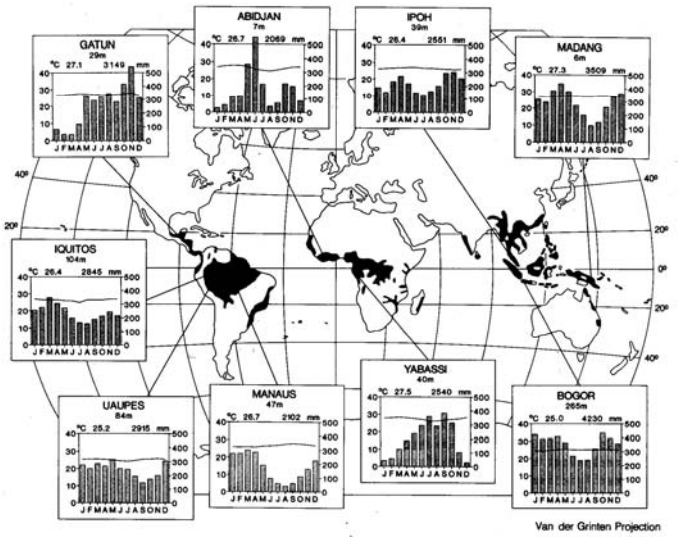
Tropical rainforests



Tropical rainforest formations

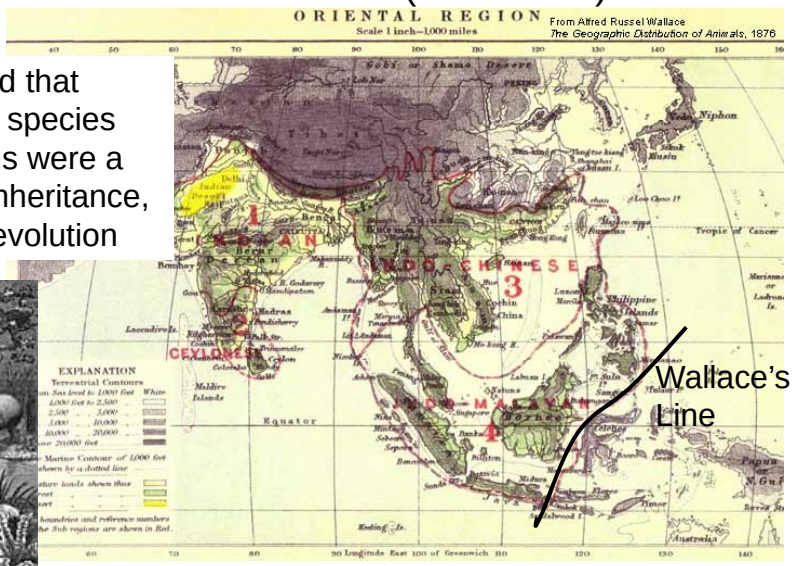
- American formation about 50% of total tropical land area (neotropics)
  - Amazon and Central America
- Equatorial Africa (20%)
  - Congo Basin
  - lower biodiversity than American or Asian
- Southeast Asia (30%) are also important (paleotropics)

Biogeographic legacies

- Indo-Malaysian formation is spread across many islands now, but 10,000 yrs ago when sea level was lower (water was frozen in ice caps), continental shelves connected many of the islands

Biogeography and Evolution

Alfred Russel Wallace (1823-1913)



Recognized that patterns of species distributions were a legacy of inheritance, recording evolution

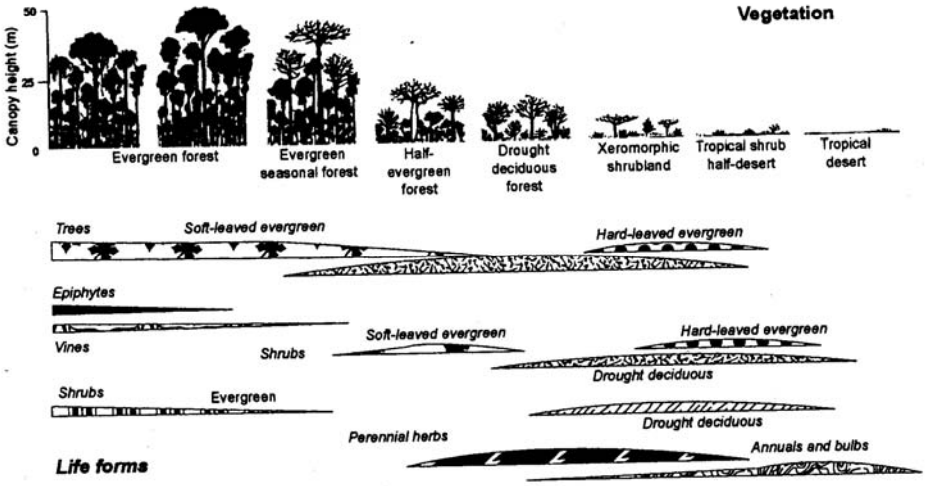
http://evolution.berkeley.edu/evolibrary/article/_0_0/history_16

Tropical climate (1)

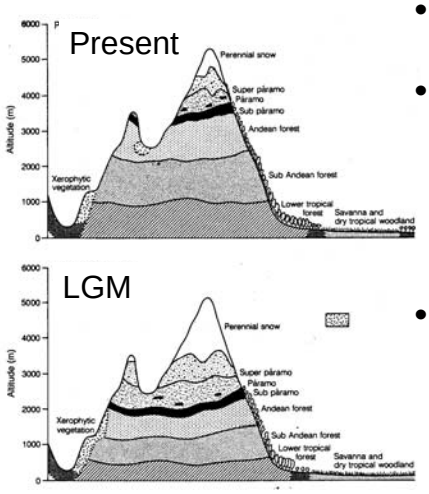
- Tropical rainforest climate is warm and wet; mean monthly temperature >18°C and minimum monthly precipitation is 60 mm. High P/E ratio.
- Diurnal temperature range (~10°) may exceed seasonal range (<5°)
- Precipitation seasonality, due to migration of ITCZ, affects large-scale vegetation patterns
  - Monsoonal areas have lower species diversity and more deciduous species
  - Teak has datable tree rings

Tropical climate (2)

- In general, precipitation regime determines dominant life forms



Tropical climate (3)



- Mountainous areas have distinct elevation zonation
- Pleistocene climate fluctuations probably contributed to evolution of diverse flora in American tropics; many relict species in topographic refugia
- Ice age conditions promoted more species interchange in SE Asia as islands became connected, and drier conditions in Africa; these formations are somewhat less diverse

Tropical evergreen forest types

- Lowland forests
- Alluvial forests
- Montane forests
- Cloud forests
- Drought-deciduous forests

Lowland forests: multilayered structure; emergent canopy trees over 30 m tall, sparse undergrowth, lianas & epiphytes are rare

Sumatra

12/2/09

Alluvial forest: multilayered, closed forest with many gaps; flooding frequency makes buttresses and stilt roots common

12/2/09

http://www.marencolodge.com/corcovado_national_park.htm

Montane forest: few trees >30 m tall; more light penetrates so palms, epiphytes and ground cover are more common

http://www.brazadv.com/brazil_tours/montane_rain_forest.asp

Cloud forest: closed forest structure with many gaps, numerous lianas & epiphytes; extensive ground cover of mosses & ferns

Alakai Swamp, Hawaii http://starbulletin.com/97/01/02/news/story4.html

Seasonal or semi-deciduous forests have evergreen and drought-deciduous trees; evergreen shrubs and saplings in understory; epiphytes are drought resistant (CAM photosynthesis in many Bromeliads, especially where seasonal drought is common)

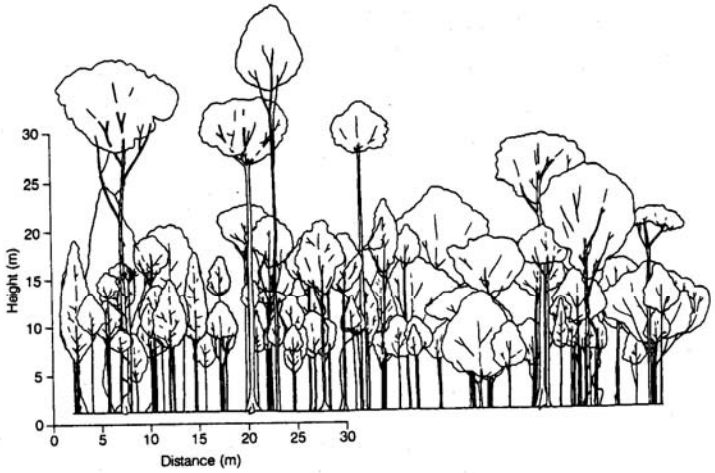
Teak forest, Thailand, dry season wet season

http://www.bfafh.de/inst4/42/tropen1.htm

Tropical forest structure and adaptations

- Canopies are multi-layered with emergent trees reaching 50 m tall (also see Figure)
- Most biomass is above ground

What is missing from this figure?



Tropical forest structure and adaptations

- Climbing lianas are common, especially in gaps; rattan is a genus of climbing palm which can reach 165 m

Tropical forest structure and adaptations

- Epiphytes may comprise 50% of tree leaf biomass in moist, montane forests. Myrmecophilous epiphytes get nutrients from ants housed in specialized structures provided by the plants

Tropical forest structure and adaptations

- Buttresses and stilt roots are common partly because roots are shallow (nutrients mainly in litter).
- Measuring DBH is challenging; leads to large uncertainties in biomass estimates

Tropical soils

- Tropical soils are highly weathered: they are generally old; and warm, wet conditions promote rapid chemical weathering and loss of nutrients.
- Oxisols are deep and clay-rich, but lacking in base cations. Well drained despite fine texture.
- Ultisols occur where seasonality is more distinct; are less strongly leached but more poorly drained.

Tropical soils (2)

- Typical reddish-brown Ultisol with very thin leaf litter (it decomposes rapidly).
- Basalt cobbles are still present, nutrient status is moderate

Disturbance in Tropical Rainforests

- Gap dynamics result from autogenic factors
- Gap microclimates are diverse; temperature, radiation and soil moisture fluctuate widely
  - Small gaps: release saplings already present in understory
  - Large gaps: invasive pioneers establish from seed rain
- Seed banks are small and seeds short-lived
- Pioneer species (many legumes) grow rapidly (17 m in 5 yrs!) and then die
  - In Costa Rica, 75% of canopy species are gap-dependent (require release from shading to grow into canopy), 1% of cover is in pioneers

Human disturbance

- Increasing exponentially over the last 50 years
- Population pressure has increased land cleared for shifting subsistence agriculture; scales are comparable to natural gap dynamics
- Large-scale clearing for agriculture, cattle ranching, timber harvest
  - In Brazilian Amazon, selective logging removed 2% of trees, but 26% of tree cover was destroyed; in Malaya 10% of trees were removed but 55% of cover was damaged
- Biodiversity of plant and animal species is obviously affected but ecosystem consequences may be less apparent

Human disturbance

- Biomass burning (mainly in tropics) releases nearly as much carbon dioxide to atmosphere as does fossil fuel burning

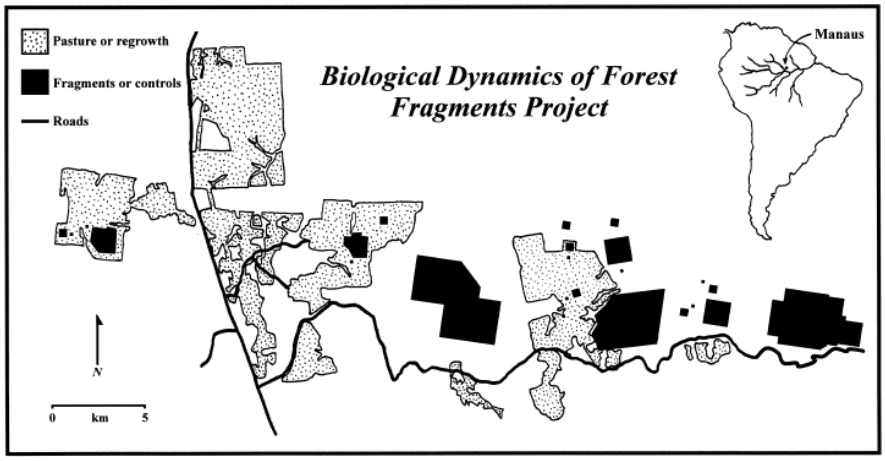
Fire in Brazilian cerrado vegetation

Human disturbance

- Methane production from cattle and rice paddies has increased exponentially

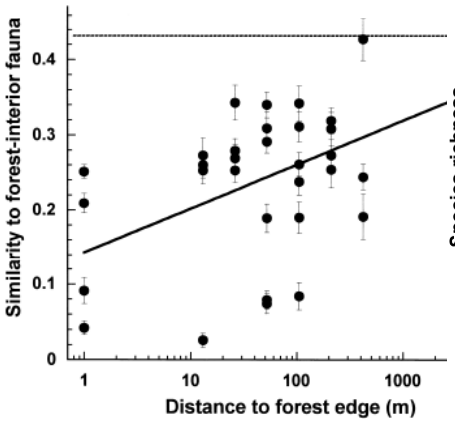
What is forest fragmentation and why is it important?

Experiment in the Amazon

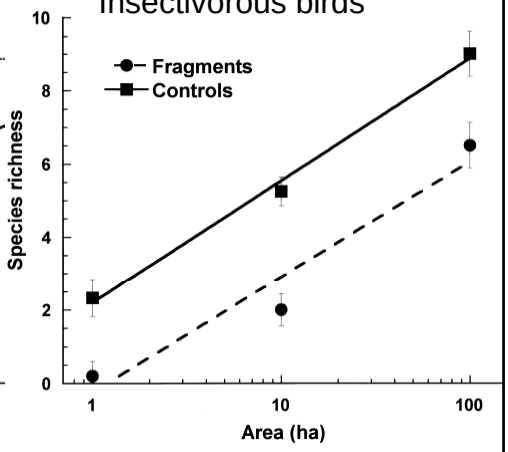


Fragmentation and diversity

Leaf-litter beetles

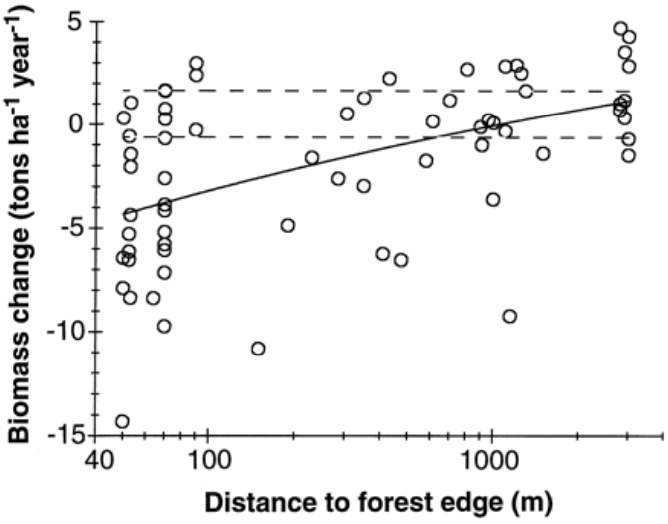


Insectivorous birds



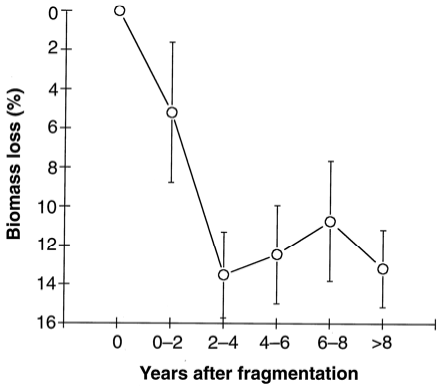
Laurance et al. 2002 Cons Bio

Forest fragmentation and “biomass collapse”



Laurance et al. 1997 Science 278 1117-1118

Forest fragments and biomass loss



- above-ground tree biomass not offset by recruitment of new trees
- losses largest within <100 meters of fragment edges, where tree mortality increased

Summary

- Effects of fragmentation extend beyond the patch that is removed
- Boundary complexity and fragment connectivity have important effects on biodiversity
- Look for conservation biologist seminars early next semester