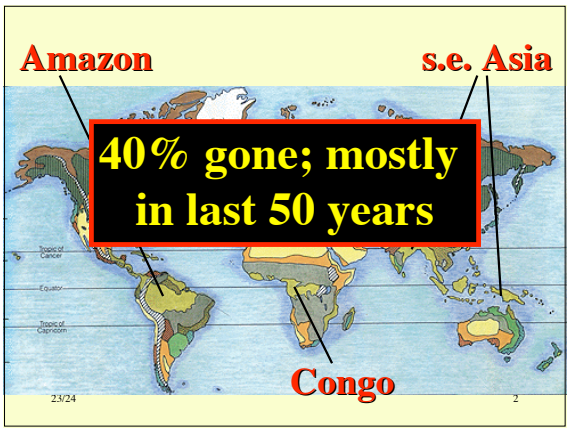

Tropical Rainforest
- la selva
only ~9% of land, but >50% of species


Amazon
s.e. Asia
40% gone; mostly in last 50 years
Congo
23/24
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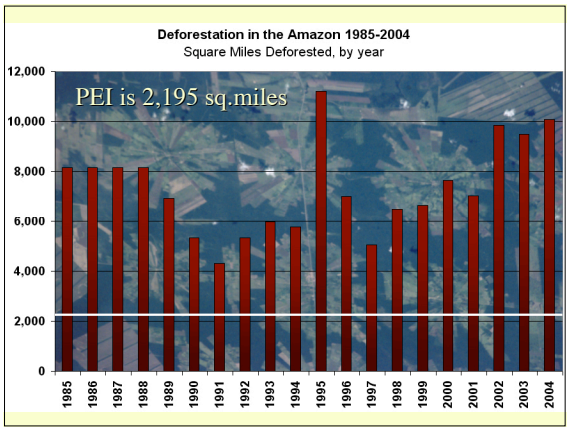
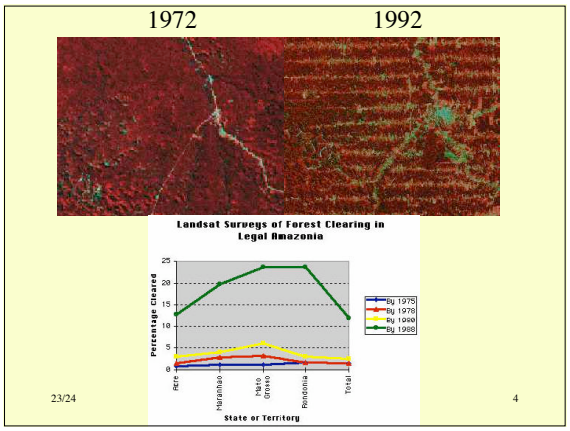
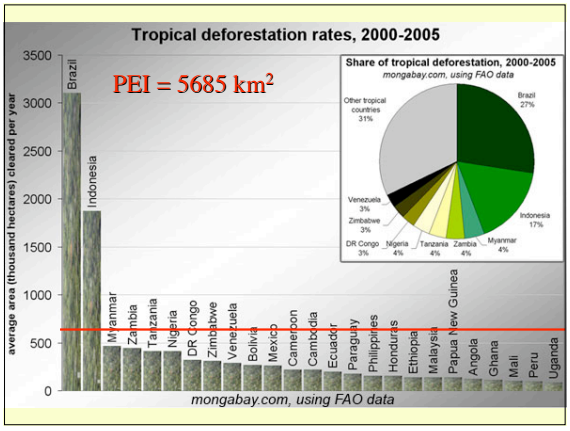
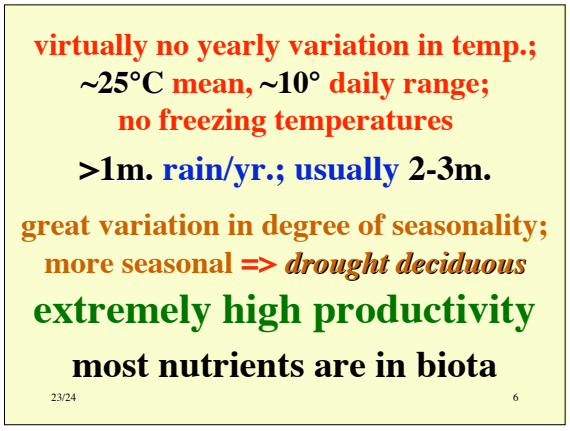

Deforestation in the Amazon 1985-2004
Square Miles Deforested, by year
PEI is 2,195 sq.miles
12,000
10,000
8,000
6,000
4,000
2,000
0
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004


1972
1992
Landsat Surveys of Forest Clearing in Legal Amazonia
Percentage Cleared
By 1975
By 1978
By 1988
By 1988
Peru
Maranhao
Mato Grosso
Rondonia
Total
State or Territory
23/24
4


Tropical deforestation rates, 2000-2005
PEI = 5685 km²
average area (thousand hectares) cleared per year
3500
3000
2500
2000
1500
1000
500
0
Brazil
Indonesia
Myanmar
Zambia
Tanzania
Nigeria
DR Congo
Zimbabwe
Venezuela
Bolivia
Mexico
Cameroon
Cambodia
Ecuador
Paraguay
Philippines
Honduras
Ethiopia
Malaysia
Papua New Guinea
Angola
Ghana
Mali
Peru
Uganda
Share of tropical deforestation, 2000-2005
mongabay.com, using FAO data
Other tropical countries 31%
Brazil 27%
Indonesia 17%
Myanmar 4%
Zambia 4%
Tanzania 4%
Nigeria 4%
DR Congo 3%
Zimbabwe 3%
Venezuela 3%
mongabay.com, using FAO data


virtually no yearly variation in temp.;
~25°C mean, ~10° daily range;
no freezing temperatures
>1m. rain/yr.; usually 2-3m.
great variation in degree of seasonality;
more seasonal => drought deciduous
extremely high productivity
most nutrients are in biota
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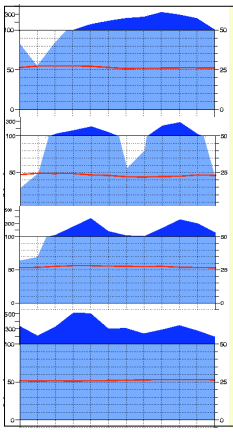

Manaus, Brasil
26.6°C; 2272 mm.

Yaounde, Cameroon
23.3°C; 1617 mm.

Colombo, Sri Lanka
27.4°C; 2396 mm.

Padang, Indonesia
26.1°C; 3924 mm.

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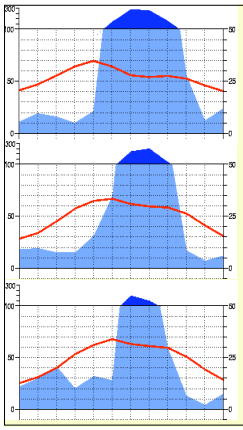

monsoon
semi-evergreen

moist deciduous

dry deciduous

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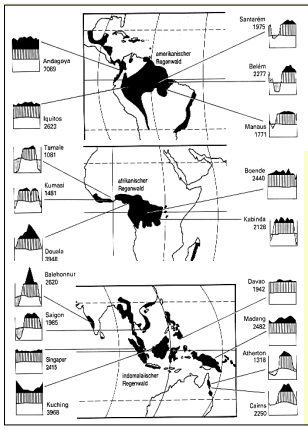

even nearby sites can have distinct rainfall régimes

"tropical rainforest" thus is not a single, uniform entity

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same climate that gives v. high productivity

also generates "wet desert" soils

EXTREMELY RAPID DECOMPOSITION

unless taken up, nutrients rapidly leached

<1% nutrients penetrate >5cm.

so, very poor soil macrofauna

2/3 tropics have laterite soils, high in Al+Fe; sequester nutrients => insoluble

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TROPICAL LATERITIC SOILS

these 2 critical factors:

- **rapid leaching & very poor soils**
- **very high potential for production**

give two major environmental imperatives:

- **maximize nutrient uptake**
- **maximize productivity**

explains many adaptive features of dominant forest vegetation - surprise!

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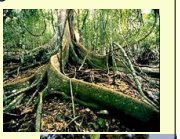
The race for absorption of nutrients

- location of absorptive roots top 5-40cm.; at surface; climbing trunks
- ~100% absorption efficiency depends on high transpiration
- mycorrhizae
- epiphytes
- leathery leaves?

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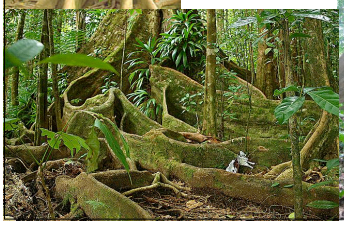
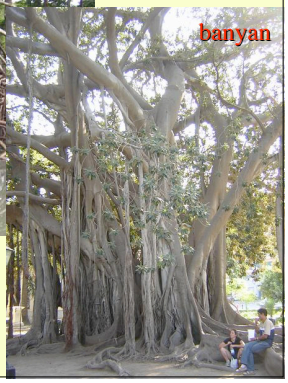
deeper roots merely structural but support mainly by other structures

BUTRESS ROOTS







mangrove

banyan

AIR-ROOTS to BUTRESS STEMS

23/24

epiphytes are abundant, given above-ground nutrients; also better light levels & RH

The race for productivity

productivity depends on two primary factors:
• transpiration rate • access to P.A.R.

high soil moisture and temperatures
=> very high potential evapotranspiration

but **light levels** & **relative humidity** are **VERY** different in **canopy** and **forest interior**

P.A.R. - **100%** vs. **1-3%**

R.H. - **70%** vs. **95+%**

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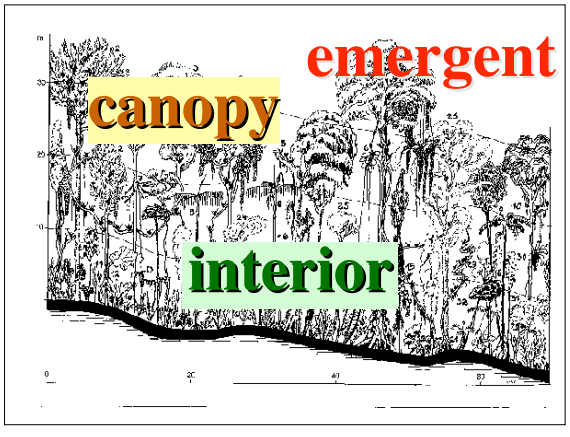
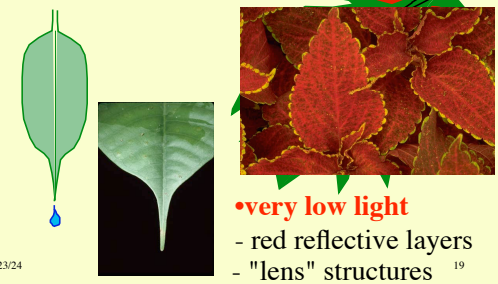


in the dark forest interior…..

•**high R.H.**

- drip-tips & sensitive foliage



•**very low light**

- red reflective layers
- "lens" structures

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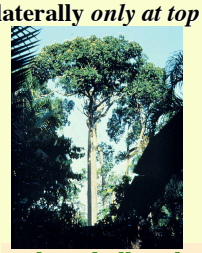
in the bright & breezy canopy…..

excellent conditions - limit set by ***nutrient availability*** & ***solar collecting capacity***

•**branches spread laterally *only at top***



•**smooth exfoliating trunk; no lower branches**

•**sclerophyllous leaves - drying (& decaying)**

MASSIVE tree investment in growing so tall

- parasitized by **vines & epiphytes**

cactus

bromeliad

strangler fig

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the structure of **tropical** & **temperate** forests **differs markedly** in both **space** and **time**

TEMEPERATE FORESTS

SPACE
- low species richness & diversity
- low life-form diversity; stratified
- uniform vegetation => monoculture

TIME
- clear time-sequence of replacement
- succession to typical climax

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TROPICAL FORESTS

SPACE
- high species richness & diversity
- high life-from diversity; unstratified
- complex 3-D structure
- heterogeneous vegetation; widely-separated individuals of given spp.

TIME
- no regular succession to typical climax
- most individuals replaced by other spp.
- => shifting, dynamic, mosaic in time

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this dynamic structure of the forests is well-illustrated by the ecology of forest gaps…..

when canopy trees collapse, forming a clearing,

canopy climate suddenly reaches to the floor

great growth potential for *ground-rooted spp.*

"pioneer" adaptations:

disposable stem; leaf shell only; vine-shedding form; often mutualisms with ants

massive resource mobilization -

biota influx; specialist nomad taxa

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an aside.....

it is widely believed that the opportunities for **extremely rapid growth** in such **widely-scattered forest clearings** was the evolutionary context in which took place

the rise of the Angiosperms
during the Cretaceous

Angiosperms are capable of great growth competition and they eventually displaced gymnosperms from the canopy of most forest systems.

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.....returning to forest dynamics.....

many animal taxa are intimately associated with specific species of trees, vines, epiphytes

thus the complex shifting mosaic in the forest vegetation is reflected in the animal biota

so the *entire biota* is spatially & temporally patchy and unpredictable

v. high alpha *and* beta diversity

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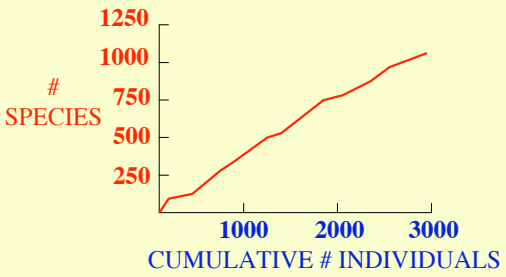
species of invertebrate in 132 samples (each $1m^2$) in single forest type, Peru



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some basic stats. on species richness:

>1/3 of ALL PLANT SPP. live in tropical forests (though not all are forest endemics) but these forests occupy <1/10 land area

Amazonia - ~1 million plant species
Asia - ~3/4 million plant species
Africa - ~1/3 million plant species

>>100 tree species/ha.
10,000-100,000 animal species/ha

>1/3 of all bird species are Neotropical; about 50% are forest endemics

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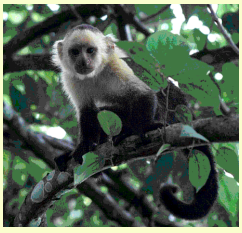
since **most primary production is in canopy**, **most species are canopy specialists** - little known

unlike in other biomes, most mammal herbivores are **arboreal** in these forests:

PRIMATES



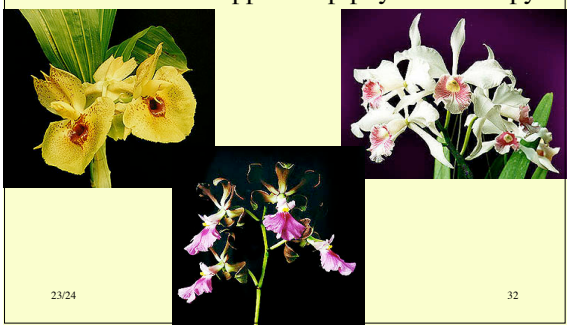
BATS

also **SQUIRRELS**

30

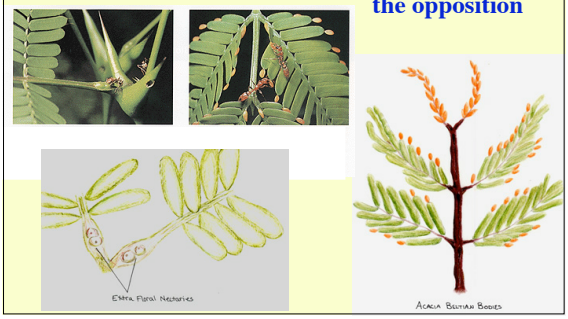
many forest birds are canopy fruit specialists

the most speciose angiosperm family is
the Orchidaceae - 20,000 spp.
and most orchid spp. are epiphytic in canopy



Animal-Plant interactions
are diverse & complex

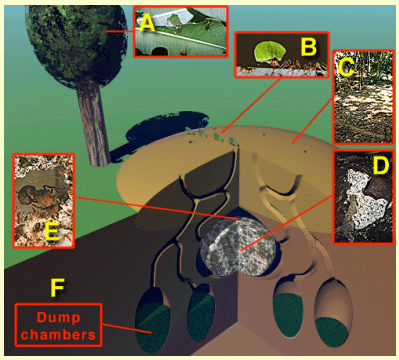
Protection rackets - Ants in Acacias
B&B for taking out the opposition



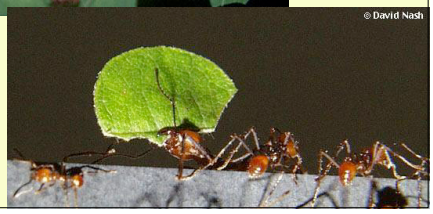
in many nutrient-poor habitats
plants provide ants with safe homes
in exchange for their nitrogenous waste

Myrmecodium - tropical Asia & Australasia

Leaf-cutter Ants cultivate, and live on, fungus



colony members cut up leaves



and take them back to the nest

in special chambers the leaves are prepared for fungus

fungus produces food for ants

Pollination

virtually all forest plants are outcrossing and only a few canopy spp. use wind

widely-separated plants need good flyers that home reliably to type

a wide array of animal pollinators is used e.g. in the Neotropical Realm, nearly 600 spp. of plant are known to be intimately involved with bats

many relationships are ***obligate*** **mutualisms**

in the tropics, as well as the familiar insects, many plants use a great diversity of **birds and mammals**.

many plants specialise on particular animal groups

bird-pollinated flowers are commonly **tubular & red**, with **sucrose nectar** and **no scent**

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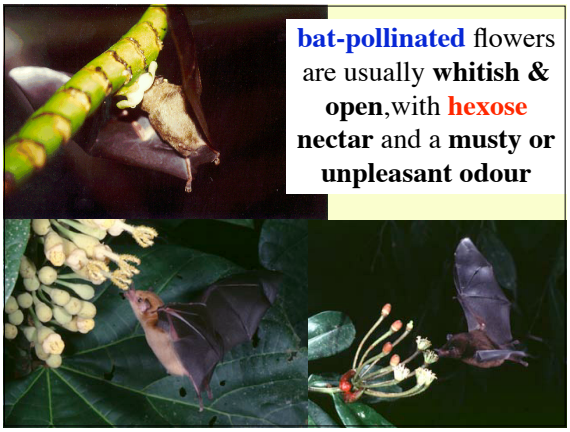

bat-pollinated flowers are usually **whitish & open**,with **hexose nectar** and a **musty or unpleasant odour**

Seed Dispersal

wind-dispersal only used by canopy epiphytes

- no wind in forest interior
- establishment on forest floor difficult

so seeds must be rather large

thus 50-90% plants use vertebrates or water

fish, birds, bats, rodents ...

adaptations for successful seed deposition

continuous availability of fruit **->**

many more frugivores in tropics -

23/24 **80%** of vertebrate fauna use fruit 41

Herbivory

in low latitudes, herbivore pressure is acute

defoliation by leaf-cutters can be devastating

thus selection for enormously diverse array of secondary chemical compounds

many such compounds specific to herbivores

fungicides e.g. quinine, camphor render tissue useless to ants

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a classic chemical defence is *LATEX*

such anti-herbivore compounds are costly

so mainly concentrated in young tissue

herbivores respond in many ways
e.g. metabolism altered -> immunity
compounds isolated and
used for own protection, attracting mates

we make use of them:
e.g. cinnamon, cloves, nutmeg,
cardamom, ginger, tea, coffee.....

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so why are the tropical systems
so rich and complex?

we know lowland tropics have a climate
where productivity reaches highest levels

but why more species?

no simple answer, but abundant & consistent
resources can be more finely divided
& rare resources can be sufficient

high productivity allows more specialization

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but also, tropical environments have
HUGELY GREATER duration
than high-latitude modern habitats

also, in Cenozoic, tropical forests have
repeatedly been much fragmented
by drying, forming isolated refuges;
this may have stimulated speciation

and recall MUCH mountain-building
occurred during last 8-10 m.y.

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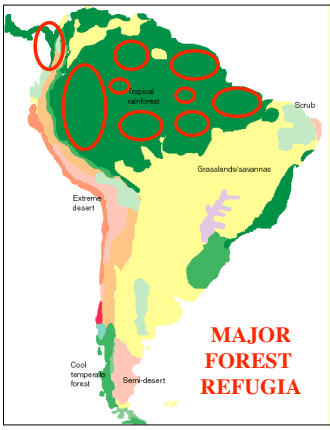


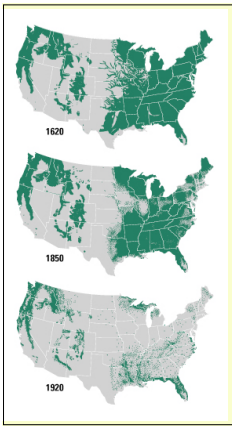
in last glacial max.,
the Amazon forest
system was broken
up into many
isolated fragments

—

during isolation,
speciation probable

—

many refugia
correspond with
endemism centres



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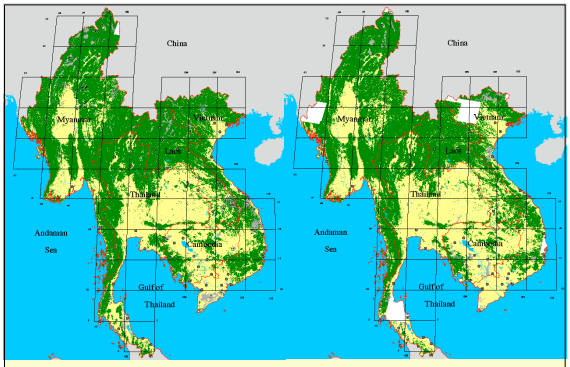

1973 1985

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