Topic 12 – Gymnosperms

I. Characteristics of
   A. Sporophytes
      - Dominant
      - Axillary branching
      - Eustele
      - Secondary Growth

Topic 12 – Gymnosperms

I. Characteristics of
   A. Sporophytes
      - Heterosporous:
        Microsporangia on sporophylls in simple strobilus, make microspores
Topic 12 – Gymnosperms

- 1 Megasporangium in 1 ovule
  - Ovules usu. in simple or complex strobilus (“cone”)
  - Each sporangium makes one functional megaspore.

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Topic 12 – Gymnosperms

I. Characteristics of
B. Gametophytes
  - Not-Dominant, not photosynthetic
  - Microgametophyte is pollen grain, develops largely in strobilus; has no antheridia.
  - Megagametophyte (also called embryo-sac) contained in ovule, has two minute archegonia.
Topic 12 – Gymnosperms

I. Characteristics of
   C. Life cycle (e.g., cycad)

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Topic 12 – Gymnosperms

I. Characteristics of
   D. Naked seed plants
      - *gymnos* = naked; *sperma* = seed
      - no fruits
      - ovule exposed in strobilus or cone at pollination.
Topic 12 – Gymnosperms

I. Characteristics of
   E. Three groups to know
      1. Cycads
      2. Conifers
      3. Ginkgo

II. Cycads
Cycads
A. Vegetative Morphology

1. Trees or shrubs
2. Pinnate leaves in rosette
3. Unbranched stem

Cycas revoluta (sago-palm)

Cycads
B. Reproductive

1. Dioecious
   a. Males w/ strobili.

Male strobilus on male plant.
Sporangia on sporophylls
**Cycads**

B. Reproductive

1. Dioecious
   
   b. Females w/ strobili or not.
**Cycads**

B. Reproductive

Seeds on sporophylls in *Cycas*.

Seeds on sporophylls in *Zamia*

**Cycads**

C. Economic botany

- Ornamental horticulture
Cycads
Rare cycads fetch big money on black market

Cycad thieves strike at Van Stadens Reserve

2009/06/02
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CONSERVATION authorities are hoping that sharp-eyed members of the public might be able to help with a weekend incident in which seven rare, protected cycads were seized from the Van Stadens Wildflower Reserve.

Reserve manager Wesley Berrington said yesterday that he was off the reserve on Sunday and returned to find the seven blue cycads (Encephalartos horridus), which are endemic to the Uitenhage area, gone.

“They were growing in our work area around our store rooms. They were just dug up. One was left behind, which seems to indicate that the thieves were disturbed.”

Cycads
Rare cycads fetch big money on black market

Thieves target rare, valuable plants

Sunday, December 12, 2004 Posted: 6:12 PM EST (2312 GMT)Sunday, December 12, 2004 Posted: 2312 GMT (0712 HKT)

COSTA MESA, California (AP) -- The thieves struck at night and knew just what they were after.

In minutes, they ripped two plants from the lavish landscaping at a home in this Los Angeles suburb, then fled when the homeowner woke up and turned on a porch light.

Total haul: $3,500.

The thieves were after cycads, palmlike plants so prized that a rare specimen can fetch $20,000 or more on the international black market. Some species have been around since the time of the dinosaurs but are now close to extinction.

"In the black market, some species of cycads are like a fine piece of art -- like a Picasso."

-- Raquel Zapata, Fairchild Tropical Botanic Garden spokeswoman

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Cycads

Research on DNA technology to help prosecute.

Barcode bars cycad smugglers

Johannesburg - Scientists at the University of Johannesburg have started a DNA bar-coding project to stop the smuggling of endangered cycad species in the country.

Botany masters student Philip Rousseau started the project with the aim of creating a barcode library for the African Encephalartos species in an attempt to control collectors in America and the Far East who are prepared to pay up to R71 000 for a large specimen of a rare species, university spokesperson Herman Botesmuller said in a statement.

Cycads

D. Biogeography & Conservation
- Pantropical (rainforest to deserts)
- Long fossil history (<200 my)
- ca. 240 extant (surviving) species
- threatened by poaching & black market
**Cycad Distribution**

- Neontological
- Paleontological

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**Fossil Cycads**

*Gymnosperms from the Middle Triassic of Antarctica: The First Structurally Preserved Cycad Pollen Cone*

Sharon D. Klein, Edith L. Taylor, Michael Kingston, and Thomas M. Taylor


The first permangent cycad pollen cone is described from the lowermost horizon of the cycad-fern floras of the McMurdo Range, Antarctica. The cone is characterized by helically arranged, wedge-shaped microsporophylls with parallel, elongate bases, each bearing transverse projections from the rhomboid distal face. The vascular cylinder consists of up to four vascular bundles. Pollen sacs that are fixed for approximately half their length and display a raised, ovate, granular, radially symmetrical pollen mass, surrounded by a distally projecting micropyle, are present within each pollen sac. Each pollen sac contains several to a dozen or more pollen grains, arranged in a monosporic, radially symmetrical fashion. The pollen sacs are united to form a distally projecting, ovate mass, and the micropyles are oriented in parallel rows. The micropyles are situated on the distal face of the pollen sacs, and the pollen grains are arranged in a distal position. The pollen grains are tricolpate, with two colpi on the distal face and one on the proximal face. The pollen sacs are united to form a distally projecting, ovate mass, and the micropyles are oriented in parallel rows. The micropyles are situated on the distal face of the pollen sacs, and the pollen grains are arranged in a distal position. The pollen grains are tricolpate, with two colpi on the distal face and one on the proximal face.

Keywords: Cycads, Delenops, gymnosperms, microsporophylls, pollen

Introduction

This approach provides a new perspective on the evolution of cycad pollen cones.

Fig. 4. Suggested reconstruction of Delenops sp. A, Cone morphology, showing helical arrangement of microsporophylls and organization of projections on microsporophyll bases. Scale bar = 1 mm. B, Morphology of a microsporophyll, showing the position of pollen sacs and extension of lateral edges into spore projections on the microsporophyll bases. Scale bar = 2.5 mm. C, Abaxial view of a microsporophyll, showing the organization of the pollen sacs into two radial clusters. Scale bar = 2.5 mm.
Cycads
E. Cycads & Guam Dementia

US territory 1898-1941, 1944-present.
Japanese 1941-1944
Chamorro = indigenous people of Guam
*Extremely healthy by historical accounts.
*20th century brought lytico-bodig, leading cause of death in 40’s, 50’s, 60’s.

Lytic-Bodig (sometimes called Guam dementia).

Demographics: Chamorro men; usu. strikes 25-40 yrs.
Symptoms:
  Lytico = progressive paralysis that resembles ALS (amyotrophic lateral sclerosis);
  Bodig = parkinsons-like shakes with Alzheimers-like dementia.
Prognosis: premature death.
NIH investigates from 1940-1990’s:
They Explore:
1. Genetics (including sex-linked)

NIH investigates from 1940-1990’s:
They Explore:
1. Genetics (including sex-linked)
2. Cycad pollen (BMAA discovered in 1950’s)
NIH investigates from 1940-1990’s:
They Explore:
1. Genetics (including sex-linked)
2. Cycad pollen (BMAA)
3. Cycads as food (“fadang” flat bread; BMAA)

NIH gives up in the 1990’s.
Enter botanist Paul Cox, Oliver Sacks, flying foxes, & the return of the cycads.

Then, Institute of Ethnobotany, NTBG, Hawaii.

Now, Institute for Ethnomedicine in Jackson Hole, Wyoming.
- Bats eat the seeds.
- Hyperaccumulate BMAA 400x in fatty tissues (apparently unaffected).

But, what’s the connection to lydigo-bodig?

- Bats eat the seeds.
- Hyperaccumulate BMAA 400x in fatty tissues (apparently unaffected).

But, what’s the connection to lydigo-bodig?

1. Why primarily in men?

2. Why could it be passed to men from other tribes only through marriage?

3. Why did it arise during 20th century, then peak in 40-60’s?
Medical Hypothesis

Cycad neurotoxins, consumption of flying foxes, and ALS-PDC disease in Guam

Paul Alan Cox, PhD and Oliver W. Sacks, MD

From the Institute for Ethnobotany (Dr. Cox), National Tropical Botanical Garden, Kilauea, HI, and Department of Neurology (Dr. Sacks), Albert Einstein College of Medicine, Bronx, NY.

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The Chamorro people of Guam have been afflicted with a complex of neurodegenerative diseases (now known as ALS-PDC) with similarities to ALS, FTD, and PD, at a far higher rate than other populations throughout the world. Chamorro consumption of flying foxes may have generated sufficiently high cumulative doses of plant neurotoxins to result in ALS-PDC neuropathologies, since the flying foxes forage on neurotoxic cycad seeds.
**Topic 12 – Gymnosperms**

I. Characteristics of

II. Cycads

III. Conifers

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**Conifers**

A. Vegetative Morphology

1. Branched trees or shrubs

2. Leaves needle-like

*Pinus resinosa* (red pine)  
*Taxus baccata* (English yew)
Conifers
A. Vegetative Morphology

4. Leaves usually evergreen (but not always)

Larix laricina (American larch)  Metasequoia glyptostroboides (dawn-redwood)

Conifers
A. Vegetative Morphology

5. Resin canals throughout.

Resin canal
Vascular bundle
stomata
Resin canal

pine needle – transverse section
Conifers
A. Vegetative Morphology

5. Resin canals throughout.

Resin makes conifers the quintessential symbol of fresh scents.
Conifers
B. Reproductive Morphology

1. Monoecious or Dioecious

male strobilus ("pollen cones" of laypersons)  female cone (a compound strobilus)
Conifers
B. Reproductive Morphology

Male strobilus: sporophylls with sporangia.

Female cone: ovule/seed scales (modified branches) in axils of bracts.

Cone of balsam fir (with bracts exerted from scales)

Seeds visible here in broken cone.
Conifers
B. Reproductive Morphology

1st Spring (pollen received; cone red, small & open)

2 seasons for fertilization, embryo & seed development (cone green & closed).

End of 2nd season, embryo, seed, & cone is mature (cone is larger, brown & woody; opens itself or via fire)

2. Seed Cones typically woody, w/ winged seeds

Cypress & Redwood Family

Pine, Spruce, & Fir Family
Pine “nuts”

Not all cones are big & woody.

Cone with one ovule in yew family

Seed has aril around it in yew.
Conifers
C. Economic botany
1. Lumber & paper pulp
2. Pine “nuts”

3. Turpentine & rosin

pine resin

distillation

 turpentine

roin
Conifers
C. Economic botany
1. Lumber & paper pulp
2. Pine “nuts”
3. Turpentine & rosin

4. Amber

5. Sounding boards
Conifers
C. Economic botany
1. Lumber & paper pulp
2. Pine “nuts”
3. Turpentine & rosin
4. Amber
5. Sounding boards

6. Christmas trees

Other uses:


8. Survival food (inner bark – Amerindiands – raw or candied, dried strips).

Conifers
C. Biogeography & Ecology

1. Pine (Pinaceae) and Cypress (Cupressaceae) families dominate north temperate zone. e.g., Taiga (Boreal Forest) Biome

* Long, cold winter with frozen groundwater;
* Short summer;
* Avg. Annual Temp of -5 to 5 degrees F;
* Most precip as snow; threat year-round.

Short growing season favors evergreeness – but keeping leaves through winter requires some adaptations.

* Conical form sheds snow, distributes weight.
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*Leaves adapted for water conservation.

C. Biogeography & Ecology

2. Podocarps (Podocarpaceae) & araucoids (Araucariaceae) dominate south temperate zone.

Norfolk Island "Pine" (Araucaria heterophylla); Norfolk Island – between New Zealand & New Caldeonia
Monkey puzzle tree (*Araucaria araucana*); central Chile

Wollemi “pine” (*Wollemia nobilis*); Australia (1994)
Podocarps (156 spp.) of southern hemisphere

Topic 12 – Gymnosperms

I. Characteristics of

II. Cycads

III. Conifers

IV. Ginkgos
Ginkgos
A. Vegetative Morphology

1. Ginkgo tree.
2. Leaves clustered on short shoots.
3. Dichotomous leaf venation.

Ginkgos
B. Reproductive Morphology
Dioecious
Ginkgos
B. Reproductive Morphology
Dioecious

Ginkgos
C. Economic botany
-Ornamental horticulture
-Seeds Asian delicacy
-Extract increases blood flow.