Introduction to Botany


I. Cycads Stories

A. Morphology
4. Gymnospermous

Megasporophyll

Ovule (seed)

4. Gymnospermous

a. Seeds loosely clustered

b. or in strobilus

I. Cycads Stories

B. Systematics
I. Cycads Stories

B. Systematics

1. Gymnosperms

   Spermatophytes

   Gymnosperms ~881 spp
   (cycads, ginkgoes, conifers)

   Angiosperms ~300K spp
   (e.g., magnolias, lilies, oaks, orchids)

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2. Ancient
   a. Among the oldest of spermatophytes

   Jurassic Diorama. Credit: Alfred F. Harrell, 1977 (Smithsonian Institution)
I. Cycads Stories

B. Systematics

2. Ancient
   a. Among the oldest of spermatophytes
   b. Predated & outlasted the dinosaurs
   c. Help tell story of changing Earth

Dinosaurs
Angiosperms
Cycads
Seed Plants

Time (Ma)
0
100
200
300
400
500
I. Cycads Stories

B. Systematics

2. Ancient
   a. Among the oldest of spermatophytes
   b. Predated & outlasted the dinosaurs
   c. Help tell story of changing Earth

C. Ecology

1. Pollination
   • Dioecious (no selfing)
   • Strobili are fruit-scented
   • Beetles pollinate
I. Cycads Stories

C. Ecology

1. Pollination
   • Fleshly & colorful seed coat attracts various vertebrates.

2. Seed dispersal

3. Herbivory defense
   • Various toxins in all parts, concentrated in pollen and seeds.

D. Economic Botany & Ethnobotany
I. Cycads Stories

D. Economic Botany & Ethnobotany

1. Ornamental
   • Aesthetic
   • Mystique of age & rarity

2. Food & medicine
   e.g., Seeds with large, starchy gametophyte.
   e.g., Bioactive chemistry (toxins) in low doses
   have various medicinal applications.

E. Conservation

1. All cycads are CITES Appendix I or II (cites.org)
I. Cycads Stories

E. Conservation

1. All cycads are CITES Appendix I or II (cites.org)
   a. 98 spp on I
      Appendix I
      Species threatened with extinction and for which plants cannot be traded except under special circumstances.
   b. 252 spp on II
      Appendix II
      Species not currently threatened with extinction, but which may become so if trade were unregulated.

2. Illegal trade > 10 billion USD (Pittman 2005)?
I. Cycads Stories

E. Conservation

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2. Illegal trade > 10 billion USD (Pittman 2005)?

Cycad thieves strike at Van Stadens Reserve

CONSERVATION authorities are hoping that sharp-eyed members of the public might be able to help with a recent incident in which seven, protected cycads were stolen from the Van Stadens NATURE RESERVE.

Reserve manager Shelley Parington 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 Karoo biome, gone.

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

Thieves target rare, valuable plants

The thieves struck last night and this morning. They targeted the rare cycads.

Twenty blue cycads were stolen from a nursery in Los Angeles, each valued at $25,000. The thieves were seen entering the nursery and stealing the cycads in broad daylight.

Total value: $500,000

In a separate incident, police have arrested a group of people suspected of stealing rare cycads from a botanical garden. The stolen cycads are rare and are valued at $300,000.

The black market for rare plants has soared in recent years, with some species of cycads selling for over $100,000 each.
I. Cycads Stories

E. Conservation

1. All cycads are CITES Appendix I or II (cites.org)
2. Illegal trade > 10 billion USD (Pittman 2005)?
3. USFW enforces CITES domestically
   - Operation Jurassic (1998; halted > 200K USD)
   - Operation Botany (1999-2001; halted > 840K USD)

F. Cycads & Guam ALS-PDC

1. Guam
   - 1898-1941 (US territory)
   - 1941-1944 (Japan)
   - 1944-present (US)

2. ALS-PDC (lytico-bodig)
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a. Symptoms:
   - Progressive neurodegenerative disease
   - Lytico = Prog. paralysis resembling Amyotrophic Lateral Sclerosis
   - Bodig = Parkinsons w/ Alzheimers-like dementia

b. Prognosis: death < 10 yrs from diagnosis.

3. Chamorro

a. Historically very healthy
3. Chamorro
   a. Historically very healthy
   b. ALS-PDC epidemic

4. NIH (1940s-1990s)
   a. Genetic Hypothesis
      1) Evidence for
         • Endemic to the Chamorro culture
         • Primarily in men
F. Cycads & Guam ALS-PDC

4. NIH (1940s-1990s)

a. Genetic Hypothesis

1) Evidence for
   • Endemic to the Chamorro culture
   • Primarily in men

2) Evidence against?
   • Why now?
   • Chamorro immigrants & emigrants
   • BMAA in the brain associated w/ neurofibrillary tangles & atrophied neurons

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BMAA

- Non-protein amino acid
- In cycad pollen & seeds
- Excitotoxic agonist of GLU
- Likely anti-herbivory defense

- GLU (glutamic acid)
  - Protein amino acid
  - Major neurotransmitter
4. NIH (1940s-1990s)
   a. Genetic Hypothesis
   b. Cycad Hypothesis (1970s-1990s)
      1) Evidence for
         • Neurotoxic BMAA in cycad seeds & pollen
         • Flatbread, dumplings made from seeds
      2) Evidence against?
         • Chamorro doing this for centuries.
         • Chamorro pre-treat the seeds to remove BMAA
4. NIH (1940s-1990s)
   a. Genetic Hypothesis
   b. Cycad Hypothesis (1970s-1990s)
   c. APS-PDC fading away, NIH gives up (1990s)

   a. Oliver Sacks (1933-2015)
      • Neurologist
      • Discovered, 1969, that L-Dopa (dopamine precursor) could "awaken"
        catatonic survivors of the 1917-28 encephalitis lethargica epidemic.
F. Cycads & Guam ALS-PDC


a. Oliver Sacks (1933-2015)

- Neurologist
- Author

1990
1997
1973
1985

• ALS-PDC fading away
• Cycads likely involved but how?

b. Paul Cox

- Botanist
- Then, Inst. Ethnobotany, NTBG, Hawaii
- Now, Inst. Ethnomedicine, Wyoming
c. A new angle on the Cycad Hypothesis
Root symbionts (cyanobacteria) make the BMAA

Biomagnification of BMAA

Cycad-Bat Hypothesis explains:
- Immigration & emigration phenomena
- Sex bias
c. A new angle on the Cycad Hypothesis

Cycad-Bat Hypothesis explains:
• Immigration & emigration phenomena
• Sex bias
• Increase & decline of ALS-PDC in 20th century

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d. Since 2002
  1) Protein-bound
     BMAA
F. Cycads & Guam ALS-PDC
  d. Since 2002
  1) Protein-bound BMAA
  2) BMAA & Alzheimer’s in N America

II. Conclusions
A. Cycads are a microcosm for importance of botany
   • Food, medicines, habitat, recreation, fuel, shelter, culture & commerce.
   • Ignore them or their biology at your peril.
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   • Food, medicines, habitat, recreation, fuel, shelter, culture & commerce.
   • Ignore them or their biology at your peril.
   • Basic research has unforeseen payoffs.

B. Zoology, medicine, law, etc. highly incomplete w/o botany
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A. Cycads are a microcosm for importance of botany
   - Food, medicines, habitat, recreation, fuel, shelter, culture & commerce.
   - Ignore them or their biology at your peril.
   - Basic research has unforeseen payoffs.

B. Zoology, medicine, law, etc. highly incomplete w/o botany

C. Importance & versatility of plants emerge from their role as producers