Pollen Analysis

Hypothesis testing
Case studies in southern Chile
The lead up to the Holocene and the Younger Dryas
Is climate change synchronous across the two hemisphere’s?

1) Southern Hemisphere records will show synchronous cooling at the Younger Dryas Chron

2) An absence of evidence for Southern Hemisphere cooling at the Younger Dryas Chron
Is climate change synchronous across the two hemisphere’s?

Kaipo Bog sequence, NZ
Lake Survey in the Chonos Archipelago – Taitao Peninsula

1993-1996
Is climate change synchronous across the two hemisphere’s?
Pilgerodendron uviferum in southern Chile

*Pilgerodendron uviferum* (D. Don) Florín, Ciprés de las Guaitecas

- Family: Cupressaceae
- Long-lived conifer (over 500 years) endemic to southern Chile and adjacent portions of Argentina
- Distribution ranges from 39° 30' S to 55° 30' S
Pilgerodendron uviferum in southern Chile

*Pilgerodendron uviferum* (D. Don) Florín, Ciprés de las Guaitecas

- Found under a high precipitation regime on poorly drained and acidic soils
Deglaciation in the Chonos Archipelago – Taitao Peninsula

17ka

14ka

- 0-1%
- 2-5%
- 6-10%
- 11-20%
- 21+%

Pilg. pollen %
Geographic and temporal extent of *Pilgerodendron* decline

<table>
<thead>
<tr>
<th>Age cal yr BP</th>
<th>Trees &amp; Shrubs</th>
<th>Herbs</th>
<th>Ferns</th>
<th>Pilgerodendron (%)</th>
<th>Pilgerodendron (pollen grains/cm²/yr)</th>
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Pilg. pollen %
### Geographic and temporal extent of *Pilgerodendron* decline

#### 2.7-1.6ka

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**Pilg. pollen %**

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*STIBNITE*
What caused the Pilgerodendron uviferum decline?

Hypotheses:

1. Interspecific competition
2. Individualistic response to climate change
3. Fire disturbance
4. Progressive changes in soil conditions
5. Impact of volcanic ash fall
6. Appearance of a pathogen

What caused the *Pilgerodendron uviferum* decline?

Hypothesis 1: Interspecific competition

- Competition between established and invading plant species may have caused declines in individual species.

- Pollen influx data shows changes in dominance of other tree species are not associated with *Pilgerodendron* decline.

⇒ Interspecific competition not the cause of *Pilgerodendron* decline.
Hypothesis 2: Individualistic response to climate change

What caused the *Pilgerodendron uviferum* decline?

- Large scale aridity in early and late Holocene may have been unsuitable for *Pilgerodendron* survival.

- Regional aridity not evident in early Holocene and regionally arid period between ~5500-2700 cal BP pre-dates *Pilgerodendron* decline.

⇒ Climate change not cause of *Pilgerodendron* decline.
What caused the *Pilgerodendron uviferum* decline?

Hypothesis 3: Fire disturbance

- Fire associated with changes in climate variability or anthropogenic activity may have resulted in decline in *Pilgerodendron*.

- Changes in *Pilgerodendron* are not contemporaneous with changing charcoal concentrations.

⇒ Fire disturbance not the cause of *Pilgerodendron* decline.
What caused the *Pilgerodendron uviferum* decline?

Hypothesis 4: Progressive changes in soil conditions

• Changes in soil conditions associated with erosion or leaching may have resulted in *Pilgerodendron* decline.

• Geochemical analysis of allogenic elements in lake sediments shows that soil erosion decreased and soil waterlogging increased at the time of the *Pilgerodendron* decline.

⇒ Changes in soil conditions favourable to *Pilgerodendron*, therefore not responsible for decline.
What caused the *Pilgerodendron uviferum* decline?

Hypothesis 5: Impact of volcanic ash fall

• Impact of volcanic ash fall may have resulted in *Pilgerodendron* death.

• 2700 cal yr BP ash fall at occurs immediately before the decline in *Pilgerodendron* on the Taitao Peninsula. Other ash falls do not result in declines.

⇒ ash fall not exclusively the cause of *Pilgerodendron* decline.
What caused the *Pilgerodendron uviferum* decline?

Hypothesis 6: Appearance of a pathogen

- Pathogens have been linked to sudden and rapid (<100 yr) decline in Hemlock (*Tsuga*) in North America and Elm (*Ulmus*) in Europe during the Holocene.

- There is a rapid (100-200 yr) decrease in *Pilgerodendron* pollen influx in the late Holocene Taitao Peninsula but slower (100-400 yr) in the early Holocene Chonos Archipelago.

⇒ Pathogen likely cause of late Holocene decline in the south but not clear in the early Holocene.
Conclusions

- Regionally, the pollen assemblages show no consistent response patterns to any one driver of the *Pilgerodendron* decline – pathogen most likely cause.

- *Pilgerodendron uviferum* shows high sensitivity to environmental change and ability to re-establish after population crash – forests still recovering from late Holocene decline in Taitao Peninsula.

- Highlights difficulty in determining whether vegetation changes were caused by a combination of processes such as climate change, volcanic activity, human activity or internal community dynamics.