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FORENSIC PALYNOLOGY

Pollen and spores

Nature's Fingerprints of Plants

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Pollen isn't just yellow dust

- ✓ It comes in a vast array of shapes and sizes and has complex surface patterns and aperture openings
- ✓ Each plant type produces pollen (or spores) that are quite distinctive from those of other plants
- ✓ Usually, pollen types of species within a single genus look nearly identical
- ✓ Sometimes pollen types of genera within a single plant family will look similar or nearly identical
- ✓ In some plant families there is a great deal of variation among the pollen genera

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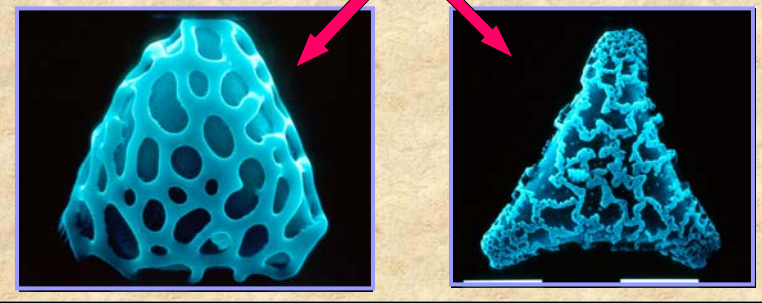
Euphorbiaceae Proteaceae Zygophyllaceae



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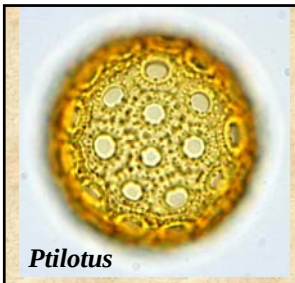
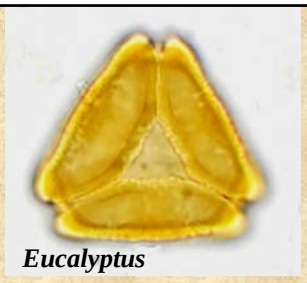


Ptilotus

Cheno-Am

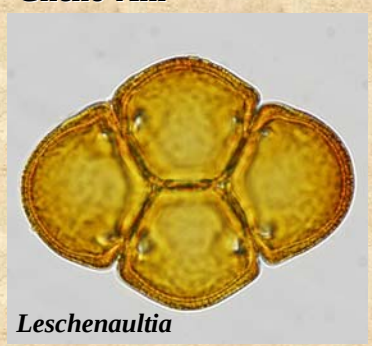
Olearia

Asteraceae



Eucalyptus

Myrtaceae



Leschenaultia

Goodeniaceae

Drosera

Droseraceae

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Aspects of Forensic Palynology

- biological role
- complexity aspect
- production and dispersal patterns
- what samples to collect & how many
- case histories as guides to future work
- how to collect and store samples correctly
- sample preparation
- pollen analysis, correct ID, size of pollen counts
- strengths and limitations of the forensic pollen data
- preventing contamination

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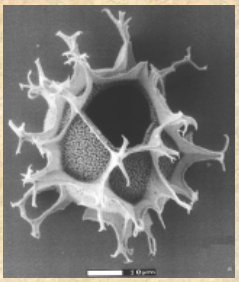
Palynology

Study of pollen, spores, and other microscopic plant bodies collectively called PALYNOMORPHS. e.g. algal cysts (dinoflagellates), algae, fungal spores, etc.



Dinoflagellate

Algae

Fungal spores

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Pollen & Spores

Plants produce either pollen or spores

- **POLLEN - carries the male sex cells of flowering plants (angiosperms) and cone producing plants (gymnosperms)**

- **SPORES - asexual reproductive bodies of cryptogams (ferns, mosses, algae, fungi, etc)**

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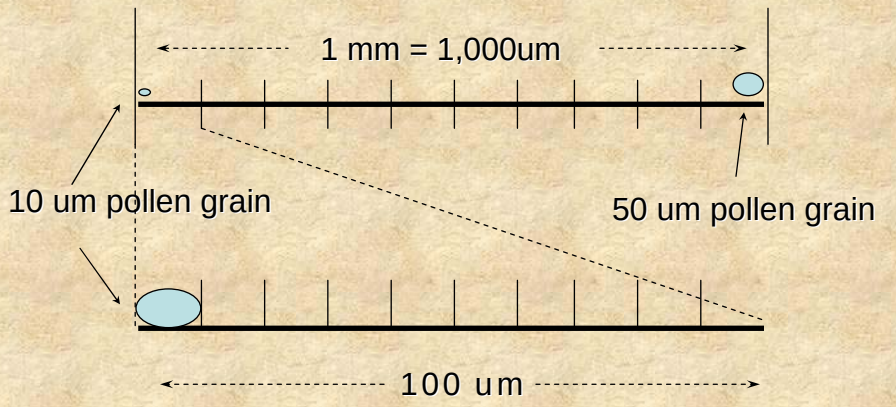
Pollen Size Range (~5-250 um)



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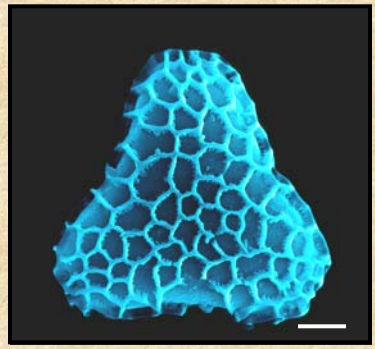
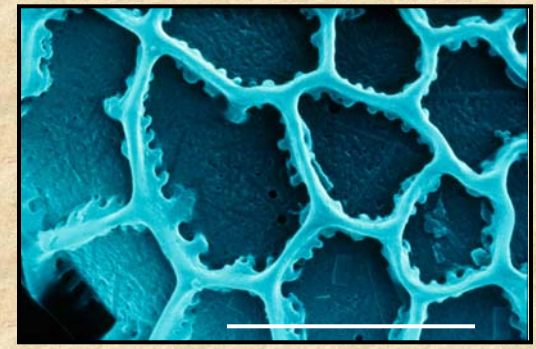
SEM details of *Proteacidites*





Proteacidites 'notredamus'

= 10 μm

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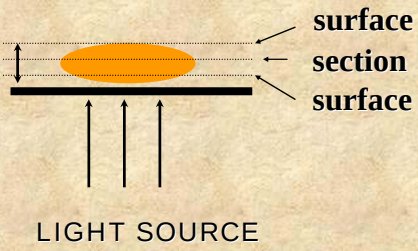
Types of microscopy used in Forensic Palynology

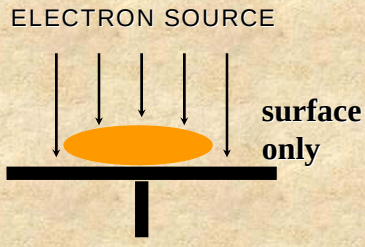
LIGHT

(transmitted light)



SEM

(scanning electron)



TEM

(transmission electron)

TEM: Looks at micro-thin sections of pollen to determine wall structure

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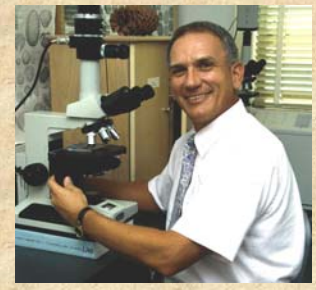
Light and TEM microscopy

Light microscope



TEM sections

Ultramicrotome

Sections 70 nm thick

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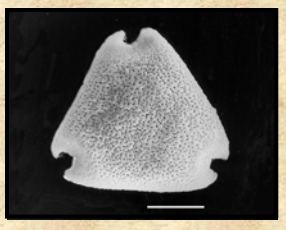
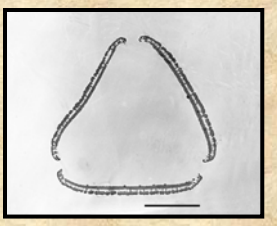
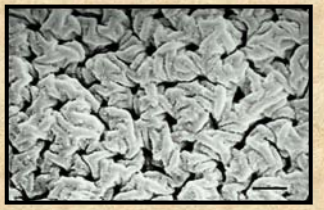
Photographs of one pollen grain

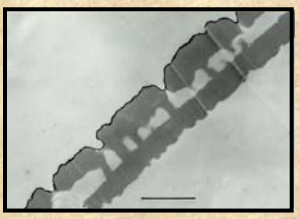
LIGHT SEM TEM







SEM (detail)



TEM (detail)

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Pollen morphology

- Each plant type produces pollen or spores that are distinctive from those of other plants; the uniqueness can sometimes only be seen at the SEM or TEM level
- Pollen and spores can usually be identified to the plant family, genus, and sometimes to the species level with LM

Characters used to differentiate pollen & spores

- ✓ Shape
- ✓ Size
- ✓ Aperture type
- ✓ Aperture number
- ✓ Wall structure (layers)
- ✓ Tectate vs. non-tectate
- ✓ Ornamentation type

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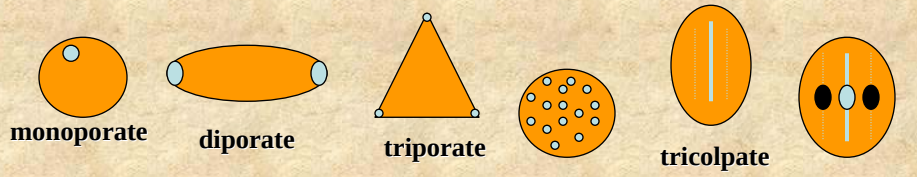
Pollen morphology

✓ **Shape** - *circular, square, elliptical, triangular, and variations thereof*

✓ **Aperture type** - *pores, colpi or combinations of them*



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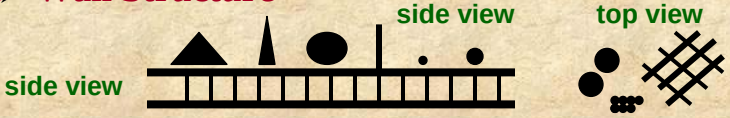
Pollen morphology (cont)

➢ **Sculpture** - *surface ornamentation, (It is usually species specific when viewed at the SEM level)*

➢ **Wall Structure**



➢ **Pollen Size** - *each pollen species has a size range, which often overlaps with other similar pollen types; why size alone is not a valid way to ID pollen grains*

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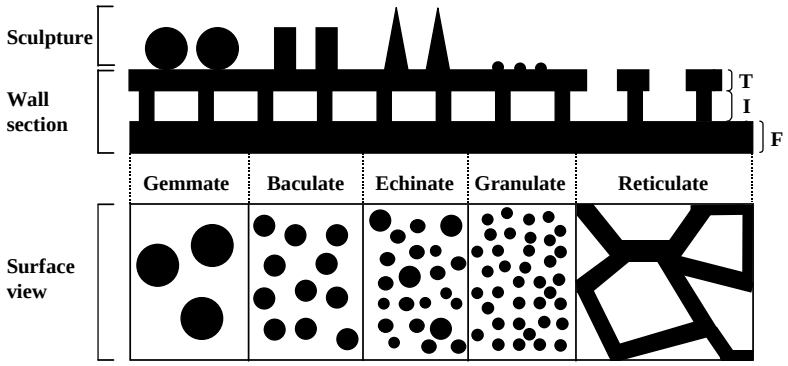
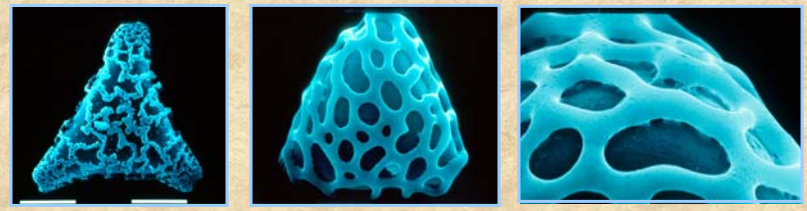
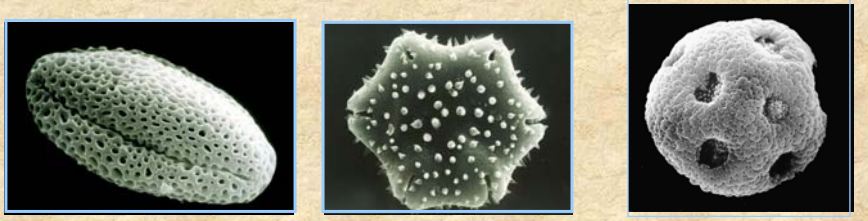
Examples of Pollen Wall Structure and Surface Sculpture



Pollen aperture and sculpture examples



Triporate, reticulate



Tricolporate, reticulate

Stephanocolpate, echinate

Periporate, verrucate

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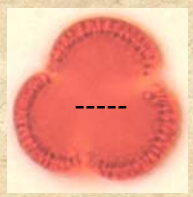
Pollen apertures and sculpture types

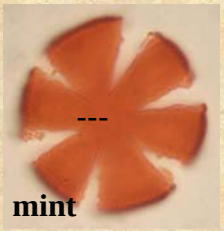
mimosa

Blue weed



mustard

clover



mint

thistle

Line = 10 microns

azalea

dogwood

dandelion

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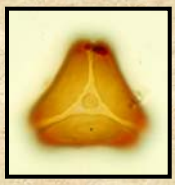
Myrtaceae Plant Family: an example where all pollen types are very similar

Myrtaceae: Gum trees (*Eucalyptus*) , paper barks (*Melaleuca*) bottlebrushes (*Callistemon*) ,



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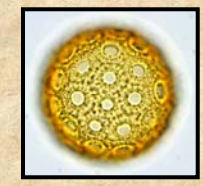
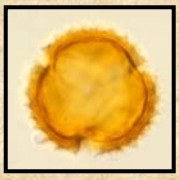
Other Plant Families where all genera are similar

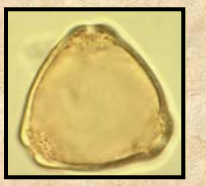
Poaceae
grasses



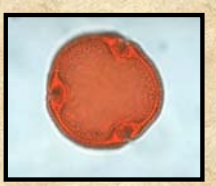
Chenopodiaceae
saltbush



Asteraceae
daisy



Casuarinaceae
she oaks



Tiliaceae
linden

Pinaceae
pine

Proteaceae
banksia sugar bush (*Protea*)

Within a genus: (pollen will often look similar)

Acacia **(wattle)**

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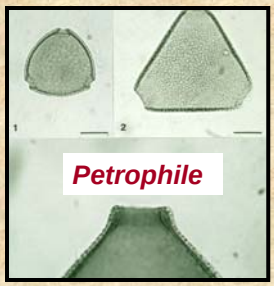
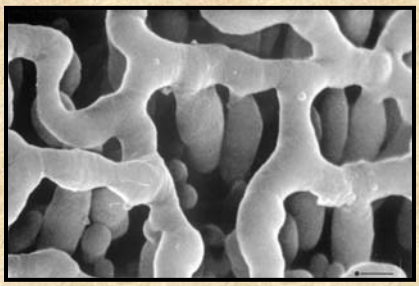
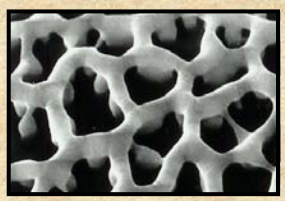
At the species level: (often only small differences)

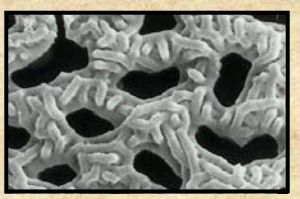
(**Proteaceae**)
40 species
of the genus



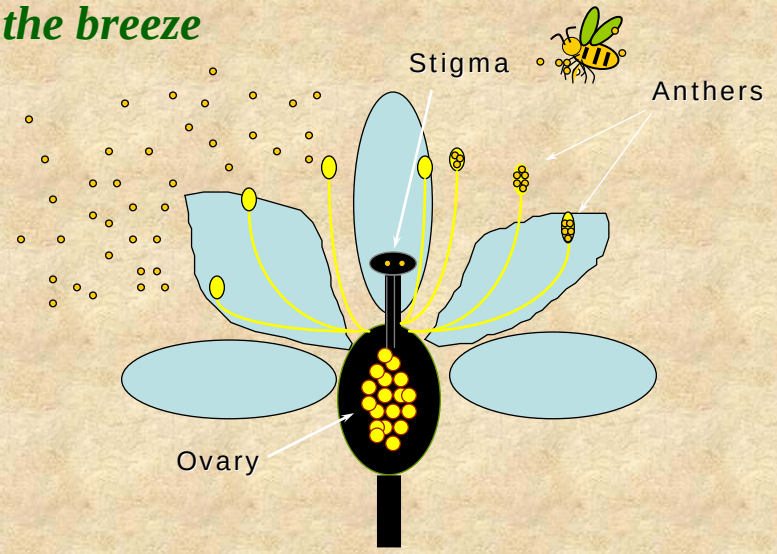


Within a genus (*Petrophile*), there is a range of morphologies, but all species have pollen features in common (reticulate pattern)





The Sex Life of Plants - is all about the birds, the bees, and the breeze



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The vast majority of dispersed pollen grains are unlucky because they end up as particulate matter and become part of soil, dirt, and dust

POLLEN & SPORES ARE EVERYWHERE

- Found in the air over the middle of the oceans
- Found in the air all over the world including the air over the North and South Poles
- Found in rivers, lakes, seas, and at the bottom of the oceans
- Found inside buildings, in cars, on and inside animals, on and inside people, in soils, and rocks up to 2.2 billion years old

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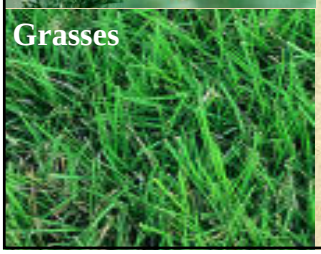

- There are about ½ million plants that produce either pollen or spores, ***each species produces a unique type of pollen or spore***
- Some plants are wind-pollinated & disperse millions of pollen grains or spores, most of which (~90%) fall very close to the plant; a few might travel great distances

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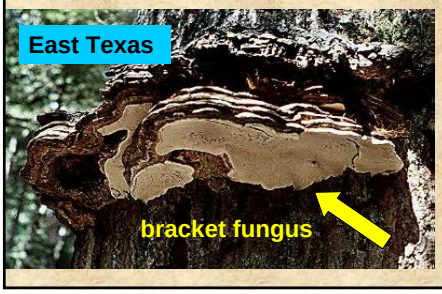
Enormity of Pollen and Spores



- During an average spring or summer day in most areas each cubic meter of air contains about 1,000-20,000 pollen & spores
- The average adult inhales about 10 m^3 of air a day, more if doing physical exercise, pollen is trapped in nasal passages, can be a key to the season of year
- During peak pollination periods there can be up to 100,000 pollen grains/m^3 of air
- Some bracket fungi such as: ***Ganoderma*** can discharge ~30 billion spores daily for months (May-September)

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Pollen Production and Dispersal

Method of pollination	Grains per anther	Where dispersed	Forensic Potential
Water plants-(hydrogamous)	1,000's	In water currents	little to none rarely preserved
Self -(autogamous)	<100	rare	rare - excellent if present
Closed flowers-(cleistogamous)	<100	very rare	rare - excellent if present
Animals/insects -(zoogamous)	100 - 1,000	near plant	excellent
Wind pollinated-(anemophilous)	1,000->100,000	95%: 25m-1km 5%: 1km-100's km	excellent-good, depending on assemblage

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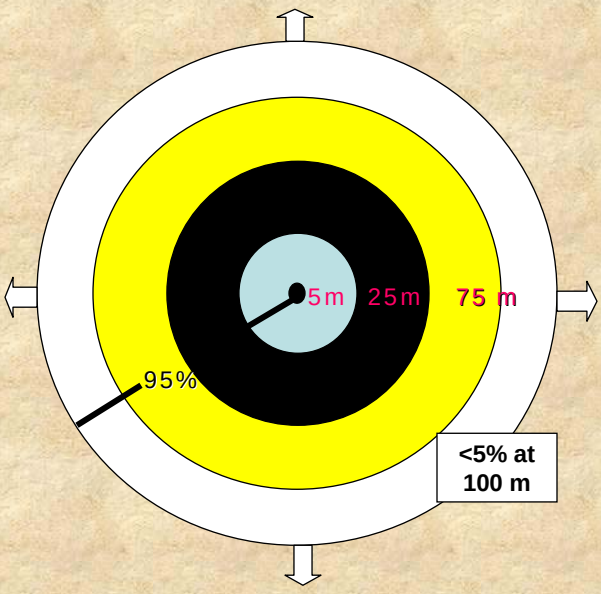
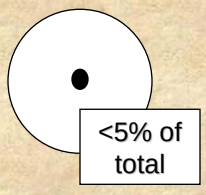
Wind pollinated types



Insect/animal pollinated types



Dispersal distances will vary depending on the pollen grain's known sinking speed

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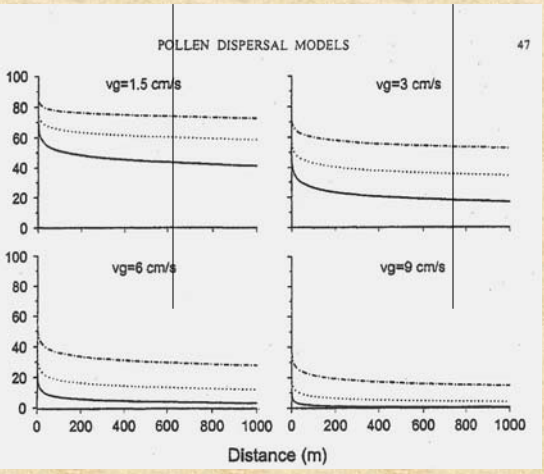
Sinking Speed: (velocity of deposition or V_g)

Percent of pollen still aloft at distances from dispersal source in winds of 3 m/sec



- ___ Stable air with a ***normal*** adiabatic lapse rate (-1°C/100m)
- …. ***Dry*** adiabatic lapse rate causing vertical gusting (-3°C/1,000 ft)
- --- Very dry adiabatic lapse rate with more vertical gusting

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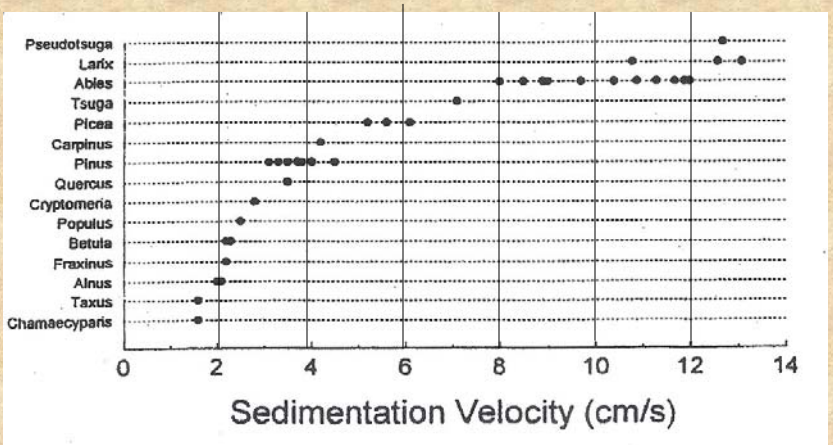
Sinking Speed of selected species



In stable air, no wind current

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Pollen Prints

- Each location produces a unique "**pollen print**" that is often so specific that it can be used to identify that precise location