# Cronostratigrafia e ricostruzioni paleoclimatiche nel Quaternario italiano: il contributo della palinologia


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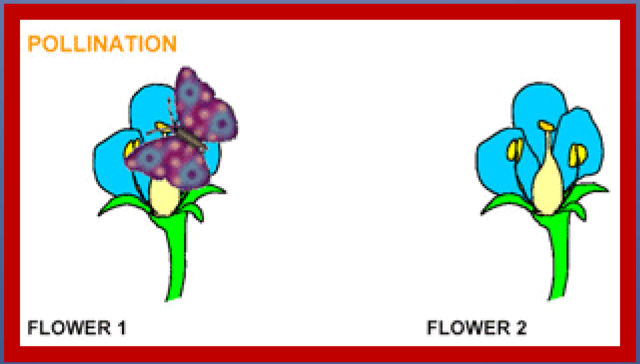
**Per qualsiasi chiarimento od informazione supplementare**




ISPRA
Istituto Superiore per la Protezione e la Ricerca Ambientale

**CORSO DI FORMAZIONE AMBIENTALE**

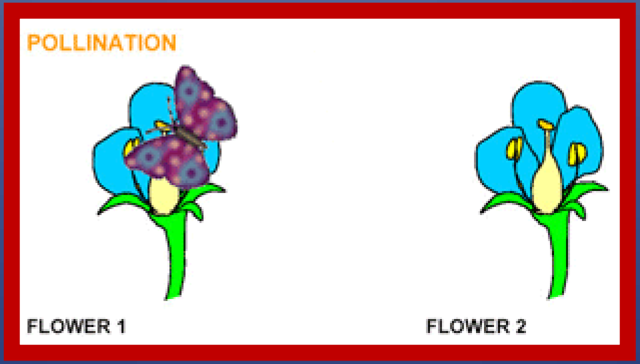
**GEOCRONOLOGIA: TECNICHE DI DATAZIONE E METODI DI CORRELAZIONE**

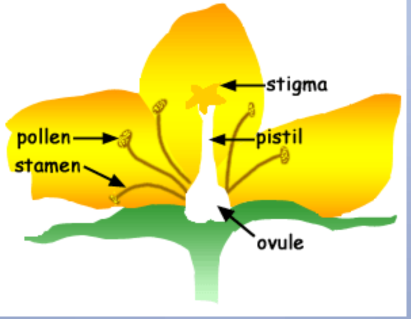
Roma, 14-16 giugno, ISPRA, Via Curtatone 3 - Sala Fazzini

# CONTRIBUTO DELLA PALINOLOGIA:

1. ricostruzioni ambientali e climatiche e

2. definizione di un quadro cronostratigrafico del Quaternario






# Analisi pollinica

## Attualmente è uno dei più importanti metodi per la ricostruzione

- flora
- vegetazione
- Clima
- Paleo-ambienti

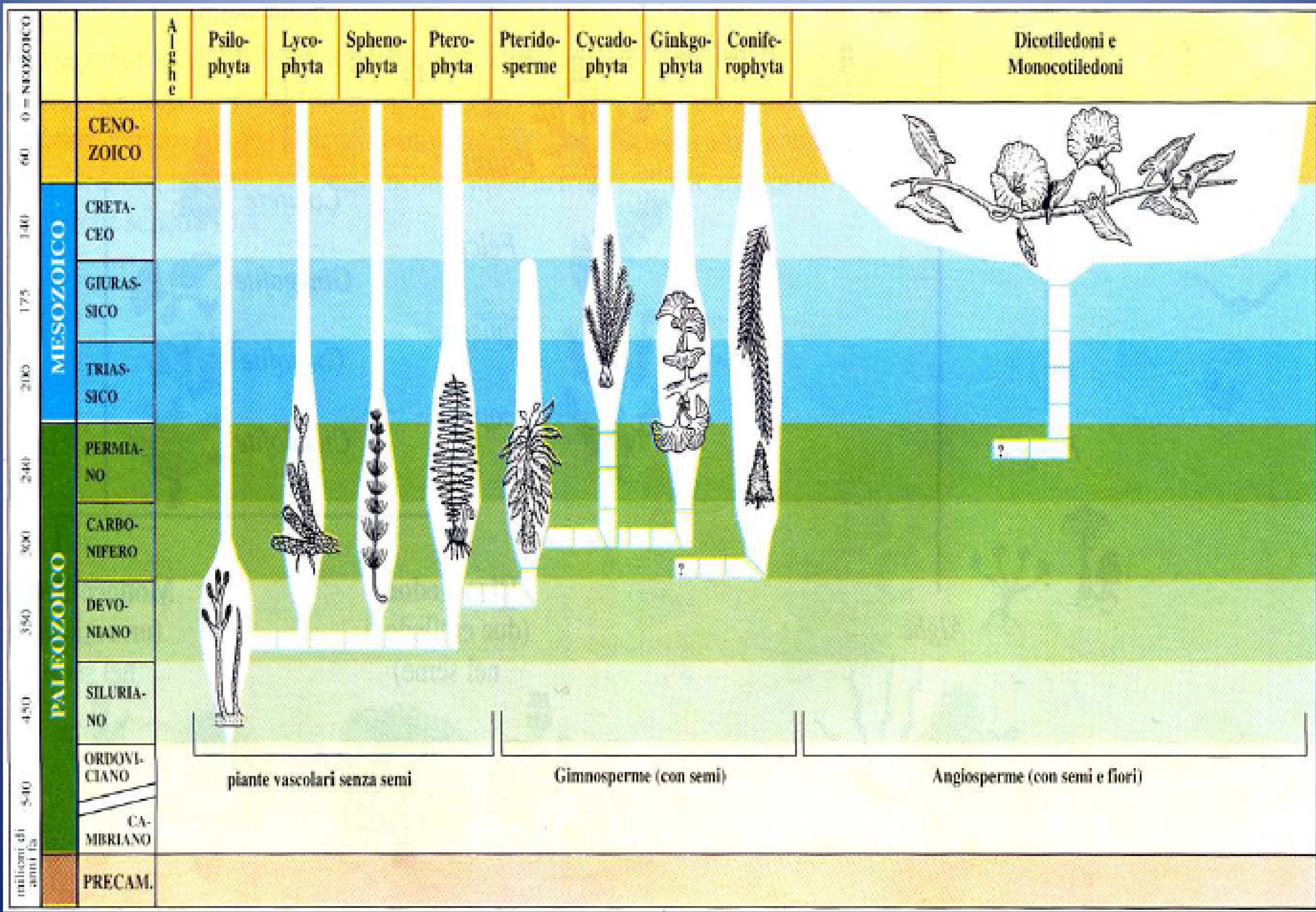
Sfondo da Hesse et al., 2009

# POLLINE

*Introduzione alla metodologia*


# POLLINE:

**gametofito maschile, i.e., la struttura che produce e contiene i gametofiti nelle angiosperme e gimnosperme.**


Alghe
Psilo-phyta
Lyco-phyta
Spheno-phyta
Ptero-phyta
Pterido-sperme
Cycado-phyta
Ginkgo-phyta
Conife-rophyta
Dicotiledoni e Monocotiledoni
0 = NEOZOICO
60
140
175
200
240
300
350
450
540
milioni di anni fa
MESOZOICO
PALEOZOICO
CENO-ZOICO
CRETA-CEO
GIURAS-SICO
TRIAS-SICO
PERMIA-NO
CARBO-NIFERO
DEVO-NIANO
SILURIA-NO
ORDOVI-CIANO
CA-MBRIANO
PRECAM.
piante vascolari senza semi
Gimnosperme (con semi)
Angiosperme (con semi e fiori)

# Essa è uno strumento utile in quanto:

**1)** i granuli pollinici sono prodotti in numero enorme;

| *Species* | *Pollen production per flower (or male cone)* | *Pollen production per inflorescence* |
|---|---|---|
| *Vallisneria spiralis* | 70 | 140 |
| *Polygonum bistorta** | 6,000 | 2,860,000 |
| *Sanguisorba officinalis* | 11,000 | – |
| *Fagus sylvatica* | 12,000 | 174,000 |
| *Calluna vulgaris* | 18,000 | – |
| *Betula verrucosa** | 20,000 | 5,453,000 |
| *Fraxinus excelsior* | 25,000 | 1,606,000 |
| *Carpinus betula* | 28,000 | – |
| *Quercus robur* | 41,000 | 555,000 |
| *Tilia cordata* | 44,000 | 200,000 |
| *Secale cereale** | 57,000 | 4,241,000 |
| *Pinus sylvestris** | 158,000 | 5,770,000 |
| *Aesculus hippocastanum* | 180,000 | 765,000 |
| *Picea excelsa* | 590,000 | – |
| *Pinus nigra** | 1,480,000 | – |
| *Populus canadensis** | – | 5,800,000 |
| *Alnus glutinosa** | – | 4,445,000 |

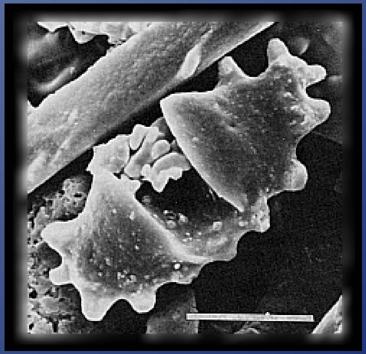
* Super-producers

**2) i granuli pollinici sono molto più diffusi dei fossili di maggiori dimensioni (es. foglie, semi, frutti, ecc.) e sono perciò meno dipendenti dalle piante madri corrispondenti;**

… semi, frutti

Pianta madre

polline



fitoliti

foglie

Oggi, l'analisi pollinica è di gran lunga il più importante metodo per la ricostruzione della flora, della vegetazione e degli ambienti del passato.

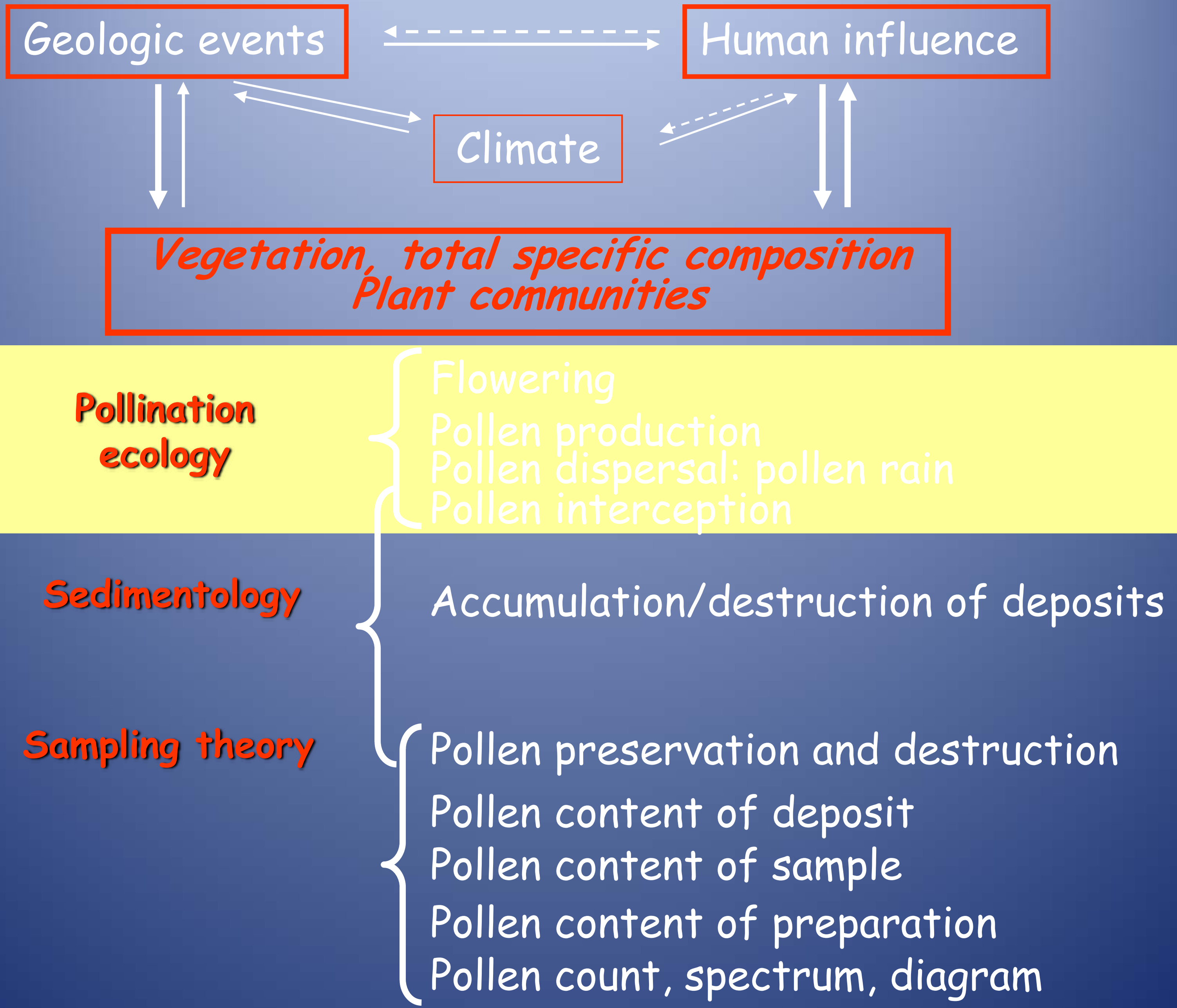
Essa è uno strumento utile in quanto:

1) i granuli pollinici sono prodotti in numero enorme;

2) i granuli pollinici sono molto più diffusi dei fossili di maggiori dimensioni (es. foglie, semi, frutti, ecc.) e sono perciò meno dipendenti dalle piante madri corrispondenti;

**3) i granuli pollinici sono estremamente resistenti e possono essere trovati in depositi nei quali altri tipi di fossile sono stati diageneticamente distrutti;**

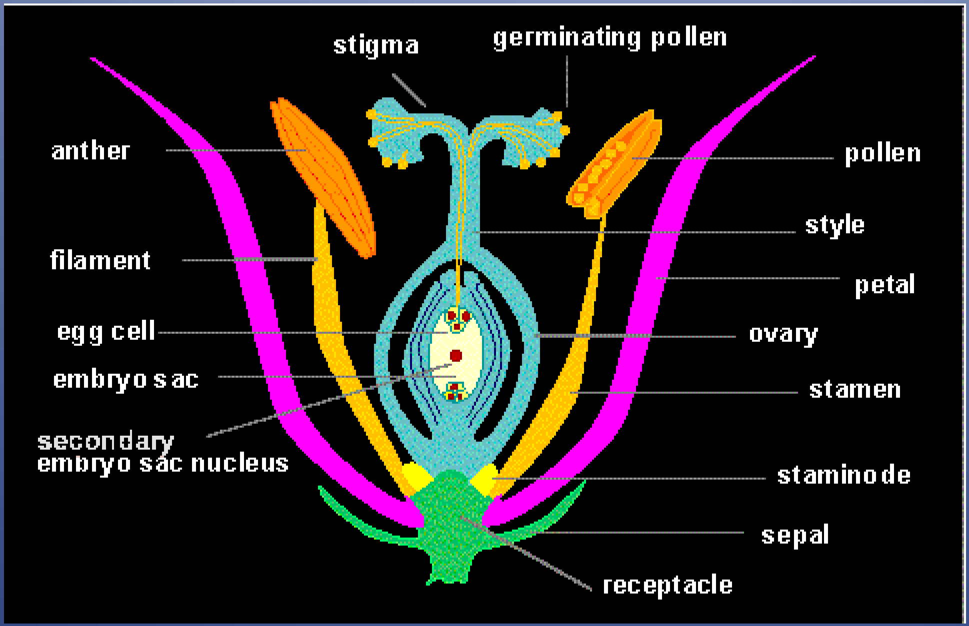
**4) i granuli pollinici possono essere recuperati in grande quantità;**




THE FLOWCHART SHOWS THE PRINCIPLE OF POLLEN ANALYSIS

# Impollinazione:

Trasporto del polline dall'antera allo stigma



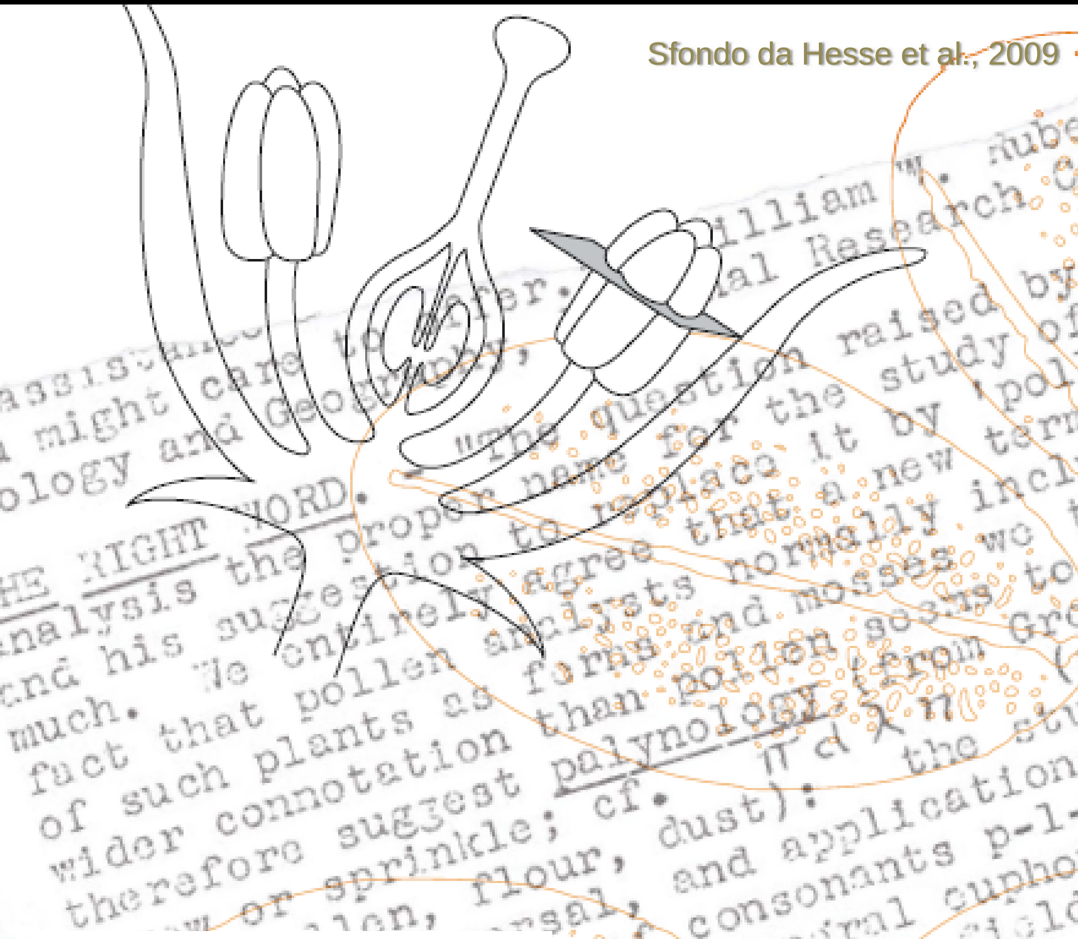
# Impollinazione

Sfondo da Hesse et al., 2009

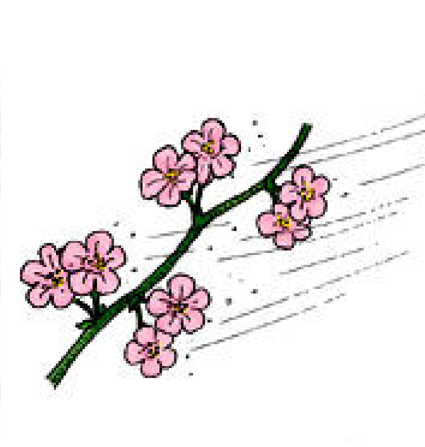
Le piante presentano diversi meccanismi attraverso i quali il polline liberato dalle antere può giungere allo stimma adatto.

Il trasferimento del polline viene effettuato tramite diversi agenti: il vento, l'acqua e gli animali.

# Impollinazione



Sfondo da Hesse et al., 2009

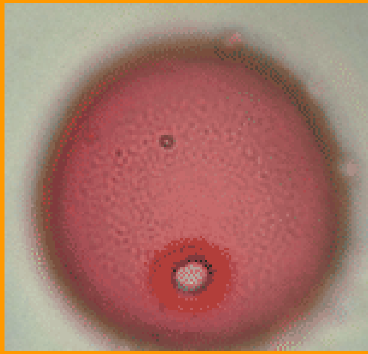


Le piante producono grandi quantità di polline che è liberato come « pioggia pollinica »

## Impollinazione anemofila

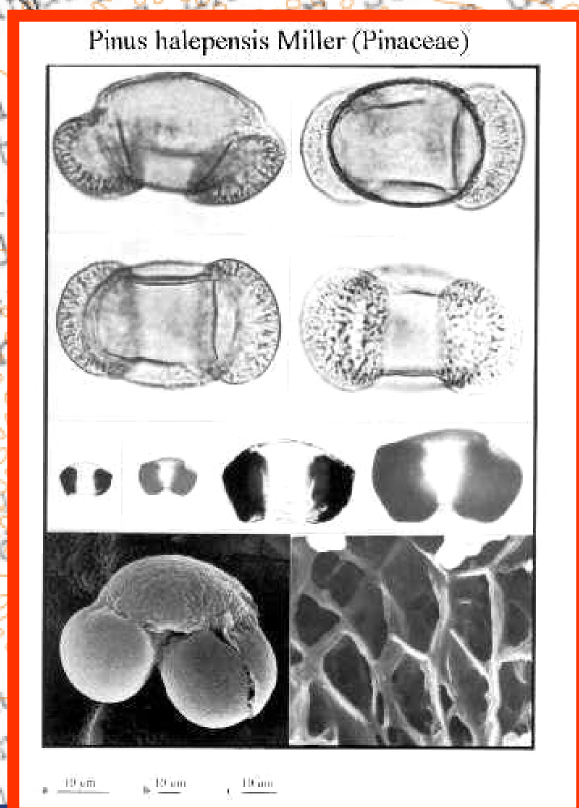
Polline:

- piccole dimensioni, liscio,
- privo di elementi scultorali prominenti



Poaceae

*Betula*




Sfondo da Hesse et al., 2009

# Impollinazione

## Impollinazione anemofila

Dimensioni dei granuli comprese tra 10-25 µm nelle Angiosperme

Granuli troppo piccoli non riuscirebbero, travolti dalla corrente d'aria, a contattare efficacemente lo stimma e così granuli troppo grossi si depositerebbero al suolo con notevole rapidità .

Gimnosperme: in media 30-60 µm ma talvolta anche > 100 µm

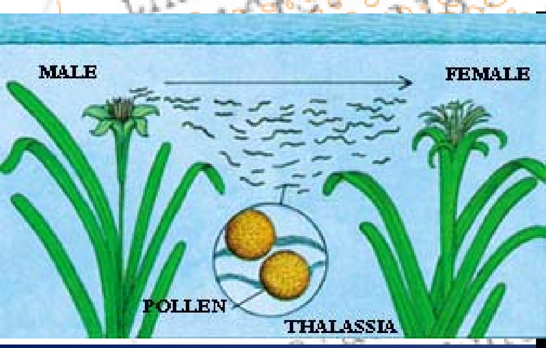
# Impollinazione

Sfondo da Hesse et al., 2009

## Impollinazione idrofila

Polline:

- Esina sottile
- Spesso numerose aperture




Effettuata da poche piante acquatiche : *Zostera*, *Ceratophyllum*, *Zannichellia*

Sfondo da Hesse et al., 2009

Impollinazione mirata, poco il polline prodotto

# Impollinazione

## Impollinazione zoofila

Polline:

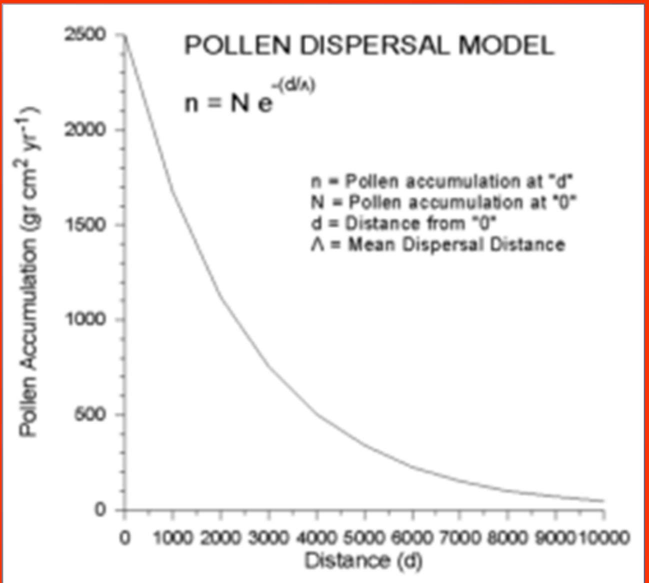
- processi superficiali (verruche, spine, ecc.: una superficie scabra favorisce l'adesione ai peli ed al corpo degli insetti
- Dimensioni abbastanza cospicue (30-60 µm)

Sfondo da Hesse et al., 2009

# Impollinazione

## Impollinazione fortuita

❖ Curva *leptocurtica*.

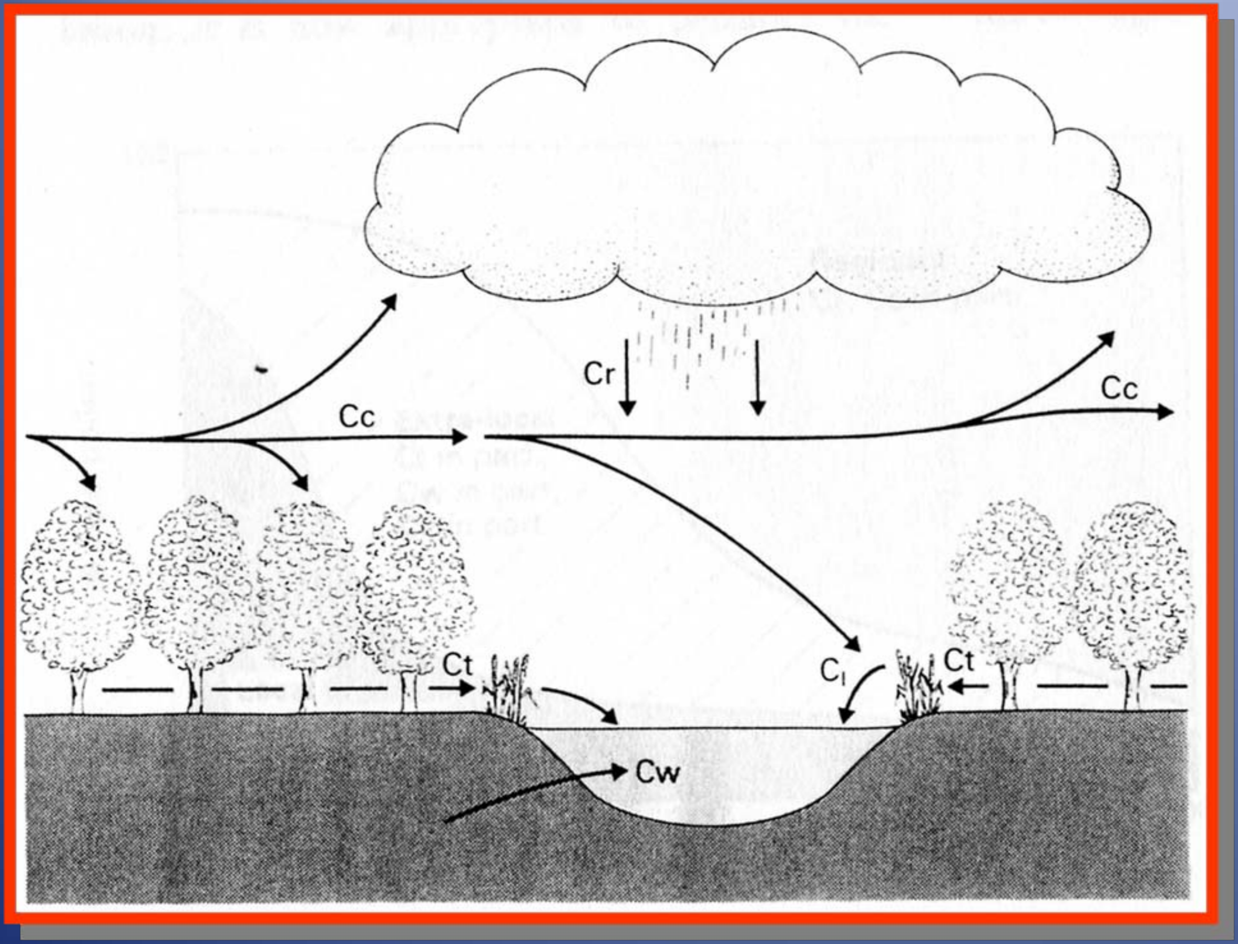



20.04 Model for airborne pollen dispersal.

**Origine del polline fossile**

❖ Prima di cominciare ad interpretare l'associazione pollinica fossile in termini di vegetazione circostante, si deve considerare **dove si sono originati e quanto hanno viaggiato i granuli pollinici**.

## Modello di Tauber (1965)




La pioggia pollinica consiste di diverse componenti principali:

CT. ***Componente dello "spazio del tronco".***

CC. ***Componente della copertura.***

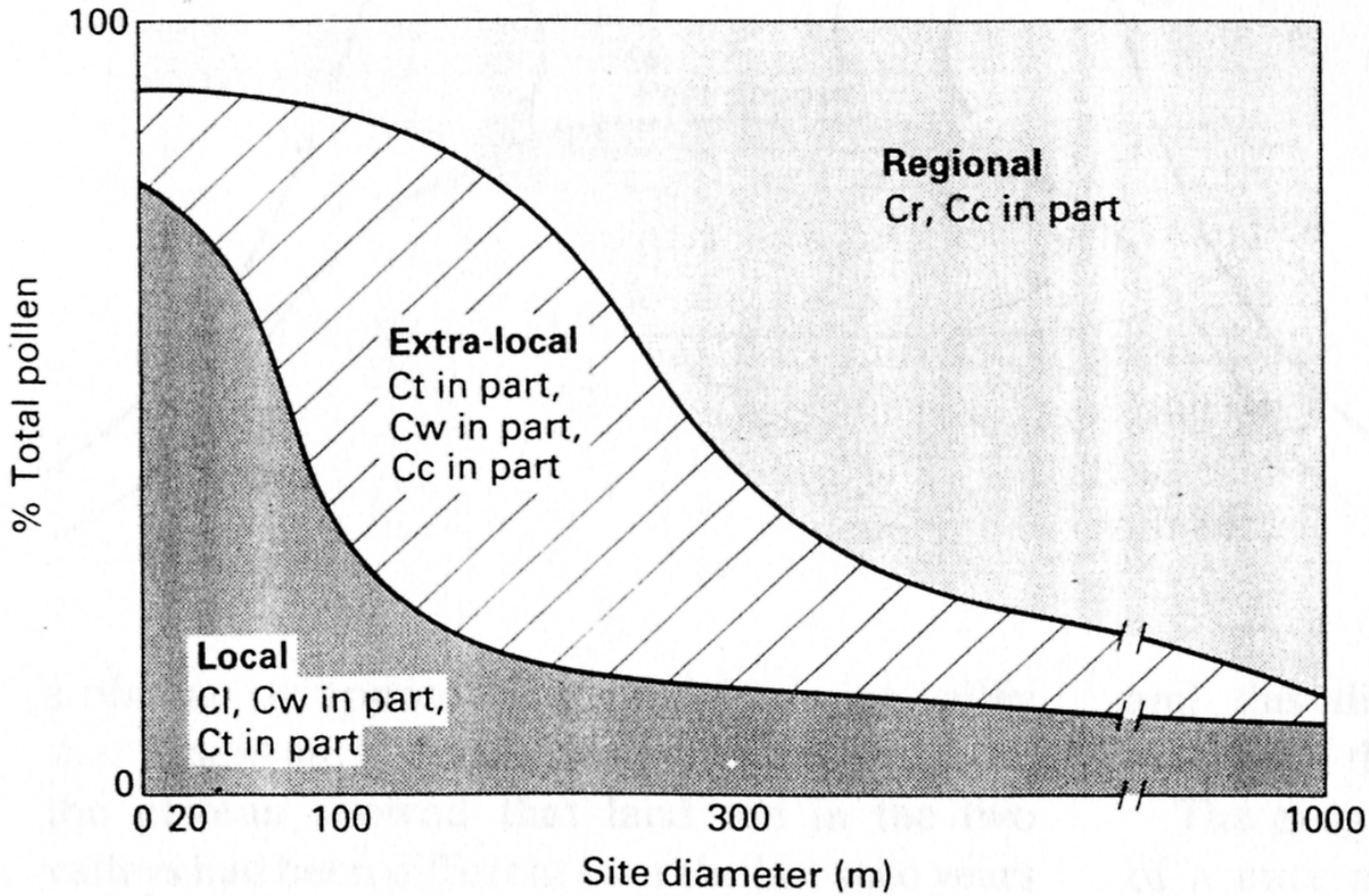
***Cr. Componente "pioggia".***

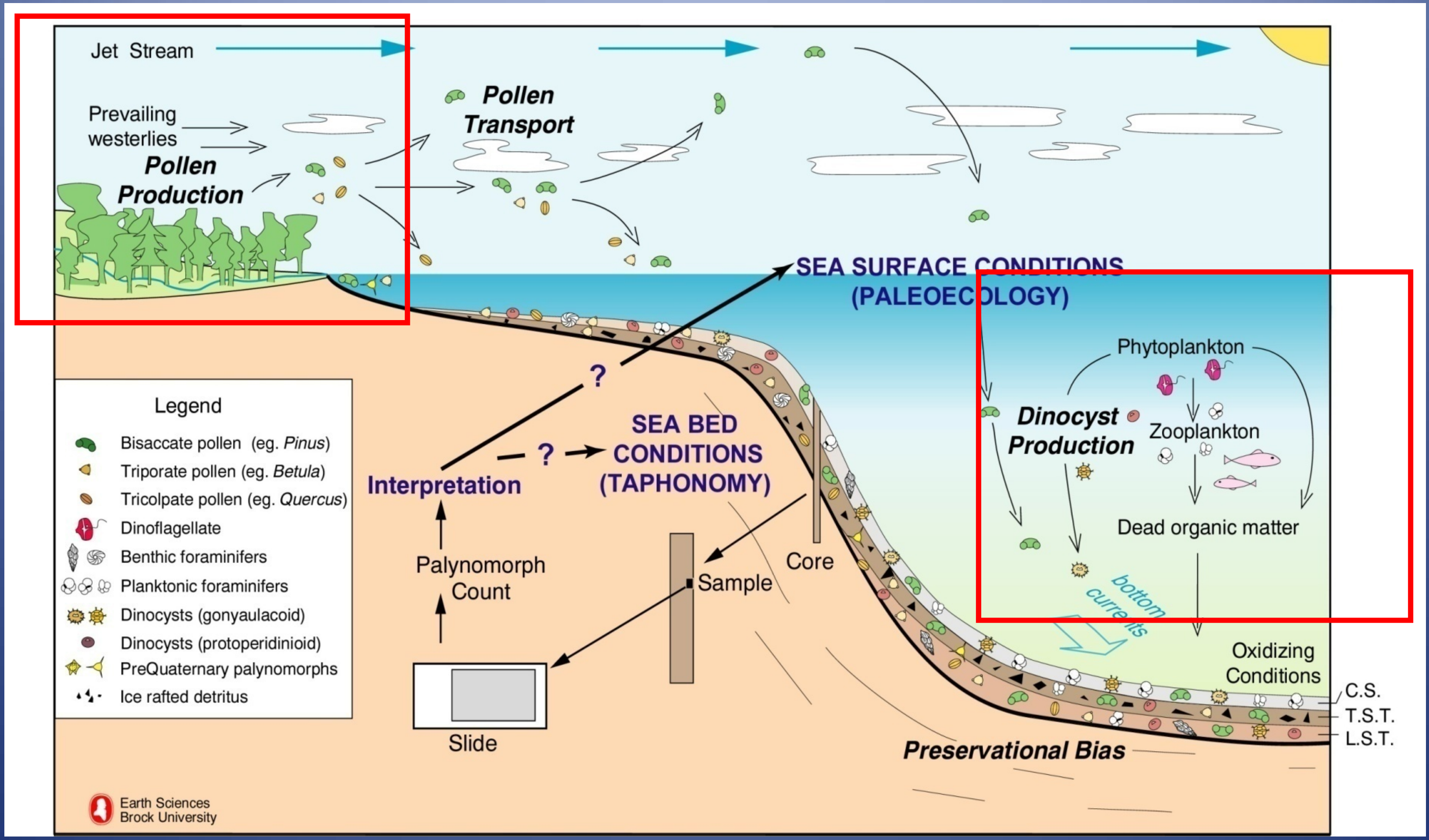
***Cl. Componente locale.***

***Cw. Componente secondaria.***

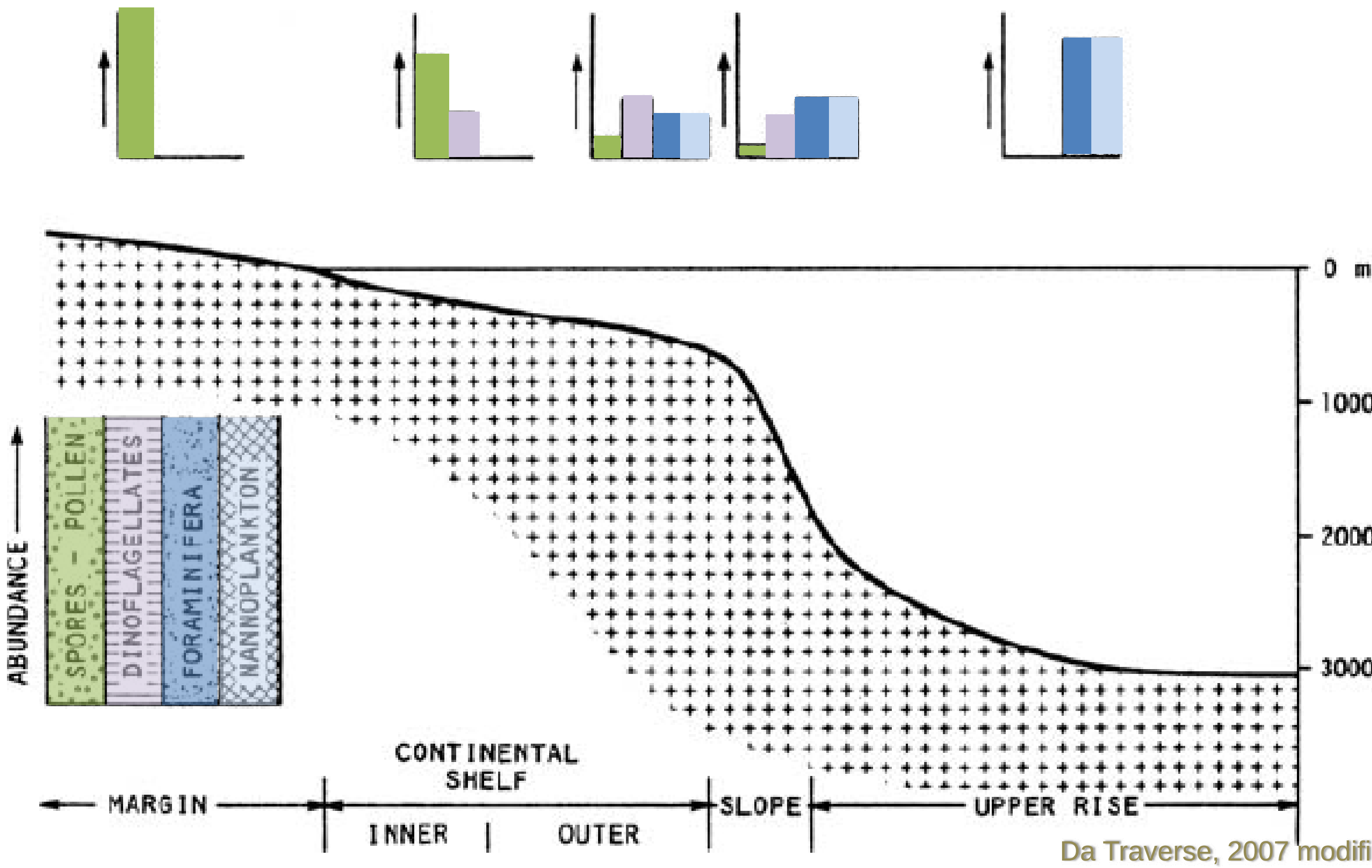
Modello di Tauber per un sito circondato da una foresta

*Produzione e dispersione del polline*

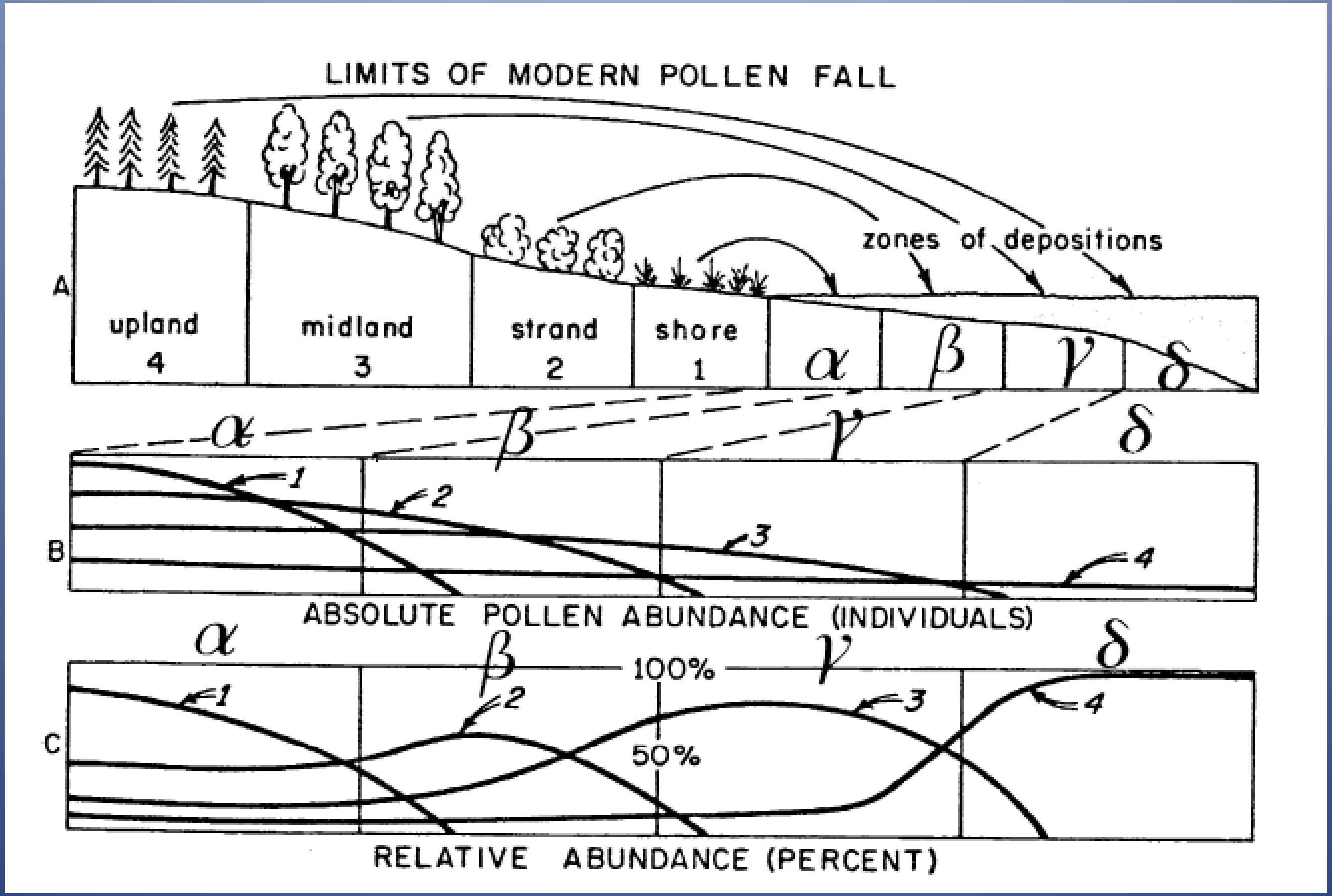




Jet Stream
Prevailing westerlies
Pollen Production
Pollen Transport
SEA SURFACE CONDITIONS (PALEOECOLOGY)
Phytoplankton
Dinocyst Production
Zooplankton
Dead organic matter
bottom currents
Oxidizing Conditions
C.S.
T.S.T.
L.S.T.
Preservational Bias
?
SEA BED CONDITIONS (TAPHONOMY)
Interpretation
Palynomorph Count
Sample
Core
Slide
Legend
Bisaccate pollen (eg. Pinus)
Triporate pollen (eg. Betula)
Tricolpate pollen (eg. Quercus)
Dinoflagellate
Benthic foraminifers
Planktonic foraminifers
Dinocysts (gonyaulacoid)
Dinocysts (protoperidinioid)
PreQuaternary palynomorphs
Ice rafted detritus
Earth Sciences
Brock University




Da Traverse, 2007 modificato




# Neves effect

Da Traverse, 2007 modificato

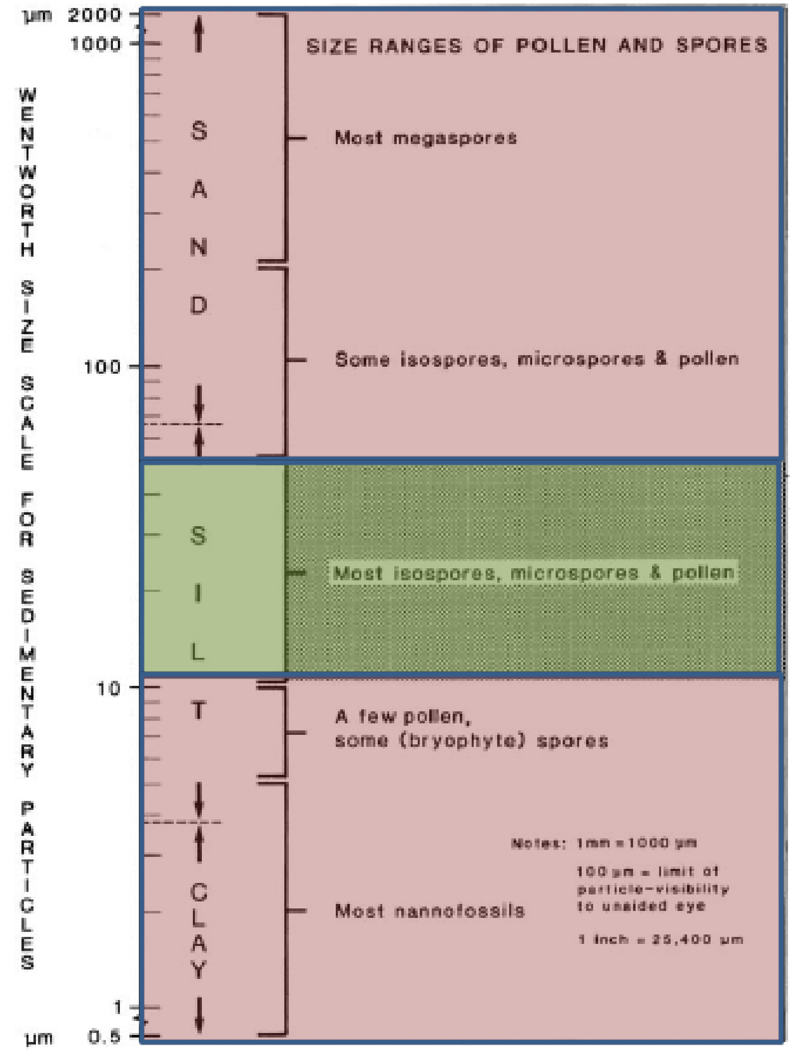
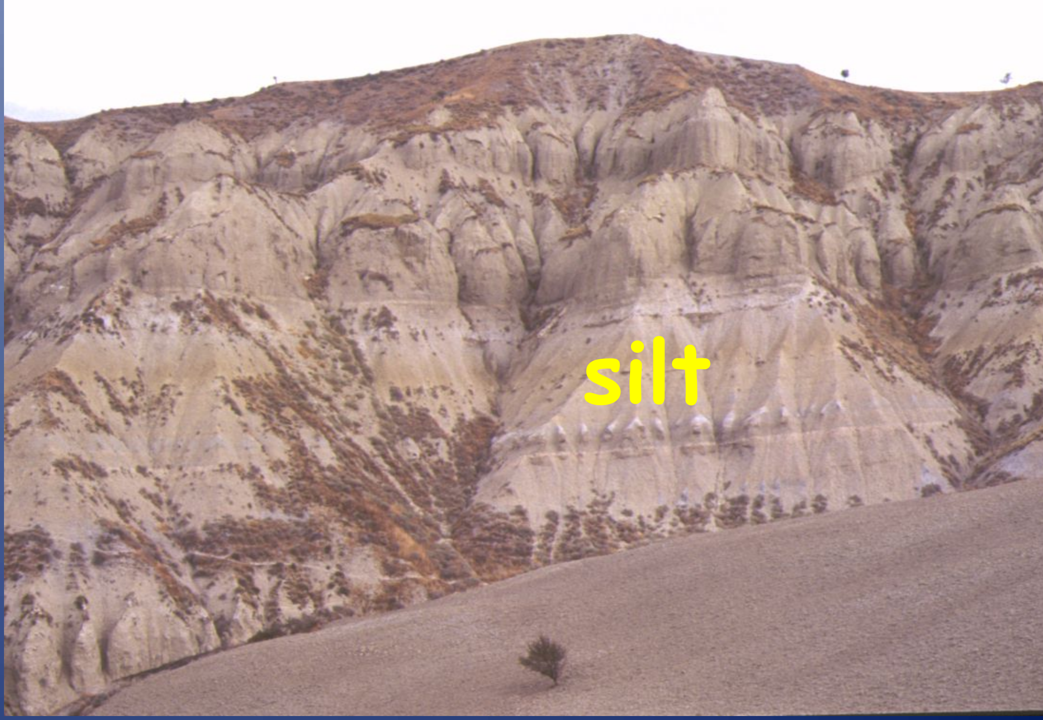



Figure 17.2 Size ranges of pollen and spores in comparison to clastic particles, per the Wentworth scale, plotted logarithmically. Most spores and pollen are silt-sized, although a few are fine sand-sized, and megaspores are practically all sand-sized. As the specific gravity of sporopollenin (about 1.4) is less than that of mineral clastic particles (about 2.5), and because palynomorphs are not solid, they will tend to sort in sedimentation in a mineral class of somewhat smaller particles than themselves (see Stanley, 1969).

Da Traverse, 2007 modificato

# Depositi lacustri e fluvio-lacustri


Piacenziano– **Valdarno Superiore** (Italia centrale)




Pleistocene inferiore – **Santarcangelo** (Italia meridionale)

# Stirone (Italia settentrionale)

# Valdarno Superiore (Italia centrale)


Gelasiano


Calabriano

Pleistocene medio – Valdarno superiore (Italia centrale)

# Suoli


- Ph > 6 non favorisce la conservazione del polline
- Polline soggetto a degradazione: fenomeni di sotto- o sovrarappresentazione

Packrat midden - Capitol Reef National Park

***Neotoma cinerea*, Chaco Canyon, New Mexico**

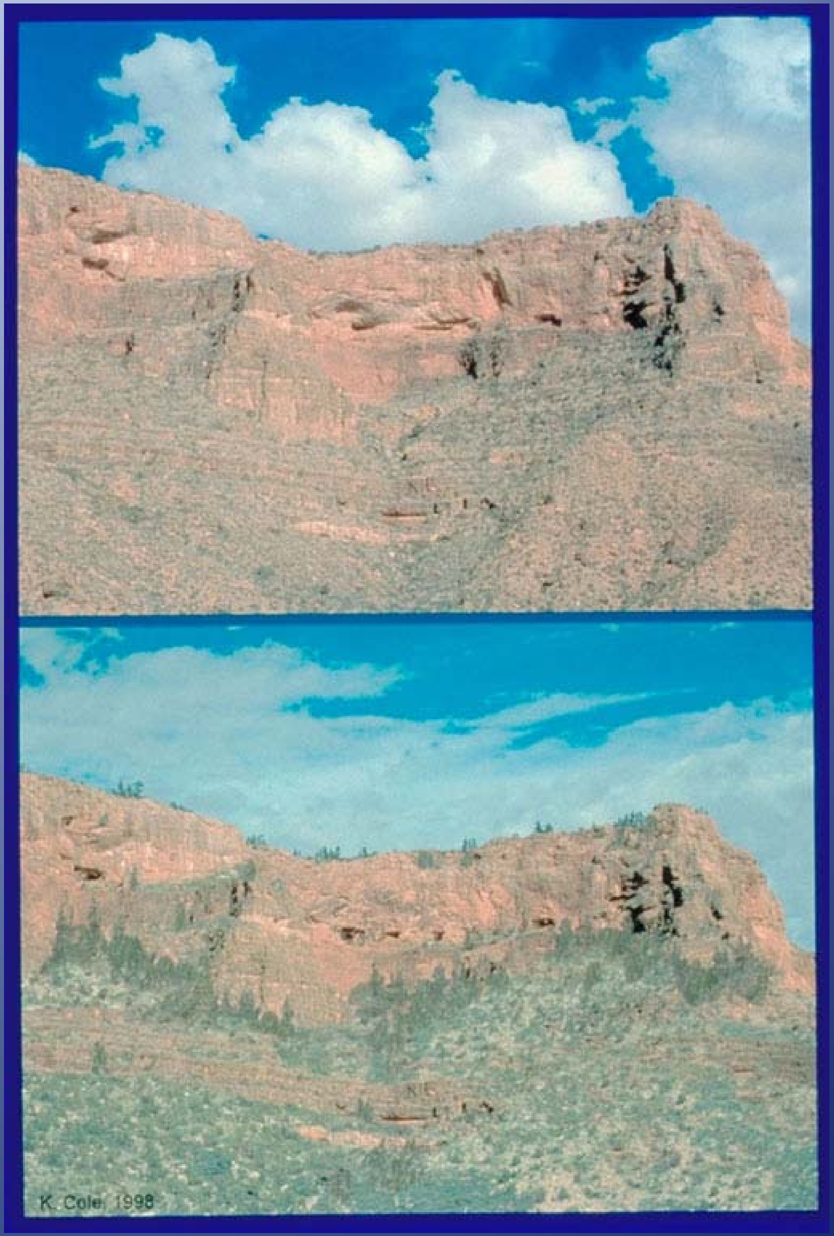
# Oggi

Deserto con arbusti,
cactus, rari ginepri

## Cambiamenti della vegetazione nel Grand Canyon

# 20KA *(glaciale)*

Bosco di ginepri, *Artemisia tridentata*, abeti, *Pseudotsuga*, pini.



# Coproliti

Feci fossilizzate di organismi antichi.

Sono una forma di traccia fossile che può essere utilizzata per ottenere informazioni sulla dieta del loro produttore e subordinatamente sulle condizioni ambientali circostanti.

# Depositi carbonatici

Analisi palinologiche in depositi carbonatici terrestri come **speleotemi** e **calcareous tufa**

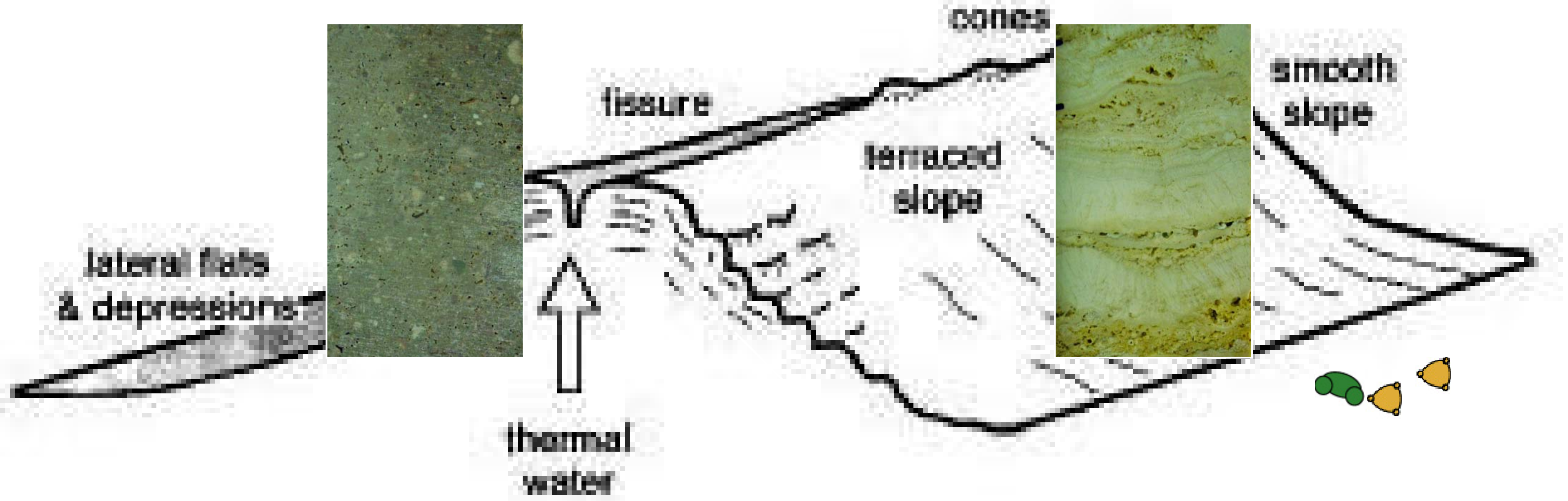
McGarry & Caseldine, 2004

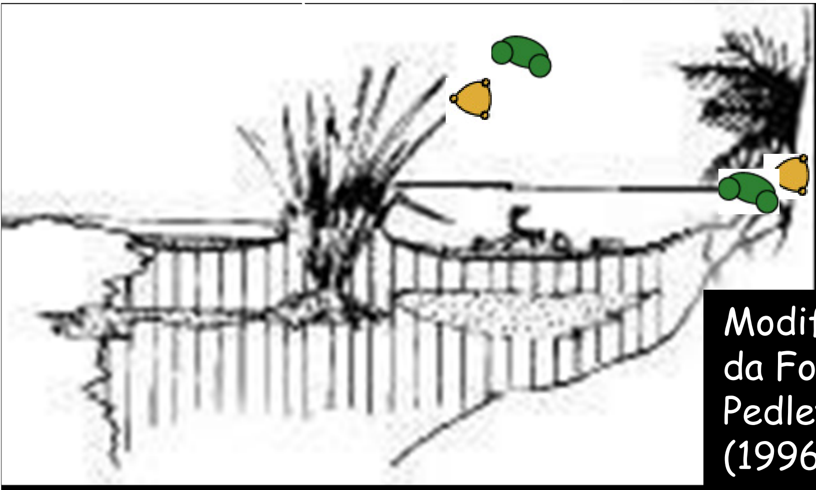
Taylor *et al.*, 1994
Burjachs & Julià, 1994
Vermoere *et al.*, 1999

Prime analisi nei travertini (Bertini *et al.*, 2008; Ricci, 2010) hanno dimostrato che:

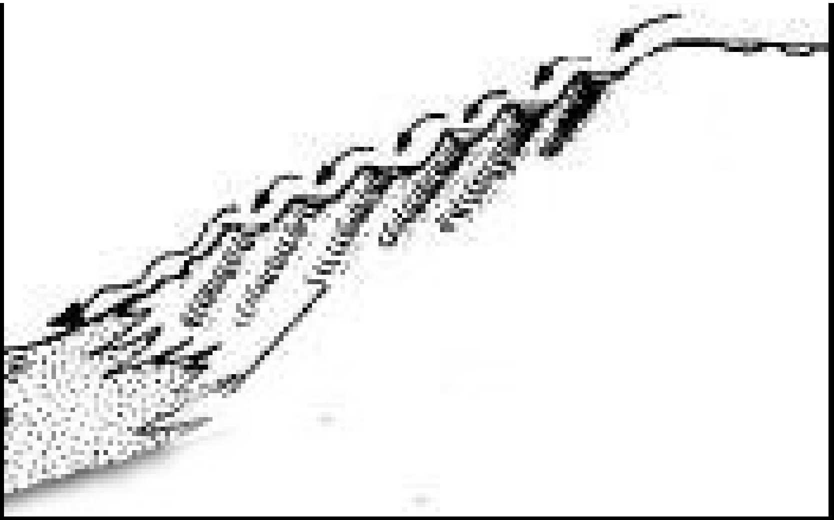
-polline è ben conservato

-polline è presente in basse concentrazioni e solo in alcune facies

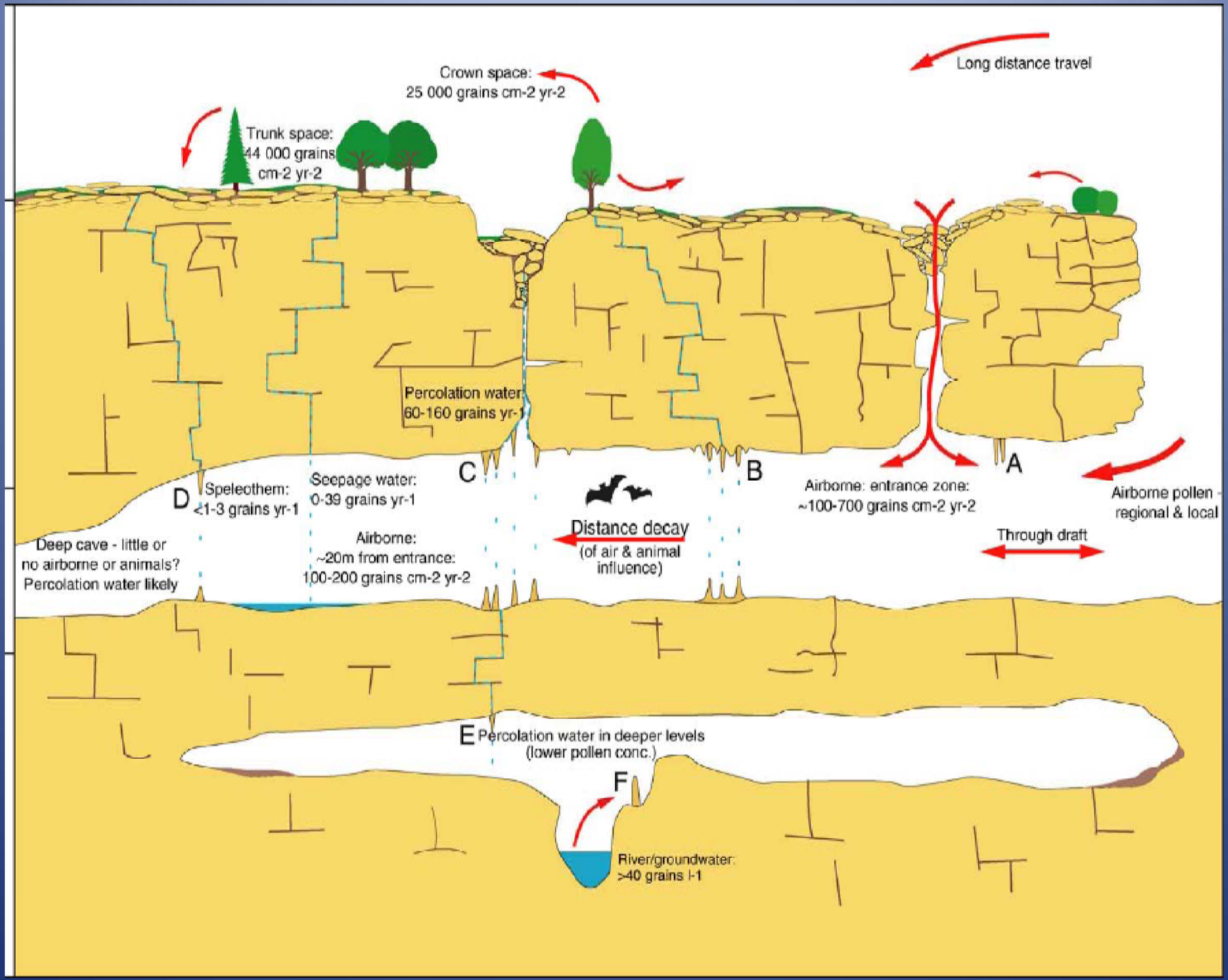



Modificato da Ford & Pedley (1996)



Ricci, 2010

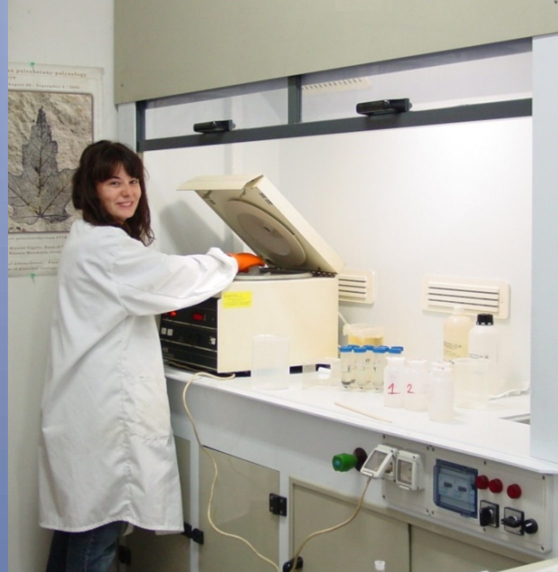

Long distance travel
Crown space:
25 000 grains cm-2 yr-2
Trunk space:
44 000 grains
cm-2 yr-2
Percolation water:
60-160 grains yr-1
C
B
A
D
Speleothem:
<1-3 grains yr-1
Seepage water:
0-39 grains yr-1
Airborne: entrance zone:
~100-700 grains cm-2 yr-2
Airborne pollen -
regional & local
Distance decay
(of air & animal
influence)
Through draft
Deep cave - little or
no airborne or animals?
Percolation water likely
Airborne:
~20m from entrance:
100-200 grains cm-2 yr-2
E
Percolation water in deeper levels
(lower pollen conc.)
F
River/groundwater:
>40 grains l-1

# Campionamento e descrizione delle facies


Da Ricci, 2010

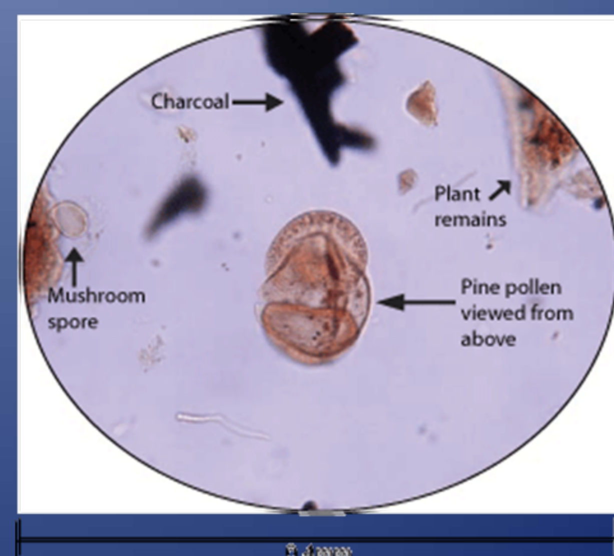
# Tecniche di Laboratorio

# Morfologia pollinica e analisi microscopica

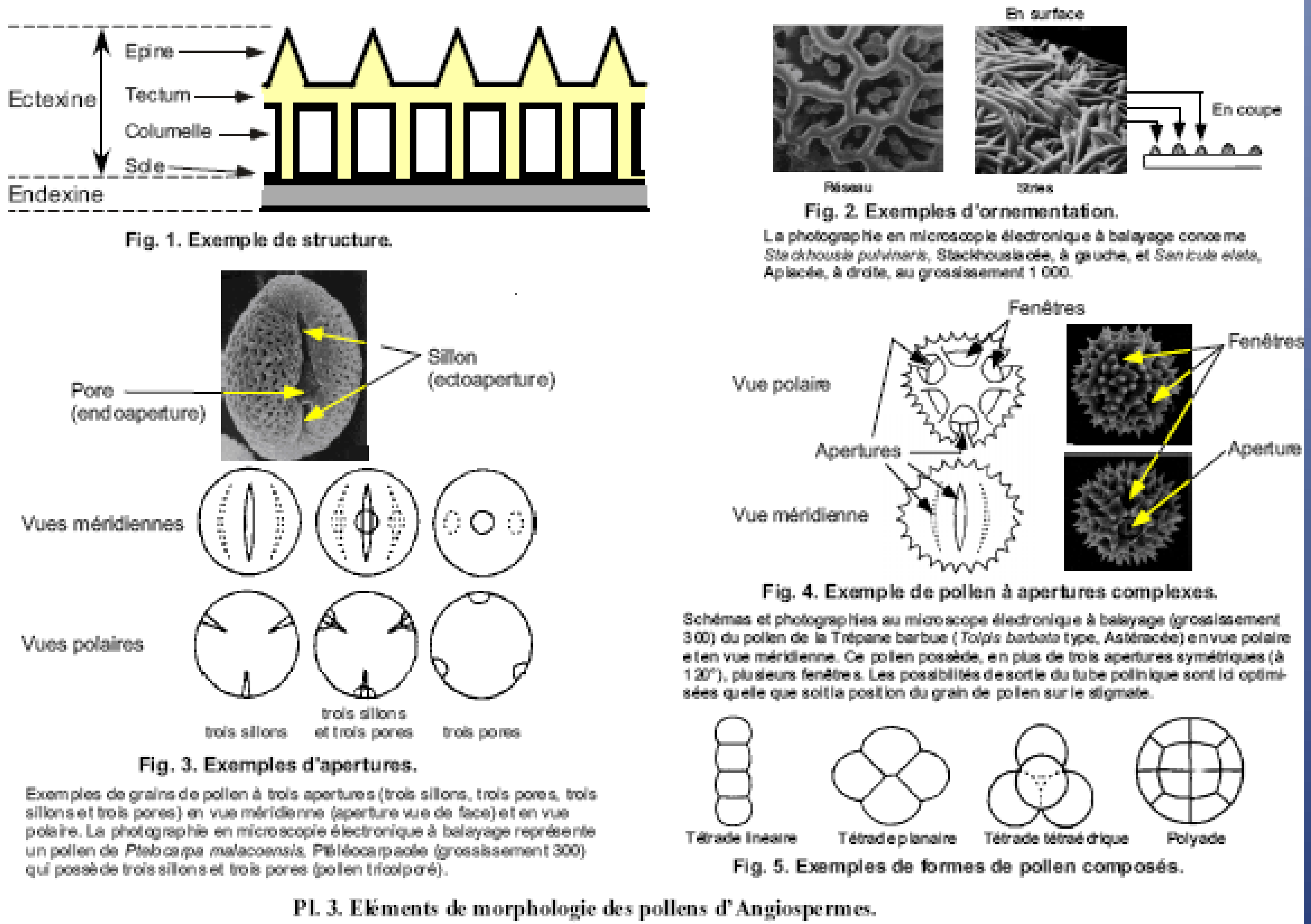


Site: Microscope:

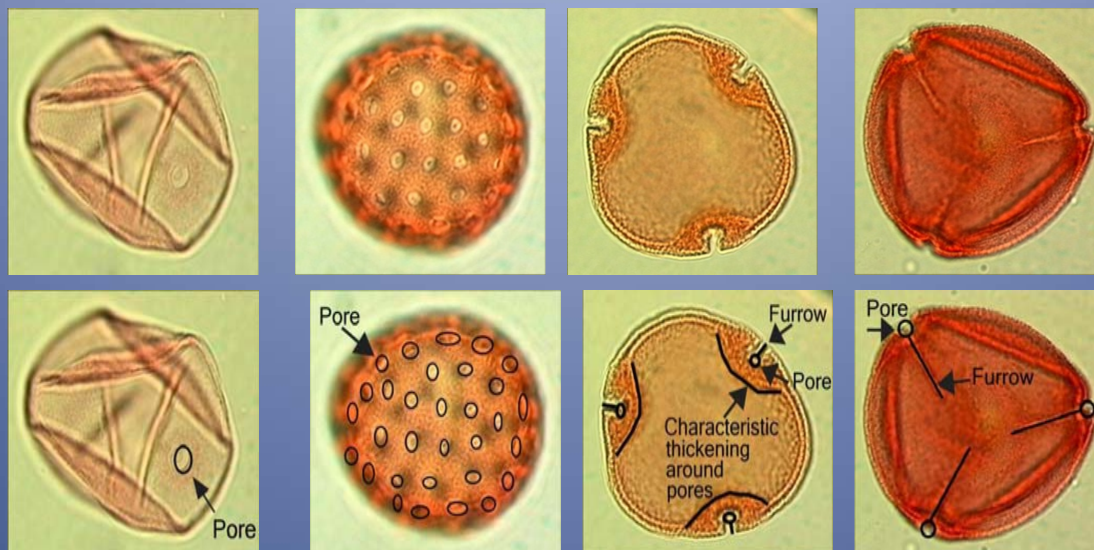
| Taxa | Tot. | 10 → |
|---|---|---|
| *Quercus* | | II |
| *Pinus* | | I |
| Poaceae | | I |



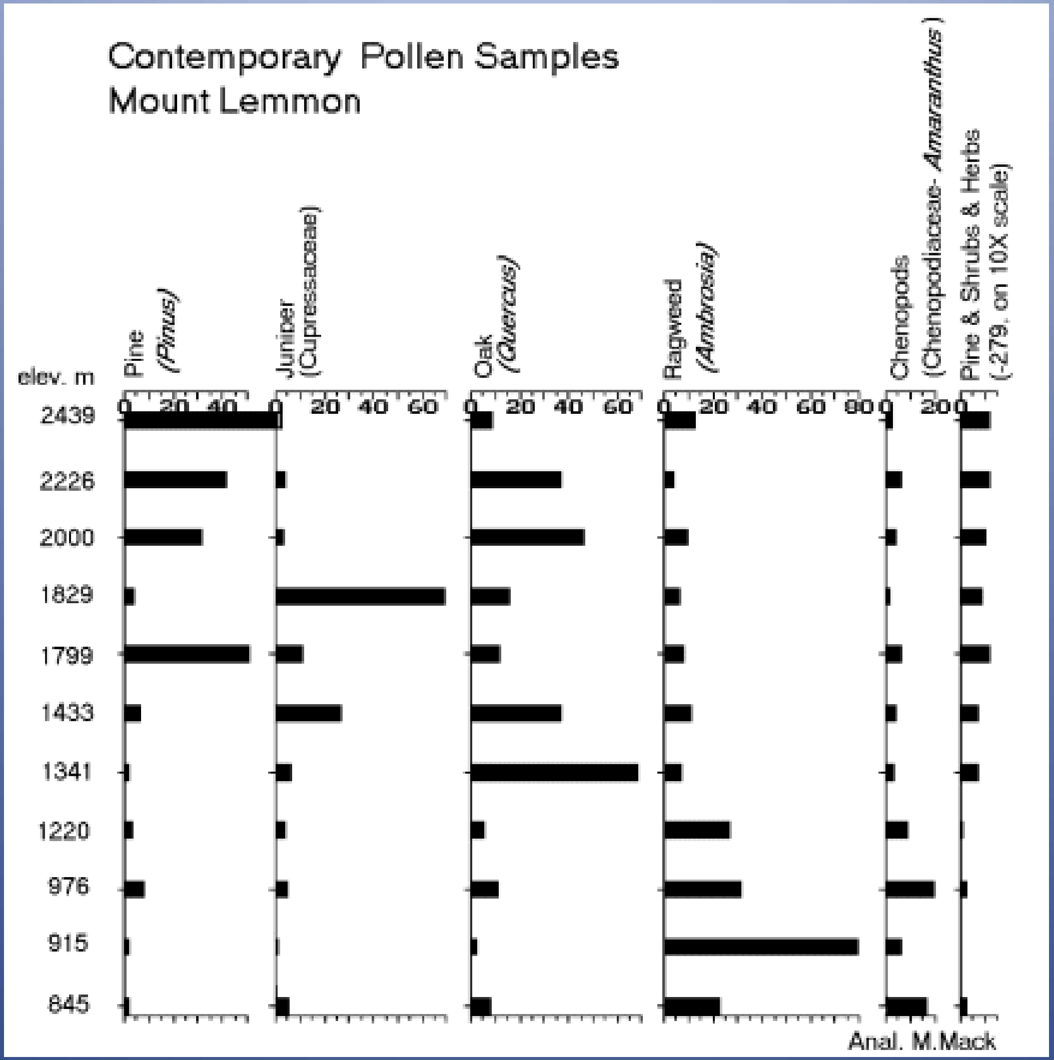
# Morfologia pollinica

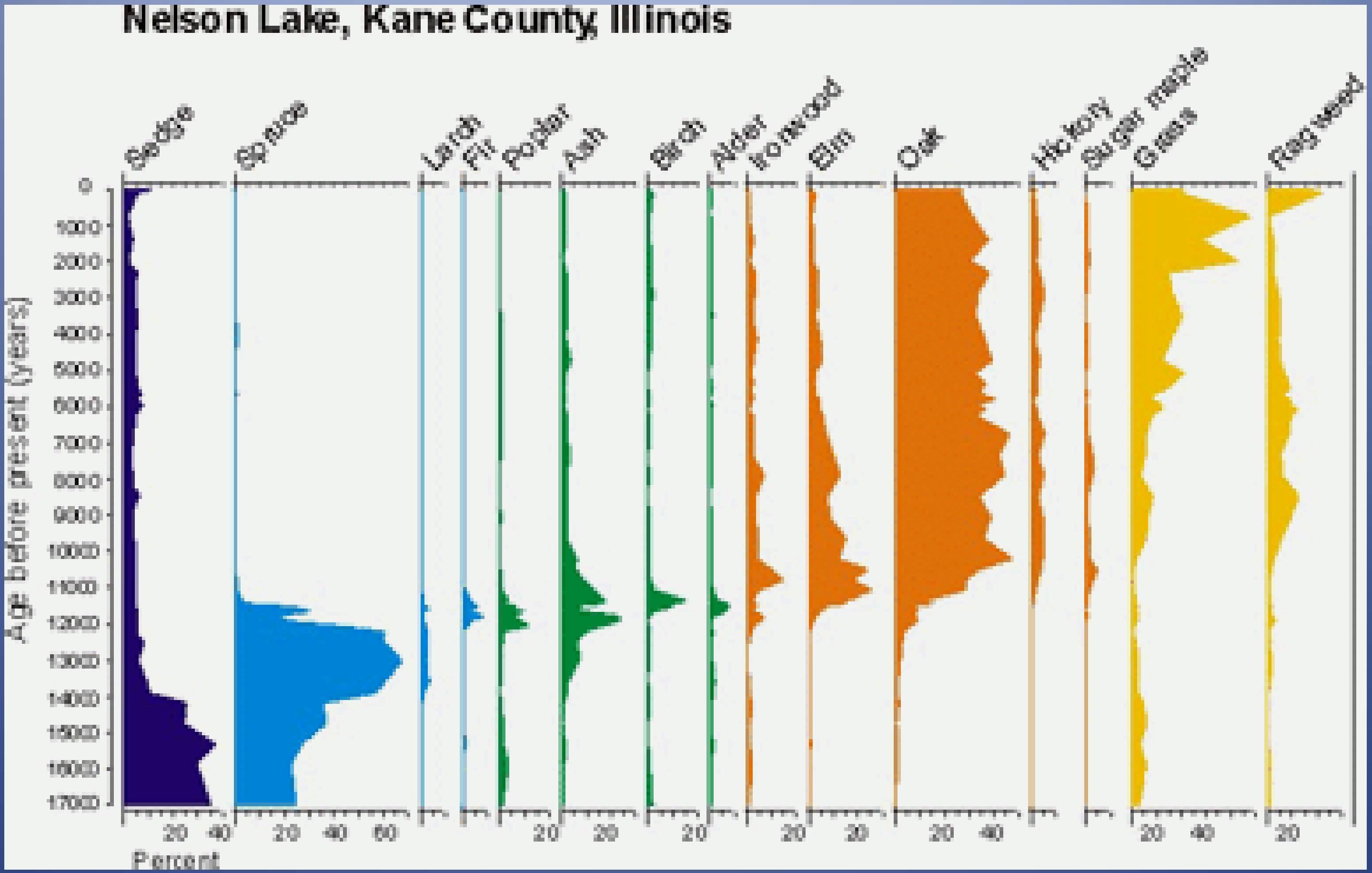



Da Defer &Suc, 2003




http://www.seillevalley.com/IdentifyingPollen.htm


Contemporary Pollen Samples
Mount Lemmon
elev. m
Pine (Pinus)
Juniper (Cupressaceae)
Oak (Quercus)
Ragweed (Ambrosia)
Chenopods (Chenopodiaceae- Amaranthus)
Pine & Shrubs & Herbs (-279, on 10X scale)
2439
2226
2000
1829
1799
1433
1341
1220
976
915
845
Anal. M.Mack



Nelson Lake, Kane County, Illinois
Sedge
Spruce
Larch
Fir
Poplar
Ash
Birch
Alder
Ironwood
Elm
Oak
Hickory
Sugar maple
Grass
Ragweed
Age before present (years)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
15000
16000
17000
20 40
20 40 60
20
20
20
20
20
20 40
20 40
20
Percent

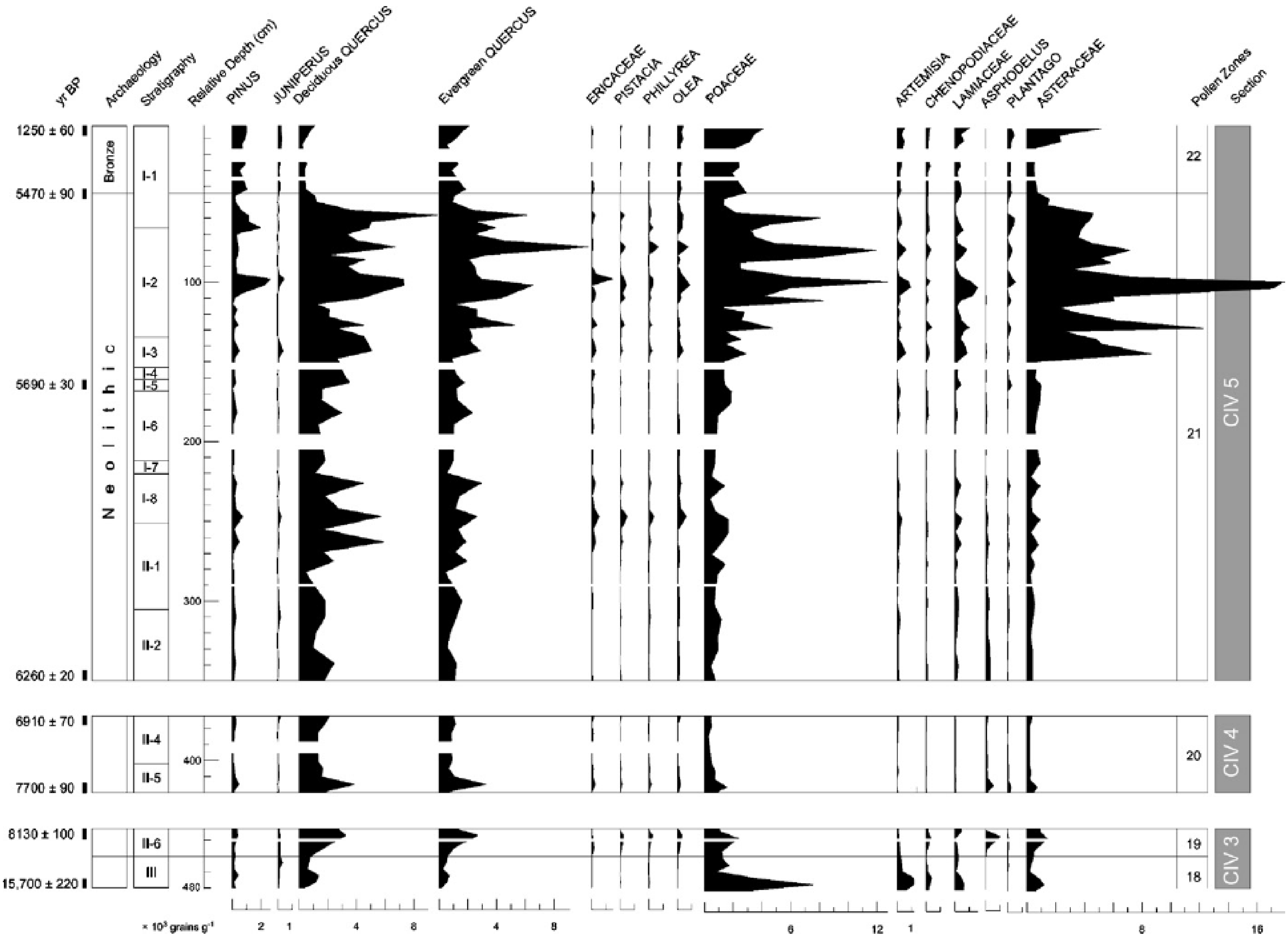
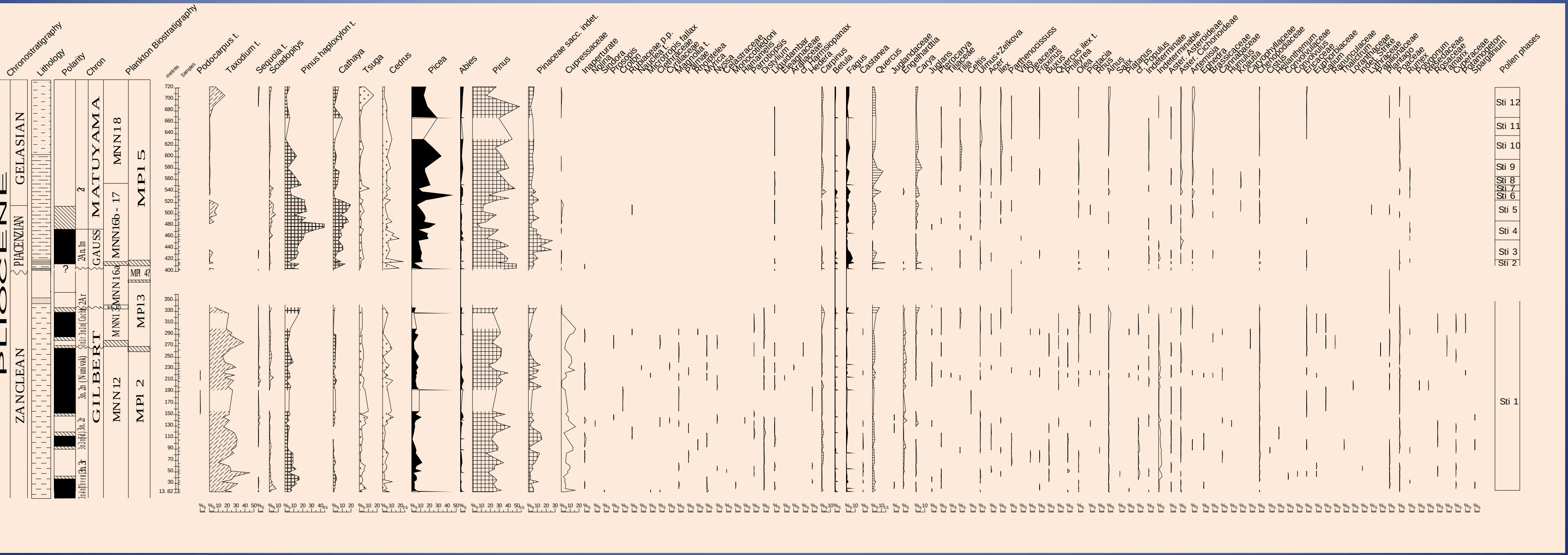



Fig. 4. Concentration pollen diagram of selected taxa for CIV Sections 3–5.

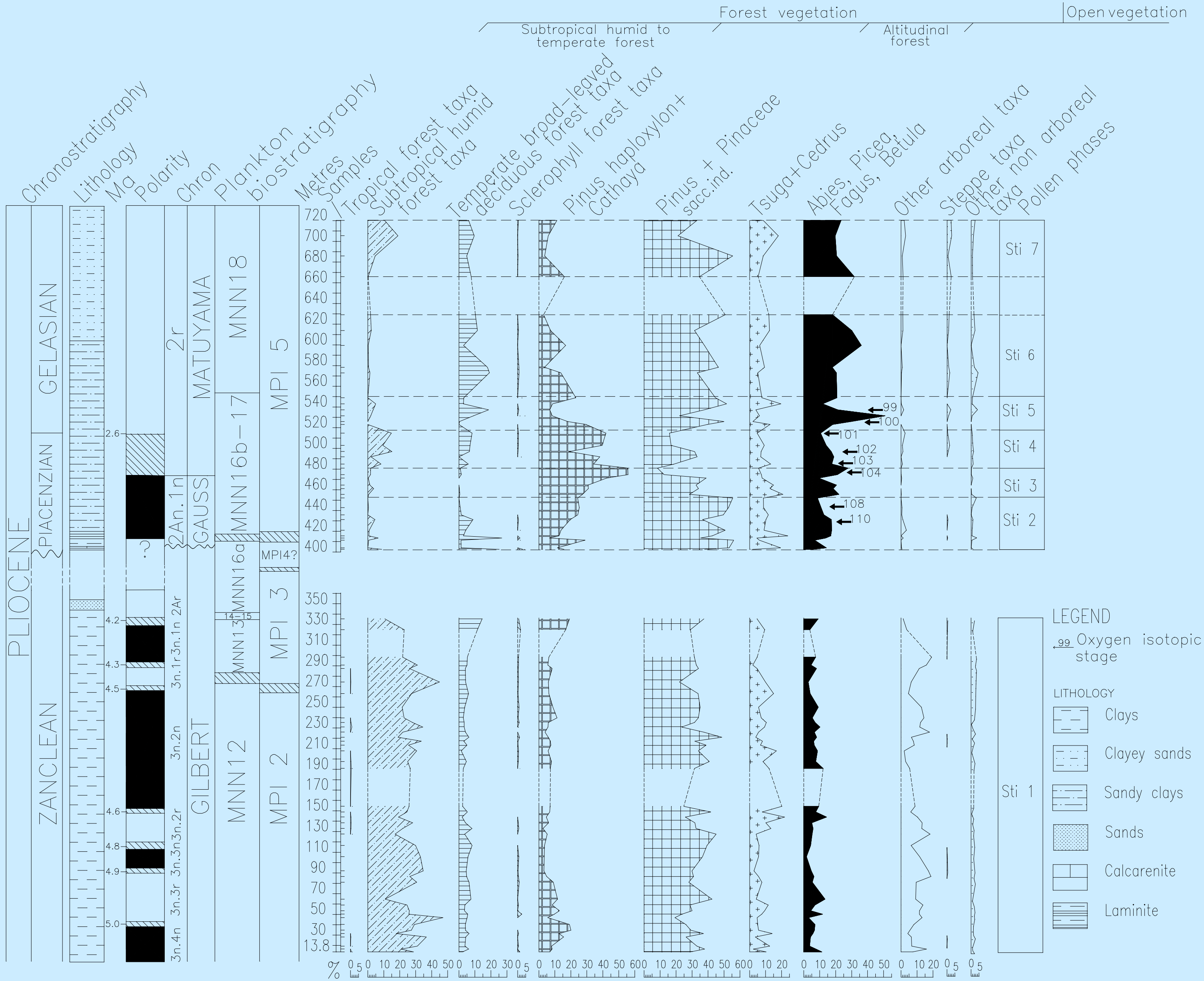
Fig. 4. Diagramme avec la concentration pollinique de quelques taxons sélectionnés de CIV, Sections 3–5.



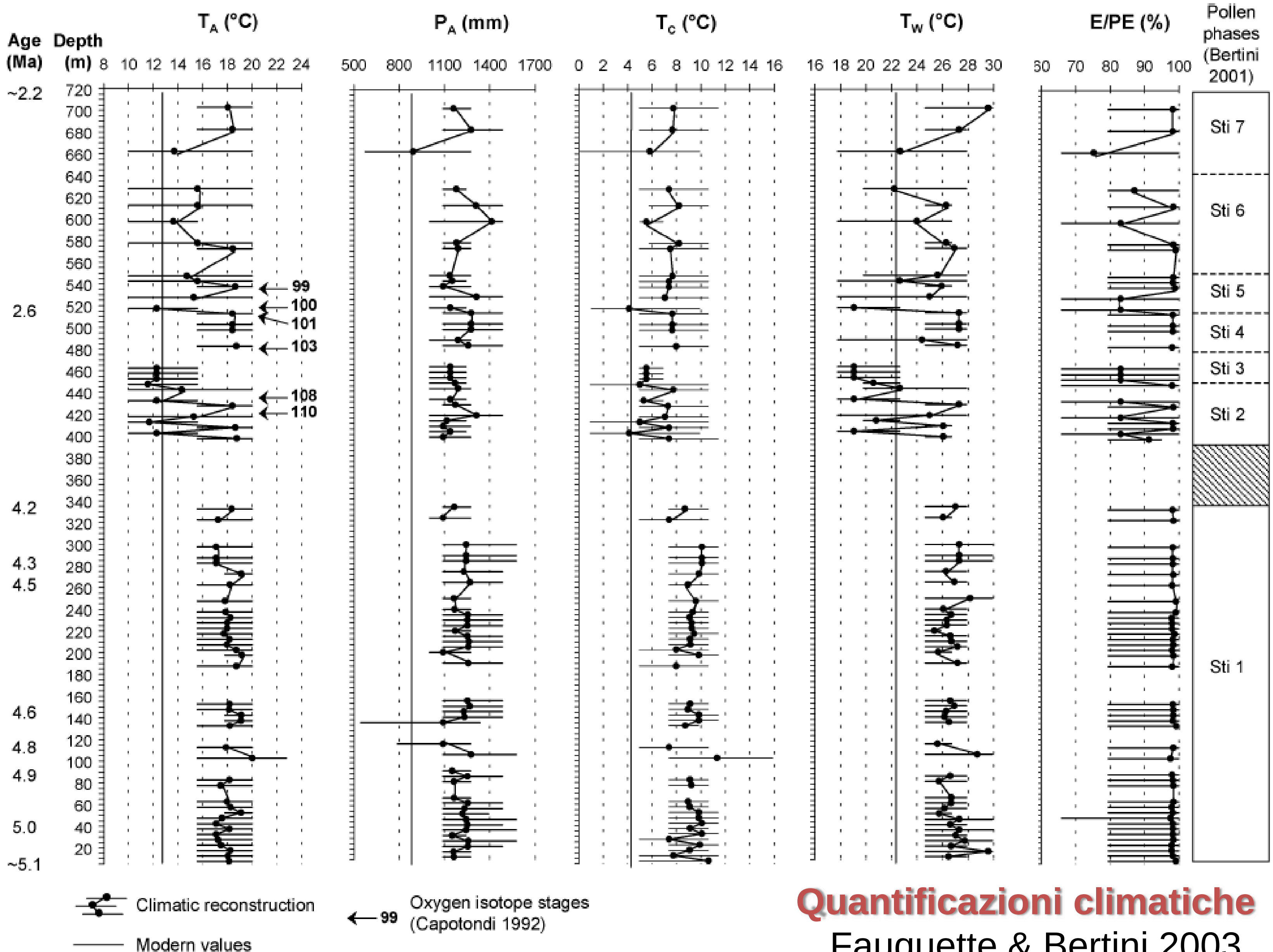

Stirone (Bertini, 2001)

| ***Pollen groupings*** | | |
|---|---|---|
| GROUP | FLORAL ELEMENTS | MODERN CLIMATIC AND ECOLOGIC SIGNIFICANCE |
| Tropical forest taxa | *Nolina, Sindora, Prosopis, Croton* , ... | Megathermic taxa living under moist or dry conditions. |
| Subtropical humid forest taxa | *Taxodium /Glyptostrobus* type (main component), *Nyssa* , *Myrica* , Arecaceae, Clethraceae,Cyrillaceae, *Engelhardia* *Sciadopitys* , *Sequoia* , Sapotaceae, *Distylium* , … | Mega-mesothermic trees living under a climatic regime with a small range of temperature and abundant and well distributed rainfall throughout the year. (Humid subtropical climate). |
| Temperate broad-leaved deciduous forest taxa | *Quercus* , *Carya* , *Carpinus* , *Ulmus* *Zelkova* , *Tilia* , *Acer* , *Pterocarya, Juglans, Fraxinus, Buxus, Liquidambar, Parrotia, Castanea, Celtis, …* | Mesothermic trees living under a climatic regime with adequate precipitation in all months. They withstanding a strong annual temperature cycle with a cold winter season and a warm summer season. (Warmer continental and humid subtropical climates). |
| Sclerophyll forest taxa | *Quercus ilex* type, *Phillyrea* , *Olea* *Pistacia* , *Cistus* ,… | Xerophilous hard-leaved trees and shrubs, which are typical of regions with a wet winter and dry summer. (Mediterranean climate). |
| *Cathaya* + *Pinus haploxylon* type | Single components | *Cathaya* is a mesothermic gymnosperm now restricted in the humid, warm-temperate to subtropical areas of the China. Because its elevational range (between 1,200-1,800 m) it occurs in an ecotonal type between the sclerophyllous and deciduous broad-leaved fo |
| *Pinus* + Pinaceae saccatae indeterminable | Single components | The genus *Pinus* includes numerous species with different ecologic and climatic requirements, since the latter cannot be used given the difficulty of pollen grains determination below the genus level. |
| *Tsuga + Cedrus* | Single components | Mesothermic and meso-microthermic gymnosperms (mid-altitude elements) which demand humidity. |
| *Abies* and *Picea* + *Fagus* and *Betula* | Single components | Microthermic needleleaf, coniferous trees (*Abies* and *Picea* They are the dominant plants of the boreal forest, corresponding to subarctic and cold continental climates characterized by cold summer and long winter with ± yearlong humid conditions. The br |
| Other Arboreal taxa | *Alnus* , *Salix* , *Platanus* , *Populus* plus indeterminate and indeterminable pollen grains. | Taxa not climatically significant, often indicative of local edaphic conditions |
| Steppe taxa | *Artemisia* (main component)+ *Ephedra* | Grasses associated with a semi-arid continental climatic regime. In the steppes of the middle-latitude winters are cold and dry and summers warm to hot. |
| Other non arboreal taxa | Asteraceae (excluded *Artemisia* Poaceae, Chenopodiaceae, Caryophyllaceae, Brassicaceae, Apiaceae, Cannabaceae, Knautia, Cistaceae, Convolvulaceae, Ericaceae, Euphorbiaceae, Ranunculaceae, Fabaceae, … | Coast-line vegetation which indicates dry climatic conditions. Cosmopolitan taxa. |

# Stirone




**Da Bertini, 2001**




## Quantificazioni climatiche

Fauquette & Bertini 2003

*Fig. 4.* Climatic evolution at Stirone during the Pliocene (between ~5.1 and ~2.2 Ma) reconstructed from pollen data. Five climatic parameters have been estimated: mean annual temperature ($T_A$), mean annual precipitation ($P_A$), mean temperature of the coldest month ($T_C$), mean temperature of the warmest month ($T_W$) and the ratio actual evapotranspiration/potential evapotranspiration (E/PE) which reflects the available moisture. The oxygen isotopic stages are shown.

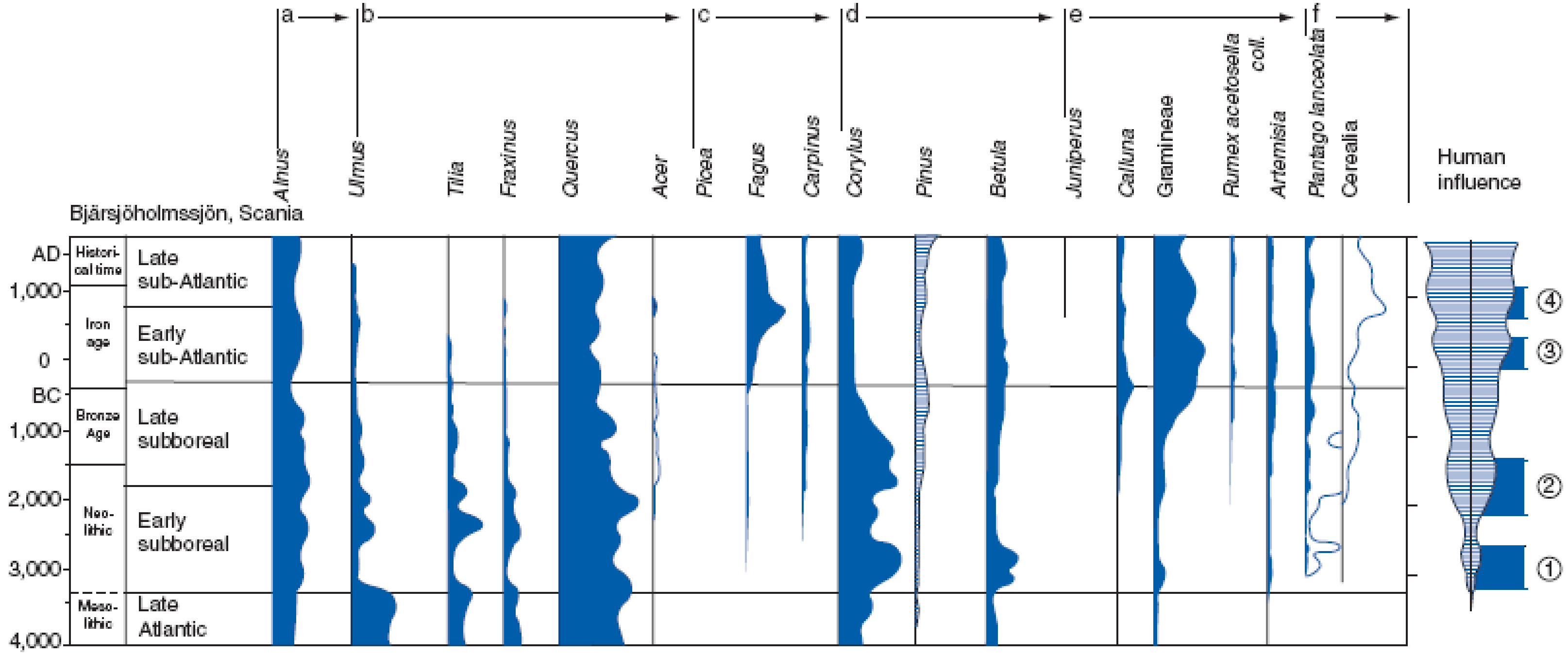
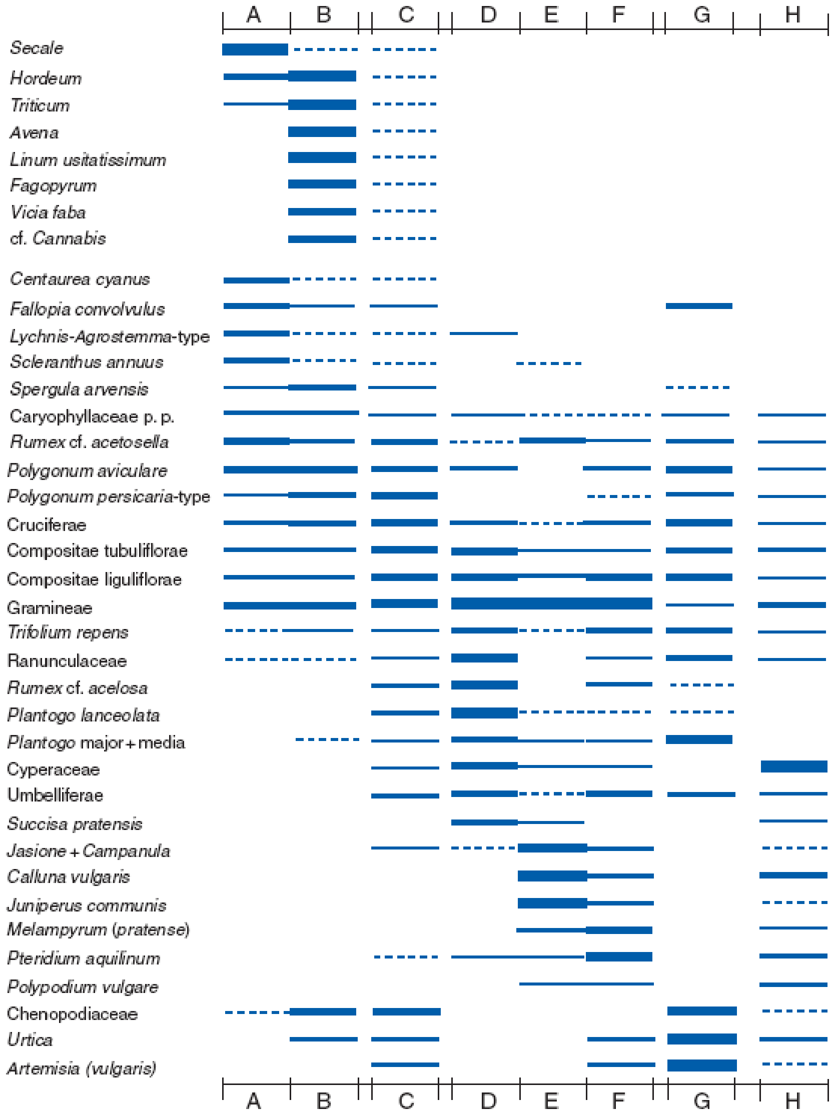


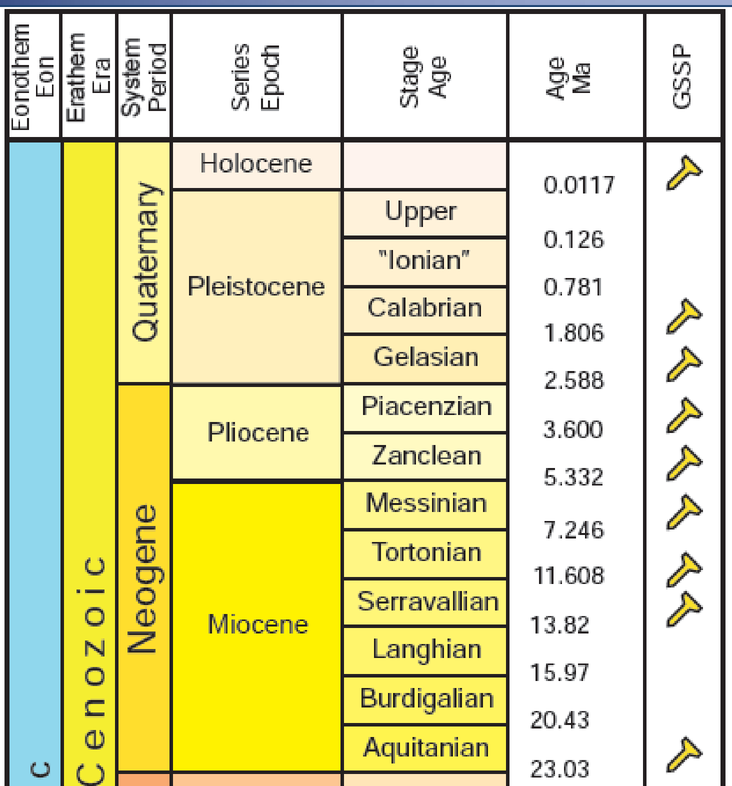

**Figure 2** Generalized human-impact diagram for the province of Skåne, southern Sweden, based on the pollen record from Bjärsjöholmssjön. Major indicator pollen for a, alder carr; b, broad-leaved forest; c, late migrating trees; d, light-demanding trees; pine (*Pinus*) assumed by the author to be long-distance pollen; e, general human-impact indicators; f, pastures (*Plantago lanceolata* = narrowleaf plantain) and arable fields (Cerealia = cereals). Phases of human impact increase (expansion) 1 to 4 were later correlated to the following archeological periods: 1. early Neolithic, 2. middle Neolithic, 3. late Bronze Age, 4. late Iron Age. From Berglund BE (1969) Vegetation and human influence in south Scandinavia during Prehistoric time. In: Berglund BE (ed.) *Impact of Man on the Scandinavian Landscape During the Last Post-Glacial*, pp. 9–28. (Oikos Suppl.).




A Winter cereals
B Summer cereals and root crops
C Fallow land
D Wet meadows and pastures
E Dry pastures (heaths, etc.)
F Hudewald (grazed forest)
G Footpath and ruderal communities
H Natural communities (esp. bogs)

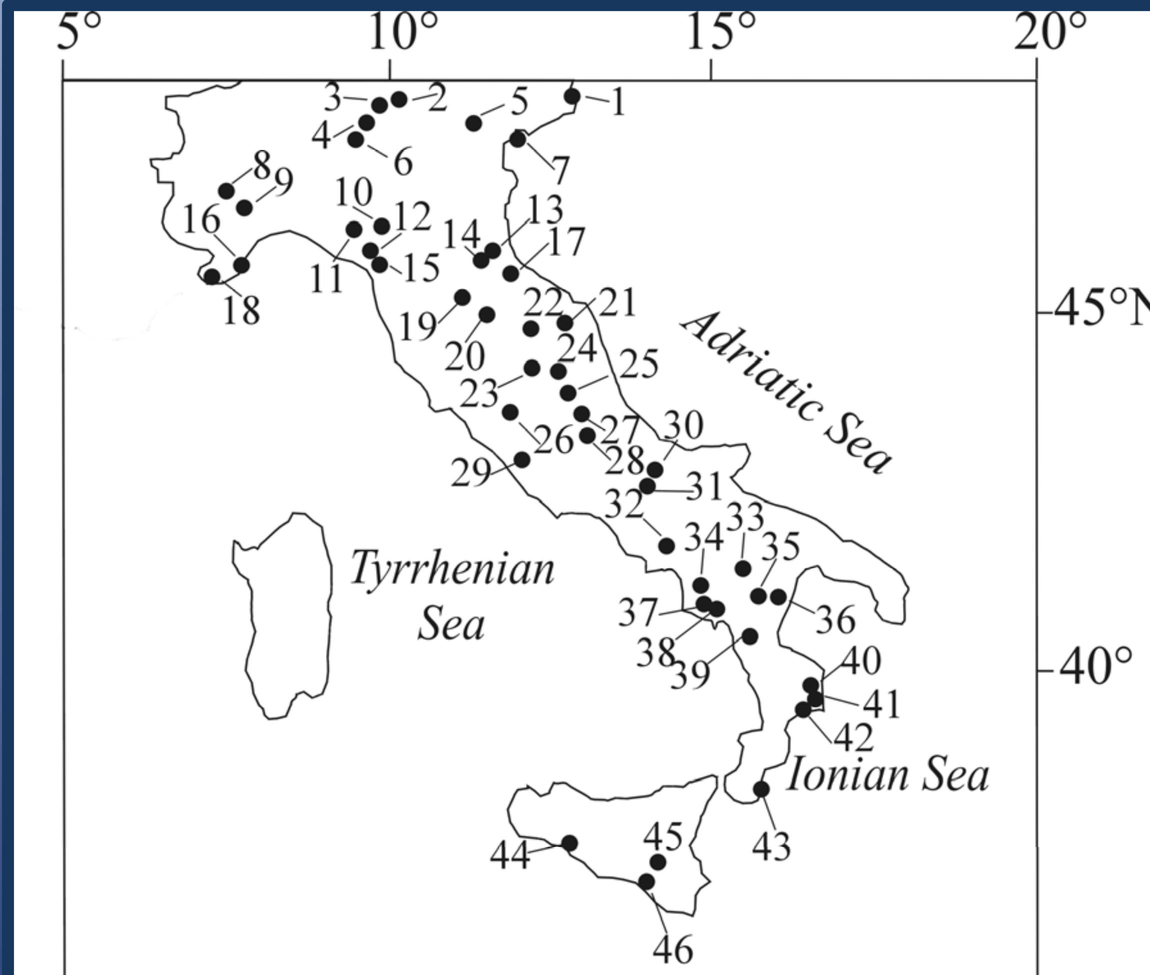
**Figure 4** The principal anthropogenic indicators in pollen diagrams and their occurrence in various farming contexts for northwestern Europe (north of the Alps). The frequency of occurrence is shown for the plants themselves, and without reference to variation in pollen production and dispersal. From Behre K-E (1981) The interpretation of anthropogenic indicators in pollen diagrams. *Pollen et Spores* 23: 225–245.

# *Siti italiani plio-pleistocenici marini e continentali*



| Eonothem Eon | Erathem Era | System Period | Series Epoch | Stage Age | Age Ma | GSSP |
|---|---|---|---|---|---|---|
| c | Cenozoic | Quaternary | Holocene | | 0.0117 | ✓ |
| | | | Pleistocene | Upper | 0.126 | |
| | | | | "Ionian" | 0.781 | |
| | | | | Calabrian | 1.806 | ✓ |
| | | | | Gelasian | 2.588 | ✓ |
| | | Neogene | Pliocene | Piacenzian | 3.600 | ✓ |
| | | | | Zanclean | 5.332 | ✓ |
| | | | Miocene | Messinian | 7.246 | ✓ |
| | | | | Tortonian | 11.608 | ✓ |
| | | | | Serravallian | 13.82 | ✓ |
| | | | | Langhian | 15.97 | |
| | | | | Burdigalian | 20.43 | |
| | | | | Aquitanian | 23.03 | ✓ |
| | | | | Chattian | | |

Modificato da " International Stratigraphic Chart- ICS_IUGS"




Da Bertini, 2010 – Quaternary International

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# Pliocene to Pleistocene palynoflora and vegetation in Italy: State of the art

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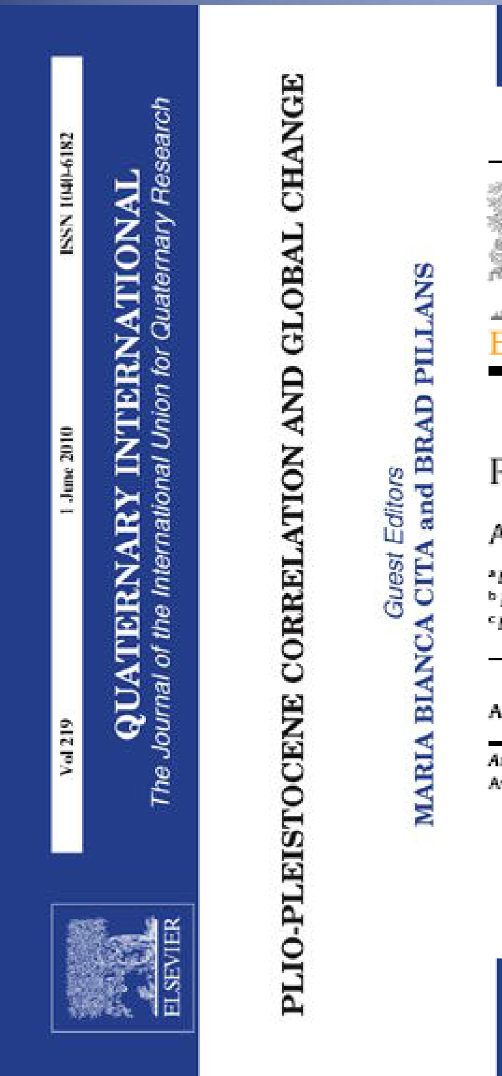
ABSTRACT

Fifty-four Italian pollen sites, spanning the last 5.3 Ma, have been the object of an updated synthesis. The chronostratigraphic framework of floral and vegetational events illustrates the development of cooler climates since the Pliocene. Floral and vegetational response to glacial/interglacial cycles, as well as major taxa replacements have been analysed with special attention to latitudinal and altitudinal gradients and to physiographic reorganizations. The pollen flora shows marked changes both at the beginning of the Pleistocene as well as at the time of the Mid-Pleistocene climate transition, when a major decrease in temperature, during both glacial and interglacial phases, occurred. Alternations of *Artemisia* steppe and thermophilous forest mark the overall glacial–interglacial vegetation changes. However, in northern Italy, the latter are rather expressed by an alternating spread of altitudinal coniferous forest (mainly *Picea*), without significant expansion of steppe vegetation, and thermophilous forest. More complex vegetational cycles than those pointed out by earlier syntheses are also testified by the detection of an alpine vegetation spreading during glacial phases and a wooded steppe in the earlier phases of interglacials, in some southern marine sections. Such diversified patterns could be associated with obliquity related warm/humid–cold/dry "interglacial"–"glacial" cycles superimposed by precession related warm/dry–cold/humid cycles. However, the role of depositional processes as well as taphonomic biases should not be ignored in the reconstruction of vegetation dynamics.

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# Proposal for Pliocene and Pleistocene land–sea correlation in the Italian area

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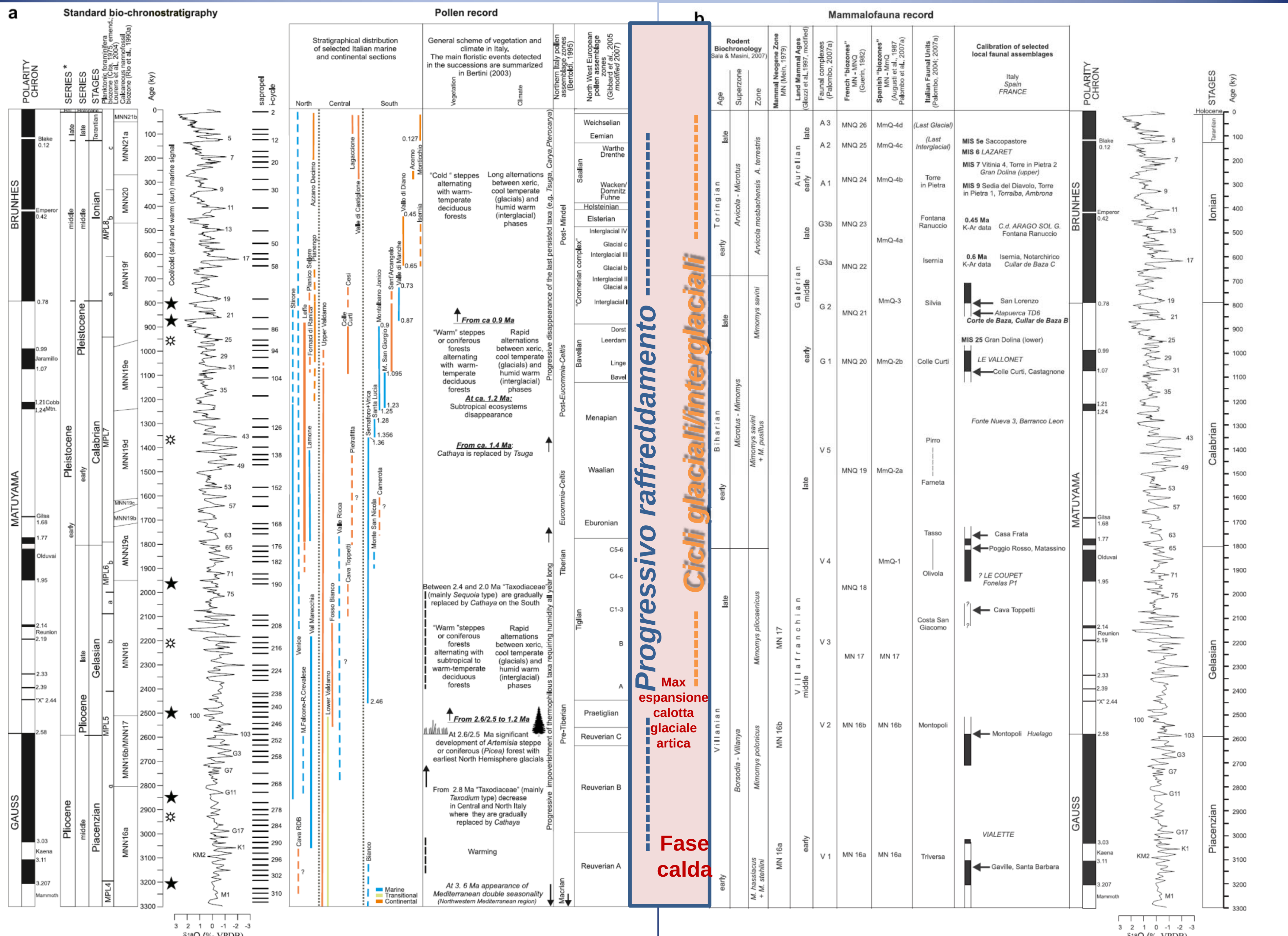
A R T I C L E I N F O

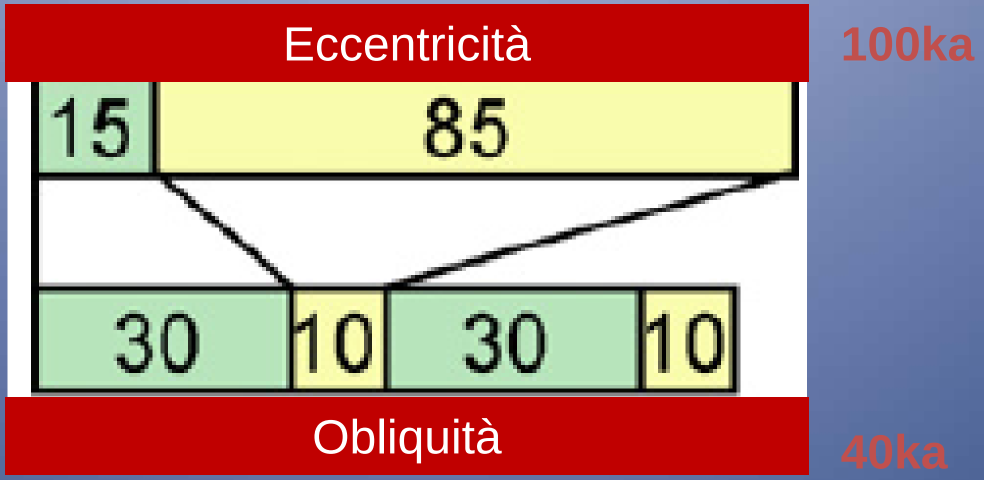
*Article history:*
Available online 6 November 2009

A B S T R A C T

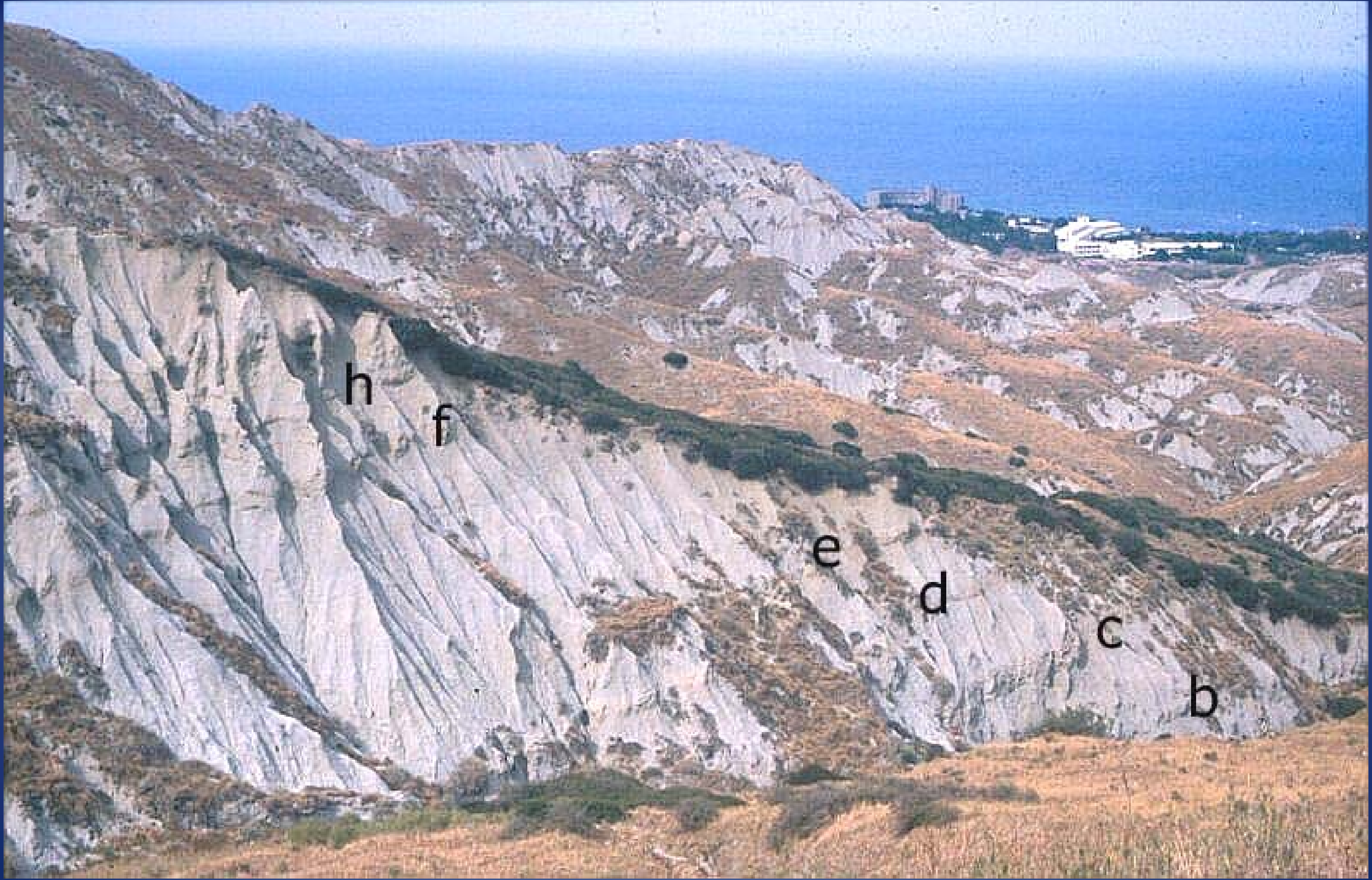
The present study attempts a correlation between calcareous plankton (foraminifera and nannofossils) and terrestrial (pollen and mammal fauna) bioevents in Italy and Mediterranean Sea, through the last 3.3 million years, within a standard chronostratigraphical time scale. The approach was basically interdisciplinary and considered biochronological, biostratigraphical, chronostratigraphical, climatostratigraphical, and tephrochronological data. Despite different timing and mode characterised evolution of marine and continental organisms in relation to their ecology and relationships with environment, the main biota changes seem related with severe climate changes. The short interval of the known global scale Pliocene warmth (~3.0 Ma) has been documented by the last significant expansion of the warm



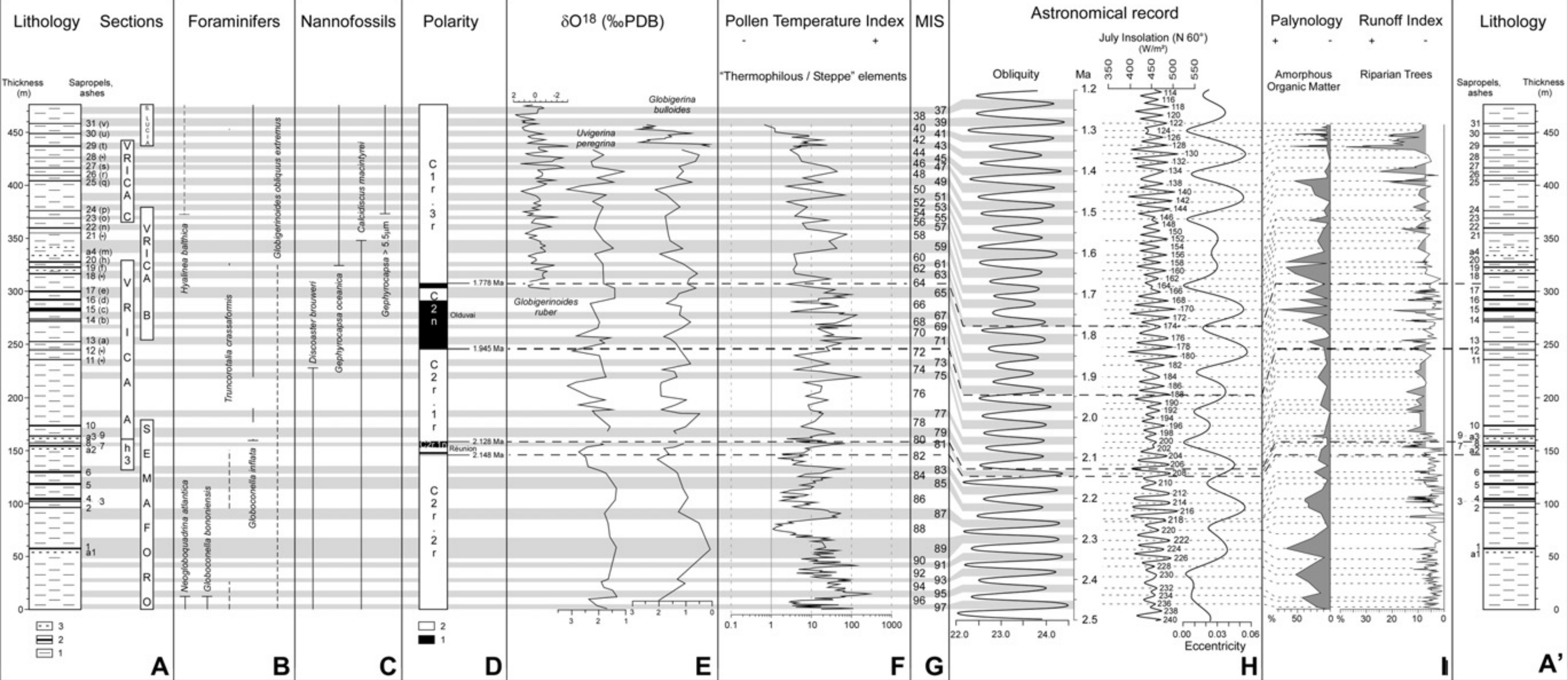
a
Standard bio-chronostratigraphy
Pollen record
b
Mammalofauna record
POLARITY CHRON
SERIES *
SERIES
STAGES
Age (ky)
Cool/cold (star) and warm (sun) marine signal
sapropel i-cycle
Stratigraphical distribution of selected Italian marine and continental sections
General scheme of vegetation and climate in Italy. The main floristic events detected in the successions are summarized in Bertini (2003)
Northern Italy pollen assemblage zones (Bertoldi, 1995)
North West European pollen assemblage zones (Gibbard et al. 2005 modified 2007)
Rodent Biochronology (Sala & Masini, 2007)
Mammal Neogene Zone MN (Mein, 1979)
Land Mammal Ages
Faunal complexes (Palombo, 2007a)
French "biozones" MN - MNQ (Guerin, 1982)
Spanish "biozones" MN - MmQ
Italian Faunal Units (Palombo, 2004; 2007a)
Calibration of selected local faunal assemblages
Italy Spain FRANCE
BRUNHES
MATUYAMA
GAUSS
Pleistocene
Pliocene
Ionian
Calabrian
Gelasian
Piacenzian
Marine
Transitional
Continental
δ18O (‰ VPDB)
Progressivo raffreddamento
Cicli glaciali/interglaciali
Max espansione calotta glaciale artica
Fase calda




*Da Leroy, 2007 modificato*




Vrica B (Crotone) - Pleistocene

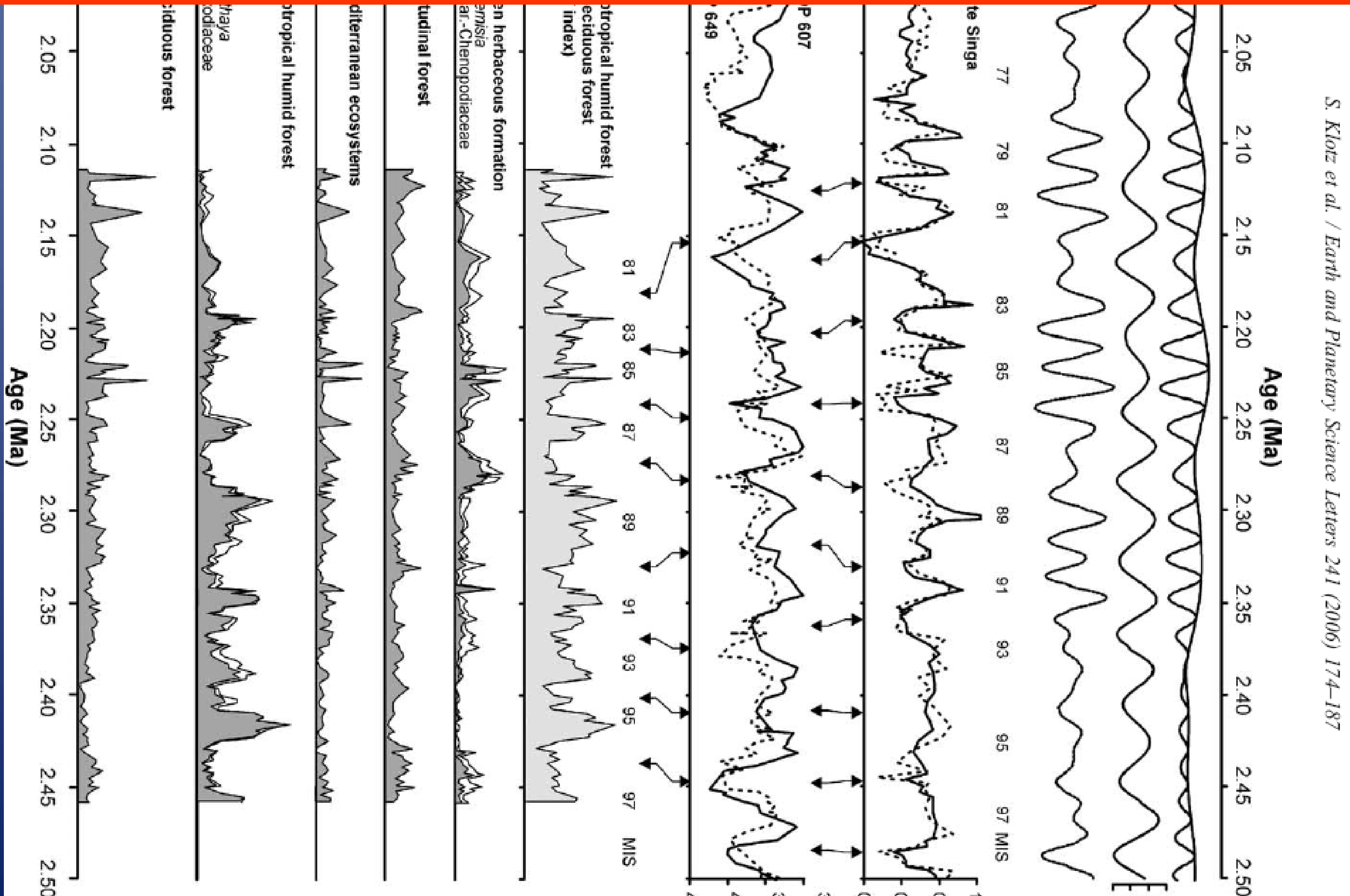



# CROTONE BASIN - From Suc et al., 2010. Quaternary International

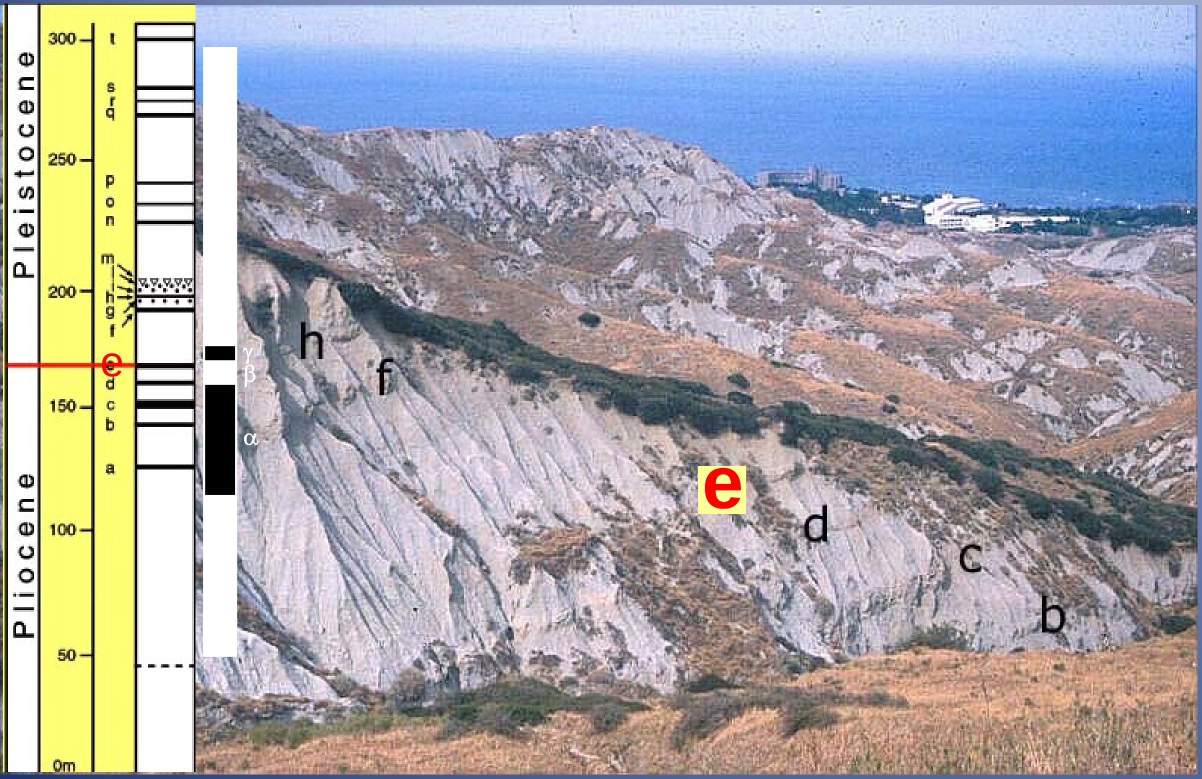
From stratigraphy to high-resolution cyclostratigraphy of the Crotone series. (A) Lithology and successive studied sections reported in Fig. 1. Sapropels are numbered from 1 to 31 (with indication of their name in previous papers), main ashes are indicated (a1–a4). (1) Clays; (2) sapropel; and (3) ash. (A0) Repeated lithology and sapropel numbering only. (B) Summary of the biostratigraphy based on the main foraminifer markers (using the results from: Spaak, 1983; Hilgen, 1990, 1991; Combourieu-Nebout and Vergnaud Grazzini, 1991; Pasini and Colalongo, 1997; Joannin et al., 2007). (C) Summary of the biostratigraphy based on the main nannofossil markers (using the results from: Rio et al., 1997; Lourens et al., 1998). (D) Magnetostratigraphy (using the results from: Tauxe et al., 1983; Zijderveld et al., 1991; and Gautier, this paper). The polarity results from hole h3 are shown in Fig. 5. (1) Normal; and (2) reverse. (E) Oxygen isotope records: on Globigerinoides ruber (Lourens et al., 1996), Uvigerina peregrina and Globigerina bulloides from the Semaforo and Vrica sections (Combourieu-Nebout and Vergnaud Grazzini, 1991), Globigerina bulloides from the Santa Lucia section (Joannin et al., 2007). (F) The Pollen Temperature Index expressed by the pollen ratio 'thermophilous/steppe' elements. The data are from Combourieu-Nebout (1987) for the Semaforo and Vrica sections, from Joannin et al. (2007) for the Santa Lucia section, and new data from N. Combourieu-Nebout. The curves are plotted on a semi-logarithmic scale. (G) Relationships with Marine Isotope Stages (MIS) as discussed by Combourieu-Nebout and Vergnaud Grazzini (1991), Lourens et al. (1996) and Joannin et al. (2007) (oxygen isotope records), by Klotz et al. (2006), completed in this study (see: Pollen Temperature Index in F). Interglacials are underlined by grey bands, glacials by white bands. (H) Astronomical parameters for the time-interval 2.5–1.2 Ma (LA04 solution: Laskar et al., 2004): obliquity, July insolation at 60N (maxima are numbered), eccentricity. Relationships between MIS and glacials–interglacials identified in the Crotone series using obliquity. (I) Palynology Runoff Index: amount of amorphous organic matter within palynological residue (Combourieu-Nebout, 1990) and frequency of riparian trees (Platanus, Parrotia persica, Liquidambar, Pterocarya, Carya, Fraxinus, Salix, Populus, Alnus, Ulmus, and Zelkova) in pollen records (Combourieu-Nebout, 1990, 1995; Joannin et al., 2007). The maxima considered are shaded (>7%). These proxies and the sapropels of the series are correlated to July insolation within the chronological framework previously defined using the MIS and obliquity correlation. This index corresponds to the Mediterranean Precession Related Sapropels Code (Hilgen, 1991; Lourens et al., 1998).

***INTERGLACIALI***: : Tmedie annue > di almeno 2.8 °C ,  T invernali > 2.2 °C e P> di 500 mm, rispetto all’attuale

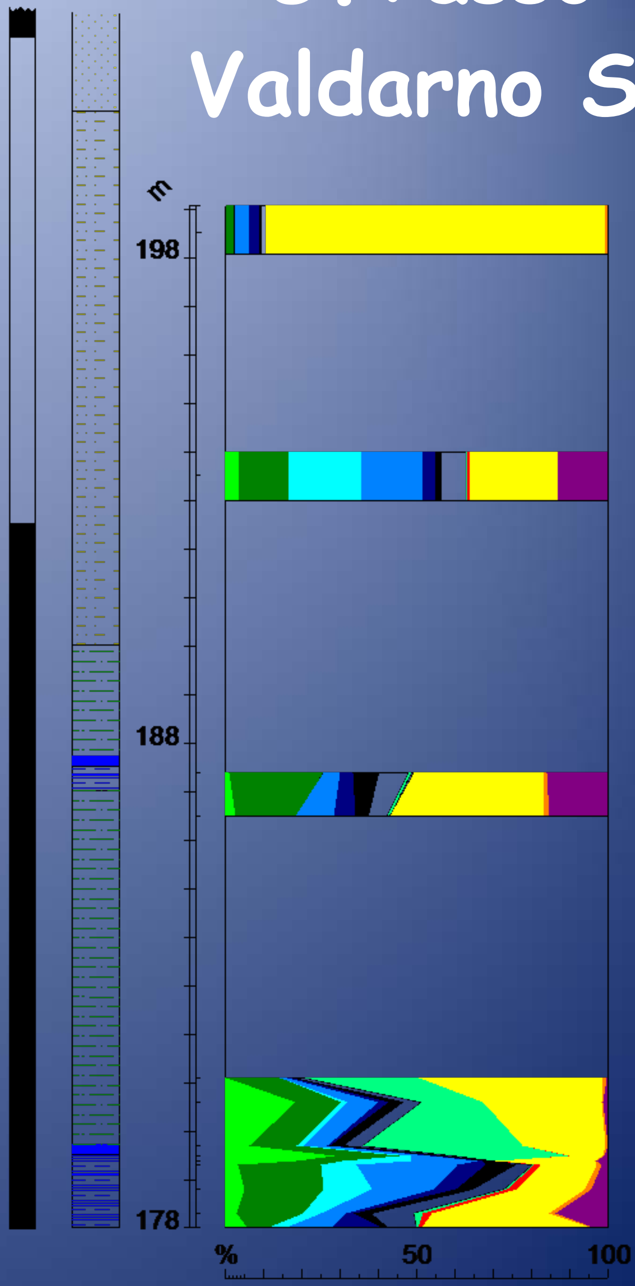
***GLACIALI***: T< ma P equivalenti, rispetto all’attuale.

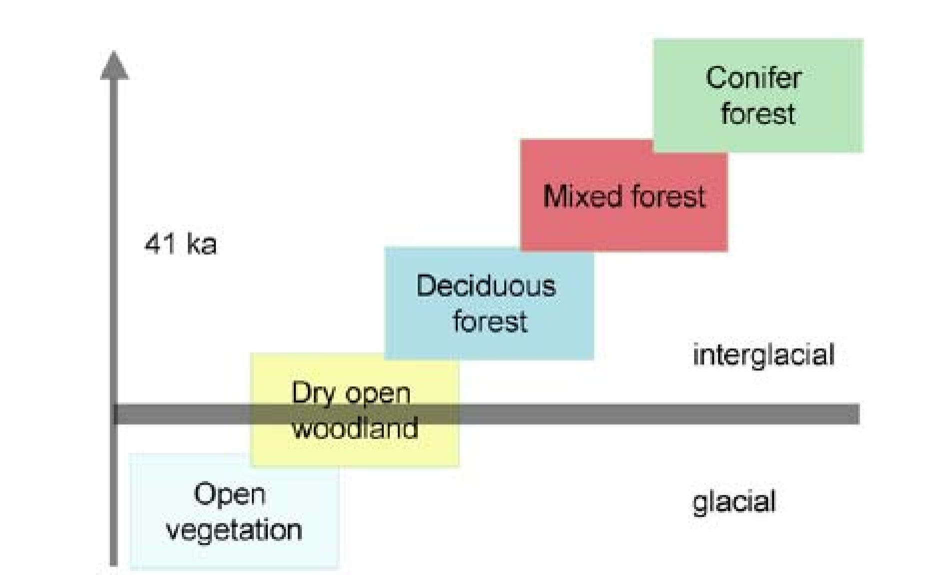


# Vrica




# G.Tasso Valdarno S.






Da Leroy, 2007