ONOCERANE I WITNESSES TO DRY CLIMATIC PHASES AT THE END OF THE LAST GLACIAL MAXIMUM AND DURING THE YOUNGER DRYAS IN NORTHERN BRAZIL

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CONTENTS

CONTEXT

Geological and ecological context

From Balbino *et al*., 2002

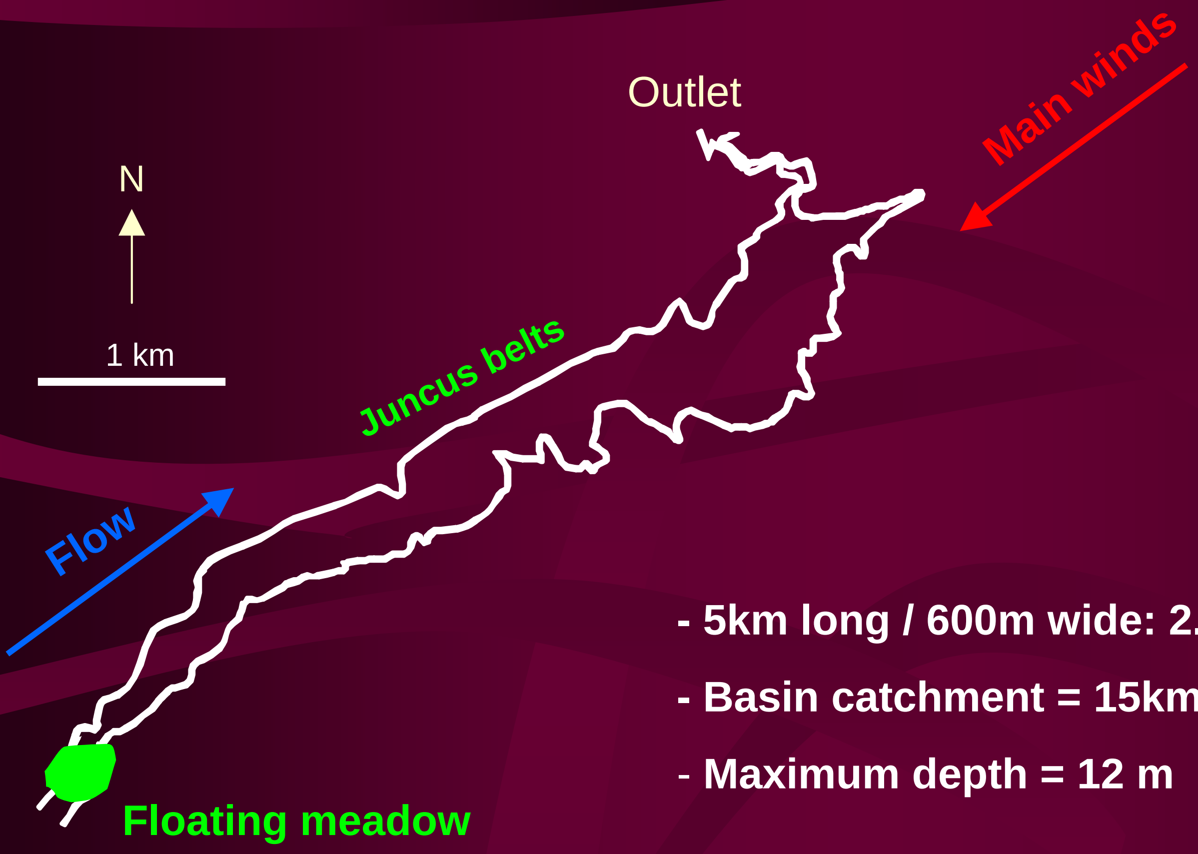
Geological and ecological context

Active dune system

Fossil dune system

Laterites

Limnological context



- 5km long / 600m wide: 2.5km²
- Basin catchment = 15km²
- Maximum depth = 12 m

- Filtering of the river by the floating meadow
- Filtering of the catchment by Juncus sp. Belts

- Highly oxygenated waters

Limnological context – present day setting

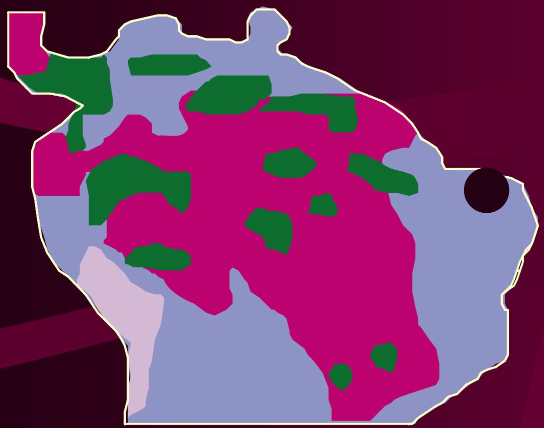
- Oligotrophic lake
- Few phytoplanktonic contribution
- Mainly higher-plant derived OM
- Strong degradation of OM

Paleoclimates in South America – Last Glacial Maximum

18,000 ^{14}C yrs BP

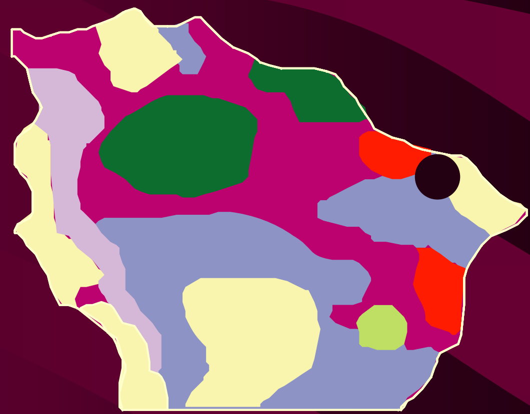
Often missing records due to sedimentary hyatuses

Colder (Stute *et al*., 1995) and dryer



Van Campo *et al*., 1993

Crowley, 1995



Adams and Faure, 1998

- Tropical humid forest
- Mixte forest
- Savanna
- Shrub
- Prairie - steppe
- Toundra
- Desert – semi-desert

Turcq *et al*., 2002

Paleoclimates in South America – Lateglacial

18,000 – 11,000 ^{14}C yrs BP

Atlantic Margin sediments : Behling *et al*., 2000

- Influx in fern spores (moisture)
- Elevated Ti/Ca (more erosion onland)

Lake Caço : Ledru *et al*., 2001 ; Sifeddine *et al*., 2003

- Pollen evidence for humid and dense forest
- Rises in water level inferred from siderite peaks

Mean wetter climate

Paleoclimates in South America – Younger Dryas

11,000 – 10,000 ^{14}C yrs BP

Cold – Northern Hemispheric event

→ Extension in Tropical South America ?

Colder (1,5 to 3°C) and **dryer** in the Andes (El Abra stadial, van't Veer *et al*., 2000)

Lake Caço : Ledru *et al*., 2002; Sifeddine *et al*, 2003 :

- Water-level drops
- AP/NAP decreases
- Increase in forest fires

} Reduction of humid forest

Mean dryer climate

Paleoclimates in South America – Holocene

10,000 ^{14}C yrs BP - Present

Relatively stable (Dansgaard *et al*., 1993)

Lake Caço : Ledru *et al*., 2001

Increase of AP/NAP

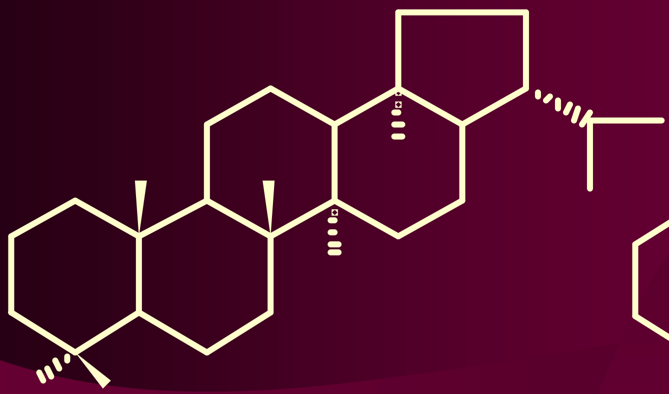
Increase in Mimosaceae and *Astronium sp*.

Establishment of present day setting

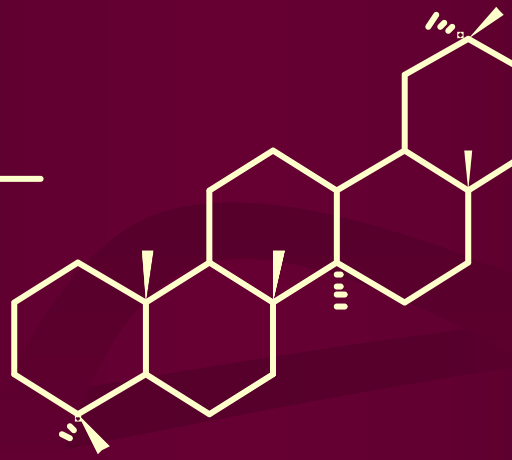
BIOMARKERS

Pentacyclic triterpenes

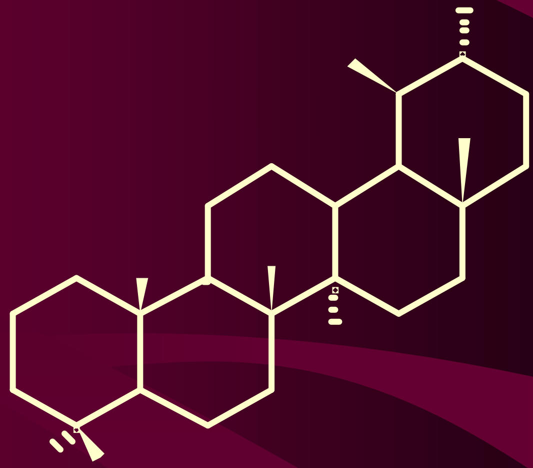
Pentacyclic triterpenes – Basic structures



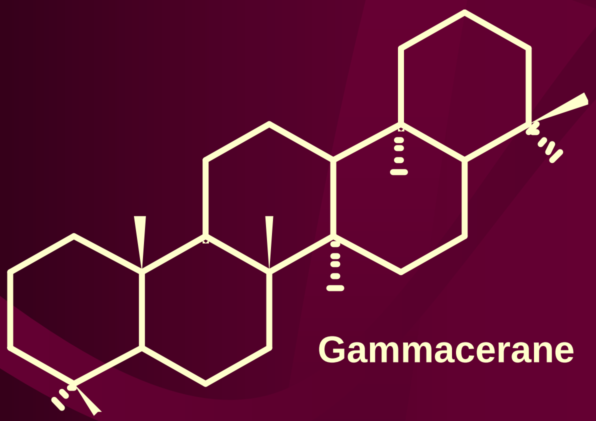
Hopane



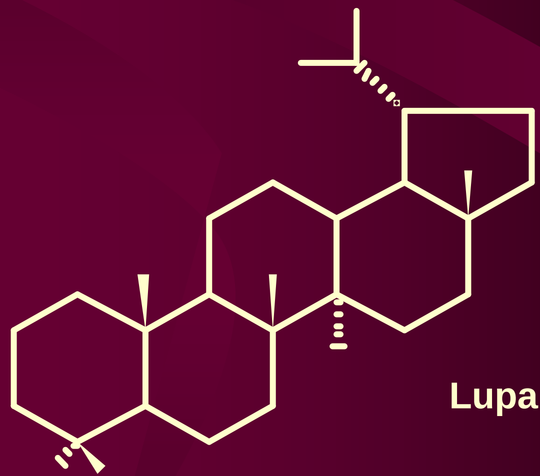
Oleanane



Ursane



Gammacerane



Lupane

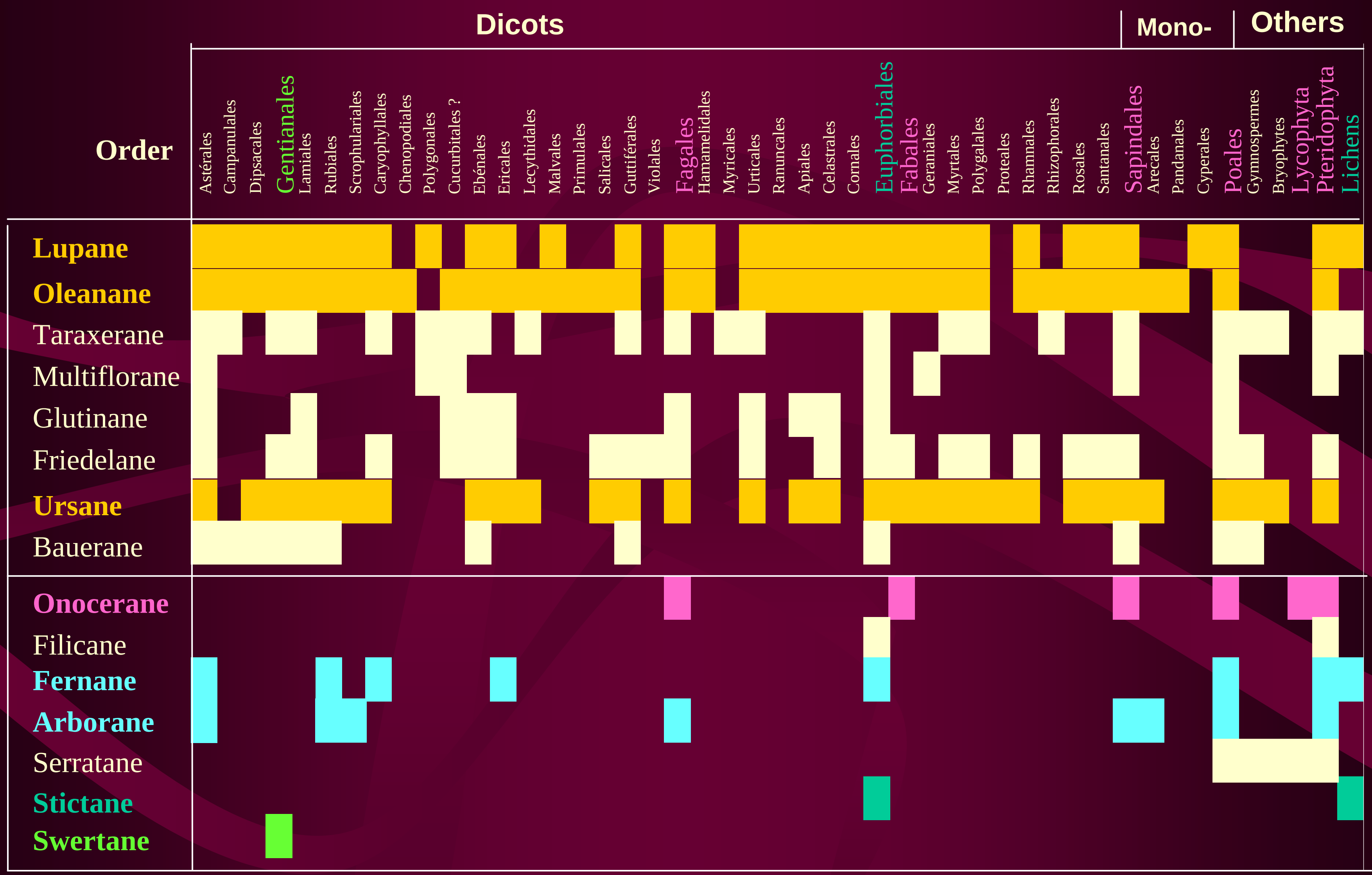
Pentacyclic triterpenes – Structural diversity

The structural diversity of PT results from :

- **Basic structures**
- **Position and isomerism of methyl groups**
- **Rings conformation**
- **Possible double bonds**
- **Associated functionnal groups**

One of the most diversified chemical familly in Nature

Pentacyclic triterpenes – Chemo-taxonomy



Pentacyclic triterpenes – Conclusion

Structural diversity

↓

Taxonomic value

↓

Potential paleoenvironnemental proxies

Poorly used in organic paleoclimate studies

Indicate higher-plant input to the sediment

MAIN OBJECTIVES

Main Objectives

Geological, limnological, ecological/botanical context

↓

Identify new biomarkers

Pentacyclic triterpenes

↓

New proxies for past climate changes in continental settings ?

4 contrasted climatic phases

↓

OM sensibility to these contrasted conditions

METHODS

Methods – Identification and quantitation

Identification by GC-MS: Trace GCQ Polaris (Finnigan)

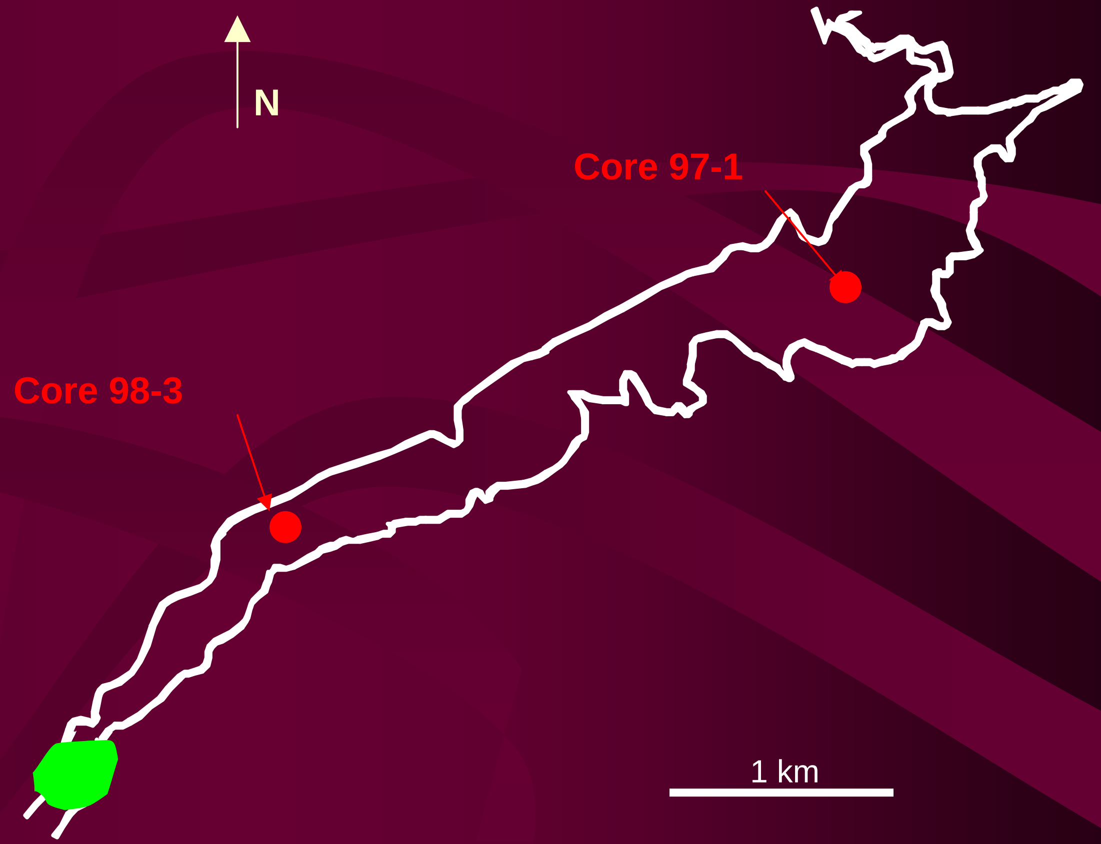
Mass spectra
Retention times

Quantitation by GC-MS

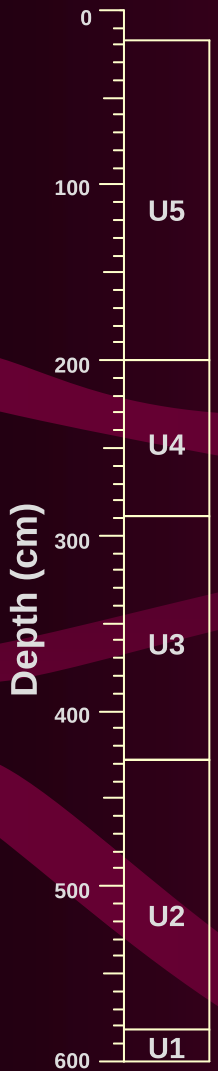
On the chromatograms, comparison of the peak area of ions m/z 414, 191, 123 for onocerane with the area of 5α cholestane (internal standard) on the TIC.

RESULTS

Results



Results



	Lithology	Mineralogy
U5	Black organic silts	Amorphous silica
U4	Greenish-brown organic silts	0 - 30% goethite 4 - 20% amorphous silica siderite
U3	Silts	50% quartz 50% kaolinite
U2	Fine grained sands	60-80% quartz
U1	Pleistocene substratum	

^{14}C dates (yrs BP)

- 4930 ± 50
- 9850 ± 70
- 14450 ± 80
- 15620 ± 80
- 16100 ± 80
- 16670 ± 100

Time

- Holocene
- Younger Dryas
- Lateglacial
- End of LGM
- Pleistocene

OM: General features

Bulk geochemistry and organic petrography:

Higher-plant in origin

- U2 and U3: Well preserved,
- U4 and U5: Refractory OM,

Molecular analyses:

Abundant :

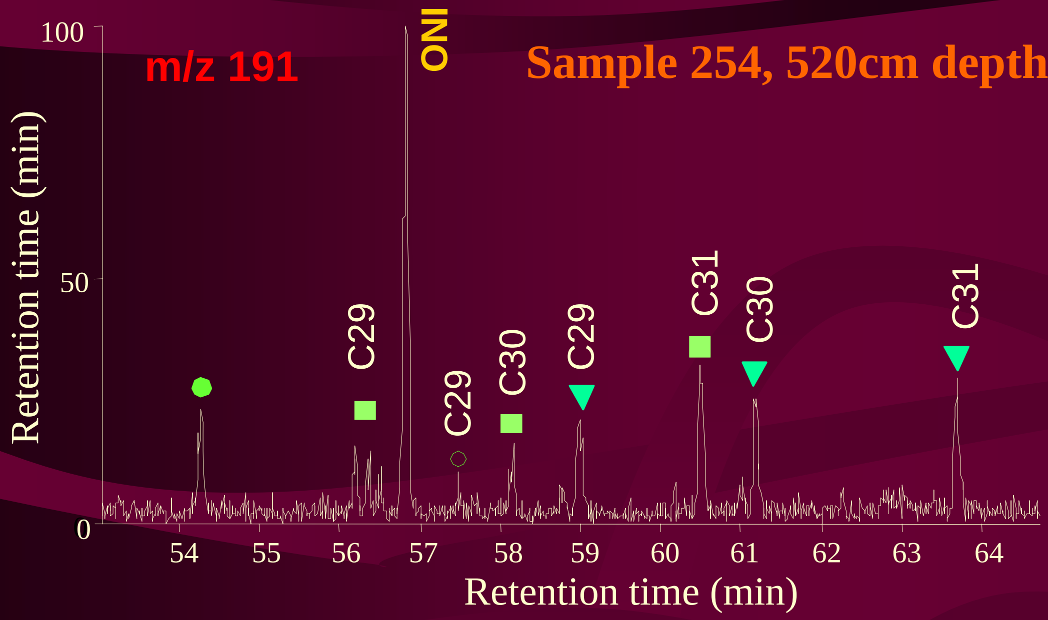
- hopanoids
- higher-plant pentacyclic triterpenes
- degraded triterpenes:
  - des-A-triterpenes
  - aromatics derived from pentacyclic triterpenes

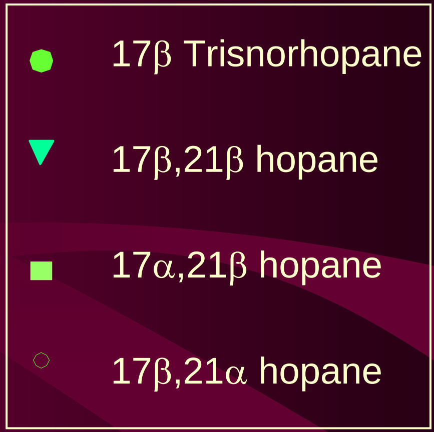
- Few n-alkyl compounds
- No evidence for any phytoplanktonic biomarker in the studied fractions

ONOCERANE I

Onocerane I – Identification

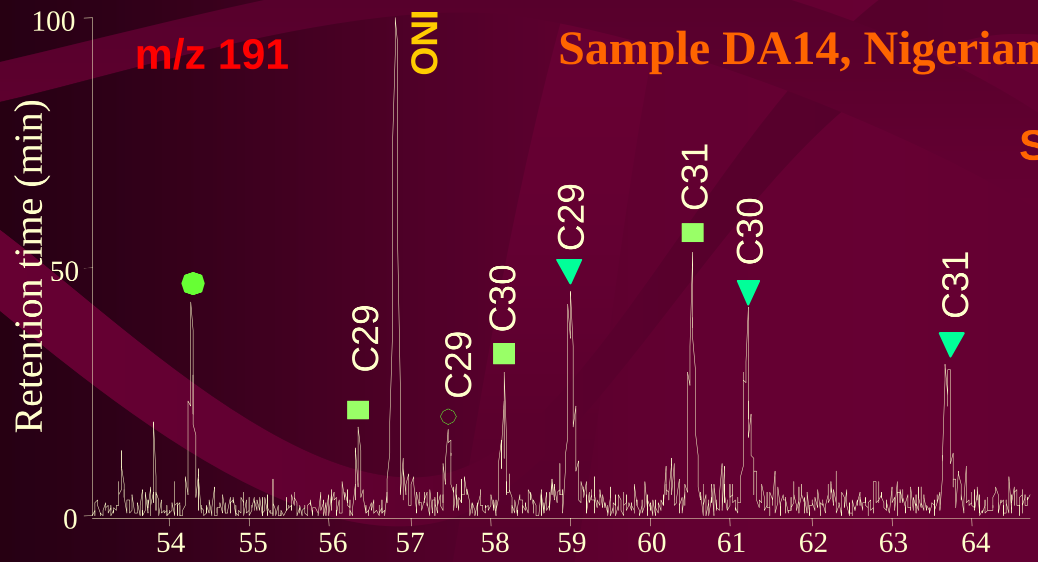
Sample 254, 520cm depth, core 98-3



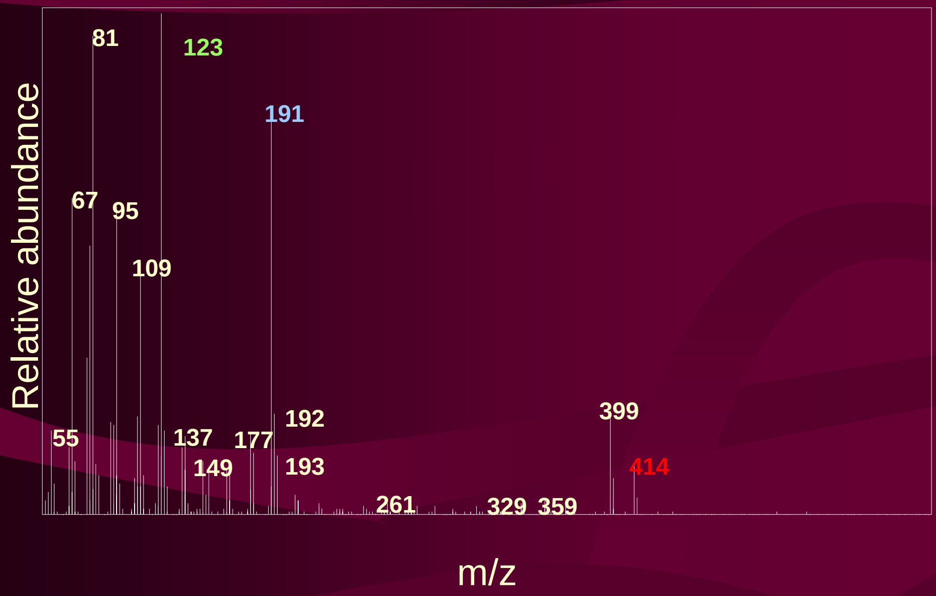


Sample DA14, Nigerian oil, Pearson and Obaje, 1999

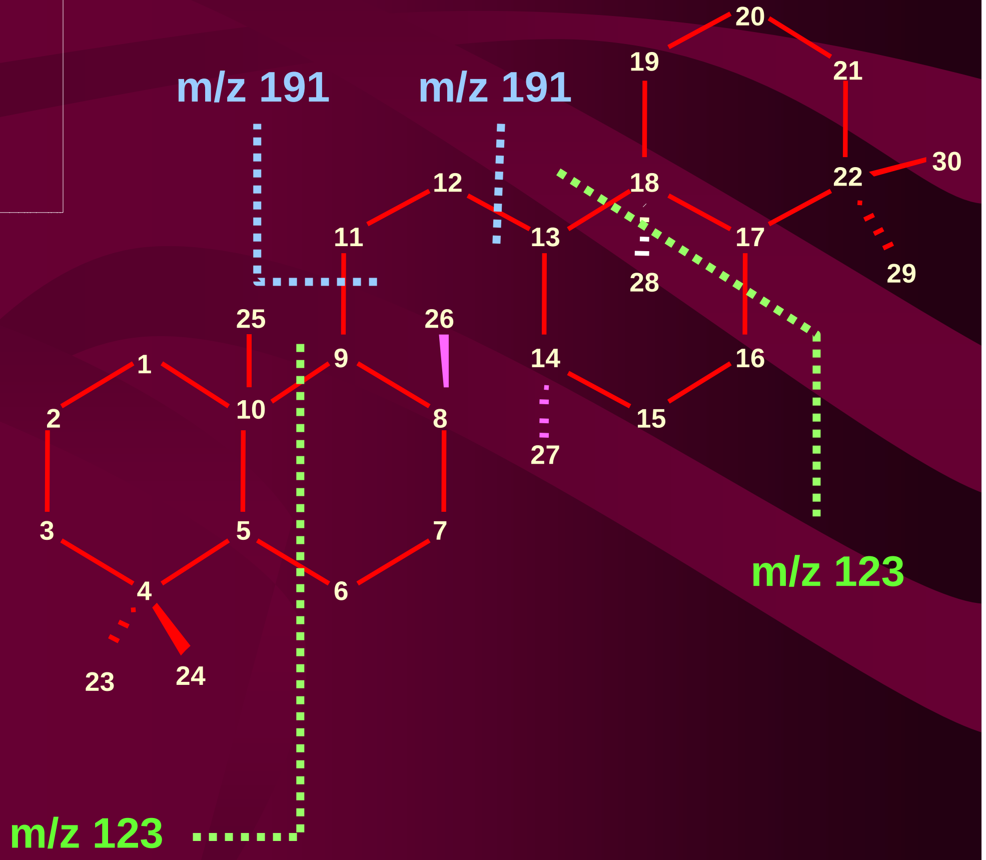
Sample provided by Pr. M.J. Pearson



Onocerane I – Identification



ONOCERANE I



Three onocerane isomers (I, II, III)

- Isomerism at C(8) et C(14) positions,

- Relative abundance of m/z 191 and 193.

Kimble *et al*., 1974

Onocerane I – Previous reports in sediments / oils

Paleozoic		Mesozoic			Cenozoic		
Carb.	Permian	Triassic	Jurassic	Cretaceous	Paleo.	Neo.	Q.

Onocerane I

- Miocene (Idaho) : Giannasi and Niklas, 1981.
- Oligocene (Montana) : Curiale, 1988.
- Paleogene (China) : Fu Jiamo *et al*., 1988.
- Oligocene (China) : Wang Tieguan *et al*., 1988.
- Up. Cretaceous (Nigeria): Pearson et Obaje, 1999.

Since the Upper Cretaceous **Angiosperms** ?

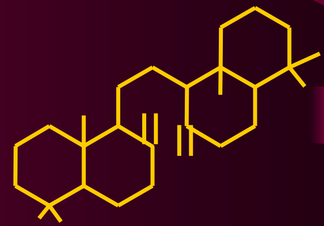
Onoceranes II and III

Carboniferous, **Jurassic** (China) : Wang Tieguan *et al*., 1988.

Tsuda *et al*., 1964 : Isomerisation between onoceranoids and serratanoids

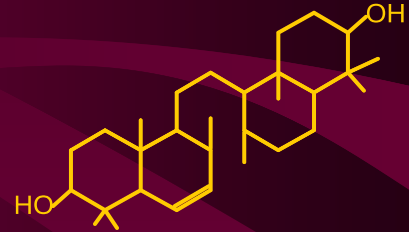
Onocerane II and III could derive from serratene-type compounds ? **Pteridophyts**

Onocerane I – Biological origin



Pteridophyts

Lemaphyllum sp., Colysis sp. (**Ferns**) : Ageta *et al*., 1982.
Lycopodium sp. (**Lycophyts**) : Habaguchi *et al*., 1968.

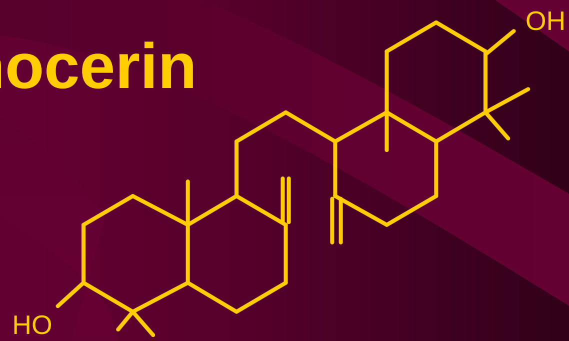


Angiosperms

Lansium domesticum (**Meliaceae**)
Cissus quadrangularis (**Vitaceae**)

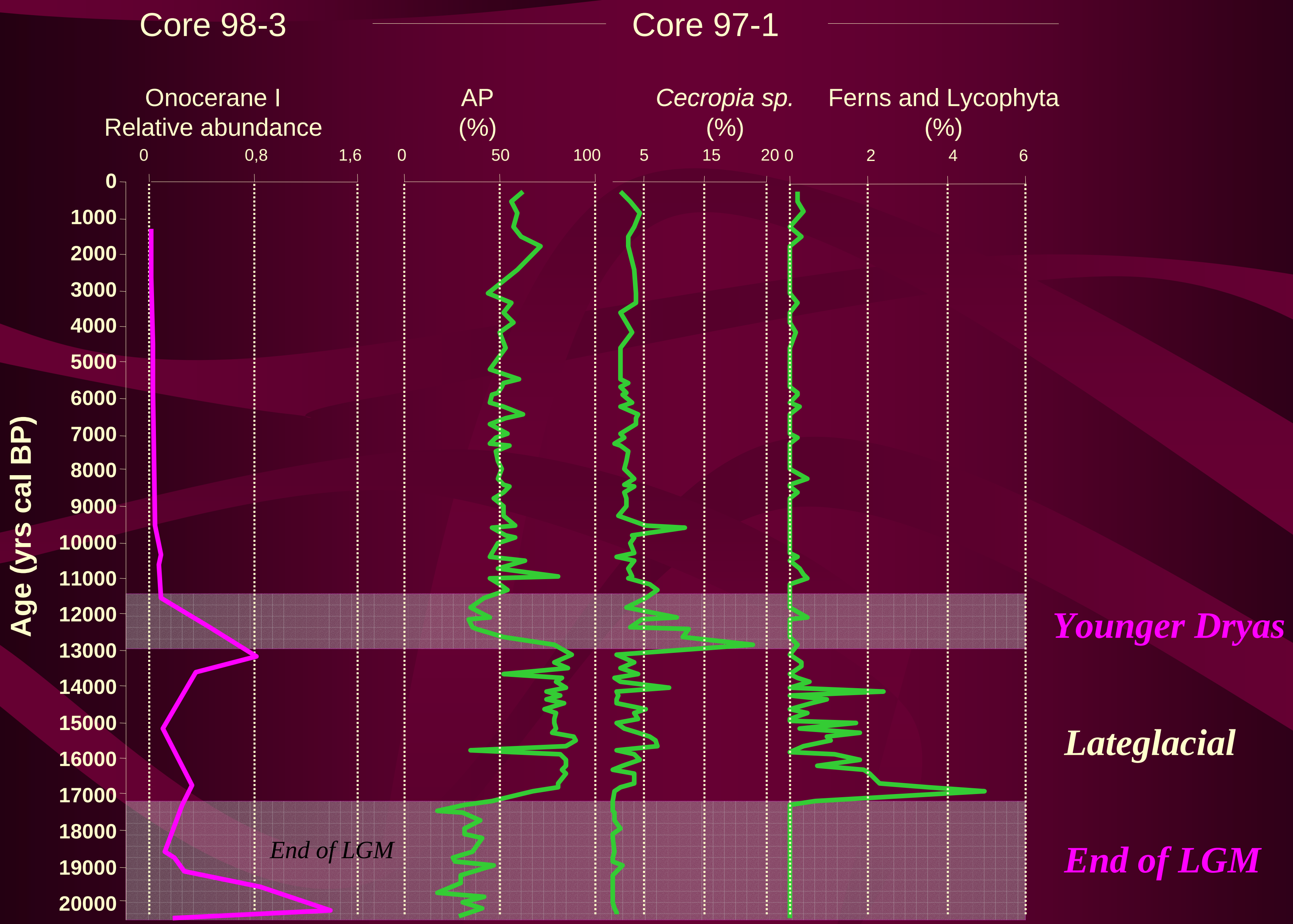
Ononis sp. (**Papillionaceae**)

Onocerin



Favors water transport in roots
Adapted to water-depleted media
Sean Mayes / Peter Dean (pers. com.)

Onocerane I – Variations of abundance

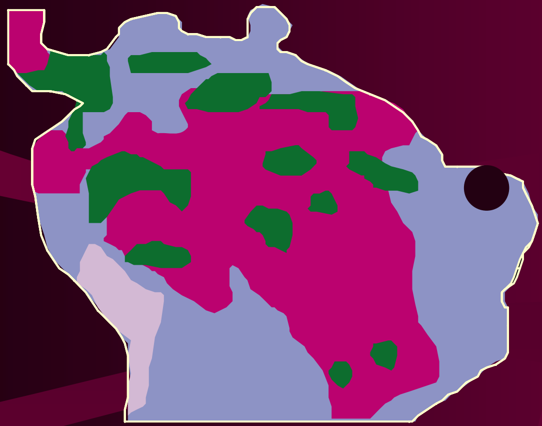


CONCLUSIONS

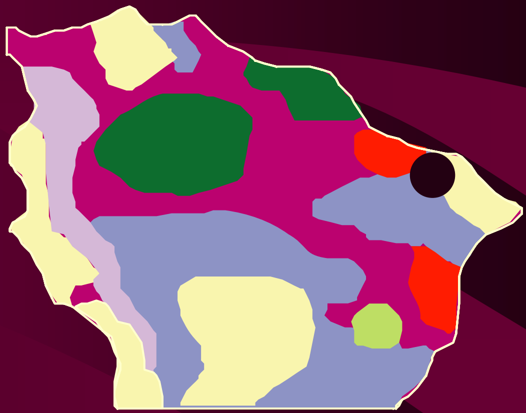
Conclusions: Palaeoclimatic implications

Onocerane I is abundant during the two dryest periods that suffered this region:

- The end of LGM


Van Campo *et al*., 1993


Crowley, 1995


Adams and Faure, 1998

The region of Lagoa do Caço was most probably of semi-arid type.

No information about the fragmentation of rainforest but evidences for the reduction of its surface.

Conclusions: Palaeoclimatic implications

Onocerane I is abundant during the two dryest periods that suffered this region:

- The Younger Dryas

Started with a dry event that allowed the development of onocerane I producers and the reduction of the Lateglacial humid forest.

Palynological and molecular analyses provide the southernmost record of Younger Dryas in South America and confirm the relative dryness of this episode.

Conclusions: onocerane I

- First report of onocerane I in Quaternary sediments

- Onocerane I was not produced by ferns or lycophyts in this setting

- Onocerane I testifies to the development of a plant well-adapted to dryness, probably close to the Ononis genus.

The Ononis genus has not yet been reported in South America

Conclusions: new proxies for vegetation changes ?

The sediments of Lagoa do Caço contain specific pentacyclic triterpenes :

Onocerane I and PTME (poster PII/096)

Each of them probably attest to the development of a single species in the catchment area.

These molecules can complement palynological studies

Due to their specificity, they are designed targets for CSIA analyses.

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