MIDDLE ORDOVICIAN ELEMENTS OF PRIMITIVE VEGETATION MARINE PALYNOMORPHS AND PROBLEMATIC MICROFOSSILS FROM THE SAQ/QASIM TRANSITIONAL BEDS IN CORE QSIM 801 CENTRAL SAUDI ARABIA. DISCUSSION WITH EUSTATIC AND CLIMATIC EVENTS

A. LE HERISSE, P. STEEMANS, C. WELLMAN, M. VECOLI

INTRODUCTION

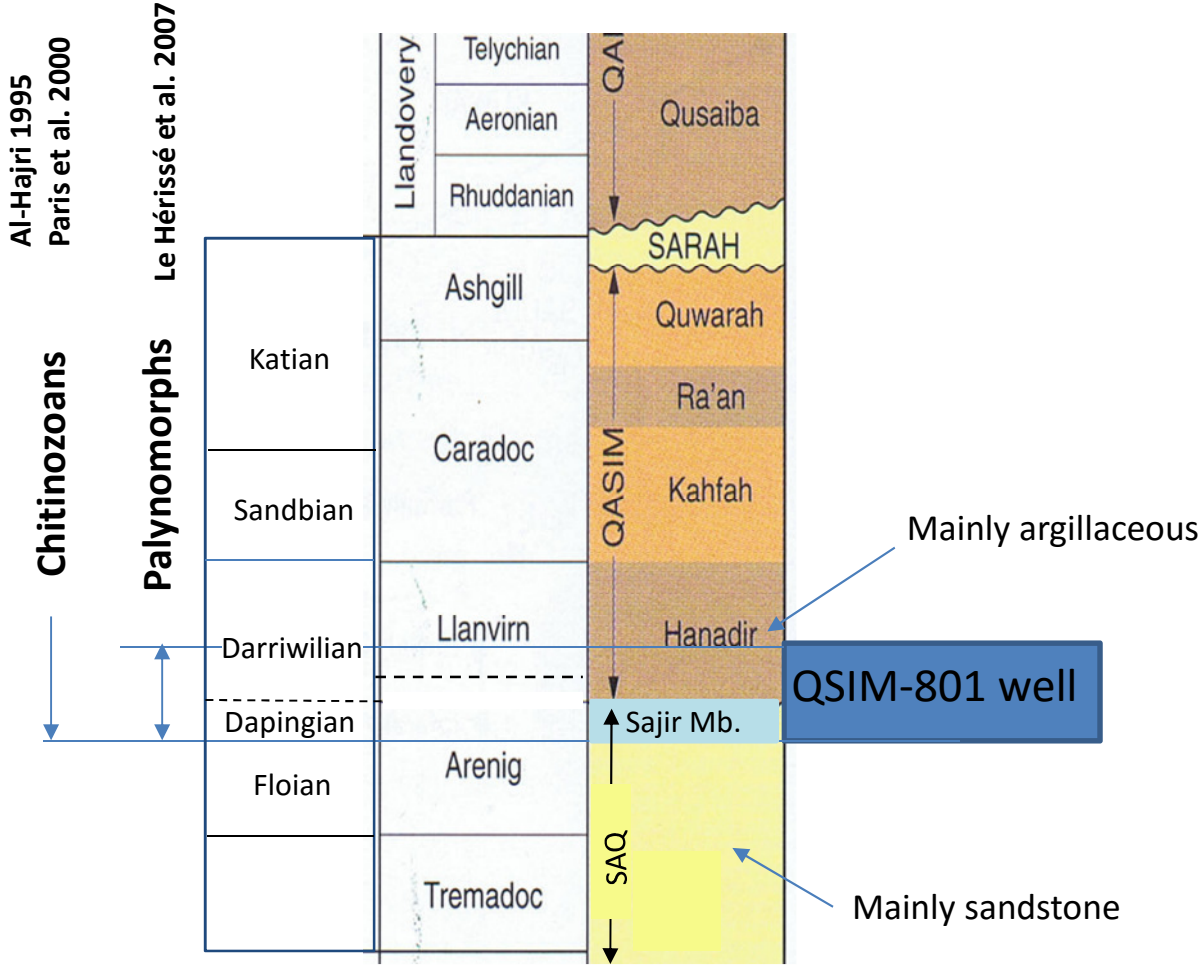
LEGEND

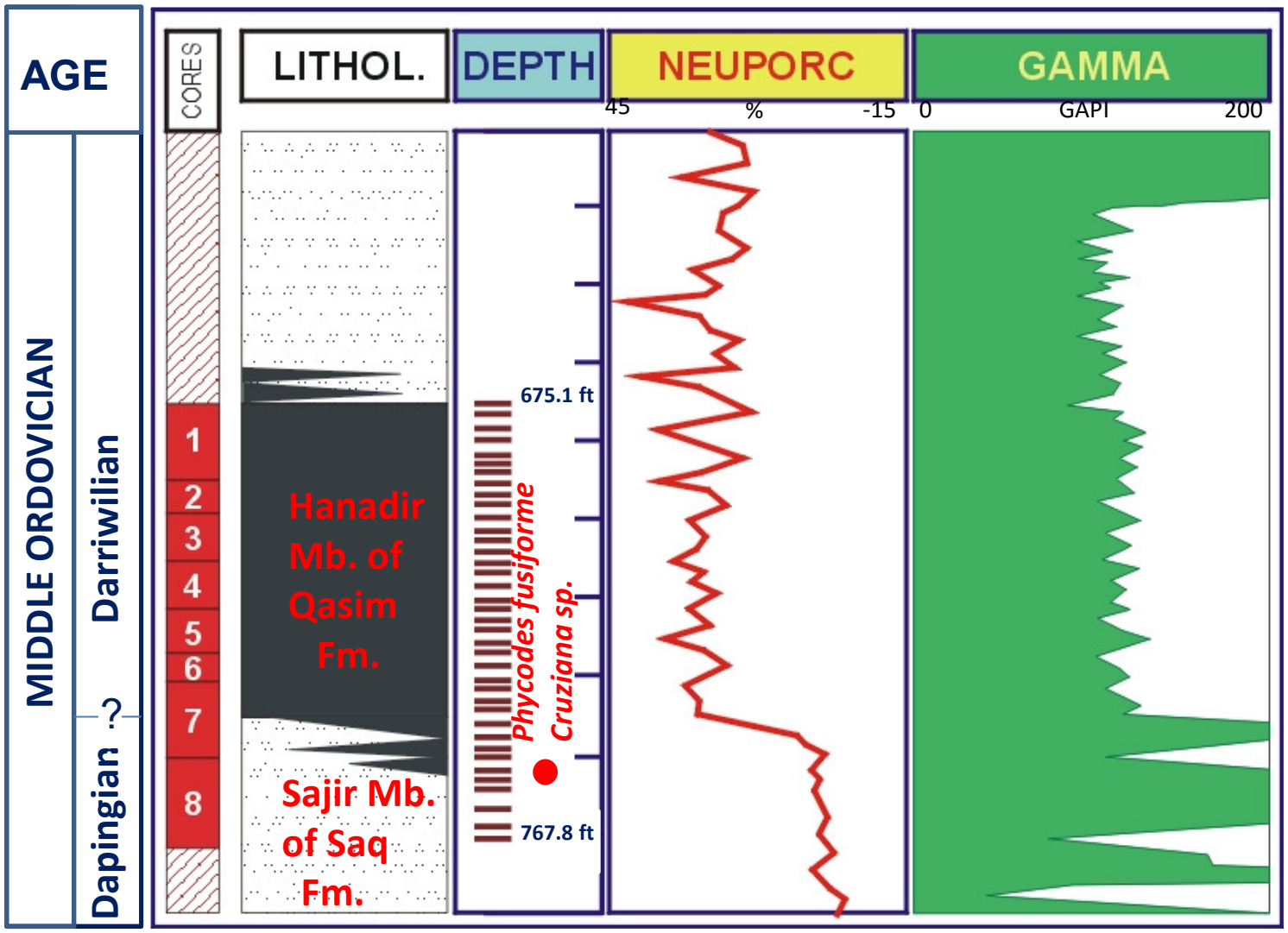
Siluro-Ordovician

Crystalline Precambrian Basement of the Arabian Shield

Geological map of the Arabian peninsula and location of the QSIM-801 water well

General stratigraphic scale and position of the QSIM-801 well in the local stratigraphy

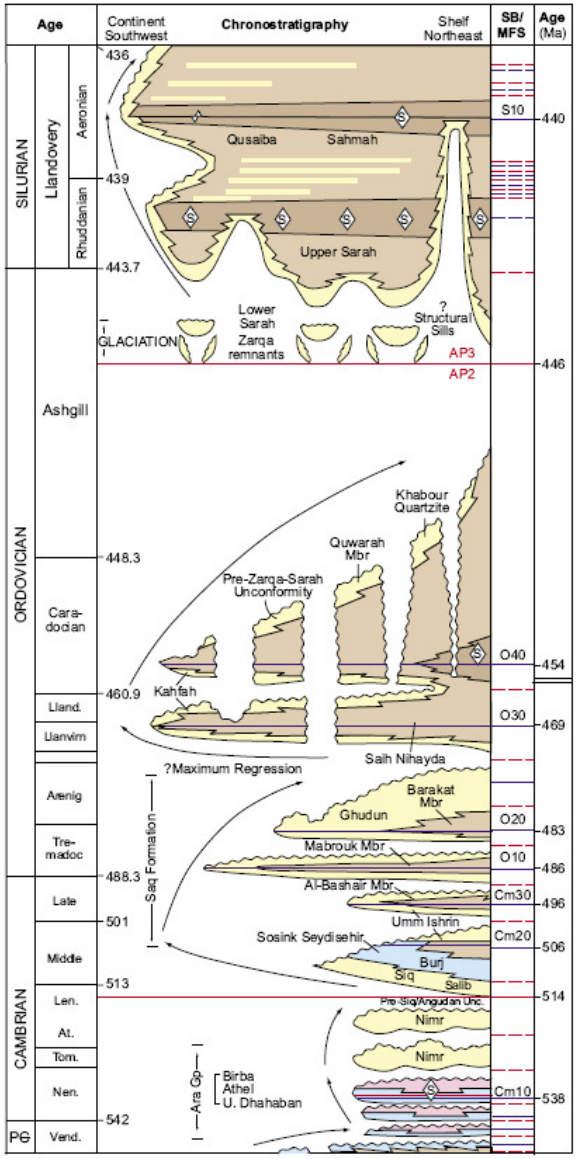




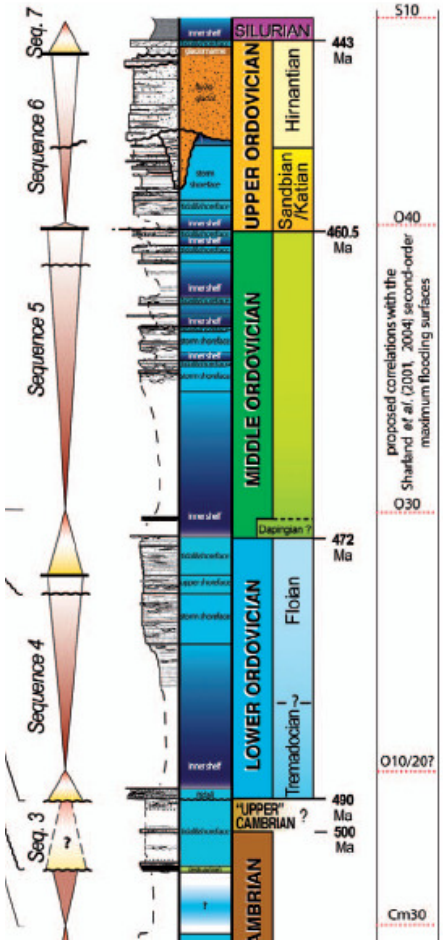
Core QSIM-801: Age, interval studied, lithology, depth and well logging data
Occurrence of ichnofossils

INTRODUCTION

Phanerozoic cycles of sea-level change on the Arabian Platform (Haq & Al-Qahtani 2005)



The Cambrian-Ordovician succession In the Ougarta Range, Algeria, North Africa (Ghienne et al., 2007)



QSIM 801

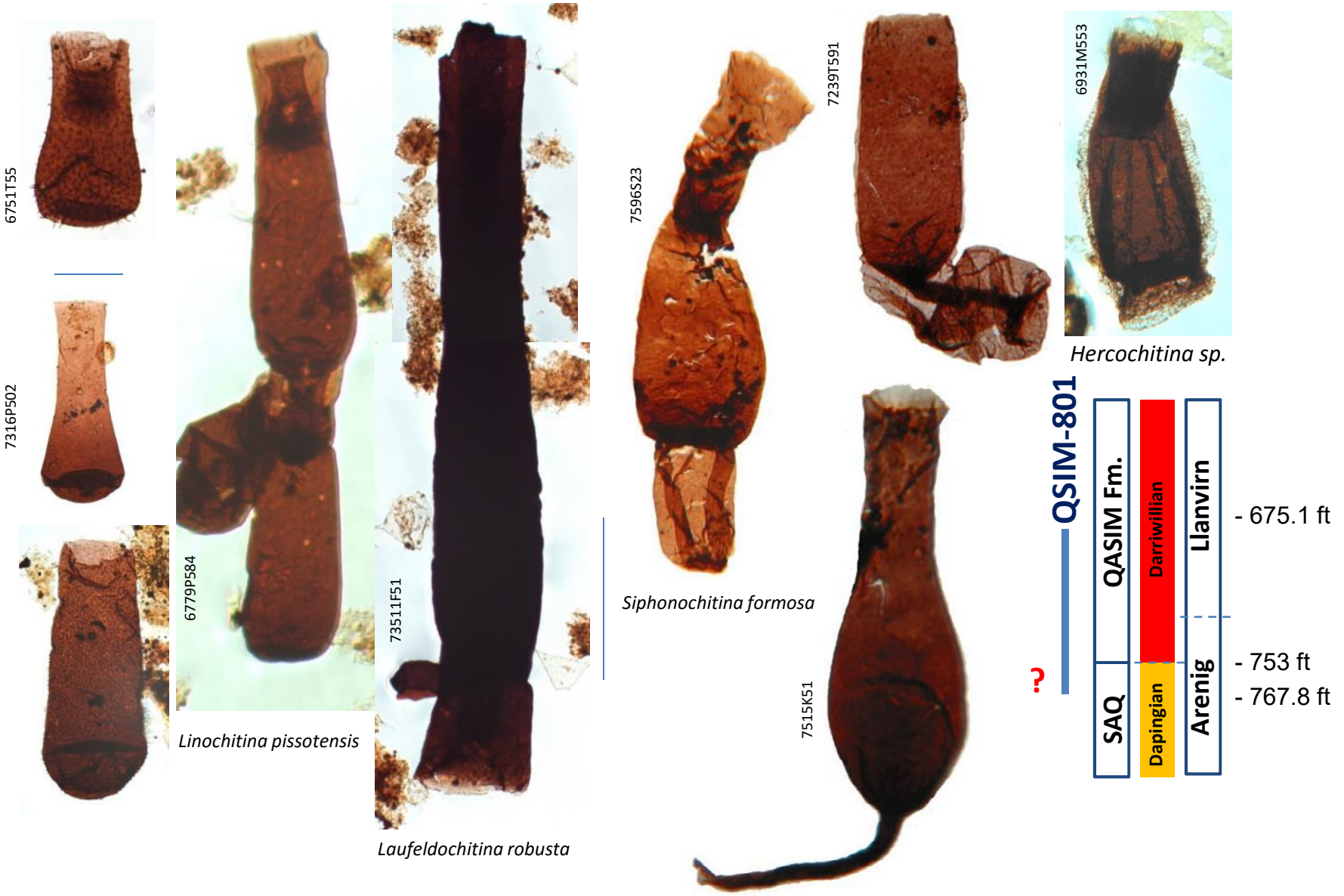
MFS O30

Arabian Plate sequence stratigraphy of the Cambrian to early Silurian interval After Sharland et al. (2001) and correlation with coeval succession of North Africa

The originality of the Middle Ordovician QSIM-801 assemblage

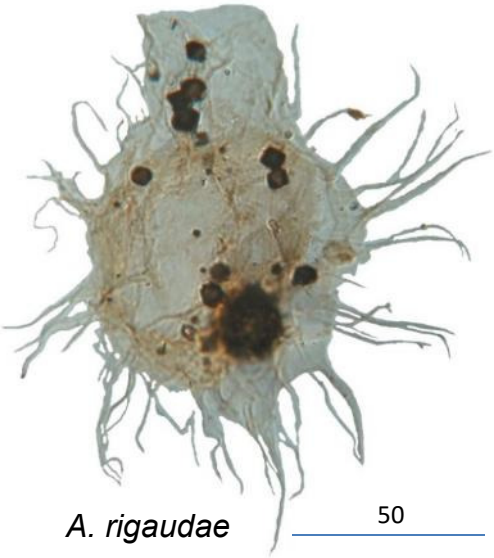
- **Assemblage of transition from littoral prodeltaic (shallow-water) environment in the Sajir Member to middle to outer shelf setting in the transgressive Hanadir Member of the Qasim Formation**
- **Among the most ancient record of land-derived palynomorphs: mid-Ordovician cryptospores and other elements of primitive vegetation**
- **Well preserved marine palynomorphs: acritarchs, prasinophycean phycomata and chitinozoa**
- **Morphological variations indicating instability of paleoenvironmental conditions**
- **Great variety and abundance of unidentified degradation-resistant organic remains : possible metazoan or fungal remains or something else**

CHITINOZOA and BIOSTRATIGRAPHY



ACRITARCHS
Dapingian-Darriwilian


A. aff. *squarrosum*

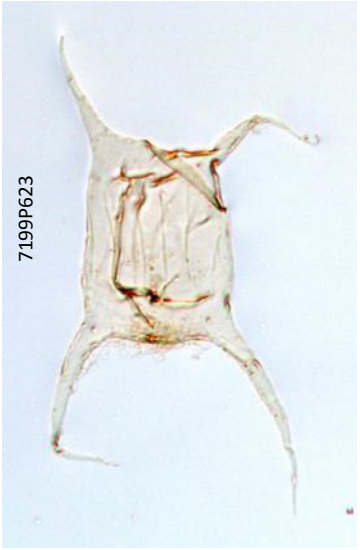


A. rigaudae

D. ancoriforme

D. cirritus

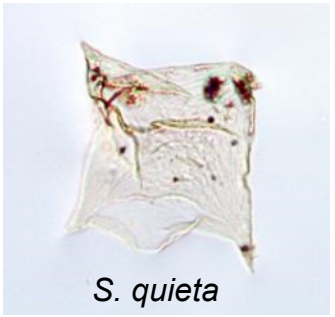
Veryhachium sp.

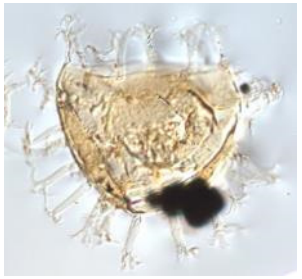


B. fortunata

B. rara

S. rarirrugulata


S. quieta

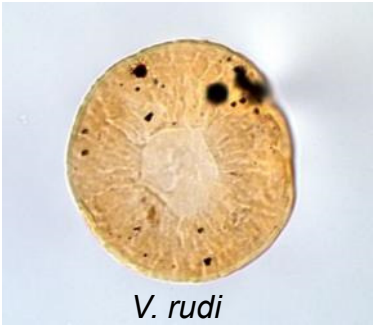



V. cf. tenuata

Leiofusa sp.

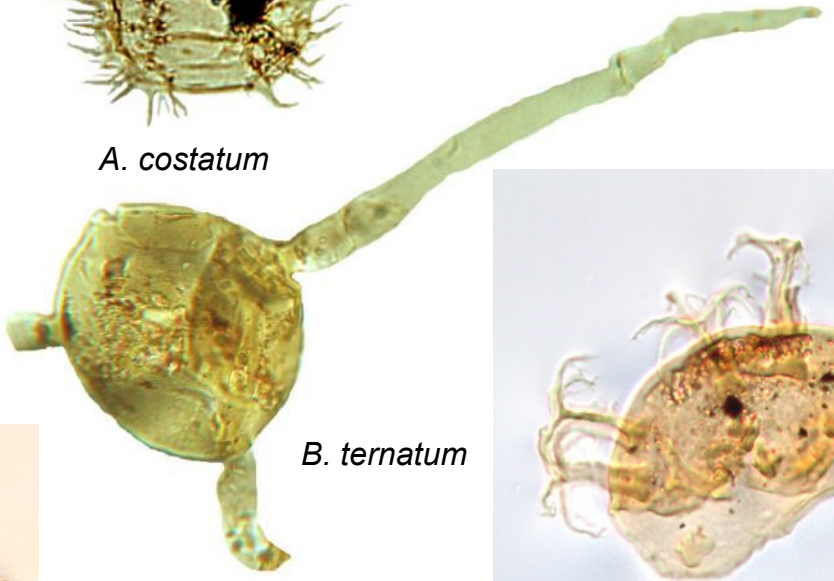
ACRITARCHS
Dapingian-Darriwilian

A. costatum

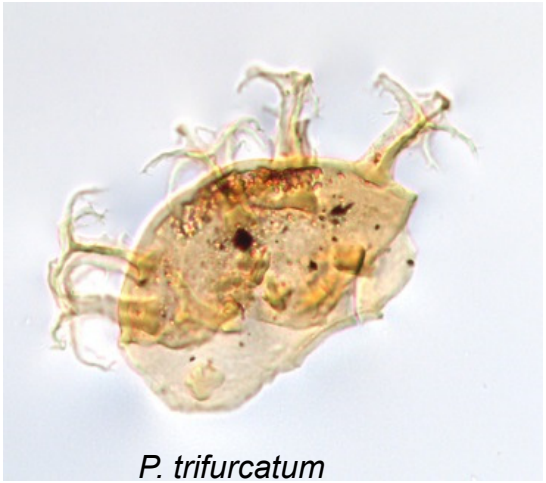


V. rudi

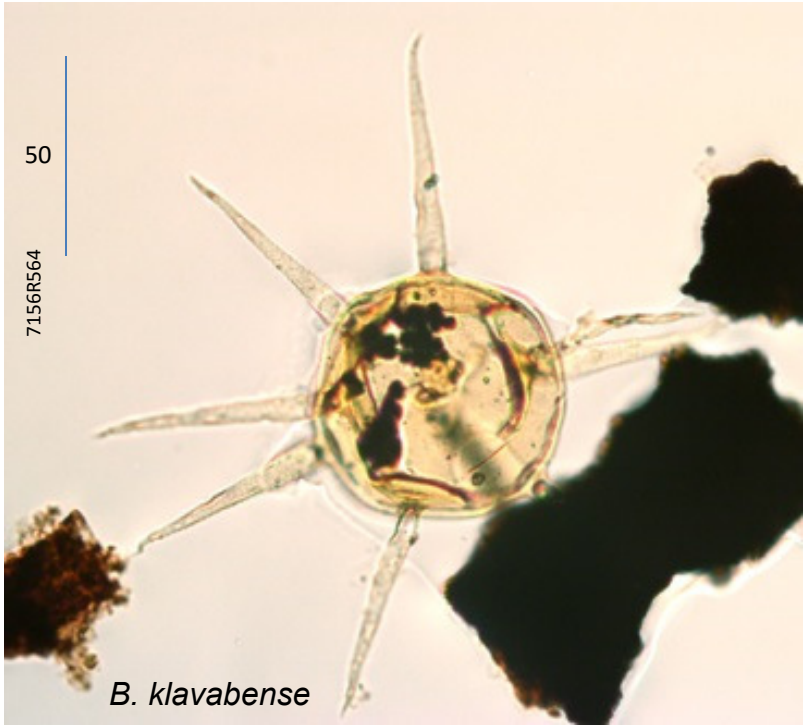
F. breviuscula



B. ternatum

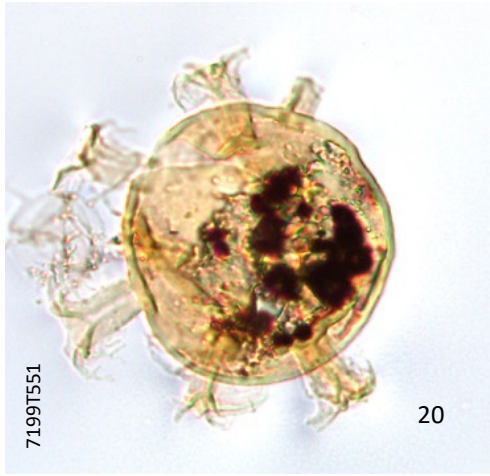


P. trifurcatum



B. klavabense

U. fusticula



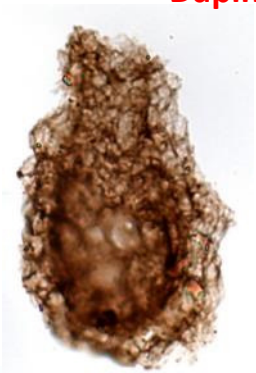
ACRITARCHS
Dapingian-Darriwilian

Focusphaera Quadros 1986

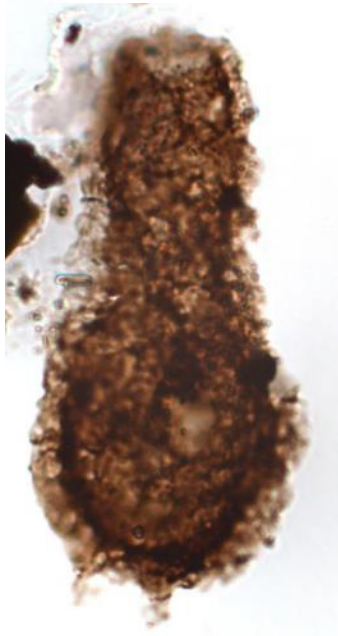
20

QSIM-801 Arabie Saoudite

Brazil, Amazonas Basin
Benjamin Constant Formation
Dapingian-Darriwilian

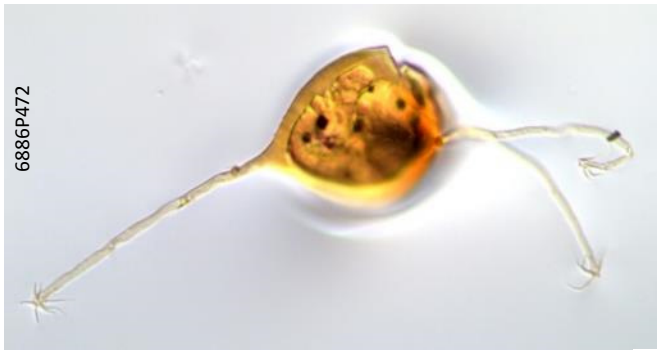


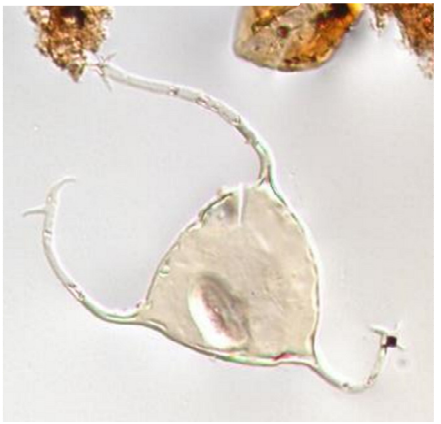
Focusphaera elongata
Quadros, 1986

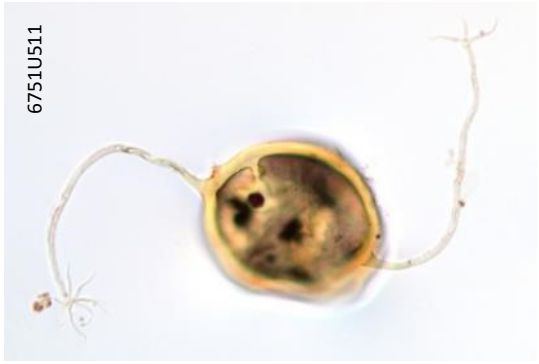


ACRITARCHS
Dapingian-Darriwilian

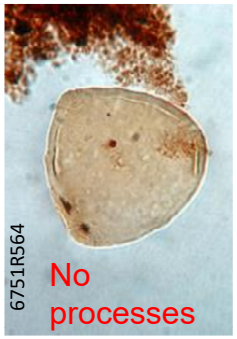
High variability of *Frankea Longiuscula* in the Hanadir Mb.



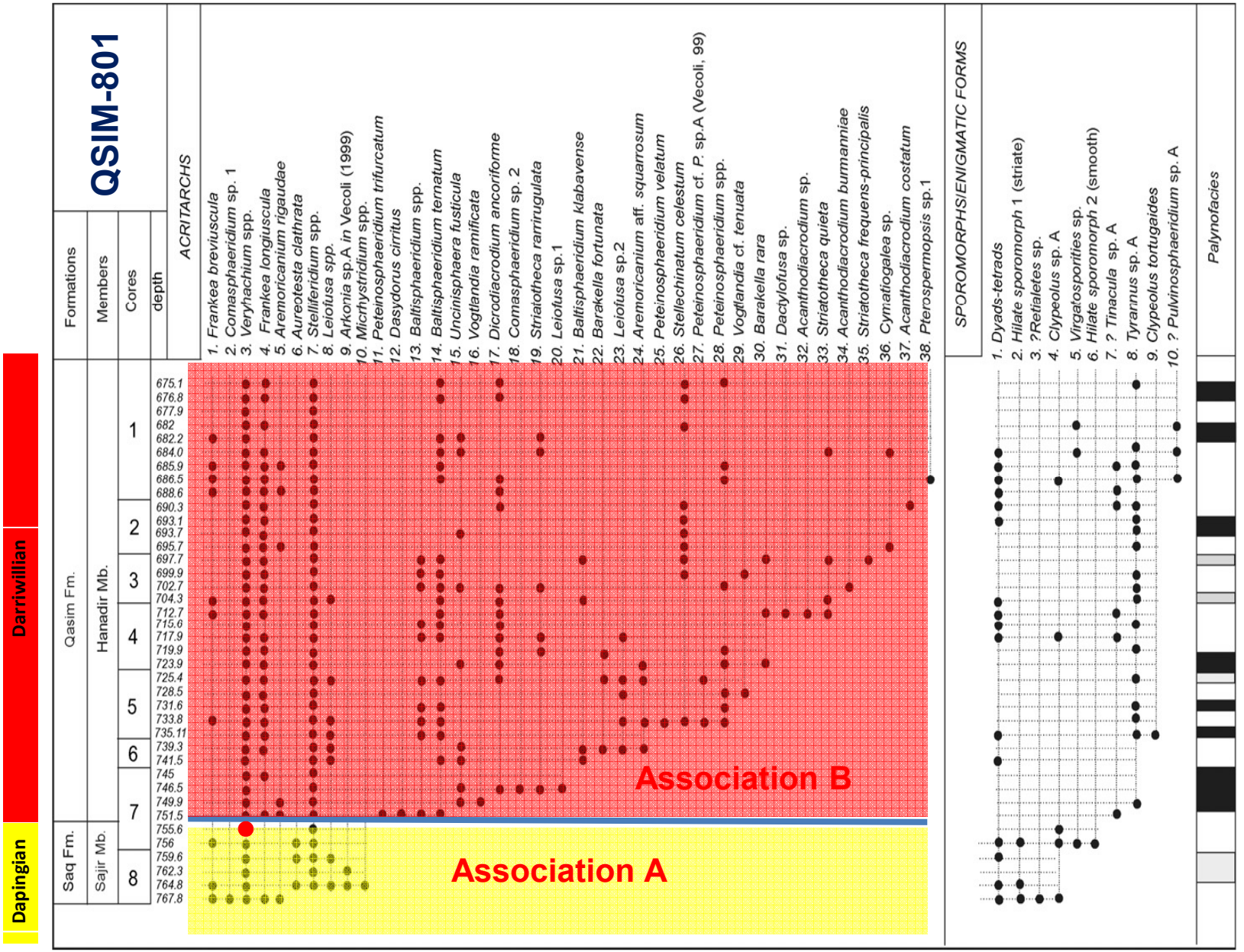




50

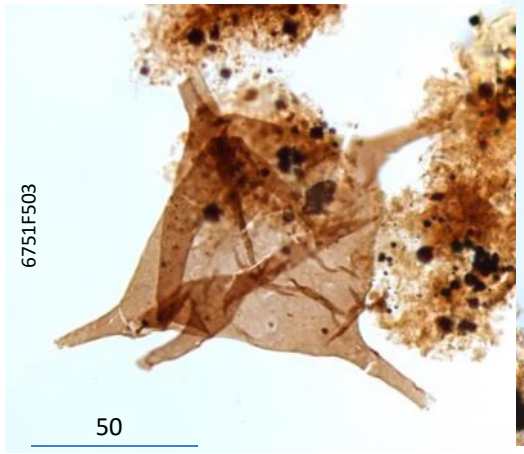


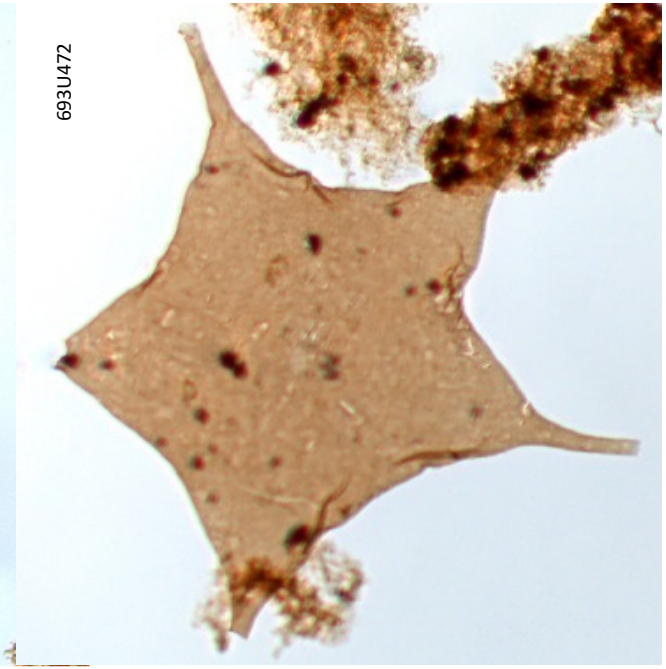
ACRITARCHS - DISTRIBUTION

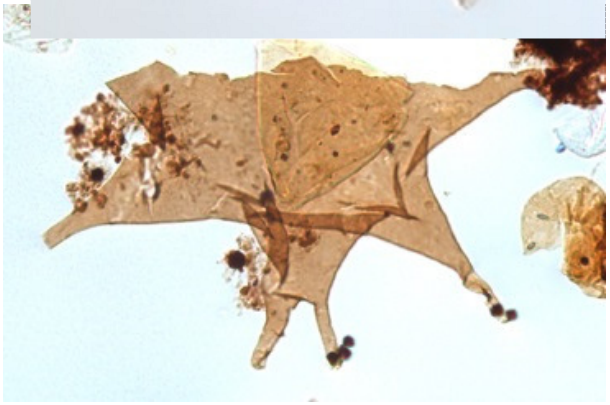


PROBLEMATIC MICROFOSILS

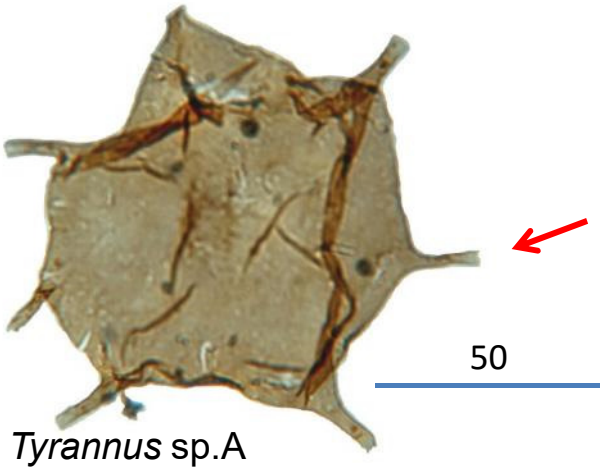
Tyrannus sp. A, a repeated occurrence all along the section







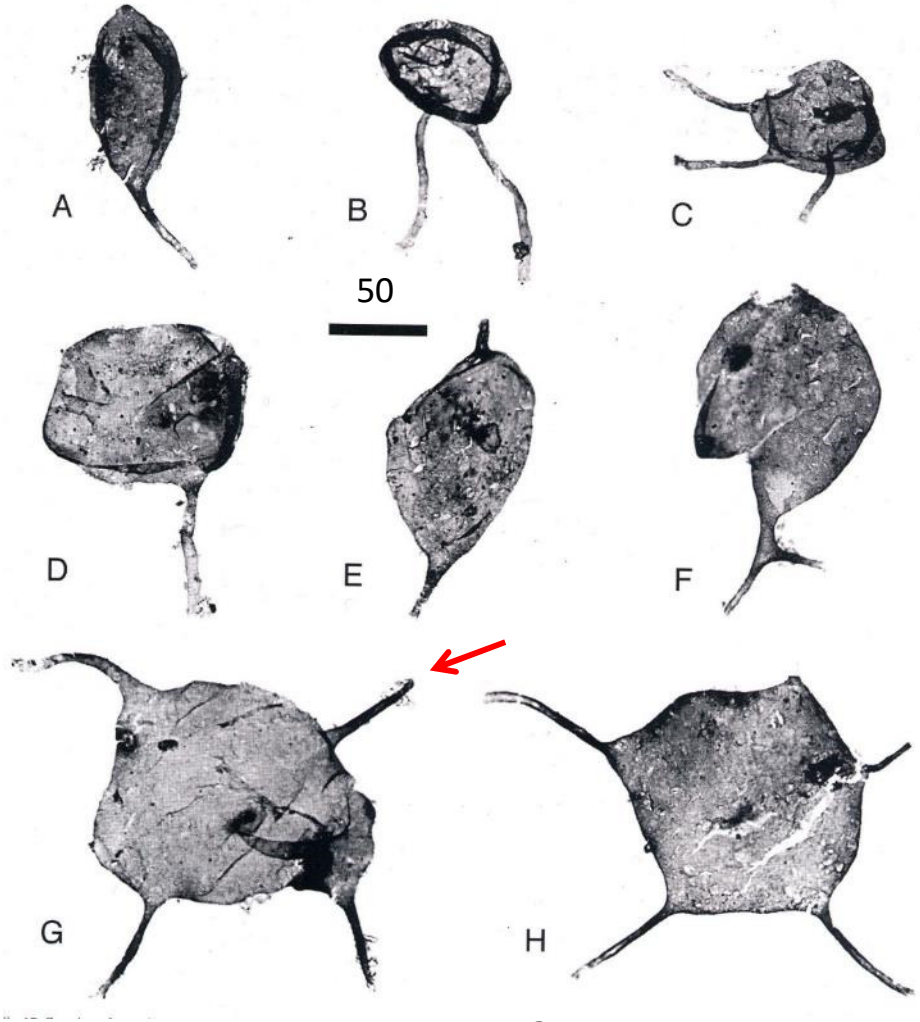
Comparison with the Neoproterozoic form *Tappania/Germinosphaera* : possibly a fungus



Tyrannus sp.A

Tyrannus giganteus

Butterfield, Knoll, Swett, 1994



Tappania/Germinosphaera

QSIM-801

Dapingian-Darriwilian boundary

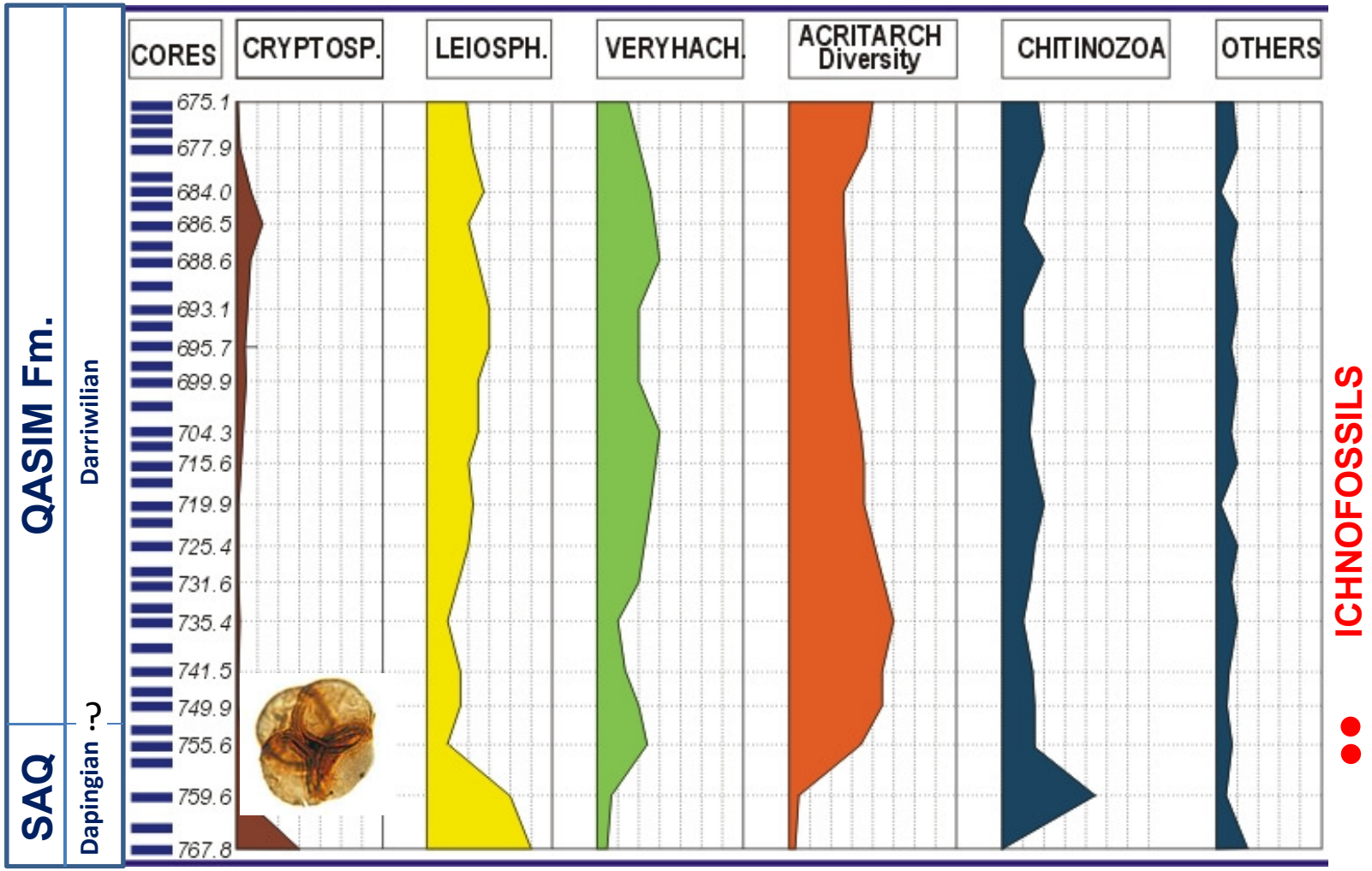
MOUSSEGOUDA CORE SECTION – Northern Chad

Latest Hirnantian –earliest Rhuddanian

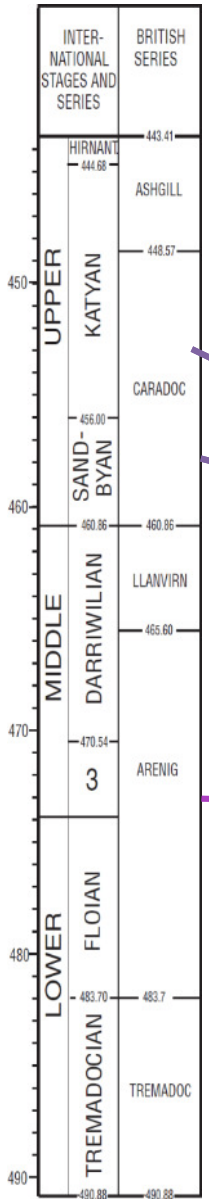
Le Hérissé, Paris, Steemans, 2013 Bulletin of Geoscience

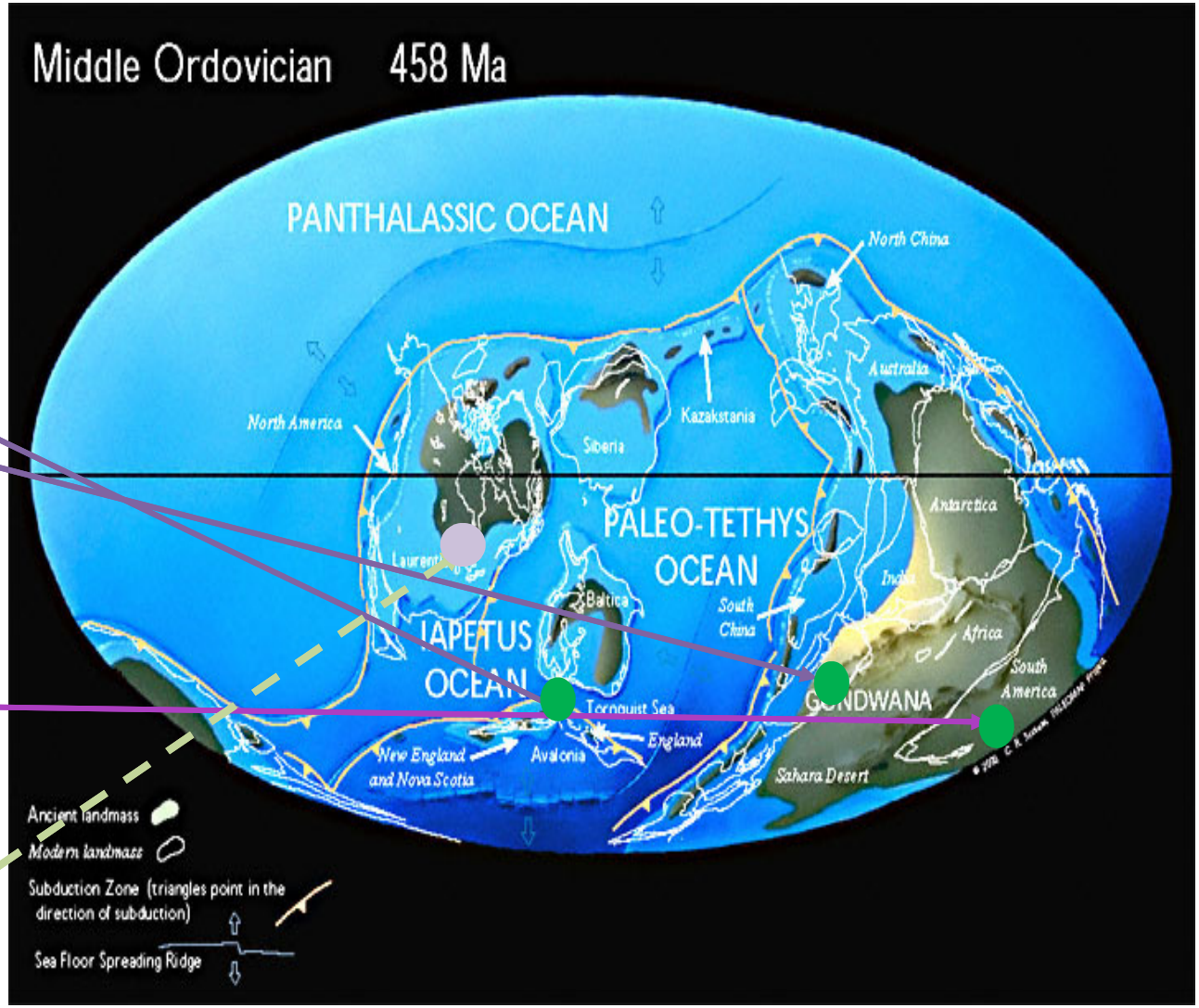
Sac-like microfossils with a pigmented wall and striate mesh-like ornamentation. They could be metazoan remains and recall cocoons (egg-cases) of clitellate annelids

IMPORTANCE OF THE ELEMENTS OF PRIMITIVE VEGETATION IN THE MIDDLE ORDOVICIAN OF QSIM 801



The oldest cryptospores





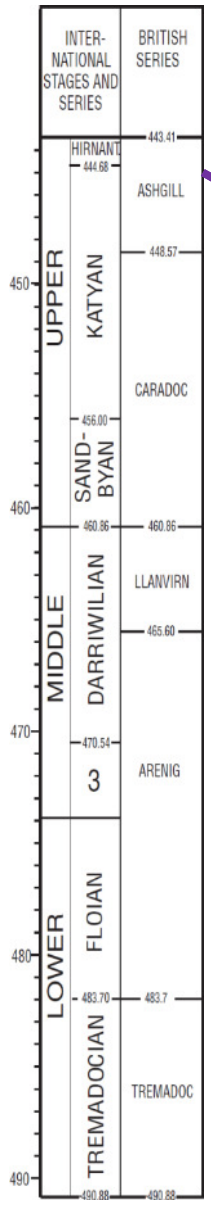
3=Dapingian

Cambrian

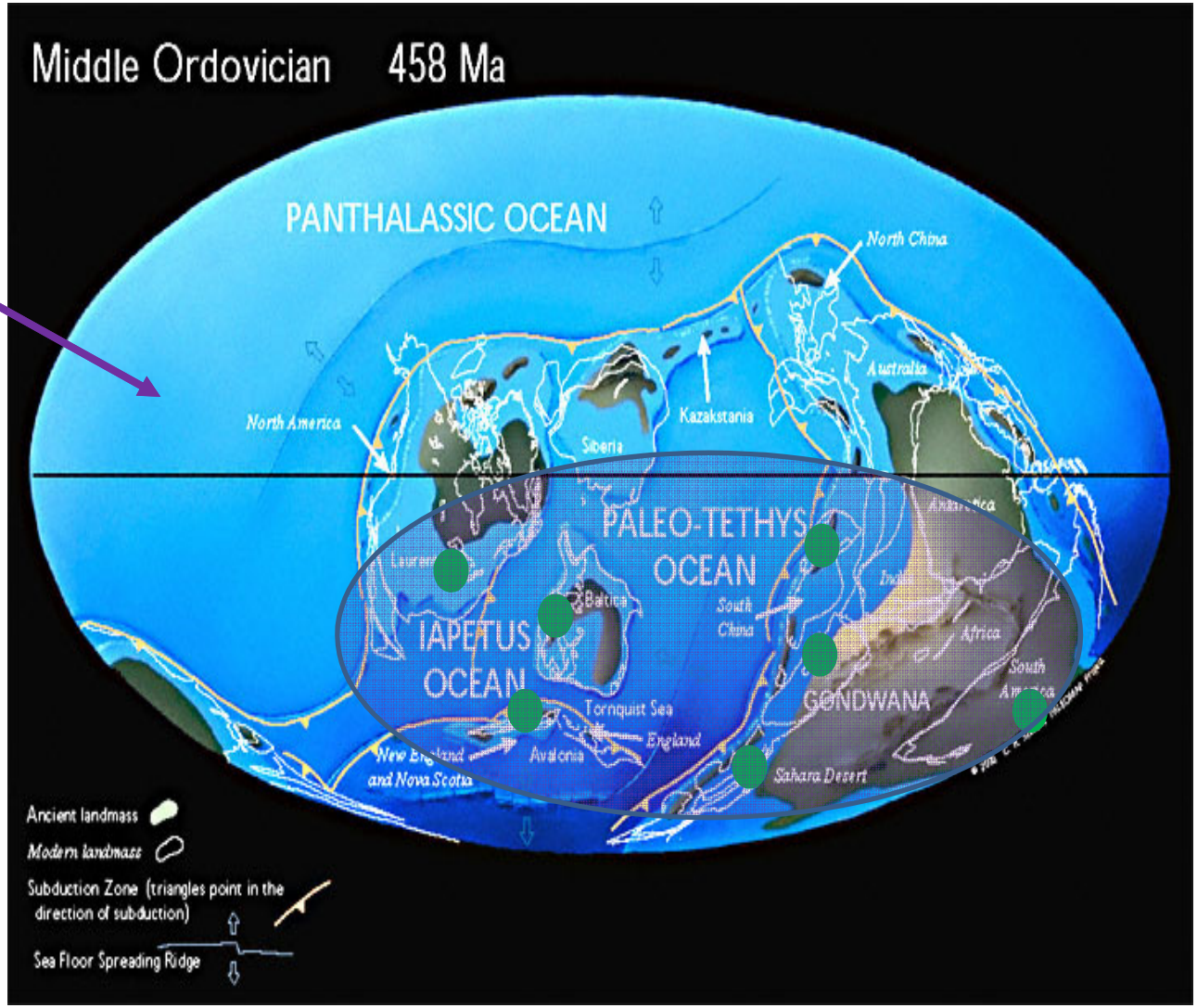
Scotese 2003

ELEMENTS OF PRIMITIVE VEGETATION

The oldest cryptospores



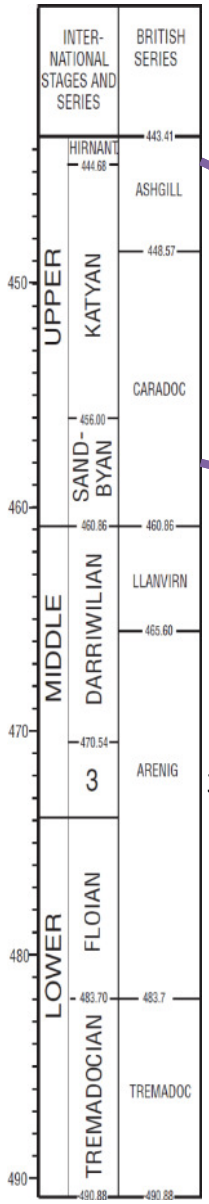
3= Dapingian



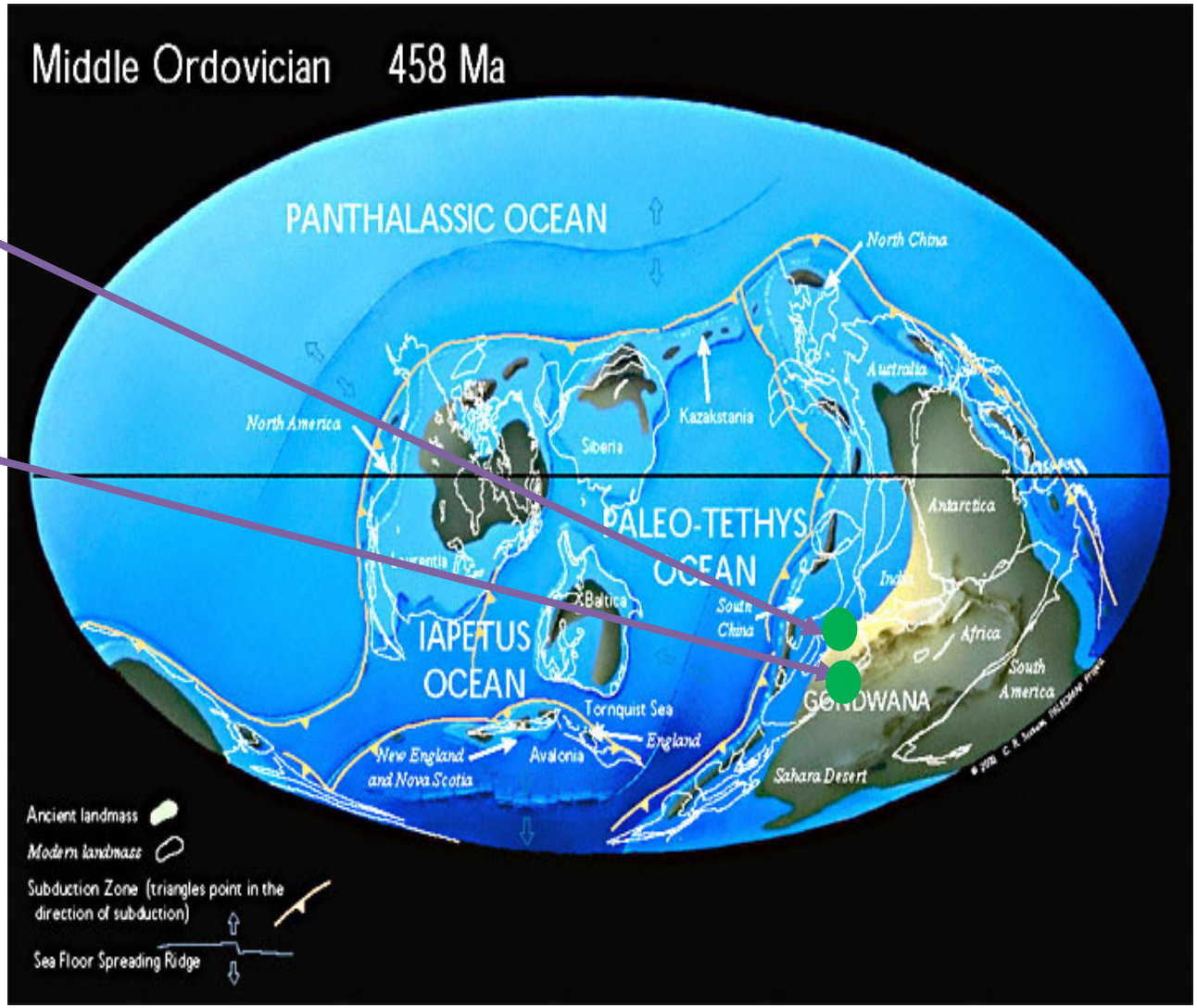
Scotese 2003

ELEMENTS OF PRIMITIVE VEGETATION

The oldest trilete spores

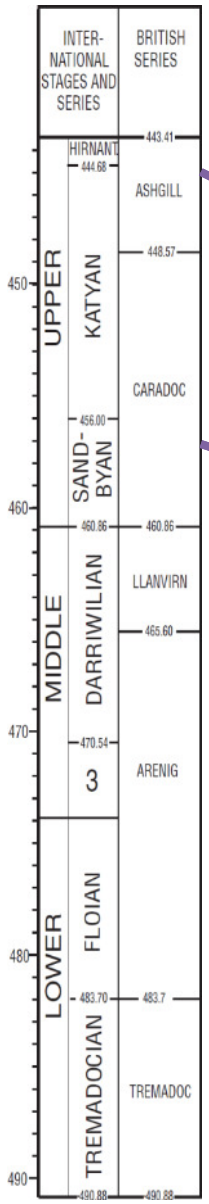


3= Dapingian

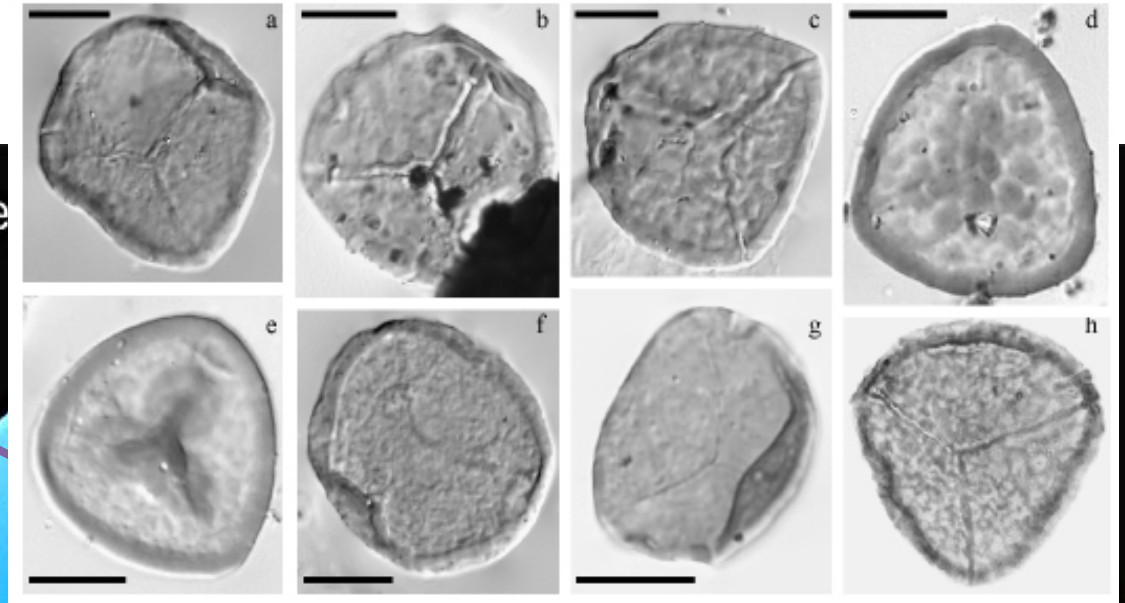


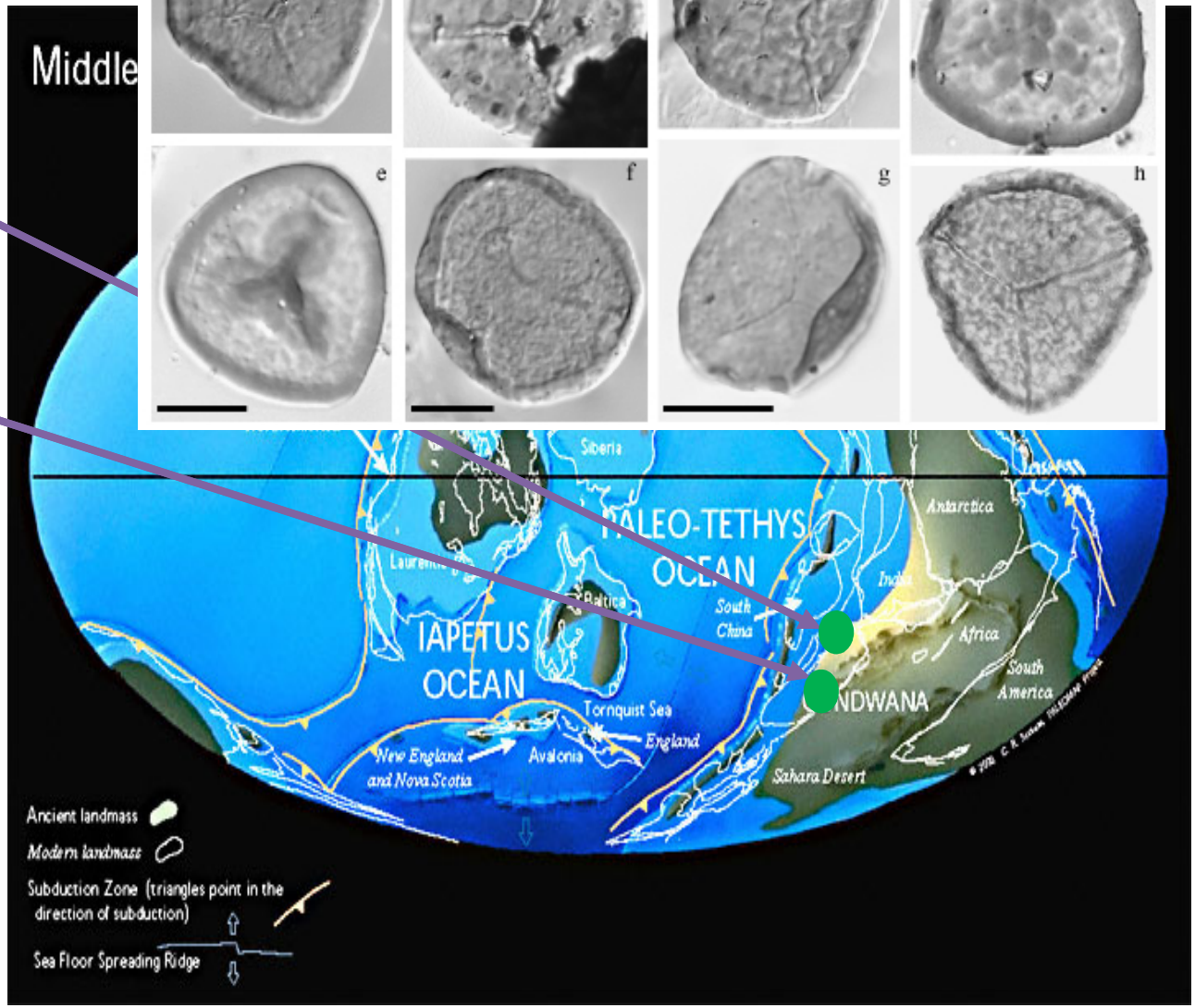
Scotese 2003

The oldest trilete spores



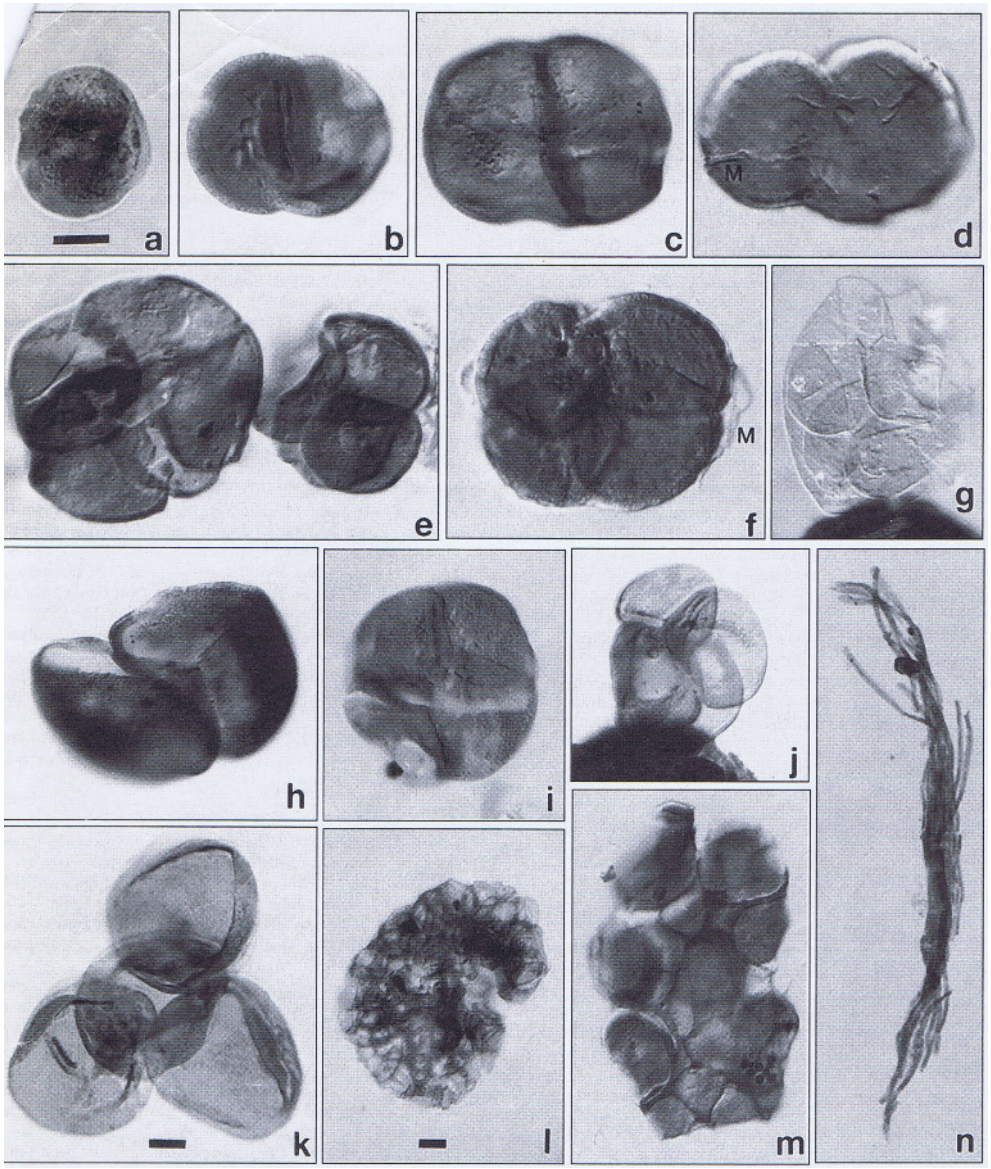
3= Dapingian





Scotese 2003

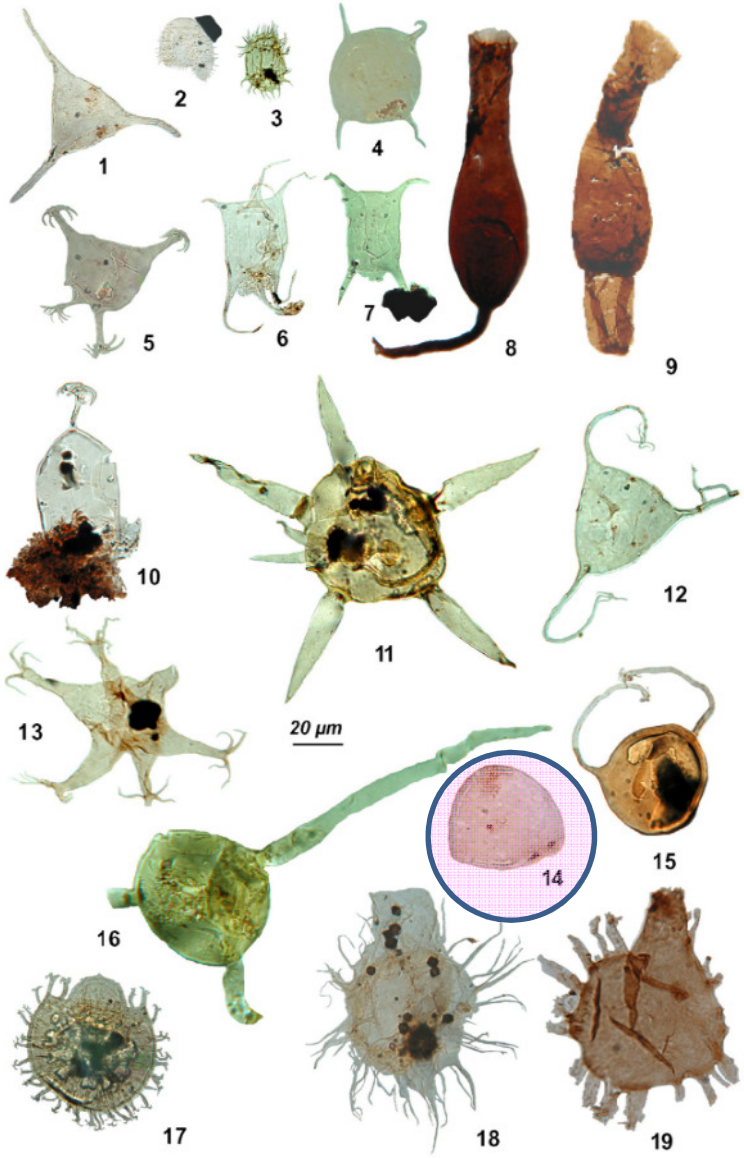
The oldest cryptospores from Saudi Arabia

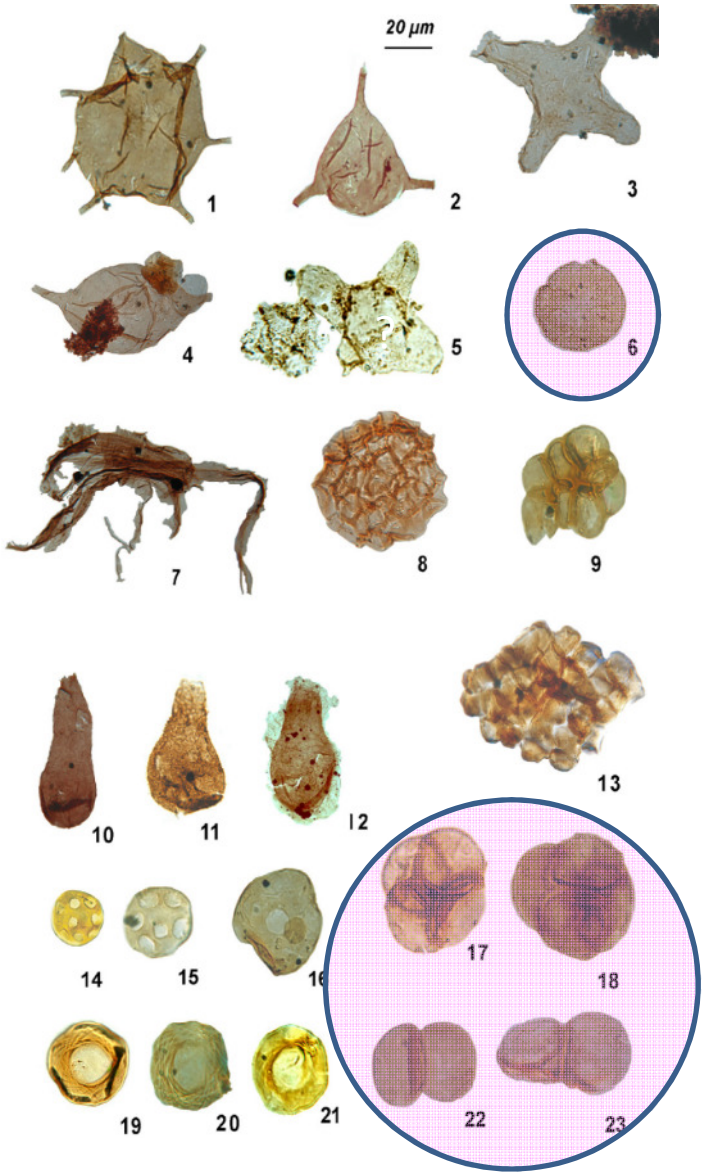


Strother et al., 1996

ELEMENTS OF PRIMITIVE VEGETATION

Palynomorphs in Le Hérissé et al., 2007





The most common cryptospores in the Qasim-801 assemblage

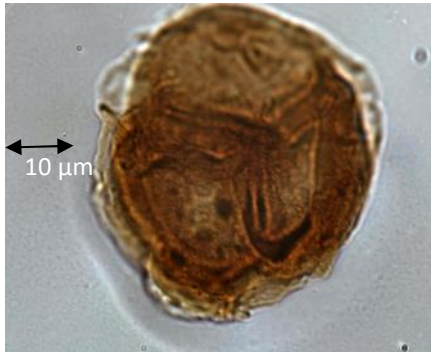
1. Tetrads

Tetrahedraletes medinensis

Tetrahedraletes grayae

n. G. n. sp.

n. G. n. sp



Velatitetras laevigata

n. G. n. sp.

n. G. n. sp.

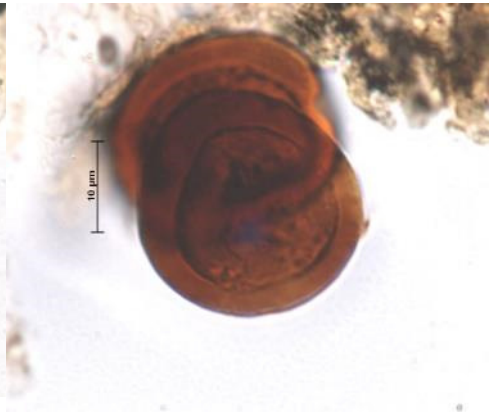
n. G. n. sp.

The most common cryptospores in the QSIM-801 assemblage

2. Dyads

n. G. n. sp.

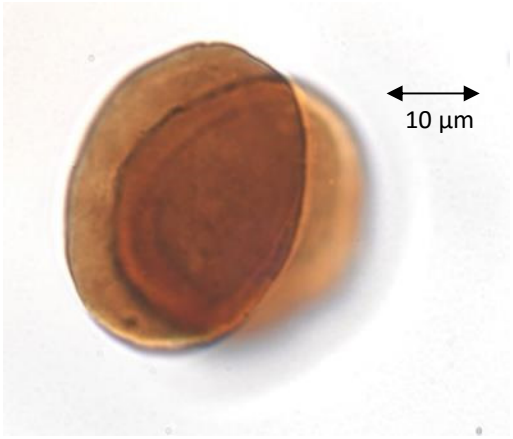
n. G. n. sp.



? n. G. n. sp.

Pseudodya. sp. B Rich 1986

Dyadospora murusdensa

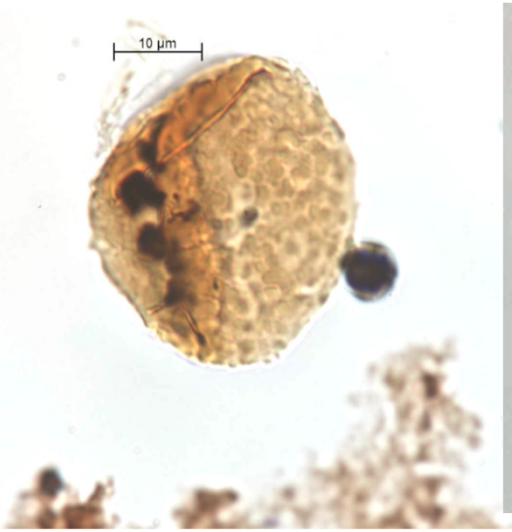


Pseudodyadospora petasus

The most common cryptospores in the Qasim-801 assemblage

3. Monads

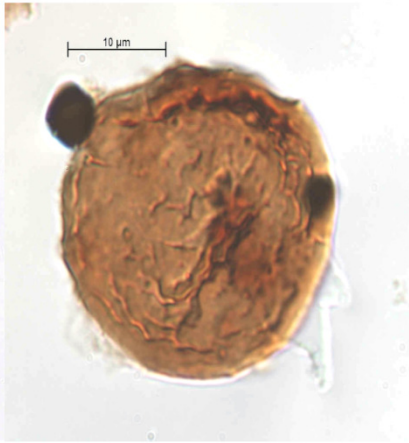
n. G. n. sp.



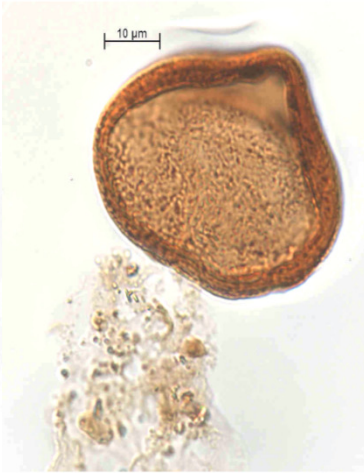
Hispanaediscus n. sp.

n. G. n. sp.

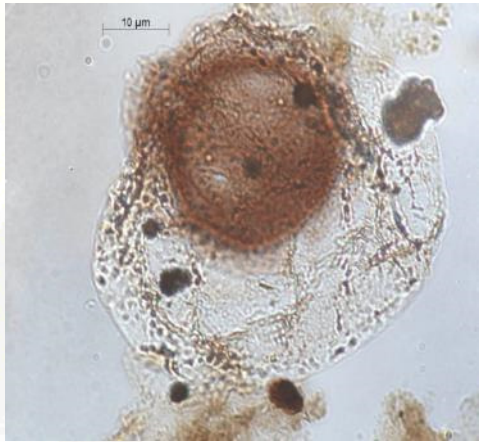
Gneudnaspora divellomedia



Rugosphaera cerebra



Hispanaediscus n. sp.



? *Sphaerasaccus glabellus*

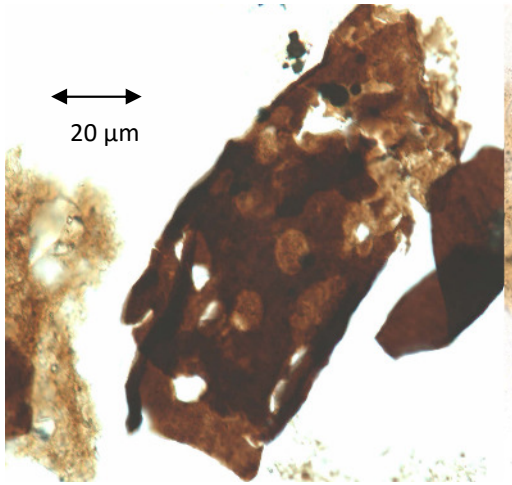
The most common cryptospores in the Qasim-801 assemblage

Composition of the assemblage

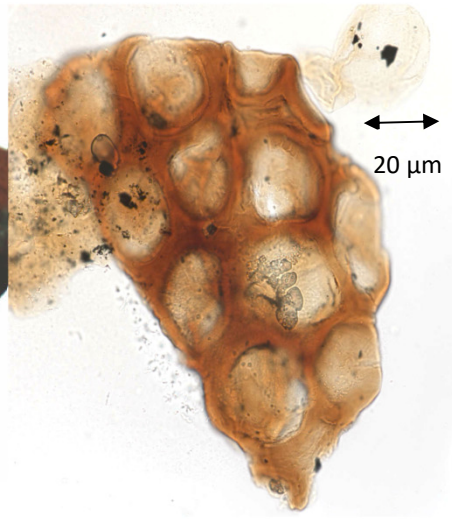
- **Tetrads : 8 species**
- **Dyads : 6 species**
- **Monads : 7 species**

A total of 21 species have been encountered in the material investigated, of which 11 are new.

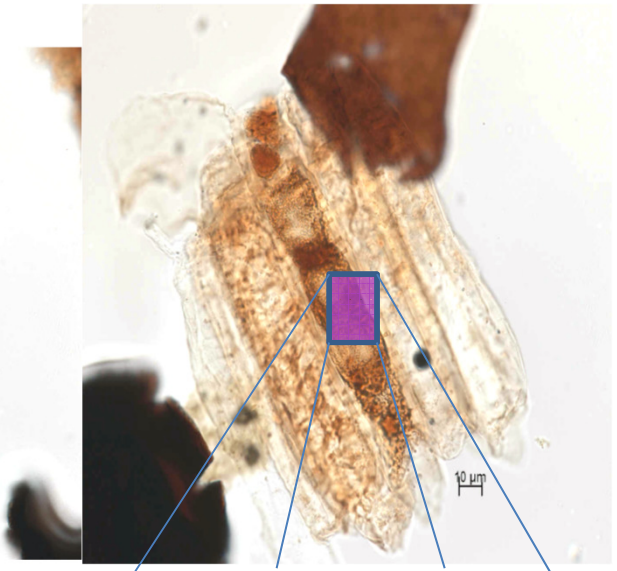
The most common organic remains in the Qasim-801 assemblage



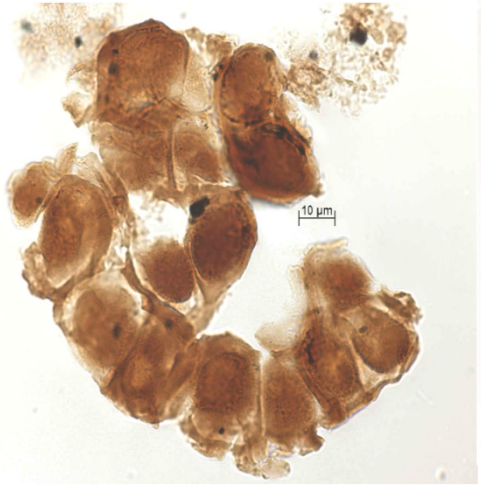
Arthropod remain



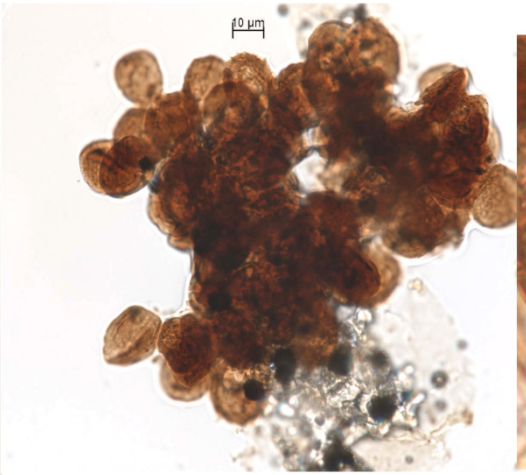
Thalle ?



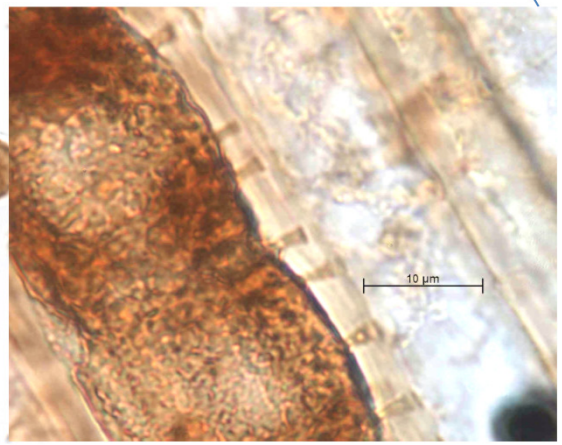
Paranch. cells of bryophites ?



?

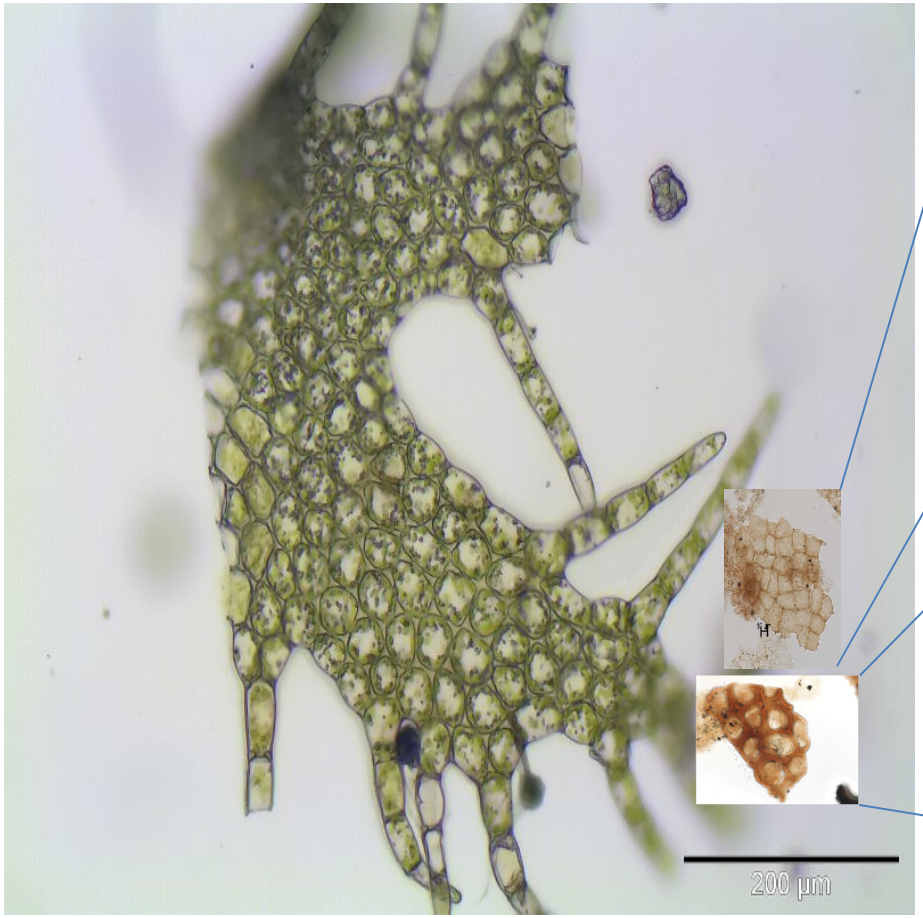


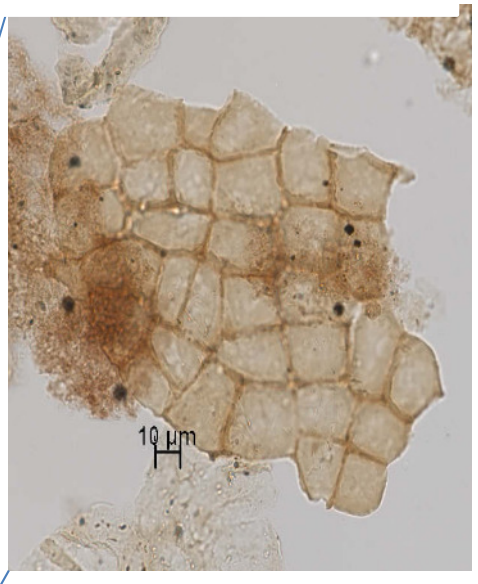
Leiosphaeridia in cluster

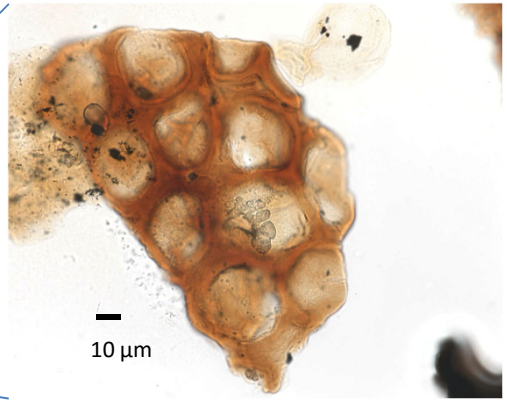


Enlargment

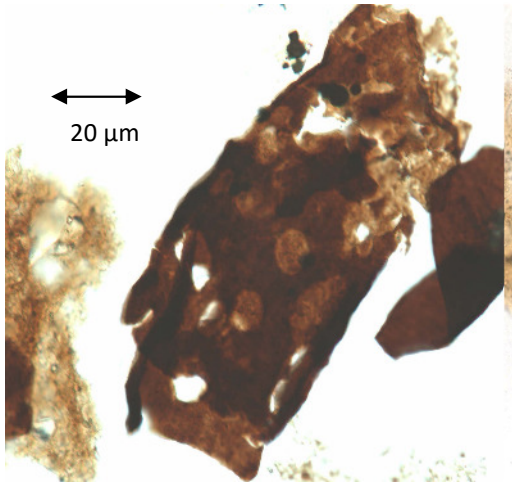
THALLE ?



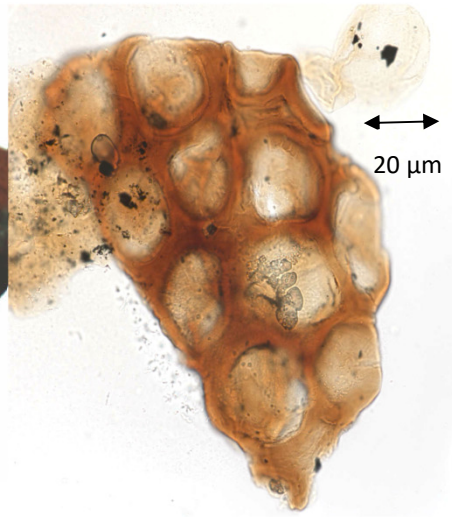




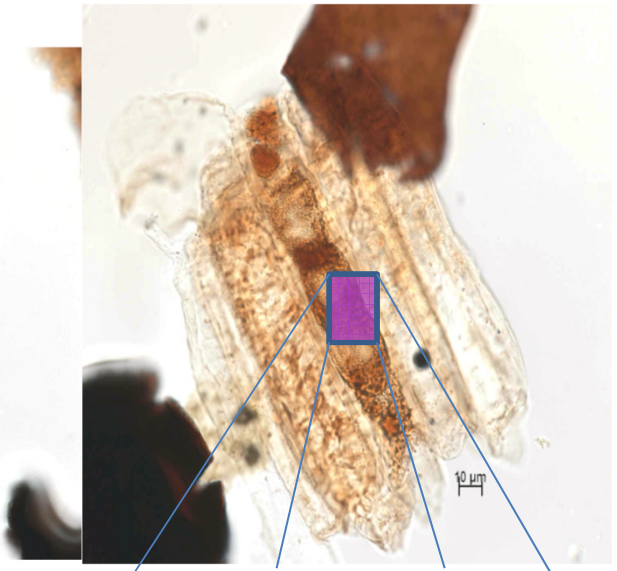
The most common organic remains in the Qasim-801 assemblage



Arthropod remain

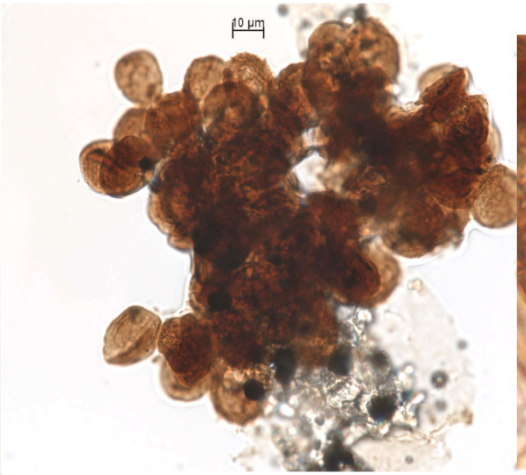


Thalle ?

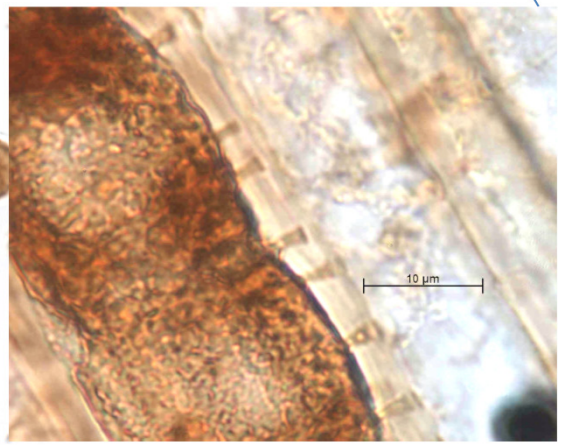


Paranch. cells of bryophites ?

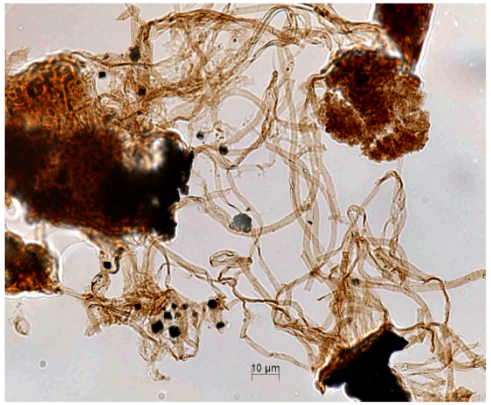
?



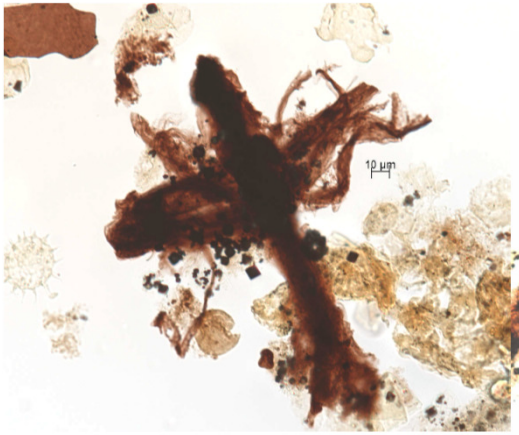
Leiosphaeridia in cluster



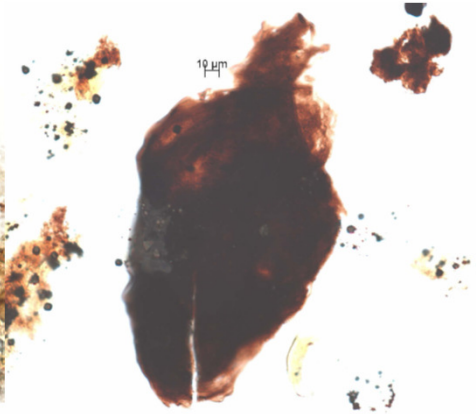
Enlargment



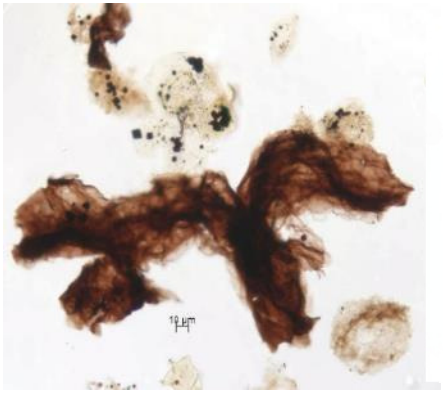
? Rhizoids



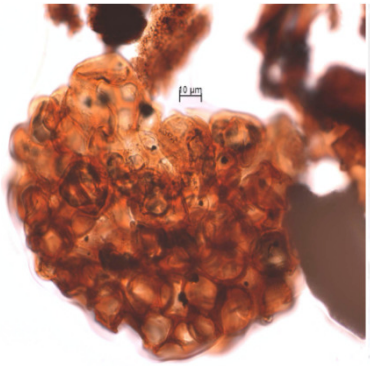
Cf. Tortotubus protuberans



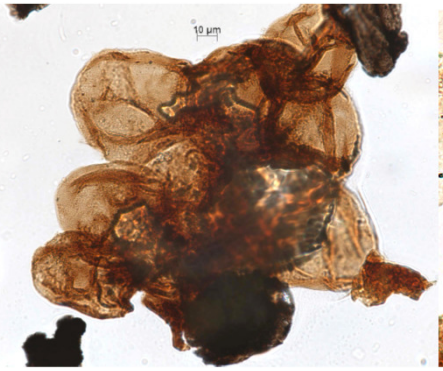
? Sporangia



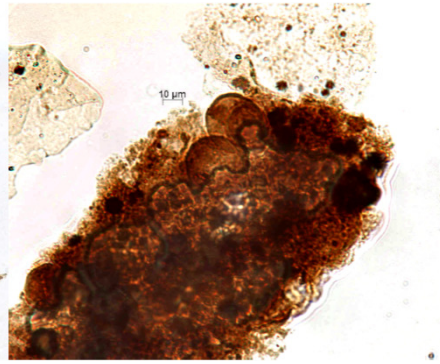
?



Cells in cluster



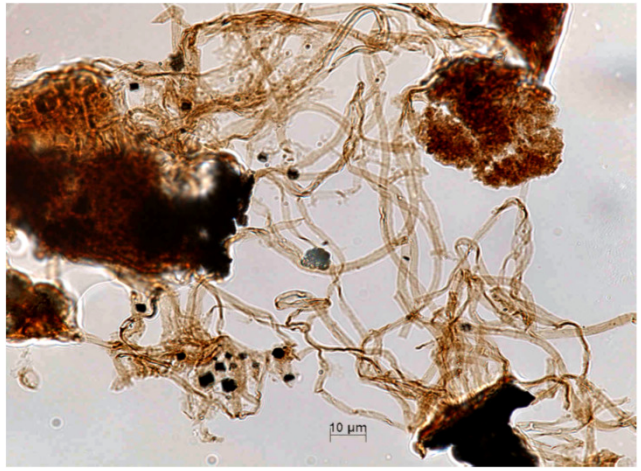
Leiosphaeridia in cluster

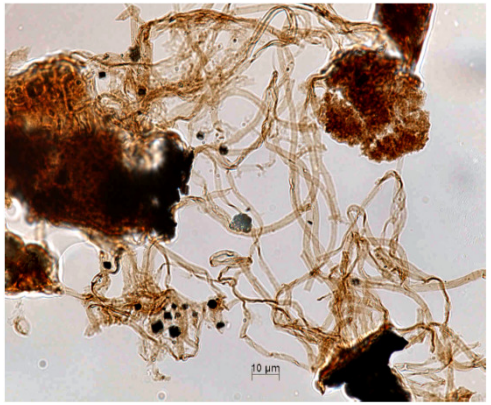


Coprolithe

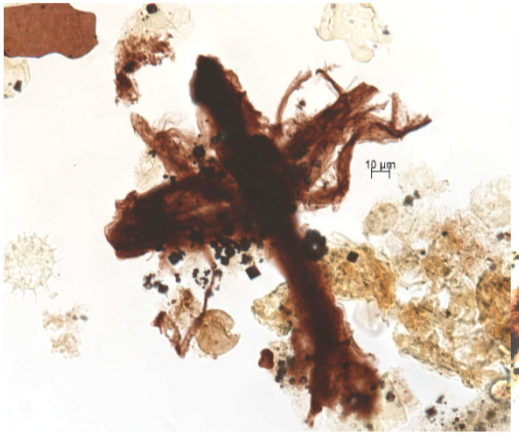
Rhysoides


250 µm obj.x6,5 R=1:3
Micro: Dialux 20EB - Photo: E4500
Calypogeia muelleriana (Schiff.) K.Mull.
Amphigastre -Fond Clair - Prép: Eau - Col: Aucune
Advocat Andre - 08/06/2007

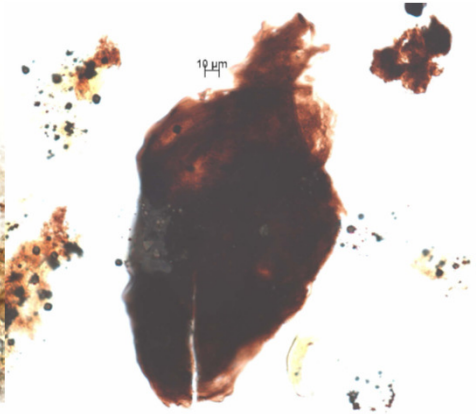

10 µm



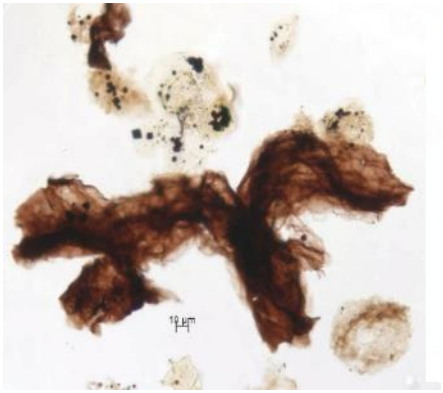
? Rhizoids



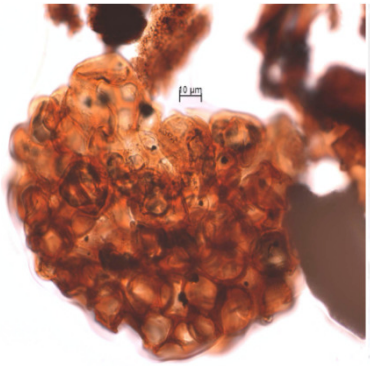
Cf. Tortotubus protuberans



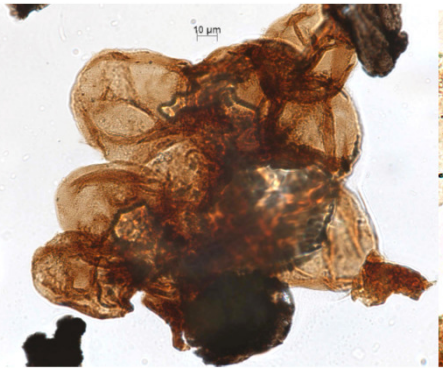
? Sporangia



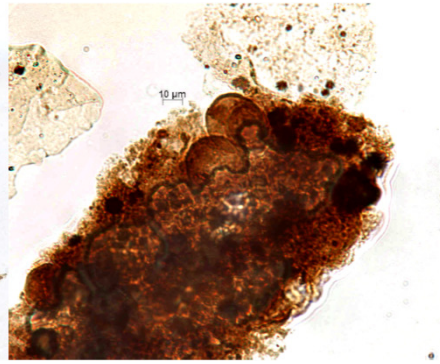
?



Cells in cluster

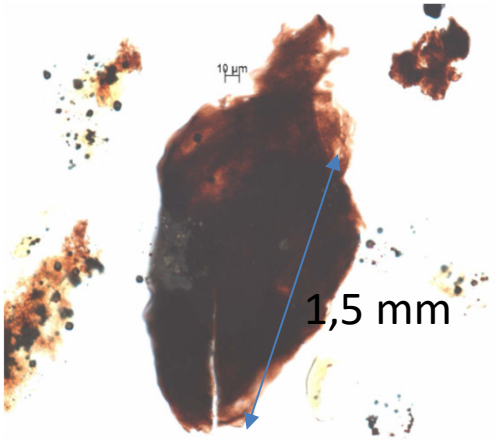


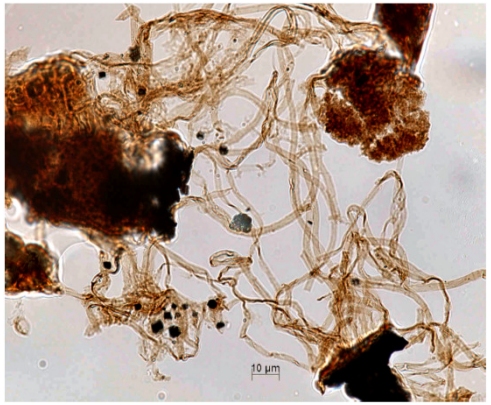
Leiosphaeridia in cluster



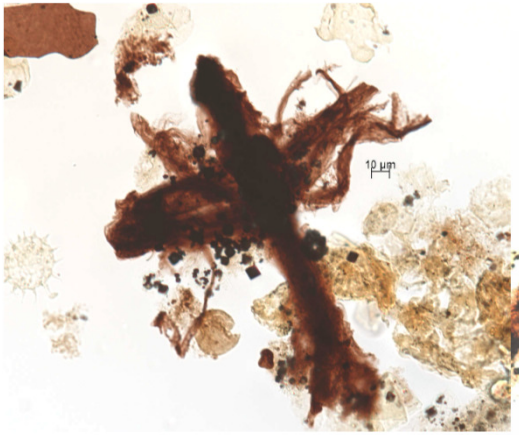
Coprolithe

SPORANGIA ?

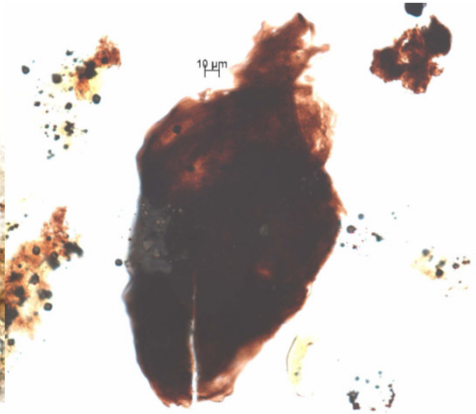




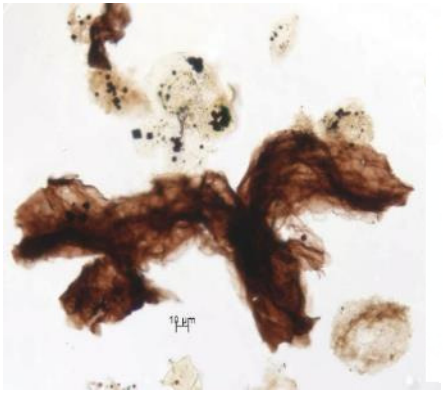
? Rhizoids



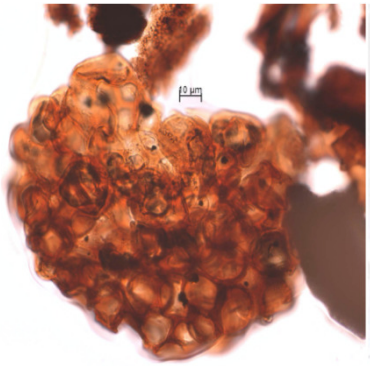
Cf. Tortotubus protuberans



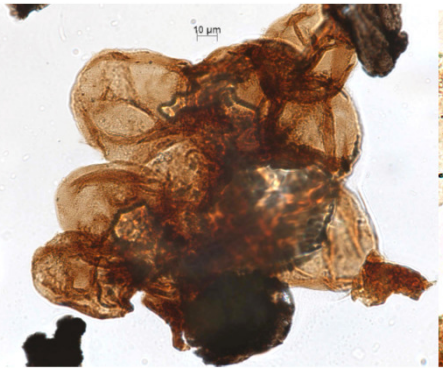
? Sporangia



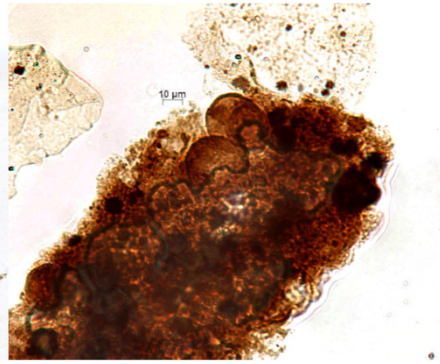
?



Cells in cluster



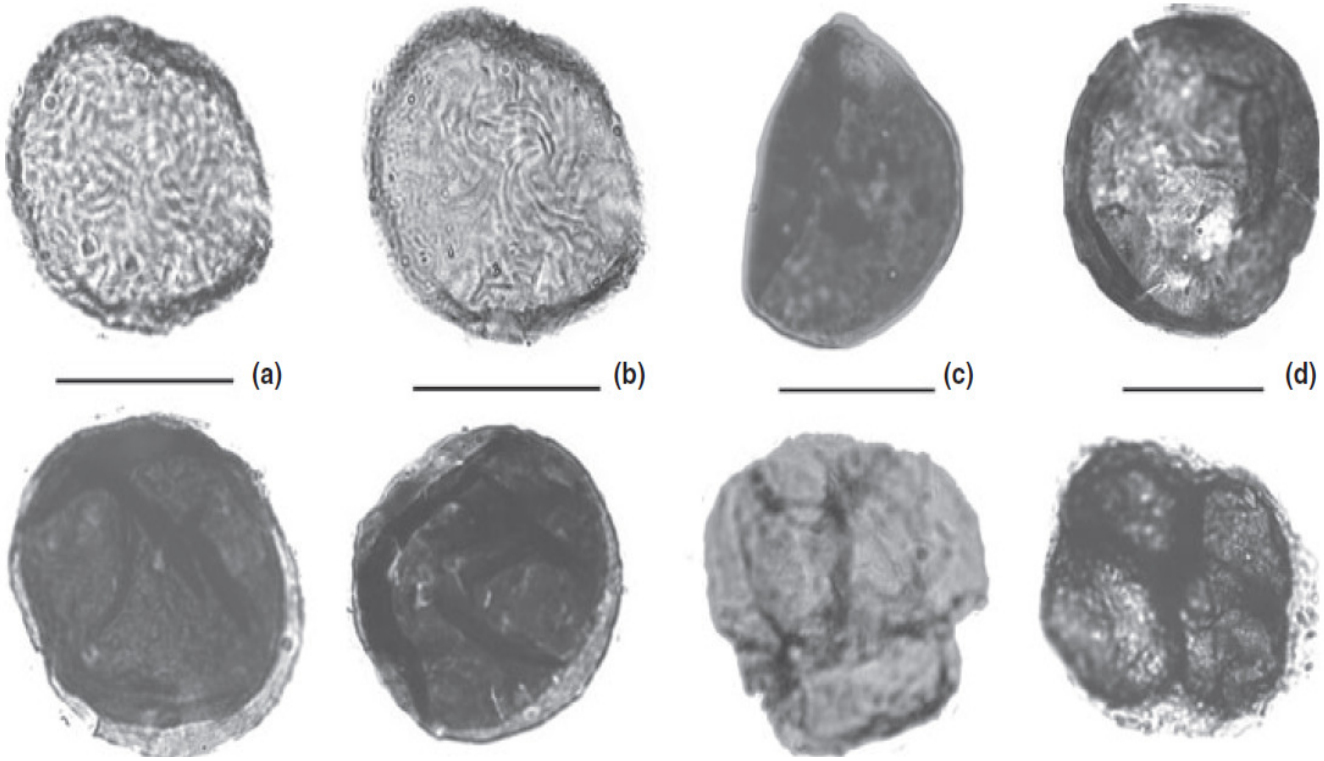
Leiosphaeridia in cluster

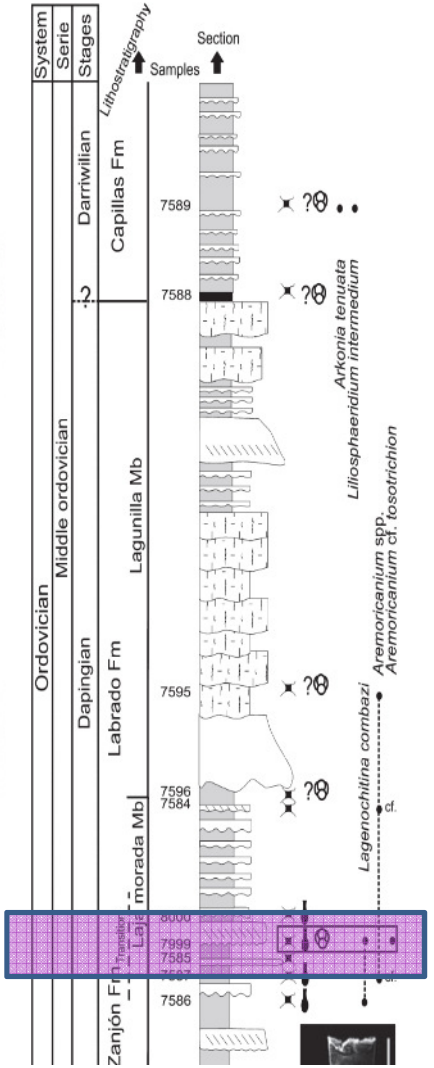


Coprolithe

CRYPTOSPORES - COMPARISONS

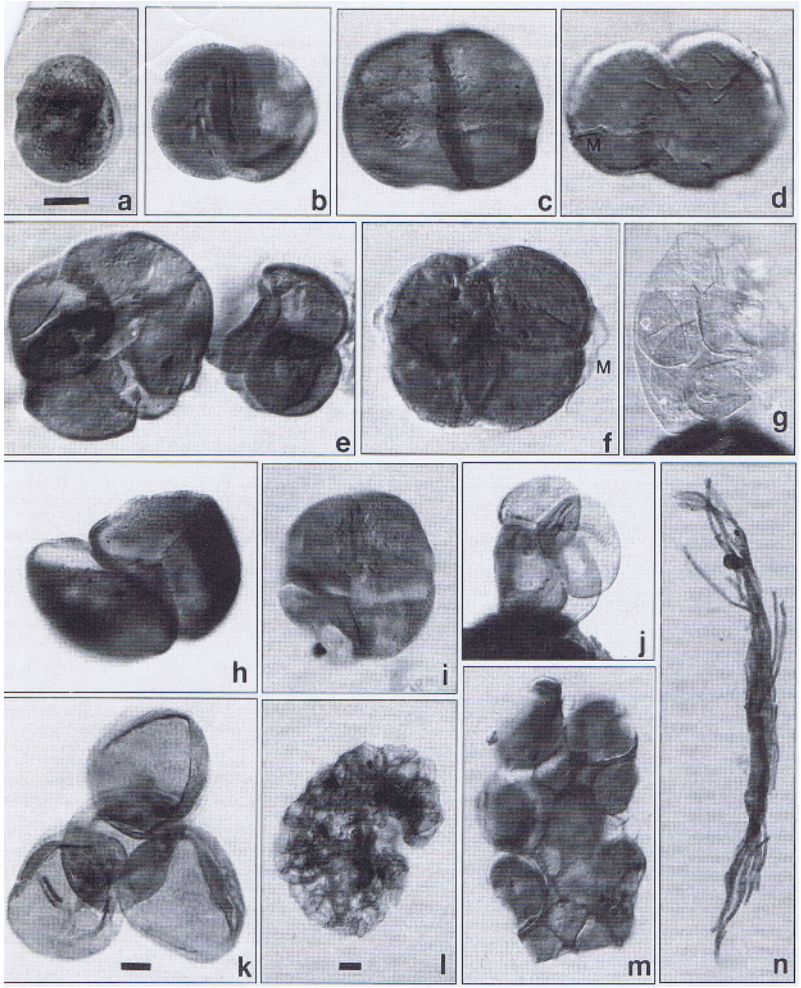
Comparison with Cryptospores associations from the Zanjon Formation. Argentina, Dapingian in age.
Rubinstein et al. 2010

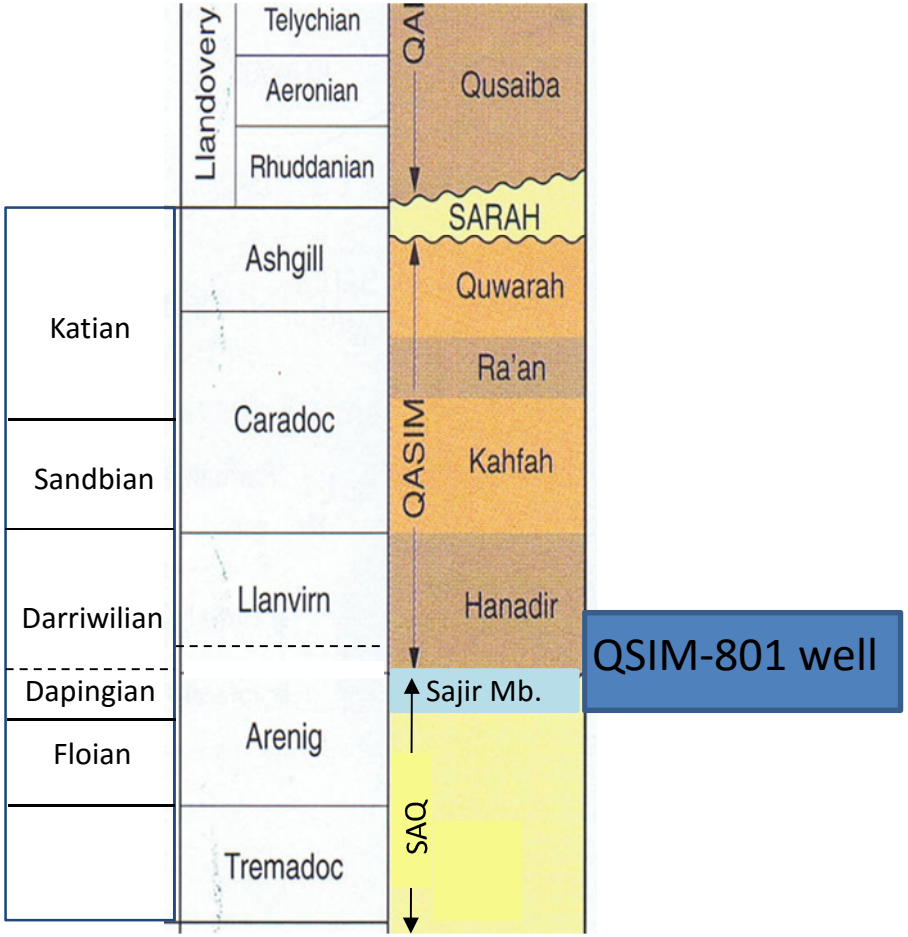




CRYPTOSPORES - COMPARISONS

Assemblage from the Hanadir Member, Saudi Arabia
Strother et al. 1996

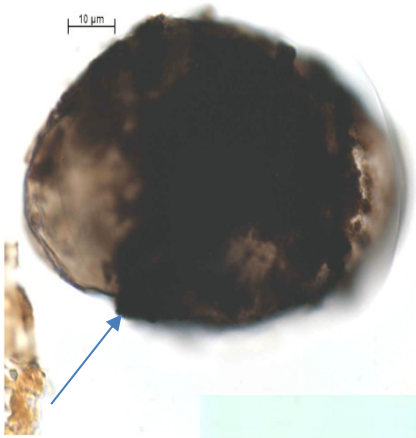


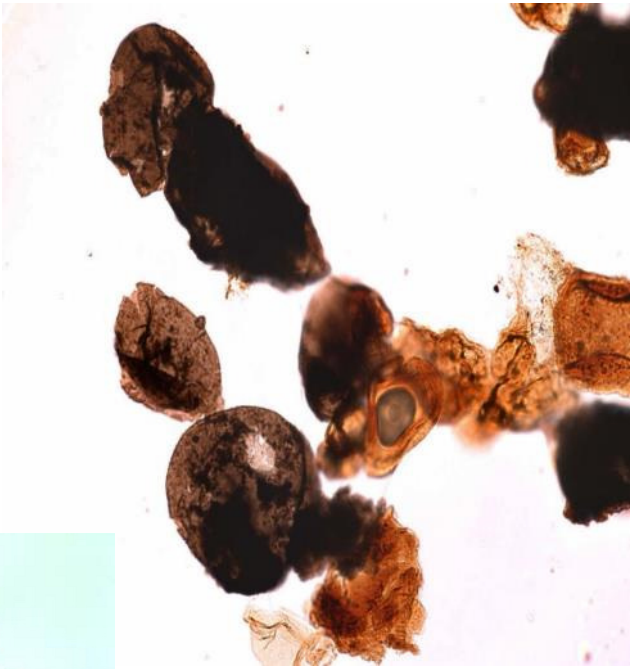


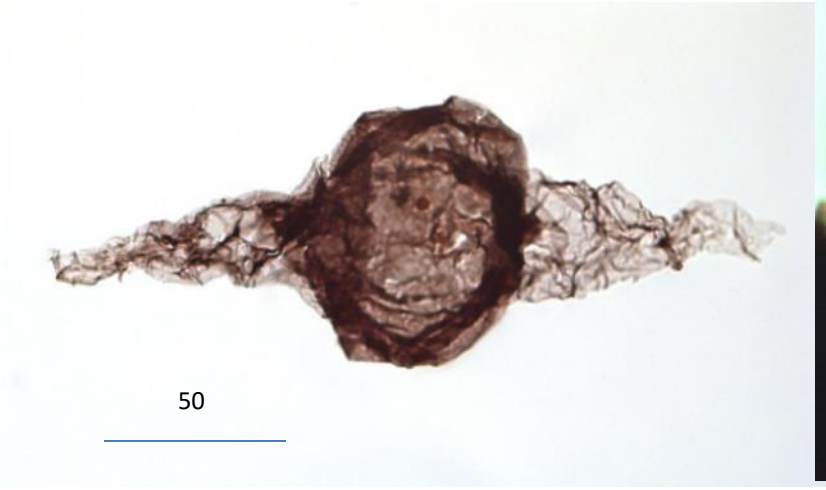
GENERAL REMARKS ON THE QSIM-801 ASSEMBLAGE

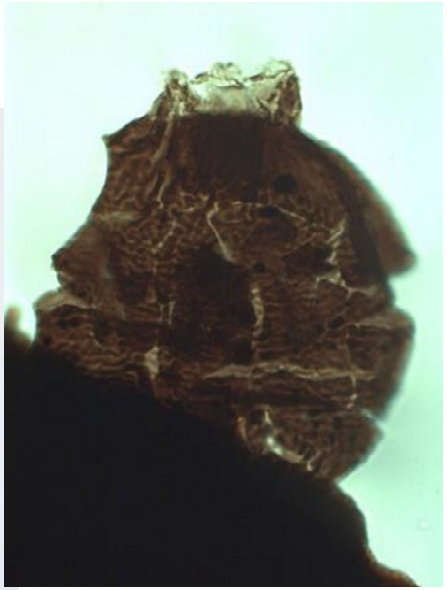
- Few cryptospores enclosed in a membrane
- Monads, dyads and tetrads, ornamented by fine grana
- Assemblage very different from the other Ordovician assemblages
- The richest pre-Ashgillian (Katian-Hirnantian) assemblage of cryptospores
- Many organic remains remaining to be analysed
- No trilete spores

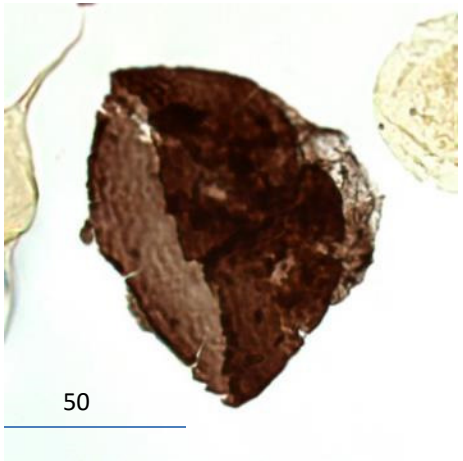
AN ACROBATIC HYPOTHESIS
BURNED PALYNOMORPHS AFTER A WILDFIRE?





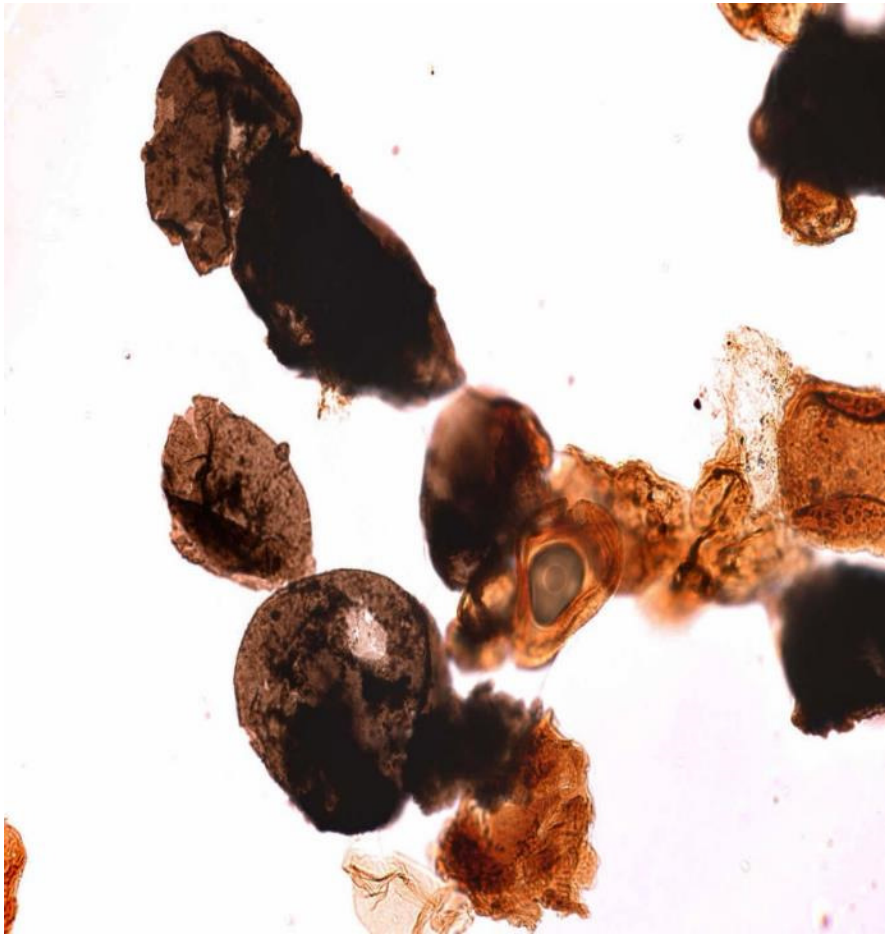






BURNED PALYNOMORPHS AFTER A WILDFIRE?

- Grey to brown in color
- Black parts looking like a crust
- The changing of color from grey to black is abrupt not progressive as in coalified palynomorphs
- Present in several samples but specially abundant in one of them



MAJOR CONCLUSIONS

Acritarchs :

- **Dapingian/Darriwilian assemblages from the transition Saq/Qasim are moderately diversified. The age remains to be precised**
- **The *Veryhachium* abundance spikes in the uppermost Saq Formation and good representativity of the genus in the base of Qasim Fm., is an indication of environmental or climatic deterioration as the presence of sea-ice conditions**

Problematic microfossils : need of complementary study using soft processes of dissolution on fresh material

Development of primitive vegetation:

- **First globally significant evidence of embryophytes colonizing habitats : « a pivotal time in the history of the planet »**
- **Did they have drawn down enough atmospheric carbon dioxide, in conjunction to paleogeographical changes and high frequency eustatic sea-level changes, to trigger the growth of ice sheets in the Middle Ordovician? (Lenton et al., 2012; Turner et al., 2012, Pohl et al., 2014).**