Commission Internationale de Microflore du Paleozoique

NEWSLETTER 40

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EDITORIAL

Newsletter 40 is a good opportunity for a major change in the administration and organisation of CIMP. This will hopefully be the last Newsletter to be issued to the membership from B.G.S. in Nottingham. During the recent "North Sea '90" Symposium held in Nottingham, the CIMP Executive met and elected Jacques Verniers of Brussels as the new Secretary General of CIMP. Jacques will take over the administration of the organisation from Pim Brugman who is leaving the Laboratory of Palaeobotany & Palynology in Utrecht to take up a post with Shell in The Hague. Although Pim was only in the post for a little over 2 years he carried out valuable work for CIMP, not least the computerisation of the mailing list and financial records. Yes, we have an up to date listing of who has paid and perhaps more importantly, who hasn't. On behalf of all the members I extend our thanks to Pim and wish him well in his new career.

Further changes can be expected in the near future. I hope in his first newsletter Jacques Verniers will be able to announce a new President for CIMP. Negotiations are delicately balanced but we hope the new President will be in office for the beginning of 1991.

This is a good opportunity for me to thank all the people over the last 13 years who have helped me with 23 or 24 issues of the Newsletter. Particular thanks are due to Janet Lines of B.G.S. and Pat Mellor of the University of Sheffield who have provided invaluable help in all aspects of its production. Any Newsletter is only as successful as the material it contains and for that I thank everyone who has submitted information.

One of the first tasks facing Jacques Verniers is the production of a membership director. We need to do that in the next 9 months but to do so need your submission. More than 150 people have replied already. The other 200-250 I realise want to but have lost the form. Well this time there is no excuse because we have reprinted it just for YOU. Please fill it in and send it to me. I'll forward them to Jacques. Do it now - it only takes a few minutes if you know your name and address.

Finally, over the last 13 years CIMP members have been fairly good in paying their annual subscriptions. It does not cost much, only £3 or 6 US dollars or the equivalent. Why not give the new Secretary a good start and pay yours today. Pay for 2 or 3 years - it will save you money in bank charges.

N.B. Now that we have a Belgian Secretary again I think we should stop victimising Belgian palynologists!! For the last 10 years they have paid twice as much as anyone else due to an administrative error. From 1990 onwards we will adjust their rate to 175 Belgian francs. We are, of course, most grateful for their outstanding contribution to our limited resources in the past.

Bernard Owens

International symposium to celebrate 25 years of palynology in the North Sea Basin

Nottingham, England
April 1990

BIOSTRATIGRAPHY RESEARCH GROUP, BRITISH GEOLOGICAL SURVEY
COMMISSION INTERNATIONALE DE MICROFLORE DU PALEOZOIQUE

ABSTRACTS

LAND-DERIVED PALYNOMORPHS FROM THE UPPER FISH-BEARING HORIZONS OF THE SILURIAN INLIERS OF THE MIDLAND VALLEY OF SCOTLAND

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The Silurian inliers of the Midland Valley of Scotland all have similar sedimentary sequences. The successions commence with turbiditic sandstones, siltstones and shales which are succeeded by highly fossiliferous sandstones and siltstones and terminate with beds of red-bed facies. This has been interpreted as a regression from deep-water to shallow-water marine conditions with the youngest strata, which contain the fish beds, deposited in a non-marine fluviatile environment. Evidence from graptolites and shelly faunas indicates and Upper Llandovery age for the marine strata. However, limited evidence has resulted in various age determinations for the overlying terrestrial strata.

Preliminary palynological investigation has recovered well preserved palynomorphs from the Pentland Hills, Hagshaw Hills and Lesmahagow inliers. The assemblages from the upper fish-bearing horizons are all essentially the same. They consist of cryptospores, miospores, banded and unbanded tubular structures, plant cuticle, "leiospheres" and the problematic, possibly freshwater, "acritarch" Moyeria. The cryptospores include laevigate alete spores, their related dyads, and various forms of permanent tetrad. The miospores are all laevigate and trilete spores of the genus Ambitisporites and Archaeozonotriletes.

The "fish bed" assemblage is typical of a Lower Wenlock age and this imposes an age constraint for the upper beds of the inliers. The dominance of land-derived palynomorphs suggests that the sediments were deposited in a marginal non-marine environment, possibly a lagoon or lake. The vegetation probably thrived at the water margins.

ASPECTS OF THE MICROPALAEONTOLOGY OF THE DEVONIAN OF NORTH DEVON

Richard Knight, Southampton University.

An integrated micropalaeontological investigation has been made of the Devonian sediments of north Devon, Southwest England. The sequence comprises a continuum of interdigitated marine and non-marine facies, of Greenschist metamorphic grade. Of this succession, the Lynton Formation, Hangman Sandstone Group, Ilfracombe Slates and Morte Slates have previously been considered impoverished of fossils. Regional geological understanding has been further impaired by local structural complexity and sedimentological monotony.

Despite the high rank, the indurated marine or marine influenced facies have proved fossiliferous. Sparse, icriodid-dominated conodont faunas were recovered from the calcareous sandstones of the Lynton Formation and the carbonates of the Ilfracombe Slates. Polygnathids and associated vicarious ramiform elements were documented exclusively from the Ilfracombe Slates. Initial problems of the oxidation and subsequent stability of opaque palynomorphs were overcome, and palynomorph assemblages were found to be virtually ubiquitous within the argillaceous marine sediments. The Total Organic Carbon content is markedly low (0.11-0.27%), irrespective of sedimentary facies, and on occasion the influence of reworking proved difficult to assess. The palynofloras are dominated by terrestrially-derived material, incorporating well preserved dispersed miospores and tetrads. Acritarchs, chitinozoa and scolecodonts are infrequent. In excess of 130 miospore taxa have been documented, in addition to 29 acritarch taxa, 11 chitinozoa variants, 33 pectiniform conodont taxa and a diverse suite of scolecodont and wood morphotypes.

Miospores have the greatest biostratigraphical utility, and where possible the conodonts provide corroborative evidence. The palynostratigraphy established for north Devon was compared with the zonational schemes of Richardson and McGregor (1986) and Streel *et al.*, (1987). The palynoflora of the Lynton Formation is dominated by acamerates, and the recovery of hystricospores and ancyrospores in conjunction with, *inter alia*, *Grandispora protea* (Naumova) Moreau-Benoit (1980) suggests an age no older than latest Emsian. The top of this unit and the overlying Hollowbrook Formation (of the Hangman Sandstone Group) are feasibly earliest Eifelian. Conodonts from an inland section (Watersmeet) of problematical stratigraphical position within the Lynton Formation are early Eifelian in aspect. The majority of the Hangman Sandstone Group has proven barren. The uppermost Rawns, Sherrycombe and Little Hangman Formations (of the Hangman Sandstone Group) yielded generally abundant, diverse miospore assemblages with a notable sparsity of bifurcates. A ?mid-late Eifelian age is interpreted. The inception of *Geminospora lemurata* (Balme) Playford (1983) within the lower part of the overlying Ilfracombe Slates suggests an earliest Givetian age. Conodont faunas from the Rillage (=Holey), Combe Martin beach and David's Stone Limestone Members are indicative of the early-mid *varcus* Zone. The entry of *Cristatisporites triangulatus* (Allen) McGregor & Camfield (1982) towards the top of the Combe Martin Slates suggests a late Givetian age, with the recovery of *Verrucosisporites bulliferus* (Taugourdeau-Lantz) Richardson & McGregor (1986) from the ?lower Kentisbury Slates indicative of the Frasnian. The miospore assemblages documented from the ?top of the Morte Slates are typical of the latest Frasnian and may feasibly be earliest Famennian.

In general the conodont faunas represent pectiniform lags. The predominance of the *Icriodus* plexus over narrow-platformed polygnathids tentatively suggests a shallow water marine environment. The probability of reworking within the sparse marine palynoflora limits a detailed biofacies study. However, there does appear to be a distinct dependency between scolecodont occurrence and ?more proximal, shallow marine facies.

An extensive geothermometric study was undertaken using organic thermal maturation indices (conodonts and vitrinites). A qualitative C.A.I of 5 is pervasive. Mean random (vitrinite) reflectivity in oil (*Rm*) varies between 4.0% and 7.8%, with no correlation between *Rm* and stratigraphical position. Coalification is interpreted as syn-orogenic, overprinting any pre-existing burial reflectance profile. Using the time independant conversion formulae of Barker and Pawlewicz (1986) the sediments have been heated regionally to temperatures in excess of 290°C.

Thomas Servais,

Acritarch evidence for a mid-Ordovician age of the Rigenée Formation (Brabant Massif, Belgium)

Acritarch assemblages from the Ordovician Rigenée Formation of the Brabant Massif are illustrated. Trispinose forms (Veryhachium, Frankea Arkonia, ...) dominate the poor preserved material. The size-range of the acritarchs is restricted (maximum diameter 20-25 microns). The discontinous section of the outcrops provides samples with acritarchs indicating a succession of species appearing between the early and the upper Llanvirn. Several new taxa are illustrated, as well as taxa not previously recorded in Belgium. Similarities exist with assemblages described in East-Germany, France, Czechoslovakia, ... but particularly with British material.

Thomas Servais,

The excess in the taxa : an example : the Ordovician Acritarchs

The acritarchs appear in the Upper Precambrian, flourish and diversify in the Early Paleozoic and attend their greatest diversity during Ordovician and Silurian times.
More than 400 publications, thesis and abstracts deal with acritarchs of Ordovician rocks.
Today, we count more than 900 species distributed in more than 160 genera in this period. The genera with the greatest number of species are Baltisphaeridium, Acanthodiacrodium, Veryhachium, Micrhystridium. A lot of other genera are monospecific . . .
Different reasons (general reasons in all systematic work in palynology ; specific reasons concerning the Ordovician acritarchs) lead to troubles in the systematics of Ordovician acritarchs which make an overvieuw very difficult and an new synthesis absolutely necessary.

HYDROCARBON SOURCE POTENTIAL OF THE LOWER PALAEOZOIC OF WALES AND THE WELSH BORDERLANDS.

Paul M. Tricker.

Department Of Geology.
Southampton University.

Chitinozoan reflectivity (Chit R_o) is an innovative technique to assess thermal maturation in Lower Palaeozoic sediments where the established means of rank determination, vitrinite reflectivity (Vit R_o), is rendered inappropriate by the absence of the vitrinite maceral. Analysis of samples containing both chitinozoa and vitrinte allow direct calibration between Chit R_o and Vit R_o. Where Lower Palaeozoic maturity values are quoted in the literature they are often ambiguous and/or vague. Chit R_o allows direct comparison with the established maturation scale.

A total of 550 samples have been examined from Wales and the Welsh Borderlands to assess maturity, amount and type of organic matter present.

Chit Ro, spore colour and fluorescence have been utilised to assess the maturity the Lower Palaeozoic sediments. Maturity values in the basin (Chit $R_{o\ mean}$ range 2 to 7 % equivalent to Vit $R_{o\ mean}$ range of 1.5 to 5 %). Spore colour is TAI >3.5 (Black). Chit $R_{o\ mean}$ values from the Borderlands are lower (range 0.5 to 1.1 % equivalent $R_{o\ mean}$ range of 0.4 to 0.9 %). Spores range from TAI 2.0 (Amber) to TAI 2.5 (Reddish brown). Results indicate maturity in basin and the shelf to be overmature and mature respectively. These findings are corroborated by fluorescence.

Total Organic Carbon (TOC) values for shelf sediments are low, under 1 % in general. Higher TOC values are found in basinal sediments, particularly of Ordovician age.

Kerogen types identified include amorphous organic matter (AOM), inertinite, vitrinite, exinite, and organoclasts (chitinozoa, acritarchs, scolecodonts and graptolites). Distribution of kerogen types is variable.

AOM is rich in basinal Ordovician samples and poor in the Silurian. Carbonates possess abundant inertinite material. Exinites, chitinozoa, acritarchs, scolecodonts and graptolites occur in variable quantities and are discovered in a variety of lithologies and environments.

A source evaluation for the Lower Palaeozoic Welsh Basin and Borderlands is concluded on the basis of the findings; shelf areas possess thermal maturities which are favourable but low quantity and poor quality of available kerogen mean the source rock potential is poor. Basinal kerogen is now overmature but occurs in higher quantity and quality.

D.McLEAN

Industrial Palynological Unit
Centre For Palynological Studies
University of Sheffield

Unusual Palynological Assemblages From The Greenmoor Rock (Westphalian A) of Sheffield: Implications for Provenance

Palynological assemblages from siltstone-fine sandstone lithologies within the Westphalian A Greenmoor Rock contain significant numbers of reworked palynomorphs. These indicate that the Greenmoor Rock is derived, at least partly, from Lower Carboniferous (Visean) and Devonian sediments. Likely source areas for these sediments are discussed.

DEVONIAN PALYNOSTRATIGRAPHY OF THE ORCADIAN BASIN, SCOTLAND.

Marshall, John., Department of Geology, The University, SOUTHAMPTON, SO9 5NH, U.K.

It is exactly twenty five years since the last significant contributions were made to the overall palynostratigraphy of the Orcadian Basin. Several palynological contributions have been made since this time but the recognition that a secure lithostratigraphic framework is generally lacking has precluded any possibility of achieving any basin-wide palynostratigraphy. This situation has been rectified through the combined sedimentological and stratigraphic studies of T.R.Astin, G.A. Blackbourn and D.A. Rogers who have produced measured and correlated sections through several parts of the basin leading in the case of Orkney (Astin, T.R. 1990. Journal of the Geological Society 148 (1)) to a major revision with fundamental implications for our understanding of the basin. The author is currently engaged on parallel palynological studies from these revised sections namely: Foula (west of Shetland), Tarbat (Easter Ross), Orkney (Mainland, Rousay, Eday, Sanday and South Ronaldsay) and Caithness (John O'Groats). Interim range charts are presented for these sections to show the potential for palynological sub-division in the Orcadian Basin. A significant number of taxa have been recognised previously unknown from the Orcadian Basin but of stratigraphical significance in areas such as Arctic Canada, Western Europe and the Russian Platform. Parallel and integrated studies on the hydrocarbon source rock potential have been carried out, latterly by S.J. Hillier (Southampton)

Palynological Investigations of the Toe Head Formation in Southwest County Cork, Ireland.

Micheal O'Liathain, University College Cork, Ireland

The transitional sequence which separates the Old Red Sandstone from the first major marine deposits in the South Munster Basin of Ireland is a distinctive unit called the Toe Head Formation.

Palynological investigations of this formation at South Dunmanus Bay, Toe Head, Cahermore, Glengarriff, North Beara and Bantry have revealed a clearer picture of the variation in the age of the formation. Preliminary data indicates a Upper Devonian LL-LN age, with the top of the formation being diachronous.

The high degree of carbonisation of the organic residues has meant that both standard and unorthodox methods of oxidisation were utilised - these are described. Most of the samples yielded a rich and diverse miospore assemblage, and the majority of the characteristic species have been identified. However, the zonal species *Retispora lepidophyta* has been found to be extremely rare - even absent - in a few samples from the lower part of the formation at South Dunmanus Bay and Toe Head.

HIGH RESOLUTION PALYNOSTRATIGRAPHY IN THE DEVONIAN AND CARBONIFEROUS SYSTEMS.

Streel, Maurice, University of Liège, Liège, Belgium.
Loboziak, Stanislas, Science de la Terre, Universite des Sciences et Techniques de Lille, Villeneuve d'Ascq, France.

High resolution palynostratigraphy depends, in the first place, on the accuracy of the taxon delineation, on the establishment of lineage links between taxa (example in Streel and Traverse, 1978) and /or on careful quantification of first (or last) occurrence events (example in Bouckaert et al., 1978). Amongst miospores, these events are obviously more reliable if studied in nearshore marine sediments where miospores are mixed and represent a wider hinterland than in continental sediments (Hopping, 1967).

It also depends however on an accurate knowledge of the stratigraphic relation between the palynomorph event and the marine faunas and floras utilised to provide biostratigraphical control.
Combined biostratigraphies even between palynomorphs like miospores versus acritarchs versus chitinozoans give better results than single group-based biostratigraphy. Often it gives spectacular results emphasizing that time is not always represented by rocks (Boumendjel et al., 1988).

Too many of these stratigraphic relations are dependent on lithological versus "Gamma-Ray/Neutron" correlations which often imply an undemonstrated continuity of deposition or/and time-equivalent lithostratigraphy. Lithostratigraphy may be shown to be diachronous even on short distances (Steemans, 1989). Examples of poor faunally-controlled miospore-zonations and their consequences on the credibility of palynology are analysed in the lower-middle Devonian layer-cake stratigraphy of Massa (1988) in Libya (Streel et al.,in press), in the delusive "major break" in spore development (Richardson & McGregor, 1986) invoked by McLaren (1988) at the Frasnian/Famennian boundary, in the alleged upper Famennian divergence between faunas and miospores from New York State and Belgium (Richardson & Ahmed, 1988), in the so-called earlier first occurrence of Retispora lepidophyta in Hunan, China (fig. 1) and Timan-Petchora, USSR (McGregor & McCutcheon, 1988), in the so-called belated first occurrence of Lycospora in northern Africa (Massa et al.,1980) (fig. 2).

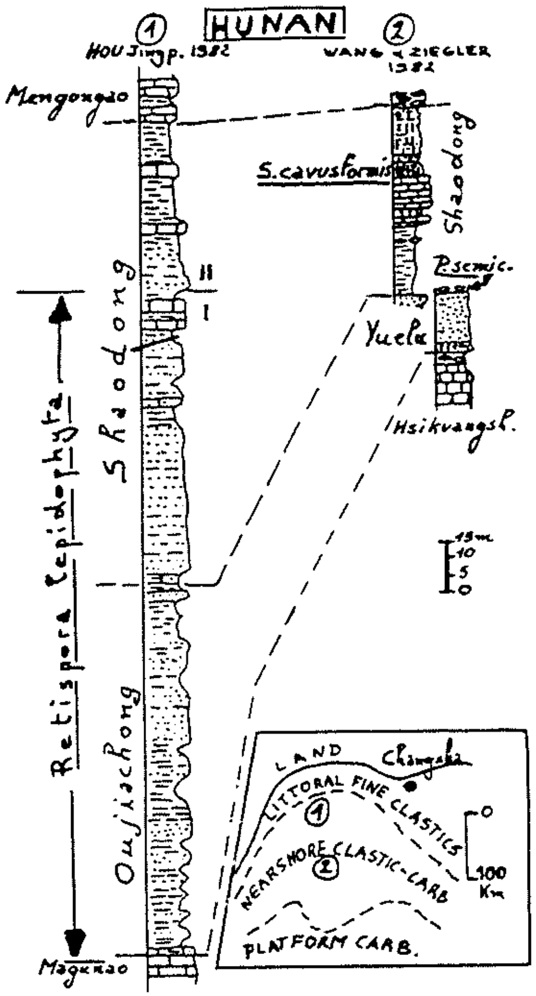


Fig.1

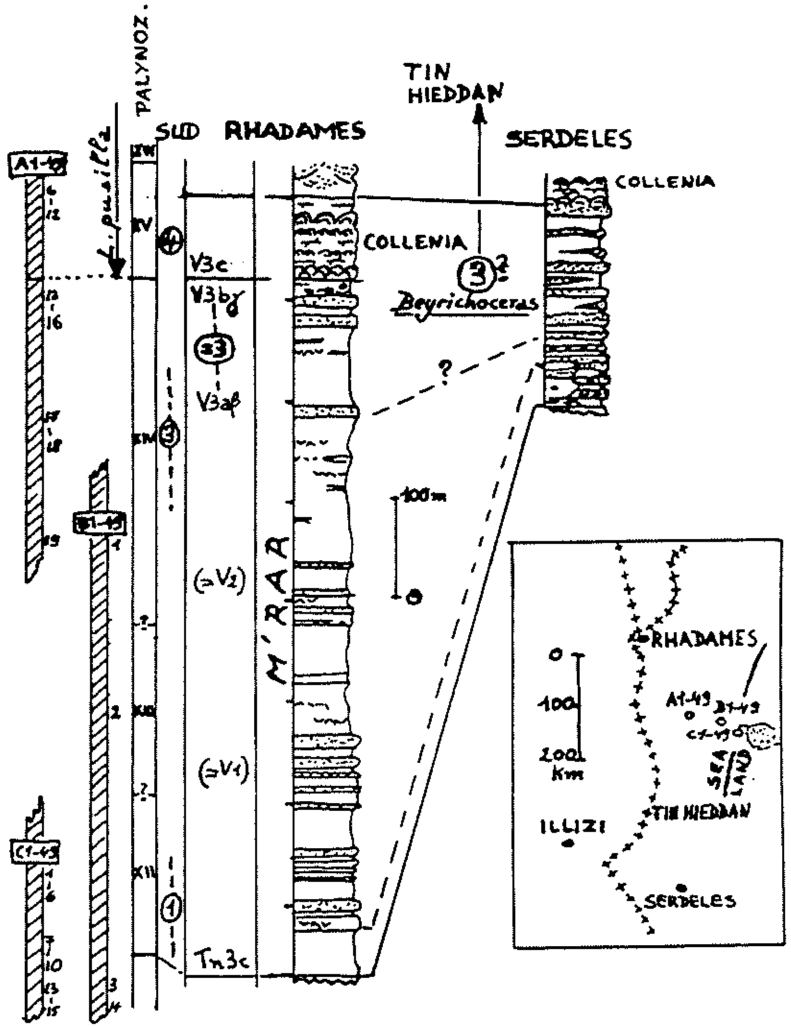


Fig.2

BIOSTRATIGRAPHY OF THE "GREY" INTERVAL FROM THE PERMIAN TO THE TRIASSIC IN EAST GREENLAND

Piasecki, Stefan: Geological Survey of Greenland, Øster Voldgade 10, DK-1350 København K, Danmark

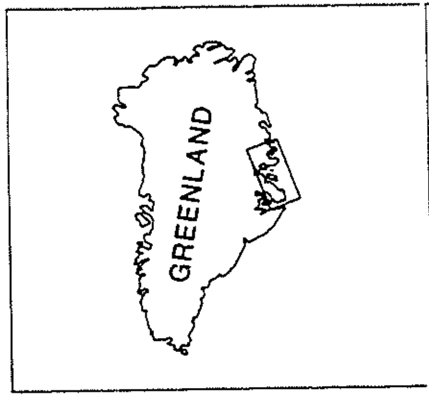
The marine fauna of the Upper Permian - Lower Triassic sequence in East Greenland has been studied with great enthusiasm since the early 1900 when the first fossils were brought back. Brachiopods and ammonites were the main groups for the biostratigraphical dating and correlation of the the sequence. Studies of reworking versus survival of typical Permian fauna into the presumed earliest Triassic combined with the precise definition of the P/T boundary placed the Kap Stosch locality among the important boundary localities of the world because of the detailed stratigraphical work on ammonites, conodonts and sporomorphs. The data suggest clearly a significant hiatus from latest Permian to earliest Triassic followed by a marine transgression which stepwise onlap the basin margins; a situation very similar to most other exposed boundary sequences.

Presently, hydrocarbon exploration for Upper Permian prospects in Jameson Land has renewed the interest for this part of the sequence and a much more complete sequence was found here in the southern part of the basin. The P/T boundary was biostratigraphically pin-pointed in one section and appeared coincident with the lithological boundary between the Upper Permian Schuchert Dal Formation and the Lower Triassic Wordie Creek Formation. A 2 meter section was sampled as detailed as possible across the boundary (40 samples of 5 cm each) and the samples were palynologically analysed.

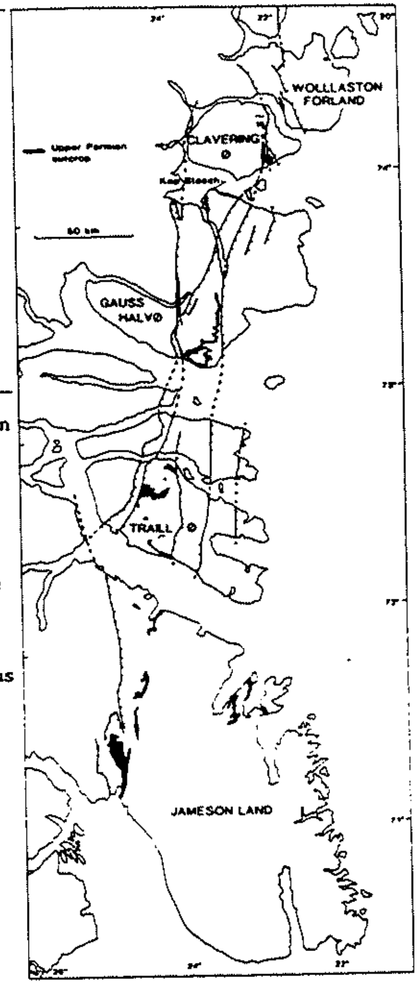
The palyno-flora shows a condensed sequence across the lithological boundary. The otherwise monotonous Upper Permian flora changes gradually in the last 1.25 meter. Trilete spores appear for the first time followed by Tympanicysta stoschiana and several cavate, trilete spores typical for the earliest Triassic; Lundbladispora, Densoisporites etc. Many typical Upper Permian species disappear within this section but may occur sporadically higher in the sequence. In contrast Crustaesporites globosus and Striatoabietites richteri become more abundant.

Marine flora is generally sparse as in most of the Permo-Triassic sequence but strongly degraded Tasmanites occur very frequently within a 15 cm thick interval in association with the first occurrence of several of the presumed Triassic species. Also acritarchs appear more frequent in this interval.

The precise position of the boundary is debatable due to lack of comparable material but the boundary must be coincident with major floral and faunal replacements. There is no doubt that the first appearance of trilete spores in the bisaccate pollen flora of Upper Permian predict the following more drastic changes in the flora at the Tasmanites-rich interval. This is succeeded by an assemblage of trilete spores which is replaced by a bisaccate pollen assemblage through an interval of rapid variations from sample to sample.



The Permian-Triassic boundary can therefore be provisionally identified within the 15 cm thick interval, approximately where most "Triassic" spores appear for the first time together with T. stoschiana and with a bloom of Tasmanites. This is 55 cm below the lithological boundary but similar displacements of the litho- and biostratigraphy have been reported from Peace River, Alberta (Jansonius 1962) and from Dalongkou, Xinjiang (Qu Lifan & Wang Zhi 1986). The earlist Triassic floras of these three localities have many common species and a more detailed correlation appears possible. This is not the case for the latest Permian flora though a somewhat similar sub-Angarian palaeogeographic position characterise the three localities, as far as their affiliation to the flora provinces are established.



THE USE OF QUANTITATIVE PALYNOFACIES STUDIES FOR PALAEOENVIRONMENTAL ANALYSIS AND CORRELATION OF WESTPHALIAN SEDIMENTS

Highton, Philip., Geology Department, Royal Holloway and Bedford New College, University of London, Egham, Surrey, England.

The study of palynofacies has been recognised as a valuable exploration tool, not just for local facies correlation but also for palaeoenvironmental analysis, to assess the hydrocarbon source potential of a rock, and to study the facies dependence of key zonal palynomorph taxa. Previous studies however have tended to concentrate on Mesozoic and Cenozoic sequences and have commonly been 'semi-quantitative', with abundances of different particle types being visually estimated rather than measured. Such studies therefore are prone to considerable operator error and prevent the full potential of palynofacies studies being realised. Image analysis equipment is of considerable use as a measuring tool to provide 'fully-quantitative' data and therefore in overcoming this problem.

Westphalian palynofacies are being studied from three different aspects:

1) Organic particle size analysis.

2) Kerogen analysis.

3) Miospore counting.

Each of these methods gives slightly different information about the rock being studied. Emphasis is placed on organic particle size analysis as the quantitative approach described has been found to be especially useful in distinguishing different depositional environments. For the fully quantitative approach to be practical, careful sample preparation procedures have to be followed. After being disturbed or diluted, samples are left for at least 24 hours to settle, during the preparation of slides for organic particle size and kerogen analysis, no oxidation or sieving of residues is used. This prevents the preferential loss of some kerogen types and size ranges.

A number of onshore localities have been investigated in a pilot study in order to develop study methods and to recognise relationships. The Westphalian B rocks of Swillington Quarry (Leeds, Yorkshire, England) have been especially useful. Here thirty metres of sediments are exposed showing a variety of different facies. In addition to the quarry section a borehole exists a few hundred metres from the quarry, allowing the lateral continuity of palynofacies to be studied.

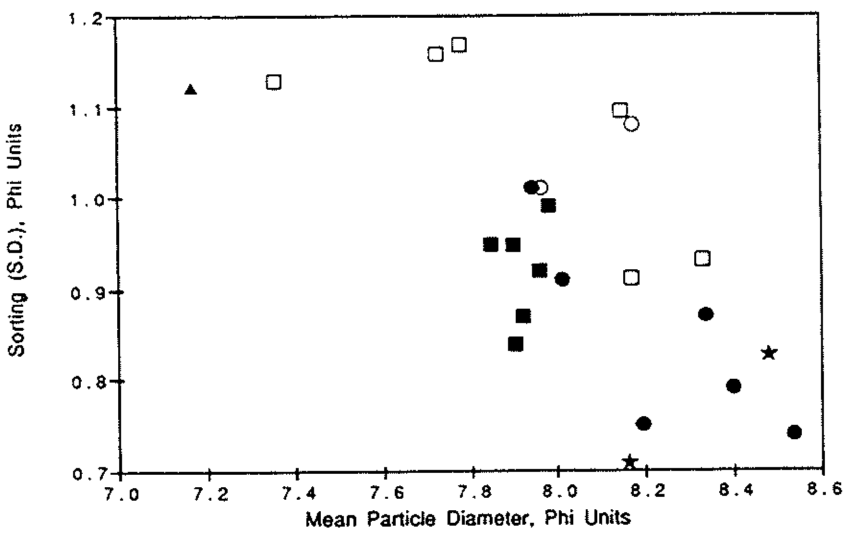
An 'Acorn Archimedes' computer based image analysis system is being used to measure various parameters and the data for many thousand particles are stored on disc. Attached to the computer are: a video camera which sends the image from the microscope to the computer, and a digitising tablet and mouse, both of which can be used to control the movement of the cursor on the screen. The image from the video camera is stored in digital form in a digitising board within the computer. The level of detection sensitivity, or 'threshold' is set by the user who decides when the computer is detecting the true edges of the particles. The particles are then identified by the operator, the cursor is moved close to the particle and the computer then detects the edge of the particle and measures various parameters. This data can then be stored on magnetic disc if required, and displayed graphically with basic statistics also calculated. The system also has basic image editing facilities which enable the manual separation of touching or overlapping particles. The software for this system has been written specifically for my application by Dr. A. Brain of Kings College, London University.

ORGANIC PARTICLE SIZE ANALYSIS

The size of organic particles in a sediment is not solely related to the grainsize of the host sediment; the origin of the particles, transport history and conditions at the site of deposition are also important. Studying organic particle size can therefore be of use in distinguishing between different depositional environments, even when lithologies are the same.

'Black Opaque Blocky' organic particles (or 'Coaly' and 'Black Wood' of others) are used for this analysis as they form a reasonably discrete group which are abundant in most Coal Measure sediments, they also have a high contrast with the light background making them ideal for 'edge detection' using image analysis. The measure used to describe particle size is the 'Nominal Projection Diameter' (NPD), this is the diameter of a circle having the same surface area as the projection of the particle being viewed. Two hundred particles are measured for each sample. This analysis usually takes up to an hour. Once the data is stored on disc particle size histograms can be constructed and basic statistics used to describe the describe the particle size distributions. These statistics include: mean size, standard deviation (sorting), skewness, kurtosis and maximum particle size measured during an analysis. Each of these variables can be of help in distinguishing different depositional environments. The figure below shows a scatter diagram of mean particle diameter (phi units) against sorting, standard deviation (phi units) for Westphalian mudstone samples.

Organic Particle Size/Sorting Results for Westphalian Mudstones from Yorkshire, U.K..



Interpreted Facies: ▲Mire/Floodplain, □Floodplain with abundant plant fragments, ■ Floodplain with abundant rootlets, ○Marginal lacustrine, ●Lacustrine, ★Marine band.

Samples from different interpreted depositional environments are shown by different symbols. The position of a point on the diagonal (lower right to top left) reflects the source and transport history of the organic matter as well as the conditions at the site of deposition. Generally samples to the bottom right of the diagram have predominantly transported organic matter deposited in low energy conditions whilst samples to the top left have predominantly locally derived organic matter deposited without appreciable current activity. A significant amount of overlap is seen but the other particle size distribution descriptors can also be used to help identify samples from different depositional environments. This method can also be used to study palynofacies from sands and silts and significant differences have been seen between different depositional environments.

Organic particle size analysis is a palynofacies technique which is particularly useful for the study of Coal Measure sediments. The technique can probably also be applied to the study of palynofacies from a wide variety of different facies of different ages.

KEROGEN ANALYSIS

The classification of organic particles on their characteristics as seen under transmitted white light and incident U.V. light is the most subjective part of a palynofacies study. Often distinctions between different particle types are unclear, this is often due to the transition in appearance between different types of organic matter. A kerogen classification scheme will be presented; this scheme doesn't differ significantly from other classification schemes except in the naming of the different kerogen types which is purely descriptive (for example 'Black Opaque Blocky') rather than interpretative (for example 'Coaly', 'Black Wood'). The proportion of different particles is measured as percentage of surface area coverage, rather than the percentage number of particles. Image analysis equipment is used to measure the surface area of particles, after identification by the user. For practical purposes, two hundred particles are measured for each sample, which takes up to an hour.

Consistent differences have been found between different depositional environments, but often considerable variation in kerogen assemblages is seen, even in what appear to be similar depositional environments. Although undoubtably of some use it is felt that too much emphasis has probably been placed on the study of kerogen in palynofacies studies in the past.

MIOSPORE COUNTING

The abundance of miospore taxa recovered from a sample can be due to a number of factors, including: 1) the plant types at the site of deposition and the relative proportion of miospores produced by these plants, 2) dispersal ranges for different miospore types, 3) size and shape sorting prior to deposition, and 4) the preservation potential of different spores within the sediment at the site of deposition.

An atlas of miospore taxa is being compiled, to date it consists of over 140 different forms and it is anticipated many more will be found before the study is complete. Counting has been done for a limited number of samples at a generic level, it is anticipated that this will continue, although the prevalence of distinctive miospore species will be recorded. Significant differences have been noticed between different facies units and characteristic assemblages have been noted laterally in the same facies unit.

In addition to the above methods an additional method, that of Fourier analysis of organic particle shape has been tried. No significant differences appear to occur in particle shape between different facies units although investigation is still continuing. The value of palynofacies data is in the integration of the methods with others during interpretation, especially organic geochemical and sedimentological methods. The techniques described are currently being used to study Westphalian sediments from the Southern North Sea, U.K..

PALYNOSTRATIGRAPHY OF THE TOURNAISIAN (HASTARIAN) ROCKS IN THE TYPE REGION OF BELGIUM

HIGGS, Kenneth , Department of Geology, University College, Cork ,Ireland

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The Tournaisian rocks of Belgium are divided chronostratgraphically into a lower Hastarian Stage and an upper Ivorian Stage. The Hastarian is essentially a mixed succession of marine clastics and carbonates ,which in terms of the lithostratigraphical notation comprises the Tn1 and Tn2 intervals. The Ivorian is composed of a thick sequence of marine carbonates which belong to the Tn3 interval.
The present study describes the first palynostratigraphy of the Hastarian Stage in Belgium. A succession of miospore assemblages have been obtained from seven boreholes located in the western part of the Namur Basin, just north of Tournai. The miospore assemblages recorded are assigned to four biozones of the miospore zonation scheme recently established for the Tournaisian rocks of Southern Ireland. However, detailed sampling in the lower part of the succession has allowed a finer resolution of the *Kraeuselisporites hibernicus - Umbonatisporites distinctus*(HD) Biozone, based on the staggered appearence of the two zonal species.
The miospore assemblages are correlated with independent conodont biostratigraphy from the boreholes. For instance, this shows that the VI-HD Biozonal boundary occurs within the *Siphonodella sandbergi* Biozone ,which is biostratigraphically lower than had been previously suggested. Microplankton and scolecodonts occur irregularly in the Hastarian succession and their distribution is discussed.

QUANTITATIVE SPORE COLOUR

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During the past twenty five years the study of petroleum source rocks has become routine in the exploration for hydrocarbons. Palynology has contributed to this through methods such as visual kerogen typing and spore colour determination. Palynological based methods although widely used have never achieved the success of more 'quantitative' techniques such as vitrinite reflectivity and organic geochemistry. It is believed that this contribution marks a revolution in our measurement and concept of spore colour. It also demonstrates how it can achieve results comparable and complementary to these other methods which will for certain applications be superior.

Spore colour although a valuable method for determining thermal maturity level has never achieved the status of vitrinite reflectivity on account of its subjectivity and limited resolution. Quantification of this measurement as described here enables a proper assessment of the method to provide an invaluable complementary maturity tool to vitrinite with a number of advantages. These include its chemical composition being comparable to that of amorphous organic matter and thus with a closer kinetic behaviour to hydrocarbon source rocks than achievable with the vitrinite maceral. Spores also show more change than vitrinite at low maturity levels and in addition some elements of any palynological assemblage are stratigraphically unique and thus identifiable if sedimentologically reworked and present as cavings in well cuttings samples.

This goal of quantification has been achieved using transmitted light microspectrophotometry of individual spores with the generated spectrum converted into the internationally defined C.I.E. colour system. This allows us to express spore colour changes in terms of x, y and L in the colour solid. The chromaticity co-ordinates x and y relate to the mix of colours present in terms of the primary colours whilst L (luminance) is the transmittance at 546nm. The equipment used is a standard Zeiss UMSP 50 microscope linked to an IBM PC for data acquisition and generation of C.I.E. co-ordinates. All measurements were made in C.I.E. standard Illuminant A. The computer V.D.U. displays a spreadsheet showing results from individual spores together with a graphical plot of their location on an enlarged section of the C.I.E. chromaticity chart which allows a quick visual assessment of their thermal maturation. Calibration shows this system to give quantified and replicable colour measurement.

Results from a large number of fossil pollen and spores has defined a thermal maturity pathway in C.I.E. space with the form of an arcuate curve; the lowest maturities occurring close to the position of a transparent object and terminating at the lower pole of the colour solid. The initial form of the curve is a gentle progression of colour change on a well defined path until at chromaticity co-ordinates of (0.52, 0.40; x, y) and at a vitrinite reflectivity of 0.6% a series of extremely rapid colour changes occur through orange to brown associated with a sharp cusp in the spore colour maturation path and a greatly increased variation in spore colour in a single sample. This colour range can encompasses the range yellow to brown in an individual spore species. At chromaticity co-ordinates (0.50, 0.37; x, y; vitrinite reflectivity approximately 1.0-1.2%) the curve becomes again well defined although less easily calibrated with vitrinite reflectivity and rapidly moves to its end-point at (0.43, 0.38; x, y) with little change in y value. Colour measurement at this point is technically more difficult on account of the low transmittance of the spore walls and in practise achieves little further resolution as the colour changes have largely ceased. A cross plot of x and L demonstrate this pronounced cusp which indicates the onset of petroleum generation and is characterised by a reversal of x value and a marked reduction in the rate of change of L. All these colour changes are consistent with the established jumps in exinite reflectivity at equivalent vitrinite reflectivities of 0.6 and 1.2%. The vitrinite reflectivity and L cross-plot also shows this break point in colour change associated with petroleum generation.

These results have been corroborated using colour measurements on a series of artificially generated spore colours produced through heating Lycopodium spores at a series of temperatures. These show a similar curved distribution with a wider pitch, together with the rapid change in spore colour around the cusp. These samples show a very rapid transition from yellow through orange to brown over a laboratory temperature range of about 210-220 C with individual samples again showing wide colour variation. The portion of the curve from brown to black also takes place across a short (200-250 C) laboratory temperature interval. This rapid collapse of the spore wall with its change in colour is parallelled by changes in the atomic H/C and O/C ratios, spore fluorescence and exinite reflectivity.

A number of existing spore colour scales have been investigated using quantitative colour measurement. The Munsell colour chip scale produced under the auspices of Phillips Petroleum was measured in reflected light and compared with the maturation path determined from geological materials which showed it to be only an approximate representation of real spore colours. The Robertson Group spore colour index determined from single mount representative spores and pollen generally follows the maturity pathway. However many adjacent points on the scale represent changes in colour richness perpendicular to the general trend rather than along it.

In reality the spore colour scale shows the following phases:

Yellows	immature
Orange to Brown	petroleum generation
Dark Brown to Black	post-mature

Most colour change occurs over the mature interval; the range of yellow colours shows the most linear change but these colours are difficult to visually estimate.

These results from the quantitative colour measurement of both the geological and laboratory material allows us to draw the following conclusions:

1) Spore colour measurements provide an accurate and well defined maturity scale in immature sediments. Outside this range vitrinite reflectivity is superior for studies of burial modelling.

2) At the onset of oil generation spore colours show a marked series of colour changes allowing easy definition of this point. Vitrinite should be used for measuring depth of burial over this interval but colour changes to establish the limits of hydrocarbon generation.

3) This rapid change in spore colour ceases with the end of oil generation. It thus provides an excellent marker for the cessation of oil generation.

4) Spore colour measurement in the oil window is not particularly reliable. Large numbers of individuals need to be measured to achieve consistent results with a colour variation such that elements at the extremities of the colour range could easily be attributed to reworking and caving.

5) Spore colour measurements show a strong correlation with other physical and chemical properties of the spore exine. It shows that spore colour has a secure basis as a reliable indicator of petroleum generation from the chemically similar amorphous organic matter. Both the geological and experimentally thermally spores indicate that petroleum generation occurs over a short temperature interval.

6) Spore colour measurement provides a reliable method of calibrating and checking qualitative spore colour standards.

7) Calibration of spore colour and vitrinite reflectivity should not be assumed. This greatly increased sophistication in spore colour measurement allows realistic comparison of the two methods, their complementary use and will allow us to compare their different kinetic behaviour.

PALYNOFACIES ANALYSIS IN THE LATE CARBONIFEROUS, AND ITS APPLICATION IN RESERVOIR AND SOURCE ROCK STUDIES.

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The Late Carboniferous Coal Measures of Europe and North America offer good potential for palynofacies analysis. Palynomorph and kerogen recovery from small quantities of available rock in drill cuttings, is generally very high throughout the Westphalian, from almost all lithologies analysed. Palynomorph assemblage diagrams are therefore normally readily obtainable from most Westphalian sections. Palynofacies analysis becomes more refined with better quality samples in cores, but cuttings still allow broad palaeoenvironmental conclusions to be drawn on stratigraphic intervals that may include several lithotypes.

Palynofacies studies in the Mesozoic and Tertiary almost invariably involve recognition of the subtle interplay of marine microplankton, freshwater algae and terrestrial spores and pollen in distinguishing a whole range of coastal plain/marginal marine depositional regimes. The Westphalian of the Euramerican pantropical coal belt was a unique time of non-marine sedimentation. Vast areas of lowland existed along the fringes northern of Gondwana and southern Laurussia. These continental plates were rapidly approaching one another close to the equator prior to their collision and the formation of Pangea in the Permian. With the exception of short-lived marine bands that yield rare acritarchs, palynofacies studies in the Westphalian involve only freshwater spores and saccates. Most of the principle spore genera have been equated with known Carboniferous plant families, and alot of information is now available on the palaeoecology of these plants from coal ball, miospore and coal petrographic studies. Palaeoecological information on the plants and their spores allow the principle palynofacies types to be modelled within a palaeoenvironmental framework.

The palynofloras of the Late Carboniferous are dominated by four miospore types. These are *Lycospora* spp., *Densosporites* spp., *Calamospora* spp. and *Crassispora kosankei*. Assemblages characteric of greater alluvial influence, flood events and channel avulsion with greater clastic input are typified by a dominance of *Crassispora kosankei*. Channel sands that form reservoirs and migration conduits are associated with this kind of assemblage. Low energy depositional environments with waterlogging and anoxia within the substrate, are dominated by *Lycospora* spp. Assemblages of this kind, where persistently developed are unlikely to be associated with major reservoir rocks. Swamp conditions with a dominance of *Lycospora* spp. tend to be found towards the centre of basins where subsidence was more continuous. Abundant coal seams and carbonaceous mudstones in such a setting provide good source rocks for both oil and gas. An abundance of *Densosporites* spp. is associated with peatswamps laid down under more stable conditions of lesser subsidence near basin edges where thicker coal seams form.

Some assemblages are rich in the lacustrine alga *Botryococcus*. These, and *Calamospora* spp. dominated assemblages that are lake shore in origin are typically associated with well developed anoxia within sediment and possibly also the water column, and are of greater source rock potential.

Discrimination of palynofacies types within a stratigraphic sequence and an understanding of the palaeoenvironment of such assemblages is of considerable use for correlative purposes.

Wolfgang Wille & Roger Neves Sheffield

Cenobial Algae from the Permo-Triassic of the North Sea

Two new forms of multicellular algae with an acid resistent organic wall have been found in samples of Late Permian and Early Triassic age in the northern North Sea. The number of cells is 8, 16 or 32; this is typical for cenobial algae (in contrast to colonial ones).

Form A has the cells in two parallel rows similar to some modern *Scenedesmus* species, form B shows a peculiar two-dimensional pattern, in which 4 or 8 cruciform groups of 4 cells each are arranged like a trellis. Both types look quite different, but a few irregular specimens are combinations of form A and form B indicating that they belong to the same species.

These fossil cenobia can be assigned to the order Chlorococcales of the class Chlorophyceae (Green Algae).

The two forms are quite frequent in the slides; the only other palynomorphs are pollen grains and spores, no acritarchs were seen. We assume a non-marine environment, which was probably hypersaline; brackish or freshwater conditions cannot be excluded, but seem less likely. The Late Triassic cenobial alga *Plaesiodictyon* occupied a similar ecological niche.

RECENT ADVANCES ON A BIOSTRATIGRAPHY WITH CHITINOZOA IN THE SILURIAN OF BELGIUM

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The poster shows the current knowledge on the biostratigraphy with Chitinozoa in the Brabant Massif. Chitinozoa proved to be very useful for stratigraphy and mapping, specially in the monotonous and thick Ordovician and Silurian sediments.

Chitinozoa were first studied in the Ordovician and Lower Llandovery of a few boreholes and from the Sennette valley (MARTIN, 1972, 1974; MARTIN & RICKARDS,1979). In the Mehaigne area eight biozones were found in the latest Llandoverian and Wenlockian (VERNIERS & RICKARDS, 1979; VERNIERS, 1981; VERNIERS, 1982). Current studies in the Ronquières area added an additional two zones in the early Gorstian (Ludlow), while in graptolite-dated boreholes of West-Flanders a refinement of most of the Llandovery was possible, with two other zones in the late Gorstian (Ludlow) were dated by correlation with Gotland, Baltic Sea.

The current knowledge permits us now to propose a provisional Chitinozoa biozonation for the Brabant Massif with a higher resolution in the Silurian than in the Ordovician. From basal Llandovery till halfway the Ludlow we can define 18 biozones, which approaches the number of graptolite zones in this same interval (25). More studies in the outcrop areas and boreholes will problably reveal more. A range-chart of selected species with short stratigraphical ranges is shown.

The Chitinozoa-biostratigraphy of the Silurian studied by other authors on Wales & Welsh Borderland (Brabant-Midlands-Welsh microcraton) (studies by K. DORNING), Scania, Gotland, Latvia and Estonia (Baltic Sea area) (studied by LAUFELD and by NESTOR), Armorican Massif (one of the northern Gondwana plates) (F. PARIS and co-workers), Bohemian Massif (microcontinent) (F. DUFCA, pers. comm.) shows a clear relationship of the Brabant Massif with the UK, the Baltic Sea area and the Bohemian Massif and much weaker with the Armorican Massif.

The proposed Chitinozoa biozonation in the Brabant Massif has thus the potential to be a standard for the deeper facies of the Silurian of NW & NE Europe, while the Baltic biozonations are indicative of the undeeper facies.

INTERNATIONAL CONFERENCE ON LATE PALAEOZOIC AND MESOZOIC FLORISTIC CHANGE

ORGANIZES:
JARDIN BOTANICO DE CORDOBA

16 – 20 April, 1990

WITH THE COLLABORATION OF:

Museo Nacional de Ciencias Naturales, Madrid

Universidade do Porto

ABSTRACTS

ON THE CURRENT STATUS OF *Sporangiostrobus* IN NORTH AMERICA

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Sporangiostrobus was first described from North American sediments by Chaloner in the late 1950's and early 1960's as compression specimens from Illinois and Ohio. Later, in 1970, *Sporangiostrobus* was found permineralized in Kansas and Iowa coal balls, with the better preserved specimens occurring in Kansas. These were described as *Sporangiostrobus kansanensis*, characterized by being bisporangiate with the sporangia aligned spirally, horizontally and vertically. The relatively massive cone axis was siphonostelic, exarch, with the xylem being exclusively primary. The sporangia were attached to an elongated pedicel, but ligules and laminae, if any, were not preserved. Microspores were of the densospore type, but highly variable, making assignment to a definite genus almost impossible. This wide range of variability, even within the same sporangium, was emphasized as a fallibility in densospore taxonomy. Megaspores were of the *Zonalesporites* type. Associated vegetative organs (leaves and stems) were tentatively assigned to *Sporangiostrobus*, but placed in separate taxa because of lack of attachment to the strobilus or each other. Still later (1977), isolated sporangia from an Iowa coal ball appeared to be aborted. Conceivably, these could be interpreted as basal transitional or apical sporangia. The determinate growth pattern typical of lycopods would seem to favor the latter interpretation.

Attention was drawn to the similarity among *Sporangiostrobus* and other massive lycopod cones, such as *Spencerites* and Pleuromeia and it was suggested that the parent plant of *Sporangiostrobus* could have had a similar morphology.

LOWER GONDWANA FLORAS OF INDIA

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The Lower Carboniferous flora, called the *Lepidodendropsis* - *Rhacopteris* flora is characterised by a fair amount of uniformity all over the world. However, during late Carboniferous times this uniformity was suddenly disturbed. While in the northern Laurasian regions Carboniferous plants continued to flourish undisturbed during the late Carboniferous, India and the southern regions of the globe underwent a widespread glaciation. The Indian glacial beds have so far failed to yield any mega- or microfossils and it is quite possible that the pre-existing vegetation could not survive under the intensely cold conditions which prevailed here at this time.

The earliest fossiliferous beds of the Permian in India closely overlie the glacial tillites. The paucity of fossil remains in these beds and their occurrence only at some places may indicate a gradual warming up of the climate and the recession of ice from places where the fossils have been reported. The fossils of the lowest beds of the Talchir "Stage" which overlie the glacial tillites must, therefore, include remains of the pioneers which followed the recession of ice. Among them are trilete miospores, which could belong to bryophytes or pteridophytes and trilete megaspores possibly belonging to some lycopsids. Megafossils include sphenopsid shoots and *Vertebraria*. Among leaf remains *Gangamopteris* and *Noeggerathiopsis* predominate over *Glossopteris*. Fructifications have been found and doubtful shoots of a conifer, *Paranocladus*, are also reported.

The beds of the Karbarbari "Stage" which follow upon the Talchir "Stage", show a fairly luxuriant flora which has left extensive deposits of coal. These beds yield a richer variety of micro- and megafossils. The spores called *Quadrisporites horridus* suggest the presence of hepatics of sphaerocarpaceous or ricciaceous affinity. A greater variety of trilete megaspores may indicate the presence of diverse heterosporous lycopsids. Megafossils include a fair variety of sphenopsid shoots and pteridophylls. Glossopterids become more diversified and conifer allies like *Buriadia*, possible ginkgophytes, and incertae sedis, are also present. In Kashmir, the beds of this stage show a remarkable admixture of Cathaysian and Euramerian forms with Gondwanan forms. They are important for determining the northern boundary of Gondwanaland.

No fossils exactly comparable with Lower Carboniferous elements are recognisable although lycopsid megaspores and *Botrychiopsis* could possibly contain the remains of some lingering elements of the previous flora.

The beds of the Damuda "Series" which follow the Karharbari are characterised by the ascendancy of *Glossopteris* leaves over *Noeggerathiopsis* and *Gangamopteris*. The beds of this "series" are divided into two successive "stages" called Barakar and Raniganj. Local variations of the Raniganj "Stage" have been called Barren Measures (or Ironstone Shales of Kulti) and Kamthi "Stage". The floras of these beds became successively richer reaching their climax in the Raniganj "Stage". The Kamthi Beds are particularly rich in glossopterid fructifications.

A sharp decline of the *Glossopteris* flora followed the close of the Raniganj "Stage" when we come into the succeeding Triassic flora characterised by the presence of *Dicroidium* leaves and its contemporaries.

PENNSYLVANIAN MEGAFLORAS OF GONDWANA: AN APPRAISAL

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With the advent of the Pennsylvanian Ice Age the latitudinal differentiation of lowland floras became strongly marked. Whereas major innovations took place in the highly diversified palaeoequatorial belt floras (Amerosinian Realm), the northern and southern hemisphere floras (Angará and Gondwana realms, respectively) were more conservative as well as much less diversified.

Gondwana floras of Pennsylvanian age were dominated by probable progymnosperms taxa such as *Nothorhacopteris*, *Botrychiopsis* and *Fedekurtzia*. These are similar to *Rhacopteris (Anisopteris)* and *Triphyllopteris* of the Mississippian, and the fragmentary knowledge of fructifications supports the assumption of a possible link. Other taxa, such as *Bergiopteris* and *Paulophyton*, are of more uncertain affinity. Fernlike foliage is virtually absent, with the noted exception of a form ascribed to *Eusphenopteris* by Césari *et al.* (1988). Sphenophytes are mainly represented by *Paracalamites* and very rare remains of foliage. Lycophytes are of small stature and belong to genera that may be compared with Mississippian forms. They are very different from the more highly evolved arborescent lycophytes of Amerosinia. Notable characteristics are the absence of parichnos (replaced in some cases by infrafoliar bladders) and the lack of specialised strobili. *Cordaites* leaves, *Ginkgophyllum*, and *Vojnowskya* are gymnosperm taxa recorded from Argentina, whereas eastern Australia shows the presence of a presumed gymnosperm with seasonal banding (this small tree was formerly identified as *Sigillaria* by Morris 1975).

Good stratigraphic control in eastern Australia shows apparent continuation from the Mississippian upwards, whereas the west-central Argentine records provide the transition to the Permian.

GONDWANAN EARLY TO LATE PERMIAN FLORAL CHANGE

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Traditionally, it has been considered that "Permian" Gondwana sequences are those which show the first appearance of glossopterids (*Rubidgia*, *Gangamopteris*) at the base and which are limited at the top by the first occurrence of *Dicroidium* and other "Early Triassic" markers. This would comprise the major part of the *Glossopteris* biochron.

Glossopteris, being the most characteristic genus of the *Glossopteris* flora (= Lower Gondwana flora), induces an idea of floral contemporaneity and considerable homogeneity. However, this is an oversimplification; a critical review of the available data suggests a more complex situation.

Indeed, there is no secure set of independent dates to support such contemporaneity. More probably, floral evolution and distribution was affected by strong environmental controls. Thus, the observed floral successions would be of an ecostratigraphic nature, and their boundaries would probably be diachronous along the different Gondwana basins.

Additionally, the affinities of each type of *Glossopteris* are not known exactly. The few structurally preserved fertile structures can sometimes be related to one or the other type of leaf, but in most cases there is no evidence of mutual correspondence. The variety of leaves, wood, detached fructifications, and pollen favours the hypothesis that the name *Glossopteris* comprises a complex artificial group, possibly involving plants of several families which were distributed differently in space and time.

Other groups, such as Sphenopsida, Lycopsida and ferns present even clearer signs of considerable floral changes along the "Lower Gondwana" sequences and regions.

The whole phytogeographic and evolutionary panorama, as well as the causes of variety, are still only dimly perceived, but the recognition of a more complex situation is already important for new approaches in further research on this subject.

BIOSTRATIGRAPHY: SYDNEY COALFIELD, CANADA - UPPER SILESIA, POLAND

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Macrofloras for Upper Silesia, southern Poland, were recorded by Gothan, Jarosz, Bocheński, Siu Fu, Woźniak, Stopa and Kotas and can be assigned to Namurian to Cantabrian ages. Moreover, palynostratigraphy for Upper Silesia is also known and recently correlated with West European coalfields of the same age.

For the Sydney Coalfields, Nova Scotia, macrofloral biostratigraphy was established by Bell and revised more recently by the present author, who recognised assemblages of late Westphalian C to basal Cantabrian ages.

It therefore appears that correlation on macrofloral grounds is established and that the younger strata of both coalfields are approximately coeval. Further work will be necessary to refine the correlation to a degree where age-equivalent coal seams can be proposed for the Upper Silesia and Sydney coalfields. Accordingly, in cooperation with the Polish Geological Survey (Sosnowiec Branch), an ambitious program is underway whereby the Sydney Coalfield is reinvestigated in the light of modern advances for interpreting palynostratigraphy. For the spore analysis, the author sampled 14 successive coal seams; over 200 samples were collected, representing Westphalian C to Cantabrian. Facies changes amongst the seams are also noted. For each coal seam up to 100 cm seat-earth and roof rocks were sampled. In addition, coal seams which serve as boundary markers for the Westphalian C/D and the Westphalian D/Cantabrian were sampled at 15 cm intervals. With this detailed sampling it should be possible to arrive at palaeoecological conclusions.

The results of this investigation are summarised and discussed.

CARBONIFEROUS MEGAFLORAS OF THE IBERIAN PENINSULA

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The different Carboniferous megafloral records from the Iberi[an] Peninsula are being reviewed.

Tournaisian floras occur in Sierra Morena. They show assembla[ges] similar to those recorded from Geigen and Kossberg in Germany, and [a]re characterised particularly by *Triphyllopteris collombiana*.

Viséan floras are poorly represented but occur in Sierra Moren[a]. *Lepidodendron lossenii* is the most characteristic taxon.

Lower Namurian floras are also found in Sierra Morena. They have n[ot] yet been studied in detail but are reasonably well preserved and comparable [to] those found elsewhere in Europe.

Middle and upper Namurian floras are unknown in the Iberi[an] Peninsula, with the exception of some poor assemblages from the Cantabri[an] Mountains, where *Neuralethopteris schlehanii* is the leading form.

Lower Westphalian (Langsettian) floras are known from t[he] Cantabrian Mountains (La Camocha in particular) and Sierra More[na] (Villanueva del Río y Minas). Duckmantian floras are well represented in Sier[ra] Morena (Peñarroya-Belmez-Espiel) and also occur in the Cantabrian Mountai[ns] (Curavacas). Although abundantly present, the medullosan pteridosperms a[re] poorly diversified in these lower Westphalian assemblages which also lack som[e] sphenopterid genera (*Crossotheca*, *Bowertia*), but are generally similar to coev[al] floras from other parts of Western Europe.

Upper Westphalian (Bolsovian and Westphalian D) floras a[re] abundantly represented in the Cantabrian Mountains and elsewhere in t[he] Peninsula. They also show a poor diversification of medullosan pteridosperm[s] (though not quite as poor as in the lower Westphalian) and generally the sam[e] sphenopterid and pecopterid taxa occur as in other parts of Western Europe. Th[e] marine influenced Westphalian D of NW Europe is a first rate candidate for th[e] Westphalian D stratotype, and its floras show transitions to both Bolsovian an[d] Cantabrian.

Stephanian floras are among the richest and most diversified in th[e] world. They are also the most complete, showing Cantabrian, Barruelia[n], Stephanian B and Stephanian C assemblages (including the late Stephanian that some French authors record as Stephanian D). Pteridosperms are generall[y] the same as elsewhere in Western Europe, but are perhaps a little mor[e] diversified. Pecopterid and sphenopterid taxa are more numerous than anywher[e] else; sphenopsids are generally the same as foundin Stephanian assemblages i[n] other parts of Western Europe. Ginkgophytes and conifers are generally lackin[g] due to the predominance of humid lowland environments.

The Carboniferous floras of the Iberian Peninsula fit in with the genera[l] run of these floras in Western Europe and clearly belong to the palaeoequatoria[l] Amerosinian Realm. This makes it difficult to admit a separation fron[m] Northwest Europa by means of a Rheic Ocean (as postulated by some authors) o[r] by means of very major strike-slip faults (as postulated by other authors).

MEGAFLORAS OF THE UPPERMOST LOWER PERMIAN OF CENTRAL MOROCCO, THEIR STRATIGRAPHICAL AND PHYTOGEOGRAPHICAL SIGNIFICANCE

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The Permian of Central Morocco outcrops in small continental grabens which accumulated clastic red beds, very often with carbonate bands; sometimes fossiliferous lenses of grey beds are found.

Two basins have been successfully investigated: "Tiddas" and "Bou Achouch".

TIDDAS BASIN - Until recently, this was considered to be unfossiliferous, but fossil plant impressions occur (mainly conifers) occur together with vertebrate footprints (*Hyloidichnus* sp., *Gilmoreichnus* sp.) in the red beds and impressions-compressions of better preserved plant remains in the rare grey shale intercalations. The following genera and species have been identified thus far: *Neuropteris* sp. aff. *N. cordata* Brongniart, *Mixoneura auriculata* (Brongniart) Zeiller , *Odontopteris gimmii* Remy, *Taeniopteris jejunata* Grand'Eury, *Annularia spicata*(von Gutbier) Schimper, *Walchia piniformis* (von Schlotheim) Sternberg, *W. imbricata* Schimper, *W. hypnoides* Brongniart, *Ernestiodendron filiciforme* (von Schlotheim) Florin, *Hermitia* (al. *Walchia*) *germanica* (Florin) Clement-Westerhof, *Hermitia* spp.

BOU ACHOUCH BASIN - In this basin, the revision of the megaflora is still underway. Carpentier (1930) identified a number of genera and species to which we can add the following: *Calamostachys dumasii* (Zeiller) Jongmans, *Sphenopteris germanica* Weiss, cf. *Prynadaeopteris anthriscifolia* (Göppert) Radczenko, *Autunia* (al. *Callipteris*) *conferta* (Sternberg) Kerp, *Rhachyphyllum* (al. *Callipteris*) *schenkii* (Heyer) Kerp, *Dicranophyllum*-like foliage and, exceptionally, ovuliferous fructifications of Peltaspermaceae. The discovery of various ginkgophyte leaves and of Voltziaceae-like polliniferous cones clearly establish that the age is at least Early Permien. Most recently, scale leaves and sterile foliage of glossopteridalean affinity have been discovered as well.

Comparisons are made with Permian megafloras from Southern Spain and from South-Western Morocco. The phytogeographical implications of the similarities and differences between these more or less coeval floras are discussed.

"PERESTROYKA" IN THE PLANT KINGDOM AT THE PALAEOZOIC-MESOZOIC BOUNDARY

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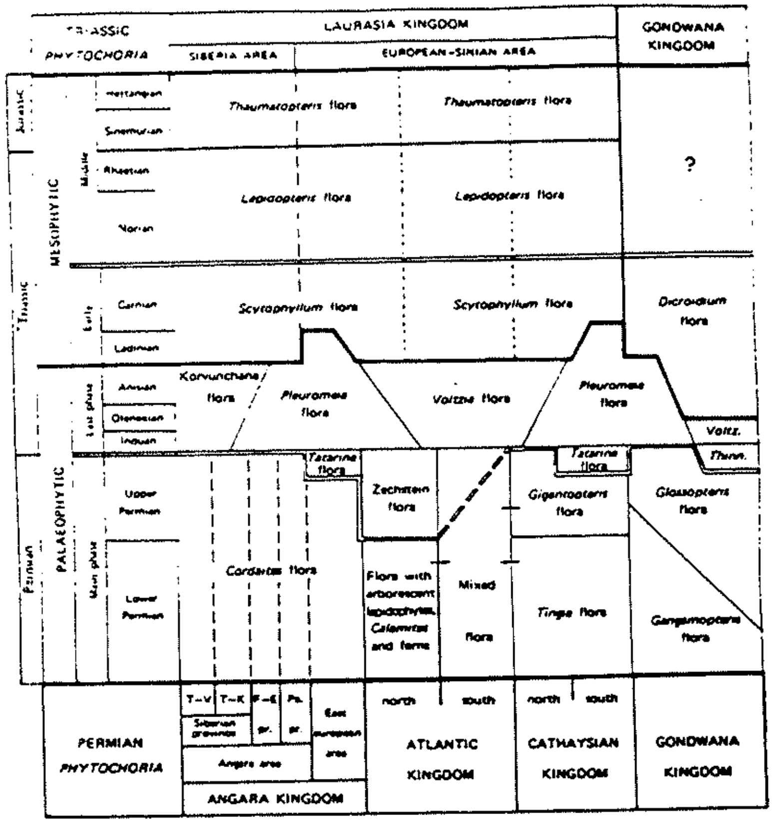
The Triassic Period was a time of reconstruction ("Perestroyka") in the plant kingdom. During the Triassic the Palaeophytic plant associations gradually changed into Mesophytic ones. The most important change took place in the middle Triassic and perestroyka itself occurred during Late Permian times and the first half of the Triassic, i.e. during a time span of c. 60 m.y.

The Late Permian and Early Triassic stage in the development of land plants may be regarded as the last stage of the Palaeophytic. Reconstruction continued during the Ladinian and Carnian which may be considered as representing the first stage of the Mesophytic. "Normal" Mesophytic begins with the Norian (=middle Mesophytic) and continues throughout the Jurassic and the Early Cretaceous (=late Mesophytic).

The reconstruction of the floral composition was accompanied by the reconstruction of the palaeogeographic zonation. The isolation and splitting up into many Palaeozoic phytochoria changed into a simpler zonation, similar to the Recent one.

The chart shows the stages of development of floras at the Palaeophytic-Mesophytic transition.



The stages of development of the floras at the Paleophytic-Mesophytic transition
Phytochoria in the Permian, after MEYEN (1970); Gondwana kingdom, after RETALLACK (1977)
Abbreviations: T–V: Taymyr-Verkhoyansk count; T–K: Taymyr-Kuznetsk count; F–E: Far East province; Pe.: Pechora province; *Voltz.*: *Voltziopsis* flora; *Thinn.*: "*Thinnfeldia*" callipteroides flora

UPPER NAMURIAN AND WESTPHALIAN ALETHOPTERIDS OF THE BOHEMIAN MASSIF

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Species of the genus *Alethopteris* from Upper Namurian and Westphalian occur on the territory of the Bohemian Massif in three regions: Upper Silesian Coal Basin (Namurian B - Westphalian A), Intrasudetic Basin (Namurian C - Westphalian D) and Central Bohemian Region, with 14 basins and smaller occurrences of Carboniferous strata (Westphalian C, D). Species from the Namurian A of the Upper Silesian Coal Basin were described by Purkyňová (1970), and a paper about Stephanian and Permian species from the Bohemian Massif was published by Simunek (1989).

Alethopteris davreuxii (Brongniart) Göppert, *A. decurrens* (Artis) Zeiller, *A. lonchitica* (Schlotheim) Zeiller and *A. valida* Boulay are all present in the Upper Silesian Coal Basin and in the Intrasudetic Basin.

In the Upper Silesian Coal Basin occur the following species: *Alethopteris jongmansii* Susta and *A. havlenae* sp.nov. (= *A.densinervosa* of Havlena 1984). Exclusive to the Intrasudetic Basin are: *Alethopteris grandinii* (Brongniart) Göppert, *A. idae* Simunek, *A.* cf. *lancifolia* Wagner, *A. lonchitifolia* Bertrand, *A. refracta* Franke, *A.* aff. *valida* Boulay (probably a new species) and *Rtynepteris pilosa* gen. et sp. nov., which is related to *Alethopteris valida* Boulay.

The Central Bohemian species of *Alethopteris* have been recorded by Wagner (1968). Presently known records are as follows: *Alethopteris grandinioides* Kessler (with three varieties - var. *grandinioides*, var. *distantinervosa* Wagner and var. *kettneri* Havlena), *A. missouriensis* (White) Wagner, *A. nemejcii* Wagner and *A. serlii* (Brongniart) Göppert.

Some species are locally rather common (for example *Alethopteris lonchitica*, *A. valida*, *A. decurrens* and *A. idae*), some others are very rare (e.g. *Alethopteris* cf. *lancifolia*, *A. davreuxii* and *A.jongmansii*). The species of *Alethopteris* from the Intrasudetic Basin are different from those of the Central Bohemian Region. Cuticles have been studied from 14 species.

NEW DATA ON LOWER CARBONIFEROUS FLORAS FROM EUROPE

Jean Galtier[1] & Nicholas Rowe[2]
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[2] Geologie & Paläontologie, R.W.T.H., Lochnerstrasse 4-20, D-5100 Aachen, FEDERAL REPUBLIC OF GERMANY

The current investigation of Lower Carboniferous floras from West Europe (France, Great Britain, Germany) and additional material from East Germany, Czecoslovakia, Morocco indicate important evolutionary changes from the early Tournaisian to the late Viséan.

Data from both anatomically preserved plants and compressions are used to demonstrate that the composition of plant assemblages reflects not only stratigraphical age but also facies control, preservation, ecology and palaeogeography.

We present examples of adjacent localities of the same age which yielded different floras reflecting taphonomic and ecological controls. We tentatively suggest to distinguish successive plant assemblages of early-mid Tournaisian, late Tournaisian-early Viséan and late Viséan-early Namurian ages. This contrasts with previously published data which are generally attributed to "Lower Carboniferous" without more precision and which have been commonly used in palaeobiogeographical analyses.

THE CONDITIONS OF DEPOSITIONAL ENVIRONMENT OF SEAMS II AND III (PUERTOLLANO BASIN, CENTRAL SPAIN) AS INFERRED FROM PETROGRAPHIC AND SULPHUR CONTENT ANALYSES

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Three sections of coal seam II (rank by vitrinite random reflectance 0.63%) and two sections of coal seam III (rank by vitrinite random reflectance 0.7-0.64%) of the Emma Opencast Mine in Puertollano, Castilla-La Mancha, were selected for the investigation of (1) microlithotypes, (2) minerite, (3) different kinds of sulphur (by chemical analysis and ISO method).

The results obtained permit the following conclusions regarding the depositional environments of these coal seams:

(1) The environment of deposition was different for the two seams investigated. Seam II shows evidence of a generally more reducing environment as follows from the abundance of clarite and vitrite and a paucity of durite and inertite. These characters are indicative of very wet conditions. However, microlithotype analysis shows that the water level fluctuated, leading to alternating oxydation-reduction potentials, albeit with a predominance of reducing conditions. In contrast, Seam III is characterised by higher durite and inertite values accompanied by rarer pyrite, thus suggesting shallower water levels, i.e. drier conditions. Durite and inertite contents decrease gradually upwards within Seam III, with vitrite and clarite remaining almost constant.

(2) The investigation of sulphur contents in relation to the organic constituents shows the following results. The presence of a high total sulphur content is related to pyrite in association with organic matter. A low total sulphur content is associated with a predominantly organic origin. (in this case its presence cannot be detected petrographically.)

The general results for Seam III agree with those reported in a preliminary study by A.H.V. Smith (*in* Wallis 1983) and palaeobotanical data published by R.H. Wagner (1989).

UPPER DEVONIAN-CARBONIFEROUS MICROFLORAS OF THE SAHARA. ASSESSMENT OF THE GONDWANAN AND EURAMERICAN INFLUENCES: A PROGRESS REPORT

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The work by Lanzoni & Magloire (1969) marks the first important stage in our knowledge on the uppermost Devonian-Carboniferous palynology of the Saharan platform. Later (1979-1980), the Illizi Basin (Eastern Algerian Sahara) and the Rhadamès Basin (Western Libya) were studied by Attar, Jardiné and Massa. The Upper Palaeozoic of Cyrenaica-Kufra has been studied at a later date (1985-1989).

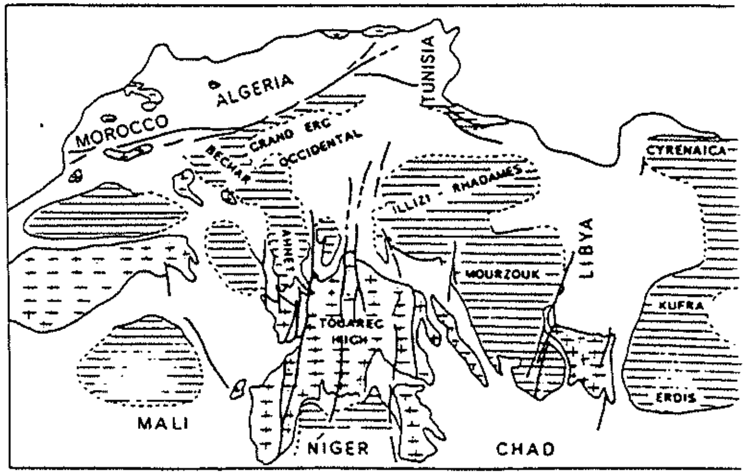
Despite these studies, it is evident that the North African Upper Devonian-Carboniferous microflora is still poorly known. One of the most important problems is the general lack of independent control on the palynological dating. At present, there is only a good independent control in the Illizi-Rhadamès Basin.

Compared to Europe (Clayton *et al.*, 1977), the microflora of these areas presents several peculiarities:

- Uppermost Devonian (Strunian): abundance of *Spelaeotriletes granulatus*, numerous small *Lagenoisporites*.
- Viséan: abundance of the spore "monolète zonale 2874" (in Lanzoni & Magloire, 1969), the late appearance of *Lycospora pusilla*, and the presence of numerous megaspores unknown from Europe.
- Serpukhovian: very great scarcity to absence of *Tripartites*, rare *Schulzospora*.
- Bashkirian and Moscovian: few monolete spores, and a great diversity of pollen grains.

The microfloral evidence suggests that strong Gondwana influences existed in the larger part of the Saharan basins.

On the other hand, in the paralic basins of Abadla and Mezarif (western Algerian Sahara), which became individualised during the Hercynian Orogenesis, the Westphalian mega- and microfloras are quite similar to those of Euramerica. In these small basins, there is little Gondwana influence. This also seems to be the case for the Moscovian microfloras of South Tunisia.



MIDDLE EASTERN PERMIAN FLORAS OF CATHAYSIAN AFFINITY

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Upper Permian floras of central Saudi Arabia, Iraq and SE Turkey show a high proportion of ferns together with sphenophytes, cordaites and possible cycadophytes. *Glossopteris* is found associated in SE Turkey. The general composition of these Middle Eastern megafloras of late Permian age is comparable to that of the East Asian Cathaysian floras, a similarity that is emphasised by the presence of two different gigantopterid species in Turkey and Saudi Arabia, respectively.

The ongoing systematic description of these Middle Eastern floras of Cathaysian aspect shows that many new species are present, a fact that can be explained by geographic remoteness from East Asia. However, some species are identical, e.g. *Lobatannularia heianensis* (Kodaira) Kawasaki, *Paratrizygia* cf. *koboensis* (Kobatake) Asama, *Fascipteris hallei* (Kawasaki) Gu & Zhi, and *Bicoemplectopteris hallei* Asama.

The recently described *Gemellitheca* from Saudi Arabia and Turkey may be a synonym of *Dizeugotheca* of South America, but the latter is too poorly known to be certain of the identification.

Permian floras of Cathaysian aspect are not only known from East Asia and the Middle East, but also from a Central American area extending from Venezuela to the southern United States. The ecotonal flora described by Broutin from Guadalcanal in southwestern Spain also shows comparable elements. These floras are the natural successors to the late Carboniferous (Stephanian) floras of the palaeoequatorial belt (Amerosinian Realm) and reflect warm, humid conditions. Where drier climatic conditions prevailed during Permian times in the palaeoequatorial belt, different floral associations became established (Euramerican or Atlantic type floras) with abundant conifers, ginkgophytes, callipterids and fewer ferns. In Saudi Arabia a succession from late Permian Cathaysian type flora to latest Permian Euramerian (Atlanctic) type flora is observed, reflecting changing climatic conditions. It is concluded that the progressive increase in drier climatic conditions in the different areas of the (Amerosinian) palaeoequatorial belt during late Carboniferous (Stephanian) and Permian times operated diachronously throughout this palaeolatitudinal belt and that humid conditions continued to be present in certain areas such as SE Turkey even as late as the latest Permian. The concept of floral provinces will have to be applied more carefully than has been done in the past.

THE UPPER PALAEOZOIC SPHENOPSIDS FROM THE INDIAN GONDWANAS

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Eight genera and approximately 20 species of sphenopsids are known from the Upper Palaeozoic deposits of the Indian Lower Gondwanas. These 8 genera are: *Sphenophyllum* and *Trizygia* belonging to the Sphenophyllales; *Schizoneura, Barakaria, Diphyllopteris, Raniganjia, Phyllotheca* and *Stellotheca*(= *Lelstotheca*) placed under the Equisetales. Most or all of these genera are known only as impressions or compressions of vegetative parts and their descriptions are based on leafy twigs, which are often fragmentary. Information on their reproductive structures is sadly lacking. Leafless equisetalean twigs from Gondwana sediments, with ridges and furrows running contiguously in successive internodes, are placed in the organ genus *Paracalamites*.

Besides a brief descriptive treatment, the stratigraphic range of these genera is indicated and the taxonomic validity of some of them is discussed. On the basis of the recently described sphenopsid, *Stellotheca* (=*Lelstotheca*) *surangei* Jeyasingh, the validity of recognising the Calamitales and the Equisetales as two distinct orders of Sphenopsida is reexamined. Some remarks regarding sphenopsid evolution are appended.

UPPER CARBONIFEROUS MEGAFLORA FROM CENTRAL SLOVENIA, NW YUGOSLAVIA

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Upper Palaeozoic sediments outcrop in the wider zone of the Sava foldbelt, east of Ljubljana. The beds are composed of quartz conglomerates, sandstones, siltstones, and argillaceous slates, which are rhythmically alternating. Locally, these beds contain numerous megafloral remains as well as comminuted plant debris. Plant remains recovered from forty-five localities between Ljubljana and Polsnik belong to the following taxa: *Lepidodendron* cf. *aculeatum, Bergeria (Lepidodendron)* sp., *Aspidiopsis (Lepidodendron* sp.), *Sigillaria boblayi, S. mamillaris, Syringodendron (Rhytidolepis), Stigmaria ficoides, Calamites roemeri, C. cistiiformis, C. haueri, C. ramifer, C. suckowii, C. sachsei, C. schuetzeiformis, Cordaites* sp., *Artisia approximata, Equisetites* cf. *hemingwayi, Trigonocarpus* sp. and *Carpolithus* sp. The finding of *Trigonocarpus* proves the existence of seed ferns in assemblages of some of the localities in this area. The megafloral remains show that in most localities the age is either Namurian-Westphalian or Westphalian. The composition of the megafloral assemblages is characteristic of the Euramerican floristic province in the region of central Slovenia during the middle Carboniferous.

ON TWO CONIFEROUS FOSSILS: *Birsinghia florinii* gen. et sp. nov. & *Paliandrolepis singularis* gen. et sp. nov. FROM THE KARHARBARI STAGE OF THE LOWER GONDWANAS OF INDIA

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A new genus of gymnospermous branched shoots is described from latest Carboniferous-Permian beds of India under the name *Birsinghia florinii*. The vegetative shoots look like those of *Buriadia heterophylla* in having simple, bifid or multifid leaves, but fertile shoots differ from those of *Buriadia* in bearing orthotropous seeds between leaves and in that the two horns of the seeds may be forked and that the seeds were pollinated by alete monosaccate pollen grains. The new genus is attributed to a pre-conifer alliance.

On the basis of association and similarities of pollen grains found in the pollen sac and in the micropylar canals of the pollen chamber a detached microsporangiate organ, *Paliandrolepis singularis* gen. et sp. nov., is tentatively assigned to *Birsinghia*.

PALAEOFLORISTIC EVOLUTION AND PALYNOBIOSTRATIGRAPHY OF THE PARANA BASIN, SOUTH BRAZIL

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The palynobiostratigraphy and the distribution of megafloras during Permian times of the Paraná Basin, South Brazil (Rio Grande do Sul State) show a floral development which appears intimately related to the changing climates and environments.

This development is reflected mainly by different proportions between the pteridophytic and gymnosperm micro- and megafloral elements.

The dominance of monosaccate pollen as well as the occurrence of plant remains related to gymnosperms (*Botrychiopsis plantiana*/*Gangamopteris* complex) in the lower sequence (*Cannanoropollis korbaensis* Zone, *Protohaploxypinus goraiensis* sub-zone) seems to be related to deposition under cold climatic conditions with glacial influences.

The coal seams and coal-bearing strata of the *Caheniasaccites ovatus* sub-zone show a microfloral diversification, with predominantly trilete spores reflecting a pteridophytic vegetation. The megafloras are also characterised predominantly by pteridophytic associations, with subordinate glossopterids and Cordaitales. These changes in the mega- and microfloral patterns are supposed to have been influenced by a general amelioration of the climate (warming effect).

Gradual variations of the climatic environmental conditions may have existed throughout Late Permian times until the Permian-Triassic transition. These are reflected by successive generations of gymnospermic striate-disaccate pollen-producing plants (*Lueckisporites virkkiae* Zone).

LYCOPHYTA AS PALAEOCLIMATIC EVOLUTIONARY INDICATORS IN THE GONDWANA SUCCESSION OF THE PARANA BASIN, SOUTH BRAZIL

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The Lycophyta played an important role in the floral associations developed during Permian times in the Gondwana area of South Brazil.

The lycophyte affinities of certain palynomorphs (*Lundbladispora*, *Vallatisporites*, *Cristatisporites*) and the well preserved casts with leaf cushions of *Lycopodiopsis*, *Brasilodendron*, suggest that the climax of Lycophyta took place during the deposition of coal and coal-related strata, under warm, seasonal, climatic conditions. At some levels dense thickets of arborescent forms have been found preserved *in situ*; their rooting systems are non stigmarioid.

The gradual change in climatic and palaeoecological conditions that occurred during the Permian/Triassic transition is reflected by the rapid decrease of pteridophytic spores, particularly those related to Lycophyta.

In the upper part of the Permian succession, lycophyte remains are found in restricted environments associated with marine transgressive phases.

CARBONIFEROUS MICROFLORAS OF THE IBERIAN PENINSULA

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The work by Dijkstra (1955) on the Spanish Carboniferous megaspores initiated the palynological research in the Iberian Peninsula. Important biostratigraphic studies were published by Neves (1964) and Chateauneuf (1973) on parts of the Cantabrian Zone, prior to the more generalised investigations undertaken for the Tenth International Congress of Carboniferous Stratigraphy and Geology, held in Madrid, 1983.

The microfloral associations are generally similar to those described for Great Britain, France, Belgium and Germany. However, there are some small differences, such as the lack of *Radiizonates aligerens* (Knox) Staplin & Jansonius in the Langsettian (Westphalian A), making the Langsettian-Duckmantian boundary a difficult one to recognise in Spain. In the well studied upper Westphalian (upper C and D) strata of the Central Asturian Coalfield the presence of *Punctatisporites obliquus* Kosanke and *Angulisporites splendidus* Bharadwaj is noted from the middle Westphalian D onwarde; these species do not appear below the Stephanian in Saar-Lorraine. The well developed Stephanian of the Cantabrian Zone has only yielded incidental microfloras. A generally high degree of carbonisation has made spore recovery difficult in this area. Extremely well preserved microfloras are known from the upper Stephanian strata of the Puertollano Coalfield in central Spain. The large proportion of densospores makes this area rather unusual and difficult to compare with the Stephanian elsewhere.

LOWER CARBONIFEROUS PTERIDOSPERMS WITH TRIFURCATE FRONDS

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Recent findings from the Lower Carboniferous of Western Europe indicate that pteridosperm fronds with a "*Diplopteridium*" morphology are widespread in Viséan sediments. They consist of a basal rachis which divides into three parts comprising two lateral secondary rachides with vegetative pinnae and a median, dichotomously branched organ which is devoid of pinnules and bears fertile organs terminally. Unequivocal examples of this fertile frond morphology are now known from Great Britain, Eastern France and Central West Germany. Fertile organs are found only rarely in attachment and may consist of either cupulate or synangiate organs. Variation is seen in terms of overall size of the vegetative and fertile fronds, degree of pinnule lobation and nervation and the presence of either cupulate or synangiate organs attached to the median fertile branch.

The current stratigraphical and palaeogeographical ranges of this type of pteridosperm foliage is discussed with a detailed comparison of vegetative and fertile components of the frond.

PALAEOECOLOGICAL STUDIES OF LATE CARBONIFEROUS PLANT MACROFOSSILS FROM BOREHOLE KEMPERKOUL-1 (SITTARD, THE NETHERLANDS)

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The cored borehole Kemperkoul-1 (southern Limburg, The Netherlands) yielded 1059 samples comprising 1679 well preserved plant remains of 157 species, including plant debris, stems and other material. The loss of cores was less than 5%.

The lithofacies of the entire core was thoroughly described by Pagnier, who distinguished lagoonal/lake, overbank/channel fill and swamp deposits.

An attempt is here made to relate these types of lithofacies to the plant associations and to individual plants.

The approach is statistical and computer-based. We may confirm the reconstructions of Carboniferous landscapes by Wagner (1970) and Scott (1976).

Calamites is indeed mainly situated in the wettest places. Interesting is the occurrence of *Bothrodendron* which makes up about 30% of plant associations in the interdistributary bay deposits.

Cordaites shows a preference for growing on the natural levees, very often together with *Calamites*. Ferns are present in small quantities in nearly all lithofacies.

Neuropteris tenuifolia also occurs in nearly every lithofacies, whereas *Eusphenopteris striata* is rather restricted to the swamp and floodplain.

The statistical approach shows a less clear-cut picture of the Carboniferous landscape as expected, when compared with the reconstructions of Jongmans, Wagner and Scott.

MIOSPORE ASSEMBLAGES FROM COAL MEASURES OF WESTPHALIAN D AGE, NORTH STAFFORDSHIRE, ENGLAND

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A study of miospore assemblages from argillaceous strata from the Etruria Marl and Newcastle groups of the Upper Coal Measures of North Staffordshire revealed a microflora assignable, in part, to the *Thymospora obscura* Assemblage XI as described by Smith and Butterworth (1967). Twelve palynological assemblages were examined, from which taxa representative of sixty species, assignable to forty nine genera are recognised.

The excellently preserved assemblages are characterised by the common occurrence of *Cadiospora magna* Kosanke 1950, *Calamospora* spp., *Crassispora kosankei* (Potonié & Kremp) Smith & Butterworth 1967, *Endosporites globiformis* (Ibrahim) Schopf, Wilson & Bentall 1944, *Florinites* spp., *Laevigatosporites* spp. *Lycospora pusilla* (Ibrahim) Schopf, Wilson & Bentall 1944, *Microreticulatisporites nobilis* (Wicher) Knox 1950, *Mooreisporites inusitatus* (Kosanke) Neves 1958, *Potonieisporites* spp., *Punctatosporites granifer* Potonié & Kremp 1956, *P. oculus* Smith & Butterworth 1967, *Raistrickia aculeata* Kosanke 1950, *Thymospora pseudothiessenii* (Kosanke) Wilson & Venkatachala 1963, *Triquitrites sculptilis* (Balme) Smith & Butterworth 1967, *T. spinosus* Kosanke 1943 and *Vestispora fenestrata* (Kosanke & Brokaw) Wilson & Venkatachala 1963.

Comparison of the assemblages recorded here with those published by other authors, is limited to those assemblages from coals obtained from the Upper Coal Measures. There is no previous published record of assemblages obtained from argillaceous rocks of an equivalent age in the British Isles. The assemblages are compared with earlier records by Smith and Butterworth (1967) from Staffordshire, Spinner (1966) from Worcestershire, and the more recent work of Smith (1987) on Oxfordshire and South Warwickshire.

Some comparison can also be made with assemblages described from other European sites and from North America, considered to be of approximately equivalent age. Of particular interest is a comparison with Upper Pennsylvanian assemblages (e.g. those described by Peppers 1964, 1970, Ravn 1979, 1986) made with assemblages obtained from several sample horizons within a shale directly overlying two thin limestone bands, which have been considered by Pollard and Wiseman (1977) as being just above the junction between the Etruria Marl and Newcastle "groups" in North Staffordshire. These assemblages contain several species of miospores first described from Pennsylvanian strata in North America, and not previously recorded in dispersed miospore assemblages from the Silesian of the British Isles. *Elaterites triferens* Wilson 1943, *Hymenospora multirugosa* Peppers 1970, *Latipulvinites kosankei* Peppers 1964 and *Columinisporites ovalis* Peppers 1964 are here reported for the first time from Upper Carboniferous assemblages in England. Their occurrence reflects a closer similarity between the microfloras of North America and the British Isles than was previously known. Peppers (1985) proposed a more refined palynological biozonation of sections of equivalent age in North America. The assemblages recorded in the present study are considered to be similar to those associated with the *Cadiospora magna* - *Mooreisportes inusitatus* MI miospore assemblage zone of Peppers.

AASP BANFF 1990
NORTH IN NINETY

The 23rd Annual Meeting of the American Association of Stratigraphic Palynologists will be held at the Banff Springs Hotel, Banff, Alberta on October 10-13, 1990. Plan now to attend and make this a successful and memorable meeting.

CALL FOR PAPERS

All members are invited to contribute papers, on any aspect of palynology, for the general technical sessions on Thursday, October 11, and Friday, October 12, 1990. Oral presentations should be planned for a 20 minute period (15 minute talk plus 5 minutes for questions/discussion) with one or two 35mm projectors. Posters should be designed to fit an area approximately 1 x 2metres. An abstract form is included with the April issue of the AASP Newsletter. Instructions for abstract preparation are on the form. Titles for both papers and posters are required by May 31, 1990. The deadline for receipt of abstracts is July 31, 1990. Please send all titles and abstracts to Thomas Demchuk at the University of Calgary.

Other details

Tyrrell Museum of Palaeontology
If enough people are interested a trip to the Tyrrell Museum at Drumheller will be arranged for Sunday, October 14. There may be a small fee to cover transportation cost.

Registration
Registration forms and relevant meeting information will be sent to all AASP members in June. The registration fee is expected to be $95 (Canadian funds). Student registration will be $70.

Special event
A mountaintop experience has been planned for the late afternoon and early evening of Thursday, October 11. We will take a smooth eight minute trip by gondola to the top of nearby Sulphur Mountain from which there are spectacular views of the Banff area. There will be time to walk along the ridge among alpine vegetation. Plans at present are to take the group photograph at the gondola upper terminal. A buffet dinner will culminate this mountaintop experience. Naturally we hope that the weather will cooperate and provide us with clear skies and warm temperatures, but expect the mountaintop to be noticeably cooler than the valley. The cost of the gondola ride and the dinner is included in the meeting registration fees.

Program

Symposium
A full-day symposium on "Event Stratigraphy, A Multidisciplinary Approach, with emphasis on the Cretaceous of the Western Interior of North America" is being organized for Wednesday, October 10, by Art Sweet and David McIntyre. Most of the speakers invited to contribute have confirmed their intention to participate. A variety of subjects,palynological and others, will be discussed.

Technical Sessions
The organization of the technical sessions on Thursday and Friday, October 11 and 12 will depend on the palynological topics in the papers submitted. The poster session will run concurrently with the technical sessions and is an important part of the Annual Meeting. Posters are eligible for the Best Poster Award. Students are invited to present their papers for judging for the L.R.Wilson Student Paper Award. The technical sessions will commence with an invited lecture by A.R.Sweet, of the Geological Survey of Canada, who will present an overview of many aspects of research on the Cretaceous - Tertiary boundary.

Field Trip
During the first part of the field trip, on Saturday, October 13, Upper Paleozoic strata in the Front Ranges of the Rocky Mountains may be observed. Aspects of Quaternary geology in the Bow Valley east of Banff will also be discussed. Upper Cretaceous strata in the Foothills east of the mountains will be discussed in the second part of the trip and stops will be made for palynological sampling. Field trip organizers are Art Sweet and David McIntyre. The field trip will end in Calgary.

Invitations
Any person who needs an invitation in order to attend the annual meeting in Banff should request such. The 1990 AASP Annual Meeting organizing committee is prepared to issue invitations but is unable to provide any financial assistance.

Banff - weather and activities
At the time of the meeting the weather should be pleasant and mild during the day but nights will be cool. Snow is always possible. The town of Banff should be relatively quiet as the tourist hordes of summer will be gone and the skiing season not yet started. A program for accompanying persons is not planned but a fair range of activities is available in the area. There are hotsprings and museums to visit, abundant shopping opportunities, remains of coal mining towns, and lakes, rivers and glaciers which can be reached by car or bus tours. There is ample opportunity for athletic activities such as hiking, cycling, running, tennis, golf, climbing and horseback riding. Why not bring the family for a fall vacation in the Canadian Rocky Mountains?

Thomas D. Demchuk, Jancis H. Ford, Bert G.T. van Helden, David J. McIntyre (Chairman); 1990 AASP Annual Meeting Organizing Committee.

Address any inquiries about the meeting to
David J. McIntyre
Institute of Sedimentary and Petroleum Geology
3303 - 33rd Street NW
Calgary, Alberta
Canada T2L 2A7
Tel. (403) 292-7089
Fax. (403) 292-5377

FIFTH INTERNATIONAL CONFERENCE ON MODERN AND FOSSIL DINOFLAGELLATES

ZEIST, THE NETHERLANDS
APRIL 19 - 25, 1993

FIRST ANNOUNCEMENT

Dino5 will focus on all aspects of modern and fossil dinoflagellates, including, but not limited to, life cycles, ecology, morphology, biology, chemistry, stratigraphy and the significance of dinoflagellates in Recent and ancient environments. The conference will be held April 19-25 1993 in Zeist, at the premises of the Royal Dutch Soccer Association, near Utrecht. The meeting is being organized under the auspices of the Laboratory of Palaeobotany and Palynology of the University of Utrecht. The third symposium on Neogene - Quaternary Dinoflagellates will be organized in conjunction with Dino5.

ORGANIZING COMMITTEE

Raimond Below (Utrecht NL)
Henk Brinkhuis (Conference Manager, Utrecht NL)
Barrie Dale (Oslo N)
John Dodge (Egham UK)
Han Leereveld (Utrecht NL)
Jan Willem Weegink (Secretary, Utrecht NL)
Henk Visscher (Chairman, Utrecht NL)

THIRD SYMPOSIUM ON NEOGENE - QUATERNARY DINOFLAGELLATES

Co-Convenors:

Martin J. Head (Toronto CANADA) & John H. Wrenn (Tulsa USA)

Please take notice of this announcement and mark your agenda's in red. Fill in the form below to secure your participation and (preliminary) registration.

FIFTH INTERNATIONAL CONFERENCE ON MODERN AND FOSSIL DINOFLAGELLATES

ZEIST, THE NETHERLANDS
APRIL 19 - 25, 1993

Preliminary Registration Form

Name:

Address:

[ ] Yes, I plan to attend Dino5

[ ] I also plan to present an [ ] oral presentation and/or [ ] poster

a probable topic will be ____________________

Please send this form to:

Symposium Secretariat
Jan Willem Weegink
Lab. Palaeobot. Palynol.
University of Utrecht
Heidelberglaan 2
3584CS Utrecht The Netherlands

Tel. xx31-30-532799
Fax. xx31-30-531357

Commission Internationale de Microflore du Paleozoique: Acritarch and Chitinozoa Subcommissions

Symposium on Acritarchs and Chitinozoa
British Geological Survey, Keyworth, Nottingham, U.K.

3 - 6 September 1991

First Circular

C.I.M.P. SYMPOSIUM ON ACRITARCHS AND CHITINOZOA,
BRITISH GEOLOGICAL SURVEY, KEYWORTH, NOTTINGHAM, U.K.
3-6 SEPTEMBER, 1991.

Invitation: You are cordially invited to attend a C.I.M.P. Symposium on Acritarchs and Chitinozoa at the headquarters of the British Geological Survey, Keyworth, Nottingham, from 3-6 September 1991. This is the first C.I.M.P. meeting to be dedicated specifically to either group since the acritarch symposium held in 1973 at Boussens, France. It will aim to review current knowledge and ideas in the fields of biostratigraphy, palaeoecology, palaeobiology, biogeography, taxonomy, evolution and classification.

Technical Sessions: Technical sessions will be held in the De La Beche Conference Centre at the British Geological Survey, Keyworth. Rooms will also be available for posters and other exhibits. One day may be set aside for a workshop session, at which problems of taxonomy and morphology can be discussed informally. Details of the technical sessions will depend on the response to this and the second circular, but it is hoped that all the major topics mentioned above will be included.

Accomodation: Accomodation will be arranged in the halls of residence of the University of Nottingham. Transport will be provided between the University and the Conference Centre. The cost of University accomodation will be included in the second circular.

Field Excursion: If there is sufficient demand, the symposium will be followed by an excursion of 3 or 4 days duration to internationally important Lower Palaeozoic sections in the Welsh Borderland.

Publication: It is hoped that papers read at the symposium will be published either in a proceedings volume or as a thematic set in a suitable journal. Further details will appear in the second circular. Intending authors will be asked to submit their manuscripts prior to or at the time of the meeting.

Second Circular: A second circular will be distributed in the autumn of 1990.

Correspondence: Please address all correspondence regarding this symposium to:

Dr. S. G. Molyneux
British Geological Survey
Keyworth
NOTTINGHAM NG12 5GG
U.K.

Tel. 06077 6111 extension 3430 (Internat. +44 6077 6111)
FAX 06077 6602 (+44 6077 6602)

C.I.M.P. Symposium on Acritarchs and Chitinozoa.

Provisional registration and request for second circular.

Name. Title.

______________________________ ______
Forenames Family name

Address.

Tel. FAX

Please tick the appropriate boxes.

My attendance is definite ☐, probable ☐, possible ☐

I will definitely ☐, probably ☐, possibly ☐, be accompanied by ___ person(s).

I/we will require accomodation in University hall of residence ☐

I am interested in attending the field excursion ☐

I expect to offer a paper* and/or a poster* ☐

*Please give provisional title:

Please return this form to:

Dr S.G. Molyneux
British Geological Survey
Keyworth
NOTTINGHAM NG12 5GG
U.K.

New C.I.M.P. Members and Changes of Address

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"Weyhill"
Old Compton Lane
Farnham
Surrey GU9 8EG
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Institute of Earth Sciences
University College of Wales
Aberystwyth
Wales SY23 3DB

Mr C H Wellman
Dept of Palaeontology
British Museum (Natural History)
Cromwell Road
London SW7 5BD

Dr H McClure
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Mr M O'Liathain
Dept of Geology
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c/o Dr A Fombella
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Indonesia

Organisers :

M. J. M. BLESS,
Maastricht, The Netherlands.

M. STREEL,
Liège, Belgium.

J. VERNIERS,
Brussel, Belgium.

Commission Internationale
de Microflore du Paleozoique
(Microfossiles Organiques)

Palaeozoic and Mesozoic Quantitative Palynology, Tectonic versus climatic control ?

A CIMP Symposium organized during the 1992 Palynological Conference at Aix-en-Provence.

Introductory lectures:
Palynology of sapropelitic sediments and paleoclimates in the Quaternary of the Mediterranean and Arabian Seas.
Palynological evidence for eustatic events in the Tropical Neogene.

Announced papers:
_Dinoflagellate/miospore quantitative distribution and relation to local tectonic trends in the Campanian/Maastrichtian of the Meuse Valley, north of Liège, Belgium and The Netherlands.
_Dinoflagellate/miospore quantitative distribution and relation to sedimentology in the Rhät of the Paris Basin.
_Miospore quantitative distribution in the Uppermost Famennian of Western Europe and relation to glacial deposits in South America.
_Acritarch/miospore quantitative distribution at the Frasnian / Famennian boundary event in Belgium.
_Detailed Chitinozoan and litho-stratigraphy in relation to cyclical patterns in the Silurian of the Caledonides.
_...

WHY NOT JOIN US ?

Your suggested title:...

Your name and address:..

TO BE RETURNED TO:

M.STREEL, Paleontology, The University
7, place du Vingt-Août, B 4000 LIEGE, Belgium

SEQUENCE STRATIGRAPHY SCHOOL AND EXCURSION

(JURASSIC OF BURGUNDY, FRANCE)

MAY / JUNE, 1991

by

P. VAIL & R. JAN DU CHENE

A week sequence stratigraphy school with practical exercises in the field will be held in Burgundy (France) in May or June, 1991.

If you are interested, please contact

R. JAN DU CHENE

at the address below

R. JAN DU CHENE 3, Square du Pomerol Domaine de Beausoleil 33170 GRADIGNAN (France) ☎ (33) 56 89 47 01