Note of the Secretary-general

In 1996 we saw the presentations of many studies on Palaeozoic and Triassic palynomorphs at different conferences or symposia. It shows that despite of sometimes adverse conditions many amongst us can stay active and present the results of good research. In this Newsletter you will find 112 abstracts.

Most studies (79) were presented during the International Palynological Conference (IX IPC) in Houston, Texas, USA, in the "CIMP Symposium on Paleozoic Palynology" organized by Reed Wicander, and also at other symposia or sessions. The CIMP wants to thank Reed for all the efforts it took to organize this successful CIMP-Symposium. You will found on p. 26 a groups photo of (most of) the participants of the CIMP-Symposium, kindly sent to us by G. Playford (Australia).

There are 18 abstracts from the **Fifth International Organization of Paleobotany Conference** in Santa Barbara, California, USA. At the **James Hall Symposium**, Second International Symposium on the Silurian System in Rochester, New York, USA, 7 abstracts on palynomorphs were presented. At the **Third Baltic Stratigraphic Conference** in Tallinn, Estonia 8 palynological or related studies were presented.

In the CIMP it became a habit to have a Symposium every two years. For 1998 we have two candidates: Pisa, Italy or Quebec-city, Canada. Because we are a democratic organization, we would like to know your preferences first. Hence we propose a written ballot. **We need your answer quick** in order to allow, in case it is accepted, the Canadian colleagues to apply in time to the organization of the CAG/MAG meeting. Please send your ballot form (p. 28) by post before Christmas or by email or fax before 6 january 1997. The votes will be counted on monday 6 january 1997 18h00 (GMT+1h).

With this Newsletter we also send out the **Newsletter N°10 of the Acritarch Subcommission**. It contains besides general information, a new call for candidates for the secretary of the Subcommission, and news from the IX IPC Conference in Houston, also a review of the presentations on Acritarchs at the VIIIth Russian Palynological Conference in Moscow sept. 30 - oct. 4 1996.

Newsletter N°16 of the Chitinozoa Subcommission is also joined with this Newsletter to its members. It includes news from the activity in the different countries or areas, working group progress reports on a Chitinozoa reference list (1966-1996), on a species list (all validly and invalidly published Chitinozoa species) and on a genera list.

Palynos and a limited amount of the second edition (1996) **World Directory of Palynologists** (IFPS) will be distributed to the CIMP members who asked for it, with a restriction of one book per institute, due to the few copies that we could pay for.

In the last newsletter we asked for **candidates for the position of CIMP president and secretary-general**, already holding their position for 6 years. This posts means some work and no benefits and hence we are not surprised to have received no candidatures. We have to extend the period for candidatures until 15 april 1997. A written ballot will be sent together with Newsletter N°52 in april 1997.

Commission Internationale de Microflore du Paléozoique

NEWSLETTER 51 Nov 1996

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Content Newsletter 51 (November 28, 1996)

NINTH INTERNATIONAL PALYNOLOGICAL CONGRESS, HOUSTON, TEXAS, USA 1996
Abstracts presented at the **CIMP symposium on Paleozoic Palynology** organized by Reed Wicander (program: see CIMP Newsletter 50, p. 21) and of abstracts of talks and posters on the Palaeozoic-Triassic presented at other symposia and workshops (authors in alphabetical order).

POLLENS AND SPORES FORMS CARBONIFEROUS SAHARAN PLATFORM: ASSESSMENT OF THE GONDWANIAN AND EURAMERICAN INFLUENCES

F. Abdesselam-Rouighi

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New palynological data on the Carboniferous of the Ghadames Basin have been used to specify the biostratigraphy and paleogeography. In Ghadames Basin we studied three wells (HFR, EME and RFK-1), in the Illizi Basin three wells (BN-1, IRLE-1, TZM-1) and an additional three wells (GK-1, DKM-1 and MR-2) in Timimoun, Béchar Basins.

A comparison between the various Saharan wells is proposed, as is a comparison with the biozonation of western Europe (Clayton et al. 1977) in order to access the Gondwanian and Euramerican influences.

PALEOPALYNOLOGICAL AND PALEOCLIMATIC STUDIES OF LOWER GONDWANA (PERMIAN) WARDHA VALLEY COAL BASIN

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Paleopalynological analyses of 39 coal seams from two coal fields in the Wardha Valley of central India have brought to light the existence of five palynozones. These palynozones range in age from early Karharbari to late Barakar in the Lower Gondwana sub-group. The generic composition of the palynozones is very distinctive when compared with the other Lower Gondwana basins of India. This suggests differences in the paleoclimate and paleoecology of this basin.

Palynozone I is present only in one of the coal fields and the affinities of the palynoflora suggest the predominance of Filicales, with a climate that was cool and moist. During palynozone II a cooling phase is indicated by the abundance of girdling monosaccates. This was followed by a prolonged phase of deposition (Palynozone III) during which there was a shift in climatic conditions from cool humid to warm humid environments. This palynozone can be further subdivided into three subzones peculiar to this basin. Palynozones IV and V have a palynoflora that indicates their age to be middle and late Barakar.

The miospore composition of the different palynozones and the fluctuation in time and space that influenced the paleoclimate are discussed in detail.

FIRST RECOGNITION OF MIDDLE DEVONIAN CHITINOZOAN MICROFAUNAS IN THE CONNECTICUT VALLEY-GASPÉ SYNCLINORIUM ON GASPÉ PENINSULA, EASTERN CANADA

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Devonian strata on the south flank of the Causapscal anticline in the west-central Connecticut Valley-Gaspé synclinorium of the Gaspé Peninsula have long proved difficult to date and correlate. The scarcity of outcrops and the nature of interbedded volcanic, carbonate and siliciclastic rocks have made correlations difficult with the Lower Devonian Upper Gaspé Limestones (UGL)-York River (YR) succession documented in the eastern and western ends of the Gaspé Peninsula. A chitinozoan study has been carried out on a section where the UGL-YR boundary was suspected, but not clearly defined, on lithological grounds. The sequence consists of volcanics (48%) interbedded with carbonates (38%) and siliciclastics (14%). The chitinozoan microfaunas are characterized by species of *Eisenackitina* (simular to *E. castor*) and *Alpenachitina* (*A. eisenacki* and *A. petrovinensis*) that are diagnostic of the Middle Devonian. In North America and North Africa, the species *E. castor* is known from the Givetian, whereas *A. eisenacki* is reported from the Eifelian and lower Givetian. In South America, the association of *A. eisenacki* and *A. petrovinensis* is known in levels referred to the lower Givetian. This is one of the few localities in the Gaspé Peninsula where Middle Devonian fossils have been documented.

Poster Display

UPPER ORDOVICIAN CHITINOZOA FROM THE LAC SAINT-JEAN OUTLIER, LAURENTIAN CRATON OF EASTERN CANADA

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In Late Ordovician time, the Laurentian craton was covered by an extensive epeiric sea. In eastern Canada, however, Upper Ordovician carbonate sediments are only preserved in a few small areas, and in particular, in the Ordovician outlier of the Lac Saint-Jean area. Macrofaunas (trilobites, graptolites) suggest a Kirkfieldian to Maysvillian age for a stratigraphic succession composed of five formations. The basal Tremblay Formation is dominated by coarse-grained sandstone and is overlain by carbonate facies of the Simard (micritic limestone), Shipshaw (fossiliferous limestone and shale), and Galets (echinodermal calcarenite) Formations. These carbonates are abruptly overlain by graptolitic shales (Pointe-Bleue Shale). The carbonate facies suggest a warm shallow water marine setting, in contrast with the more temperate marine conditions recognized for the Middle Ordovician carbonates of the St. Lawrence Lowlands. The Simard and Shipshaw Formations and the Pointe-Bleue Shale have been sampled for chitinozoans. Two distinct assemblages have been identified. The first assemblage extends from the uppermost strata of the Simard to the Shipshaw Formations, an interval assigned to the Edenian by macrofaunas. Chitinozoan microfaunas are characterized by slender forms of *Belonechitina robusta* and *Hercochitina spinetum*. The diagnostic species from the Edenian of the St. Lawrence Lowlands (*Acanthochitina cancellata, Ancyrochitina spongiosa, Hercochitina lineola*) are absent. The first assemblage correlates with the microfaunas described from the lower part of the Lindsay Formation (Simcoe Group) in southern Ontario and the Viola Limestone in the Arbuckle Anticline (Sycamore Creek section) of southern Oklahoma. This biostratigraphic similarity is also associated with a similar sedimentation history (carbonates to shales) recorded in both areas in Edenian and Maysvillian times, and contrasts with the coeval deposition of deep-water Utica Shale and flysch sediments of the Lorraine Group in the St. Lawrence Lowlands. The second assemblage spans the lower 15 meters of the Pointe-Bleue Shale. Five meters above the carbonate-shale contact, in the upper Maysvillian *A. manitoulinensis* graptolite zone, the chitinozoan microfauna is characterized by the appearance of *Conochitina* sp. 2, an index-taxon of the *Conochitina* sp. 2 biozone, as defined in the lower *A. manitoulinensis* zone of the Lorraine Group in the St. Lawrence Lowlands.

CORRELATION OF EARLY PERMIAN PALYNOSTRATIGRAPHIC ZONES AND DEPOSITIONAL ENVIRONMENT OF LOWER GONDWANA SEDIMENTS OF EASTERN INDIA, BHUTAN, WESTERN AUSTRALIA, AND SOUTH AFRICA

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Correlation of ten palynostratigraphic zones from Chuparbhita, seven from Hura, and fourteen from Saharjuri basins in eastern India and four palynostratigraphic zones from Bhutan, eastern Himalaya, recovered from Lower Gondwana sediments has revealed Early Permian palynoassemblages. Radial-monosaccate-dominated early Early Permian palynozones have been identified from the basal sediments of eastern Indian basins. Palynozones in the successive strata reveal *Scheuringipollenites*-dominated palynozones. *Stratopodocar, Striatites, Faunipollenites, Scheuringipollenites* order of dominance is recorded at short stratigraphic intervals. Monosaccate, non-striate, and striate disaccate taxa are Permian climate indicator taxa. Variations in the frequency and combination of saccate taxa suggest climatic fluctuations. More frequent variations in the frequency and combination of trilete and monolete taxa in the palynozones suggest changing patterns of ecological factors. 'Ecological Marker horizons' are identified in the palynostratigraphic zones of eastern Indian basins on the basis of qualitative and quantitative dominance of brackish water acritarchs in the palynoassemblage and are recognised as a marine transgressional phase in the continental facies of deposition. '*Marsupipollenites* Climatic Marker horizon' is distinguished in the Indian basins and palynozone of Bhutan. '*Marsupipollenites* Marker horizon' is correlated with the late Early Permian *Marsupipollenites* in the palynozones of Canning basin and Zambia. Ecological Marker horizon of marine transgression' in the eastern Indian basins is correlated with the late Early Permian shallow marine environment in Bhutan and acritarch swarm influx in the South African and Western Australian basins. Correlation of the Early Permian palynostratigraphic zones of Indian subcontinent with the Early Permian palynozones of Canning basin, Western Australia, and Zambia, South Africa, reveal identical depositional environments during late Early Permian in all the basins. Identical depositional environment suggests closer palaeogeography of the continents during the Early Permian.

SILURIAN SPORES AND CRYPTOSPORES FROM THE ARISAIG GROUP, NOVA SCOTIA

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The siliciclastic shallow marine rocks of the Arisaig Group span the entire Silurian Period. A detailed palynological investigation of the sediments has shown that most of the rocks are dominated by acritarchs, but that a diverse, well preserved, allochthonous assemblage of early spores and cryptospores is present. Thirty two taxa have been recognized, of which ten species are regarded as new.

Llandovery and early Wenlock deposits contain only a few species of laevigate miospores and subordinate obligate tetrads. Dyads were not observed. In marked contrast, 17 species of trilete miospores and 14 species of obligate and hilate cryptospores were recovered from the late Silurian. This radiation, primarily of sculptured sporomorphs, begins in the Homerian and shows a diversity climax during the Gorstian. Species diversity is maintained or falls off slightly through the Ludfordian and the Pridoli even though proximal deposits are sampled. The tempo and composition of these Southern Avalonian events are remarkably similar to those reported from Northern Avalonia and suggest that the stagnation of diversity reported from the Welsh Basin during the latest Silurian is a true evolutionary event and is not facies controlled.

THE MISSISSIPPIAN PALYNOSTRATIGRAPHY OF RUGEN, GERMANY

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Well-preserved spore assemblages are described from two deep, exploration wells on the Baltic island of Rügen. The composite succession in the two boreholes investigated (Rügen 2 and Wiek 3) comprises approximately 1.8km of marine Mississippian (Dinantian) mudstones, calcareous mudstones, siltstones and limestones. Eight miospore biozones are recognized; four in the Tournaisian and four in the Viséan. In ascending order these are; the *Spelaeotriletes balteatus - Rugospora polyptycha* (BP) Biozone, the *Spelaeotriletes pretiosus - Raistrickia clavata* (PC) Biozone, the *Schopfites claviger - Auroraspora macra* (CM) Biozone, the *Gorgonispora multiplicabilis - Convolutispora circumvallata* (MC) Biozone, the *Lycospara pusilla* (Pu) Biozone, the *Knoxrsporites triradiatus - Knoxisporites stephanephorus* (TS) Biozone, the *Perotrilites tessellatus - Schulzospora campyloptera* (TC) Biozone and the *Tripartites vetustus - Dictyotriletes peltatus* (VP) Biozone. The MC and VP biozones are erected on the basis of the Rügen miospore succession. Their bases are defined by the first appearances of *Gorgonispora multiplicabilis* and *Dicryotriletes peltatus* respectively. The BP, PC, CM, Pu and TS Biozones correlate with existing zones of the same name in Western Europe and are essentially defined by the same criteria. The Rügen miospore-succession compares closely with those in the British Isles and Western Pomerania. Correlation with the zonal schemes of both areas can be made at several stratigraphic levels.

DEVONIAN SPORES OF THE PRAIRIE EVAPORITE FORMATION AND THEIR IMPORTANCE TO INTERPRETING THE FORMATION OF THE POTASH DEPOSITS

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The Prairie Evaporite Formation in Saskatchewan contains one of the world' largest potash deposits. The typical practices for mining the potash is to use clay seams found within the salts to "guide" the mining equipment through the potash deposit. Each mine has its own system for identifying these clay seams. Salt and clay seam samples were collected and analyzed for the palynomorph assemblage present. The clay seams were found to contain an assemblage of spores that could be used to correlate not only the clay seams within a particular mine but also between the mines in a regional manner.

Of particular interest was the discovery of four different suites of spores (based entirely upon their complexity) and one barren suite. These suites, when correlated against the clay seams, indicate that the depositional environments of the different salts was quite variable. The clay seams within the sylvite (KCl) deposits were barren or with very simple spores and this is interpreted as a concentration of the formation brines during arid conditions. The clay seams within the halite deposits contained a variety of both zonate spores (*Grandispora*) and spores with simple, bifurcate spines (*Hystricosporites*), and sometimes are associated with megaspores and wood. This is interpreted as representing a freshing of the brine or less arid conditions. Based upon the absenceof marine palynomorphs, it is thought that a marine influence of the Elk Point Basin at this time was minimal, when compared to the lower Leofnard Member, which consists largely of halite. Furthermore, the palynological evidence reversed the prior interpretation that the potash deposit was secondary in nature, but rather indicates that the occurrence of the salts is primary and their origin climatically controlled.

PALYNOLOGICAL AND PALAEOBOTANICAL STUDIES OF THE INDIAN LOWER GONDWANA SEQUENCES

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The Indian Lower Gondwana sediments contain a rich assemblage of plant fossils while animal fossils are rare and limited to few horizons only. This sequence is characterized by the typical *Glossopteris* flora. Palynologically, the older sediments are characterized by the dominance of trilete-bearing radial monosaccate pollen grains and *Gangamopteris* dominant flora. The overlying sequences are succeeded by non-striate disaccate pollen grains followed by striate disaccate taxa and are associated with *Glossopteris* dominant flora. Some of these taxa continue, though with a decline, and replaced by *Dicroidium* flora during Early Triassic. This succession is broadly comparable with those of the other Gondwana continents.

In the Indian subcontinent, the Lower Gondwana sedimentation commenced with a severe glaciation during Early Permian Period. Frequent marine incursions influenced more the marginal basins while it was limited in extent in cratonic basins. Following glaciation the climate ameliorated becoming milder and moist permitting luxuriant growth of vegetation as is evidenced by thick deposits of coal. Towards the close of the period the climate turned arid. Similar climatic changes are adduced to be prevalent mostly through the Permian Period of different Gondwanic continents. Recent palynological and palaeobotanical evidences through Permian of India are reviewed in the present communication along with geological, palaeontological, as well as the phytogeographical perspectives.

DEVONIAN PALYNOMORPHS FROM THE WESTERN BORDER OF THE PARNAÍBA BASIN, TOCANTINS VALLEY REGION, NORTHERN BRAZIL

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Up to now, with only few exceptions, most of the palynological investigations in Paleozoic basins of northern Brazil have been carried out in connection with hydrocarbon exploration by PETROBRAS. As a result, much of the available data in these basins is still restricted to subsurface studies in the form of unpublished reports, in spite of locally extensive Paleozoic outcrops.

The aim of the present study is to provide updated palynological information for poorly studied Middle and Upper Devonian outcrops on the western border of the Parnaiba Basin (Tocantins valley area, Tocantins State, northern Brazil), and to improve the understanding of the local biostratigraphy and palcoccology. Twenty-two outcrop samples (mostly derived from the Pimenteira Formation) have been investigated. Many of them correspond to silty or shaly horizons within a dominantly sandy sequence, characterized by well developed tempastites with prominent hummocky cross-stratification. Most samples have yielded miospore-domminated microfloras, with acritarchs and chitinozoans as minor components (not more than 15% in average).

Altogether, the studied assemblages comprise at least 56 species. Amongst these are biostratigrapncally significant forms such as the miospore species *Gemmospora lemurata, Grandispora libyensis, G. megaformis, G. velata, Granulatisporites frustulentus, Verrucretusispora robusta*, and *Verrucosisporites premmus*, the actitarchs *Maranhites brasiliensis, Estiastra rhytidoa*, and *Duvernaysphaera angelae*, and the chitinozoans *Ancyrochilina langei, Angochitina mourai* and *Ramochitina ramosi*. Many of the identified miospores are typical members of Middle Devonian assemblages in Gandwanan or Euramerican regions. Therefore, they allow easy correlation of the local successions with Devonian miospore zonal schemes established in those areas by Richardson & McGregor (1986) and Street *et al* (1987). Middle Devonian and Frasnian ages are well characterized for at the least the Pimenteira Formation in the studied area.

Sediments and their palynological content reflect the dominance of nearshore marine environments under strong terrestrial influence during the Middle Devonian. The presence of shelly macrcofossils such as brachiopods (*Mucrospirefer cf. pedroanus*, ambocoeliids, and chonetaceans), in addition to the chitinozoans and abundant land-derived phytodebris, are consistent with the inference of shallow marine environment. Deeper water settings are inferred for the Frasnian on the basis of lithofaciological and palynological evidence.

NOMENCLATURE: WHAT'S HOT AND WHAT'S NOT IN 1996. NEWS, VIEWS AND PERSPECTIVES ON FOSSIL PLANT AND PALYNOMORPH NOMENCLATURE.

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Nomenclature is an indispensable aspect of biological research. There is obvious truth in William Shakespeare's contention that "That which we call a rose by any other name would smell as sweet"; however, it is also true that chaos would prevail if we each had our own name for that beautiful, aromatic flower. A standard system of nomenclature is a basic prerequisite for meaningful communication: in biology, Linnean nomenclature has provided such a foundation. Linnean nomenclature may not be perfect, but it is universal and has more flexibility than its detractors claim. Its universality is arguably its greatest strength, and the future course of Linnean nomenclature is of potential concern to all biologists and paleontologists.

These are active times (exciting for some, vexing for others) in the world of Linnean nomenclature, especially botanical nomenclature. Not only have there been significant changes to the International Code of Botanical Nomenclature in recent years (for example Latin or English descriptions required for fossil plants) and proposals to change it in the future (e.g. "Names in Current Use" listings and registration of names), but suggestions are afoot to produce a "panbiological" nomenclatural code by the year 2000. This poster highlights some current issues and the current structure of the botanical nomenclatural "establishment" (which of course includes the present authors). Paleobotanists and palynologists wishing to give feedback on controversial issues can do so either by way of their own window on this "establishment" - the *International Association for Plant Taxonomy* sponsored *Committee for Fossil Plants*, or through letters or articles to such publications as *Taxon*, *Palynos* or the *IOP Newsletter*.

Poster Display

PALYNOSTRATIGRAPHY AND PALYNOFACIES OF THE CARBONIFEROUS (TOURNAISIAN-NAMURIAN), COURTMACSHERRY AND LISPATRICK FORMATIONS OF THE SOUTH MUNSTER BASIN, IRELAND

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Strata composing the Courtmacsherry and Lispatrick Formations are predominantly of a fine-grained marine clastic nature and strictly range from Tournaisian - Viséan in age. Palynological and palynofacies analysis has been carried out on the mudrocks from these uppermost basinal formations. Despite the high thermal maturity and poor-preservation of the palynomorphs present, palynological and biostratigraphical evidence can be gleaned from these organic-rich rocks.

Members 1 and 2 of the Courtmacsherry Formation have yielded *Spelaeotriletes pretiosus - Raistrickia clavata* (PC) (Mid-Tournaisian) miospore biozonal assemblages. Members 3 and 4 of the Courtmacsherry Formation and that of the lower part of the Lispatrick Formation have yielded poor assemblages which indicate an age of no older than that of the *Perotrilites tesselatus - Schulzospora campyloptera* (TC) miospore biozone (Mid-Viséan). So far, the evidence for the intervening miospore biozones is minimal, with a condensed stratigraphical sequence suggested.

Preliminary characterization of the depositional environments using palynofacies analysis suggests the Courtmacsherry Formation is of a probable anoxic basinal slope or restricted basinal situation; grading into more distal basinal facies for the Lispatrick Formation.

CARBON ISOTOPES, KEROGEN TYPES AND THE PERMIAN/TRIASSIC BOUNDARY IN AUSTRALIA

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Evolution of the Earth and its biota are intimately linked. If changes are to be measured reliably, an accurate timescale is required. The existing fossil and rock records show that numerous extinction and oceanic chemical 'events' have occurred through time, but to test their synchroneity demands an agreed set of parameters to be used as time markers. Fossils, geochronology, palaeomagnetics, and isotopes have all been used. Numeric ages based on isotopic decay would seem, *a priori*, to be unique, but significant variance can result from analytical methods. Changes of either fossils, or magnetics, or isotopes, give a relative time scale; all use pattern recognition techniques, such as the simple shape of an isotopic curve, sequences of normal/reversed polarity, or the spine density and cavate construction of a spore. Historically, changes in fossils define the boundary between the Permian and Triassic. Other parameters may supplement and complement this, and when established, be used as proxies. In this paper, we discuss the current use of carbon isotopes of organic matter to locate the boundary in Australia. We first review the global, independent age evidence for using these parameters with the realization that the boundary position itself is under review. In our data set, from the western Australian basins, we have evidence that organic matter type and isotopic signature are strongly correlated. From a fauna bearing core, dated as Early Triassic by the bivalves *Claraia stachei*, *C. sp. cf. concentrica* and *C. perthensis*, woody-dominated kerogen assemblages have an isotopic signature in common with Permian values (C^{13} -23.5 to -24.8‰) from elsewhere in Australia, whilst spinose acritarch-dominated assemblages, from the same core, are lighter isotopically (C^{13} -28 to -34‰), and equate with values given elsewhere for the Triassic. The heavier, more typical Permian, isotopic values in the Triassic may result from reworking of older kerogen, but evidence for reworking is lacking. For this area, the use of carbon isotopic values for age dating seems premature. Its future application demands a rigorous assessment against all available geologic and paleobiologic parameters.

CARNIAN AND NORIAN PALYNOFLORAS FROM THE NEWARK SUPERGROUP, EASTERN UNITED STATES AND CANADA, AND THE ARGANA BASIN OF MOROCCO; RELATIONSHIP TO TRIASSIC CLIMATE ZONES

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The cyclostratigraphy and magnetic reversal stratigraphy of continuous cores from the Late Triassic Newark basin has established a rigorous temporal and paleogeographic framework that permits high-resolution correlation between separate, but tectonically similar, rift basins in the United States, Canada, and Morocco. Preliminary comparisons of Carnian and Norian palynofloras from the Taylorsville, Fundy, and Argana basins suggest that percentages of monosaccate and bisaccate genera increased over 7° of paleolatitude from the humid, equatorial environment of the Taylorsville basin to the subequatorial arid zone that encompassed the Fundy and Argana basins.

Palynofloras recovered from cores of the Upper Taylorsville basin section are dated as Early Norian on the basis of palynofloral composition and initial paleomagnetic results. These assemblages contain abundant *Camerosporites secatus* and *C. verrucosus*. Correlative palynomorph-bearing units from the Argana basin have been identified on the basis of preliminary paleomagnetic data. These assemblages are dominated by *Triadispora* spp., bisaccate species of the genera *Alisporites* and *Klausipollenites*, and monosaccate species of *Cordaitina* and *Daughertyspora*. Rare grains of *Camerosporites verrucosus* and *Patinasporites densus* are also present. Monosaccate genera such as *Cordaitina*, *Daughertyspora*, and *Tulesporites* also predominate in the oldest assemblages yet recovered from the Fundy basin of maritime Canada. These palynofloras are dated as Early to Mid-Carnian based on the presence of the index species *Cycadopites stonei*, *Lagenella martinii*, and *Brodispora striata*, providing the first age estimates for the basal Fundy basin section.

Poster Display

PALYNO-BIOSTRATIGRAPHY OF DEVONIAN STRATA IN NORTHEASTERN ESFAHAN CITY, CENTRAL IRAN

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Devonian sediments are well-exposed in northeastern Esfahan City. The sequence is 700 m thick and it has been divided into the Padeha and Bahram Formations. The Devonian sequence is disconformable with the Silurian strata below and Upper Permian above. A total of 100 samples were treated for palynomorph entities. Eighty-three palynomorth species were identified and arranged in six local stratigraphical zones as follows: Assemblage zones I through IV appear in the Padeha formation and extend through basal part of the Bahram formation. These are characterized by the presence of *Chomotriletes vedugensis*, *Saharidia lusca*, *Papulogbata annulata*, *Stellinium actoaster*, *Deltotosoma intonsum*, *Lagenicula minutus*, *Samarisporites triangulatus* and *Archaeopersaccus scabratus*. Assemblage zones V through VI occur in the Bahram Formation and they are characterized by the appearance of *Horologinella horologa*, *Gorgonisphaeridium chuoense*, *Grandispora cornuta*, *Grandispora cornuta*, *Grandispora famenensis*, *Retispora lepidophyta* and *Vallatisporites pusillites*. The acritarchs and miospores of these zones were compared with those of elsewhere. The comparison reveals broad similarity with those of North Africa and western Australia. Since some acritarch species of Iranian Platform, such as *Deltotosoma*, *Papulogabata*, *Horologinella* and *Saharidia* have been only recorded from western Australia and north Africa, thus it would be reasonable to suggest that Iranian Platform, Australia and Africa were located at the same paleo-latitude during the Upper Devonian

PALYNO-BIOSTRATIGRAPHY OF LOWER PALEOZOIC STRATA IN NORTHEASTERN ALBORZ RANGE OF IRAN

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At northeastern Alborz Mountain Ranges, a lower paleozoic sequence ranging from Cambrian through Ordovician, and Silurian periods were studied for palynomorph entities. A total of 115 acritarch species were identified and arranged in four local stratigraphical zones as following:

Assemblage zone I: This zone appears in the Upper Cambrian strata and is characterized by the presence of *Ooidium rossicum*, *Timofeevia Lancarae*, *T. Pentagonalis*, *T. Phosphoritica*, *Cristallinium cambriense*, and *Goniosphaeridium dentatum*.
Assemblage zone II: This zone appears in the Lower Ordovician sediments (Lashkarak Fm.) and is characterized by the occurrence of *Dactylofusa squama*, *Acanthodiacrodium angustum*, *Arbusculidium filamentosum*, *Coryphidium milada*, *Striatotheca triangulata*, *Cymatiogalea cuvillieri*, *Stelliferidium cortinulum*, and *Vulvanisphaera africana*.
Assemblage zone III: This zone appears in the upper Ordocician sediments (Gelli Fm.) And is characterized by the presence of *Veryhachium subglobosum*, *Villosacapsula setosapellicula*, *Actinotodissus crassus*, *Ordovaeridium ternatun*, *O. Inflatum*, and *O. Insculptum*..
Assemblage zone IV: This zone occurs in the Silurian sediment (Niur Fm.) And is characterized by the appearance of *Dactylofusa estillis*, *D. Maranhensis*, *Evittia denticulata*, *Neoverthachium carminae*, *Visbysphaera brevifurcata* and *V. microspinosa*.

The acritarch species of these zones were compared with those of elsewhere. The comparison reveals that the encountered species of Iran are similar to those of southern Europe, north Africa, and South America. Therefore, it would be reasonable to consider the northeastern Alborz Mountain Ranges of Iran, part of the Mediterranian Acritarch Province.

MEGASPORE BIOSTRATIGRAPHY OF THE TRIASSIC SEQUENCE I PENINSULAR INDIA

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Megaspores were not known earlier from the late Lower Triassic sequence (Deoli Member of Panchet Formation) of Peninsular India. Altogether nine species of megaspores belonging to the genera *Banksisporites*, *Biharisporites*, *Verrutriletes*, *Talchirella*, *Srivastavaesporites*, *Pantiella* and *Maiturisporites* have been described from the Deoli Member of Panchet Formation, exposed in the (Dhardharia Nala Section) southeastern part of Lugu Hill (23°44'58"N : 85°45'57"E), East Bokaro Coalfield (a disconnected part of Damodar Valley Basin), India. Out of these, one species each of *Biharisporites*, *Verrutriletes* and *Talchirella* is new to science. Quantitatively the assemblage is characterized by the preponderance of *Srivastavaesporites* and *Banksisporites*. A comparison of this assemblage with other known Indian megaspore assemblages from: I) early Lower Triassic (Maitur Member of Panchet Formation, Damodar Valley Basin), ii) Lower-Middle Triassic (Nidpur Beds, South Rewa Basin), and iii) Upper Triassic (Tiki Formation, south Rewa Basin) reveals the megaspore biostratigraphy of the Triassic sequence in Peninsular India.

THE TRUE DIVERSITY IN THE PALYNOLOGICAL SAMPLES AS STRATIGRAPHIC TOOL IN THE UPPERMOST PERMIAN OF THE RUSSIAN PLATFORM

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Palynological diversity provides important floristic information reflecting to some extent the diversity of that palaeophytocoenosis which was the source of the miospores forming the assemblage under consideration. This feature, however, is usually strongly masked during the transition from the sample to the spectrum which is essentially accidental (random sampling without return). The examination of distribution of species according to their abundances in spectrum shows that this distribution is close to logarithmically normal, truncated at the point 1/2, and allows estimation of the true diversity of the samples. In the Tatarian of the Russian Platform, the true diversities of samples decrease monotonously along the stratigraphic sequence (from 267 species in the Uppermost Kazanian up to 34 - 45 species in the Uppermost Tatarian). This fact, probably reflecting a real trend in the evolution of Tatarian vegetation, may serve as a useful tool for regional stratigraphic correlations along with traditionally studied quantitative composition of spectra.

SEQUENCE STRATIGRAPHICAL ANALYSIS OF THE LOWER MUSCHELKALK (MIDDLE TRIASSIC, ANISIAN) IN THE GERMAN BASIN: SEDIMENTOLOGICAL AND PALYNOLOGICALASPECTS

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In the western German Basin, the Lower Muschelkalk is represented by a series of 100 meters peritidal sediments consisting of muddy limestones (Wellenkalk) and bioclastic calcarenites. These bioclastic beds (Oolith-, Terebratel-, Schaumkalk-beds) are lithostratigraphical marker horizons traditionally used for basin-wide correlation.

The lateral facies distribution of the Lower Muschelkalk reflects a shallow SSE-sloping homoclinal carbonate ramp. This ramp was subdivided from NW to SE into a shallow lagoonal, intertidal and subtidal zone, each showing characteristic sediment types. On the shallow ramp the calcarenitic beds consist of bioclastic peloid grainstones, on the deeper ramp they are represented by crinoidal wacke/packstones.

The cyclic sedimentation of the Lower Muschelkalk is documented by vertical facies *successions* consisting of characteristic facies units. The entire series represents the first of two sequences within the German Middle Triassic corresponding to a third order cycle. In the studied sections, the TST and HST of this sequence are documented. The LST is recognized in the Upper Buntsandstein. Lower and Middle Wellenkalk (muW1 to muW2) show a clear transgressive trend within the TST. Maximum flooding occured around the Terebratel-beds (muWT). The Upper Wellenkalk (muW3) builds up the HST showing a clear regressive trend. The sequence boundary is situated at the base of the Middle Muschelkalk (mm) evaporites.

Detailed sedimentological analysis allows the further subdivision of the Lower Muschelkalk into 20 stacked meter-scale minor cycles, each showing a shallowing upward trend. These cycles display all characteristic features of sequences, i.e. the succession of system tracts separated by sequence boundaries. Therefore they are interpreted as high-frequency sequences. Sequence boundary and LST are represented by hardgrounds overlain by bioclastic grainstones on the shallow ramp and crinoidal wacke-/packstones on the deeper ramp (TST). The following muddy limestones (Wellenkalk) build the HST.

Palynofacies analysis of the Lower Muschelkalk shows high amounts of inertinit and pollen grains. Spores are rare. Relative high amounts of degraded organic matter are interpreted as pollen in differently advanced degradational stages. Acritarphs and prasinophytes become strikingly abundant in the upper part of the Lower Muschelkalk showing a peak (up to 15%) in the upper muW2 to the lower muW3. This interval corresponds to the late TST and early HST of the Lower Muschelkalk sequence. The same trend may be recognized in the high-frequency sequences which superimpose the Lower Muschelkalk sequence. Significant changes in the palynomorph associations, especially the relative abundance of marine plankton, indicate the major transgressive and regressive trends.

DEPOSITIONAL ENVIRONMENT AND PALYNOMORPHS FROM THE MIDDLE RHAETIAN OF THE SVEDATA-1 BOREHOLE, SWEDEN

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The Svedala-1 bore-hole is situated in SW Scania, southern Sweden. The core consists of both Palaeozoic and Mesozoic sediments of which the coal-bearing interval 1514-1578 meters is the subject of this presentation. This sequence has been investigated palynologically and sedimentologically. The palynomorph content is exceptionally well-preserved and dominated by spores and pollen grains. Among others, the presence of *Riciesporites tuberculatus* Lundblad and *Limbosporites lundbladii* Nilsson narrows the relative age dating to Middle Rhaetian.

In the investigated material, sedimentological facies analysis revealed gradual shifts between palaeosol development (i.e. subaerial exposure), and deposition in a muddy, occasionally wave agitated, lacustrine setting. Evidence exists for the repeated occurrence of lacustrine microdeltas, which subsequently were colonized by plants (rootlets). Palaeopedological data indicate a humid palaeoclimate (in sharp contrast to the underlying Norian redbeds), and the presence of gleysols (poorly drained soils) and luvisols (well drained soils). No suggestion of marine conditions has been recorded but the presence of the colonial green microalga, *Botryococcus*, indicates freshwater composition deposition close to the point of dispersal for the parent. The excellent preservation also confirms that transport over any great distance has not been involved and that deposition occurred under calm, undisturbed conditions.

Poster Display

TETRAD VARIATIONS IN LIVING AND EXTINCT PTERIDOPHYTES AND THEIR BEARING ON THE INTERPRETATION OF CRYPTOSPORES

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The occurrence of a diverse range of megasporangial contents in *Selaginella* has been investigated. The presence of a variety of dyad forms, emphasises the flexibility of tetrad organization within this genus. Variation in tetrad form is known to have occurred among lycopsid and fern magasporangia in the Carboniferous and it is frequently assumed that such varition in tetrad contents among pteridophytes in the Devonian led to the origin of the ovule. This presentation will assess tetrad variations in the fossil record, principally with reference to megaspores, but also to the widespread occurrence of dyads in the Ordovician-Devonian.

PALYNOLOGY AND ORGANIC GEOCHEMISTRY OF THERMALLY IMMATURE LATE UPPER DEVONIAN SEDIMENTS OF THE PAFFRATH SYNCLINE, RHENISH SLATE MOUNTAINS, GERMANY

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The vitrinite reflectance of Upper Devonian sediments in the northern part of the Rhenish Slate Mountains ranges from $\%R_{max}$ = 2.9 to >7. Only in the Paffrath and the Büdesheim Syncline the thermal maturity is much lower ($\%R_{max}$ = 0.7 to 1.). Until recently it was believed that the youngest Devonian sediments in the Paffrath Syncline are of early Famennian age. However, during routine palynological analyses a hitherto unknown late Famennian succession has been recognized in some boreholes. Dark grey mudstones and marls dominate over few thin intercalated limestone layers. The sediments are highly fossiliferous.

The very well preserved miospore assemblages are rich and diverse. Species of the *Diducites* complex are particularly abundant. Based on the occurrence of other stratigraphically significant species such as *Retispora lepidophyta*, *Grandispora cornuta*, *G. aff. echinata*, *G. gracilis*, *Raistrickia variabilis*, *Endoculeospora gradzinskii* and *Cyrtospora cristifera*, the assemblage has been assigned to the Oppel Zone LV. The presence of a diverse population of acanthomorph acritarchs and prasinophyte green algae clearly indicates that the sediments were deposited in a marine environment.

The sediments are lean in organic carbon (0.2-0.9% TOC). According to Rock-Eval parameters (Tmax, HI) the kerogen is classified as immature Type IV. The low yields of C_{15+} soluble organic matter and total C_{11}-C_{40} *n*-alkanes in most samples also indicate immature organic matter of poor quality. Average calculated vitrinite reflectance values of 0.61 - 0.66% were determined from aromatic maturity parameters (e.g. MPR). The distributions of terpanes and steranes give evidence of contribution of terrestrial, algal and bacterial biomass to the organic matter in the sediments. A predominance of hopanes and moretanes over steranes suggests a major terrigenous input from higher land plants.

SEDIMENTATION PALYNOLOGY Pz^3 OF THE EAST OF TUNGUS SYNECLISE (TS)

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The existing criteria for one type use of palynological data when dividing sedimentations of Siberian Platform's Upper Paleozoic palynozones of A. F. Dibner (1978) and L. L. Dryagina (1988); standardized palynocomplexes (MCK, 1988), palynocomplexes of L. N. Peterson (1980; 1988) and V. V. Krugovykh (1988), turned out to be useless in fact due to the following reasons (discovered by the author) in the result of layer by layer palynological investigation of reference sections: 1 - palynozones-indicators of age, the names of which include dominant taxons (A.F.Dibner), do not occur in chronological succession, sometimes manifesting in the section repeatedly, because quantitative correlations of "leading" types do not consider attribution of plants to conditions of growth (facies, climate) and regularity of sedimentation;
2 - types-indicators of age, accepted in palynocomplexes as "leading" for carboniferous deposits (L. N. Peterson), have been discovered together with marine permian fauna: that is, they may come from the previous layer. In similar cases the role of young taxons is underestimated. Owing to our new data in the east of TS, there are revealed only two miospores, providing reliability of upper paleozoic thick layers division by palynological data and meeting requirements of "palynozone"category: 1 - Remysporites spp. (6,3-56,7%)-Cyclobaculisporites spp.(0-24,0%)-Cordaitina spp. (0,8-46,9%)-Ginkgo-cycadophytus spp. (0,6-14,1%). In the spectrum are also various genera of Calamospora, Punctatis-porites, Leiotriletes, Nigrisporites, Trachytriletes, Grani,-Granulatisporites, Acanthotriletes, individually Raistrickia, Lycospora, Turrisporites, Mo-nosaccites, Disaccites, Acritarcha. This association of miospores was revealed from marine sediments, there pevails fauna of arenaceous foraminifer (within P_1 k+P_2 u tiers) & flora (within tiers from C_2 b to P_2 u, with predominance of C_2 b+C_3 g). In connection with this, it is necessary to review standards of Kuzbass flora complexes of this level. 2 - Ginkgocycadophytus spp. (26,5-70,0%)- Cordaitina spp. (17,6-40,0%) - Raistrickia+Neo-raistrickia spp. (7,0-45,0%) - Acanthotriletes spp. (6-25,0%) - Leiotriletes spp.(up to 10,0%). There also is noted the increased grade of chagrenate and tubercular spores and their greater sort variety. This association is characterized by complex of flora (within P_2 kz+P_2 t tiers).

Poster Display

SYSTEMATIC AND STRATIGRAPHIC STUDY OF THE *GRANDISPORA* COMPLEX IN THE FAMENNIAN OF NORTHWEST AND EAST EUROPE

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In Europe different miospore zonation schemes have been erected for the Late Devonian rocks in northwest and east Europe, and correlation of these has been problematical. However, in both regions *Grandispora* taxa are common elements in the respective spore successions, and these have important intra-continental correlation potential. In order to assess this potential, a C.I.M.P. working group has undertaken a taxonomic study of the *Grandispora* complex in the Famennian of both regions. Representative material from Belarus, Poland, Germany, Belgium, France and Ireland has been exchanged and then jointly studied at four workshop meetings. A concensus of agreement has been reached on the morphographical delineation and nomenclature of fifteen *Grandispora* species and a summary of the taxonomic details is presented. The stratigraphic range of each species in northwest and east Europe is documented and compared, and new correlations of the Famennian miospore zones are proposed.

EARLY LAND PLANT PHYLOGENY: RECENT MORPHOLOGICAL AND MOLECULAR EVIDENCE

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New data from molecular biology and evidence from the comparative morphology of living and fossil plants provide diverse, but complimentary, perspectives on the phylogenetic relationships of major groups of land plants and "green algae". Significant new sources of data include paleobotanical information on the morphology of early land plants as well as neobotanical evidence on male gamete ultrastructure and gametogenesis, data on molecular sequences - in particular the widely sampled chloroplast *rbcL* gene and *rRNAs* (e.g., nuclear 18S and 26S; chloroplast 16S and 23S) - and evidence on other aspects of gene structure (e.g., inversions, introns). Interpreting phylogenetic patterns from these diverse data is facilitated by cladistic analysis which has fostered a common theoretical and analytical framework for evaluating competing hypotheses of relationship. These new data support monophyly of green plants (land plants plus "green algae") and land plants (embryophytes) and provide strong evidence that land plants evolved from "green algae" at the "charophycean" grade. Within land plants, there is support for monophyly of the four major extant groups (liverworts, hornworts, mosses, vascular plants) but relationships among these groups are poorly understood. Current evidence suggests that "bryophytes" (liverworts, hornworts, mosses) are a paraphyletic assemblage with liverworts basal to a moss-hornwort-vascular plant clade. Within vascular plants, comparative morphology and some molecular data point to a sister-group relationship between lycopsids and a clade comprising all other extant vascular plants.

Phylogenetic studies imply that the evolution of groups such as liverworts, and perhaps also hornworts and mosses, predates the evolution of vascular plants. This interpretation is consistent with palynological evidence of an early terrestrial flora of basal embryophytes and "bryophyte" grade taxa in the late Ordovician and Silurian, although the precise relationships of most cryptospores to higher land plant groups remains enigmatic. The late appearance of "bryophyte" macrofossils is an outstanding anomaly and suggests that current interpretations of the early fossil record may be influenced by biases affecting the representation and/or recognition of "bryophyte" grade plants.

THE SPLENDOURS AND ODDITIES OF OMANS'LOWER PALEOZOIC HAIMA SUPERGROUP

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The Haima Supergroup of Oman variously comprises terrestrial to fully marine strata, deposited during Cambrian through to earliest Silurian times. Biostratigraphic data (including graptolites, trilobites, conodonts and shelly faunas) are generally scarce. Palynology provides the key regional biostratigraphic tool, although again recovery is confined to isolated windows of marine-influenced strata: these broadly span the CambroOrdovician boundary, as well as ranging from a Llanvirnian through to earliest Llandvirnian age. The oldest assemblages are dominated by acanthomorphs and diacromorphic acritarchs, with chitinozoa and cryptospores becoming increasingly significant from Middle/Late Ordovician times onwards: primitive miospores characterize the earliest Silurian assemblages.

A pragmatic, relatively coarse five-fold palynozonation is routinely used to date these strata. This scheme draws upon the diverse suite of palynomorphs logged at any specific level, with chitinozoa underpinning the Ordovician biozones and cryptospores critical in delineating the Caradoc/Ashgill Epochs. The interplay between the various palynomorphs/ organic debris also provides an indication of proximity to the paleo-coastline, as well as a qualitative indication of source rock potential in the upper levels.

Overall the Lower Paleozoic of Oman has yielded remarkably unusual floras, which in part are quite unlike anything documented from either the Arabian Peninsula or the remainder of Gondwana. Bizarre acanthomorphic acritarchs are found in abundance, as well as a diversity of unusual netromorphs and sphaeromorphs: most are recovered from Middle/Upper Ordovician strata. The cryptospore assemblages are also remarkably diverse, but display strong similarities to floras documented from the type Llandoverian and Wenlockian sections of England and Wales. Current research is focused on fully documenting these floras, which in the longer term may help to refine the existing palynozonation.

PALYNOLOGICAL ANALYSIS OF THE PERMIAN-TRIASSIC TRANSITION IN NORTHERN ITALY

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The Permian-Triassic biotic crisis is known for its devastating effect in the marine realm. It is still unclear, however, how it affected the terrestrial vegetation. In order to obtain insight in the process of collapse of the Late Permian terrestrial ecosystem and its subsequent recovery in the Early Triassic, pollen and spore assemblages may reflect floral turnover. Latest Permian assemblages from the Southern Alps (Italy) show a dominance of gymnospermous pollen, while earliest Triassic assemblages are characterized by the frequent occurrence of lycopodiophytic microspores. Recognition of a transition between these two constrasting assemblages is difficult to detect, due to overwhelming dominance of fungal remains in the palynomorph association. We present the preliminary results of a thorough search for pollen and spore types, performed on 'fungal spike' material from the Tesero Horizon, the basal part of the Werfen Formation in the Southern Alps.

Poster Display

CELLULARLY PRESERVED MICROFOSSILS FROM THREE BILLION YEARS OLD IRON ORE SUPERGROUP, KASHIA, ORISSA, INDIA

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Cellularly preserved spheroidal and tubular microfossils have been identified in bedded carbonaceous cherts from the Archaean of Iron Ore Supergroup dating to be older than ±3.0 billion years. The bedded carbonaceous chert is exposed at Kashia (22°04' : 85°22') Orissa. The spheroidal fossils are either solitary with distinct vacuole or they are arranged in loose colonies. Some of them preserve distinct organic sheaths around indicidual cells. In few cases, distinct binary fission is seen. The tubular forms are narrow and septate. These fossils are among the oldest now known from the geological record of India and their findings substantiate previous reports of Archaean microfossils in iron Ore Supergroup.

PALYNOSTRATIGRAPHY OF THE MIDDLE TRIASSIC SUCCESSION ON THE NORTHERN BARENTS SEA

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Exploration in the Barents Sea area has until now taken place in areas south of 74°30' where about 50 wells, resulted in 16 discoveries. The area north of 74°30' was not open for the oil industry before a first regional seismic package was offered to the industry by the Norwegian Petroleum Directorate (NPD) in 1994. The exploration in these severe areas is expected to be slow, although NPD has gathered a considerable amount of data during recent years. As part of NPD's long term exploration program in this area, IKU Petroleum Research carried out shallow stratigraphic drillings on the Sentralbanken and Gardabanken Highs during the summer of 1990. One aim was to improve the knowledge of the middle Triassic succession which is one of the stratigraphic levels where oil and gas plays are expected. Two of the three cores that were drilled penetrated middle Triassic rocks, including a 20 m Anisian and a 90 m Ladinian core. A Jurassic/Cretaceous core drilled on the Sentralbanken High is presented at this conference by Williams and Larssen.

The Anisian assemblage from core 7532/02-U-01 contained poor to well preserved acritarchs, pollen and spores with the two latter as dominant groups. Presence of *Jerseyiaspora punctispinosa*, *Asseretaspora* group and *Cordaitina gunyalensis* suggests a middle to late Anisian age for this succession. This assemblage closely resembles Assemblage K of Hochuli *et al* 1989, which were indirectly dated as late Anisian by comparison with similar assemblages from ammonite dated beds on Spitsbergen.

The Ladinian assemblage from core 7427/03-U-01 contained moderately to well preserved assemblages of acritarchs, pollen and spores. Presence of *Echinitosporites iliacoides* together with *Ovalipollis pseudoalatus*, *Protodiploxypinus ornatus* and *Triadispora verrucata* apperaing together with *Kraeuselisporites cooksonae*, *Thomsonisporites toralis* and *Schizaeoisporites worsleyi* all points to an early Ladinian age for this succession. This assemblage closely resembles Assemblage I of Hochuli *et al* 1989, which were indirectly dated as early Ladinian by records of similar assemblages from ammonite dated beds on Spitsbergen.

DIFFERENTIAL TRANSPORT OF *CONTAGISPORITES OPTIVUS* AND *GEMINOSPORA LEMURATA* WITHIN A SINGLE DEVONIAN LAKE

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The Devonian of East Greenland comprises a thick sequence of continental clastic sediments. West of the main bounding fault to this basin are scattered Devonian outliers which formed within small extensional basins. One such basin is represented by the Devonian sequence on Ella Ø, where close to the basal unconformity four lacustrine beds occur intercalated with conglomerates. Detailed analysis of one lake unit shows it to have significant lateral variation. At proximal localities high on the unconformity surface it mostly comprises lacustrine turbidities while at distal locations were within a deep stratified lake. Significantly this lake shows a sequence of progressive deepening with the development of stratification and anoxia followed by shallowing and ultimately drying out. Water depth estimates determined following restoration of the unconformity surface for post-Devonian tectonic rotation are of the order of 100 meters at maximum depth in distal locations.

Macrofossil plant debris within the lake sediments shows differential transport with fronds (primarily *Svalbardia/Archaeopteris*) and frond debris at proximal localities but only logs present within distal lacustrine sediments. Conspicuous within the palynological assemblages are *G. lemurata* and *C. optivus* which are the known *in situ* microspores and megaspores for *Svalbardia/Archaeopteris* and presumed to have originated from the same parent plant. Three logged sections within a single lake unit were profiled for 'absolute' abundances of microspores, megaspores *G. lemurata* and *C. optivus* in addition to kerogen type, T.O.C. calcite content and atomic H/C ratio. This provides detailed information within which to interpret changes in palynomorph abundance with sedimentary environment both laterally between sections and vertically within single sections. These data permit comparisons of differential transport between the megaspore and microspore pair and demonstrate significant changes in palynological assemblage composition which occur. This has major implication for the use of abundance data in defining spore assemblages for biozonation.

RHABDOSPORITES LANGII, GEMINOSPORA LEMURATA AND *CONTAGISPORITES OPTIVUS*: AN ORIGIN FOR HETEROSPORY WITHIN THE PROGYMNOSPERMS

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A major Mid Devonian floral event is the incoming and proliferation of the archaeopteridalean progymnosperms. They are generally accepted to have originated from the aneurophytalean progymnosperms. The spores from both groups (the microspore *Geminospora lemurata* and its megaspore *Contagisporites optivus* - Archaeopteridales; *Rhabdosporites langii* - Aneurophytales) are well represented in the Orcadian Basin, Scotland.

Study of a long section in southern Orkney shows that *G. lemurata* first occurs not by progressive size reduction of *R. langii* but as a small thick-walled spore ('early form') which is presumed to originate by heterochrony directly from an immature *Rhabdosporites*. It then progressively increases in size. This early stage of evolution can be timed using the lacustrine cyclicity. Subsequently a rapid increase in abundance occurs with *G. lemurata* replacing *R. langii* as the dominant element of the palynofloras. Originating after the first appearance of *G. lemurata* are spores transitional in morphology between *R. langii* and *C. optivus* indicating the progressive development of the megaspore. These changes, together with the presence of a three-walled species of *Rhabdosporites*, give a hint of the complex changes occurring within the sporangia of the archaeopteridalean group at this time. These changes show how detailed investigation of related spore taxa can reveal the pattern of the development of heterospory in the progymnosperms. This permits for the first time a test of the theoretical models for the development of heterospory.

The recognition that an 'early form' of *G. lemurata* exists indicates that some caution should be exercised in using the first occurrence of this species as a stratigraphic marker.

BIOSTRATIGRAPHY AND PALYNOFACIES OF THE DEVONIAN-CARBONIFEROUS BOUNDARY BEDS IN EASTERN BELGIUM (CHANXHE, TOHOGNE ANDROYSEUX)

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Three sections from eastern Belgium ranging from Upper Devonian to Lower Carboniferous have been analyzed. The uppermost Devonian beds are well exposed in the Chanxhe and Royseux sections, while the transition between latest Devonian and earliest Carboniferous has been observed in Tohogne (borehole section). These three sections expose sandstones at their base gradually replaced by limestone towards their top. Interbedded shales are frequent.

The studied sections show a remarkable micropaleontological content (Conodonts, Foraminifers, Spores and Acritarchs) which enables a detailed subdivision and allows accurate correlation with other reference sections.

Samples from the uppermost Famennian transgression in Chanxhe show, from the base to the top, a succession of three different assemblages of acritarchs (sphaeromorphs, *Gorgonisphaeridium* and a third much more diversified assemblage), each of them associated with a characteristic palynofacies. These can be related with the succeeding facies: alluvio-lagoonal; inshore; offshore. The acritarch assemblages are similar to those described from Ohio and Indiana by Wicander (1974) and Wicander & Loeblich (1977).

The decreasing size of *Retispora lepidophyta* was used to make regional correlations between many sections from the central and the eastern part of the Dinant Synclinorium (Streel, 1966). However, our measurements indicate that the mean size of *Retispora lepidophyta* first increases from 53µm to 65µm, then decreases progressively to 50µm. This appears useful to correlate our three sections with other reference sections.

Poster Display

REWORKED PALYNOMORPHS AS PROVENANCE INDICATORS IN THE YEADONIAN (LATE CARBONIFEROUS) OF THE PENNINE BASIN, U.K.

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The Lower and Upper Haslingden Flags may be differentiated from other Yeadonian sediments in the Pennine Basin on the basis of their petrographical nature and their contained reworked palynomorph assemblages. These lithostratigraphical units consist of a distinct "green" (chlorine) lithofacies and contain reworked Cambro-Silurian and Devonian acritarch assemblages, These characteristics allow:

1) the differentiation of these from other Yeadonian sediments;
2) the recognition of correlative fine-grained sediments in areas in which the Haslingden Flags are not developed as arenaceous lithofacies;
3) the identification of the provenance of the Haslingden Flags from, at least in part, unmetamorphosed (i.e. extra-Caledonide) Cambro-Silurian terrances, and/or from Devonian sediments which contained reworked Lower Palaeozoic palynomorphs.

Studies indicate a western provenance for these sediments. The presence of Gondwanan/Avalonian Ordovician acritarchs, the absence of Baltic/Laurentian Ordovician acritarchs, and the presence of marine Devonian forms suggests that sediment originated from the west or southwest. Areas of Lower Palaeozoic sediments between Ireland and Avalonian Canada may have provided the original sedimentary material but this may have been supplied to the Pennine Carboniferous Basin via multiple phases of reworking involving Devonian sediments.

PALYNOLOGICAL AND SPECTRAL GAMMA-RAY IDENTIFICATION OF CRYPTIC MARINE FLOODING HORIZONS IN THE NAMURIAN (LATE CARBONIFEROUS) KINDERSCOUT DELTA, PENNINE BASIN, UK.

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Detailed sedimentological, spectral gamma ray and palynological sampling of sections through the Kinderscoutian R_{1c} ammonoid biozone in a transect across the Pennine Basin allows the recognition of features which are diagnostic of maximum flooding surfaces in diverse depositional settings. Data from goniatite-bearing marine horizons provide a set of criteria which are applicable to the recognition of maximum flooding surfaces in depositional situations in which marine macrofauna are not necessarily preserved. Examples of these include a section representative of a deep basinal setting (Blake Brook, North Staffordshire) and a section in an unstable, turbidite-dominated delta-slope setting (Blackden Brook, North Derbyshire).

While marine flooding surfaces do not bound units of genetically related strata they are vital for local and regional correlation. The identification of flooding surfaces (whether represented by classic marine band facies or by cryptic correlatives of these) remains key to any understanding of the Kinderscoutian succession in the Pennine Basin. Recognition and differentiation of sequence stratigraphic systems tracts may be wholly reliant upon the identification of key stratal surfaces (sequence boundaries, initial and maximum flooding surface). Identification of these can be difficult in different depositional settings. In particular, the recognition of cryptic marine flooding surfaces in basinal and unstable delta-slope depositional environments increases stratigraphic resolution, allowing a more complete succession of systems tracts to be recognized.

STRATIGRAPHICAL SIGNIFICANCE OF STRIATE AND NON-STRIATE DISACCATE POLLEN IN THE BRITISH CARBONIFEROUS.

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Silesian striate disaccate pollen grains are described from three horizons in the Westphalian of England and Scotland. Westphalian D miospore assemblages from mainly clastic sediments of the Newcastle Group in North Staffordshire are associated with common striate pollen attributed to the genera *Complexisporites* Jizba, *Lunatisporites*, Leschik, *Protohaploxypinus* Samoilovich and *Striatoabeites* Zoricheva and Sedova. *Complexisporites* and *Protohaploxypinus* species are also well represented in early, Bolsovian grey coal measures of the Canonbie Coalfield, Dumbriesshire, Scotland. The third horizon containing striate disaccate pollen is in cored mudstones of the Vanderbeckei Marine Band (basal Duckmantian) from the U.K. sector of the Southern North Sea Carboniferous Basin.

Occurring at all three horizons is a complex of monosaccate *Potoniersporites* pollen grains in which the corpus is thickened proximally by verrucose elements. Alignment of the verrucae frequently results in a distinctive linear pattern of "pseudo-taenae".

Non-striate disaccate pollen of the genera *Pityosporites* Manum, *Parasporites* Schopf and *Limitisporites* Klaus are recorded through the Westphalian. Their earliest British records so far are from goniatite-dated sections in the Marsdenian and Kinderscoutian of the Pennine Basin.

LATE CAMBRIAN ACRITARCH BIOSTRATIGRAPHY OF THE UPPER MISSISSIPPI RIVER VALLEY, MIDCONTINENT U.S.A.

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This is the first report of acritarchs from the type area of the Upper Cambrian St. Croix Series (Dresbachian, Franconian and Trempealeauan stages) in the Upper Mississippi River Valley. The Dresbachian Eau Claire Formation contains a distinctive acritarch assemblage that is correlative throughout Wisconsin, Illinois, Michigan, and Ohio. Several new acritarchs are present in the Eau Claire Formation and occur with *Corollasphaeridium normalisum* Yin 1968, *Granomarginata* sp., *Stelliferidium* sp., *Timofeevia* sp., filaments, algal clusters at various localities in the study area. Where possible, the acritarch distribution is integrated with the North American trilobite zonation. Acritarchs are rarely recovered from the uppermost Cambrian (Franconian and Trempealeauan stages) in this area because sediments are predominately coarse clastic. The majority of samples from these stages were either barren or yielded only algal clusters

Organic-walled microfossils from the upper Midcontinent and Canadian Rockies exhibit taxonomic differences compared with similar aged floras from Gondwana. Assemblages from China have some species in common with North American Late Cambrian acritarch assemblages. This suggests, at least preliminarily, that paleobiogeography previously defined using trilobites is valid for organic-walled microfossils during the Late Cambrian. Correlative strata from the upper Midcontinent and the Reelfoot Rift area to the south show some differences in acritarch assemblages. Paleoecological controls are thought to be responsible for the absence of new Eau Claire species from the Dresbachian in the Reelfoot Rift area, and conversely specimens of *Crystallinium* found in the Reelfoot were absent from the Eau Claire Formation in Illinois, Michigan and Wisconsin.

LATE SILURIAN-EARLIEST DEVONIAN ACRITARCHS FROM THE DADAS FORMATION, SOUTH-CENTRAL TURKEY

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The Dadas Formation is exposed at the Dadas - Hacertun Section near the town of Hazro, southeastern Turkey. The lower Dadas Formation consists of shales and a few thin limestones, whereas the upper part of the unit contains shales and coarser-grained siliciclastics. The acritarchs recovered from this unit are thermally unaltered, diverse and exceptionally well preserved. The assemblages includes the following taxa among others: *Aureosphaera* sp., *"Baltisphaeridium" gueltaense, Cymatiosphaera mariae, Cymatiosphaera* spp., *Cymbosphaeridium pilar, Diexallophasis remota, Diexallophasis sampetrensis, Eupoikilofusa striatifera, Eupoikilofusa striatifera* var. *stereula, Hapsidopalla* sp., *Helios granades, Leiofusa bernesgae, Leoniella carminae, Leoniella vilis, Lophodiacrodium peptno, Multtplicisphaeridium* spp., *Neoveryhachium carminae, Ononagella* spp., *Oppilatala* sp., *Ornia* sp., *Percultisphaera stiphrospinata, Pterospermella* spp., *Quadraditum fantasticum, Stellinium peleteri, Stellinium rabians, Tasmanites* sp., *Tunisphaeridium tentaculaferum, Veryhachium* spp., and *Visbysphaera* spp.

The acritarch assemblage from the Dadas Formation is similar to Late Silurian to earliest Devonian assemblages reported from the circum Mediterranean (Algeria, Jordan, Spain, Tunisia), Sweden and the Former Soviet Union.

Poster Display

PALEOECOLOGICAL SIGNIFICANCE OF THE HYDRODICTYACEAE, ?SCENEDESMACEAE AND ZYGNEMATACEAE (CHLOROPHYTA) IN THE OLDER PALEOZOIC

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Palynomorphs assignable to the Order Zygnematales (Family Zygnemataceae) and Order Chlorococcales (Family Hydrodictyaceae, Family Scenedesmaceae) are not commonly reported in the Early and Middle Paleozoic palynological literature. This absence is inferred to result from the destruction of these microfossils during processing or the authors choosing not to refer to, or illustrate, specimens. Several algal types are illustrated here that display morphological characters attributable to extant members of the Division Chlorophyta.

Geometrical, planar coenobia, here assigned to the Hydrodictyaceae, have been recovered from the Ordovician Bromide Formation of Oklahoma, subsurface Ordovician of Michigan and the Silurian Neagha Shale and Cabott Head Shale of New York and Ontario. Representatives of *Kalyfia* have been isolated from the Silurian Osgood Shale of Kentucky. Other planar coenobia from the Devonian Iquiri Formation of Bolivia and unnamed subsurface units of Paraguay and Poland are also illustrated. A probable non-planar coenobia has been recovered from the Precambrian ("Nonesuch Shale") from Michigan and unnamed Cambrian strata from U. S. A. and Oman.

Specimens with morphlogies comparable to *?Scenedesmus* have been isolated from the Lower Devonian Holland Quarry Shale of Ohio. Examples of the Zygnemataceae are also illustrated from the Holland Quarry Shale.

Present information strongly indicates that these microfossils are paleoecologically significant. With minor exceptions, they occur in marine palynofacies indictative of fresh water influence. In Devonian, or younger Paleozoic, they usually occur with palynological assemblages dominated by spores and terrestrial plant debris. Their presence in near-shore marine (saline/brackish water) depositional environments and absence in unquestionably non-marine rocks may be related to water geochemistry.

Poster Display

CAMBRIAN ACRITARCH BIOCHRONOLOGY AND THE DURATION OF ACRITARCH ZONES

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Organic-walled planktonic microfossils, comprising prasinophytes and protists of unknown affinities, referred to as the informal group Acritarcha, are distributed worldwide in shallow marine Cambrian strata. Their morphological diversity during Cambrian times is revealed by more than 330 species. Taxonomic change in succeeding assemblages has allowed establishment of acritarch biozones that can be correlated with trilobite zones and recognizable in shelf basins surrounding Cambrian palaeocontinents belonging to different faunal provinces. The boundaries of acritarch zones seem to reflect global changes in phytoplankton marking radiation and extinction events. Four formal acritarch zones (and corresponding biochrons) are recognized in the Lower Cambrian.

The duration of the two earliest Cambrian biochrons, the *Asteridium-Comasphaeridium* and *Skiagia-Fimbriaglomerella* Biochrons, is estimated to 2-5 Ma per each biochron. This is based on isotopic age determinations of rock units either comprising, or within successions containing, age diagnostic acritarch and faunal assemblages and embracing the Precambrian-Cambrian boundary. Middle and Upper Cambrian acritarch zones have not been formally recognized, but 10 to 12 zones are defined in various palaeogeographic regions. The duration of the biochrons can be only roughly estimated since they are unevenly represented in the fossil record and probably span time intervals of differing lengths. However, accepting recently established numerical ages for the Middle and Late Cambrian, these biochrons could span comparable periods of time, approximately 2-3 Ma.

THE *MESSAOUDII-TRIFIDUM* ASSEMBLAGE: HIGH RESOLUTION ACRITARCH BIOSTRATIGRAPHY IN THE PERI-GONDWANAN LOWER ORDOVICIAN

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The messaoudii-trifidum assemblage is a distinct microflora from the lower Ordovician of peri-Gondwanan Europe. It is characterized by *Cymatiogalea messaoudii* and *Stelliferidium trifidum*, plus taxa that appear to be restricted to this microflora (e.g., *Acantliodiacrodiuni ? dilatum, Stellechinatum sicaforme and Vavrdovella arenigu*). In many respects the assemblage appears to be transitional between known Tremadoc and Arenig microfloras, and has been used to establish an assemblage biozone across the Tremadoc-Arenig series boundary in northwest England.

The base of the *messaoudii-trifidum* assemblage Biozone has not been located in any section, but the lowest microfloras assigned to the assemblage in northwest England are placed in the upper Tremadoc *Araneograptus murrayi* graptolite Biozone. The top of the *messaoudii-trifidum* Biozone correlates approximately with the top of the basal Arenig *Tetragraptus phyllograptoides* Biozone. The acritarch biozone thus spans three graptolite biozones (*murrayi, Hunnegraptus copiosus, phyllograptoides*). Recent estimates place the base of the *murrayi* Biozone at 490 MA, and the top of the *phyllograptoides Biozone* at 479 MA, giving a duration of I I my for the *messaoudii-trifiduni* Biozone. In northwest England, the *messaoudii-trifidum* assemblage may be divided into five sub-assemblages, each with an estimated duration of between 1my and 4my, and with an average duration of 2.2my. At this level, the acritarchs are able to achieve finer stratigraphic resolution than the graptolites.

Acritarchs of the *messaoudii-trifidum* assemblage are known from Germany (Rügen), Spain, the Czech Republic and North Africa, as well as other parts of the U.K. (e.g., Isle of Man, South Wales). So far, the sub-assemblages identified in northwest England have not been recognized in these areas, but they offer the possibility of high resolution stratigraphic correlations across the Tremadoc-Arenig boundary in this region of peri-Gondwana.

APPEARANCE OF MICROFOSSILS IN HIGH-GRADE METAMORPHIC ROCKS FROM SW - GERMANY

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Organic-walled microfossils have the outstanding property of being highly resistant to high pressures and temperatures. They may be altered to graphite under such conditions; nevertheless their morphology is preserved in many cases in a flattened form, from which they can still be identified. Two groups of such organic-walled microfossils are the acritarchs and the chitinozoans, and here acritarchs are reported for the first time from high-grade metamorphic rocks of upper amphibolite to lower granulite facies.

Until now high-grade metamorphic rocks have been considered to be devoid of fossils, which is a particular disadvantage if the age of the protoliths of these rocks has to be estimated. This estimation has to be based now just on radiometric data, which cannot by its very nature give anything more than a minimum age for deposition. Palynological investigation of metasediments have shown that some organic-walled microfossils are resistant to some metamorphism and tectonic stress, and it is therefore an important question with regard to the highest metamorphic grade to which such resistance can be expected to be found.

The acritarchs here reported were found in gneiss-samples of the northern Black Forest/SW - Germany (Kinzigite - Gneiss). The sedimentation age of the gneiss protoliths can now be dated using the fossils they contain: the acritarchs of the Kinzigite - Gneiss indicate late Precambrian.

Poster Display

PALYNOLOGICAL FINDINGS IN IACUSTRINE SEDIMENTS OF THE GERMAN LOWER ROTLIEGEND (BOREHOLE OBERHAUSEN I, SAAR-NAHE BECKEN, SW GERMANY)

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Lower Rotliegend lacustrine sediments of the Saar-Nahe-Becken (SW-Germany) were met by the borehole Oberhausen I. The core of 40.55 m length is predominantly comprised of sediments of the Odernheim layer (Lebach Group). The sequence was studied according to its pollen and spores content. 12 from 35 samples show sufficient concentration of miospores to evaluate the sequence. In the most cases, the preservation of the miospores permit a determination to their genera only, but occasionally to their species *Potoniesporites* und *Vittatina* are the most common genera. The whole spectrum indicates a parallelisation with the Lower Autunian *Vittatina costabilis*-zone.

The vegetation during the presence of the Odernheim-lake was dominated by Coniferes, followed by Cycadees and Cordaites. Xerophytes increase gradually from bottom to top, as shown by increasing contents of conifer-miospores, bisaccate miospores and taenite/striate miospores.

The palynodebris of all samples indicates the existence of an eutrophic lake with a basal anoxic layer at the beginning of the sedimentation. Change in the composition of palynodebris and a decrease in pyrite in sediments from the middle part of the core to the top give evidence for a decreasingly anoxic environment. The growing diversity of miospore species which takes part parallel to this development may be due to an increase in xerophil floras or due to ecological changes (e.g. transition of strand line).

Poster Display

ABOUT THE CORRELATION OF DIFFERENT ZONES WITH METAMORPHIC FORMATIONS FROM ROMANIA BY THE ACRITARCHS' ASSEMBLAGES DATA

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For the old metamorphic formations from Romania of the Proterozoic and Paleozoic age, where other paleobiological rests are not preserved, the acritarch assemblages reflect very well all the primary paleoenvironmental factors from initial basin of sedimentation.

These acritarchs have supported subsequently all changes of the initial basin, represented by the establish of the new sedimentological conditions, the succession of glacial phases, tectonic and metamorphic events, paleogeographical changes.

So, the acritarchs' assemblages are the alone witness of the primary sedimentary events and are also very well elements for a palynostratigraphical correlation, of these old formations.

We have analyzed and interpreted acritarchs' assemblages from the Bretila Group (Riphean), Rebra Group (Vendian), Tulghes Group (Lower Cambrian) from the East Carpathians and have been correlated with similar zones from the East European Platform or with the other classic regions.

From the Dobrogea County the old metamorphic formations have represented by the Orliga Group (Riphean-Vendian) and the Greenschists Series (Lower Cambrian). These last formations are similar to the East Carpathians ones, because the content of acritarchs' assemblages, tectonic events and the metamorphic degree which have affected these two initial geosyncline basins are also the same.

The acritarchs' assemblages are composed by the taxa of Sphaeromorphitae, Acanthomorphitae, Herkomorphitae, Netromorphitae, Diacromorphitae and other important subgroups.

A very important question in the correlation of acritarchs assemblages from the metamorphic formations is the presence of the rework phenomenon generated by the overthrust, metamorphism, transgression and other geological and tectonic events.

LATE PALEOSOIC MIOSPORES NOMENCLATURE DATABASE (LPMN)

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The palynological information system of dispersed miospores from the Late Paleozoic is carried out for development investigations in keeping and processing of the paleontological and stratigraphical data.

LPMN Database is the result of 1) modification of Potonie and Kremp morphological classification of Devonian, Carboniferous and Permian miospores; 2)revision and description of the dispersed miospores forma-genera; and 3) Diagnostic key creation for dispersed miospores identification.

The database includes the information about synonymy, stratigraphic position, geographic distribution, number of species and bibliography concerning descriptions of dispersed miospore genera.

Poster Display

STABLE CARBON ISOTOPE RATIOS OF SORTED ORGANIC WALLED MICROFOSSILS OF EARLY PALEOZOIC AGE

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Stable carbon isotope compositions are usually measured on the total organic residue. This organic fraction corresponds to remains of various origin that include both terrestrial and marine material. The aim of this study is to evaluate the stable carbon isotope signature of the main components of palynological residues. We analyzed sorted organic walled microfossils from Early Paleozoic samples selected in such a way that they permit to test successively the parameters that may have introduced the most significant shifts in the registered ^{13}C.

The following procedure is applied. 1) The influence of biological affinities is tested respectively on chitinozoans, scolecodonts, leiospheres, graptolite remains, eurypterid cuticles, tracheids. 2) The variation of the ^{13}C through time is controlled using different collections of specimens belonging to a single palynomorph group we extracted from samples of various age, but from the same area. 3) The influence of the paleoclimatic factors are documented on material coming from sites of contrasted paleolatitudinal location. 4) Every group of palynomorphs was extracted from rock samples of different thermal maturation in order to test the influence of burial and metamorphic processes. 5) We used core samples or rock samples free of any oxidation in order to eliminate possible weathering effects.

Variation of 1 to 2% in the ^{13}C values have been commonly recorded for various marine organic walled microfossils of vegetal or animal origin. These variations may reach 4% when the organic matter is of terrestrial origin. We conclude that the documentation of stratigraphic ^{13}C incursions could be optimized by suing a single kind of palynomorph. This procedure should avoid isotopic shifts produced by the accumulation of organic matter of different sources and of different biological affinities.

CONTRIBUTION OF THE CHITINOZOANS TO THE SELECTION OF A GSSP FOR THE SECOND MIDDLE ORDOVICIAN STAGE IN SOUTHERN CHINA

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The goal of the Subcommission on Ordovician Stratigraphy is basically to select both index species and Global Stratotype Sections and Points (GSSP) for the main chronostratigraphic subdivisions of the Ordovician System. Because of obvious faunal provincialism, probably due to highly contrasted latitudinal position of the main paleocontinents, only a few decisions have been adopted for the moment.

Concerning the subdivision of the Middle Ordovician Series into two stages, neither the index fossil, nor the GSSP for the base of the second stage, are yet definitively adopted. *Undulograptus austrodentatus*, a graptolite reported from South China, Australia, North America, South America, Baltoscandia, is the index species proposed by the Subcommission. The graptolite and conodont-bearing sequence of the Jiangshan-Changshan-Yushan (JCY) area in South China, and especially the Huangnitang section, should provide a suitable GSSP for this limit as the range of *U. austrodentatus* is well constrain in this area. However, *U. austrodentatus* is absent from northern Gondwana regions and, therefore, alternative paleontological ties are strongly needed for correlation of the high latitudinal sequences devoid of diagnostic graptolites or conodonts.

For that reason, we investigated chitinozoans from 4 sections of the JCY area, including the candidate stratotype section of Huangnitang. A total of 85 closely spaced samples of black calcareous shales from the Ningkuo Formation have been processed. In spite of occasionally deep weathering, most of them yielded chitinozoans ranging from very poor (a few fragments) to fairly rich assemblages (up to several tens of specimens per gram of rock). The preservation is moderate, i.e. the vesicles are usually flattened and their opaque and brittle wall indicates a thermal alteration. Extensive observation with scanning electron microscope, however, permitted generic and even specific identifications. The most common recorded taxa belong to the genera *Conochitina*, *Cyathochitina* and *Rhabdochitina*, whereas *Tanuchitina*, *Laufeldochitina*, *Belonechitina* and *Desmochitina* are only represented by a few individuals. It is worthy to note the first occurrence of *Sagenachitina*, a typical northern Gondwana taxon, in the lower part of the *austrodentatus* graptolite zone. This taxon should be used for fairly accurate location of the base of the second Middle Ordovician stage in the cold northern Gondwana sequences where *austrodentatus* is missing.

THE CONTRIBUTION OF PALYNODATA

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Since its initiation by Gerhard Kremp 30 years ago, PALYNODATA has developed a datafile which contains stratigraphic, geographic and taxonomic information for the palynomorphs reported in over 19,000 published documents. The size of the datafile increases by 700 - 1,000 documents per year. The database can be queried for the reported occurrences of one or more taxa of interest, for the palynomorphs reported from a combination of ages and/or locations, or for publications by a particular author. The datafile and the software to search it are available in CD-ROM format for IBM and compatible PCs.

BIOSTRATIGRAPHY OF THE ORDOVICIAN CHITINOZOA OF NORTHWESTERN LYBIA

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Chitinozoans from the subsurface of northwestern Lybia have been investigated. A biozonation, representing the Lower to Upper Ordovician interval is settled. It fits well with that of Northern Gondwana, and almost all the biozones establish by Paris (1990) have been documented.

An erosive event, spanning the Middle Arenigian to Lower Llanvirnian, is highlighted with the aid of index biozones, while a hiatus in the recording of some biozones is probably related to water-mass control factors rather than non-deposition or emersion.

From a paleobiogeographic viewpoint Arenigian and Llanvirnian chitinozoans are those typical of the Gondwana Domain, including Avalonia; in the Late Llandeilian a first consistent wave of migration drives typical Baltic elements to the cold sea of Lybia. Later, in the Caradocian, some entries from Laurentia also occur.

But substantially, the chitinozoan microfaunas remain distinct all through the Ordovician, showing a strong influence by water-temperature and water-mass control; it also happens in the Latest Ordovician, despite the fact that some megafossil groups exhibit decreasing in provincialism.

THE CARBONIFEROUS-PERMIAN MIOSPORES FROM SARDINIA (ITALY). AN EXAMPLE OF PLANT MIGRATION FROM FAR EAST AND SOUTH EAST PANGEA TO SOUTHERN EUROPE AT THE END OF CARBONIFEROUS

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A composite microflora with Euramerican, southern Gondwanan and European-Russian elements settled in southwestern Sardinia in the Late Paleozoic. The meso-xerophyte Coniferales, especially represented by *Potonieispories* pollen, occupied a preminent place in the vegetation; but Striatites and Distriatites pollen are also present, and the hydrophytic component, which ranges from small to medium total percentage, is very diversified in genera and species.

The relative age is questionable; Ghzelian-Asselian or Stephanian-Autunian is possible according to the microflora. Radiometric age's analysis of the rhyolithic and rhyodacitic lavas alternated in the sediments, are in progress.

The changes in relative proportion of the composition reflect an amelioration of the paleoclimate from a dry seasonal climate to a more wet one. The presence of far eastern European and far southeastern Gondwanan elements in southern Europe is testimony to a wave of plant migration that, since the assembling of Pangea, began in the Namurian-Westphalian.

Elements common to the European Russian platform are: *Bifurcatisporites sublaevis*, *Distriatites bullaeformis*, *Limitisporites isjumicus*, *Lueckisporites anticus*, *Potonieisporites radiosus*, *Potonieisporites solidus*, *Striatodiplopinites pseudobullaeformis*.

Gondwanan elements are: *Candidispora candida*, *Cannanoropollis* sp., *Crucisaccites* sp. cf. *indicus*, *Densipolienites inrisus*, *Divarisaccus lelii*, *Guthoerlisporites magnificus*, *Plicatpollenites diffusus*, *Plicatipollenites gondwanensi* and *Plicatipollenites trigonalis*.

Euramerian elements are those common to the Stephanian-Autunian of the Massif Central and the Virgilian-Early Wolfcampian of the U.S. Midcontinent. A close similarity to the "Stéphano-Autunien" microflora of Guadalcanal (southwestern Spain) has also been observed.

UPPER DEVONIAN PALYNOFLORA FROM THE CENTRAL IRAN BASIN

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A fairly diversified, moderately well-preserved palynoflora, dominated by organic-walled marine microphytoplankton (acritarchs and prasinophyte phycomata) and with a subordinate miospore complement, has been retrieved from surface samples of the lower Shishtu Formation (Shishtu I) of the Ozbak-Kuh Group, north of Tabas, east-central Iran. The overlying upper Shishtu Formation (Shishtu II) is virtually devoid of palynomorphs. Twenty-four species of prasinophyte phycomata (5 genera) and 59 species of acritarchs (29 genera) are identifiable, including some 14 new species. Microphytoplankton yield is variable among samples, but the following previously instituted species occur fairly persistently: *Cymatiosphaera perimembrana, Daillydium pentaster, Dictyotidium craticulum, Gorgonisphaeridium condensum, G. pierispinosum, Polyedryxium pharaonis, Stellinium micropolygonale, Unellium lunatum, U. piriforme,* and *Veryhachium downiei*. The associated miospore flora is poorly diversified and indifferently preserved, many forms being identifiable only at generic level. *Geminospora lemurata*, quantitatively the most important species, is distributed throughout the palyniferous section, suggesting that the contemporaneous coastal vegetation was not diverse, and was most likely dominated by archaeopterid progymnosperms and ferns.

The palynological evidence suggests that the lower Shishtu Formation accumulated in an open marine, nearshore situation during early Late Devonian (Frasnian) time; this corroborates the faunal evidence. Overall, the lower Shishtu palynofloral assemblage has a relatively uniform taxonomic complexion, lacking any post-Devonian elements that might provide confirmation of the Devonian/Carboniferous boundary at or near the top of Shishtu I. Beyond Iran, similarities are closest with approximately coeval assemblages from Belgium and Western Australia.

PALYNOLOGICAL INVESTIGATIONS IN WESTERN SIBERIA

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Intensive investigation of mineral resources in Siberia in connection with prospecting of hydrocarbon raw materials required the integration of geologic data. To facilitate these studies branch institutes and laboratorial complexes with palynological expertise were organized in different towns (Novosibirsk, Tomsk, Tjumen). The aim of their work was the substantiation of the stratigraphical and facies correlation in predominantly thick continental sequences in Western Siberia.

Palynological investigations in Tomsk began in the fifties in the branch of the Siberian research institute of geology, geophysics and mineral resources (Novosibirsk). For almost thirty years, since 1958, L.G. Markova has been the head of the laboratory. Stratigraphy, paleoflora, paleogeography, and other disciplines were under her auspices. L. G. Markova was the first investigator to explore the Upper Jurassic-Lower Cretaceous flora in Siberia. She is the permanent member and organizer of All-Union palynological commission, and various conferences, including those of international venue.

The laboratory originally consisted of two groups of palynologists. One of these groups (L. V. Aleksandrova, L. L. Iljenok, et al.) was engaged in study of Cenozoic spores and pollen for the geological survey until 1985. The second group (L. G. Markova, A. V. Skuratenko, et al.) investigated palynocomplexes in the older section in association with prospecting of hydrocarbon raw materials.

In the fifties-sixties, Tomsk palynologists conducted regional investigations associated with teams of stratigraphers and other paleontologists from various organizations. These investigations had been directed to the study of the geological structure of Western Siberia. Tomsk palynologists worked primarily with Mesozoic-Cenozoic sediments and authored numerous publications on the paleoflora, the history of vegetation, and paleolandscapes of the Jurassic, Cretaceous, and Paleogene. All this has significantly enhanced our knowledge of the correlation of these deposits.

Beginning with the 1970's, Tomsk palynologists began studing mineral resources in the southeastern part of Western Siberia. This resulted in a series of articles devoted to further details of Jurassic, Cretaceous, and Paleogenic deposits for industrial geological organizations. Almost all stages of the Jurassic were distinguished, including a palynocomplex datum of early Toarian age; paleozones in the Paleogene were established; and the palynocomplex of the Upper Permian was disovered. The correlation of the Jurassic palynocomplexes with faunistically characterized deposits in the north of Siberia and for Paleogene and Neogene with marine sections of the Crimea and the Caucasus were carried out. Lastly, Late Devonian, Middle Carboniferous, and Middle Triassic palynological assemblages were defined.

Since 1995, the laboratory of palynology has been under the auspices of Tomsk State University and associated with the laboratory of micropaleontology. This transfer is connected both with integration of faunal and floral data and to facilitate mentoring of young workers by experienced palynologists.

Since the sixties, studies on the course "Micropaleontology" with the section "Spore-palynic analysis" are conducted at the laboratory. The first in Russia, the text-book on this course has been published, and is scheduled for reprinting. Lately, special training of students according to individual disciplines is being conducted in their third year of study. Under leadership of highly trained specialists, students take part in investigations of main directions of laboratory programs, fulfill course and diploma work, prepare scientific reports for conferences, and publish their articles.

Large tasks are on the horizon for palynologists at Tomsk University. First of all, they, together with paleobotanists, continue work on detailed studies of the oil-and gas-bearing Jurassic deposits. In addition, Devonian palynocomplexes on the basis of extensive collections available in the paleontological museum are being recognized. Stratigraphical investigations of the eastern continental region in Western Siberia are also planned.

THE GEOLOGIC SIGNIFICANCE OF THE LATE PALEOZOIC PHYTOPLANKTON BLACKOUT

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The rapid decline in acritarch abundance and diversity toward the end of the Devonian is considered to represent a major breakdown in marine primary production. A low level of phytoplankton diversity in the fossil record, here designated as the "phytoplankton blackout", is maintained for about 150 million years and ends with the appearance of modern phytoplankton groups toward the end of the Triassic. Arguments are renewed and expanded in favor of TAPPAN's phytoplankton periodicity model suggesting that the Carboniferous to Late Triassic was a time characterized by nutrient fluxes, food chains and general conditions in the oceanic environment quite different from those existing before and after. Unfortunately, this fundamental phenomenon has found little acceptance and consideration in recent discussions concerning event stratigraphy, paleoenvironments and biotic crises.

Emphasis is placed in this paper on the apparent coincidence of the beginning and the end of the phytoplankton blackout with plate tectonic events in the assembly and break-up of Pangea. It is suggested that a combination of factors such as retention of sediments in continental basins, climate-controlled predominance of physical weathering, disruption of oceanic circulation, changes in the type and amount of continental margin sedimentation, a lowered rate of subduction, and blankets of low-salinity surface waters spreading over potentially high productivity shelf areas at low latitudes may indeed have caused sustained nutrient depletion in the ocean as proposed by TAPPAN. Retention of nutrients by the increasing biomass of terrestrial vegetation during the Late Devonian had an additional effect. This contradicts recently expressed notions that the development of an upland vegetation cover caused eutrophication in the ocean resulting in the black shales and extinction events during the Late Devonian.

PALYNOSTRATIGRAPHY OF WESTERN SIBERIA TRIASSIC DEPOSITS

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Division of the Triassic effusive sedimentary rocks in West Siberia is carried on the base of spore and pollen indexes. Systematization of the great number of obtained data made it possible to reveal five pollen complexes (PC) of different ages: 1(1). Taeniasporites-Krauselisporites-Artrisporties-Lower Triassic (Ind); 1(2). Calamosporites-Punctatisporites-Discisporites microdiscus-Vitreisporites-Lower Trianssic (Ind); 2. Alisporites tenuicorpus-Taeniasporites-Nevesisporites fossulatus-Olen'ok; 3. Nevesisporites limatulus-Retusotriletes-Striatites-Anisian; 4. Duplexisporites-Aratrisporites delicatum-Gnetaceaepollenites Ladinian-Carnian; 5. Dipteridaceae (Dictiophyllum)-Cycadopites medius-Striatites-Norian-Rhaetian.

Similarity was found between the early Triassic (Indian) pollen complex of southwestern part of West Siberia and the European ones and also between the northeastern PC1(2) of West Siberia and Siberian PC itself.

Pollen complexes of Olen'ok and more younger Triassic rocks correlate well with the PC of Middle and East Siberia.

EARLY NEOPROTEROZOIC PALYNOMORPHS FROM NORTHERN BALTICA—PALEOBIOLOGICAL, PALEOENVIRONMENTAL AND BIOSTRATIGRAPHIC ASPECTS

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As with their significantly younger counterparts, palynomorphs of Early Neoproterozoic age (1000-650 Ma) are successfully used not only as evidence for ancient life, but also for biostratigraphical and paleoenvironmental analysis. The paleocontinent of Baltica houses a number of Early Neoproterozoic sequences as allochthonous successions in the Caledonian fold belt and as supracrustal successions in aulacogens and troughs. In order to better understand Early Neoproterozoic geological development, two principally important key areas in northern Baltica were sampled for palynological and stable isotope geochemical investigations.

Shales and siltstones from the Early Neoproterozoic Kildin, Volokovaya and Einovskaya Groups and the Skarbeevskaya Formation (Kildin Island, Sredni and Rybachi Peninsulas, all on the Murmansk coast) and the Chapoma Formation (on the Tiersky coast) on the Kola Peninsula, Northwest Russia yielded assemblages of moderately well-preserved acritarchs, prasinophytes and probable cyanobacterial sheaths. The assemblages consist of cosmopolitan taxa recovered from various Early Neoproterozoic (Late and terminal Riphean) settings in Baltica, Siberia, Laurentia and elsewhere. As with several other Neoproterozoic units, successions interpreted as representing deltaic conditions yielded the highest taxonomic diversity, whereas rocks from turbiditic successions yielded the lowest. Preliminary carbon stable isotope data yielded bulk $^{13}C_{carb}$ - values varying between -2.39% and -0.06% vs. PDB for investigated successions in the Murmansk Coast area, whereas values ranging -6.44% and -4.32% apply for the nearly time-coeval succession in the Tiersky Coast. These values compare well to values obtained from Early Neoproterozoic successions elsewhere. The investigated units are, on the grounds of comparable paleontological contents, correlated with units in northern and southern Scandinavia, Svalbard, East Greenland and the southern Urals.

THE DISTRIBUTION AND ECOLOGICAL SIGNIFICANCE OF MEGASPORES FROM THE UPPER CARBONIFEROUS (NAMURIAN A, MISSISSIPPIAN) COAL-BEARING SEQUENCE OF DALQUHANDY, DOUGLAS COALFIELD, LANKARKSHIRE, SCOTLAND

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The Douglas Coalfield of Lanarkshire, Scotland, of early Upper Carboniferous age contains a thick sequence of coal-bearing strata of the Limestone Coal Group. Ten coals occur in an eighty-five meter sequence. Lycopsid megaspores occur abundantly in most of these coals. Ten species of megaspore are recorded from the coals and a discussion of their distribution will be presented. The spores are typical of other Namurian A assemblages and are characterized by the abundance of *Lagenicula subpilosa* forma *major*, *Setosisporites brevispinosus*, *S. hirsutsu*, *S. splendidus*, *Zonalesporites brasserti* and *Rotatispotites rotatus*. Comparisons are made with assemblages from the Lower Limestone Group and other localities in the Limestone Coal Group.

These coals represent the first major economic coals found in Britain. They indicate a major climatic change with a significant increase in rainfall. The main peatr contributors appear to be heterosporous lycophtes but in addition to arborescent taxa many of the parent plants appear to have been sub-arborescent or herbaceous. A comparison with Wesphalian peat-forming communities will be presented.

ACRITARCH DISTRIBUTIONS AND THEIR INTERPRETATION, AN EXAMPLE: THE ORDOVICIAN

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The Group Acritarcha, as defined by Evitt (1963) and as currently understood by most workers, represents a heterogeneous plexus of acid-resistant, organic-walled microfossils of unknown biological affinities. This informal category includes organisms of different origins which cannot be placed into any existing classification, representing therefore a "waste basket" for palynomorphs which cannot be classified into another group. Nevertheless, this group has become very important in solving biostratigraphical, palaeobiogeographical, and palaeoenvironmental problems, especially in Lower Palaeozoic sediments.

The biological origin of the various components of the group is complex. Acritarchs do not only represent the reproductive stages of marine planktic algae, as suggested by several authors, but very probably also include eggs of planktonic animals, as well as other organisms. The interpretation of the ecological and palaeogeographical distribution of the acritarchs is therefore much more complicated than some published papers may suggest.

The Ordovician is the period in which the diversity of the acritarchs reached its acme. Over 250 genera and more than 2000 species are described in the 70 articles concerning Ordovician acritarchs. Only a complete review of this literature can give an indication of the world-wide distribution of Ordovician acritarchs.

The review of the Ordovician literature indicates that nearly nothing is known about the palaeoenvironmental distribution of the acritarchs. Some arguments may suggest evidence for a world-wide provincialism of the acritarch assemblages, as already postulated in the early 1970s. Today, some authors define up to 5 biogeographic provinces in the Ordovician. However, this provincialism must be considered as only speculative, because the exact distribution of the continental blocks, the local palaeoenvironmental parameters, the influence of palaeocurrents, etc., are generally unknown.

PROPOSAL OF A GLOSSARY OF MORPHOGRAPHIC TERMS USED FOR THE DESCRIPTION OF ACRITARCHS

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"Acritarchs" is a term introduced by Evitt (1963) to designate an informal, utilitarian category of organic-walled microfossils of unknown and probably varied biological affinities. For taxonomic purposes, the "group" acritarch is placed under the Code of Botanical Nomenclature, under the heading *Incertae Sedis*, and thus has no status as a Class, Order, or other saprogeneric unit.

Because acritarchs are a heterogenous and polyphyletic collection of organisms of uncertain affinities, they are difficult to classify. Some elements of the acritarch group show similarities, with varying degrees of confidence, to living and extant algae groups, to cysts of marine microphytoplankton, or to eggs of planktonic organisms. Although the biological affinities of acritarchs are not known in detail, they are very useful in solving biostratigraphical, palaeobiogeographical, and palaeoenvironmental problems.

The classification of acritarchs is purely phenetic and based essentially on their morphology. The morphological diversity has necessitated the introduction of a large number of morphographical terms, many of which are generally used inconsistently.

The major objective of the proposed glossary is to reach consensus in the use of nomenclatural elements. The glossary, which will serve as a manual for the description of "acritarchs" includes a review of most of the morphographical terms used for the acritarch group. It is organized in different sections, each of which groups a series of terms, which will be defined, discussed and illustrated by line-drawings and photographs. These sections comprise: the definition of the Group Acritarcha; the general terminology; the symmetry of the vesicle; the vesicle outline and shape; the vesicle wall; the ornament types; the ornament distribution; the process structure and its *general terminology; the* process shape; the process tip terminology; the process base terminology (union with the central cavity); the sculptural elements; the excystment openings; the measurement parameters; as well as list of groups and subgroups, families and subfamilies created for the acritarch group.

Poster Display

SCANNING ELECTRON MICROSCOPY OF POLISHED, SLIGHTLY ETCHED SURFACES OF SILURIAN LIMESTONES FROM GOTLAND (SWEDEN): A METHOD TO OBSERVE PALYNOMORPHS *IN SITU*

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Palynomorphs widely occur as silt-sized particles in fine-grained sedimentary rocks. Palynologists, therefore, prefer collecting samples from shales or siltstones. Generally, palynomorphs are not considered to be very abundant in limestones, although they are typically much better preserved in this lithology.

The Silurian of Gotland consists primarily of alternating micritic limestones and marls. In contrast to marls, limestones in alternating limestone-marl sequences on Gotland usually show little or no signs of mechanical compaction. Therefore, fossils, including palynomorphs, are uncompacted in the limestones, whereas they are flattened in marls.

The use of scanning electron microscopy on polished, slightly etched rock samples allows the observation of numerous fossil groups *in situ*, including palynomorphs, represented by acritarchs, chitinozoans and prasinophytes. Limestones show beautiful, three-dimensionally preserved specimens, allowing the study of the outer and inner wall surfaces. In contrast, siltstones and marls provide slightly to strongly deformed, partly damaged specimens, which become completely flattened and crushed when the sediment is highly compacted.

The observation of palynomorphs in polished surfaces can thus complement the standard preparation technique of hydrofluoric and hydrochloric digestion of rock samples, whereby parts of the palynological spectrum may be lost during heavy-liquid separation, filtering, centrifugation or bleaching procedures. Furthermore, the use of polished rock surfaces ensures that the complete spectrum of organic-walled microfossils, including very small specimens (smaller than 10 µm) are available for study. In addition, this method allows one to view the distribution and orientation of the palynomorphs *in situ* within the sediment, providing information on their compaction and diagenetic alteration.

PALYNOLOGY OF THE LUDLOWIAN BURGSVIK FORMAITON OF GOTLAND, SWEDEN

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The Burgsvik Formation in Kattelviken, southeastern Gotland, crops out in a belt about 50 km long and less than 1 km wide. It is 50 m thick and distinguished from the underlying Eke Formation and overlying Hamra Formation by abundant coarse terrigenous sediments interbedded with siltstones and shales. Sediments of the Burgsvik Formation are considered as having been deposited in supratidal to tidal environments. Dated by conodonts, these beds are Early to Late Whitcliffian or Ludfordian in age (post *Leintwardensis* graptolite biozone).

Nine of twelve samples (kindly provided by Dr. A. Le Herisse) from the upper part of the formation contain abundant well-preserved crypto spores and trilete spores. Numerous filaments or hyphae, possibly related to ascomycetous fungi (Sherwood-Pike & Gray 1985), in addition to many spores and cryptospores were found. The assemblage is very close to that described form Wales by Burgess & Richardson in 1995. It belongs to the *lubycus-Poeciomorphus* biozone, and is contemporaneous with or younger than the *Stellatispora inframurinata* var *cambrensis* sub-zone of Burgess & Richardson (1995).

The mean diameter of the cryptospores and trilete spores ranges between 39 and 46 µm. This observation appears to relate to a general trend of increasing diameter of sporomorphs throughout the Silurian, however the values obtained in Gotland are much higher than those measured in the Lower Devonian from the Welsh Borderland and Belgium. Although the specimens of sporomorphs are abundant, their diversity is low: fewer than 30 species have been identified from nine samples.

PRECISIONS ON THE PALYNOSTRATIGRAPHY OF THE SILURO-DEVONIAN BOUNDARY IN LYBIA

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Well preserved and diversified cryptospores, miospores and acritarchs assemblages have been recovered from a relatively continuous borehole sequence (A1-61) spanning the Siluro-Devonian boundary in the northwestern part of the Ghadamis basin, Libya. The sequence is represented by Lochkovian beds of the Tadrart Fm., transgressive on the Ludlow-Pridoli beds of the upper part of the Alternances argilo-greseuses Formation.

The interest of the present review compared with previous works on contemporaneous material from different boreholes from North African basins, is to propose a biostratigraphic succession based on close samples, precisely dated from the Ludlow-Middle Pridoli and Early Lochkovian by chitinozoa. More than 100 species of cryptospores and miospores were observed, and new detailed morphological interpretations are given. Assemblages are correlated with the spore Zonations established in the Type sequences of the Welsh Borderland and compared to other sporomorph sequences studied in Baltic (Gotland) and those initially demonstrated in Libya.

Comparison of species diversity from high to low latitude assemblages is of great importance for Silurian phytogeography. Affinities between acritarch associations from Libya and those previously described in Gondwanan and peri-Gondwanan sequences in the Siluro-Devonian interval are also discussed.

THE MORPHOLOGICAL BASIS FOR EVOLUTION IN THE CRYPTOSPORES

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Morphology forms the basis of cryptospore taxonomy and from that taxonomy we are now beginning to formulate evolutionary hypotheses of relatedness within the cryptospores. For example, similarities in sculpture are used to tie together dyads and tetrads and, in the upper Silurian, certain trilete spores and cryptospores are clearly related. Thus we see that the dyads do not necessarily represent an evolutionary lineage that is separate from the tetrad line. Early dyads, from the Llanvirnian of Saudi Arabia, show a high degree of size variability within the dyad pair and in overall size. The tetrads from this interval seem to be more variable in size and attachment as well when compared to Silurian species. However the appearance and persistence of these Ordovician forms, as pointed out recently by Wellman, seems to indicate a considerable period of stasis in cryptospore evolution throughout the Ordovician.

Dyad size within an assemblage may provide clues to original ploidy, by comparisons with tetrad volumes from possibly related forms, although the data is currently mixed on this point. There is some evidence from studies of sporogenesis in recent cryptogams, that the dyad condition could be ancestral to the certain lycopods which form a wall after the first meiotic division.

Earlier tabulations of taxon counts through time showed a gradual shift of cryptospore to trilete spore dominance up to the Siluro-Devonian boundary, where ratios exceed 1:1. However, the recent publication of Burgess reveals a greater abundance of triletes lower in the section than seen previously. It is possible that such evolutionary trends are facies controlled and that we need more well-developed sequences before the evolutionary succession from cryptospores to triletes is known with some degree of confidence.

PHANEROZOIC PHYTOPLANKTON DIVERSITY IS DECOUPLED FROM MARINE INVERTEBRATE DIVERSITY

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Four separately constructed curves of Phanerozoic acritarch/prasinophyte generic diversity show a similar pattern of a mid-Paleozoic peak followed by severe depletion at the end of the Devonian with only moderate numbers remaining throughout the Phanerozoic. These data were combined with a dinoflagellate diversity curve to obtain an overall picture of organic-walled phytoplankton diversity over Phanerozoic time. The composite curve reveals a diversity low from the terminal Devonian decline to the rise in dinoflagellates during the Jurassic. This general pattern is unlike that of coeval benthic marine invertebrates who maintained elevated diversity through the remainder of the Paleozoic. At this scale of resolution, benthic invertebrate diversity appears to be decoupled from that of organic-walled phytoplankton.

Studies of modern suspension feeders indicate a moderate degree of food selectivity, implying that trophic partitioning could be an important selective factor in shallow marine habitats. There should be a correlation between phytoplankton and invertebrate diversity. Indeed, extinction scenarios commonly call for the demise of phytoplankton as a precursor to invertebrate decline. If benthic marine suspension feeders and phytoplankton are necessarily trophically coupled, this might indicate that a major phytoplankton group is missing from the fossil record during the lower Carboniferous through Permian interval. There is some evidence from molecular studies in diatoms supporting this claim.

Alternatively, if the ability of suspension/filter feeders to survive on heterogeneous food sources implies only a very weak trophic link to primary producers, a correlation between phytoplankton diversity and marine invertebrate diversity should not be expected. The trophic links between phytoplankton, zooplankton and nekton are more direct and may translate into a stronger diversity correlation. Thus, the decline in acritarch/prasinophyte diversity at the end of the Devonian may have been an important factor in the demise of agnathans and placoderms.

UPPER CARBONIFEROUS (MOSCOVIAN) MICROFLORAS OF EASTERN NORTH GREENLAND

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The marine Carboniferous sediments in Amdrup Land, eastern North Greenland contain excellently preserved spores and pollen in thin shale units interbedded with marine gypsum. The microfloras occur in sediments dated as late early Moscovian and late Moscovian on the basis of fusulinids and they can be directly correlated to the Russian zonation.

The Moscovian microfloras of eastern North Greenland and nearby Bjørnøya and Spitsbergen are poorly known. This poster presents the first preliminary results of a study of the eastern North Greenland microfloras. They are dominated by saccate pollen; striate and nonstriate bisaccate pollen are surprisingly abundant. Spores are present but of minor importance compared to saccate pollen whereas acritarchs are rare.

The eastern North Greenland microfloras form an important link for correlation of the well known microfloras of NW Europe to the south and Arctic Canada to the west, and potentially for correlation of the NW European palynomorph-based zonation and the Russian fusulinid-based zonation.

MICROPHYTOSTRATIGRAPHIC SCALES FOR RIPHEAN - LOWER PALEOZOIC AND MESOZOIC SEDIMENTARY ROCKS OF RUSSIA AND METHODOLOGICAL ASPECTS ITS ELABORATION

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Stratigraphic investigations of Phanerozoic in the oil-gas bearing regions of Russia and adjacent territories of the Former Soviet Union during last two decades were marked with eleboration of autonomous biostratigraphic scales on such groups microfossils as miospores, dinoflagellate cysts and acritarchs. Presently there are a good many of similar microphytostratigraphic scales with a variety of detail for deposits from Riphean to Neogene. Most of these have become the essential part of the regional different rank stratigraphic shemes.

Palynologists of VNIGRI have participated in the elaboration of such regional stratigrapic schemes. Riphean-Vendian acritarch scale of the north Russian platform (Pretimanje), Riphean - Cambrian of the North and South Siberian platform, palynostratigraphic scales of the Carboniferous, Triassic, Jurassic, Lower Cretaceous of the north and southeast Russian platform, Jurassic ones of West Siberia and West Kazakhstan have been made, some of them were for the first time. These schemes /scales have been carried out in accordance with the requirements of the National Stratigraphic Code, in a single methodological key interpretation of palynological data. These are distiguished by a rather high degree detailed and used in practice of petroleum industry on territories of Russia and West Kazakhstan.

DETERMINATION OF SPORE COLOR ALTERATION BY MEANS OF COLOR IMAGE ANALYSIS

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This investigation presents the first results of the application of Color Image Analysis to palynology. Eleven selected palynological slides from one core interval from the Carboniferous Coal Measures in the southern part of the Netherlands were examined. The vitrinite reflectance values of this Carboniferous section range from 0.70 to 0.95 % Rr, whereas the TAI values according to the scheme of D. Batten (Aberdeen) range from 4.5 to 5.

From each of the eleven studied slides eight specimens of the sporomorph *Crassispora kosankei* were selected. The color composition of each spore specimen was determined by measuring the intensities of the red, green and blue color components on two selected areas. The data were evaluated using nested analysis of variance.

Our study shows that the color alteration of spores due to thermal stress is most sensitive in the red part of the visible light spectrum. Three different sources of error can be distinguished. Within the studied sporomorph population, the variance which can be attributed to rank amounts to 65 %. The variance due to variation within the sporomorphs of one sample and the variance due to the variation within one sporomorph amount to 22 % and 13 %, respectively.

The results of this investigation indicate that the application of Color Image Analysis is an useful tool and reduces the subjectivity in spore color alteration studies. This method allows for a more subtle subdivision of rank on the basis of spore color alteration, as compared to TAI.

Poster Display

CHITINOZOA BIOSTRATIGRAPHY OF THE UPPER ORDOVICIAN OF THE BRABANT MASSIF, BELGIUM

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The results of recent studies on the Chitinozoa in the upper Ordovician of the Brabant Massif, both in boreholes and outcrops are presented. The borehole sections and outcrop areas were chosen in an attempt to clarify the upper Ordovician lithostratigraphy and to date, with Chitinozoa, this interval and especially the subduction related volcano-sedimentary complexes. A lithostratigraphical succession for the upper Ordovician of the Brabant Massif is proposed. Although the deep anchizonal metamorphism, Chitinozoa are moderately frequent, diverse and reasonably well preserved.

The Baltoscandian Chitinozoa biozonation of Nolvak & Grahn (1993) proved to be well applicable in the Brabant Massif. Four of their zones were recognized: *cervicornis*, *bergstroemi*, *barbata* and *taugourdeaui* and a good correlation with their biozonation was possible for other Chitinozoa assemblages even when the index species were absent.

The volcano-sedimentary complexes in three localities, the Fauquez outcrop area, the Deerlijk and the Lichtervelde borehole sections, could be dated. They are of a *bergstroemi* to *rugata* age. This corresponds to the lower and middle part of the Pirgu Stage, in terms of Baltoscandian chronostratigraphy, Ashgill.

CHITINOZOA BIOZONATION OF THE WENLOCK OF THE BUILT AREA, WALES, U.K., PRELIMINARY RESULTS

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The graptolite biozonation for the Wenlock was defined by Elles in 1900 in the Wenlock shales of the Built area, central Wales, U.K. Recently the graptolite localities were recollected and studied by J. Harris (1990, unpublished) and later by J. Zalasiewicz and M. Williams (in prep.). Sediments were deposited in the deeper parts of the Welsh basin and are exclusively siliciclastic. The aim of this study is to record in the same samples and sections the biostratigraphical ranges of different groups and biozones as graptolites, Chitinozoa, acritarchs, spores and other fossils if present. It is also the aim to correlate in detail the graptolite and other biozonations established in the deeper parts of the basin with the fossiliferous Wenlock strata from the shallower parts of the basin in the Welsh Borderland, where the stratotypes of the boundaries of the Wenlock series and stages were defined.

In this part of the study the preliminary results are presented of the Chitinozoa from some forty samples sampled throughout the Wenlock from the Built area, in the Built Mudstone Formation. The samples are all well situated versus the graptolite biozonation. The Chitinozoa assemblages are moderately diverse and in medium to poor concentration. Their preservation is moderate to good, showing a slight thermal alteration. The different assemblages will be presented and compared with existing biozonations and especially with the global Chitinozoa biozonation for the Silurian (Verniers et al. 1995)

EARLY NEOPROTEROZOIC BIOMINERALIZED PROTISTS AND ACCOMPANYING ACRITARCHS

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Vase- and gourd-shaped microfossils attributed to *Melanocyrillium* Bloeser occur abundantly in Early Neoproterozoic strata. Occurring worldwide, the fossils were planktonic and are found in uncompressed condition in rocks representing various environments. Because they are largely preserved undistorted, it is believed that they may have possessed mineralized walls and were compared to ciliate-like protists. Fluorescence microscopy of Swedish material (ca 0.8-0.7 GA Visingsö Group) reveals smooth, and probably lightly mineralized walls of even thickness. The original mineralogy has not been conclusively established, but it seems reasonable to assume that it might have been "calcareous". Our new observations reinforce the former interpretation of these microfossils as possible planktonic protist micropredators that produced calcareous loricas.

Extremely abundant haptophyte-like scales occur in petrographic thin sections of silicified micritic carbonates from the Elbobreen and Ryssø Formations in Nordaustlandet, Svalbard. Comparable microfossils were reported from the early Neoproterozoic Beck Spring Dolomite in eastern California (Licari, 1978) and the Tindir Group in Alaska (Allison and Hilgert, 1986). While the mineralogy of Beck Spring and Tindir microfossils is unclear, the present scales display features consistent with a carbonate composition. Although rarely found, these fossils and accompanying diagnostic acritarchs have a cosmopolitan distribution. From their local abundance can be inferred that controlled biomineralization may be an exceedingly ancient feature among protists. However, it may seem that diagenetic alteration over extended periods of time may have reduced the possibility of preservation of delicate mineralized protists to the level of fortuitous events. Their ability for extending the accumulation of carbonate minerals into offshore shelf environments in pre-Phanerozoic times makes these fossils quite significant.

BIODIVERSITY, SPECIATION AND EXTINCTION OF NEOPROTEROZOIC AND CAMBRIAN PHYTOPLANKTON

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Among the most abundant microfossils in Proterozoic and Cambrian rocks, acritarchs reveal diversity fluctuations reflecting trends of changing primary productivity near the Proterozoic-Phanerozoic boundary. Late Neoproterozoic radiations (550-542 Ma) reached levels comparable to those of any portion of the Cambrian system. Microbiotas from successions pertaining to each Cambrian biochron display fluctuations in specific diversity. The rise of diverse acritarch assemblages during the late Neoproterozoic and Cambrian was probably essential for early marine metazoan differentiation, but there are difficulties in correlating the diversity, speciation and extinction patterns of protists to established early metazoan diversity trends. The assemblages from analyzed Cambrian biochrons reveal that Cambrian protist assemblages evolved over relatively short time spans, apparently emanating from low-diversity residual populations after gradual diversity decline. The characteristic microbiotas of the terminal Neoproterozoic, Lower, Middle and Upper Cambrian burgeon during relatively narrow biochronal time spans, subsequently falling to nearly the initial levels. Because of decreasing time spans involved in the Upper Vendian, Lower, Middle and Upper Cambrian biochrons, respectively, the tempo of species turnover seems to have varied considerably during the segments of time comprised by the Neoproterozoic and Cambrian. Speciation levels gradually decreased during Lower and Middle Cambrian times, whereas extinction levels increased during the entire time span of the Lower Cambrian, a trend that seems to have reversed during Middle Cambrian and most of Late Cambrian times.

THE CONTINENTAL PERMIAN (ROTLIEGEND) OF NORTHWESTERN EUROPE: INTEGRATION OF TECTONOSTRATIGRAPHY, MAGNETOSTRATIGRAPHY AND PALYNOSTRATIGRAPHY

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The continental Rotliegend deposits of the Mid-European Permian Basin comprise four distinctive tectonosequences (TS I-IV).The time of formation of these units is constrained by limited paleomagnetic, palynological and radiometric data.

TS I is characterized by large-scale volcanics and is confined to fault-controlled depressions, particularly in the eastern part of the basin (Germany, Poland, Norway). The presence of a latest Gzhelian excursion of normal magnetic polarity (Kartamysh Reversal) may approximate the Carboniferous/Permian (Gzhelian/Asselian) boundary (approx. 290 Ma) within the tectonosequence. Palynological information confirms a Gzhelian-Asselian age.

TS II is formed after the main volcanic phase and includes sediments in local graben structures in NE Germany and Poland. In combination with paleomagnetic data, palynological and megafloral associations suggest an essentially Asselian age of the tectonosequence, with a possible extension into the Sakmarian.

TS III follows a period of prolonged uplift and erosion, and reflects initial thermal subsidence of the eastern part of the basin (Germany, Poland).The onset of the Permian-Triassic Mixed Polarity Superchron, marked by the Illawarra Reversal (approx. 257 Ma), indicates an early Tatarian (Russian classification), late Murgabian-early Midian (Tethys classification) or Capitanian (North American classification) age for the tectonosequence.

TS IV represents the main phase of lateral expansion of Rotliegend sedimentation and reflects subsidence of the western part of the basin (The Netherlands, North Sea). Combined palaeomagnetic and palynological data indicate a post-Kazanian (late Tatarian and post-Tatarian hiatus of Russian classification) or late Midian-Chanxingian (Tethys classification) age for the interval comprising TS IV and the overlying latest Permian marine-evaporitic Zechstein. The numerical age for the Permian/Triassic boundary is 250 Ma.

PHYTOPLANKTON PALEOGEOGRAPHY NEAR CAMBRIAN-ORDOVICIAN BOUNDARY

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Three Late Cambrian-Early Ordovician phytoplankton provinces were established: cold-water Peri-Gondwana province, temperate Baltic province and warm-water province. Provincialism of late Late Cambrian is not clear because of the shortage of data. Early Tremadocian acritarch assemblages in Peri-Gondwana and Baltic provinces had similar taxonomic composition, while several taxa were characteristic only for warm-water province. Provincialism was mostly expressed in Late Tremadocian. Peri-Gondwana and warm-water provinces were characterized by the presence of typical taxa. Phytoplankton assemblages in Baltic province showed a mixed composition with a number of cryophylic and thermophylic forms.

Poster Display

PALYNOLOGICAL EVIDENCE FOR THE MID-CARBONIFEROUS BOUNDARY IN XIAHEYAN OF ZHONGWEI, NINGZIA, CHINA

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Xiaheyan in Zhongwei of Ningzia lies at the eastern margin of the Caledonian Fold Belt in North Qilian Mountains, China, where the Carboniferous marine and non-marine alternation coal-bearing strata are well developed. The Jingyuan Formation of Lower Carboniferous and the Hongtuwa Formation of the Upper Carboniferous were deposited continuously. They are mainly composed of greyish black shales and sandstones, intercalated with thin-bedded limestones and lenticules, yielding abundant conodonts, ammonoids, fusulinids, megaplants and miospores. Three spore-pollen assemblage zones are recognized based on the systematic study on palynology from the two formations, namely,

1). *Tripartites trilinguus—Simozonotriletes sinensis* (TS) Zone;
2). *Lycospora subtriquetra—Gansusispora mammilla* (SM) Zone;
3). *Gardenasporites pinnatus—Microreticulatisporites concavus* (PC)Zone.

The TS Zone is correlative to the NC (*Bellispores nitidus—Reticulatisporites carnosus*), TK (*Stenozonotriletes triangulus—Rotaspora knoxi*) Zones of West Europe and TA (*Tripartites trilinguis—Simozonotriletes arcuatus*), VR (*Simozonotriletes verrucus—Stenozonotriletes arcuatus*) Zones of Jingyuan, China, and is corresponding to the upper part of Namurian E Zone. SM Zone is comparable with SO (*Lycospora subtriquetra—Krauselisporites ornatus*) Zone of West Europe and SB (*Densosporites sphaerotriangularis—Dictyotriletes bireticulatus*) Zone of Jingyuan, China, and is corresponding to Namurian H Zone. This conclusion is in agreement with the age given by Namurian H index fossil of conodont *Declinognathodus noduliferus* (Ellison and Graves) which appears at the lower part of the Hongtuwa Formation. The Lower and Upper Carboniferous boundary in Xiaheyan can be placed between TS and SM Zones. This boundary position is also identical with the *Eumorphoceras* Zone and *Homoceras* Zone of goniatite which is adopted as the international definition on Mid-Carboniferous boundary.

SEDIMENTOLOGICAL AND PALYNOLOGICAL CHARACTERIZATION OF THE PERMIAN BOLZANO VOLCANIC COMPLEX, SOUTHERN ALPS, ITALY

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The Bolzano Volcanic complex is comprised of a series of rhyolitic pyroclastics, basic to intermediate lavas and intercalated fluvial and lacustrine sediments. In the area of study the Bolzano Volcanic Complex overlies the Ponte Gardena Conglomerate or Variscan basement and underlies the Gröden Formation. Active block faulting formed hydrologically closed drainage basins resulting in alluvial fan (debris flow and sheet flood) and lacustrine facies. The fluvial and lacustrine facies are composed exclusively of reworked volcanic rocks and do not exhibit evidence of pyroclastic activity during deposition. Lacustrine sediments are an intercalation of organic rich laminates, carbonate and silica-rich layers (derived from the weathering of volcanic glass and quartz).

An abundant and diverse pollen and spore assemblage has been recovered from lacustrine depositional environments. Many palynomorphs exhibit three-dimensional preservation. This is the result of silica-precipitation from lake waters that retards compaction of palynomorphs. The palynomorph assemblage includes *Alisporites, Convolutispora, Jugasporites, Lueckisporites, Protohaploxypinus, Striatoabieites, Striatopodocarpites, Vitreisporites* and *Vittatina*. Palynofacies range from amorphous (algal) to structured (terrestrial) dominated assemblages which can be related to specific depositional environments in the Bolzano Volcanic Complex.

MIDDLE AND UPPER DEVONIAN PALYNOLOGY AND PALYNOFACIES, HOLY CROSS MOUNTAIN REGION, POLAND

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Abundant and diverse Middle and Upper Devonian spores and acritarchs have been recovered from core samples of the Gielczew IG-5 and Terebin IG-5 wells. These wells are located in the Holy Cross Mountain region of Poland and consist primarily of carbonates and calcareous shales. Palynomorphs and conodonts date the sections penetrated by these wells as upper Givetian through lower Famennian.

Palynofacies of these intervals range from amorphous (algal) to structured (terrestrial) dominated. The palynomorph assemblages includes the spores *Ancyrospora, Apiculiretusispora, Calamospora, Camarozonotriletes, Chelinospora, Corystisporites, Cristatisporites, Dibolisporites, Emphanisporites, Geminospora, Gneudaspora, Grandispora, Hystrichosporites, Lanatisporites, Oculatisporites, Retusotriletes, Samarisporites* and *Verrucosisporites*. The acritarch assemblage consists primarily of *Cymatiosphaera, Daillydium, Gorgonisphaeridium, Multiplicisphaeridium, Polyedryxium, Stellinium* and *Veryhachium*. Several new spores, acritarchs and algal coenobia (Hydrodictyaceae) were recovered and can be associated with specific palynofacies.

Poster Display

THE PHYTOGEOGRAPHY OF THE EARLY TRIASSIC ON PALYNOLOGICAL DATA

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The distribution analysis of the Early Triassic characteristic palynofloras conforms to the palaeofloristic areas: Angarian, subangarian, Euramerian, Gondwanian, which have been proposed on plant fossils. The climatic peculiarities of these areas are marked by several groups of miospores, belonging to xerophytic and hygrophytic mother plants peculiarity.

Poster Display

ORDOVICIAN ACRITARCH IN CHINA

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The Ordovician is widely exposed in China. Data of Ordovician acritarchs in China are well known for use in stratigraphical correlation and for discussing palaeogeographical attribution. The aspects of Ordovician acritarchs can be summarized as follows: 1) The diversity of acritarch assemblage form North China is a little higher than those from contemporary strata of South China, and all exhibit obvious acritarch paleoproviniarism; 2) Arenigian acritarchs show a prominent increase in both richness and diversity. The Mediterranean (Peri-Gondwana) acritarch Paleoprovince, which is characterized by *Arbusculidium, Coryphidium, Striatotheca*, etc., extends to most of South China while acritarch assemblages of North China are attributed to Baltic acritarch Paleoprovince; 3) Near the end of Arenigian, the acritarch assemblages of South China are changed to displaying typical aspect of Baltic acritarch Paleoprovince; 4) *Moyeria* recognized as the fossil pellicle of a euglenid has commonly been discovered from Late Ordovician-Early Silurian strata of South China, Southwest margin of North China and Tarim Basin.

ON THE DISCOVERY OF KEUPER PALYNOFLORA IN THE TARIM BASIN OF XINJIANG, CHINA

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The best exposure representing Mesozoic deposits of southern Xinjiang in the Suqa section of the Tarim Basin. The Upper Triassic deposits of Kuqa is 2286 m. in thickness. It consists of five formations. Over 30 genera and 50 species have been discovered here. Of palaeophytogeographical interst is the fact that the palynological assemblages of Upper Triassic of Kuqa bear a striking resemblance to those of the Lunz Keuper of Austria.

Poster Display

LOWER CHESTERIAN (LATE VISEAN) PALYNOMORPHS FROM THE BLACK WARRIOR BASIN, NORTHWEST ALABAMA

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Lower Chesterian strata in northwestern Alabama are composed of the Pride Mountain Formation, the Hartselle Sandstone, and the lower part of the Bangor Limestone in ascending order. All these strata are Brigantian (V3c) in age on the basis of fossil fauna.

Palynomorphs from the Pride Mountain Formation and the Hartselle Sandstone are very similar: *Lycospora* spp. and *Apiculatisporis baccatus* are common in both units; *Schulzospora* spp., *Rotaspora fracta, Tripartites vetustus, Grandispora spinosa, Raistrickia nigra* and *Cirratriradites granulatipunctatus* occur in low frequency. However, *Discernisporites micromanifestus* and *Crassispora* sp. (with punctuate ornaments) are rare or absent in the Hartselle Sandstone, but more common in the Pride Mountain Formation. The palynomorphs in the lower part of the Bangor Limestone differ from those in the Pride Mountain Formation and the Hartselle Sandstone in the disappearance of *Apiculatisporis baccatus, Rotaspora fracta, Tripartites vetustus*, and *Raistrickia nigra*. After declining in the Hartselle Sandstone, *Crassispora* sp. (with punctuate ornaments) is a common component of the lower Bangor Limestone. *Lycospora* spp. is not as abundant as in the underlying strata.

Based on the occurrence of *Rotaspora fracta, Tripartites vetustus, Grandispora spinosa*, and *Raistrickia nigra*, the Pride Mountain Formation and the Hartselle Sandstone palynomorph assemblages correlate with the VF zone of West Europe, which is in agreement with the age assignment based on fossil fauna. The palynomorph spectra of the Pride Mountain Formation and Hartselle Sandstone are similar to those of the Hardinsburg Formation of Illinois and Kentucky, USA, and from the Visean of the Midland Valley of Scotland. It is difficult to correlate the palynomorphs of the lower part of the Bangor Limestone with existing zonation schemes due to the lack of key components. Based on its stratigraphic relation with the Hartselle Sandstone and the lack of *Crassispora kosankei, Potonieisporites* spp. and *Savitrisporites nux*, we may correlate the palynomorphs of the lower Bangor Limestone with either the top of the VF zone or the lower NC zone of West Europe or both. *Crassispora kosankei* and *Potonieisporites* spp. first occur in the Namurian (upper NC zone) of Europe. *Savitrisporites nux* occurs in the Parkwood Formation (Namurian E zone) of central Alabama. Phytogeographically, the palynomorphs from the Chesterian of northwest Alabama belong to the *Grandispora* suite of Sullivan.

PALEOZOIC TAXONOMIC DATABASE USING HYPERTEXT MARKUP LANGUAGE

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We are building a database containing mainly Paleozoic spore and pollen taxonomic information. The goal of this database is to include all the type species and holotype data, as well as new combinations in order to simplify and speed literature searches.

The database is built using HyperText Markup Language (HTML). The reasons to choose HTML are:

(1) operating system independence, i.e. portability. Most commercially available database system software are based in MS-Windows. Moreover, all of them, as far as we know, are not cross platform, meaning that a database built on one platform cannot be used in a different operating system. The database built using HTML can be distributed on IBM-PC running MS-Windows, Macintosh, and UNIX boxes, etc.
(2) networking possibility. HTML is the language used in designing the World Wide Web. Thus network distribution or retrieving is possible. The network capability will benefit more palynologists than a stand-alone database.
(3) low cost. Building a HTML database involves using a HTML editor and a viewer. There are quite a few HTML editors available over the internet for either IBM-PC running MS-Windows or Macintosh, which are either free of charge or cost less than US$50. One may also use the HTML macro for MS Word or WordPerfect to do the editing. The HTML viewers can be any web browsers, including the well-known Netscape Navigator, Mosaic, MS-Explorer. Off-line viewers (no network required) are also available. The I-view is for IBM PC running MS-Windows, and a Power Macintosh version is under development. The HTML-viewer is for Macintosh. Both have search functions. Another possible selection is the free Acrobat Reader from Adobe, which is designed for Portable Format Document. The Acrobat Reader will be able to read HTML files in the near future.
(4) Simplicity. The database is simple to build and update. Building a HTML database is similar to using a word processor. The use of template further simplify the process because taxonomic information is almost fixed in format, most information can be copied and pasted into the database. Updating the database is possible by users since all HTML files can be edited.
(5) ability to display both text and images on screen. This is a must for taxonomic databases.
(6) ability to go to related taxa from the displayed taxa by embedded hypertext links.

Poster Display

MORPHOLOGICAL DIVERSITY OF SILURIAN SPORES FROM EASTERN NORTH AMERICA. John H. Beck, Weston Observatory, Boston College, Weston, MA. 02193 USA

The Ordovician and Silurian record of the first land plants is largely known only from the spore and cryptospore record as macroscopic remains before the Ludlow are rare. Hence, accurate characterization of spore characters is essential if the phylogeny of early embryophytes is to be developed. Recently, both light microscopy and SEM analysis have been used to characterize more than 50 spore and cryptospore taxa in Wenlock and Ludlow nearshore marine deposits of Nova Scotia and Britian. Many specimens are highly ornamented and display a wide range of morphological variation. In contrast, Silurian assemblages from the central Appalachians are dominated by variously shaped, but subtly ornamented smooth-walled spores. In both cases, however, actual diversity is clouded by limitations inherent to traditional qualitative description methods which do not always allow the unambiguous recognition of morphological discontinuity in fossil populations. An image analysis system using NIH image processing software is currently being tested as a quantitive alternative. Shape and pattern recognition metrics employing percent coverage of selected density, closeness of fit to geometric ideal types, and pattern analysis of surface sculpture are providing new quantitative characters for sporomorph taxonomy and phylogeny.

WHAT HAPPENED NEXT? Christopher M. Berry and Muriel Fairon-Demaret. Services Associés de Paléontologie de l'Université de Liège, Place du Vingt-Août 7, B-4000, LIEGE, Belgium.

While some Rhyniopsida survive into the Middle Devonian, members of the Zosterophyllopsida/Lycopsida lineage continue beyond. However it is the Trimerophytopsida which was apparently the crucible of uppermost Lower/Middle Devonian plant evolution. The ribbed xylem column and dichotomous/pseudomonopodial branching of the more advanced trimerophytes were well suited to processes of non-adaptive evolution which allowed the establishment of major lineages, including perhaps Progymnospermopsida, Sphenopsida and Filicopsida. Devonian Cladoxylopsida are often regarded as intermediaries between trimerophytes and horsetails/ferns. We have revised the morphology of classic members of the group.

Hyenia elegans, *Calamophyton primaevum*, and *Cladoxylon scoparium* Kr. & W. are synonymous. *Hyenia 'complexa'* of Leclercq belongs to the same genus. Evidence for a rhizome is unconvincing.

The 'fronds' of *Pseudosporochnus nodosus* Lecl. & Bks are not planate: typical examples are composed of a central axis and subopposite to alternately arranged dichotomising ultimate units in which successive dichotomies are perpendicular. A new Venezuelan genus, otherwise similar to *Pseudosporochnus*, has lateral branching systems in which ultimate units arise from the central axis in a three-dimensional fashion.

The earliest putative cladoxylopsids (*Foozia* Gerr., *Protohyenia* An.) have the simplest morphology; later taxa are unlikely to have evolved by reduction. Progress will be made towards identifying patterns of evolution within Cladoxylopsida by understanding the relationship between morphology, anatomy and development. These methods may also be applied to closely related Iridopteridales.

Having cleared up some of the 'mythology' surrounding Devonian Cladoxylopsida we now intend to work towards producing a realistic modern assessment of the role of these plants and their relatives in land plant phylogeny.

BIOLOGICAL ROLES FOR PHENOLIC COMPOUNDS IN THE EVOLUTION OF EARLY LAND PLANTS. Gillian A. Cooper-Driver, Department of Biology, Boston University, Boston, MA. 02215. USA

The ecological struggle for the first vascular plants to survive in a terrestrial environment must have been intense. Coupled with the lack of readily available resources, such as water and nutrients, early land plants were faced with competition from other land invading organisms. Although fossils of unequivocal herbivores are lacking from early terrestrial ecosystems, there are examples of plants with "stained lesions" and "wound response tissues" suggesting an early evolution of biochemical responses to soil or other microbial communities. Phenolic compounds are presently known to play a major role in controlling litter decomposition and hence nutrient cycling by soil detritivores and also to protect below ground and photosynthetic tissues from bacterial and fungal pathogens. Did, as in some extant plants, lignin or other cell wall phenolics rapidly accumulate at sites of attempted penetration by plant pathogens or had such mechanisms of defense not yet arisen? Can we assume that lignin and suberin and other cinnamate derived secondary compounds played similar roles during the evolution of early land plants comparable to the role they play today? Such questions will be discussed in the light of our knowledge of both extinct and extant ecosystems.

STABLE CARBON ISOTOPE VARIABILITY OF PLANT TISSUES: IMPLICATIONS FOR INTERPRETATION OF THE FOSSIL RECORD. Mary E. Dettmann, Mike Pole, and George R. Stewart, Department of Botany, University of Queensland, Qld. 4-72, Australia

To test the application of stable carbon isotopes to interpretation of past environments a comparative study has been undertaken on %C and $\delta^{13}C$ ratios of some 100 extant gymnosperm and angiosperm taxa. Percentage carbon and $\delta^{13}C$ signals have been determined for whole leaves and their cuticle and vascular tissue fractions of C_3, CAM, and C_4 plants from a range of semi-arid to mesic communities. A strong relationship was found between the $\delta^{13}C$ value of whole leaf, cuticular, and vascular tissue with the values expressing a depletion series. Moreover, a strong relationship was found between ^{13}C natural abundance of each aliquot and moisture availability, with a depletion gradient from dry-zone to mesic communities. The implications for fossil studies are discussed.

THE PERMO-CARBONIFEROUS FLORISTIC TRANSITION, SW U.S.A. William A. DiMichele and Sergius H. Mamay, Paleobiology Department, Smithsonian Institution, Washington, DC 20560 USA

Assemblages of fossil plants from Texas and New Mexico span the Carboniferous-Permian transition. The most common floras in the Virgilian (late Stephanian) are rich in medullosan pteridosperms and marattialean tree ferns, and are typically Carboniferous in aspect. They occur in coaly, organic shales and associated mudstones, representing wet floodplains and swamps. Rare in the Virgilian are floras of Permian aspect, dominated by *Sphenopteridium*, walchian conifers, and other seed plants. These usually occur as thin beds at the base of channel fill sequences, closely associated with floodplain coals and shales, and may be lag deposits emplaced during rising base levels. The juxtaposition of these floras in the Virgilian records the fluctuation of regional climate from drier during sealevel low stands to wetter during high stands.

During the Wolfcampian (Asselian-Sakmarian), seed-plant dominated floras become increasingly common; particularly abundant are conifers and taeniopterids. Floras rich in medullosans and pecopterids occur with less frequency. The depositional association of these floras at the outcrop scale diminishes in the basal Wolfcampian, coincident with the disappearance of coaly shales. Although "Carboniferous" type floras continue to occur into the Wolfcampian, they become progressively rarer.

The proximate cause of this transition appears to be episodic fluctuations of seasonally wetter and drier climates grading toward ever drier. The ultimate driving mechanisms may have been a combination of south polar glaciations and drift of the western portions of Euramerica northward into drier climate belts.

Upper Stephanian and Lower Autunian assemblages of miospores from the Bohemian Massif. Jana Drabkova, Czech Geological Survay, Klarov 3/131, 11821 Praha 1 Czech Republic

An abundant, predominantly autochtonous, miospore assemblage comes from the Kounov Coal Seam [Upper Stephanian, Slany Formation, Central Bohemian Region]. It is characterised by predominance of spores. Monolete spores are very common, mainly genera Laevigatosporites or Punctatosporites. Stratigraphically significant spores are e.g. Cadiospora magna, Endosporites formosus, Kosankeisporites elegans. The last Stephanian unit - Semily Formation [Krkonose Piedmont Basin] contains some miospore assemblages similar to the Kounov Member. Other "Autunian-like" assemblages are formed by Potonieisporites and Florinites. Some bisaccates and Vittatina are presented. Three Autunian horizons were examined in the Krkonose Piedmont Basin. The miospore monosaccate genus Potonieisporites predominates in the miospore assemblage of the lowermoust Rudnik horizon. Bisaccate pollen genera as Illinites, Vesicaspora, Gardenaisporites, Protohaploxipinus and genus Vittatina are present, spores are rare. Some miospore assemblages of higher Haje Horizon differ from Rudnik Horizon by high proportion of genus Vittatina and by the presence of Costaepollenites and striated bisaccates of the genera Hamiapollenites and Striatopodocarpites. The Haje Coal Seam contains a high proportion of spores. These assemblages have "Stephanian-like" character. The genus Vesicaspora predominates in the uppermost Kalna Horizon.

PALEOENVIRONMENTS OF EARLY LAND PLANTS: AN EXAMPLE FROM THE EARLY DEVONIAN OF GASPÉ, CANADA. C.L. Hotton and F.M. Hueber, Department of Paleobiology, NHB MRC 121, National Museum of Natural History, Washington, DC, 20560; D.H. Griffing, Paleontological Research Institution, Ithaca, New York, 14850; and J.S. Bridge, Department of Geological Sciences, Binghamton University, Binghamton, New York 13902-6000, USA

We report here on an ongoing study of the paleoenvironments of early land plants (embryophytes) from the Emsian Cap-aux-Os Member of the Battery Point Formation, Gaspé Bay, well known for its rich assemblages of plant fossils. Sedimentological and paleontological evidence suggests the overall environment is a tidally influenced coastal plain experiencing occasional marine incursions. Well preserved plant megafossils are restricted to fine-grained deposits interpreted as late stage channel fills, crevasse splays, levees and marshes. The presence of delicate rhizomorphs in paleosols implies that plants occupied better drained environments as well. Most megafloral assemblages are autochthonous or parautochthonous. Individual plant assemblages are largely monodominant. We see some evidence of clade-dependent niche partitioning: zosterophylls commonly occur in very low energy, wet subenvironments that apparently persisted over time, whereas trimerophytes are especially prominent in more energetic, probably more ephemeral subenvironments such as levees. Many zosterophylls, rarely found in a fertile state, may have been site occupiers, relying primarily on vegetative growth to occupy space once established, whereas trimerophytes, often fertile, were probably colonizers, dispersing widely through abundant spore production.

The embryophyte megaflora so far comprises approximately 20 species, including 6 genera of zosterophylls, several species of lycopsids, six to eight species of trimerophytes, one or possibly two rhyniopsids, and two probable hepatics. Palynofloral diversity is at least twice that of megafossils; furthermore, spores associated with major megafossil groups comprise only a small fraction of the total morphological diversity of the dispersed spore record. The unknown spore morphotypes reveal a major cryptic component of the vegetation, many of which are likely to reflect plants of bryophyte grade.

TRIASSIC FLORAS AND PHYTOGEOGRAPHY IN EASTERN EURASIA. Tatsuaki Kimura and Ge Sun, Institute of Natural History, 24-14-3 Takada, Toshima-ku, Tokyo, 171 Japan, and Nanjing Institute of Geology and Palaeontology, Academia Sinica, Nanjing, P. R. China

Since the first author (1985) reviewed the Triassic floras and phytogeography in Eastern Eurasia including Japan, Korea, southern Primorye, China, Viet Nam and Southeast Asia, palaeobotanical studies of Triassic plants in those areas have been remarkably advanced, especially in the vast territory of China. So it should be necessary to make an emended reviewal on the basis of newly obtained results.

In Eastern Eurasia, Early and Middle Triassic floras are represented by *Pleuromeia* and *Pleuromeia-Annalepis-Scytophyllum* assemblages, and Late Triassic floras are by *Danaeopsis-Bernouillia* assemblage located northward and by *Dictyophyllum-Clathropteris* assemblage located southward and eastern Northeast China. In addition, recently Gondwana-type assemblage was found in southern Xizang (Tibet). Each *Dictyophyllum-Clathropteris* assemblage shows its own provinciality in the floristic composition. It is difficult to make precise age-determination of floras derived from the strata of non-marine origin, especially so in the *Danaeopsis-Bernouillia* assemblage.

IN-SITU PREPOLLEN OF TELANGIUM SCHWEITZERI FROM THE UPPERMOST DEVONIAN OF IRELAND. Sharon D. Klavins and Lawrence C. Matten, Southern Illinois University, Carbondale, IL, USA, 62901-6509.

The lyginopterid pollen organ Telangium schweitzeri occurs in Uppermost Devonian (lower Tournaisian 1b) sediments at Ballyheigue, County Kerry, Ireland in association with other pteridosperm organs. Matten and Fine described in situ prepollen at the light microscope level in their original diagnosis of the species (1994). Peels of longitudinal sections of type specimens containing prepollen were prepared using a modification of the technique described by Daghlian and Taylor (1979). The specimens were coated with palladium-gold and examined using a Hitachi S-570 SEM. Details for description were obtained from four specimens. The prepollen are angular and small (average diameter = 11.7 µm). A trilete scar is visible on the distal surface. The surface is laevigate and lacks any prominent structures. In preliminary comparison with taxa described from the dispersed spore flora, the prepollen are morphologically similar to Auroraspora and Remusotriletes. Confirmation of the identity of the in situ prepollen with a dispersed spore taxon will provide information on temporal and geographic distribution of T. schweitzeri. A reconstruction of an early lyginopterid seed fern from Ballyheigue predicts connection among Telangium (pollen organ), Hydrasperma (cupulate ovules), and Laceya (stem and frond). This study will be followed with an examination of prepollen in the pollen chamber of Hydrasperma in the hope that correspondence of features will confirm the association of Telangium with Hydrasperma and support the reconstruction of Laceya.

PALYNOLOGICAL ANALYSIS OF THE PERMIAN-TRIASSIC TRANSITION IN NORTHERN ITALY. Cindy V. Looy, Martijn Smit, Bas Van De Schootbrugge & Henk Visscher, Laboratory of Palaeobotany & Palynology, Budapestlaan 4, 3584 CD Utrecht, The Netherlands

The Permian-Triassic biotic crisis is known for its devastating effect in the marine realm. It is still unclear, however, how it affected the terrestrial vegetation. In order to obtain insight in the process of collapse of the Late Permian terrestrial ecosystem and its subsequent recovery in the Early Triassic, pollen and spore assemblages may reflect floral turnover. Latest Permian assemblages from the Southern Alps (Italy) show a dominance of gymnospermous pollen, while earliest Triassic assemblages are characterized by the frequent occurrence of lycopodiophytic microspores. Recognition of a transition between these two constrasting assemblages is difficult to detect, due to overwhelming dominance of fungal remains in the palynomorph association. We present the prelimnary results of a thorough search for pollen and spore types, performed on 'fungal spike' material from the Tesero Horizon, the basal part of the Werfen Formation in the Southern Alps.

UPPER GIVETIAN FLORA FROM GILBOA AND CAIRO, NEW YORK: FLORISTICS AND PALEOENVIRONMENTS. Lawrence C. Matten, Department of Plant Biology, Southern Illinois University, Carbondale, IL. 62901 USA

Two large Givetian floras occur in New York State. The Gilboa flora contains 12 taxa and is dominated by lycopods and Eospermatopteris. The plants are found in near shore environments and in several different matrices. Coarse sandstones contain such plants as Eospermatopteris, a Pseudosporochnus-like plant, and several lycopods and represent a forest subjected to rapid, short-term flooding. Finer grained sediments with higher carbon content include such plants as Aneurophyton. A paleosol occurs at the base of the Eospermatopteris stumps. The Cairo flora is located about 40 km to the east, contains 10 taxa, and occurs in much finer and more carbonaceous sediments representing lower energy environments. The flora is dominated by progymnosperms and ferns. Eight genera of pyritized axes occur in a fine-grained, fissile shale containing masses of ostracods. Sections reveal numerous spores indicating a far more diverse flora that can be seen from the megafossils. Coarser sediments adjacent to the pyritized floral component yield compressions of a lycopod having three-forked leaves like Colpodexylon and a fertile progymnosperm like Protopteridium. The Cairo flora is thought to represent plants occuring in lacustrine deposits representing one of the alluvial plain environments.

LATE CARBONIFEROUS (STEPHANIAN) AND EARLY PERMIAN SPOROMORPHS FROM RUHUHU BASIN, SOUTHWESTERN TANZANIA. MAYAGILO, Jean-Frank. Tanzania Petroleum Development Corporation, Directorate of Exploration and Production, PO. box 5233, Dar Es Salaam, Tanzania.

Palynological analysis was done on samples from Ruhuhu basin. Sporomorphs recorded indicate a Late Carboniferous to Early Permian age. Fifty-two genera with seventy-eight species were identified. Marker species include *Zinjisporites spinosus, Microbaculispora tentula, Granolatisporites confluens, Gondisporites splendens, Vittatina fasciolata, Latosporites colliensis,* and *Striatopodocarpites ociostriatus.*

Four bio-events have been identified based on cluster analysis. The bio-events might have been influenced by the climatic factors and depositional environments. Depositional environment varied from glacial to post glacial fluvio lacustrine.

THE MESSAGE OF LATE PALEOZOIC PALEOSOLS - GLOBAL ENVIRONMENTAL CHANGE AT THE END OF THE CARBONIFEROUS ?

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Paleosols are important constituents of terrestrial environments, and sedimentary sequences reflecting such environments can often be interpreted more correctly if the role of paleosols is properly understood. Despite their partially limited preservation potential, paleosols within alluvial series are powerful indicators of paleoclimate, paleodrainage conditions, paleocatenary relationships and interruptions of sedimentation. Moreover they evolved to helpful tools for establishing sequence stratigraphy in terrestrial settings. Climatic conditions, especially the influence of temperature and rainfall, determines soil development and which of the chemical compounds will remain in the soil. Paleoenvironmental interpretation of paleosols depends on the recognition of diagnostic features that usually reflect complex influences of biotic/abiotic processes. Moreover, although paleosols resemble modern soil profiles, the effects of diagenetic alteration must also be taken into account.
Upper Carboniferous and Lower Permian Rotliegend deposits of the North German Variscan foreland basin as well as of German intermontane areas (Saale Basin, Saar-Nahe Basin) contain a wide variety of paleosol-types. Both detailed investigations of almost 13,000 metres of cores from 43 wells and of several outcrops made it possible to recognize change of lithofacies and biofacies patterns including paleosol development during a stratigraphic interval from the base of the Westphalian C (Bolsovian) to Lower Permian (Asselian) Rotliegend.
There was recognized a climatic controlled succession from tropical-humid conditions during the Westphalian C/D characterized by hydromorphic gleysols reflecting poor drainage conditions in waterlogged, mainly deltaic environments and ferrugi-nous/ferrallitic paleosols on well-drained alluvial plains to seasonal semiarid conditions during the early/middle Stephanian characterized by calcic paleosols on well-drained places. This relatively strong climatic change may be the response on several more or less interacting causes. These are the shift of megafacies belts due to northward movement of Laurasia, the increasing continent mass after Variscan collision possibly influencing circulation systems, and in particular the tectonical controlled disappearance of the widely extended self-regulating paleotropical wetland area, previously containing rich hygrophilous floras. Over this investigation area the first occurrence of calcisols therefore marks a nearly isochronous line situated around the Westphalian/Stephanian boundary, which is biostratigraphically proofed. So we got an additional useful tool for stratigraphic correlation procederes of exploration wells on the one hand, and one more indication of change of floristic dominance patterns at the end of the Westphalian on the other hand.

FOSSILS, ANATOMY, AND FILICALEAN FERN PHYLOGENY: A REVIEW AND OVERVIEW.

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There is a growing recognition that the fossil record of ferns is both richer and more informative than previously realized. Together with an increasing emphasis on whole plant reconstruction, the application of numerical cladistic methodology, and the advent of molecular systematics, this recognition has brought extinct species to the forefront of fern phylogeny. Studies that include fossil taxa have recently demonstrated that ferns as a whole form a polyphyletic grade group, that the Filicales is a paraphyletic assemblage, and that the heterosporous water ferns are monophyletic. The results of these studies are roughly concordant with those using molecular data and/or morphological characters of living species only, but may be more informative because extinct taxa allow us to resolve overall phylogenetic pattern. An increased emphasis on ferns in Upper Cretaceous and Tertiary compression floras is documenting a much more taxonomically diverse and ecologically important fern component than previously recognized. Our preliminary assessment reveals that evolution of stem/frond anatomical characters correlates strongly with phylogenetic relationships of the "Filicales" as hypothesized from molecular studies. When viewed in this context, the rapidly growing body of anatomical information for filicalean fossil ferns has great promise as an important data source for integrated systematic studies.

INDICATORS OF EARLY LAND PLANT DIVERSITY.

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Several different methods were used to assess early land plant diversity, including:
i. **Sporomorph diversity trends.** The earliest palynological assemblages with cryptospore tetrads of probable embryophyte affinity also contain numerous monads and dyads. Thus, the Ordovician cryptospore record does not support the idea of a gradualistic radiating speciation. Lower Silurian assemblages show maximum variation in tetrad morphologies with sculptured cryptospores becoming diverse during the Homerian stage. Taxon counts show a replacement of cryptospores by triletes with the turnover points occurring in Ludlovian-Lochovian time, depending upon the sample.
ii. **A sample coprolite.** A spore cluster originally noted by Lang from the terrestrial Freshwater East locality (Přídoli) is described as a coprolite. Scores of different spores, mostly alete, are found within the coprolite, implying that these cryptospore monads were from terrestrial sources. If this is true, it would dramatically affect estimates of plant diversity based on spore diversity, given that similar monads can dominate near-shore marine assemblages throughout the Silurian. These simple cryptospores could represent algal or bryophytic sources.
iii. **Qualitative assessment.** Fossiliferous slabs from the Silurian and Lower Devonian of Great Britain were assessed for their cover of various plant fragments. This method reveals that nematophytes were far more common than previously thought. The reproductive biology of these plants continues to remains elusive, however, preventing a realistic appraisal of their phylogenetic affinities.

THE ROLE OF FUNGI IN SHAPING THE LOWER DEVONIAN ECOSYSTEM. Thomas N. Taylor[1], Hagen Hass[2], Hans Kerp[2], and Volker Mossbrugger[3]. [1]Department of Botany, University of Kansas, Lawrence, Kansas 66045 USA, [2]Abteilung Paläobotanik, Westfälische Wilhelms-Universität, Hindenburgplatz 57-59, D-48143 Münster, Germany, [3]Department of Geology and Palaeontology, Eberhard Karls-Universität, Sigwartstrasse 10, D-72076 Tübingen, Germany

Historically the principal emphasis of studies dealing with the Lower Devonian Rhynie chert has centered on the anatomy and morphology of the various macroplants, which in turn has provided basic data about the origin and subsequent evolution of early land plants. Of equal important in the establishment and regulation of this paleoecosystem were various fungal groups that functioned as saprophytes, parasites and various types of mutualists. As heterotrophs fungi were especially important as primary decomposers. The Rhynie chert lagerstätte contains various types of aquatic fungi including one form that possesses an isomorphic alternation of generation. Based on specific host responses, other chytridiomycetes functioned as parasites. In one parasitic symbiosis involving *Palaeonitella* as the host, the fungal infection resulted in the increase in size of certain cells. Still other chytrids functioned as mycoparasites. Here the parasite attacked chlamydospores of endomycorrhizal fungi resulting in a host response in the form of distinct conical papillae formed on the inner surface of the spore. In modern ecosystems mycoparasites of this type are important in that they reduce the number of potential mycorrhizal infections in the next generation. Endomycorrhizae were also present during the Lower Devonian. In this type of mutualism the fungus obtains a carbon source by means on intercellular shrub-like haustoria termed arbuscules, while one of the primary benefits to the plant is an increase in nutrient uptake. The presence of arbuscules in several Rhynie chert macroplants demonstrates that this type of symbiosis is not only ancient, but may have appreciably contributed to the initial establishment of land plants. Lichens in the Rhynie chert represent another example of a terrestrial mutualism that played an important role in the potential establishment of this Lower Devonian ecosystem. In this ancient association the photobiont is represented as a cyanobacterium, while the affinity of the fungus may be a zygomycete. In this paper we will characterize some of these 400 million-year-old interactions involving fungi and relate them to the dynamic interrelationships that exist in modern ecosystems.

ANIMALS IN EARLY TERRESTRIAL ECOSYSTEMS. William Shear, Department of Biology, Hampden-Sydney College, Hampden-Sydney VA 23943 USA, and Paul Selden, Department of Earth Sciences, University of Manchester, Manchester M13 9PL, UK.

Evidence of the earliest terrestrial animals is approximately synchronous with the earliest macrofossil evidence for vascular and non-vascular land plants. Terrestrial arthropods are now known from several sites in North America and Europe, ranging in age from lowermost Přídolí to Famennian. None of the animals yet found can be identified definitively as herbivorous; instead detritivores and predators predominate, leading to inferences regarding trophic relationships in early terrestrial ecosystems. It would appear that animals and plants were largely "decoupled" trophically, with most primary productivity flowing through detritivores. The herbivore level is postulated to be a later development. It is suggested that arthropods first attacked nutrient-rich, poorly defended plant organs, such as spores and seeds.

EVOLUTIONARY HYPOTHESES OF CRYPTOSPORE PRODUCING PLANTS BASED ON WALL ULTRASTRUCTURE

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Ordovician and Silurian cryptospore walls fall into two broad ultrastructural categories - unlamellated and lamellated. Those within the former category include the naked cryptospores (i.e., those without a common envelope around all the spore bodies) *Pseudodyadospora* (pseudodyad) and *Tetrahedraletes medinensis* (naked tetrad). The enclosed forms *Velatitetras* (tetrad) and *Segestrespora* (dyad) may have an occasional lamella, but are essentially unlamellated. The only lamellated forms recognized so far are dyads - *Dyadospora murusdensa* (naked dyad) and *Dyadospora murusattenuata* (enclosed dyad). *D. murusattenuata* occurs in two forms, one of which is lamellated (with structure similar to *D. murusdensa*) and one of which is not (resembling a pseudodyad). These two broad categories form the basis for a set of hypotheses for the evolutionary relationships within cryptospore producing plants and between cryptospore producing plants and their possible descendants.

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BIOEVENTS IN THE SILURIAN ARISAIG GROUP: A PALYNOLOGICAL PERSPECTIVE

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The siliciclastic shallow marine rocks of the Arisaig Group span the entire Silurian Period. A detailed palynological investigation of the sediments has shown that most of the rocks are dominated by acritarchs, but that a diverse, well preserved, allochthonous assemblage of spores and cryptospores is present. Taken together, the analysis of these two microfossil groups sheds new light on a range of topics that include early land plant evolution, marine phytoplankton trends and sedimentology.

A major radiation of vascular plants occurred during the latter half of the Silurian Period. Llandovery and early Wenlock deposits contain only a few species of smooth walled miospores and subordinate tetrads. In marked contrast, 18 species of smooth and sculpted trilete miospores and 15 species of cryptospores have been recovered from Homerian to Downtonian sediments. The tempo and composition of this diversification is important, not only because it is the most diverse Silurian sporomorph assemblage reported from North America, but also it is closely referable to well studied assemblages described from the Welsh Basin and fits neatly into the sporomorph-graptolite biozonation scheme recently proposed by Burgess & Richardson (1995).

Studies of marine phytoplankton (acritarchs & prasinophytes) collated from 115 samples from 20 measured sections scattered throughout the Arisaig Group, reveal an overall species diversity decline from the latest Ashgill (Beechhill Cove Fm.) and Llandovery (Ross Brook Fm.) up to the Ludfordian Moydart Formation. This trend, while overprinted by unique environmental and diagenetic fluctuations, is consistent with global diversity patterns and provides insight into local primary productivity and water column dynamics. The palynomorph data set is less revealing when substrate characterization is the issue. Minimum variance cluster analysis of the entire palynomorph data set (marine and nonmarine) reveals that closely spaced samples, taken from a range of sediment types (mudstone to fine siltstone), are much more likely to group together than with similar sediment samples taken from sections measured above or below. Invertebrate communities (bivalves & brachiopods) are clearly more sensitive to substrate changes than palynomorphs.

SILURIAN DEPOSITIONAL CYCLICITY, SEQUENCES, AND BIOTIC EVENTS IN THE BRITISH ISLES, SCANDINAVIA, BALTIC, AND CENTRAL EUROPE

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At least six major sedimentary depositional cycles can be recognized during the interval from the latest Ordovician to Devonian. They are labelled Sh1-6 after the county of Shropshire in England, where they are recognized. The broad intervals for the cycles are: Sh1, late Hirnantian to mid Aeronian; Sh2, mid Aeronian to early Sheinwoodian; Sh3, mid Sheinwoodian to late Homerian; Sh4, early Gorstian to earliest Ludfornian; Sh5, early Ludfordian to late Ludfordian; Sh6, late Ludfordian to late Pridoli. Several apparently lower order cycles, with less marked sequence boundaries, can also be widely recognized.

ACRITARCH, CHITINOZOAN, AND SPORE EVIDENCE OF LUDLOW CYCLICITY AND THE MID LUDLOW DEPOSITIONAL SEQUENCE BOUNDARY

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The Gorstian and Ludfordian succession in the type Ludlow and surrounding areas of the Welsh Borderland of England comprises a moderately thick shelf section of argillaceous silty limestones and calcareous siltstones. Two major sedimentary cycles are recognized. The marine microflora, including acritarchs, together with the marine microfauna, including chitinozoans, show marked cyclic quantitative and qualitative changes in assemblage composition within each cycle. Land derived spores are generally of low abundance, though the changes that are recognized in part probably reflect cyclic changes in the amount of inner shelf sediment transprot towards the outer shelf. The mid Ludlow depositional boundary is conspicuous over much of the inner shelf and separates the two major sedimentary cycles of the Ludlow Stage.

LUDLOW CHITINOZOAN BIOZONATION OF THE WELSH BASIN

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Five chitinozoan biozones are recognised in the type Ludlow area and coeval sections in the Welsh Borderland of England. The Welsh Basin includes the international type areas for the Llandovery, Wenlock and Ludlow series. The base of the Ludlow Series and of the Gorstian Stage is defined at Pitch Coppice Quarry (SO 4723 7298) and the base of the Ludfordian Stage at Sunnyhill Quarry (SO 4950 7255), near Ludlow, Shropshire.

Chitinozoan biozones have been erected on the basis of the first occurrences of reference species and significant increase in abundance of key species. Preference has been given to taxa that are well established and recorded from other regional localities. The top of each biozone is recognised by the base of each succeeding biozone.

Ancyrochitina gutnica Biozone. *A. gutnica* Laufeld 1974, is commonly recorded from the Much Wenlock Limestone Formation with records from the lower part of the Lower Elton Formation and correlative strata.

Cingulochitina convexa Biozone. The base of this biozone is defined by the first occurrence of *C. convexa* (Laufeld 1974). The species is first recorded 90m above the base of the Ludlow Series and approximately 30m above the base of the Middle Elton Formation on Goggin Road, Mortimer Forest near Ludlow, Shropshire.

Angochitina elongata Biozone. The base is defined by the first occurence of *A. elongata* Eisenack 1931, 130m above the base of the Ludlow Series and approximately 70m above the base of the Middle Elton Formation along Goggin Road.

Eisenackitina lagenomorpha Biozone. A significant increase in abundance of *E. lagenomorpha* (Eisenack 1931) and the base of the *E. lagenomorpha* Biozone, is apparent 0.4m below the base of the Ludfordian at Sunnyhill Quarry. The sudden acme of *E. lagenomorpha* is recognised across the Welsh Borderlands.

Gotlandochitina villosa Biozone. The base is defined by the first occurrence of *G. villosa* Laufeld 1974, in the uppermost part of the Lower Leintwardine Formation. 0.85m below the base of the Upper Leintwardine Formation on the Whitcliffe, Ludlow. *G. villosa* is recorded from a similar stratigraphic level at Ledbury, the northern part of the Woolhope Inlier and the May Hill Inlier.

ACRITARCH, CHITINOZOAN, AND SPORE ZONATIONS IN THE LLANDOVERY, WENLOCK, LUDLOW, AND PRIDOLI SERIES OF THE SILURIAN SYSTEM

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The marine and terrestrial palynomorphs provide a high resolution biostratigraphy in Paleozoic sedimentary sequences, including the Silurian. Separate biozonations can be recognized for each of the major morphologic groupings within the acritarchs and chitinozoans, primarily based on the first appearance of key forms. Chitinozoans are of particular value in deep marine to shelf sequences, acritarchs in offshore to inshore shelf sequences and spores in nearshore marine, lacustrine, and terrestrial sequences.

A REVIEW OF PLANT EVOLUTION DURING SILURIAN TIME

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The Silurian Period is a critical time in the development of the terrestrial flora. Fossil evidence for the evolution of plants during this interval is based on macroscopic plant axes with and without attached sporangia and microscopic plant debris (spores, cryptospores, nematoclasts and cuticular fragments). Even though palynological evidence indicates that the embryophytes probably evolved by mid-Ordovician time, the palynological record shows progressive changes and trends beginning in the Ashgillian. Lower Silurian macroscopic plant remains are rare and always problematic in origin. From the Homerian onward, however, we begin to pick up fragments of plant axes that look more and more like tracheophytes, although there is debate among paleobotanists about the nature of some "tracheid-like" tissues. Palynologists have recognized this "Homerian event" as many sculptured cryptospores and, to some extent, trilete spores are found in Homerian strata in the Welsh Basin, the Prague Basin and in North America. Recent studies on *in situ* spores have reinforced the relations between spore type and plant sources, but the dominance of simple cryptospores in many assemblages acts to obscure botanical affinity for many types. Downtonian plant assemblages are still dominated by plant debris of unknown or nematophytic origin, but in Devonian sediments, tracheophyte remains clearly dominate terrestrial organic debris.

During the Silurian interval, plants evolved from (probable) thallophytic embryophytic ancestors into axial, tracheid-bearing plants. Fossil evidence bears out this simple model. The tracheophytes subsequently diversified during the Devonian Period.

CHITINOZOA BIOZONATION OF THE WENLOCK OF THE BUILT AREA, WALES, U.K., PRELIMINARY RESULTS

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The graptolite biozonation for the Wenlock was defined by Elles in 1900 in the Wenlock shales of the Built area, central Wales, U.K. Recently the graptolite localities were recollected and studies by J. Harris (1990, unpublished) and later by J. Zalasiewicz and M. Williams (in prep.). Sediments were deposited in the deeper parts of the Welsh basin and are exclusively siliciclastic. The aim of this study is to record in the same samples and sections the biostratigraphical ranges of different groups and biozones as graptolites, Chitinozoa, acritarchs, spores, and other fossils if present. It is also the aim to correlate in detail the graptolite and other biozonations established in the deeper parts of the basin with the fossiliferous Wenlock strata from the shallower parts of the basin in the Welsh Borderland, where the stratotypes of the boundaries of the Wenlock series and stages were defined.

In this part of the study the preliminary results are presented of the Chitinozoa from some 40 samples sampled throughout the Wenlock from the Built area, in the Built Mudstone Formation. The samples are all well situated versus the graptolite biozonation. The Chitinozoa assemblages are moderately diverse and in medium to poor concentration. Their preservation is moderate to good, showing a slight thermal alteration. The different assemblages will be presented and compared with existing biozonations and especially with the global Chitinozoa biozonation for the Silurian.

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THE THIRD BALTIC STRATIGRAPHICAL CONFERENCE

ABSTRACTS
FIELD GUIDE

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Tartu 1996

THIRD BALTIC STRATIGRAPHIC CONFERENCE, TALLINN, ESTONIA (8-11 October, 1996).

PALYNOLOGICAL STUDY OF THE DEVONIAN SERIES OF THE EAST BALTIC AREA: PRELIMINARY RESULTS FROM THE GAUJA REGIONAL STAGE AT KÜLLATOVA, ESTONIA

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The East Baltic Devonian succession is a classical one for the Devonian of Europe. It is particularly well-known for its fossil vertebrate content which, in Latvia, has provided with 250 different species (Lŷarskaya and Lukševičs, 1992). However, its correlation to the standard conodont zonation is still widely unsolved (e.g., Mark-Kurik, 1991a, 1991b, 1995). The use of spore assemblages may help to solve this problem (e.g., Valiukevičius, 1994).

In this topic, one of us (E. M.-K.) processed with sampling through the Devonian series of SE Estonia. Eleven samples were prepared for palynomorphs (A.-M. C.). Only one was positive (S.L.). This sample, from the collections of the Geological Museum of Tartu University, comes from the Gauja Regional Stage (RS) at Küllatova. It is an old refractory clay quarry, presently out of use, which, before the Second World War, belonged to the "Eesti Schamott" company. Küllatova is mainly known for its fossil flora in which Thomson (1940) mentioned both spores and macroremains. The latter have been determined as "*Hostimella*" sp. (now *Hostinella*). Yurina (1988) identified *Archaeopteris* sp. and *A. fissilis* from Küllatova and from the Lode clay quarry in Latvia. Lode and Küllatova are both in the upper Gauja Regional Stage, locally called Lode Member or Lode Formation (Kuršs, 1992).

At Küllatova, the organic matter is scarce and composed of continental plant debris only: cuticle debris, woody debris and miospores. No figured elements, indicative of a marine origin, has been found. The miospores, although rare, are well preserved. In this preliminary study, our main objective was to identify specimens with a determinable morphology which could give a dating to the sample. The reference spore zonation is the one of Avkhimovitch *et al.* (1993) for the Middle and Upper Devonian of the East European Platform (EEP). Among the species encountered, *Samarisporites triangulatus* is a worldwide known species which appears in the early Givetian *ensensis bipennatus* conodont zone (CZ) (Loboziak *et al.*, 1991). This *ensensis bipennatus* CZ together with the underlying *ensensis obliquimarginatus* CZ constitute a single zone of the presently used standard conodont zonation, viz., the *hemiansatus* CZ. The latter defines the lower boundary of the Givetian Stage (Walliser *et al.*, 1995). *S. triangulatus* is known on the EEP from the *C. triangulatus–C. serratus* (TS) subzone to the *A. bucerus–A. variabilis insignis* (BI) subzone (Avkhimovitch *et al.*, 1993). This interval is correlated to the *S. triangulatus–A. ancyrea* (TA) and *S. triangulatus–C. concinna* (TCo) Oppel zones of the Ardenno–Rhenish type marine Devonian *sensu* Streel *et al.* (1987). These zones correlate with the early Givetian to earliest Frasnian, *ensensis bipennatus* to *falsiovalis* CZ.

The other recognised taxa of the Küllatova assemblage include *Geminospora lemurata*, *G. micromanifesta*, *Samarisporites eximius* and *Retusotriletes rugulatus*. They also comprise a few specimens that we compare to species figured by Avkhimovitch *et al.* (1993), i.e., *Ancyrospora* sp. cf. *Ancyrospora incisa* [Avkhimovitch *et al.*, 1993, pl. 10: 1], *Dictyotriletes* sp. cf. *Reticulatisporites perlotus* [*ibid.*, pl. 10: 9], *Perotrilites* sp. cf. *Rugospora*? *impolita* [*ibid.*, pl. 9: 13]. This assemblage leads to consider that the Küllatova sample is preferably from the upper range zone of *S. triangulatus*, viz., in the *A. incisa–G. micromanifesta* (IM) subzone at the Givetian–Frasnian transition.

Even though this result is preliminary and does not allow to date the whole Gauja RS, it is not in disagreement with the hypothesis of Blieck *et al.* (in press) that the Gauja RS may be partly Givetian and partly Frasnian in age. It is no more in disagreement with the fact that the Plavinas RS, above the Gauja and Amata RS, has yielded a poor conodont assemblage which suggests a correlation to the early Frasnian *asymmetricus* CZ (of the old zonation; equivalent to the *falsiovalis* to earliest *hassi* CZ of the present zonation) (Valiukevičius, 1994). Another possibility which has not to be discounted is that the Gauja and/or Plavinas Formations are of different ages in different localities of the East Baltic area. This situation is indeed classical for siliciclastic series. In any case, such a problem can only be solved by a dense sampling of the formations under consideration.

This is a contribution to IGCP 328: Palaeozoic Microvertebrates

ISOTOPIC DATA COMBINED WITH BIOSTRATIGRAPHY: AN ORDOVICIAN CASE STUDY

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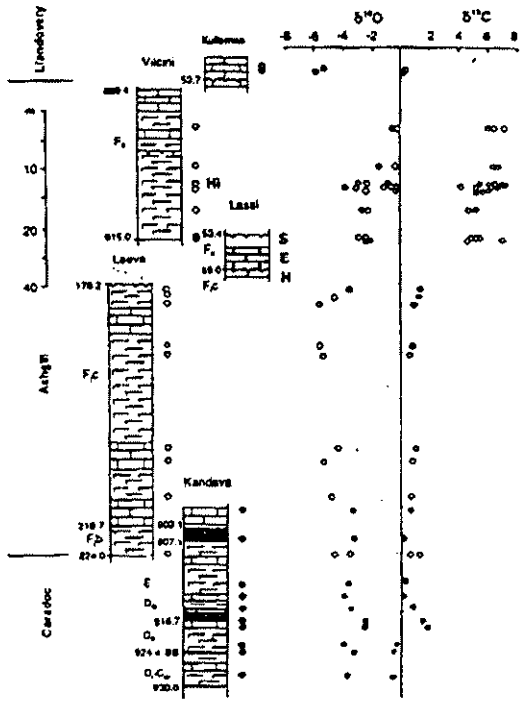
The changes in the isotopic composition of carbonates and the organic matter (Marshall and Middleton, 1990; Brenchley *et al.*, 1995) form the most informative record of the development of the late Ordovician ice cap in the Gondwanaland and its influence on the ecosystems in different parts of the Earth. The results of the last five years have demonstrated a pronounced late Ordovician excursion in both $\delta^{13}C$ and $\delta^{18}O$ values in the East Baltic (Brenchley *et al.*, 1994) and existence of a distinct chemostratigraphical unit which comprises the latest Ordovician (Porkunian) deposits of various lithofacies (Fig.). This interval is more distinct in the sequences where the Hirnantia fauna (*s. l.*) has been recorded (southern Estonia, western Latvia).

In spite of a good biostratigraphical framework (biozonation by chitinozoans and ostracodes) and detailed lithostratigraphy, the dating of the stratigraphical levels of the major glacial phases appears to be difficult, particularly with regard to the detailed correlation of the boundary beds of the Pirgu and Porkuni stages and the Ordovician–Silurian boundary in Central East Baltic (especially concernig the *persculptus* zone).

The first level, the Pirgu–Porkuni boundary interval, is roughly contemporaneous to the fast growth of the major continental ice cap. Precise dating of this event in northern Estonia, where the type sections of the Ordovician regional Pirgu and Porkuni stages are located, is related to the problems of correlation of the members of the Adila (sensu lato), Kabala and Ärina formations. Due to the occurrence of poorly fossiliferous intervals and discontinuous succession of the lithofacies, the age of some of these units has not been definite. The preliminary isotope data in one section in the Hiiumaa Island show that the positive shift in $\delta^{13}C$ values fall into the lower, palaeontologically poorly characterized part of the Ärina Formation. The isotope excursion is documented from the Porkuni Stage of the mainland of Estonia also. The isotopic data seems to be the most firm basis for the correlation of the sequences from the stratotype area and Central East Baltic where the topmost Ordovician Porkuni Stage comprises the *Hirnantia* fauna.

In central and southern East Baltic, the correlation and age of the Taučionys Formation, comprising the strata with *Holorhynchus giganteus*, has been an old subject for discussion. Originally this formation has been considered as the oldest part of the Porkuni Stage. An alternative correlation and presumably pre-Porkuni age is based on the distribution of zonal chitinozoa *Spinachitina taugourdeaui* and the recent occurrence of *Holorhynchus* in some North Estonian sections. The studies on the isotopic composition of the shells of the mentioned pentamerid brachiopods (Brenchley *et al.*, in press) indicate its pre-Hirnantian age in the East Baltic and Scandinavia.



The isotopic data from upper Ordovician sequences and also the preliminary data from the uppermost middle Ordovician (Caradocian) in the East Baltic show the importance of chemostratigraphy for the correlation of stratigraphical intervals corresponding to the epochs of rapid and notable changes of palaeoenvironment.

SOME SILURIAN ACRITARCHS FROM THE HOLY CROSS MOUNTAINS (CENTRAL POLAND)

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The Lower and Middle Silurian in the Holy Cross Mountains is developed in a monotonous facies of graptolite shales, while the Upper Silurian comprises an up to 2000 m thick series of greywackes commonly being regarded as flysch-like deposits connected with the Caledonian disturbances.

The total thickness of the Silurian deposits in the southern part of the Holy Cross Mountains is about 700 metres. In this region the sequence of the Lower and Middle Silurian is well exposed near the Bardo village in the northern wing of the Bardo Syncline, especially along the Przgowiec Ravine.

In this outcrop, the Wenlockian deposits are represented by dark yellow and brown mudstone shales from *Cyrtograptus lundgreni* to *Testograptus testis* Biozone. The Ludlovian is represented by dark grey siltstone shales from *Gothograptus nassa* to *Saetograptus leintwardinensis* Biozone and greywackes with fauna which indicates *Bohemograptus* Biozone. All biozones mentioned above are described according to the regional stratigraphic division. The acritarch assemblages presented in this paper come from the uppermost Wenlockian and the lowermost Ludlowian.

In the *Monograptus ludensis* Biozone the following acritarchs were found: *Tylotopalla*, *Leiofusa parvitalis*.

The next, *Spinograptus spinosus* Biozone, is divided into two subzones. The lower, *Pristiograptus dubius* subzone, contains, e.g., *Dateriocradus*, *Micrhystridium*, *Dictyotidium* cf. *alveolatum*, *Pterospermopsis*, *Multiplicicispaeridium* and *?Ammonidium ludloviense*.

In the upper, *Pristiograptus gotlandicus* subzone, *Oppilatala* cf. *insolita*, *Deunffia*, *Diexalophasis*, *Evittia* cf. *denticulata denticulata* and *Eupoikilofusa stratifera typica* occur.

WENLOCK OCEANIC EPISODES AND EVENTS IN THE SUCCESSION OF CHITINOZOANS IN ESTONIA

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Identification of the boundaries of Wenlockian episodes and events by L. Jeppsson in the sections of Ireviken 3, Vattenfallet and Slitebrottet 1 and 2 allows us to distinguish these levels also in Estonia, particularly in the Ohesaare section. These are purely chitinozoan correlative intervals, not proven by the conodont succession.

The Ireviken Event is expressed by an abrupt decline of the chitinozoan species diversity. Eleven chitinozoan taxa disappeared and 10 chitinozoan datum levels were established. The most important is the sixth level, marking the extinction of *Angochitina longicollis* and *Eisenackitina dolioliformis*. This event is represented in the lower part of the Mustjala Member and Tõlla Beds of the Jaani Stage.

The Vattenfallet Secundo Episode is characterized by a moderate species diversity. In Estonian sections it embraces the upper part of the Mustjala Member, Ninase and Paramaja members. L. Jeppsson ascribed to this episode also the lower subunits of the Slite Beds (a, b, c, d, e), but the correlation of this part of the sequence with Estonian sections is still unclear. Partly it may be correlated with the Vilsandi and Maasi beds of the Jaagarahu Stage.

The Sanda Primo Episode is characterized by a diverse assemblage of chitinozoans. Six species, including *Gotlandochitina martinssoni* and *Conochitina lagena*, appeared in this interval for the first time. This episode is well represented in the lower part of the Jamaja Formation of the Jaagarahu Stage.

The Boge Event has not been studied for chitinozoans, but we may suppose, that it is related to an extensive stratigraphic gap between the Jaagarahu and Rootsiküla stages, occurring in northern sections of Saaremaa. In the Ohesaare section, the interval of the Boge Event coincides roughly with the middle part of the Jamaja Formation.

Chitinozoans of the Allekvia Primo Episode and the Valleviken Event were studied by Laufeld in the reference section of the quarry of Slitebrottet 1. The disappearance of *Gotlandochitina martinssoni* and *G. spinosa* makes it possible to correlate this interval with the middle-upper part of the Jamaja Formation in the Ohesaare core. In most sections of Saaremaa, the lower part of this interval is followed by a stratigraphic gap. The correlation of the upper 40 m of the Jamaja Formation in the Ohesaare section is still unclear as it contains a rich assemblage of chitinozoans, probably missing in Gotland.

The Hellvi Secundo Episode and the Mulde Event are well represented in the Sõrve Formation of the Ohesaare section. Nine species disappear in the Mulde and Halla beds in Gotland and 12 species disappear in the upper part of the Sõrve Formation.

The topmost Klinte Secundo Episode has not been studied in Estonia, as the lagoonal dolomites of the Rootsiküla Stage are barren of chitinozoans.

The model of the Primo and Secundo cycles fits well with the diversity cycles of chitinozoans in the Wenlock succession of Estonia. Their diversity and abundance are higher during primo episodes and lower during secundo episodes. During these events a more or less abrupt decrease in chitinozoan diversity took place. The most severe extinction periods in the chitinozoan assemblage occurred during the Ireviken and Mulde events.

HIGH-RESOLUTION CHITINOZOAN BIOSTRATIGRAPHY OF SOME ORDOVICIAN EVENTS IN BALTOSCANDIA

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On the basis of publications and unpublished data from more than 30 sections an improved chitinozoan zonation is proposed for the Ordovician sequence of Baltoscandia. From the first appearance of chitinozoans in the latest Tremadoc Varangu Stage to the top of the Ordovician 24 zones and subzones can be defined with the total number of taxa amounting 128. The greatest precision is achieved in the Middle and Upper Ordovician, where chitinozoan evolution surpassed that of other investigated faunal elements. Some examples.

1. Detailed information about chitinozoan distribution allowed a precise dating of all four Ordovician impact craters known in Baltoscandia. The craters are not of the same age as earlier suggested.

2. The influence of volcanic ash falls on marine environment can be discussed in the light of results of detailed, bed-by-bed investigations near the Middle Ordovician Kinnekulle bentonite bed. This influence was smaller than hitherto supposed.

3. A detailed chitinozoan zonal succession in the lowermost Caradoc at Fjäcka (Dalarna, Sweden) was in some conflict with that in the East Baltic sections. The order of appearance of stratigraphically important taxa in the lower Dalby Limestone seemed to be inverse, and some layers were empty, as stated already by Laufeld (1967). According to the new data, the previous sampling and possibly also definitions of some conodont zones have to be revised. The main reason is the tectonically changed order of different blocks of limestones and weathering not noticed or described earlier.

4. Incorrect order of the layers in borehole cores is more common and serious than earlier suspected. Two examples: from Ukmerge (Lithuania) and Grötlingbo (Gotland, Sweden) can be demonstrated and proved in the light of chitinozoan biostratigraphy.

THE DISTINCTION OF PERI-GONDWANA AND BALTICA BY THE PALAEOBIOGEOGRAPHICAL DISTRIBUTION PATTERN OF CAMBRO-ORDOVICIAN ACRITARCHS

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The estimation of the palaeogeographic position of continental blocks is primarily based on palaeomagnetical studies and lithofacies analysis. However, faunal ana floral studies also provide useful data for the reconstruction of the palaeogeography.

Acritarchs are the most common group of organic-walled microfossils in the Lower Palaeozoic. Acritarchs are usually interpreted as various life stages of phytoplanktic origin, but some morphotypes represent probably remains of organisms of both the animal and vegetal kingdoms (e.g. eggs, exoskeletal parts of arthropods, etc.). Despite of the unknown biological affinities of this polyphyletic group, acritarchs are commonly used to resolve biostratigraphical and palaeobiogeographical problems in Lower Palaeozoic sediments.

The distribution of the acritarchs is complex and influenced by numerous palaeoenvironmental (light, nutrients, salinity, water depth), palaeoclimatological and palaeogeographical factors. A thorough review of Ordovician acritarch literature shows that the Tremadoc to early Llanvirn is a time interval for which a global acritarch distribution pattern can be proposed. It is possible to differentiate a high latitude, cold to temperate-water realm and a low latitude, warm-water realm. Cold-water assemblages are recorded from numerous localities at the northern border of Gondwana in the southern hemisphere. Assemblages related to warm-water areas are described from Canada, the United States, northern China and Australia. It appears that Baltica occupied an intermediate position with mixed microfloras. Although a distinction of separate "provinces" within the cold-water realms is difficult, the differentiation between these two units appears evident and a distinction of the assemblages from peri-Gondwana and the microfloras from Baltica is possible in the Early to Middle Ordovician. This scenario confirms the distribution pattern proposed for other fossil groups (brachiopods, trilobites, conodonts, graptolites, chitinozoans) and fits well with the scenario based on the most recent geophysical and palaeomagnetical data. The acritarch distribution pattern also supports the Ordovician rotation of Baltica as postulated by Torsvik *et al.* (1990).

NEW BIOSTRATIGRAPHICAL RESULTS IN THE UPPER ORDOVICIAN OF BELGIUM AND THE PALAEOBIOGEOGRAPHICAL RELATIONSHIP TO BALTICA

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New studies on chitinozoans and the revision of the graptolite faunas provide new biostratigraphical results and allow the proposal of an updated model for the stratigraphical succession in the Upper Ordovician of the Brabant Massif, Belgium, and comparisons with adjacent regions. New studies on chitinozoans confirm the high biostratigraphical potential of this palynomorph group and indicate very precise ages. Correlations with the Baltoscandian chitinozoan zonation by Nõlvak and Grahn (1993) can be easily drawn. Preliminary results (of studies which are still in progress) indicate the presence of the *Fungochitina fungiformis*, *Tanuchitina bergstroemi*, *Conochitina rugata* and *Spinachitina taugourdeaui* chitinozoan Biozones. Although the Baltoscandian index species appear absent in the Belgian succession, a good correlation is still possible. As a result of the detailed biostratigraphy by chitinozoans, a precise dating of the subduction related Late Ordovician volcanism in the Brabant Massif is possible. The volcano-sedimentary complexes in three localities (the Fauquez outcrop area and the Deerlijk and Lichtervelde borehole sections) are coeval and are of *bergstroemi* to *rugata* age. This corresponds to the lower and middle part of the Baltoscandian Pirgu Stage.

Graptolites in the Brabant Massif are present in several formations. The graptolite fauna from the Ittre Formation indicates an early Caradoc age. The fauna from the Fauquez Formation is attributed to a time interval spanning the *Dicranograptus clingani* and *Pleurograptus linearis* Biozones. The youngest fauna, recovered from the Lichtervelde borehole, belongs to the *Dicellograptus complanatus* and *Dicellograptus anceps* Biozones. While palaeobiogeographical interpretations from the available graptolite data remain difficult, other macrofossil groups recovered from both the Brabant Massif and the Sambre-Meuse-Band (brachiopods, trilobites, corals, and green algae) and the chitinozoan assemblages provide valuable biogeographical information. These fossil groups clearly indicate that Belgium was no longer located in cold water environments in the Late Ordovician, but already in relation with Baltic faunas at lower latitudes and in a warmer environment. All these data confirm the rapid drift of the East Avalonia terrain (including Belgium) from peri-Gondwana towards Baltica during the Ordovician.

CHANGES IN PHYTOPLANKTON BIODIVERSITY DURING NEOPROTEROZOIC AND CAMBRIAN TIMES

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Acritarchs are extremely abundant in Neoproterozoic and Cambrian successions, where their established cosmopolitan distribution and the relatively short duration of taxa make them ideal study objects in attempts at reconstructing biotic diversity trends. The Neoproterozoic and the entire Cambrian System reveal patterns in the origination and extinction of phytoplankton that suggest important fluctuations in the composition and taxonomic diversity of primary productivity. Well-defined plankton assemblages indicate that early Neoproterozoic planters remained unscathed for relatively brief periods of time, collapsing into low-diversity assemblages at around Cryogenian times. Morphologically diverse acritarchs and cyanobacteria briefly flourished during "Redkinian" or "Ediacaran" times, declining rapidly during late Neoproterozoic, "Kotlinian" or "Yudomian", times. The rise of diverse acritarch assemblages during the late Neoproterozoic and Cambrian was essential for early marine metazoan differentiation, but there are difficulties in correlating the diversity, speciation and extinction patterns of protists to established early metazoan diversity trends. In the early Cambrian, major evolutionary change in the lower trophic levels seem qualitatively and probably quantitatively mirrored by the higher levels of the food web. Primary producing phytoplankton changed steeply, but steadily, through *Platysolenites* and *Schmidtiellus* times and reached an undisputable acme in early Cambrian *Holmia kjerulfi* times. As reflected by plankton biodiversity, it seems that a gradual decline occurred after *Holmia* times, and acritarch diversity reached a very low level in middle Cambrian *Paradoxides forchhammeri* times. Recovery to nearly *Holmia* levels occurred subsequently with the addition of new acritarch taxa during late Cambrian times. Cambrian protist assemblages evolved over relatively short time spans, apparently emanating from low-diversity residual populations after gradual diversity decline. The characteristic microbiotas of the terminal Neoproterozoic, Lower, Middle and Upper Cambrian burgeon during relatively narrow time spans, subsequently falling to nearly initial levels. Because of decreasing time spans involved in the Upper Vendian, Lower, Middle and Upper Cambrian biochrons, respectively, the tempos of species turnover seem to have varied considerably. Speciation levels gradually decreased during Lower and Middle Cambrian times, whereas extinction levels increased during the entire time span of the Lower Cambrian, a trend that seems to have reversed during the Middle Cambrian and during most of the Late Cambrian.

Photo courtesy of Geoffrey Clayton, Australia

CIMP meeting at IX International Palynological Congress, Houston, Texas, U S A; Tuesday, June 25, 1996

AGENDA OF FUTURE PALYNOLOGICAL CONFERENCES, SYMPOSIA, WORKSHOPS 1997-1999:

September 7-13 1997: **Third Symposium of African Palynology**. Univ. Witwatersrand Johannesburd, South Africa.
Contact: Dr. Ann Cadman, BPI (Palaeontology), University of Witwatersrand, PO WITS 2050, South Africa. Fax.: +27 11 403 1423; Email: 106caa@cosmos.wits.ca.za

September 14-19 1997: **Evolution of the Marine Phytoplankton**, seminars as part of the AASP annual meeting. Marine Biological Laboratory, Swope Conference Centre, Woods Hole Massachusetts, USA.
Contact: Dr. Paul K. Strother, Department of Geology and Geophysics, The Weston Observatory of Boston College, 381 Concord Road, Weston, Massachussets 02193, USA. Tel.: + 1 617 552 8395; Fax.: +1 617 552 8388; Email: strother@hermes.bc.edu

July 20-27 1997 **Subcommission on Devonian Stratigraphy Meeting**, "Devonian cycles, sequences and bioevents", University of Rochester, USA and field excursions in the New York state and possibly Pennsylvania.
Contact: Dr. Carlton E. Brett, Department of Earth and Environmental Sciences, 227 Hutchinson Hall, University of Rochester, Rochester, New York 14627 USA; Tel.: +1 716 275 5713; Fax.: +1 716 244 5689; Email: cebh@db1.cc.rochester.edu.

(to be confirmed) second half of june 1998. Field Meeting of the **Silurian Stratigraphic Subcommission** in Ossa Morena SW Spain and Portugal.
Contact: see next CIMP Newsletter.

1999 (announced) 8th International Symposium on the Ordovician System, organized by **Ordovician Stratigraphic Subcommission**, Prague, Czech Republic.
Contact: see next CIMP Newsletter

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C.I.M.P. WORKING GROUPS AND SUBCOMMISSIONS

Vallatisporites Working Group
Contact person: Bernard Owens, British Geological Survey,
Keyworth, Nottinghamshire, NG12 5GG, U.K.

"Lycospora" First Occurrence Working Group
Contact person: Elzbieta Turneau, Instytut Nauk Geologicznych,
Polska Akademia Nauk, Ul. Senacka 1/3, 31-002 Krakow, Poland.

Upper Devonian "Grandispora" Working Group
Contact person: Ken Higgs, Department of Geology,
University College Cork, Cork, Ireland.

Acritarch Subcommission
Chairman: Stuart Molyneux, British Geological Survey,
Keyworth, Nottinghamshire, NG12 5GG, U.K.
Secretary: Thomas Servais, Lab. ass. de Paléontologie,
Université de Liège, 7 Place du Vingt-Août, B-4000 Liège, Belgium

Chitinozoa Subcommission
Chairman: Florentin Paris, CNRS - URA 1364, Universite de Rennes 1,
Campus de Beaulieu F35042 RENNES Cedex France.
Secretary: Stuart Sutherland, Natural History Museum, Dept. of Palaeontology,
Cromwell Road, London, SW7 5BD, U.K.

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From the C.I.M.P. constitution: **"members of C.I.M.P. shall be all palynologists who desire to belong to C.I.M.P."** The C.I.M.P. Newsletter is open for all members for announcements for symposia or conferences, abstracts of previous ones, news from the working groups and subcommissions, changes of address of members or other messages. These should reach the secretary the end of march and of october.

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In order to maintain our aim of issuing at least two Newsletters each year (may and november), it is vital that we receive your subscriptions on a regular basis.

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Next CIMP Symposium(a) in 1998

Two proposals were received for the organization of our next CIMP Symposium in 1998.

1. PISA, Italy (second half of september 1998).

The symposium will be held 15 km away from Pisa, in Tirrenia, a holiday village along the Mediterranean coast. There is an airport in Pisa for easy connections and, of course, a railway station. Tirrenia is linked with Pisa by public buses (very frequent, about each hour, at least). A free (or cheap) bus card may be obtained for the CIMP members. Moreover buses from the University can be provided to carry the symposium members from Pisa to Tirrenia and for longer trips.

The symposium members will be housed in the same hotel, only 50 meters far from the sea shore.Two halls are available for meeting sessions, one of them large enough to permit general sessions (accommodation estimated for maximum 70-80 persons). The price of the complete accommodation (low season) is 75,000 lire/day /person (prices of 1996), including bed and meals.

Two touring tours may be organized: one to Pisa and another to our Natural History Museum, located on the southern slope of the Pisan Mountains, in an ancient, very interesting Carthusian monastery. The gala dinner may cost about 40,000 lire per person (very provisional price; cheaper alternatives are looked for).

Excursion. Because the Tuscan Palaeozoic basement is metamorphic with no recoverable palynomorphs, a geological excursion is proposed to the Apuane Alps (i.e. a marble-excursion near the famous marble locality Carrara, north of Pisa).

Financial support from the University will be asked, particularly in order to invite some East European colleagues to the conference by covering all their expenses.

Organization: Prof. Dr. M. Tongiorgi, Universita di Pisa, Via S. Maria 53, I-56126 Pisa, Italy. (Email: tong@dst.unipi.it).

2. QUEBEC CITY, QUEBEC, Canada (18-20 May 1998).

The Geological Association of Canada (GAC) and the Mineralogical Association of Canada (MAC) will hold in 1998 its annual meeting in Québec City. Palynologists from the Québec Geoscience Center would be pleased to organize a CIMP symposium at this joint annual meeting of the GAC/MAC. The idea of taking advantage of the Québec 98 GAC/MAC meeting to organize a CIMP Symposium came up during the CIMP Symposium in 1994 in Sheffield (U.K.) and was also discussed at the CIMP Symposium (9 IPC, Houston) this year.

This event could be an excellent opportunity for the CIMP members to echo the vitality of international palynology within the geological community, to get information on Canadian geological activities, to meet scientists from other geological disciplines and to participate in field trips organized for the annual meeting or in the workshops accompanying this event.

Special field-trip for the CIMP Symposium.
Unfortunately at the end of may the meteorological conditions in Gaspésie or the island of Anticosti are very uncertain (outcrops possibly still covered with snow and cold weather). In the Québec area the weather is better in may (it can be warm and sunny but also cool and rainy; participants are advised in advance to bring warm, rainproof clothing, gloves and field boots).
Special field trip A (2 to 3 days): near Québec City: Cambro-Ordovician sections in the Appalachian and Ordovician platform sequences (very aprox. costs: 400-500 CAN$).
Special field trip B (± 6 days): Québec-Gaspé area: geology of the Basses Terres and Appalachians, Bas du Fleuve et Gaspésie (Cambrian-Ordovician, Silurian-Lower Devonian, some Carboniferous)(very aprox. costs.: 800-1000 CAN$).

Technical sessions will be held in the "Centre des Congres", old Québec City. Registration GAC/MAC: 200-220 Can$. Prices (all in Can $; add about 14% tax):
Transport: Airport to old Québec City: taxi 17-25$, hotelbus 9$; to Sainte Foy: taxi 10-17 $, hotelbus 7$. Buses within city: 1.85$ (cash) or 1.40$ (pre-purchased).

Accommodation:
Residence at the Laval University (20-30 min. bus from Congress Centre: 25$/p/day); hotels in St. Foy (30-40 min. bus from Congress Centre: 50-80-120$/room/day);
hotels in Québec City near Congress Centre: 60-80-100-120$/room/day);
Bed and Breakfast places in Québec City: 50-85-110 $/day).
Meals: breakfast: 4-8$: lunch: 8-15$; dinner: 9-15-25$.

To be able to submit a formal proposal to the Québec 1998 Scientific Program Committee a decision is asked from the CIMP by early January 1997.

Organization: Prof. Dr. Aicha Achab and Esther Asselin, Québec Geoscience Centre. 2535 Laurier Boulevard, P.O. Box 7500, Sainte Foy, Québec G1V 4C7 Canada. (Email: achab@gcs.nrcan.gc.ca; asselin@gcs.nrcan.gc.ca).

Postal ballot.

Please **send, fax or email** your choice for the next CIMP symposium(a) in 1998 to the CIMP secretary-general **by post before 21 december 1996.** The votes will be counted on **monday 6 january 1997 at 18h00** (Belgian times).

Please, choose only one proposal from the following three proposals:
(1) a full CIMP Symposium in Pisa, Italy. Yes - No
(2) a full CIMP Symposium in Québec, Canada. Yes - No
(3) two CIMP Symposia: a CIMP Symposium in Québec, Canada (covering all palynomorph groups but accentuating on the Spores and Chitinozoa) and a CIMP Symposium in Pisa (workshop of the Acritarch Subcommission). Yes - No
Please indicate inteset in field trips:
Intesest in Italian Field trip (Yes - No).
Interest in Canadian Field trip A (Yes - No); Field trip B (Yes - No)