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CLIMATES : PAST, PRESENT AND FUTURE

CLIMATES



ABSTRACTS

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AGUSTI, J., LLENAS, M., CABRERA, L. & GARCÉS, M. *Sabadell, Barcelona* - Mammal turnover and climate evolution in the Neogene of Eastern Spain.

Quantitative analysis of the rodent succession in the Vallès-Penedès Basin (NE Spain) enables the recognition of an alternation of dry and humid phases in that area during the Miocene and early Pliocene times. The rodent record in this basin ranges from the early Miocene (late Ramblian, MN 3) to the early Pliocene (early Ruscinian, MN 14). Previous gaps in the Miocene record affecting mammal units MN 5 and MN 6 have been filled after recent research in the area. As a difference with previous analysis, the early Miocene (MN 3) indicates forest, humid conditions, similar to those observed in the early Miocene of Central Europe. Increasing dryer conditions are recorded across the MN 4 and MN 5 mammal units, but a recuperation of humidity is observed in the late Aragonian (late middle Miocene) times (MN 6-MN 8). The middle-late Miocene transition, characterized by the dispersal of the equid *Hipparion* (Aragonian-Vallesian boundary), coincides with a new dry period, which is followed by a new humid peak in the early Vallesian (early Tortonian). The late Vallesian (MN 10) involved a dramatic change in the mammal composition, which led to the disappearance of most of the forest-dwellers characterizing the late Aragonian and Vallesian times. The trend towards dryer conditions persists in the early Turolian times. The observed pattern of rodent evolution is coincident with the large mammal and paleobotanical record of the basin.

AMORE F.O., CIAMPO. G., DI DONATO V., ESPOSITO E., RUSSO ERMOLLI E. & STAITI D. *Napoli*.- **An integrated micropaleontological approach applied to Late Pleistocene-Holocene paleoclimatic changes (Gaeta Bay, Italy).**

Paleoclimatic studies have been performed on three cores from the Gaeta Bay continental shelf (Central Tyrrhenian Sea). On the basis of calcareous nannofossils, foraminifera, ostracods and pollen associations, paleoclimatic curves have been realized and sea level oscillations have also been detected. The cores (C5 500 cm long, 111 mbsl; C8 362 cm long, 126 mbsl) consist of two units separated by a discontinuity surface. The more distal core (C9 470 cm long, 212 mbsl) presents a continuous sedimentary record. The total time interval spanned is from Late Pleistocene (5 d? Stage) to Holocene. The analysis of the acoustic profiles (Senatore, 1966) identified a prograding wedge system with clinoforms increasing in dip seaward. Thus, the lower interval in the C5 is older than in the other cores. The analysed sedimentary body lies above the Tyrrhenian reflector (younger than 115.000 yrs). Moreover, the lower part of C5, C8 cores might be correlated with stage 5d.(C5) and 5b (C8), on the basis of the absence of the *Emiliana huxley* Acme. The C9 core lower interval should correspond to stage 2 *partim*. The upper parts of all the cores represent the Late Glacial-Holocene interval. Correlation among them has been realized on the basis of paleoclimatic patterns and foraminiferal ecozones. The basal units of all the cores correspond to episodes characterized by calcareous nannofossils, foraminifera and pollen cold assemblages and by near-shore ostracod assemblages testifying to sea level low-stands. The increase of warm taxa at the base of Late-Glacial Holocene interval correspond to a gradual sea level increase as testified to by the ostracod assemblages.

AZANZA, B., ALBERDI, M.T. & PRADO, J.L. *Madrid*. - Mammalian diversity patterns and climate changes during Plio-Pleistocene in Western Mediterranean Area.

Models to explain the regulation and maintenance of diversity through time can be tested using the fossil record. A major problem is how to control the variation in diversity through time. Two alternative approaches are considered here based on unequal (biochronological units) and equal time intervals. Both of them are resolved by multivariate methods using similarity and parsimony respectively. Patterns of mammalian specific turnover, richness and faunal composition were assessed in the light of relative sampling quality and their correlation evaluated with major changes in environmental conditions. Between 6.0 and 3.5 Ma species richness was maintained rather constant. Nevertheless, the pattern of turnover shows significantly high value of first occurrences between 5.5-5.25 Ma, the last occurrences were also high but just in the following interval drop significantly. This can be represented more by a turnover than a dispersion event. The first- and last-occurrences rate quotient tracked one another closely suggesting that a broad range of rate curves are possible within the equilibrium. Nevertheless, this equilibrium is disrupted around 3.5-2.5 Ma, and from 1 Ma up to now. In both cases it was associated with increases in standing richness whose acmes were near 3.0 and 0.5 Ma respectively and with high values in first occurrences. Between 2.5-1.0 Ma the species richness fell drastically but most of the families were recorded. On the contrary, the pattern of turnover was rather constant during this time. The patterns correlate clearly with the climate changes. Near 5.4 Ma there is a first pulse of glaciation (Messinian crisis), between 3.0-2.6 Ma there was the onset of bipolar glaciation followed by glacial-interglacial cycles of moderate amplitude sustained at the orbital periodicity of 41 ka. After 0.9 glacial maxima became more extreme and the dominant periodicity of variation shifted to 100Ma. attributed to massive Northern Hemisphere ice sheets.

BARTHOLDY, J. & BELLAS, S. *Berlin*.- Paleogeographical and paleoclimatological implications, based on application of integrated bio- and sequence-stratigraphy, in the Middle Eocene marine deposits of the northern Tatra Mts. Range, Poland.

The investigated area is located in the Polish part of the West Carpathians, south of Zakopane town. In terms of microfacies analysis, four sections were studied, one of them composite, between the Dolina Sucha valley to the east and the Dolina Mala Laka to the west. Their thickness ranges between 5 and 30 m (BARTHOLDY *et al.* 1995).

Deposition began in the upper part of Lutetian with a basic marine conglomerate, which mainly consists of pre-tertiary components. Upwards following sandy, biogenic limestones which are interpreted as being deposited in an inner shelf environment. They are conformably overlain by marls and allodapic limestones of the middle shelf.

The studied microfauna from the above limestones permitted an age assignment of the large foraminifera assemblage in the *Nummulites brongniarti* total range zone (sensu RACEY, 1994) as it was modified from SCHAUB (1981). In addition, three calcareous nanofossil associations (cna1 - cna3) were recognised in the marly layers, which allowed a precise age estimation. The last (younger) association (cna3) is characteristic of the middle part of the biozone *Discoaster saipanensis* (NP17) sensu MARTINI & MÜLLER (1986).

On the bases of vertical development of the recorded microfacies and their integrated biostratigraphic control, two depositional cycles could be partly identified; the first one is correlated with the 3.5 cycle according to HAQ *et al.* (1988), while the second one is correlated with the 3.6 cycle of the same authors. Both cycles belong to the upper part of supercycle TA3 (Bartonian).

Higher diversity of the *Nummulites* and *Discocyclines* taxa in the lower part of the studied successions, points to the relatively warm climate optimum at the base of Bartonian. By contrast, a decrease in the diversity of the above species, together with the appearance of the first *Heterostegina* point to a colder climate during the middle Bartonian. Both evidences fit well with data published by OBERHÄNSLI (1996) for the same time interval.

Integration of the bio-, sequence-stratigraphical and paleoecological data clearly underlined the dominant role of sea-level fluctuations on the depositional environment, over the regional tectonic control.

BEERLING, D. J., *Sheffield*. - The influence of climate and atmospheric composition on vegetation function through the Phanerozoic.

Whole scale changes in climate and atmospheric composition, particularly CO₂ and O₂ over the Phanerozoic (the past 400 Ma) will have exerted a strong influence on photosynthetic carbon fixation by plants, and ultimately the productivity and structure of terrestrial vegetation. This presentation will describe temporal and spatial aspects of investigations being made in Sheffield to quantify these effects on vegetation function. The impact of continuous changes in CO₂, O₂ concentrations and temperature over the past 400 Ma has been investigated through leaf-scale modeling, based on the stomatal characters of fossil leaves, and tested against stable carbon isotope data from fossilised organic matter spanning the same interval. The global scale approach has been investigated by driving a dynamic global model of terrestrial net primary productivity (NPP) coupled to a biogeochemistry model of carbon and nitrogen dynamics in vegetation, litter and soils with global palaeoclimate datasets derived from a general circulation model of the Earth's climate. The resulting global simulations of NPP, leaf area index and soil carbon concentration in the Carboniferous, Jurassic and Cretaceous are compared with the global distribution of a variety of climatically sensitive facies and fossil floras to provide a first test of the results.

BELLAS, S., *Berlin*. - Latest Eocene to Oligocene palaeoclimatologic changes and diversities trend based on the marine record of calcareous nannofossils: Ionian Zone, Epirus, Greece.

Compared to the Cretaceous-Tertiary and Pleistocene extinctions, little interest has been focused on the events spanning the Eocene to Oligocene (E/O) transition. The latter significant climate shift, began with a warm subtropical earth in the Early to Middle Eocene, and occurred via the development of the first glaciers on Antarctica and the filling with cooler waters of the ocean basins (HAY, 1993); The shift was completed with decreasing temperatures prevailing during the Oligocene Epoch. Therefore, as PROTHERO (1994) has already suggested, the Late Eocene to Oligocene time-interval was in a palaeoclimatological sense fundamental for the „establishment“ of ice-conditions, and subsequently the differentiation of the past biocommunity record during post-Eocene earth history.

In this concept, after high resolution biostratigraphical investigations (BELLAS & FRYDAS, 1996), and in order to recognize possible fossil-traces of this climatic shift, the calcareous nannofossils recovered from four sections were semi-quantitatively evaluated. The studied outcrops are exposed in Epirus, NW. Greece, and their sediments belong to the Ionian Basin, located in the eastern Mediterranean Sea. The palaeogeographical position of these sediments is very important, since they have been deposited in the transitional higher middle latitude realm of Tethys (ca. 40° N).

Total diversities of the calcareous nannofossils along these sections, corrected for the reworking effect, give indirect evidence for the nannoflora response to the Oligocene cooling. The recorded pattern of the changes obtained, mainly highlights two important aspects. The first one indicates that no abrupt event took place at the E/O boundary (in the mean of a catastrophic phenomenon), in agreement with the weak diversities change, particularly across the boundary noted also by AUBRY (1992). Only cumulative frequencies of specific indicators showed significantly decrease or even extinction of a few species, but they did not affect the general pattern of diversity. Secondly, and despite the occurrence of medium-scale variations, a short-term positive change can be primarily observed (earliest Oligocene increased productivity?); It was followed by a long-term negative trend (productivity decline?), which obviously lasted during the whole Oligocene up to the earliest Miocene, where the diversities and temperatures seem to recover again. Furthermore, data from different parts of the Ionian Basin are illustrated and discussed.

BERGER, J.-P. *Fribourg*. - Climatic changes in the Swiss Molasse (Oligo-Miocene).

New studies on biostratigraphy, paleomagnetism, paleobotany and stable isotopes ($\delta^{18}\text{O}$, $\delta^{13}\text{C}$) are now available to present a synthesis of the paleoclimatic conditions governing the Swiss Molasse Basin during the Oligocene and Miocene.

We present here a new stratigraphic chart of the Oligocene and Miocene of Switzerland which correlates lithostratigraphy, paleomagnetism, radiometric ages, marine biozones (calcareous nannoplankton, planktonic forams), continental biozones (charophytes, mammals), stable isotopes and stratigraphic position of the principal fossil localities.

We discuss also the methodological problems linked with stable isotopes analyses on rocks, freshwater fauna (ostracods and gastropods) and flora (charophytes) and their consequences in terms of paleoclimatic reconstructions.

A general subtropical to warm temperate climate was already proposed by HEER (1855), and preliminary paleoclimatic results based on paleobotany and stable isotopes have been published by BERGER (1987, 1990). The new detailed isotopic curve is deduced from Early Oligocene to Middle Miocene deposits and shows a lot of positive and negative excursions. Some of them (as for example in the Late Oligocene) are correlated with important floral and faunal changes observed in the fossil record (occurrence and diversity of palms, taxodiaceae, large and small mammals...). Others are more difficult to interpret and could be the results of local evaporation effects and/or transgressive-regressive episodes.

This record also provides some results concerning the relationships between alpine tectonics, relief formation and climate changes. A good example is given by the Late Oligocene deposits, with the coexistence of evaporitic basin (dry). *Taxodium* swamps and *Sequoia* forests (humid) which is certainly dependent on the relief created by the alpine orogeny and beginning of the subalpine molasse thrusting.

BONFIGLIO, L., MARRA, A.C., Messina, MASINI, F. Palermo.- The contribution of Quaternary vertebrates to the paleoenvironmental and paleoclimatic reconstructions in Sicily.

The use of fossil vertebrates for palaeoecological - palaeoclimatic inferences is limited in islands. First, insular environments are usually characterized by poorly diversified assemblages. In a second place, the reorganization of mammal communities in response to climatic-environmental changes is strongly conditioned by geographic barriers. Furthermore, insular endemic mammals sometimes underwent to such dramatic adaptive changes which may render their meaning as ecological-climatic indicators difficult to be detected. Sicily experienced at least four vertebrate dispersal events during Quaternary. The marked endemism and the extremely low diversification of the fossil assemblages of the early and early-middle Pleistocene does not allow any reliable interpretation. The younger assemblages, on the contrary, are more diversified and, although they display some endemic characters, are similar to those of southern peninsular Italy. The late-middle and early-late Pleistocene assemblages are characterized by the occurrence of a red deer, a strongly endemic megalocerine, auroch, bison, elephants, a hippo, boar, a brown bear and three large social carnivores (*Panthera leo*, *Crocuta crocuta*, *Canis lupus*). These assemblages are indicative of a climate with temperate, mediterranean affinity and of landscapes in which forested areas were associated with more open environments. The relatively low abundance of the red deer and the dominance of the megalocerine in several assemblages suggests that a mediterranean - type forest locally dominated during some climatic phases. The assemblages of the second part of the late Pleistocene are characterized by a dramatic drop in diversity, with the disappearance of elephants, the hippo, the bison, of the endemic megalocerine, and of the largest predators. This would indicate an environmental crisis likely linked to drier climatic oscillations of the late Pleniglacial, as is suggested also by the spreading of the ground vole which is the dominant small mammal in several assemblages. The late glacial is marked by the spreading of equids (horses and ass), which are indicators of open landscapes and of xerophytic steppe-like cover. The beginning of the Holocene is characterized by the expansion of forested areas and by a more humid climate as suggested by the abundance of red deer, by the dispersal of the common dormice and of the water vole.

BOYD, A., *Copenhagen*. - Mid-Pleistocene climate of Rhodos, Greece as indicated by Leaves deposited in a marine setting.

The Kolymbia Flora of Rhodos, Greece is a half million year old leaf flora that records a wider distribution of present day relict plant taxa (e.g., *Pinus canariensis*, Liquidambar, *Zelkova*). The flora consists of 35 different conifer and angiosperm species and was deposited in about 200m waters depth off the coast of Rhodos. Although *Quercus coccifera* and other taxa representing dry climatic conditions are present, the dominating presence of Liquidambar, and the presence of *Fagus*, *P. canariensis*, and *Vitis* indicate wetter and more mesic climatic conditions in the Eastern Mediterranean during this time than at present. Similar aged floras in the western Mediterranean are more dominated by a dry element. This suggests that the eastern Mediterranean was an area of refugia with the last occurrence of many taxa possibly founded here. When the Kolymbia flora is compared to similar aged florules in more paleolandward deposits on Rhodos, leaf taphonomical sorting is indicated. This has consequences for determining paleoclimate based on single florules.

BUJATTI-NARBESHUBER, M., Vienna - Pleistocene/Holocene (P/H) boundary oceanic Koefels-comet Impact Series Scenario (KISS) of 12.850 yr BP Global-warming Threshold Triad (GTT).

Parallel to terminal Wisconsin mass extinctions (Grayson, 1989) is now detailed paleoanthropological evidence for a P/H *Homo s.s.* near extinction. Genetic mitochondrial DNA and *Alu* element simulation analysis dates the collapse of *Homo* effective population to 18.000 in recent Pleistocene past (Sherry, S., AAPA, 1997). Geophysical and geochemical evidence suggests a P/H-KISS as a mini KT impact scenario (Alvarez, 1980) triggering mass extinction and civilisatory, Tectural Phase in *Homo* evolution: e.g. Koefels crater in Tyrol with circular (Seiberl, 1986) impact-geomagnetism, shatter cones (Zvonaric, 1996), pumice with a meteoritic component in rare earth elements and isotope analysis (Bujatti-Narbes-huber M. et al., J. Paleopathology, 7, 2, 83, 1995). There is hard sociocultural evidence (e.g. C14 dated rock impactor ideograms, Monte Alegre, Roosevelt A., 1995) and even the history-date of 12.850 BC (Maya-calendar, Muck, O., 1975). My alternative interpretation of P/H climate and volcanism increase (Zielinsky, 1996) is thus: ending the 200 yr Gerzensee/Killarney cooling event from 13.050 BP, impact volcanism began with 12.850 cal yr BP (= 1950) isochrone Laacher See Tephra. Climate changed with the direct impact effect of global cooling by sunlight reflection via high stratospheric water & volcanic sulfuric acid vapors (atmospheric albedo phase 1); resolved by 6 yr tree ring and 12 yr lake varves (Kaiser F, 1993) till 12.838 BP. First by gravity, later by greenhouse gases (higher atmospheric water & CO2 content) this atmospheric, subtropic (Tibetan), subpolar albedo phases 1, 2, 3 were sequentially removed by the indirect KISS effect on long term climate (greenhouse phase 1); 200 yr varves or rings until 12.650 BP, End Alleröd Temperature Maximum. The resultant melt water pulse from the Agassiz and Baltic Ice Lake finally stopped ocean circulation (thermohaline phase 1); 200 varve plus Younger Dryas duration of 1150 yr ice core (GRIP) till 11.500 BP. After subcritical circulation weakening, that started 11.350 BP with Preboreal Oscillation, PBO (thermohaline phase 2) from 11.230 to 11.100 BP from Baltic Ice Lake final drainage (all data 50 yrs earlier than S.Björk et al., Science 274, 1155, 1996) the damped flow (thermohaline phase 3) of Holocene was established. It contrasts Pleistocene (thermo-haline phase 0) of rapid oscillations, critically regulating ice age dynamics. All 4 phases make the GTT scenario of above/ below/ at threshold bipolar half-center tipping-regulation for hot climate prediction.

CARACUEL, J.E. & OLORIZ, F. *Jaén, Granada*. - Testing Upper Jurassic bioclasts for $\delta^{18}\text{O}$ measurements and palaeotemperature interpretations.

More than 70 analyses of $\delta^{18}\text{O}$ in bioclasts (belemnites, aptychi, bivalves, echinoderms and brachiopods) were made in epiocenic samples from the Upper Jurassic in the Subbetic (S Spain), the Sierra Norte (Mallorca Island), and the Trento Plateau (Venetian Alps, N Italy). Every bioclast considered was peer examined under cathodoluminescence (CL), optical (OP) and scanning electron microscopy (SEM), to test their preservation and structure. Along with calculated $\delta^{18}\text{O}$ palaeotemperature (according to Craig, 1965), we also analysed Mg, Mn, Sr, Fe, Na & Ba, by ICP, and Mn, Sr, P & Fe by WDS micropobe.

Belemnites were found to be the most reliable bioclast for palaeotemperature interpretations based on $\delta^{18}\text{O}$ measurements, according to: a) little or no recrystallization of their radial-concentric prismatic calcite, as seen under OP and SEM; b) higher similarity indexes ($\delta^{18}\text{O}_{\text{bioclast}} - \delta^{18}\text{O}_{\text{rock matrix}}$) both for $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$; c) generalized non-CL calcite; d) geochemical data according to assumed values for low-Mg calcite precipitated in equilibrium with the seawater; e) palaeotemperatures obtained are reasonable, and fit well with expected and published data (both isotopic and computer simulations, global climatic model).

Reasons for belemnites to be the best bioclasts for $\delta^{18}\text{O}$ palaeotemperature measurements are: a) a comparatively massive structure that hindered diagenetic overprints; b) their very low-Mg calcite composition, which is more resistant to diagenesis than high-Mg calcite or aragonite; c) the thickness of the rostrum which also hampered diagenetic overprints and facilitated selective sampling of the material to be analysed (better preserved areas as the rostrum solidum far from the apex and the rostrum cavum or alveolar rostrum). Moreover, belemnite rostra are quite abundant in the sections studied, with respect to other bioclasts, except ammonites which are extremely unreliable due to the aragonitic composition of their shells, which commonly were lost during fossil diagenesis.

CHALINE, J., *Dijon*.- Are climatic changes a driving force in hominid Evolution?

A comparison of the Eastside Story and the Inside Story theories shows that the Eastside Story approach, with its claim that climate was responsible for the appearance of bipedalism and hominization, now seems to be ruled out by the biological, paleogeographical, paleontological and paleoclimatic data on which it was based. Biological data support the embryonic origin of cranio-facial contraction which determine the increase in cranial capacity and the position of the foramen magnum implying bipedalism. In Inside story, developmental biology appears as the driving force of Hominid evolution but climate exerts a significant influence and was involved: (1) in the prior establishment of ecological niches which allowed the common ancestor to become differentiated into three sub-species; (2) by dividing up the area of distribution of species, resulting in the present-day sub-species of gorillas and chimpanzees; (3) by facilitating relative fluctuations in the geographical ranges of the various species, particularly the spread of australopithecines across the African savanna from north (Chad, Ethiopia) to south (South Africa), and (4) by determining adaptive geographical differentiations among *Homo erectus* and *Homo sapiens* (pigmentation, hemoglobin, etc.).

CHALONER, W.G. *Egham*. - Deciduous vs. Evergreen: A climatic Response?

The process of seasonal leaf shedding or deciduousness is generally seen as an adaptation to a particular climatic regime. But views as to the environmental constraint that produced it, and its history through geological time are divergent. Physiological considerations generally suggest that annual leaf shedding is broadly correlated with a season of water stress, either through low temperature restricting root uptake, as in high latitude winter conditions, or a season of aridity as in savanna. But other phenomena, especially nutrient cycling, are evidently involved, Axelrod suggested that the savanna pattern pre-adapted temperate angiosperm tree species in the New World to survive a cold winter season during the Tertiary climatic decline through middle and high latitudes. Spicer and others point to the necessity of leaf shedding to survive under a high latitude dark winter in the Cretaceous „greenhouse“ world. These two eminently plausible scenarios then suggest that deciduousness arose in response to two very different climatic phenomena, in different settings. However, there is a further factor which may derive from the climatic adaptation, but is mediated in a different way. The structural and chemical defense commitment made to leaves destined to last more than one season clearly affect the palatability of the soft mesophytic short-lived leaf versus the evergreen. The predation resistance strategy of interrupted leaf margins is more in evidence in deciduous leaves than evergreen, which may explain how the entire versus interrupted leaf margin shows a (derived) correlation with climate. The distribution of modern deciduous and evergreen conifers in the Pinaceae and Taxodiaceae presents further odd contradictions to a simplistic interpretation of climatic causality. The interplay between the deciduous and evergreen habit cannot be seen as a response to climate alone.

CHIRA, C., FILIPESCU, S. & CODREA, V. *Cluj-Napoca* - Palaeoclimatic evolution in the Miocene from the Transylvanian Depression reflected in the fossil record.

The first marine palaeofauna with Miocene affinities occurs in the upper part of Vima Formation (Egerian). Its Mediterranean character suggests a warming of the climate. Eggenburgian was a relatively warm interval, as indicated by the marine subtropical mollusc associations where the large pectinids prevail (*Chlamys gigas* Biozone - Corus Formation). The warming is also confirmed by the nannoplankton (NN2 partim, NN3 partim) and the low latitude foraminifera (?M2-3) within the Chechis Formation.

The relatively scarce fossil record of the Hida Formation (Ottangian), suggests a cooling interval, probably related with Atlantic and Boreal influences. The most notable warming during the Miocene was recorded at the level of Dej Formation (Lower Badenian). The occurrence of the subtropical nannoplankton (NN5), foraminifera (M5) and molluscs (*Neopycnodonte navicularis* Zone) could be correlated with an important global warming. The same climatic pattern can be proven on land by the presence of a rhinocerotid species, *Lartetotherium sansaniensis*, from Dobarca (MN 5), an inhabitant of dry open woodlands. The following tendency started in the upper part of the Dej Formation, where the subtropical foraminifera (?M6) become scarce. The new marine microfauna from the Upper Badenian confirm the slight cooling of the environment as well. Although the severe restriction of the connections with the open seas makes the global correlations in the aquatic realm difficult, the fossil associations confirm that the Early Sarmatian started with a new short warming, followed again by a cooling episode. As the rich bivalves populations suggest, the Late Miocene marked the last significant warming. At the same level, in a warm and moist environment, lived *Aceratherium incisivum* from Ungurei (Pannonian s.str., MN 9).

CLAUSING, A. *Halle (Saale)* - Lamination and primary production in fossil lakes and relations to the palaeoclimate.

Laminated lake sediments can be observed at least since the Palaeozoic. They may be produced by: 1. changing clastic input, 2. organic production of planktic and benthic organisms, or 3. physico-chemical processes (e.g. evaporation). Gradually mixing of these main processes additionally occurs. Development and construction of lake lamination has mainly been studied in various recent environments (varves, Eifel Maar lakes). In order to understand the development of organic lamination, comparison is best made to studies from recent environments and then compared to earth history. In this study the focus is on lake sediments from the Palaeogene and the Permian. They show similar characteristics and may give new ideas on the interpretation of the palaeoenvironment, its palaeoecology and possibly the palaeoclimate. Sediments of the Upper Oligocene Enspel lake are rich in organic remains, which represent remnants of the primary production in the lake. A rhythmical change between layers with chrysophyte cysts, diatoms, dinoflagellates and such composed of organic and inorganic matter repeatedly occurs. Laminar horizons are preserved which are identical to some laminar successions in extant eutrophic lakes. In those, the lamination is produced by the annual succession of planktic organisms in the lakes. Lake Meisenheim (Rotliegend) is characterized by laminites with a cyclicity of light grey and dark laminae. The microtexture shows organic matter enriched (dark) and purely inorganically composed layers (bright). This pattern is obviously also similar to a periodic lamination as observed in extant lakes but differs strongly by the preservation. Sedimentary and palaeontological features point to physical and biological influence on the production of the laminae. The development of the laminae point to recurring effects in the primary production which could be understood as periodical events in the lake as produced by the climate in the Lower Permian.

COPPA M.G. *Napoli*, ROSSO, A., SANFILIPPO R. *Catania*. - **Micro- and macrofaunistic analysis of the cold Pleistocene section of Torre S. Gennaro (Brindisi, Southern Italy).**

The section of Torre S. Gennaro (Brindisi, Southern Italy) has been studied. The sequence, 19 m thick shows a basal part consisting of poorly stratified, sub-horizontal muddy sands. At about 12 m from the base these levels are cut off by gently dipping muddy-sandy layers beginning with a coarser bioclastic cemented layer.

Benthic associations (foraminifers, molluscs, serpulids and bryozoans) testify to a palaeoenvironment near the infralittoral-circalittoral boundary, with a slight upward shallowing in the depositional paleoenvironment. Benthic assemblages from the lower part of the section, below the cemented layer, were referred to a Coastal Detritic Biocoenosis. The overlying layers, only yielding microfaunas, were seemingly deposited in a lower infralittoral paleoenvironment. Microfaunas also comprise some epiphytic and euryhaline taxa, respectively suggesting the presence of plants and salinity variations.

The section has been referred to the Early Pleistocene (Emilian to Sicilian), due to the presence of the foraminifers *Bulimina etnea* and *Hyalinea baltica*, and the molluscs *Artica islandica* and *Mya truncata*.

Sedimentation occurred during cold phases, as inferred from macro- and microfaunas, whose composition suggests an affinity with present-day North Atlantic communities.

DE PUTTER, TH. *Mons*, LOUTRE, M.F. & WANSARD, G. *Louvain-la Neuve*. - **Decadal climate variability revealed by spectral analysis of Nile River historical discharge (622AD-1470AD).**

Built in the beginning of the 7th cent. AD, the Roda nilometer (now in Cairo) has recorded more than 2,000 gauge readings, i.e. annual low-water level and flood level, from 622AD to the beginning of this century. These data have been compiled, discussed and published by several authors (TOUSSOUN, 1925; GHALEB, 1951; POPPER, 1951). Spectral analysis of the 622AD-1470AD data set yields several statistically significant periodicities, for both low-water levels (11.9yr, 18.5yr, ~21yr, ~29yr) and flood levels (~7yr, 14.6yr, ~21.4yr, 26.6yr, ~33yr, ~76yr). Evolutive spectral analysis shows that the periods in low-water level fluctuations are more time-stable than those in the flood level variations. It should also be noted that the low-water levels variability does exhibit periods similar to those related to stable astronomical forcing (11.9yr, 18.6yr, 22yr & 29yr). By contrast, flood level discharge results from the summer rainfalls in Ethiopia and, hence, is expected to be controlled by intrinsically more variable ocean/atmosphere interactions. This possible duality in forcing adds to the complexity of the Nile Basin, in terms of topography, hydrology and climates. Further work is planned to elucidate the origin of most of the periodicities and check their accordance with those published for hydrologically related systems (e.g. Lake Turkana).

DINIZ, F., Lisboa - Pollen records from Pliocene deposits of Portugal: vegetation and climatic evolution.

This study is based on pollen records from five deposits (Rio Maior, Abum, Pombal, Barracão and Obidos), situated to NW of the Tagus tertiary basin. Correlation with european and NW mediterranean palynostratigraphies has shown that they cover a period ranging from the Miocene through to the Pliocene-Quaternary boundary. The passage from the Lower to the Upper Pliocene was recognisable at Rio Maior. The microflora is dominated by: *Pinus*, Cupressaceae, *Myrica* and Ericaceae pollens with the exotic elements, Cyrillaceae-Clethraceae, *Symplocos*, *Engelhardia* and *Magnolia* frequently found in the lower strata. During the Pliocene profound transformations affected those assemblages: development and later decay of the swamp group, progressive impoverishment of the evergreen sclerophyll forest in favour of open floristic assemblages such as Cupressaceae and finally a general paleofloristic depletion confirmed by the low pollen concentration of *Pinus*, Ericaceae, temperate elements and herbs. The paleoflora shows a clear affinity to the present day flora of China, Mexico, Florida and Macaronesian Islands, however the closest models are the laurissilva which exist in China and laurissilva macaronesian type found in Madeira. Concerning climatic evolution two levels are clear re: temperature and moisture; one at the passage Lower/Upper Pliocene demonstrating decrease in temperature, the other within the Upper Pliocene showing decreased humidity and finally a change from wetter to dryer conditions observed in the two sections of Abum (upper part of the Pliocene sequence) where a fairly clear magnetostratigraphic record dominated by normal polarity was interpreted as the Gausse Epoch and the reversed polarity registered at the top of Abum (section 1) was assumed to be the base of Matuyama Epoch.

DI GERONIMO, I., DI GERONIMO, R., LA PERNA, R., ROSSO A., SANFILIPPO, R.
Catania. - **Cold shelf communities from a Sicily Pleistocene site.**

A section in Early Pleistocene deposits, cropping out in SE Sicily, has been studied. Sediments are fine-grained (muddy-sandy) and contain coarse macrofauna layers. The sequence can be summarized as follows: 1) a lower part (40 cm thick) with a few *Aequipecten opercularis* beds; 2) a richly fossiliferous middle part (80 cm), with *Arctica islandica* beds alternating with muddy layers yielding *Turritella communis*; 3) a mainly pelitic upper part (ca. 29 cm) with scant macrofauna.

A. islandica forms numerous high-density beds of disarticulated, horizontally-laying valves. Joined valves, not in life position, also rarely occur. Valves are large, well-preserved and entire (except for diagenetic breakages). They often are heavily encrusted by bryozoans and serpulids. Paleoecologic observations point to a mid-shelf area (Circalittoral) affected by changing hydrodynamic phases. Low-energy levels led to mud-dwelling or mistophilous communities, and to the colonization of *Arctica* valves by epibionts. Communities are characterized by North Atlantic immigrant species, among which *A. islandica* is the dominant one. Compositional and structural differences between the present-day Mediterranean and Atlantic communities and the cold-water Pleistocene ones are discussed. The edaphic and climatic factors in the cold community development are also evaluated.

ERBACHER, J. *Tübingen*, HERRLE, J. *Bochum*, & HEMLEBEN, CH. *Tübingen* - Paleoclimatologic consequences of mid-Cretaceous anoxic events from the Vocontian Basin, SE-France - micropaleontological evidence.

Benthic foraminifera and their habitats are influenced by numerous factors such as nutrient flux, bottom water oxygenation, current activity, sedimentation rates etc. However, in open marine intermediate water depths, nutrient supply and oxygenation are the most important factors controlling the distribution and composition of benthic foraminiferal assemblages. Here we present results of our studies from benthic foraminiferal assemblages around mid-Cretaceous black shale levels from the Vocontian Basin. The distribution of benthic foraminifera around different black-shale horizons differs between black shales that are the product of an increased marine productivity and those which are the result of detritic organic matter that has been transported into the basin. Planktic foraminiferal, nannoplankton and Rock Eval data suggest eutrophic conditions and relatively warmer and more humid climates during productivity anoxic events (P-OAE) than during detritic anoxic events (D-OAE, Erbacher et al. 1996). Therefore, benthic foraminiferal assemblages can serve as a key to understand the origin of anoxia in marine basins and can indirectly be used as an indicator for paleoclimatologic changes.

ESPER, O., SCHNEIDER, R., ZONNEVELD, K.A.F. & WILLEMS, H. *Bremen*. - On dinoflagellate cyst assemblages based on palaeoecological reconstruction of the Late Quaternary Agulhas Current (South Atlantic).

In the last several years of oceanic research it has become more and more apparent that assemblages of dinoflagellates, which are generally unicellular marine algae, react significantly to environmental changes. The dinoflagellate life cycle, consisting of a motile thecate stage and a fossilisable resting cyst stage, is important. The organic walled dinoflagellate cysts preserved in sediments are believed to reflect the relationship between their corresponding motile stages in the upper water column and environmental parameters such as temperature, salinity and nutrient supply. The aim of the present study is to use dinoflagellates to reconstruct the palaeoecology of the Agulhas Current, which forms part of the global thermohaline circulation pattern, offshore the southern coast of South Africa. For these purposes, organic walled dinoflagellate cysts (dinocysts) of core GEOB 3603-2 have been analysed at several depths ranging from isotopic stage 1 to 6. The analysis of the dinocyst assemblages shows a predominance of mainly autotrophic gonyaulacoid dinocysts during interglacial times and a change to heterotrophic protoperidinoid dinocyst predominance during glacial times. The highest dinocyst abundance (measured in cysts per cm³ of sediment) is found in intermediate times, the assemblage being composed of mainly gonyaulacoid dinocysts such as *Spiniferites ramosus* and *Nematosphaeropsis labyrinthus*, which prefer intermediate water temperatures. The contrasting distribution patterns of the protoperidinoid and gonyaulacoid dinocysts throughout the core might possibly reflect the influence of different watermasses or stratification, but further examinations are necessary to provide more precise information.

FEIST-BURKHARDT, S. *Darmstadt*, & PITTET, B. *Fribourg*. - Dinoflagellate cyst morphology depending on palaeoenvironment: an example from the Swiss Upper Jurassic.

In a quantitative study the dinoflagellate cyst assemblages of the Upper Oxfordian bifurcatus and bimammatum zones from the Swiss Jura Mountains have been analyzed. From the four sections studied, three belong to the shallow marine carbonate platform and one to the more basinal realm. The dinoflagellate cyst assemblages recovered are presented and their compositional differences between platform and basin are discussed.

The samples from the basin yielded rich and diverse dinoflagellate cyst assemblages, showing a typical Upper Oxfordian composition. They are closely comparable to those described from coeval strata from France (Courtinat & Gaillard, 1980) and the upper Malm alpha of SW-Germany (Brenner, 1988).

The samples from the platform are generally less rich and less diverse than those from the basin but basically they show the same species composition. There are a few exceptions. Some species which are regularly present in the basin are absent or appear only sporadically in very few numbers on the platform. On the other hand, the assemblages from the platform are often dominated by one species belonging to the genus *Mendicodinium*. This species seems to be an indicator for proximal conditions.

The distribution pattern of *Mendicodinium* spp. and the morphologically closely related *Ctenidodinium chondrum* seems to depend on water depth. Ornamented forms (*Mendicodinium* sp. B), and forms showing parasutural crests (*Ctenidodinium chondrum*) are typical for the basin, the less ornamented form *Mendicodinium* sp. A prevails on the platform.

Detailed morphological studies on the plexus *Mendicodinium* / *Ctenidodinium* suggest that the two "genera" are the final stages of a morphological series, increase and decrease of surface ornament being the result of environmental factors.

FEIST-BURKHARDT, S. PROSS, J. *Darmstadt*, & WILLE, W. *Tübingen*. - **High-resolution palynostratigraphy: the lower Middle Jurassic of SW Germany.**

In Southwest Germany the earliest Aalenian ammonite zone of *Leioceras opalinum* is represented by up to 130 m of claystone, the so-called "Opalinuston". 32 core samples from a borehole at Überkingen near the Aalenian type locality along with samples from other localities nearby formed the subject of a detailed dinoflagellate study.

More than 50 dinocyst species were discovered, only half of them as yet described. These species can be attributed to seven families two of which - the Nannoceratopsiaceae and Phallocystaceae - had their main radiation already in the late Liassic. In the Opalinuston the latter family is the most diverse with 20 species. Three species of *Scrinocassis* (Scrinocassiaceae) are very typical for these measures. The base of the sequence which coincides with the base of the Middle Jurassic is marked by the first occurrence of *Kallosphaeridium* spp., the earliest representatives of the Gonyaulacaceae. This family will become the dominant dinoflagellate cyst group from the Bajocian onward.

Stratigraphically the most interesting species are *Nannoceratopsis triangulata* PRAUSS 1987 and the Peridiniacean "*Morgenrothia iunior*" (undescribed). Both are restricted to the latest Toarcian *levesquei* and the earliest Aalenian *opalinum* zones. The second species has a very marked acme at the stage boundary. *Phallocysta* (?) *frommernensis* BELOW 1987 is characteristic for the middle part of the Opalinuston. At a regional scale it seems feasible to subdivide the *opalinum* zone into three units by dinoflagellate cysts.

FIGUEIRAL, I. *Tübingen*, JONES, T. *Cardiff*, MOSBRUGGER, V. *Tübingen*, ROWE, N. *Montpellier*, & SCHLESER, G. *Jülich*. - **Miocene wood assemblages identified by laboratory charring techniques: preliminary results and palaeoclimatic implications.**

Techniques developed for charcoal analysis by Quaternary researchers to reconstruct palaeovegetation, have been successfully applied to the study of Tertiary fossil woods and lignites. The fossil wood is sealed in aluminium foil, then charcoaled at 400°C for 20 minutes. The resulting charcoal can be manually fractured along the 3 anatomical planes, and observed directly under a compound microscope. This rapid technique avoids time-consuming 'traditional' methods of chemical softening, embedding and microtoming of fossil wood, permitting the analysis of large sample numbers. Furthermore the charcoaled fragments are highly suitable for SEM, and since no chemical treatment has been involved can be used in biogeochemical analyses such as determination of $\delta^{13}\text{C}$. Preliminary investigations have concentrated on fossil wood collected from the late Miocene browncoal seams of the Lower Rhine Embayment, Germany. Modern understanding of the variations in wood anatomy, even between different growth rings in a single fragment, constrains the taxonomic level to which the wood can be confidently identified. This constraint is compounded by possible differences between the Miocene plants and their modern descendants whose anatomical characteristics are used as a reference. The relative proportions of Gymnosperms and Angiosperms obtained from the material studied appears to shed new light on current palaeovegetation reconstructions.

FRENZEL, P., REICH, M. & WINN, K., *Greifswald, Kiel.- An Eemian marine microfauna from the well Dagebüll (Pleistocene, northwest Germany).*

92 samples of a 17 m long core (13.01-30.36m) with marine sediments of Eemian age from Dagebüll (northwestern Germany) are studied. A palaeoenvironmental reconstruction of the then nearshore area in the German Bight (north Sea) is based both on the faunal associations and on oxygen/carbon isotope data. Palaeoecological conditions indicated by these two methods are compared.

The grain size fraction $>63\mu\text{m}$ contains specimens and remains of Ostracoda, Foraminifera, Holothuroidea, Echinoidea, Ophiuroidea, Asteroidea, Bivalvia, Gastropoda, Bryozoa, Porifera, Polychaeta, Pisces and coprolites. All studied species are still present in the North Sea and Baltic Sea.

The ostracods are particularly useful as environmental indicators in the palaeoreconstruction. The fauna is characteristic for shallow marine conditions ($<20\text{m}$ water depth, in the upper part of the succession $<10\text{m}$ water depth) with about 30-35‰ salinity and slightly increasing temperature.

The high resolution oxygen/carbon isotope data support these findings with a change to warmer conditions beginning from 24m to 22m and from 18m to 15.5m. A reversal to slightly cooler conditions is indicated above this level. The data confirm that salinity changes were minimal and gradual, although the bottom water ventilation varied considerably, especially in the upper part of the Eemian sequence.

GALL, J.C., GRAUVOGEL-STAMM *Strasbourg*, L. NEL, A. *Paris* & PAPIER, F. *Strasbourg*. - **Reconstruction of the Buntsandstein climate: a multi-episod story.**

At the beginning of the century, the Buntsandstein landscapes of Western Europe were compared to the modern huge deserts and the climate was believed to be arid. Later, the Triassic red beds were interpreted as the result of lateritization. More recently prevailed the model of a hot climate with strong contrasting seasons, alternately humid and dry. The discovery of humerous fossils in the Upper Buntsandstein, including plants and animals, both aquatic and terrestrial, suggests the need for nuances in the reconstruction of the Buntsandstein climate. The entomofauna is rich, comprising about 200 taxa. The most abundant group belongs to the crockroaches, insects typical for warm and humid climates. Clusters of insect eggs were protected against desiccation by a sheath of mucilage. The vegetation was dominated by the gymnosperms. Among them, occurs a common taxa, *Aethophyllum*, which is an herbaceous conifer. It respresented a plant able to colonize rapidly the temporary aquatic environments of the Upper Buntsandstein. Indication about a more diverse vegetaion than admitted is given by the discovery of tettigoniid grasshoppers which exhibit a forewing venation looking strikingly like that of an angiosperm leaf. Such a feature may be interpreted as an example of exaptation of a witness of the presence of a flowering plant still unknown. Occurence of millipeds and mygalomorph spiders corroborate the conclusion that during the Buntsandstein time, the climate was rather hot and wet.

GOLOVNEVA, L. B. *St. Petersburg.* - Maastrichtian (Late Cretaceous) climate and distribution of high latitude dinosaurs and floras in the northern Pacific region.

The investigation of foliar physiognomy of the Maastrichtian fossil floras and distribution of dinosaur faunas allow to estimate the Maastrichtian climates in the northeastern part of Eurasia and northwestern part of North America. These data indicate that differences between high and middle latitude climates were inconsiderable and latitudinal thermal gradient was rather low. The mean annual temperatures in the Maastrichtian were approximately around 10-14°C and cold month mean temperatures were around 3-5°C. Winter temperatures at high latitudes were so high due to the heating of these areas by warm high latitude upwellings (Nessov, Golovneva, 1990), which do not occur today. Warm deep oceanic currents were formed at low latitudes in shallow epicontinental seas, where warm saline dense water sank to the bottom and flowed into deep parts of the ocean. The cooling in the Northern Hemisphere, especially in high latitudes, and increase of latitudinal thermal gradient near the Cretaceous-Tertiary boundary were caused by changes of the vertical oceanic circulation towards a model similar to the recent one. Low thermal gradient, distribution of similar environments over large areas and predominance of juvenile individuals in dinosaur assemblages contradict the hypothesis of southward winter migrations of polar dinosaurs. But, it is not clear, how dinosaurs could survive during cold winter period and incubate eggs and bring up the young during short summers. It is supposed, that polar dinosaurs were heterothermal and, probably, ovoviviparous.

GORTHNER, A., *Tübingen*.- Shell parameters of marine bivalves as an indicator of the environment.

The aim of the research was to use shell parameters of marine molluscs as a quantitative climatical or environmental proxy. Therefore, an extensive collection of recent shells was made from beaches with extreme environmental conditions. The morphological parameters of these shells were measured and related to various environmental quantities from a literature database.

The "Relative Shell-Thickness" (RST) was introduced as a new morphological parameter and a method was developed and tested to measure this parameter in both fossil and recent material.

The RST does not depend on the size of a shell and is therefore not dependent on the age of the individual as well. The uni- and multivariate statistical examinations show the average RST of whole populations of molluscs with different species can be used as an environmental proxy. The average RST in the examined populations up to now is mainly influenced by salinity, less by temperature or wave energy. A substantially better correlation of the RST with temperature is indicated in warmer water (above 17°C).

Based on each different species of molluscs separately, the analyses become much more evident. In the Baltic Sea for instance the different species show quite variable reactions to the changing salinity if the RST is considered, and in general not in concordance with maximum shell size. A good proxy of salinity can be found in *Mytilus edulis*.

GUICHARD, S., JORISSEN, F.J., CARBONEL, P., PEYPOUQUET, J.P., MARTINEZ, P., *Talence*. - **A 236 000 years benthic foraminiferal and ostracod record from the N.W. Africa upwelling area.**

Core 17K, which contains a continuous record down to isotopic stage 7, is located near the N.W. African upwelling area (25°16'80"N, 17°06'45"W, 2975 m depth). Several paleoenvironmental proxies, using benthic foraminiferal and ostracod compositions, have been developed and compared with geochemical proxies. The percentage of organic carbon recorded in the sediment and the Benthic Foraminifera Accumulation Rate (BFAR), show a very good correlation with highest values being recorded during glacial times (isotopic stages 6 and 2). This similarity suggests little variability in the quality of the downward flux of organic matter in time. Surprisingly, in core 17K, no deep infaunal foraminifera species are found, except for a short period in stage 2. This suggests that interstitial water oxygenation concentration were always sufficiently high to permit habitation by benthic faunas. Besides, ostracod density increased during isotopic stages 6 and 2, with species indicating good sediment-water interface ventilation. Actually, the core results have registered a benthic environment evolution in a predominantly oligotrophic context. In this core, the highest values of paleoproductivity are recorded in glacial stages when the influence of upwelling was higher, either as a result of intensification of the upwelling process, as a result of a coastward drift of the upwelling zone or as a combination of the two phenomena.

HABLY, L. *Budapest* - Movement of terranes: a new light on palaeoclimatological interpretations.

Floral changes have been generally interpreted as a result of changes in climatic conditions or palaeoenvironment. During the past decades floristic changes in the Tertiary of Hungary have been explained in the same way. Warming and cooling trends have been revealed on the basis of which climate diagrams have been suggested. However, these explanations were sometimes contradictory. Regions of the same or nearly the same age provided considerably different floras, though, they are situated close to each other. Based on the differences these floras should belong to different climatic zones, however, their closeness seems to deny this idea. The terrane approach eliminates these contradictions as well as draws attention to the fact that as late as the younger Tertiary large-scale movements took place which resulted in considerable floral and climatic differences between the Pannonian Basin and other European floras. Formation of terranes was recorded for the first time in the Cordilleras. In Europe the most typical region consisting of terranes is the Pannonian Basin, which in spite of its small dimension is constructed of several units. That is the reason for the fact that notable floristical and seeming climatological differences have been demonstrated even inside the Pannonian Basin. The situation of these units compared to each other as well as to Europe had been changing continuously in the course of the history of Earth and large-scale movements came to an end only 8 million years ago. Floristical differences correspond quite well to the terrane model. However, in view of terrane movements, theories on climatic changes have to be revised and similarly cooling and warming trends have to be evaluated with respect to the given situation of the terranes.

HART, M.B. *Plymouth*. - The distribution of planktonic Foraminifera and their contribution to our understanding of Cretaceous palaeoclimates.

During the Cretaceous the planktonic Foraminifera underwent a major diversification, colonising a wider range of water depths and geographical regions. Bandy [1961, *Micropaleontology*] was the first to recognise the potential of using this regional distribution to reconstruct different palaeoceanographic regimes. Using new data from the South Atlantic Ocean, Antarctic Ocean and Indian Ocean it is possible to show the poleward migration of warm-water taxa during the Cretaceous and compare it with data already available for the North Atlantic Ocean. Instead of the present-day 9 latitudinal zones based on planktonic Foraminifera it is only possible to identify five with any degree of reliability. These are, from north-to-south, the 'boreal', transitional, tropical, transitional and 'austral'. In some of the developing oceans during the Cretaceous [eg. eastern Indian Ocean] there are local biogeoprovinces with quite distinctive local assemblages or morphotypes. While these do not reflect on the climatic zonation they provide an interesting insight into the development of the plankton. Migration into higher latitudes can be demonstrated against currently published time-scale. The foraminiferal distributions will be compared with climatic maps produced by the assessment of other data sources.

HAY, W. W., DeCONTO, R. M., WOLD, C. N. *Boulder*. - A new view of Cretaceous paleoclimatology and paleoceanography

The results of a simulation of the Late Cretaceous climate using the GENESIS Earth System model suggest that the Earth had overall higher temperatures, with the equatorial region approaching 34 C. This has broad implications for how the climate system operated. There was a much higher vapor content in the atmosphere, and a much greater role for latent heat transport in achieving the global energy balance. The classic Late Cretaceous climate paradox, that the lesser meridional temperature gradient implies slower winds and ocean currents and less poleward energy transport, while also implying greater poleward energy transport to account for the reduced temperature gradient, is explained by the increased vapor content of the air. The replacement of air molecules by vapor molecules creates atmospheric pressure differences that make up for the loss of pressure difference due to the warmer polar temperatures. As a result, wind and ocean current speeds were about the same as today. The increased rates of evaporation and precipitation caused greater regional salinity contrasts in the ocean, so that salinity became a major factor in controlling ocean circulation. Although the overall structure of the ocean was probably the same as today, the ocean interior differed in important details. The layer of cool, low salinity intermediate water that characterizes much of the ocean today was replaced by warmer, saline water from the Tethys and young Atlantic.

The paleoceanography of the Early Cretaceous ocean was different from that of the Late Cretaceous because ocean salinities were much higher before the large extraction of salt in the South Atlantic. Higher salinities imply a greater change in the density of seawater with temperature as the water cools to freezing, and hence a different behaviour in deep water formation.

HÖLL, C., KARWATH, B., ZONNEVELD, K.A.F., WILLEMS, H. *Bremen* - Late Quaternary calcareous dinoflagellates and their potential for palaeo-environmental reconstructions.

Late Quaternary sediments of the Equatorial Atlantic have been investigated for their calcareous and organic-walled dinoflagellate cyst content. To date, ecological information on calcareous dinoflagellates has been extremely limited. In order to enhance the information on (palaeo-) environmental affinities of calcareous dinoflagellates and to determine their potential for (palaeo-) oceanographic reconstructions, the temporal distribution patterns of calcareous dinoflagellates have been compared with those of the ecologically much better known organic-walled dinoflagellate cysts. This has been done by utilising the statistical method of Detrended correspondence analysis (DCA). Furthermore, this method was used to determine which environmental gradients have a major influence on the species composition. By using existing information derived from other studies (such as e.g. Organic Carbon and Sand content), these gradients could be interpreted in terms of productivity and glacial-interglacial trends. Using Redundancy analysis (RDA), the direct relationships between the distribution patterns of the calcareous dinoflagellates with the above mentioned external gradients could be determined. In the studied region for the last 140 ka the calcareous dinoflagellates show enhanced abundances in periods with reduced productivity related to relatively stratified, oligotrophic water conditions. These present results subscribe the usefulness of calcareous dinoflagellates as tools for reconstructing (palaeo-) environments.

JURKSCHAT, TH. & FENNER, J. *Hannover*. - Environmental changes in the pre-evaporitic Messinian of the Lorca Basin (SE-Spain) - diatom results.

During late Messinian time the Lorca Basin, part of the Betic strait, desiccated. Investigations were made to show how the diatom flora reacted to this regression. Near the City of Lorca (Province of Murcia, SE-Spain) an about 125 m profile at the La Serrata-ridge was lithologically mapped and sampled. The profile comprises of marl, sandstone, gypsum and diatomite, partially laminated. The frequency of all siliceous microfossils (especially diatoms) was determined quantitatively. The presence of diatom species used in the North- and Equatorial Pacific for biostratigraphically classification of upper Miocene deposits allows the arrangement to the uppermost Miocene for lower 87,5 m of the profile (6,6-5,3 Ma B.P.; magnetic epoche 6 and 5).

In total 116 diatom species were found; a single sample contains between 13 and 36 species (a minimum of 300 valves counted). Throughout the studied sequence a stress environment must have prevailed, because the diatom assemblages are dominated by *Thalassionema nitzschioides* (up to 80 %), a species-group that tolerates high measures of ecological changes (e.g. salinity). Abundant fluctuations of this species-group as well as changes in the composition of the rest of the assemblage show 5 dessication cycles before the final deposition of 20 m thick gypsum layers. Each of the five cycles recognized starts with a high amount of holoplanktonic species and towards the top meroplanktonic species increase. In the upper cycles freshwater diatoms slightly increase in abundance. Benthic diatoms are rare (2-4%) throughout the whole profile and show no systematic changes in abundance. Laminated sediments were deposited during periods when evaporation exceeded replenishment and exchange of the water column and became stratified (stagnation model). During the periods of transgression the more normal marine situation provides conditions better suitable for holoplanktonic species. The final sedimentation cycle shows a complete evaporation; it is covered with huge gypsum layers.

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KARWATH, B., DÜRKOOP, A., RÜHLEMANN, C. & WILLEMS, H., *Bremen - Calcareous dinoflagellates as indicators of low paleoproductivity in the western tropical Brazil Basin.*

The temporal distribution of calcareous dinoflagellates was studied by light microscopy from a Brazilian continental slope sediment core for the last 420,000 yrs. We observed the cysts *Sphaerodinella tuberosa*, *Sphaerodinella albatrosiana*, *Orthopithonella granifera*, *Calciodinellum operosum*, *Rhabdothorax* sp. and the coccoid-vegetative *Thoracosphaera heimii*. *T. heimii* contents vary between 67 and 94%, averaging 83% of the total assemblage. Encystment is part of a sexual life-cycle and occurs comparatively seldom in view of the production of *T. heimii* shells. In contrast, the formation of *T. heimii* shells is purely vegetative (non-sexual), and divisions occur every 1 to 3 days. Consequently, the production of *T. heimii* results in far greater sedimentary deposition of calcareous material than the production of cyst-forming dinoflagellates. CaCO_3 accumulation deduced from sediment cores recovered above the lysocline can be used as paleoproductivity indicator in the oligotrophic tropical ocean, since calcareous organisms dominate under low productivity conditions. Counts of calcareous dinoflagellates, especially the vegetative *T. heimii*, show increased amounts during periods of low carbonate accumulation in cold climatic stages. Therefore, the inverse relationship of *T. heimii* and calcareous cysts to low CaCO_3 accumulation indicates higher production of calcareous dinoflagellates during times of low paleoproductivity in the western Brazil Basin.

KARWATH, B., DÜRKOOP, A., RÜHLEMANN, C. & WILLEMS, H., *Bremen.* - Distribution of calcareous dinoflagellates in Core GeoB 2204-2 (South Atlantic, Brazil Basin).

To demonstrate a possible relationship of the distribution of calcareous dinoflagellates in marine sediments to glacial/interglacial cycles, quantitative studies of the core GeoB 2204-2 (08°31.7'S; 34° 01.3'W, Brazil Basin) were undertaken. Studies reached as far back as the end of isotopic stage 11 (3.885.000 yrs; 9 m core-depth). Examination of the sediment took place with lightmicroscopic methods using polarisation techniques (JANOFKSKE, 1996). Relevant calcareous dinoflagellates are the cysts *Sphaerodinella tuberosa*, *Sphaerodinella albatrosiana*, *Orthopithonella granifera*, *Calciodinellum operosum*, *Rhabdothorax* sp. and the coccoid-vegetative *Thoracosphaera heimii*. *T. heimii* often reaches 90% and more of the subrecent calcareous dinoflagellate associations. Whereas most calcareous dinoflagellates produce a cyst only at a certain time within their life-cycle, each individual *T. heimii* possesses a calcareous shell which is left for reproduction only, thus giving a clearer productivity-signal within the sediment. Counts of calcareous dinoflagellates in core geoB 2204-2, especially the vegetative *T. heimii*, show heightened amounts of individuals per g of dry-weight sediment within the glacials and the cold events during the interglacials. Furthermore, comparison with additional data of the core geoB 2204-2 revealed an inverse dependence of the amount of *T. heimii* on the contents of total organic carbon TOC (wt. %) within the sediment. Comparison with oceanographic conditions in this region suggests a heightened productivity of *T. heimii* during periods with lowered thermo- and nutricline.

KORPAS-HODI, M., NAGY, E., NAGY-BODOR, E., SZÉKVÖLGYI, K. & O. KOVACS, L. *Budapest*. - **Late Miocene Climate, climate cycles and their effect on sedimentation (Transdanubia, West-Hungary).**

The aim of the study was to contribute to the climate reconstruction and to understand those cyclic variations which controlled paleoecosystem variations through Pannonian times. In order to achieve this goal, we have carried out detailed paleontological and sedimentological studies on Pannonian sediments of three boreholes and in one of them (Nagylózs-1) we have examined also the paleosols. Based on the data thus acquired, local and relative climate curves were reconstructed for each borehole and mean annual temperatures were calculated on the basis of quantitative analysis of sporomorph species encountered in the samples compared with modern equivalents. Relative changes in precipitation were calculated by using the changing depth to calcic horizon as from the soil surface. Cyclicity of sedimentation has been evidenced by the results of high resolution grain-size analysis and by the well logs. Cyclic changes of relative water depth and salinity were detected by the paleoecological analysis of the mollusc fauna. Timing was based on magnetostratigraphic measurements. Based on the above, a synthetic curve showing the alterations of the paleoenvironment was constructed. According to our calculations, mean annual temperature was about 10-13°C, the climate was warm temperate, similar to that of the present Mediterranean. The climate curves show a clear 400 ky periodicity, the first part of each cycle was warm and dry, while the second part seems to have been cool and humid. The 4th order sedimentary cycle, established by the high resolution sedimentological and well log analyses is in good correlation with the above described climatic cyclicity, though with a slight shift in time. It is suggested that the studied Pannonian 4th order sedimentary sequences were strongly controlled by the 400 ky climate cycle. 5th order sequences revealed within the 4th order cycle are identified with a clear orbital excentricity cycle of 100 ky periodicity.

KOUWENBERG, L.L.R., LEEREVELD, H. & GALEOTTI, S. *Utrecht*. - Orbitally influenced climatic change reflected in the palynological record of Late Albian black shales from Central Italy.

Mid-Cretaceous pelagic sediments exposed in Central Italy show distinct lithological rhythmicities. The Late Albian Amadeus segment consists of bundles of limestones, marls and black shale layers. Various studies have reported cycles in the carbonate content and foraminiferal assemblages, of which the frequencies match the precession (=B120 kyr) and short eccentricity (=B1100 kyr) cycles. The present study concentrates on the organic-walled dinoflagellate cysts and pollen and spores present in the two meter thick Amadeus segment in the Fiume Bosso section. Fluctuations in the palynological record probably related to different cycles could be observed. In this study, productivity proxies respond to eccentricity cycles rather than precession cycles, indicating that black shale/marl bundles represent periods of lower productivity compared to the more calcareous parts in the segment. These bundles are interpreted to be formed during conditions of decreased nutrient supply as a result of lower circulation rates and/or reduced vertical mixing. The individual black shale layers in the bundles contain higher numbers of pollen and spores indicating enhanced run-off (more humid climatic conditions) during precessional lows. Increased fresh water input during periods of lower circulation intensity could have induced stratification of the water column, reducing circulation intensity even further. This stratification is considered to be the main cause for limited mixing of the water layers, creating dysoxic conditions favourable for the preservation of organic matter.

KOVAR-EDER, J. *Vienna*. - Stratigraphic and Palaeobiogeographic Investigations of Fossil Plant Taxa Reflecting Floristic, Vegetational and Climatic Changes in Europe During Neogene Time.

The evaluation of stratigraphic and palaeogeographic distribution of fossil plant taxa is based on the database of European/West Asian Tertiary plant localities (currently about 600 sites of leaves and diaspores). The distributional history of several taxa is investigated to interpret climatic changes during the Oligo-/Miocene. Different patterns have been recognized so far:

Laurophyllous taxa present in Europe since the Eocene and disappearing in Central Europe during the (Lower, Middle) Miocene. They are still present at younger sites in S and SE Europe as well as in the Rhenish embayment, where they constitute relicts during Miocene and Pliocene time.

Deciduous taxa that invade Europe during (mostly late Lower, middle to early Late) Miocene time. Some of them appear in the E earlier than in the W. Species of one genus may exhibit almost complementary distribution patterns.

Taxa that invade Europe during the Oligocene and are widely distributed during Miocene time. Therefore, their ecological tolerance is regarded to be greater than that of other taxa.

Taxa indicating a shift in their ecological tolerance.

Neither the time of appearance nor disappearance of the taxa following the delineated patterns is entirely synchronous. More likely they express distinct trends in the floristic and vegetational evolution, reflecting general climatic changes such as decrease in humidity and shift of the periods of precipitation, probable increase of temperature extremes, and decrease of mean annual temperature. Clearly, these changes are among others connected with the regional palaeogeographic development. The causal complexity is not yet fully understood.

KOWALEWSKI, M. *Tübingen*, FLESSA, K.W. *Tucson*, GOODFRIEND, G.A. *Washington DC*, DETTMAN, D.L. & ZACHOS, J. *Santa Cruz*. - **Implications of temporal resolution for the use of benthic shelly faunas in paleoenvironmental and paleoclimatic reconstructions.**

Information obtained from shells of benthic organisms (stable isotopes, ecology, preservation) is often used in paleoenvironmental and paleoclimatic interpretation, including high-resolution studies of local environmental conditions and short-term climate changes. A compilation of radiocarbon dates indicates, however, that currently forming shell deposits undergo extensive age-mixing with median time-averaging of 2,465 years in nearshore environments and 8,870 years in shelf environments. Amino-acid dating of mollusk shells from the Colorado River delta (Gulf of California) shows that, even at the highest sampling resolution, mixing in shell accumulations is on the scale of several hundred years. Yet, specimens of the same species that differ in age by as little as 100 years drastically differ in their stable isotope signature: $\delta^{18}O$ is lower, and shows more intrashell variability, in a shell collected in 1884 than in a shell collected in 1994. This reflects the greater, and strongly seasonal, influx of freshwater to the Colorado delta in the past (associated with the seasonal snow melt in the Rocky Mts.). The bad news is that, even at the highest sampling resolution, shells vary in age and stable isotope signature -- age-mixing in shell beds may limit climatic and environmental reconstructions to a resolution of thousands to tens of thousands of years. In the older fossil record, a sufficient number of specimens should be analyzed to encompass the environmental and climatic variation of the age-mixed specimens. The good news is that within the range of high-resolution dating techniques (the late Pleistocene and the Holocene), shell deposits offer a continuous, high-resolution record of climatic and environmental conditions. We are now combining radiocarbon, amino-acid, and oxygen isotope data to study the magnitude and seasonality of the freshwater influx in the Colorado delta during the past 1,000 years.

KRASSILOV, V.A. *Moscow*. - Major climatic changes, causes and consequences.

A causal model is proposed holding terrestrial biomass fluctuations as a critical factor of climatic change upon the following scheme: transgressions --> terrestrial biomass reduction --> increase of atmospheric carbon dioxide concentration --> global warming --> repatterning of precipitation, with maxima shifting from the equatorial zone to high latitudes --> the adequate biomass redistribution, with more terrestrial biomass concentrated in the high latitude than in the tropical biomes. In particular, the equatorial biomass concentrations in the form of the rain-forest biome are transient and are related to glacial climate. With regression, the causal chain is reversed. Characteristically, a sharp drop of global mean temperatures rapidly follows major regressions, e. g. at the Cretaceous/Tertiary boundary. A one third biomass reduction can double atmospheric carbon dioxide, but the effect is mitigated by an increased productivity of terrestrial plant communities. On the other hand, the climatic effects are magnified by oceanic processes triggered by the biomass-related events: biomass reduction --> greenhouse warming --> dry equatorial climate --> increase of tropical upwellings --> release of additional carbon dioxide and further warming or, alternatively, biomass increase --> cooling --> humid equatorial climate --> increased inflow of fresh water (as evidenced by the carbon isotope excursions) damping the upwellings --> a corresponding drop (up to 20 per cent) of the atmospheric carbon dioxide concentration. A correlation of the long-time eustatic curve with latitudinal shifts of zonal vegetation boundaries is evidence of the above scheme.

KREMENETSKI, C. V. & SULERZHITSKY, L. D. *Moscow - Macrofossil data on Holocene treeline shift in Russia.*

Radiocarbon dated macrofossils from 114 sites in Arctic Russia and Siberia permit to reconstruct the shift of northern treeline during last 10000 years which was primarily under climatic control. There is a good correlation between northern treeline and the position of arctic atmospheric front. **Spruce** *Picea obovata* Ledeb. reached its modern limit by 8000 BP. Between 8000-4500/4300 it was spread farther to the north. **Larch** *Larix* Mill. ca. 10000 BP reached 70° 18' N in West Siberia and 74° 20' in Taimyr. Ca 9000 BP it grew at 72° 10' N 146° 50' E in East Siberia. In many part of Siberia there is evidence of more northern, than present, position of larch limit up to 5000/4500 BP. Present limit of larch established ca 3200 BP in Norilsk region and Malozemelskay, a tundra in north European Russia and ca 3500 BP in Lena River valley. **Birch-tree** (*Betula pubescens* Ehr., *B. pendula* Roth.) between 8000-9000 in Taimyr. In Yamal peninsula by 8000 BP birch tree limit was near 70° N. In North Siberian lowland ca 10800-11800 BP birch reached 69° 45' N. Ca 9000 BP it penetrated up to 72° 15' N. Ca 5000/4500 BP northern limit of birch-tree became like modern one. Only near the mouth of Yenisey River birch-tree persisted up to 2500/2400 BP. **Shrub alder** *Alnus fruticosa* **Dwarf pine** *Pinus pumila* (Pall.) Regel, **currant** *Ribes* L., **raspberry** *Rubus idaeus* L., **great bilberry** *Vaccinium uliginosum* L., **bog-berry** *Oxycoccus palustris* Pers. and some herbs moved northwards 10000-9000 BP and 8000-5000/4500 BP. Fossil wood evidence correlate well with results of global climate modelling and palaeoclimate simulation CLIMAP for 9000 BP and 6000 BP.

KROBICKI, M. *Krakow*. - Palaeoenvironmental and palaeoclimatological conditions of distribution of oyster buildups during the Meso- and Cenozoic.

Among the organic reefs occurring in the recent world ocean the coral and oyster reefs are the commonest structures. Depending on the shape, size and taphonomic character, the oyster buildups can be divided into bioherms, biostromes and proper reefs. The recent species are capable of accommodating wide range of salinities (8-30 pro mille) although prefer the typical, brackish conditions of estuaries, lagoons, deltas and mangrove swamps where optimum salinity prevails (18-20 pro mille). The Mesozoic history of these structures reveals directional changes in optimum palaeoenvironmental conditions since their appearance in the Middle Jurassic. Lower Jurassic oyster-like bivalves produced bioherms in presumably lagoonal conditions. The Middle Jurassic real oysters formed huge accumulations in brackish environments. Since the Lower Cretaceous a gradual change in preferences have been observed to less saline, brackish conditions. Such a general trend was very subtle but distinct and persistent. It has lasted and became more pronounced also in the Upper Cretaceous and has continued in the Tertiary up to Recent, almost exclusively brackish conditions. The fossil oyster buildups are most common in the Tertiary and are known from all the continents. The Mesozoic and Cenozoic oyster buildups in brackish environments reflect the warm-climate conditions. The outlines of global palaeogeographic reconstructions of this span of time connected with locations of oyster reefs, bioherms, biostromes or beds suggest climatical control of their occurrences. In this sense present world-wide occurrences of these structures implicate the tropics as the optimum temperature range for their growth. Paleogeographic distribution of oyster buildups from Jurassic to Recent depends on both palaeoenvironmental and palaeoclimatical conditions.

KUNZMANN, L. & WALTHER, H. *Dresden* - The importance of Tertiary megafloreal leaf-assemblages for interpretation of climate evolution.

Evidence of changes in vegetation and climate during Tertiary in Middle Europe is preserved in sediments containing megascopic plant-remains (leaves, fruits, cones, seeds) in the Palaeogene of the Weisse-Elbe-Basin (Saxony, Germany), a terrestrial to marginally marine browncoal basin. Megafloreal assemblages are recognized: for example the Upper Eocene Zeitz complex with evergreen broadleaf forests (subtropical to warm-humid) and the Lower Oligocene Haselbach complex with mixed mesophytic forests (warm-humid to temperate). Near Eocene / Oligocene boundary (neo-) arctotertiary floral elements immigrated from Western Siberia to Central Europe. This was the first appearance of modern deciduous woody plants in this region. The change should be compared with the Grand Coupure of Vertebrate Palaeontology. The immigration of (neo-) arctotertiary elements into Central European vegetation is controlled by both climatic and palaeogeographical conditions (sealevel changes and the closing of East European seaways). A detailed knowledge of all fossil species of a floral assemblage and taphonomic features are conditions for further investigation, e. g. reconstruction of vegetation units. We are able to give summarized results about the development of the vegetation in space and time. Floral assemblages with index fossils (leaves, fruits, seeds, cones) and their long term changes during Tertiary can be used by geologists in different ways in the field work. It seems to be difficult or impossible to recognize short term climatic changes with megafossils. For this only palynological data can be used.

KÜRSCHNER, W., M., WAGNER, F., *Utrecht*, DILCHER, D. L., *Gainesville*, VISSCHER, H. *Utrecht*. - **Photomorphogenesis in deciduous and evergreen angiosperm leaves and its consequences for palaeoatmospheric CO₂ reconstructions.**

Supplementary to direct measurements of air bubbles trapped in ice cores and proxy records that are based on geochemical analysis of carbonates and coeval organic matter from marine or terrestrial sediments, stomata analysis of fossil plant leaves is increasingly utilized as a measure of palaeoatmospheric [CO₂]. This method is based on the inverse relationship between the stomatal frequency and the [CO₂] of the ambient atmosphere. Stomatal frequency is usually expressed as stomatal density or as stomatal index (the ratio of stomata to epidermal cells). The latter expresses frequency independently of variation in epidermal cell size, and thus remains the more sensitive parameter for detecting stomatal frequency changes. In woody plants, the significance of this species specific physiological response is repeatedly confirmed, experimentally, from historical series of leaves collected since the onset of industrialization and from subfossil leaf sequences preserved in peat profiles for temperate deciduous tree species. Apart from atm. CO₂ however, also a number of other environmental variables (light, water & nutrient supply, temperature) can affect stomatal frequency.

Photomorphogenesis in plants, and particular in the development of leaves, greatly depends on the amounts of incident light available during growth. The resulting leaf anatomical alterations, therefore, found in the sun and shade leaves are by far the most prominent and involve profound changes in stomatal density. Recent studies have emphasized the variation of stomatal density/ - index between sun and shade morphotypes and the intrinsic variation over the leaf surface and highlighted the potential errors for palaeoatmospheric CO₂ reconstructions if natural variation and sampling bias were not taken into account. Against this background we summarize leaf anatomical data from fossil sun and shade morphotypes of two temperate deciduous tree species (1) European tree birches (*Betula pendula* / *B. pubescens*), (2) the durmast oak (*Quercus petraea*), and we present new data from the loblolly bay (*Gordonia lasianthus*), which is an evergreen subtropical tree species confined to the southeastern United States.

KVACEK, Z. *Prague*. - Climatic oscillations versus environmental changes in Tertiary plant palaeoclimatology.

Plant communities are the best climatic indicators because they thrive only in limited ecological circumstances. However, estimates based on mere comparisons of local floristic assemblages may be misleading. They express only limited parts of the vegetation at a given period. The example of the Early Miocene section of the North Bohemian Basin shows, how quickly the composition of plant megafossils changes due to different environmental conditions and sedimentary settings, thereby imitating climatic oscillation. Taken together this floristic complex corresponds to a warm temperate humid climate.

To eliminate this edaphic bias, it is essential that only assemblages that reflect a similar sedimentary/ecological setting should be directly compared. Such an example is shown from the Late Oligocene volcanic area of the Ceske stredohori Mts. Two local assemblages of mesophytic character are embedded in diatomite, i. e. equivalent sedimentary setting. The assemblage Suletice (26-29 MA) with prevailing thermophilous elements (*Plantanus neptuni*, *Engelhardia*, *Icaciniphyllum*, Lauraceae) indicates more subtropical conditions, while the assemblage of Bechlejovice (25 MA) composed of mostly deciduous broad-leaved trees and shrubs corresponds to a temperate climate. Thus a climatic decline seems to have occurred within the Late Oligocene.

LOEFFLER, S.-B. *Tübingen* - Molluscs of the Lower Oligocene "Zementmergel Formation" (Lower Inn Valley, Tyrol) - possibilities of palaeoclimatic and -ecologic reconstructions.

The studies are part of the Collaborative Research Initiative (SFB 275) of the Faculty of Geosciences at the University of Tuebingen. They concern the investigation of the Lower Oligocene "Zementmergel Formation" of the Lower Inn Valley (Tyrol, Austria) with respect to palaeoecologic and palaeoclimatic reconstructions. A detailed study of the molluscs including a taxonomic revision of this fauna, which was historically described shows a mixture of at least two different faunal associations: an autochthonous soft bottomed deeper water fauna as well as an allochthonous shallow water fauna, swept into the basin. The fauna already shows the beginning of the developing paratethyal fauna. First measurements of oxygen isotopes on calcitic shelled pectinids show values between -3,56 and -1,00 promille. However the diagenetic transformation is probably a factor which is not to undervalued, as REM- and cathodoluminescence analyses show.

MANDIC, O. & HARZHAUSER, M. *Vienna*. - Biostratigraphy and Paleoecology of younger Miocene Molluscs from the Eisenstadt Basin.

Nearshore sediments of the younger Middle Sarmatian and Pannonian (Middle-Late Miocene) have been investigated at St. Margarethen-Gemeindewald (N-Burgenland).

As a consequence of the beginning isolation of the Central Paratethys from the Mediterranean during the late Badenian most of the stenohaline-marine species disappeared and an endemic Sarmatian mollusc fauna evolved at salinity conditions of about 17 per mille. At the Sarmatian/Pannonian boundary local tectonics and worldwide regressive tendencies result in the final isolation of the Pannonian Basin from the Eastern Paratethys (STEININGER & RÖGL, 1985). Decrease of salinity to 3-10 per mille caused the extinction of the Sarmatian mollusc fauna and settlement of Pannonian brackish to limnic fluvial species. The radiation of molluscs following these changes allows a subdivision of the Sarmatian and Pannonian of the Central Paratethys in distinct biozones.

The 30m thick sand and gravel section of St. Margarethen consists of three biostratigraphical units, distinguished by typical mollusc-assemblages. The first unit bears the typical representatives of the younger Middle Sarmatian *Maetra*-beds, consisting of *Calliostoma podolicum* (DUB.), *Irus gregarius* (GOLDF.), *Maetra vitaliana* ORB. and *Pirenella disjuncta* (SOW.). In the second unit of the section the occurrence of *Melanopsis impressa* KRAUSS together with the marker fossil *Congeria ornithopsis* BRUS. corresponds well to Pannonian zone B. The fauna of the third unit consists of large specimens of the *Melanopsis fossilis*-group, representatives of the *Melanopsis bougei*-group and *Congeria partschi* CZJZEK, characterising the Pannonian zone C/D.

MARJANAC, LJ. & PAUNOVIC, M. *Zagreb* - Glacial and periglacial paleoenvironments as evidence of ice age maximum in Croatia.

Explorations of Quaternary deposits in the caves and in the open outcrops on the territory of Croatia have yielded data about various types of sediments originating from the glacial and periglacial environments that must have existed here during the Pleistocene. Moraines have been found on Mt. Risnjak, Mt. Velebit, in the Paklenica canyon and on the coast of Novigradsko more (northwards from Zadar). Kame-terraces built of fluvio-glacial deposits are located on the Krk and Pag islands in several places and are evidence of a valley glacier. Glacial lake deposits with occasional occurrence of dropstones are found on the coast below Paklenica, on the coast of Novigradsko more, near Obrovac, in Kninsko, Erveniko and egarsko polje, and indicate the close position of ice tongue. Cryoturbation and ice wedge casts were found in the Vindija cave, in Pleistocene fine-grained deposits on Krk island, and near Daruvar in NE Croatia. Loess deposits are quite extensive, from the islands in the NW Adriatic (Susak, Unije, Srakane, Loinj, Rab, Pag) to the NE inland of Croatia where polygonal pattern is well visible, documenting former permafrost areas. Dating is still a big problem on most of the listed locations, but there are indications that most of the exposures show Wurmian and older deposits. Regarding also the evidence from neighbouring Slovenia, we believe that Dinarides have been glaciated during the ice age maximum. Several ice tongues reached the present sea level, which was then at least 150m lower. Accordingly, the border of the Pleistocene glaciation maximum must be extended much further southeastwards, over the Dinarides and part of Adriatic. The territory of Croatia, except northwards and northeastwards of Zagreb, has never been considered as permafrost area, but having in mind the listed evidence we should reconsider the fact of permafrost extent in relation to much larger ice cover of the Alpine and Dinaride area during the Pleistocene glacial maximum.

MARTÍN-CLOSAS, C. & PICÓ, P. *Barcelona* - Wind-drifted plant remains and palaeoclimatic interpretations. An example in the Oligocene of Sarral (Ebro Basin, Catalonia, Spain).

Land plant macroremains such as leaves and diaspores are currently used as palaeoclimatic indicators. However in most palaeoclimatic studies taphonomic biases are not clearly analysed. Wind is one of the main abiotic mechanisms of dispersion of plant remains and its influence on the selection of such remains has been extensively documented. It is of particular interest that wind tends to select small leaves of the outer canopy of forested areas and long and narrow leaves over large planar leaves. In particular situations this may result in a leaf assemblage that gives distorted information of the source vegetation. Such a situation is described in the Lower Oligocene of Sarral (Southeastern Ebro Basin). The assemblage is dominated by small leaflets of Leguminosae along with long and narrow leaves of *Salix*, *Zizyphus*, *Phoebe* and needle leaves of *Pinus*, which were attributed by previous authors to a xerophytic source vegetation. A quantification of the total area of leaves, the distribution of shape along with the absence of evidence of transport by water suggests that this assemblage is almost exclusively formed by wind transported remains. This is consistent with the sedimentological analysis of the unit containing these leaves. A large palustrine belt densely covered by charophytes surrounded a reduced lacustrine area, where leaves were deposited. No fluvial channels have been found up to now to drain towards the central lacustrine area. According to our results the source vegetation of Sarral was not significantly different from the vegetation of other Oligocene localities of the same basin. Differences are only the result of wind selection.

MARTINETTO, E. *Torino*, MOMOHARA, A. *Chiba* & LIU, Y. *Nanching* - A paleoclimatic analysis of the Pliocene floras of Italy based on the modern East Asian analogues.

In the western part of the Po Basin (northern Italy) a rich plant macrofossil documentation has been recently provided by more than twenty Early and Middle Pliocene successions made up of different kinds of lithofacies, corresponding to a wide range of depositional environments: marine offshores, coastal plain deltas, alluvial fans at the fringe of mountain slopes. These plant assemblages have been used for paleocarpological analyses, which provided a considerable mass of paleofloral data (more than 300 taxa). With a few exceptions, the fruit and seed taxa could be assigned to modern genera, thus permitting an analysis of the ecological requirements of their Recent relatives for climatic reconstructions. As usual for the Neogene of Europe, the Pliocene floras of northern Italy include an high percentage of "exotic" (extra-European) genera (60% to 20%). Just a scanty portion of such "exotic" genera are presently confined to N-America, while many are restricted to East Asia; the remaining ones display an East Asian\eastern North American disjunction, an Asian-Australian areal pattern or an Old World tropical-subtropical one. Anyway, East Asia is at present the only place where most of these genera are growing together. We try to exploit these floristic affinities in order to extract paleoclimatic data as accurate as possible, by analyzing the distribution in the vegetational zones of East Asia of the modern genera and the climatic constraints of their area. This analysis is expected to suggest the most probable range of such paleoclimatic parameters as mean annual temperature, annual range of temperature, mean annual rainfall. The available results suggest that the floristic setting of the Early Pliocene fits well with the warm temperate "Evergreen Broad-Leaved Forest" of modern East Asia, while the Middle Pliocene one is best compared with "mesophytic" forest types, indicating a slightly cooler temperate climate. A major complication hampers this analysis: the Italian fossil assemblages can be assigned to the recent Asian analogues just from the floristic point of view, while the vegetation types seem to be different.

McELWAIN, J.C., *Sheffield*.- Do fossil plants signal palaeo-atmospheric CO₂ concentrations in the geological past?

Fossil (pre-Quaternary), sub-fossil (Quaternary) and herbarium (spanning the last two centuries) leaves have been shown to provide a morphological signal of the atmospheric CO₂ environment in which they developed by means of their stomatal density and index. An inverse relationship between stomatal density/index and atmospheric CO₂ concentration has been documented for all the studies to date concerning fossil and subfossil material. Furthermore, this relationship has been demonstrated experimentally by growing plants under elevated and reduced CO₂ concentrations. To date the mechanism which controls the stomatal density response to atmospheric CO₂ concentration remains unknown. However, the study of stomatal parameters of fossil plants has been successfully utilised as a proxy indicator of palaeo-CO₂ levels. This paper presents new estimates of palaeo-atmospheric CO₂ concentrations for the Middle Eocene (Lutetian), based on the stomatal ratios of fossil Lauraceae species from Bournemouth in England. Estimates of atmospheric CO₂ concentrations derived from stomatal data from plants from the Lower Devonian, Upper Carboniferous, Lower Permian and Middle Jurassic are reviewed in light of new data. Semi-quantitative palaeo-CO₂ estimates based on the stomatal ratio (a ratio of fossil stomatal index to that of a selected nearest living equivalent) method have in the past relied on the use of a Carboniferous standard. The application of a new standard based on the present day CO₂ level is reported here for comparison. These data indicate elevated atmospheric CO₂ concentrations during the Lower Devonian, Middle Jurassic and Middle Eocene and reduced concentrations during the Upper Carboniferous and Early Permian.

MICHALIK, J. & REHAKOV, D. *Bratislava*. - Reflexions of Late Tithonian, Berriasian and Valanginian global climatic changes in the composition of marine microplankton associations.

The composition of Berriasian and Valanginian microplankton associations has been quantitatively studied in northern Mediterranean sequences exposed in several Spanish, Alpine and Carpathian sections. During early Cretaceous time, the N European shelf margin was the site of pelagic carbonate sedimentation with local threshold and reefal developments.

An distinct change at Ti-4 (end of Early Tithonian) was accompanied by a decrease of terrigenous clastic input, decrease of calcareous dinoflagellate plankton content and rapid evolution of both calpionellids and calcareous nannoplankton. These facts can be taken as evidence for arid climatic conditions. Another, shorter significant event in plankton evolution possibly connected with abrupt climatic change happened during the uppermost Tithonian (Ti - 7) Colomi Subzone. Relatively diversified crassicollarian and nannoconid associations were replaced by poorly diversified (opportunistic ?) Alpina Subzone microplankton.

A new calpionellid diversity maximum with high radiation appeared during Elliptica Subzone of Calpionella Zone. It coincides with the Be - 4 regressive period. On elevated shelf areas, high diversity and radiation persisted since the Oblonga Subzone of the Calpionellopsis Zone. Weathering, erosion and runoff recorded during the dramatic Be -7 sea level drop event was accompanied by increase of dinoflagellate abundance.

Terrigenous influx was reestablished during the Late Valanginian Va- 4 lowstand. It coincides with the positive excursion of $\delta^{13}\text{C}$ connected with greenhouse climatic conditions. At the same time a sudden decrease in calpionellid abundance and diversity is recorded. A similar event was reported in nannoconid evolution.

- **MUTTERLOSE, J. *Bochum*.- Sedimentary cycles and the response of marine biota in the early Cretaceous of NW Europe**

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- The scope of this paper is to discuss the palaeoceanographic changes occurring within the early Cretaceous of NW Europe by integrating sedimentological and palaeontological observations. These data are based on most recent studies of the lithology, geochemistry and palaeoecology of the Berriasian - Albian interval. Short term and long term variations of sediments throughout the boreal early Cretaceous are described and related to shifts occurring in the biota. The palaeoceanographic implications are discussed. Based on sedimentological and palaeontological observations four different sized cycles can be differentiated:

- Extremely small-scale bedding rhythms on the scale of a few microns are reflected by the laminated sediments of the Barremian and early Aptian. The lamination is caused by seasonal fluctuation of phytoplankton.

- Pale-dark rhythms, having a thickness of about 0.5m, occur throughout the early Cretaceous and are interpreted as Milankovitch cycles. The variation most likely had a climatic control, pale beds representing warm, seasonally arid climates typical of the Tethyan Realm. Dark beds reflect normal boreal colder sea - warm hinterland type climatic conditions.

- Superimposed on these small-scale rhythms are lower order cycles which are marked by a relative concentration of pale versus dark rhythms. Lower order cycles can be recognised most accurately on gamma-ray logs.

- Third order cycles can be derived from the distribution of biota over longer intervals. In particular the distribution of nannofossils, foraminifera and cephalopods reflect major palaeoceanographic changes. Sea level high stands allowed an influx of tethyan species into the NW European seas and a migration of boreal taxa towards the south. These periods represent on a global scale phases of major floral and faunal exchanges and are ideally suited for interregional correlation.

NAGY-BODOR, E., JÁRAI-KOMLODY, M., MEDVE A., CSERNY T. *Budapest - Climatic changes in the western part of Lake Balaton and the Great Hungarian Plain during the Quaternary: palynology, paleoclimate and paleoenvironment.*

In Hungary, the Nagy-Alföld (Great Plain) and the western part of Dunántúl (Transdanubia) are today, and were - as shown by our investigations - during the Late Glacial and the Holocene, areas featured by a different morphology and different climatic changes. As a result, they also had a different vegetation. As also shown by palynological data, in the Great Plain an extremely continental climate, whereas in the western part of Transdanubia a somewhat milder climate prevailed even during the Late Glacial. In both areas, the climatic changes coincided, with the difference that in Transdanubia the climate was 2 to 3°C milder. In Dryas I in the Late Glacial, the climate prevailing in the western part of Transdanubia showed similarities to the climate prevailing in the Great Plain in Dryas II. During the interstadials, the vegetation dominating Transdanubia in the Bölling can be identified with the vegetation appearing in the Great Plain during the Alleröd. During a period of ten thousand years of the Holocene, as recently, the influence of several floral regions dominated within the basin. Therefore, a distinction can be made between the paleovegetation featuring Transdanubia and the Great Plain, on the basis of pollen spectra. The plain area of the Great Plain was characterized by the dominance of sand steppe meadows, grassy steppes, and - along rivers - *Alnus* and *Betula* riparian forests under continental climatic conditions, whereas the western part of Transdanubia covered by hilly regions was dominated by mixed deciduous forests under a submediterranean influence. In both areas, the Atlantic climatic optimum (with climate indicator species) appeared at the same time. A comparison of these data with the results of climatic changes detected on the basis of carbonate content and O¹⁸ and C¹³ isotopes, has shown that they can be well correlated with the pollen data, starting from Bölling (the beginning of a period during which the area was constantly covered by water). In the western areas of Lake Balaton, within the Late Glacial periods and the Holocene phases, the minor increases and decreases in temperature that can be detected on the basis of pollen grains exhibit an excellent matching with data obtained from carbonate and isotope tests. The shifts of approx. 200 to 300 years of diagrams shown on the basis of various tests result from a delayed response of the flora to the abiotic ecological events.

NEBELSICK, J., *Tübingen*, BASSI, D., *Ferrara*, & DROBNE, K., *Ljubljana*. - Palaeoecology of Oligocene Carbonates from Slovenia: implications for palaeoclimatic reconstructions.

Ambient sea surface temperatures belong to the most important controls of carbonate development. The presence and diversity of specific components and the nature of facies development can be used to characterize the carbonates as belonging to biogeographic zones (for example tropical, warm- or cold-temperate). The Lower Oligocene Gornji-Grad Formation of Slovenia is part of a highly varied transgressive sequence over a Triassic basement and contains a rich variation in organisms and facies. The carbonates consist predominantly of poorly sorted biogenic rudstones; wacke- and grainstones can also occur. Dominating components are a moderately diverse coral fauna including both solitary and colonial forms, a rich coralline algae flora; large foraminifera, small benthic foraminifera and molluscs. Dasycladacean algae, gastropods, bryozoans, brachiopods, echinoderms are subordinate.

Differences between and within facies can be attributed to the highly differentiated character of the underlying sediments over which these sediments transgressed, the high degree of terrigenous influence as well as a general deepening (=3D transgression). Important clues as to paleotemperatures may be given by the presence of corals, the fact that reefs as such are missing; the diversity of red algae and the presence of green algae.

NEES, S., *Git sur Yvette*, ARMAND, L., AYRESS, M., De DECKKER, P., PASSLOW, V., *Canberra*, & LABRACHERIE, M. *Talence*. - **Microfossil evidence for paleoceanographic history of the last 160.000 years of the Indian-Pacific Ocean gateway.**

Core MD 88-779 was taken during the 1988 APSARA IV cruise with the French RV Marion Dufresne. The core is situated on the south-Tasman rise (47°50.69'S, 146°32.75'E) at a depth of 2260 m and has a recovery of 6.70 m. Indications from initial summaries of the core suggest the first two glacial cycles are covered in the first 2.6 m of the core. General sampling of the core was initially at every 10cm for the length of the core. Microfossil and stable isotope studies were performed to determine the palaeoceanographic history at the core location, in particular benthic foraminifera, benthic ostracods, and diatoms; other analyses include CaCO₃, benthic isotopes and sedimentary observations. The benthic foraminiferal records show a distinct glacial/interglacial abundance pattern in core samples. They indicate a highly variable pattern of occurrence of enhanced sea-surface productivity events during isotopic stages 6, 4 and 1. Increased abundances of high productivity indicating species of benthic foraminifera suggest a dislocation of a productive oceanographic feature (Polar Front) in the past, presumably in latitudinal order. Faunal correlations of core samples with various surface samples along a north-south transect revealed a good correlation of species groups with deep-sea regimes north and south of the SE Indian Ridge. The diatom record is very poor and there is an unexpected removal of the diatoms from glacial water influence. The analyses gave no evidence for sea-ice cover during glacial periods. Analyses of ostracod assemblages revealed low speciation and small variation. Current investigations aim to investigate dissolution effects and winnowing in glacial sediments.

OSCHMANN, W. *Tübingen*, HERBIN, J.-P. *Rueil-Malmaison*, RÖSSLER, J. *Frankfurt*, LIU, Ch. *Tübingen*. - **Palaeoecological and geochemical data support a Milankovitch-cyclicity within the Kimmeridge Clay (England, Late Jurassic).**

In the last years there is a controversial discussion of black shale origin and preservation of organic-carbon. On the one hand preservation of organic matter in sediments and sedimentary rocks is thought to be related to oxygen depletion or anoxia in marine benthic environments causing incomplete decomposition of organic matter. On the other hand high rates of preserved organic matter in sediments are assumed to be a result of high rates of primary production and a strong flux of organic matter to the benthic environment, where the rate of burial exceeds the rate of decomposition. From modern environments this anoxia versus productivity debate received strong support on the productivity side and many authors state that there is no relationship between the amount of preservation of organic matter in sediments and the amount of oxygen available for organisms in benthic environments.

The macrobenthic fauna from the Kimmeridge Clay of Yorkshire (core samples) supports the reconstruction of palaeo-oxygen levels which can be compared with TOC-measurements. Both signals show a remarkable synchronous cyclic pattern and indicate a link between primary production and benthic oxygen levels. Time series analyses of the cycles confirm a Milankovitch pattern indicating a climatic control of the primary production and on the oxygen availability in the benthic environment.

PÓVOAS, L. Lisbon, CHALINE, J. & BRUNET-LECOMTE, P. Dijon - The study of Rodent populations: an approach to the Quaternary paleoclimatology in Portugal.

We will refer to two different studies. (1) About an Upper Pleistocene Rodent fauna from the Caldeirão Cave - a prehistoric site located 8km N of Tomar (Center of Portugal) - which sedimentary filling (6.2m thick) yielded three major rodent assemblages during that period suggesting three main successive environmental and climatic phases, from bottom to top: open and dry steppe landscapes interrupted by wood zones under a dry and cold climate (30000 to 20000 BP); development of forests under a more wet and still temperate climate (19000 to 18000 BP) and, after a phase of erosion, again a dry climate with, already, a mediterranean character (16000 to 10000 BP). To reach these conclusions we have compared the fossil assemblages that include *Apodemus sylvaticus*, *Eliomys quercinus*, *Allocriquetus bursae*, *Microtus arvalis* and *agrestis*, *Microtus brecciensis* and *cabrerae*, *Microtus (Terricola) duodecimcostatus* and *Iusitanicus*, *Chionomys nivalis*, *Arvicola* cf. *sapidus*, *Castor fiber*, with a actual fauna accumulation produced by an barn-owl (*Tyto alba*) at Avecasta, 11 km far from Caldeirão Cave, and studied by the same methods as the fossil ones. The distinction between some species were made by means of a discriminant analysis taking present species as reference. Morphometric and statistic analyses were applied to all faunas. (2) An Holocene micromammal assemblage from Algarão da Goldra (4 km SE from Loulé, Algarve, Portugal), studied by the same methods and showing a typical distribution of a dry biotope under a mediterranean climate from the South of the Iberian Peninsula allowed, for the first time in the Holocene of Portugal, the identification of the species *Mus spretus*.

RASSER, M. & PILLER, W. E. *Vienna* - Crustose algal buildups in the Upper Austrian Molasse Zone (Late Eocene).

Late Eocene sediments of the Upper Austrian Molasse Zone contain up to 80 m thick red algal limestones ("Lithothamnienkalk") which are underlain by up to 40 m thick siliciclastic series. Red algal limestones mainly consist of algal debris and rhodolith pavements. In distinct horizons, however, up to 7 m thick crustose algal buildups develop either on the siliciclastic basal series or rhodolith pavements.

The buildups consist of up to 1 cm thick consecutive coralline algal crusts, mainly formed by *Mesophyllum* sp., and of crustose corals. Growthforms of *Mesophyllum* sp. cause considerable cavities, which are filled by finegrained bioclasts and micrite. No bioerosion was observed within the buildups.

Modern crustose algal buildups are known from temperate to tropical environments. Tropical and subtropical buildups ("algal ridges") are restricted to the intertidal/shallow subtidal and usually develop from coral reefs. Temperate buildups are known from the Northern Atlantic and the Mediterranean. They occur either in the rocky intertidal ("trottoir") or on soft red algal sediments ("coralligène de plateau") from 30 to 150 m water depth.

Comparisons with modern equivalents provide the possibility to interpret the palaeoecology of the Late Eocene algal buildups.

REUMER, J.W.F. *Rotterdam*. - Paleoeecology and urban ecology: two complementary subjects.

Paleoecology can be defined as the study of past environments and of the relations of fossil plants and animals to each other and to their contemporaneous surroundings. Paleoeecology studies environmental parameters, such as climatic changes, extraterrestrial influences, movements of vegetational belts, and the reactions of taxa to such supposed agentia, as well as intra- and inter-specific relations of fossil taxa as far as these can be deduced from the sedimentary history and the fossil record. One major factor makes paleoecology more difficult to study than recent ecology: the fact that we are unable to study actual organisms, their behaviour and interactions. Paleontologists usually work with scanty remains of organisms, and they do not use the organism but the taxon as the primary source of information. There is no such thing as experimental paleoecology, in which reactions of organisms to environmental stresses can be studied.

Urban ecology is the study of the urban environment and of the relations of the plants and animals (including man) to each other and to the urban surroundings. The urban substrate can be seen as a changed environment, i.e. changed by human action and not by natural processes. The organisms living in urban surroundings react to the changes in the form of extinctions, colonisations, migrations, adaptations, formation of island populations, etcetera. It is here that resemblances between paleoecology and urban ecology can be observed. There are examples of range-extensions as a result of changes in the substrate, as a result of climatic change, or due to new introductions in an existing ecosystem; and of extinctions due to habitat destruction. When new taxa occupy a certain region, or when taxa go extinct, this may potentially be reflected in the fossil record. Phenomena such as described above can thus be regarded as paleoecological phenomena occurring at the present time.

RÖHL, J., SCHMID-RÖHL, A., OSCHMANN, W. *Tübingen*. - **Time seriesanalysis of high resolution sedimentological and geochemical data within the Posidonia Shales (Lias epsilon) from SW-Germany evaluation of climatic forced cyclicity.**

Changes in orbital parameters influence solar insolation and thus earth climates. Climatic variations affect sedimentary processes and ecosystems. Time series-analysis - via fast fourier transformations - are an appropriate tool to analyse cyclic variations (e. g. Milankovitch-cyclicity) in sedimentary environments.

Two sections of the Lower Toarcian Posidonia Shales from Southwest Germany (Dotternhausen and Denkingen) were investigated in detail (sampling average distance = 1.7 cm). The investigation of carbon and sulfur contents provided datasets of total organic carbon (TOC), total inorganic carbon (TIC), total organic carbon-carbonate free (TOC-KFB) and among others elemental sulfur (S). Sulphides-minerals and organic sulphur compounds (OSC) are the metabolic waste products of heterotrophic anaerobic bacteria (sulphate reducing bacteria). The minimum amount of organic carbon consumed by these bacteria can be estimated from the amount of sulphides (C_{loss}). The TOC+ C_{loss} -KFB dataset is a minimum estimation for the primary productivity in the ancient Posidonia Shales Sea.

The original and modified (for example the recalculation of different compaction rates) time series were examined using mathematical computer software (e. g. Matlab). Some of the power spectra support evidence for Milankovitch-cyclicity. The Milankovitch-cyclicity within the Posidonia Shales of SW-Germany permits an estimation of an average sedimentation rate in the order of 5mm/ka.

ROHLING, E. J., *Southampton*.- Understanding climate change: the palaeontological contribution.

To understand past climate change, the first requirement is that we establish sound correlations between marine, terrestrial and (if available) ice records. Only then can we determine whether changes observed in the various spheres are synchronous or not, and if not, whether leads and lags may be defined. In general, there is a widely accepted approach to investigations of synchronicity of climatically induced signals which goes from general placement of a section within the established geological time-scale (period, stage, sub-stage). This is done with all techniques available, such as biostratigraphy, magnetostratigraphy, isotope stratigraphy, etc. More accuracy is subsequently obtained through analyses of the so-called 'Milankovitch' cycles that may be present in for example the isotopic and faunal/floral records, or indeed even in the lithological variations. Recognition of these cycles with periods of 400 000, 100 000, 40 000 and about 20 000 years allows for potential correlation between study sites on time-scales in the order of 10 000 years, and also provides some broad first-order information on the past climates. Next, the correlations may be improved through the application of absolute dating techniques (eg. AMS radiocarbon for the last 40 000 years), and high-quality lateral correlations ('time-lines') may also be obtained using, for example, tephra layers, which are continuous over very large areas and are deposited geologically instantaneously. Similarly, Marine and Continental records may be correlated on the basis of preserved pollen and spores in the marine sequence, which may be related to the continental vegetation record. This works especially well if there have been abrupt changes in vegetation that are reflected in both records. On small geographic scales, and only when supported by other correlation tools, records of 'cooling' and 'warming' may be correlated as well between sites. This climatic 'event' stratigraphy, however, may be conducive to circular reasoning where the event is used to correlate and is subsequently found to be synchronous. After this introduction, I discuss the various contributions to the description of palaeoclimate through geological history that are being made, and may continue to be made, by palaeontology. I compare the nature of these contributions with those made by increasingly important chemical 'proxies', and on that basis I strongly argue against the apparent perception with policy makers and the general public that good palaeo-environmental science may only come from high-profile groups using elaborate analytical equipment. However, I also argue that the days of doing only palaeontology in palaeo-environmental studies are definitely over. We need to associate intensively, and compare results, with researchers from other disciplines, especially geochemistry. Only then can we achieve the multi-proxy descriptions of palaeo-environments that allow for cross-checks and much needed validations of our conclusions. There is a great difference between the current intensive use of palaeobotanical data and restricted use of faunal records, to modelling studies of palaeoclimate. This difference is essentially due to differences in interpretation techniques and knowledge about (palaeo)habitats. The task ahead is for us to move away from producing results that are exclusively qualitative and so open to multiple interpretations that they become very difficult to apply in other studies. Instead, we need to develop new techniques, and elaborate existing ones, for semi-quantitative or fully quantitative reconstructions of key-elements of the palaeo- environment. A common misunderstanding among palaeontologists concerning the perceived need for their work seems to be that they think along lines of traditional palaeontology. In fact, in a more applied sense, or in other words, in a more strictly and explicitly

interpreted sense, palaeontology does have a lot to offer. No other discipline can as accurately tell us what past living conditions were like as a palaeontological study describing which organisms actually were present at any given time. It is now up to us to decipher the general limiting factors of that life, bearing in mind that these factors may have been changing through time. Hence, we will need to work towards description of virtually total habitats, with such controls as location/hydrography (e.g. mountains, cave, coastal upwelling, salt-marsh, etc.), food availability/productivity, temperature and seasonal contrasts, etc. There are two alternative ways for doing this: (1) through a multivariate whole-fauna approach; (2) through step-by-step description on the basis of the best understood (key) indicator species. Once the main controls have been identified, we need to produce at least order of magnitude estimates of their variability through time, and preferably also assess how accurate we consider our estimates to be. Such quantitative information is 'testable' through multi-proxy validation exercises based on results from a variety of disciplines. The end-results of this will provide important 'real life' information that can be applied in palaeoclimate modelling.

RUDNER, E. Pécs, BABOS, K. Budapest, & SÜMEGI, P. Debrecen - Modelling of climatic change by wood anatomy and quatermalacology at upper pleniglacial/inter-pleniglacial transition in Hungary.

In this work we have compared the results of anthracotomical and quatermalacological studies carried out at the same loess profiles and fossil soils. Samples were obtained from the same quantities of sediments using finestratigraphy. Each sample contains many fired pieces of charcoal so that radiocarbon analysis could be carried out, thus we can realize fired layers cyclically in the profiles, with reforestation phases nearly every 2000 years. The anthracotomical data suggest open (mosaic) forest-steppe vegetation under a mild and wet climate between 27-32000 BP years and a dry and mild climatic between 25-27000 Bp years. The main forest trees were from the species of *Picea* genus and *Pinus silvestris*-group. Based on quatermalacological and radiocarbon analysis some ancient Balcanic elements immigrated into the southern part of Carpathian Basin from the northern part of Balkan peninsula between 25000-32000 BP years. One of the most important immigrant Mollusc was *Granaria frumentum* which spread in the southern and central part of the basin. The ancient distribution of this Mollusc clearly reflected the development of a climatic transitional zone in the central part of Carpathian.Basin. The *Granaria frumentum* with charcoal remains can be found in a palaeosoil horizon. Between 25-23000 BP years we could not recognize forests on the area, the climate changed to dry and cold, forests declined. After 25000 BP years *Granaria frumentum* and the other thermophilous Molluscs also declined and some typical cryoxerophilous Molluscs immigrated into the Carpathian Basin from Central Asia and The Carpathians. This transition of malacofauna indicated a strong environmental change and the beginning of dust accumulation and loess formation as do the anthracotomical data. The characteristic Mollusc species of loess development period was the cryophyllous-xerophyllous Central Asian mountainous Mollusc, *Vallonia tenuilabris*.

RUSSO, B. & SIANI, G. *Napoli*. - First report on planktonic foraminiferal assemblages from the core S13-33 (eastern equatorial Atlantic): paleoclimatic interpretation.

A quantitative analysis of planktonic foraminifers from the core S13-33 (eastern equatorial Atlantic, Lat.: 0°51'S, Long.: 12°45'W, water depth: 3500 m, length: 494 cm) allowed us to distinguish from bottom to top five intervals (A-E), whose assemblages correlate with those of the five ERICSON & WOLLIN (1968) climatic zones, going from V zone-upper part (late Pleistocene) to Z zone (Holocene). **A Interval** (core bottom-433 cm). Warm assemblage (V zone-upper part): positive peak of *Globorotalia menardii* complex, associated with *G. truncatulinoides*; increasing of *G. inflata*. **B Interval** (433-352 cm). Cool assemblage (W zone): absence of *G. menardii* complex, presence of *G. inflata* and *G. truncatulinoides*. **C Interval** (352-204 cm). Warm assemblage (X zone-Last Interglacial): positive peak of *G. menardii* complex, with a relatively significant presence of *G. m. flexuosa*, and of *G. truncatulinoides*, *Pulleniatina obliquiloculata* and *Globorotaloides hexagonus*; decreasing of *G. inflata*. **D Interval** (204-47 cm). Cool assemblage (Y zone-Last Glacial): absence of *G. menardii* complex, positive peak of *G. truncatulinoides*; relative abundance of *G. inflata*; the correlation with Y zone is confirmed by the slight pulse of *G. truncatulinoides* at 197 cm, by *P. obliquiloculata* and *Globigerina bulloides* trends and by the absence of *G. hexagonus*. **E Interval** (47-5 cm). Warm assemblage (Z zone): positive peak of *G. menardii* complex, constituted only by *G. menardii* and *G. tumida*, presence of *G. truncatulinoides*; sharp decreasing of *G. inflata*, increasing of *P. obliquiloculata*, absence of *G. hexagonus*. The top core assemblage differs from that of the E interval for the increasing of the cool species. The climatic oscillations inferred by the percentage changes of the most significant species along the core closely fit those shown by the "total fauna" (foraminiferal) climatic curve.

RUSSO E. E. *Napoli*. - Middle Pleistocene glacial-interglacial cycles: pollen analysis of the Acerno lacustrine succession (Campania, Italy).

The Acerno paleolacustrine basin is located in the southern Apennines at 655 m asl. The pollen analysis of the lacustrine succession (100 m core) allowed two glacial phases and one interglacial to be recognised. The pollen spectra of the basal part of the sequence are characterised by high amounts of herbaceous and steppic elements, reflecting a typically cold climate open landscape. Anyway, during this period, the oak forest elements still survive in a quite diversified association maybe due to the moisture availability which characterises the high altitude regions. The pollen spectra of the middle part of the core show a forest phase where a rich arboreal association develops to the detriment of the herbaceous and steppic elements. This interglacial period passes, through a long transitional phase, to a second glacial period characterised by the highest amounts of herbaceous and steppic elements. Almost all the arboreal taxa sharply decrease their percentages in response to the incoming of cold and dry climatic conditions. The floral association recognised on the basis of pollen analysis is typical of middle and late Pleistocene. The absence of tertiary relicts suggests an age younger than the Vallo di Diano paleolacustrine succession (0.45-0.65) where these elements were still represented (Karner *et al.*, in press; Russo Ermolli, 1994). Waiting for new datations (in progress), we can only ascribe this succession to an ill-defined moment of the middle-late Pleistocene probably in the isotopic stages range 12 to 6. The middle Pleistocene climatic cyclicity is characterised by a period of 100.000 years (Ruddiman *et al.*, 1989). Thus, the recognition of three climatic fluctuations (1.5 cycles) in the Acerno succession allows the duration of the lacustrine phase to be estimated at around 150.000 years.

SALVIGNAC, M.E., LABRACHERIE, M., DUPRAT, J. & LABEYRIE, L. *Bordeaux*. - Hydrologic evolution in the Southern Ocean over the last two climatic cycles.

The middle and high latitudes of the Ocean are very important in the global climatic system. The Southern Ocean is defined by well-marked circumpolar hydrological fronts with strong temperature and salinity gradients that regulate the intermediate and deep water formation. Paleoceanographic changes are obtained from two deep-sea sediment cores MD 88-769 and MD 94-102 located in the Subantarctic Indian Ocean. The study of high resolution proxy records within a well-constrained chronostratigraphic scale has revealed important variations in the position of the Polar Front Zone (PFZ) and of the Subtropical Front (STF) during the last 300.000 years. The chronology is established by AMS ¹⁴C dating for the last 40.000 years. Stratigraphic control over the last 300.000 years is provided by oxygen isotopic records from benthic foraminifers correlated with the SPECMAP time scale (Martinson et al., 1987). Sea surface temperatures (SSTs) derive from planktonic foraminifer assemblages using the modern analogue technique. The evolution of SSTs is somewhat different during the last two climatic cycles. There are the same fluctuations in the isotopic stages 5 and 7 with a first well-defined warming (stages 5.5 and 7.5) followed by a great cooling (stages 5.4 and 7.4). However, the estimated past SSTs for isotopic stage 7.5 do not reach those of the isotopic stage 5e. For all the glacial periods (isotopic stages 2, 4, 6 and 8), the SST reconstructions indicate that the PFZ has migrated 3° northward of its present position. The greatest shift happened at the last glacial maximum at the same time as some ice rafting events, even though no salinity variations were recorded. The larger southward excursion (near 6° of latitude) of the STF occurred during the Eemien event (5e). The deep-sea sediment core MD 88-769 gives interesting SST record which can be compared with the atmospheric temperatures registered at the Vostok site. The sea surface paleotemperatures and Vostok ice core Deuterium record prove to be in close correlation during both the glacial-interglacial changes and the subtle fluctuations.

SARNTHEIN, M. & STATTEGGER *Kiel* - Late Quaternary changes in global oceanic thermohaline circulation: North Atlantic microfossil and isotopic evidence vs. model predictions.

Both recent sediment records from the deep sea and time-series models demonstrate that the great climatic changes in the late Quaternary actually occurred on decadal and 100-year time-scales. Beyond the ongoing Milankovitch orbital forcing the global variability was linked to changes in the oceanic thermohaline circulation, changes that were linked to mega-iceberg surges and/or changes in high-latitude precipitation budgets which, in turn, ultimately may be triggered by changes in low-latitude wind speeds and precipitation. These physical processes of climate control may basically apply also to the mechanisms and rates of climatic change in pre-Quaternary times such as in the Mesozoic "greenhouse world". Any reconstructions and model simulations of the past ocean require quantitative, high-resolution sediment records of paleotemperature, salinity, density, nutrients, and productivity near the sea surface, moreover, of deep and intermediate-water ventilation. In the Quaternary, the crucial quantitative proxydata are derived via transfer functions from species counts, the geochemical, and (C and O) stable-isotope composition of planktonic and benthic foraminifers, moreover, from coccoliths and the stable isotopes and flux rates of organic carbon and nitrogen. Further proxydata that are more difficult to interpret, are based on diatoms, radiolarians, and accumulation rates of biogenic opal. Such model simulations of past climatic changes require a set of proxydata as boundary conditions, the consistency of reconstructed paleoclimatic signals and their spatial and temporal distributions can be tested by model sensitivity studies. Most important for Global Change research, model studies provide the only meaningful syntheses of past climatic scenarios and their potential forcings. However, past scenarios reconstructed from proxydata as well as control runs for the modern ocean provide the only means for testing the validity of (primarily deductive) model predictions, as will be demonstrated along with late Quaternary meltwater debacles in the North Atlantic, their potential release processes and global implications.

SCHERBACHER, M., SCHMIEDL, G., JELEN, B., RIFELJ, H. & HEMLEBEN, Ch.
Tübingen, Ljubljana - Ecosystem evolution of Oligocene basins in the Eastern Alps indicated by foraminiferal faunas and stable isotopes.

Several sections from the Oligocene of Northern Slovenia and the Lower Inntal Valley (Austria) were investigated with respect to sediment facies and foraminiferal content. The main objective is to reconstruct the paleoenvironmental history of the eastern Alpine region. In both areas the sediments exhibit transgressive sequences beginning with conglomerates, sandstones and mudstones of terrestrial origin overlaid by carbonates and muddy marls indicating full marine conditions. These transgressive sequences are discussed as reflecting both the global sea level rise during the Lower and Middle Oligocene and the regional tectonic evolution. The foraminiferal faunal analysis was carried out on the $>125\mu\text{m}$ size fraction. Both basins show a similar faunal evolution including brackish, shallow marine and deeper marine assemblages corroborating the sedimentological results. In the lower part of the Slovenian marly sediments the benthic foraminiferal assemblages are dominated by infaunal species suggesting high fluxes of organic matter and low oxygen contents of the bottom water. In contrast, the younger part of this sequence is characterized by a high portion of epibenthic species and high abundances of planktic foraminifera indicating open marine and oligotrophic conditions as well as ventilated bottom waters. Comparison of the Oligocene paleoenvironment of Northern Slovenia and the lower Inntal Valley provides information about global climatic changes and the early tectonic evolution of the Eastern Alps.

SCHLAF, J., MANDIC, O., PILLER, W.E., HARZHAUSER, M. & BASSANT, P. *Vienna, Frankfurt, Paris. - Paleocology in the Lower Miocene of the Mut Basin (S-Turkey).*

As part of the Austrian/German scientific project "Climatic, paleogeographic and paleobiogeographic development of the Eastern Mediterranean to Western Indo-Pacific in the Late Oligocene to Early Miocene" and studies on sequence stratigraphy by the Institute Français du Petrole several sections in the Burdigalian (Lower Miocene) of the Mut basin (S-Turkey) have been studied.

In the Mut Basin the Burdigalian marine sediments transgrade on lacustrine and fluvial Aquitanian deposits. At the base of the succession sandy and marly sediments are developed slowly passing upwards into carbonate buildups. The sections at the locality Burunköy (N'Mut) give a general idea of the lateral and vertical changes of the facies distribution corresponding to this transgression.

The lowermost part of the sections are represented by coloured fluvial/continental gravels to clays. The marine recognized by the typical littoral to shallow marine mollusc assemblages in a still siliciclastic environment. Coquinas with *Potamides*, *Arcids*, *Venerids*, and *Ostreids* are abundant. The reduction of the coarse grained siliciclastics permitted growth of small "*Porites*"-patches accompanied by rhodoliths and characteristic reef inhabiting molluscs as *Spondylus*, *Antigona* and *Cypraea*. An 80m thick carbonate platform consisting predominantly of bioclastic debris develops on top. Lower energetic, restricted, intraplatform facies is reflected by packstones and marls rich in burrowing irregular echinoids and thin shelled molluscs as *Flabellipecten* and *Ficus*.

SCHMIEDL, G., HEMLEBEN *Tübingen*, CH., KELLER *Freiburg*, J. & SEGL, M. *Bremen*. - **Benthic foraminifera from the Ionian Sea indicating changes in African monsoon during the last 330 kyr.**

To reconstruct deep water circulation and productivity changes in the Eastern Mediterranean during the last 330,000 years we studied deep-sea benthic foraminifera in a Late Quaternary piston core from the Ionian Sea. The benthic foraminiferal fauna exhibits excessive fluctuations in foraminiferal number, diversity and species composition. During times of sapropel formation (S1 to S10) benthic foraminiferal number and diversity are very low. This reflects a strong oxygen deficiency at the bottom which points to a reduction of deep water circulation. After each sapropel event the fauna recovers very slowly as is indicated by a gradual increase in diversity. Abundances of the high-productivity species *Globobulimina affinis* and *Chilostomella ovoidea* appear to vary on the precessional cycle. These species only display high abundances close to sapropel layers. Their occurrence probably responds to monsoon-driven fresh water and associated nutrient input into the Eastern Mediterranean causing enhanced organic carbon fluxes to the sea floor. The long-term faunal patterns resemble those from the Southwest African continental margin. These faunal fluctuations in both regions probably reflect changes in the African climate system, providing information about the history of trade wind and monsoon intensities.

SCHUDACK, M.E. *Halle (Saale)*. - The role of ostracods and charophytes to detect late Jurassic paleoclimates in Central Europe and North America.

For the late Jurassic, a change from humid to more arid and generally cooler climates has been suggested, but the correlation with a Tithonian/Berriasian sea-level lowstand and lower water temperatures has only been demonstrated in very few papers. This study intends to seek evidence for such a cooling trend by the use of ostracods and charophytes, based on two examples: (1) For the Kimmeridgian/Tithonian nonmarine Morrison Formation in the Western Interior Basin, USA, both temporal and latitudinal trends from warm climates, in the south and near the base of the formation to slightly cooler climates in the north and in the upper parts of the sections have been detected on the base of taxonomic studies of the charophyte flora. New $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ isotope data from some charophyte and ostracod species out of two long-ranging sections have revealed trends versus lighter compositions towards the top of the formation for all the monospecific sample series tested. This might be interpreted as a general cooling trend, but some more interpretations must be discussed. From preserved vital effects and $\delta^{18}\text{O}/\delta^{13}\text{C}$ plots of charophyte/ostracod associations showing coherent groupings similar to those from modern lakes, it is likely that the calcite shells have preserved a high degree of isotopic fidelity. (2). The biogeography of marine ostracods in Central and Western Europe also parallels the suggested cooling trend. An increase in diversification of marine ostracod biogeography and in the degree of endemisms can be observed. In addition, there is a gradual southward migration of many species from the subboreally influenced areas in the northwest towards the margin of the Tethys in the southeast, mainly from the Kimmeridgian into the Tithonian and most obvious for the genus *Cytherelloidea*, which is generally considered as indicative for relatively warm water temperatures. These data are in correspondence with a suggested increase in the influx of cold boreal waters into Central Europe.

SUBALLYOVA, D. *Lyon.* - Palynology and Cyclostratigraphy of two Mediterranean sections - Citadel, Zakynthos Island and Monte San Nicola, Sicily - (Pliocene-Pleistocene).

In the Mediterranean region, the response of the vegetation to the earliest, north hemisphere glacial/interglacial cycles is known: the steppe phases correspond to the glacials, forest phases to interglacials. Upper Cenozoic climatic changes are considered to have been controlled by the cyclic variations of the Earth's orbital parameters (eccentricity, obliquity, precession); geochemical (CaCO_3 , $\delta^{18}\text{O}$) and micropale-ontological (foraminifers mainly) records have been correlated with the astronomic curves. Palynological records - pollen flora and palynofacies - start to be understood in terms of high-resolution cyclostratigraphy by "tuning" to the astronomical parameters also. This approach is put into practice on the base of a scope of pre-established stratigraphy (paleomagnetism and foraminifers). Special attention is focused on a relationship between the pollen records and the lithological type of sediments (clays, sapropels, turbidites).

The palynological study of the Citadel section (which covered a well developed, about 80 m of thickness, the Olduvai paleomagnetic event) provides a succession of pollen assemblages and in consequence a succession of climatic (glacial/interglacial) changes correlated with the curve of $\delta^{18}\text{O}$ of reference (ODP Site 846, Shackleton et al., 1995) and then with the astronomically calculated sequence of obliquity. At the same time the curves of CaCO_3 content and of $\delta^{18}\text{O}$ are drawn up and correlated. This integral approach leads to the demonstration of lag between different parameters. The time of "response" of plants to the climatic changes is proposed and discussed.

In addition, the study of palynofacies was provided and maximal abundance of the M.O.A. (as indicator of anoxic conditions) is correlated with the sequence of precession, which leads to high-resolution stratigraphy.

TERRAL, J.-F. *Montpellier*. - Reconstruction of Holocene paleoclimate for southern France using quantitative anatomy of modern and ancient olive charcoal.

Quantitative anatomical criteria from modern and ancient wild olive charcoal, correlated with climatic variations are used to reconstruct climatic variation in the past.

Based on a modern wood collection, morphometric analyses show that "vessel density" and "hydraulic conductivity" varies according to the mean annual temperatures and the mean annual precipitations, respectively. These relationships are modeled by regressive analysis and are applied to ancient data from two archaeological sites (Cova de l'Espérit and Montou, France). Taking account of the mode of charcoal transport and deposition in archaeological sites, the climatic reconstruction is at cultural resolution and micro-regional scale. Along the archaeological sequences (from the Mesolithic to the Bronze Age), a slight increase of temperature is recorded. The precipitation curve is more fluctuated and shows the existence of two wet phases, dating back to the Atlantic phase and to the transition Sub-boreal / Sub-atlantic.

YAVUZ, N. *Ankara*, NAGY, E. *Budapest*. - Palynological Approach to the Climate in Western Turkey in the Neogene.

66 samples were examined palynologically from the Seyitomer Coal Basin, Kutahya province, West Anatolia. Coal, marl, shale and mudstone samples were collected from the 45 m thick Middle-Upper Miocene sequence of an opencast coal mine. Samples are palynologically productive and can therefore be assumed to give a reliable climatic signal. Ferns are mainly represented by Polypodiaceae (9.7%) and Osmundaceae. Coniferae are predominant with 47.4%. Among them *Pinus* is abundant. Angiospermae constitute 26% of the samples. Main subtropical species include Taxodiaceae, *Cedrus*, *Podocarpus*, *Rhus*, etc. Consistent occurrence of Taxodiaceae with Cyrillaceae, Myricaceae and *Jussiaea* pollen suggests presence of a subtropical swamp forest. Taxodiaceae percent reaches up to 36% in some coal samples. Tropical plants are not abundant.

Temperate tree species (*Pterocarya*, *Carya*, *Ulmus*) are coupled with warm-temperate undergrowth (*Ostrya*, *Caprifoliaceae*). Freshwater conditions are reflected by green algae *Zygnemataceae*. The contribution of water plants is fairly small but the existence of *Myriophyllum*, *Trapa* and *Nymphaeaceae* together with *Osmundaceae* indicates maximum humidity conditions in the lower part of the sequence. The vegetation is indicative of subtropical conditions. The climate was most probably subtropical.

ZAKHAROV, V.A. *Novosibirsk.* - Climates of the Siberian Arctic through Mesozoic time.

In Siberia a multidisciplinary research of climates in the geological past has been carried out over 30 years based on the study of flora (paleobotanic and palynological remains), terrestrial and marine fauna, minerals and elements, climate indicators, oxygen stable isotopes, sedimentary sequences and crust of weathering. As a result of these interdisciplinary researches it is concluded that there existed uniform quasi-tropical semiarid climate in Early Triassic, moderately warm semihumid climate in Middle Triassic, warm semihumid climate in Late Triassic with a change to moderate - warm semihumid climate by the end Triassic period. In Jurassic and Cretaceous the climate was quasi-subtropical semihumid in the north and semiarid in the south. There was no ice polar "cap" during Mesozoic. Northern geographical pole was situated in the region of modern Bering Strait. Arctic Siberia was between 50 and 60 paleolatitudes. Despite a uniform climate, climatic fluctuations are established in Siberian Arctic Mesozoic. In all 8 warm periods, alternating with the same number of cold ones have been recognized. Warm periods are recorded in Early and Late Triassic, at the end of Early Jurassic, early and late in Late Jurassic, in Aptian, Cenomanian, Santonian and Campanian. The range of climatic fluctuations are not equivalent. The periodicity approximated 13 million years. Consequently, warm periods (and accordingly, cold ones) came every 26 million years. The influence of World Ocean on Siberian Arctic climate during the Mesozoic was minimal because of remoteness of this territory. Here seasonal climatic fluctuations were most drastic. It means, that Siberian Arctic, as well as Siberia as a whole, is a rather suitable place for reconstruction of Mesozoic climate in the Northern hemisphere.

ZONNEVELD, K.A.F. *Bremen*, GANSSEN, G. *Amsterdam*, TROELSTRA, S. *Amsterdam*, VERSTEEGH, G.J.M. *den Burg*, & VISSCHER, H., *Utrecht*. - **Mechanisms forcing abrupt fluctuations of the Indian Ocean summer monsoon during the last deglaciation.**

A piston core from the Somali upwelling area is studied with high resolution on its dinoflagellate cyst content for the interval between 20 and 10 ka BP. Variations in cyst association are inferred to reflect changes in Indian Ocean summer monsoon intensity.

Comparison of these fluctuations with changes in contrast between 30° N and 30° S July insolation and the $\delta^{18}\text{O}$ GRIP ice-core values suggests that different mechanisms influenced monsoon intensity in different time intervals. A general trend in monsoon intensity follows variations in insolation contrast. The interval between 18.7-12.5 ka BP is characterised by a weak SW monsoon. Fluctuations in SW-monsoon intensity in this interval may be forced by variations in the atmospheric-, oceanic circulation. A rapid transition towards strong SW-monsoons at 12.5 ka BP may be the result of variations in atmospheric circulation and melting of the snow/ice fields in central Asia/Tibet. Variations in glacial-interglacial boundary conditions

related to temperature change at northern latitudes are likely to have influenced SW-monsoon intensity between 12.5-10 ka BP whereas after 10 ka BP variations in tropical land surface boundary conditions may have been the dominant forcing factor.

WEISS; R. H. *Köln* - Geographical and stratigraphical data from publications concerning palynomorphs of Gondwana and Perigondwana.

A database entitled Bibliography of Gondwana Palynology has been published recently. The book contains 3214 literature citations concerning the palaeopalynology of all former parts of the ancient Gondwana supercontinent, as well as those related to mixed microfloral assemblages containing typical Gondwanan elements from the areas surrounding Gondwana. The bibliography reveals that palynological work in different countries is often proceeding more or less independent of progress in other areas. The cited publications were written in 11 languages. Obviously one of the reasons for an imperfect knowledge of published information is the language barrier. A great deal of work needs to be done in order to improve international scientific communication. For a better support of scientific study it would be advantageous to find out quickly which palynological papers have been written referring to a certain country for one or more determined periods of time. Further having knowledge of as much as possible results of researches in different countries referring to a certain period of time is essential for solving questions of international and inter-regional correlations. For these reasons a new type of infobase in tabulated form has been conceived and is being compiled at present. This infobase will be able to deliver detailed information on the geographical and stratigraphical occurrence of the palynomorphs covered by the publications included in the bibliography. Within the infobase the data concerning a publication are stored in one line, when only one collecting locality referring to one epoch or stage is mentioned. Publications dealing with assemblages from different places and stratigraphical horizons are represented by quite a lot of such lines. A special form has been developed to register necessary information for the infobase. The 9 data fields of this form have the following contents:

Field 1: Registration numbers of literature citations (from the bibliography).

Fields 2-4: Geographical data: Country; Region/Province/District/State; Basin/Area/Locality.

Fields 5-8: Stratigraphical data: Period; Subperiod; Epoch/Stage; Formation/Zone.

Field 9: Notes (reference to palaeoecology, palaeogeography, biozone, n. sp., etc.)

The fundamental aim for creating the infobase has been the completion of cross references to the bibliography with geographical and stratigraphical indices, so that the scientists could take advantage of the cited papers independently of their language.