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THE EEMIAN
Local sequences, global perspectives

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The Eemian
Local sequences, global perspectives

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Dr. P.L. Gibbard & Dr. Th. van Kolfschoten
The Eemian
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The 1998 INQUA-SEQS symposium The Eemian Local sequences, global perspectives has its actual origin in a discussion on Quaternary stratigraphic boundaries which took place in the INQUA Commission on Stratigraphy some years ago. Not only the Plio-/Pleistocene boundary was discussed, but there also was a consensus that the Early/Middle and Middle/Late Pleistocene boundaries need to be defined properly. The Commission was of the opinion that in order to define the lower boundary of the Late Pleistocene, detailed information from the type area of the Eemian is essential and therefore contacted the National Geological Survey of the Netherlands. The Survey accepted the request of the INQUA-Commission of Stratigraphy to contribute to the discussion and formed a multidisciplinary team to (re)investigate the 'old' samples from the type area and to study new cores from the Amsterdam Basin. An international advisory board with members of the INQUA-Commission on Stratigraphy and of the Subcommission on European Quaternary Stratigraphy (SEQS) was formed to support the project and to stimulate international co-operation. The SEQS furthermore decided to devote the 1998 annual meeting to the Eemian.

The Netherlands Institute of Applied Geosciences (NITG-TNO) agreed to organize the SEQS-Eemian symposium despite the fact that the meeting was planned shortly after the 1996 SEQS symposium The Dawn of the Quaternary. The organisation of the meeting coincided with the preparation of the proceedings of the 1996 SEQS meeting and, more important with a major reorganisation of the institute. In spite of this it appeared to be possible, due to the dedication of the members of the organizing committee, Ms. G. Kroon in particular, to realize a second SEQS symposium in the congress centre Rolduc, Kerkrade within two years.

The first circular resulted in a positive international and multidisciplinary response from colleagues investigating marine sequences as well as from those focusing on the continental record in Europe, or even further away. The sheer variety of topics with a wide geographical range characterizes this volume of abstracts of the presentations at the symposium. All these topics have in common that they focus on the Eemian, a relatively short period about 120,000 years ago, but still poorly known in all its details. The NITG-TNO Eemian project as well as other projects presented during this symposium will increase our knowledge of the Eemian and the organizing Committee hopes that the symposium will also encourage future research and co-operation.

Dr. Th. van Kolfschoten
President SEQS
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1 THE EEMIAN IN EASTERN SIBERIA

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The Eemian Interglacial in Eastern Siberia as a whole is characterized by rather warm and humid climate. River terraces (15-22 m height) of this age are identified along all the main Eastern Siberian streams. The fluvial deposits are composed of stratified sands with gravels and sandy-loams. Cryogenic features dated to the Early Weichselian are present in the upper part of the sections. Climatic changes recorded at the base level are caused by ice melting that resulted in formation of an accumulation level along the shoreline of Lake Baikal (20-25 m high in the North and 17-19 m in the South). According to the palynological evidene forests were widely distributed in Eastern Siberia during this interglacial. Steppe forests existed only in the southern part in the Transbaikal area along the river valleys. The pollen diagrams show that mountain slopes around South Baikal were covered by birch forests (73-82%) with a minor stands of Pinus sibirica, Picea abies, Pinus sylvestris (14-20%). In the middle of interglacial stage the climate became more arid. Aeolian began to be deposited with loess-like deposits accumulating in the southern part of the Baikal shoreline and the Selenga valley. Freshwater mollusc faunas are known from fluvial sediments of the Barguzin valley. This fauna includes river species such as Gyraulus acronicus, Pissidium amnicum, Unio sp. and Valvata confusa. The species composition and, in particular, the presence of Unio indicate climatic conditions that were similar to those today. At the beginning of Late Pleistocene representatives of the Mammoth fauna were widely distributed including Mammuthus primigenius, Bison sp., Ovis sp. and Coelodonta antiquitatis. Their fossil remains are known from fluvial deposits of the rivers Angara, Irkut, Selenga, Chikoi and Uda. Moreover, fossils of Coelodonta antiquitatis, Equus caballus (small form) and Bison sp. have been collected from the lake terrace on the northern part of Lake Baikal.
The small mammal fauna of this time are known only from two sites in Pribaikalie - Igetei and Ust-Oda area. List of small mammals at the Ust-Oda site includes both forest (Clethrionomys rufocanus, Myopus sp.) and steppe species (Lagurus sp.). The Igetei local fauna is represented only by steppe species.
THE POLLEN AND INSECT RECORD OF THE EEMIAN IN LONG POLLEN SEQUENCES IN FRANCE: A STATE OF ART

ANDRIEU V., BEAULIEU J.L. (de), CHEDDADI R., GUIOT J., PONEL P., REILLE M., Laboratoire de Botanique Historique et Palynologie, IMEP ERS 6100 CNRS, Faculté des Sciences St Jérôme, 13 397 Marseille Cedex 20, France

Seven long pollen sequences, showing a continuous record of the Eemian, have been analysed in France. These sequences are situated in the Massif Central (Ribains, Lac du Bouchet: sequences I + HH, Lac de St Front), the Vosges (La Grande Pile: sequences. 11 + XX) and the Alpes piedmont, near Lyon (Les Echets). The latitudinal range of these sequences is narrow: it is contained between 44°55' (Massif Central) to 47°44' (Vosges). And the altitudinal range is contained between 267 m et 1200 m altitude. In the Massif Central, the vegetation is characterized by a Pinus sylvestris forest around the sites and by a deciduous forest in the nearby valleys. The climate is continental. In the alpes piedmont (les Echets) and in the Vosges (La Grande Pile), the vegetation consists in a Quercus-Carpinus forest and the climate can be considered as eurosiberian.

The biostratigraphic record.
The Eemian biostratigraphic successions of the french sequences are very similar. The Betula expansion is considered to mark the onset of the interglacial. The early expansion of Ulmus followed by successive maxima of Quercus, Corylus, Taxus, and then an expansion of Carpinus corresponds to the classic woodland succession associated with the Eemian in central Europe. The appearance of Carpinus coincides with the first regular pollen records of Abies and Picea and may be regarded as indicative of climate deterioration. Abies and Picea progressively replace the deciduous forest and then a boreal-type Pinus forest develops. The end of the interglacial is characterized by an open forest with Pinus and Betula. At the same time, the main component of the herbaceous community is the Poaceae and Artemisia, indicating drier and colder conditions. It exists biostratigraphical particularities between the sites. For example, in the Massif Central, we note that the beginning of the installation of the Picea forest is not synchronous from one site to another one. This time lag is all the more surprising since the sites are very near and situated at the same altitude. An other regional diachronism concerns Carpinus what expanded earlier in the southern site of Ribains than in the Vosges (Beaulieu and Reille, 1992). This situation suggests for this taxa, a south-north migration different from that of the Holocene (Huntley and Birks, 1983). The main characteristic of the Eemian biostratigraphy is the absence or the very sparse notations of Fagus, indicating this tree did not play any role in the regional vegetation.

The climatic trends.
Quantitative climate reconstruction based on pollen (Guiot et al., 1992; Cheddadi et al., 1998) and Coleoptera assemblages (Ponel, 1995) have been carried out at La Grande Pile and at Lac du Bouchet: Neither the pollen nor the Coleoptera records indicate any cold period, as reported by the G.R.I.P. project (1993). The substantial cooling evidenced in the upper part of the Eemian (Picea phase), in the Massif Central, on the basis of palaeomagnetic data (Thouveny et al., 1994), is not fully supported by the pollen spectra. (in particular, no answer of Artemisia to the supposed negative climate shift).

The duration.
At La Grande Pile, Eemian chronology has been established following Woillard and Mook (1982): the interglacial is supposed to have lasted ca 20 ka, from 130 ka to 110 ka. Very concordant results have been evidenced at Devils Hole (Central Nevada, U.S.A., Winograd et al., 1992, 1996) and in the Antarctic sequence of Vostok (Jouzel et al., 1993, Sowers et al., 1993, Waelpbroeck et al., 1995)

Conclusion
In the near future, it will be necessary to focus our interest on Eemian laminated sequences (for example St Front, in the Massif Central) and to analyse the pollen content in high resolution. In the same way, it will be interesting to use other proxies like plant macrofossils and insect remains to better characterize the vegetation structure and the climate trends of this interglacial.
3 EARLY LATE PLEISTOCENE MAMMAL FAUNAS FROM CENTRAL AND SOUTHERN ITALY: BIOEVENTS AND PALAEOECOLOGICAL CONSIDERATIONS

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The first occurrence of the modern subspecies of the fallow deer *Dama dama dama* is the bioevent which characterises the early Late Pleistocene (late Aurelian Mammal Age; Isotopic Stage 5) mammal faunas. The main fossiliferous deposits referable to this time span are Grotta dei Moscerini (lower levels), Guattari and Fossellone (Latium, Central Italy) and Grotta Romanelli (terre rosse), S. Sidero, Melpignano and other coastal caves deposits from Salento (Apulia, Southern Italy). The late Aurelian faunas are characterised, beside the first occurrence of *Dama dama dama*, by the disappearance of several taxa of mammals. The equid *Equus hydruntinus* becomes quite common (mainly in the Salento deposits), while taxa of Galerian origin survive in the Italian peninsula (medium sized dogs ‘*Canis arnensis-mosbachensis*’ group).

The comparison between the Tyrrenian and the Adriatic coasts faunal assemblages allow the definition of a series of important climatic events, as well as the modification of the microclimate and the environmental conditions.
4 PALAEOECOLOGICAL AND PALAEOCLIMATIC REMARKS ON THE TYRRHENIAN OF BOVETTO AND RAVAGNESE (REGGIO CALABRIA, SOUTHERN ITALY)

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Over 340 molluscan species, including 37 senegalese guests, were recovered in the classical Tyrrhenian outcrops of Bovetto and Ravagnese. Out of 37 species, 17 of them are recorded for the first time in the Mediterranean Tyrrhenian. In addition new species are going to be added to the SG stock. It is noteworthy that 89% of these Tyrrhenian molluscan SGs (32 out of 37) are present in the Bovettot and Ravagnese sections. This increase in the number of the S.G. is due to the presence in the Bovetto sections of biofacies that are deeper than those of the classical upper infralittoral Tyrrhenian outcrops. Therefore the possible bias of grouping SGs that migrated into the Mediterranean at different times is completely vanished and this has a basic importance for the palaeobiogeographic interpretation of the Tyrrhenian. Moreover it appears obvious that the phenomenon of migration of the S.G. is more important than what was previously assumed through the available data with the previous data. The recovered warm-water assemblages infer temperature conditions similar to those of the Mediterranean Pliocene before 3 M.a. Nevertheless this datum needs to be interpreted in a different palaeobiogeographic scenario that is characterised by the lack of SGs in the Adriatic Sea and along the Moroccan and Portuguese coasts.
5 DIATOM ANALYSIS OF EEMIAN DEPOSITS AT LA GRANDE PILE
(VOSGES, FRANCE)

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The fossil diatoms from La Grande Pile GP9011, have been the subject of palaeoecological studies. Thirty samples of sediment were taken from depths 1700-1430 cm. The palynological analysis of this part of the core indicates that sediments represent the whole of the Eemian Interglacial Stage. Diatom zones from 1680 - 1430 cm depth are dominated by planktonic forms, typical of a deep-water lake. Species characteristic of cold and oligotrophic waters dominate at the first stage of development of this lake. They are followed by those corresponding to the warm, eutrophic waters and are followed later by those appropriate for the acido-, dystrophic habitats. Oligotrophic diatoms of genus Cyclotella, mainly C. ocellata, C. comensis, C. distinguenda var. unipunctata, appeared first, then an increase of alkaliphilous diatoms of greater trophic requirements is noted, especially Asterionella formosa and Fragilaria nanoide,s and later Cyclotella stelligera and Aulacoseira subarctica. In the upper part of this layer, the alkaliphilous planktonic diatoms are reduced and acidophilous, oligo-, dystrophic diatoms like Tabellaria fenestrata, T. flocculosa and Aulacoseira distans become dominant. They are accompanied by abundant benthic diatoms of the genus Pinnularia, Eunotia, Peronia, Fragilaria, which are typical of acid peat bogs.
FRESHWATER FISHES, AMPHIBIANS AND REPTILES IN EEMIAN DEPOSITS OF CENTRAL EUROPE

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Generally, fossil remains of organisms that shows only a minor tendency towards evolutionary changes are not very useful for biostratigraphy classifications. However, some vertebrates can be excellent ecological indicators and therefore helpful in the reconstruction of prehistoric ecosystems and climatic conditions, especially some fishes, amphibians and reptiles. The poikilotherm metabolism of the animals allows them to inhabit only ceratin specific thermal environments.

Fish, as well as herpetofaunas, have been discovered from some Eemian deposits in northern Central Germany. These deposits have been correlated with the Eemian on the basis of the mammalian biostratigraphy and pollen analysis. They display the occurrence of several species during this interglacial. The remains came from both lacustrine deposits (e.g. Gröbern, near Gräfenhainichen/Saxony-Anhalt and Schönfeld near Calau/Brandenburg) and travertine facies (e.g. Burgtonna and Taubach/Thuringia). Whereas the fish fauna from both facies types is fundamentally different, the herpetofauna shows remarkable similarities. A more or less continuous development of the fish- and herpetofauna over a longer time span has so far only been discovered only in the lake sediments at Schönfeld. Here the deposits span the entire Eemian Stage, from the end of the Saalian glaciation to the beginning of the Weichselian Glaciation. The distribution of several fish species was clearly dependent on the climatic development (e.g. Tinca tinca), as well as on the degree of the eutrophication of the lake (e.g. Carassius carassius). Of particular climatic importance are the swamp turtle Emys orbicularis (reproduction rate is correlated with high summer temperatures) and the northern distribution of the aesculapian snake Elaphe longissima (paramediterranean species). Almost identical fish, amphibian, and reptilian faunas can be found in northern Central Europe in the early interglacial, as well as during the climatic optimum of the Holocene (Boreal/Atlantic).
FLORISTIC, PHYTOCOENOTIC AND CLIMATIC SUCCESSIONS OF THE EEMIAN (MIKULINO) INTERGLACIAL ACCORDING TO PALYNLOGIC DATA ON LOESS-PALAEOSOIL SECTIONS OF THE UPPER DON, MIDDLE DESNA AND MIDDLE DNIESTER REGIONS OF THE RUSSIAN PLAIN

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No lacustrine and bog deposits of Eemian (Mikulino) age have been found in the southern Russian Plain. During the Mikulino the Dniester, middle and lower Dnieper, Don, upper Oka, middle Kuma River basins and other regions with loess-palaeosol formations (LPF) were subjected to the development of fossil soils, loess horizons, and alluvial deposits. The author’s reconstructions of landscapes and climate during the Eemian and other warm and cold periods of the Late and Middle Pleistocene have been based on detailed palynological analysis and complex (lithological, palaeopedological, microteriologial, etc.) investigation of reference sections of the main loess stratoregions. It has been established that during the Mikulino interglacial, forest was dominant all over the East European loess province, with the exception of the Dniester-Prut and Oka-Don regions which were occupied by forest-steppe. During the optimum phases, the forests consisted primarily of broad-leaved and coniferous/broad-leaved communities of European and Panholarctic elements.

Complete Pleistocene sequence is preserved in Strelitsa reference section in the Don region. Here the Mikulino interglacial is represented by the Salyon Soil formed on the Dnieper Loess and part of the Krutitsk Soil overlying it. Both soils form the Mezin Soil complex. Forest steppe was dominant throughout the whole interglacial. Forest formations underwent a series of transformations (9 successional phases) during this period. In the Arapovich section in the Middle Desna the Dnieper moraine is overlain by a 14 m thick Late Pleistocene loess-soil formation. On the basis of palynostratigraphical evidence, the author considers Mikulino interglacial to be represented here by sands and clayey silts that overly the Saalien moraine together with superposed Salyon Soil and the lowermost part of chernozem Krutitsk Soil. Eleven phases in evolution of the forest vegetation have been established for this warm period.

Palynological study of the sections situated in the extra-glacial region (e.g. Molodova I and V, Korman’, Ketrosy) allowed Bolikhovskaya and Pashkevich to describe Mikulino interglacial and 19 Valdai (9 interstadials and 10 stadials) events in evolution of the flora, vegetation, and climate of the Middle Dniester region. A soil complex exposed in the Moldova I section at the 20 m depth was developed during the Mikulino. The complex consists of two brown forest soils with a loess layer between. Seven alternating phases in evolution of the forest steppe vegetation have been recognised during this interglacial. Several smaller climato-stratigraphical units have been established within the Eemian climate oscillation in the region (‘thermoxerotic’ and ‘thermohygrotic’ stages, ‘substages’, and ‘endothermal coolings’). The main ‘endothermal’ cooling has been in the Moldova I, Arapovich and Strelitsa sections. Second ‘endothermal’ was established in the first half of the interglacial (Arapovich). Thus the complicated structure of the Eemian (Mikulino) interglacial is confirmed by the data from the Bisingen section (Field et al., 1993).

Among glacial stages in evolution of LPF of the Russian Plain, the most complicated climate oscillations are typical of the Valdai glacial which is characterized by 10 stadials, 9 interstadials, and several smaller phases. Studying Late Pleistocene sequences of extra-glacial regions, one must take into account the fact that landscape-climatic situations have been reconstructed that resemble interglacials for the Ketrosy (first Early Valdai) Interstadial in middle the Desna region, and the Kishlyanski (second Early Valdai) and Dniester (third Middle Valdai) Interstadials in the middle Dniester region.
MAMMALIAN DISPERSAL ON ISLANDS: A CASE HISTORY FROM THE LAST INTERGLACIAL DEPOSITS OF SOUTHERN CALABRIA AND SICILY

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Mammalian dispersal in islands depends on the existing geography, since the sea is for most mammals an insurmountable obstacle to cross. Insular mammalian faunas are less diverse than the faunas of the continents and are characterized by a whole set of peculiar modifications. The endemic mammals on islands have undergone changes from the moment they became isolated on the island and it might be assumed that there is some correlation between the degree of changes and the time of arrival on the island. The degree of endemism can give information on the time which elapsed between the colonization and the deposits in which the endemic form is found. Continental large mammals and endemic taxa from the last interglacial deposits of southern Calabria illustrate the palaeogeographical features of the areas connecting, respectively, peninsular Italy to Southern Calabria and to Sicily (Catanzaro isthmus and Messina Strait areas). Sicily experienced at least four mammal dispersal events during the Pleistocene. The older assemblages (M. Pellegrino faunal complex and Elephas falconeri faunal complex), show marked endemic features and extremely low diversification which make a comparison with any continental assemblages and the identification of the dispersal routes very difficult. The younger late-Middle Pleistocene-Late Pleistocene assemblages (Elephas mnaidriensis faunal complex and Castello faunal complex), on the contrary, are more diverse and balanced, and seem similar to those of southern peninsular Italy. Southern Calabria, which is now connected to peninsular Italy by the Catanzaro isthmus, has been considered a 'fossil island'. This is beause, in the basal of Eutyrrhenian littoral deposits yield a small sized elephant, a dwarf megalocerine (Megaceroides calabriae) and of a small hippo. Moreover, in southern Calabria a late Last Interglacial assemblage contains continental vertebrates (Homo sapiens neandertalensis, Elephas antiquus, Hippopotamus amphibius, Cervus palmidactyloceros, Dicerorhinus kirchbergensis, Alca impennis) which never reached Sicily. In the E. mnaidriensis assemblages of Sicily, most of the large mammal taxa (red deer, auroch, bison, boar, brown bear, wolf, lion, hyena) are characterized by slightly reduced body size, with respect to homologous forms from the mainland. This sicilian assemblages also contain a dwarf strongly endemic megalocerine (Megaceroides carburangelensis) that is closely related to the calabrian endemic megaricine Megaceroides calabriae, and an endemic hippo (Hippopotamus pentlandi). The latter may be compared with the large european hippo of the Hippopotamus antiquus group. In addition, these two endemic sicilian taxa seem to derive from ancestors which became extinct in peninsular Italy in the Middle Pleistocene. The E. mnaidriensis assemblages of Late-Middle Pleistocene-Late Pleistocene age in Sicily, if compared with the mammal assemblages from the Last Interglacial deposits of southern Calabria, give some information on mammalian dispersals in Sicily. This dispersal was controlled by two palaeogeographical barriers, in the area of Messina Strait and the Catanzaro isthmus respectively. A Middle Pleistocene dispersal event through the Catanzaro isthmus introduced some taxa (elephant, hippo, megaricine) into southern Calabria which subsequently was separated from peninsular Italy. A second stock of continental taxa reached Southern Calabria during a the Late Middle Pleistocene dispersal event. This together with the older calabrian endemic forms, spread into Sicily via the Messina Strait where a land bridge probably existed in the Late Middle Pleistocene. During the late Last Interglacial dispersal event, later via the Catanzaro isthmus, the connection between Calabria and Sicily was again interrupted up to the glacial dispersal event what introduced the Castello complex assemblages into Sicily.
THE EEMIAN OF THE NETHERLANDS; ENVIRONMENT, CLIMATE AND AGE


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In North-West Europe correlation of Eemian deposits has been done mainly by pollen. This biostratigraphical tool is used mainly the remigration of the genera of trees, after their absence during the previous period in which the Scandinavian land-ice covered vast parts of the area. Although pollen zones on a European scale are not isochronous units, within the Central and Northern Netherlands (200 x 200 km) the boundaries between these zones are used to be isochronous. The reconstruction of environment and climate is especially based on the data from the Eemian type area.

Deposits of Eemian age with a high preservation potential are the basin-fills, composed of clay and silt. A number of glacial depressions in the Central Netherlands has served as a sink for this type of deposit, in which important erosional breaks are absent over a longer period of the Eemian. Eventually the basin became filled with sediment. Erosional phases seem to be absent in the Amsterdam-Terminal borehole between 37 and 63 m below surface (pollen zones E1 to E5).

The reconstruction of the Eemian sealevel is hampered by some difficulties. At the end of the Saalian the area is undergoing glacial rebound. No indications, such as isolation basins, are found in the sedimentary record. We are confident that from pollen zone E3 onward isostasy is not a major factor in the sedimentation processes. The lowest point of the sill separating the glacial basin from the sea, is governing the moment at which the Amsterdam basin is intruded by seawater. This level is interpreted to be 35 to 45 m below present sealevel. A fast rise takes place and reaches a level of at least 14 m below present sealevel in pollen zone E4b. Shortly thereafter during pollen zone E5 the maximum level of 8 m below present sealevel is reached. We interprete the sandy tidal sediments to be deposited at a sealevel, about 15 m lower (pollen zone E5). The final Eemian sealevel drop takes place in pollen zone E6.

The fresh water diatomite contains a diatom-assemblage indicating cold circumstances during pollen zones LS and E1. The brackish and salt water sediments contain Bucella frigida, a foramspecies indicating a colder signal. Possibly the stratification of the lagoon is the cause of the presence of colder deeper water and shallower warmer water. Higher up in the sequence the presence of lusitanian forams and mediterranean shellspecies indicate the marine waters to be slightly warmer than at present at this locality. However, this seems to be less than thought in the past.

A chronostratigraphical correlation of the Eemian with the oxygen-isotope record has been conducted by means of amino-acid-datings. The correlation with stage 5e is established. The duration of the Eemian has been estimated by Muller (1974) to be about 11,000 years. Kukla et al. (1997) and Winograd et al. (1997) suggest this period to be twice as long. The first results of the U/Th-dating of Eemian shells of the Amsterdam-Terminal borehole indicate that the youngest deposits at Amsterdam are formed about 117 ka ago.
10 IPSWICHIAN MAMMALIAN ASSEMBLAGES IN THE CONTEXT OF THE BRITISH FLUVIAL RECORD

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Recent re-examination of mammalian assemblages from British fluvial sequences, particularly that of the River Thames, has led to the conclusion that four separate post-Anglian/Elsterian interglacials are represented. This contribution will endeavour to identify the correct stratigraphic position of the Ipswichian/Eemian within this sequence.

Previous interpretations have envisaged only two interglacials within the post-Anglian record, the Hoxnian/Holsteinian and the Ipswichian/Eemian. The majority of interglacial sites in the Thames were formerly regarded as Ipswichian but many are now considered to represent additional post-Hoxnian/pre-Ipswichian temperate episodes in the Middle Pleistocene. Distinguishing the true Ipswichian from these additional stages is problematic, particularly since palynology, when applied to fluvial sediments, has proved to be insufficiently sensitive. However, biostratigraphic analysis of mammalian remains from these deposits has identified the presence of a highly diagnostic Ipswichian fauna, characterised by the presence of *Hippopotamus amphibius*, which may in turn be clearly distinguished from the three earlier interglacial faunas. On the basis of this evidence, it is suggested that the Ipswichian is the last of the four post-Anglian temperate episodes indicated in the Thames sequence. Support for this model has also come from aminostratigraphy, which has consistently returned lower ratios from sites containing the distinctive hippopotamus assemblage.
BOREHOLE AMSTERDAM TERMINAL: HEAVY MINERAL DATA OF THE EEMIAN TYPE AREA

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Investigations of heavy mineral assemblages from this borehole offer the possibility of obtaining evidence on the origin of material that filled the southern part of the glacial basin beneath Amsterdam.

The following succession could be established. It comprises (in stratigraphical order):

Drente Formation
The basal sandy infilling shows a mixture of material from the nearby floor of the basin and glacial sediment material. Gravel in the size-fraction 3-5 mm shows glacier-derived material exclusively. In the central parts of the glacial basin the silts that form the main part of the Saalian infilling yield higher values for alterites, indicating more influence from ice-pushed deposits, bordering the basin. Deposits of the early Middle Pleistocene Sterksel Formation (sediments of the river Rhine) seem to have acted as source material.

Eem Formation
The sandlayer at the base of the diatomite contains material from another source. This source is, most probably, to be found in the northern part of the North Sea Basin. It is characterized by high values for hornblende and epidote, together with low values for alterites and garnet. This can be seen to indicate a primary Scandinavian origin of the sand-fraction for the sediment.
This association continues up to the top of the clayey deposits with the exception of two samples. One sample (63.53-63.56 m) shows an admixture with fresh material from the basin fringes, the other (39.51-39.57 m) presents an association characterized by an extremely high frequency of garnet. The may have been caused by a strong selective sorting of heavy minerals.
The uppermost sandy beds of the marine sequence show a strong increase in alterite with a maximum of volcanic minerals, indicating the influence of the Rhine system. However, this influence is short-lived and basin-derived sediments occur again.

Twente Formation
With the exception of the typical garnet-rich cover-sand facies at the top, the sediment of this formation seems for the greater part to be derived from local sources.

The succession presented here is characteristic of the infilling of the southern part of the Amsterdam glacial basin. The northern part has a somewhat different history, of which only very little is known due to lack of investigations.
HEAVY MINERAL DATA OF THE EEMIAN TYPE SECTION, AMERSFOORT, BOREHOLE IA

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The study of heavy mineral of this borehole was undertaken for documentation reasons. The lack of other mineralogical studies in the Amersfoort basin in the immediate neighbourhood of this borehole, could not be compared with other localities.

The following succession could be established (from bottom to top):

A stage, reaching and including the lowermost marine sediments of the Eemian, which shows strong affinities with known fluvioglacial deposits in the neighbourhood. They are characterized by a mixture of associations from deposits, pushed during glaciation of the area.

This is followed by an association which shows some influence of the River Rhinesystem. This is indicated by higher values for volcanic minerals and alterites. It is found in the marine sands of the Eemian.

Only one sample could be studied from the marine Eemian clayey deposits. It shows an epidote/hornblende/garnet association, which almost completely lacks alterite and volcanics. The specific grainsize and the admixture of material from another source area seem to be responsible for this change. The other source-area is in the North Sea Basin.

The Weichselian sands above the Eemian deposits show a garnet-rich association, which can be attributed to aeolian processes causing selective enrichment.
EEMIAN MARINE DEPOSITS ON THE KOLA PENINSULA AND
FLUCTUATIONS OF THE BARENTS SEA LEVEL

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The study of the foraminifera, marine molluscs and lithology in many sections on the Kola Peninsula and Winter coast of the White Sea has been undertaken. Correlation by means of faunal stratigraphy of marine deposits with the sections of Fjøsanger and Bø in Norway allowed the recognition of four Eemian and one Early-Middle Weichselian transgressions on the Kola Peninsula. Only two transgressions had been previously determined in this region. Besides these three phases of the late-postglacial transgression have been defined.

The first 'boreal-arctic' transgression took place at the end of Saalian (sensu latoital) glacial and at the very beginning of Mikulinian (Eemian, I interval). The sediments of this transgression rest either at low heights in the foundation of mikulinian deposits (sections at Pono River and in Fjøsanger) or at high points (hole 209 on the Winter coast of the White Sea and Kamenka River). The maximum sea level recorded being 215 m.

The second 'boreal' transgression took place in the warmest III interval of Mikulinian (Eemian). Three Ionium-deficiency dates (86, 114 and 97 kyr) have been obtained from sections on the Chapoma River, Kachkovka River and Swjatonosskij Bay respectively. During this interval the sea level was declining from 150 to 50 m.

The deposits of the third 'post boreal' transgression have been discovered in broad range of altitudes from - 21 to + 65 m (hole 202, to the east of the Chapoma River, Ludjanoi Brook, Ûstja-Pjalka River). The fauna at this time was poorer than during the second transgression. The accumulation occurred during Oxygen Isotope Substage 5c. The maximum sea level reached 92 m at this time. The fourth 'strelginian' transgression is known only from the Strelina River and hole 202. The boreal-lusitanian foraminifera are absent; indeed, among the boreal species only 4 were found. The maximum sea level at this time was 86 m (Oxygen Isotope Substage 5a). The deposits of the fifth (Early-Middle Weichselian) transgression have been discovered in sections along the Kunzhevaya River, Chapoma River and in hole 202. These sediments contain the coldest foraminifera and mollusc complexes. Their fauna correlates well with Bø section. Their age is about 65. The maximum altitude of the sea level was 137 m. Thus may be explained by glacio-isostatic subsidence driven by Early Weichselian glaciation in the Kola Peninsula.
14 RENEWED MULTIDISCIPLINARY INVESTIGATIONS OF THE EEMIAN
OF THE AMERSFOORT TYPE AREA

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Investigations of the Eemian Stage stratigraphy have a long tradition in the Netherlands. It started in the first half of the 19th century with the discovery of a temperate lusitanian diatom flora and mollusc fauna in marine deposits obtained from percussion drillings with a bailer sampler. The drillings were made for the reconnaissance and extraction of groundwater in Amsterdam. This same marine flora and fauna was observed and described in corings from a valley system of the Eem, the small river flowing through Amersfoort, the Netherlands. The Eemian period was named after this river.

In the 20th century the palynological zonation of the Eemian was defined in. Van der Vlerk and Florschütz (1953) standardized this zonation for the Netherlands. It is notable that all over N.W. Europe the vegetational succession derived from the pollen analytical data shows a remarkable similar pattern. At the end of the 1950’s the Eemian age deposits in the Amersfoort area were reinvestigated. Eemian age and younger deposits, sampled from new boreholes and temporary excavations, could be studied in detail. The foraminifera results were published separately by Van Voorthuysen (1958). The results of the palynological research were published by Zagwijin in 1961. The title of his publication ‘Vegetation, climate and radiocarbon datings in the Late Pleistocene of the Netherlands, Part I Eemian and Early Weichselian’ emphasizes vegetation and climate. This contrasted with the past when the investigations of the marine deposits were focussed on the mere presence of species of molluscs and diatoms. The regular geological mapping of the subsurface of the Netherlands (1:50.000) with more sophisticated coring systems resulted in new interesting sites with Eemian deposits. It proved possible to reconstruct a sealevel curve of the Eemian for the Netherlands (Zagwijin, 1983). The curve is based on changes in the sedimentary environment of the marine deposits and the relative dating of the level where important changes occur by means of the pollen zones.

In the 1990’s during the detailed geological mapping 1:50.000 of Amsterdam (mapsheet 25) new borings became available. The studies of these cored borings had a multidisciplinary character. In order to understand the sedimentary processes and environmental changes at the right hierarchical time and space scales, apart from pollen, diatoms, dinoflagellates, foraminifera and molluscs have been studied as well. This multidisciplinary approach and the thus obtained new ideas about the infilling of the glacial basin resulted in additional research of the stored samples of the borings Amersfoort 1 en 2. The infilling of the Amersfoort basin started with a gyttja layer (pollen zone E2). During pollen zones E3 and E4a the fresh water conditions changed into a marine environment, esp. a brackish lagoon. The adjustment of the vegetation to cooler summers and warmer winters and an oceanic climate during the second part of the Eemian (Carpinus zone, E5) is very well recorded. During the lower part of the Carpinus zone clays were deposited while in the upper part sands dominated. Both inside and outside the basin sedimentary conditions, shore displacement and vegetation history at the end of the Eemian are difficult to reconstruct due to a complex erosional and depositional history. In Amersfoort the termination of the Eemian is represented by the replacement of Abies-Carpinus-Picea forests by moorlands with Ericaceae, Sphagnum and Pinus. At some places Alnus stands were still present as well.
BOREHOLE AMSTERDAM-TERMINAL: POLLEN ANALYTICAL DATA OF THE EEMIAN TYPE AREA

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Renewed mapping of the subsurface of the Amsterdam area has resulted in new cored drillings from the Glacial Basin of Amsterdam. In combination with older available data of the basin (Zagwijn, 1983), the borehole Amsterdam-Terminal was cored in the deeper part of the glacial basin in 1997.

The sequence starts with a warved clay at the base of the infilling which, according to the pollen association, was of Late Saalian age at the top. During the pollen zones E1 (Betula), E2 (Pinus) and E3 (Quercus) diatomite was deposited under fresh water conditions. During the first period of the Corylus phase (E4) the depositional conditions changed fundamentally. A gradual increase of organic material resulted in an organic rich layer (sapropel). This deposit is known as the Harting Layer. It is assigned to pollen zone E4a, which is characterized by increasing percentages of Corylus and a still higher frequency of Quercus pollen. The presence of the algae of Pediasstrum and Tetraëdron is a striking phenomena in the Harting Layer. During the Corylus phase the input of clastic sediment increased and rhythmically layered clays were deposited. The Taxus zone (E4b) is represented by a sticky crumbly clay. During the Carpinus zone (E5) clay and sand were laid down. Except for the upper part, where some thin clay layers are present, the infilling of the glacial basin ends predominantly with sands. The relatively high percentages of Chenopodiaceae in the intercalated clay indicate the presence of tidal flats and perhaps salt marshes not far off in the basin. The development of these tidal flats and salt marshes took place during the Carpinus phase (E5) of the Eemian.

Because of the percentages of Juniperus and Hippophae, found at a higher level near the top of the infilling, the presence of a habitat for the pioneer vegetation of 'sand dunes' is supposed. This sediment is probably already of Early Weichselian age.
BOREHOLE AMERSFOORT I: POLLEN ANALYTICAL DATA OF THE EEMIAN TYPE AREA

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The Eemian stratigraphy in the Glacial Basin of Amersfoort (Central Netherlands) was studied at the end of the fifties and the beginning of the sixties, using samples taken from boreholes and temporary excavations. Biostratigraphic methods applied were foraminifera, pollen and diatom analyses. A general outline of the Eemian palynostratigraphy of the Amersfoort area was presented by Zagwijn (1961).

Most of the interglacial vegetation succession is reflected in the identified pollen assemblages. An initial phase with Pinus (pollen zone E2) was followed by immigration of Quercus (pollen zone E3). After the Quercus maximum the Corylus phase (pollen zone E4) of the Eemian is present in fine-grained sediments overlying the layers rich in organic material at the base of the infilling. According to the pollenflora the coarse sands situated on top of the fine-grained sediments belong to the Carpinus-dominated pollen zone E5.

In order to compare the older data of the Eemian with the data obtained from new investigations (geological mapping 1:50.000) in the subsurface of the Netherlands, especially in the glacial basin of Amsterdam, it was necessary to investigate the Amersfoort samples again. In the course of the seventies the pollen grains of Taxus could be recognized and determined at the Geological Survey. Therefore the recent diagrams have a more complete pollen zonation than the older ones, while some other differences appear as well.

At the poster the outline of the Eemian palynostratigraphy in the stratotype area is presented. Old and new data are shown and compared. In combination with the results of other disciplines it offers also the possibility to get an impression of the surplus value of multidisciplinary studies on different sedimentary environments, present in the infilling of the glacial basin.
COLEOPTERA FROM INTERGLACIAL DEPOSITS FROM TRAFALGAR SQUARE, LONDON: QUANTIFIED ESTIMATES OF THE THERMAL CLIMATE

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The southern part of Trafalgar Square, central London, is built upon a Weichselian gravel sequence that underlies the lowest terrace of the River Thames. From time to time foundation excavations show that these gravels lie on eroded remnants of interglacial deposits that are by general agreement attributed to the Eemian Interglacial. In the excavations for the foundations of the Uganda House interglacial organic silty sands were encountered with molluscs plant remains together with bones of hippopotamus, elephant and lion. This organic silt is also rich in insect remains particularly of Coleoptera and an assemblage of 161 taxa has been obtained, of which 127 can be determined to the species level. Nineteen of these have southern and central European distributions today which do not reach as far north as the British and one genus is not found living anywhere in Eurasia at the present day. Using the Mutual Climatic Range method it has been possible to quantify the climate at the thermal maximum of the Eemian interglacial in southern England in terms of the mean temperatures of the warmest and coldest months.
CLIMATOSTRATIGRAPHIC AT UNITS OF THE UPPER NEOPLEISTOCENE IN THE SOUTHERN FORE-URALS

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The Upper Pleistocene stratigraphical scheme in the Southern Fore-Urals is as follows:

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<td>Upper Neopleistocene</td>
<td>Kudashevo</td>
<td>Ostashkovo</td>
<td>Upper Weichselian</td>
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<td>Tabulda</td>
<td>Leningrad</td>
<td>Middle Weichselian</td>
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<td></td>
<td>Saigatka</td>
<td>Podporozhie</td>
<td>Lower Weichselian</td>
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<td>Mikulino</td>
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Mikulino Horizon. Alluvial deposits are practically unknown. They can occur locally beneath Ostashkovo sediments, which are associated with tectonic uplift of the region and fluvial erosion. In the Bashkir Fore-Urals lacustrine silts (0.2-0.8 m) containing a fauna of freshwater molluscs and with soils are known (e.g. Sultanaevo). Yellow-brown loess clayey loams (3 m thick) from the middle of the III Terrace above the floodplain of the Kama River (Krasnyi Bor) may be of Mikulino age. They also contain fauna of small mammals, described by Suhoj (1972). This period was characterized by Pinus-Betula forests with an Picea, Tilia, Quercus, Ulmus, and Carpinus. Treeless areas were covered by meadows with herbage and Chenopodiaceae.

Saigatka Horizon. On the left bank of the Kama River this unit consists of two parts. A lower part represented by loess loams with disseminated of carbonate, iron and manganese hydroxides and a upper part with green-brown lacustrine loams. The total thickness is 0.35-1 m. In the Bashkir Fore Urals these deposits are represented by green-brown clays and yellow-brown loams beneath subaerial sediments and periglacial brown siltite of the III terrace. Small mammals, molluscs and ostracoda are known from these deposits. This cold period was characterized by periglacial steppe with coniferous open woodlands.

Tabulda Horizon. Deposits of this time are wide developed in river valleys of the South Fore Urals and are represented by fluvial and lacustrine sediments (3-7 m thick) of the lower part of the II terrace or subaerial sediments (soil: 0.2-0.6 m thick). The remains of large mammals, molluscs, ostracoda and Upper Palaeolithic firestone implements are recorded from these sediments. Radiocarbon dates are: 34900 ± 100 y. (LU-1377A) (Tabulda) and 22660 ± 125 (BashGI-35), 28800 ± 124 (BashGI-36). This period was characterized by Pinus forests with small numbers of deciduous trees (Tilia, Quercus, Carpinus) and Betula. Picea-Pinus forests with Abies dominated the beginning and the end of the interglacial and in the north of the region.

Kudashevo Horizon. Deposits (7-13 m thick; subaerial - 1,25 m thick) are wide spread and cover interflues, slopes and on the II terrace. They are represented by periglacial alluvium or lake talus loams. Radiocarbon dates from these sediments give: 18315±300 (BashGI-41) (Staroye Kudashevo). At this time the vegetation represented by was a herb-dominated Artemisia-Chenopodiaceae meadow-steppe association. The Picea forests with some Betula and broad leaf trees occurred in the river valleys.
THE GREAT BASIN, USA, VEGETATION SEQUENCE ON GLACIAL-INTERGLACIAL TIMESCALES: THE EEMIAN

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The recent investigation of well-dated continental sequences at Owens Lake and the Great Salt Lake in western U.S.A. permit the comparison of interglacial vegetation over the last 0.5 Ma. The completion of other sequences, now underway, will permit more detailed chronological and geographical comparisons, but the current information is sufficient to contrast the southeastern- and northwestern-Great Basin, and to compare the current interglacial (Holocene) with the previous one (Eemian). The continental sequence is similar to the marine sequence in timing, but the continental vegetation is more variable, showing long-term trends and abrupt changes not evident in the marine record. The southwestern Great Basin (Owens Lake, W 118, N 36, 1067 m) is characterized by juniper woodland (Juniperus > 50%) during full-glacial intervals, and desert vegetation (Ambrosia > 10%) during interglacials. In contrast, the northwestern Great Basin (Great Salt Lake, W 113, N 41, 1280 m) vegetation sequence shows conifer dominance (Pinus, 20-30 %) during glacial and steppe - woodland (Juniperus 5 - 10 %) during interglacials. It appears that juniper woodland has migrated northward and retreated southward during each interglacial - glacial cycle. Over the last 5 interglacials, the peak percentages of Juniperus has gradually increased in the southeastern Great Basin, but has decreased in the northwestern Great Basin. Other than this progressive trend, the Eemian appears to be little different from the Holocene, with the following exception. Both records indicate that the Eemian was warmer and wetter than the Holocene. Owens Lake dried completely during the Holocene and no sediments are preserved at the coring site younger than 10,000 yr B.P., but the entire Eemian appears to be preserved in this core. For the Great Salt Lake, the percentages of desert taxa (Ambrosia, Sarcobatus), and of aquatic taxa (Cyperaceae, Typha-Sparganium) are higher during the Eemian than during the Holocene.

20 LAST INTERGLACIAL IN TRANSREGIONAL ASPECT:
CONTINENTAL LOESS-PALAEOSOL SUCCESSIONS AND MARINE
DEPOSITS FROM CENTRAL ASIA TO THE BLACK SEA SHORE

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The most complete Upper Pleistocene loess-palaeosol successions and marine deposits in south Russia
and Ukraine as well as the last interglacial pedocomplex in Central Asia have been studied. Despite the
long distance correlation, there is a good coincidence in cyclicity and composition of the last
interglacial pedocomplexes in different areas. In Central Asia the last interglacial pedocomplex consists
of three palaeosols: the lower one is a leached cinnamon soil, the middle and upper ones are
carbonaceous cinnamon. In loess sections of northern Black Sea shore area the last interglacial
pedocomplex is represented by chernozem-like soil at the bottom and by cashtanosem soils above.
During the last interglacial, the Black Sea was connected to Mediterranean Sea while the Karangat
Basin (=Eemian) had almost normal salinity - 30-35%, witnessed by Acanthocardia tuberculata and
Paphia senescens. The level of the Karangat Sea was a few metres higher than the present Black Sea.
The composition of Karangat deposits in the Eltigen section, Crimea, mostly demonstrates three or five
sedimentary cycles corresponding to sea level oscillations that were probably palaeoclimatically
induced. The lagoon facies of the second and the third cycles contains a micromammal fauna with the
very characteristic forms Lagurus lagurus and Arvicola ex gr. Terrestris, which are peculiar to the Late
Pleistocene. On the basis of palaeomagnetic data an interval 10 m thick of anomalous direction of
geomagnetic field occurs in the lower part of the Karangat sequence in Eltigen that has been interpreted
as the Blake Event. In the Caspian Sea the last interglacial was represented by the Late Khazar
transgression water level which reached higher than that of today. The salinity of the Khazar Basin was
close to that of the present day Caspian Sea. The link between the Karangat and Khazar Basins, through
the Manych channel, was not continuously present. After the last interglacial the Black Sea level fell
over 100 m. The dried shelf from the mouth of the river Dniester to the Crimean peninsula was an area
of loess sedimentation. The northern coastline of the Black Sea was located at the outer margin of the
shelf around 250-300 km south of the present mouths of the Dniester, Dnieper and Don Rivers.
MAMMAL FAUNA OF THE EEMIAN (KAZANTSEVO) INTERGLACIAL IN SOUTHWESTERN SIBERIA

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Global changes of palaeoclimatic during the Quaternary had varying influences on the environmental conditions of different regions of Eurasia. This can most vividly be seen when interglacial faunas and floras of its western and eastern (intracontinental) regions characterized by different hydrothermal regimes are analysed.

Until recently, interglacial teriofaunas were almost unknown from Siberia. Biostratigraphical studies in the Kuznetsk Basin (southeast of Western Siberia) have allowed the reconstruction of the features and the sequence of the faunas corresponding both to glacial and interglacial periods (Foronova, 1990, 1998). In southwestern Siberia (extraglacial zone) it had been found that interglacial faunas were neither typically forest, nor ‘antiquus’, like in western, central, and eastern Europe. Due to the continental climate and features of vegetation zonality, they mostly retained a forest-steppe (sometimes steppe) guise, but unlike periglacial faunas, they did not contain arctic elements. In interglacial times, forms corresponding to humid biotopes occurred widely, the variety of deer increasing.

The comparison of European and Asian faunas from the Last Interglacial (Eemian - Mikulin - Kazantsevo) shows a change of specific composition from west to east: the number of forest species is progressively reduced, while forest-steppe and steppe forms become predominant.

In the Kuznetsk Basin, the fauna corresponding to the Eemian (Kazantsevo) interglacial is contained in the upper part of alluvial Chernigovo Suite and in the lower part of dilluvial-prolluvial loess-like loams with fossil soils (Bachatsk Suite). These sediments occur in almost all the mining pits of the Kuznetsk Basin. Their stratigraphical analogues in Western Siberia give TL-dates from 130 ± 31 to 100 ± 17 ka. The fauna includes: Canis ex gr. lupus, Ursus cf. arctos, Panthera spelaea, Gulo gulo, Equus sp., Coelodonta antiquitatis, Cervus elaphus, Megaloceros giganteus, Alcinae gen. indet. And Bison priscus. The most typical faunal elements are: various Cervidae, Equus ex gr. germanicus (a representative of the lineage of caballoid wide-finger horses) and a relatively thick-enamel adaptation (form) within early Mammuthus primigenius. This form, a typical representative of which is M. primigenius from Early Mousterian site Chokurcha (Crimea), occurred widely in Europe and in southern Siberia. Unlike Europe, where the change of glacial and interglacial conditions and respective vegetation zones was more sharply defined, in Western Siberia (according to the phenogram of enamel thickness and plate frequency of molars), this form shows more gradual transitions to adjacent forms, that is why its adaptive peak is not so well-pronounced. No remains of Palaeoloxodon antiquus, associated with forest zones, have been found in the Kuznetsk Basin.

The last Interglacial in Western Siberia was the warmest of the interglacial periods. During its optimum, the temperatures reached +5°C (summer) and +7°C (winter). Southtaiga and middletaiga forest vegetation was well-developed in the northern and central parts of the region. The extraglacial zone was occupied by forest-steppe and steppe landscapes, the borders of which extended southwards to 53° N. Lat.

It is thought that the first part of the interglacial was more humid, while more arid climate was typical of the second part. Microteriofauna derived from thick fossil soils of the Bachatsk Suite is represented by Lagurus lagurus, Eolagurus luteus, Myospalax myospalax, and Citellus erythrogenys, that together
imply a meadow-steppe landscape. Spore-pollen records from loess-like loams show the predominance of steppe vegetation in the Kuznetsk Basin (herbaceous pollen representing 79-90% of the total). Pollen of grasses, Composites and angiosperms predominates. The pollen of the frutescent and arborescent reach 14%.

These data imply diverse habitats of the Eemian vertebrate fauna in southwestern Siberia. In general, the fauna has features of forest-steppe communities. Open steppe areas and light woodlands were inhabited by mammoths, cave lions, horses, rhinoceroses and bison, while isolated forests and the floodplains of rivers and lakes, which were well-developed in Eemian time, were probably a habitat of deer and some carnivores.
EVIDENCE FOR SUBDUED CLIMATIC VARIABILITY DURING THE LAST INTERGLACIAL IN NORTHWEST GREECE

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The question of intra-Eemian climatic variability, initially suggested by the GRIP ice core data, is still largely unanswered. Differences in the Eemian sections between GRIP and the companion GISP2 core, along with evidence of disturbed layering and analyses of gases trapped within the ice, suggest that the apparent climatic instability is a result of stratigraphical disturbances. Results from marine and terrestrial records have been mixed in terms of supporting or refuting the notion of Eemian climatic instability, but if detected at all, oscillations have generally been shorter and less extreme than in the GRIP core. Thus, although the occurrence of large-amplitude changes can probably be ruled out, the issue of subdued Eemian climatic variability, perhaps on a scale similar to that recently recognised in the Holocene, still needs to be addressed. Here we present isotope and pollen results at ~75-150 year resolution of the last interglacial interval from a new borehole sequence in northwest Greece. In addition to recording a polyphase lateglacial period, the record also indicates climatic variability throughout the interglacial. With the exception of one discrete cool/dry event beginning at around 121.5 kyr BP, this variability takes the form of a series of well-defined, sustained phase changes.
23 THE NORTH SEA-BARENTS SEA SEAWAY AND THE NORTHWEST EUROPEAN CLIMATE IN THE EEMIAN - MOLLUSCS AND ENVIRONMENTAL IMPLICATIONS

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During the Eemian/Mikhulinian a more than one hundred kilometre wide seaway existed from the southern North Sea through Schleswig-Holstein, the Baltic, Karelia and northwards to the White Sea-Barents Sea.

Previous publications, especially in Russian, have discussed the oceanographic implications of this feature, which has had no parallel in the Holocene. Questions such as was energy transported to/from the Atlantic and the Arctic Ocean along this route, and did it influence the NW European climate are extremely important.

Marine sediments with mollusc faunas from this seaway are best exposed in southern Denmark and northern Russia, but known also from smaller exposures and numerous borings between these areas. Pollen studies of the marine sediments indicate that they are of the same age, spanning the interval from the *Pinus-Quercus* zone and at least into the *Carpinus* zone. However, comparison of the faunas evoke a complex and apparently contradictory picture of the seaway's hydrography. At its two ends, in the south-western Baltic and northern Russia, conditions were considerably warmer than now, and saline waters penetrated far into the Baltic and into the North Russian river basins. However, in the middle, in the 'Karelian passage' from the Gulf of Finland to northern Lake Onega, faunas indicate cold and low-saline water.

These steep heat and salinity gradients are difficult to reconcile with water exchange through the Karelian passage. As a tentative solution to the problem we suggest that the connection over the narrow continental water divide to the north of Lake Onega functioned only for a short period, probably at the time of rapid eustatic sea-level rise in the early Eemian. During the main part of the Eemian, the Karelian passage was probably not a passage but an oceanographic cul-de-sac extending from the Gulf of Finland to northern Lake Onega, as a parallel to the Gulf of Bothnia. The climatic significance of the extensive marine cover would then have been mainly as an oceanic heat/cold reservoir, lending an oceanic aspect to the climate in adjacent land areas. Alternatively, the faunas of the Karelian passage could be interpreted to show that a cold southward going undercurrent compensated for a warm northward directed surface current. There is indeed evidence for highly stratified water masses in the North Russian marine faunas. However, we do not favour this solution, as it entails that all traces of the warm surface current should have been removed from the extensive region of the Karelian passage. These results are preliminary products of ongoing fieldwork in northern Russia (the PECHORA and ARKHANGELSK Projects) and Denmark (the CATLINA Project).
ESR DATES ON MERKINE INTERGLACIAL DEPOSITS IN LITHUANIA
AND EEMIAN DEPOSITS ON THE BELGIAN COAST

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The introduction of electron spin resonance (ESR) dating method has provided an accurate chronology
for the Merkine (Eemian, Mikulinian) Interglacial.
For dating of the Merkine organic lacustrine deposits five shell, samples were taken from a section at
Netiesos, on the right bank of Nemunas River about 6 km down from Merkine town. The shells were of
the freshwater Pelecypod and Gastropod species. All shell sample ages have been determined using the
ESR method at the Institute of Geology, Tallinn Technical University, Estonia. The age of freshwater
mollusc shells collected from lake and bog deposits of the Merkine interglacial at Netiesos were
determined as 112.1 ± 25.9 (lower samples) and 101.5 ± 11.5 ka BP (upper samples). The results
obtained show that the deposits at Netiesos are undoubtedly of Merkine (Eemian) Interglacial in age.
The Eemian deposits in the vicinity of Meeterke site (Belgium) were specially excavated in 1993.
Here beneath a thin cover of Weichselian sand the outcrop shows two lithological units of Eemian age.
The lower unit up to 5 m thick is tidal flat deposits with sandy, silty and clayey laminations. The upper
unit overlying the coastal sequence consists of shell-bearing sandy deposits which probably correspond
to a period of high sea level stand during the Eemian stage (DeMoor and Motaert, 1993). The two
shell samples were collected from this site for ESR analysis yielded ages of 104.4 ± 9.5 and 97.1 ± 8.9
ka BP respectively.
The ESR dates derived from the Netiesos and Meeterke sections are in good agreement and correlate
well with those previously obtained on the Merkine Interglacial at the Jonionys stratotype section
(Southern Lithuania) at about 109.5 ± 8.5 ka BP.
Data from the Netiesos, Jonionys and Meeterke sections are also consistent with the ages obtained on
interglacial deposits using the optically stimulated luminescence (OSL) and independent
palaeontological and geological evidence from these sections.
25 DISTRIBUTION AND SEDIMENTOLOGY OF EEMIAN DEPOSITS IN THE WESTERN NETHERLANDS WITH SPECIAL REFERENCE TO THE AMSTERDAM GLACIAL BASIN

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Eemian deposits are found over large areas in the subsoil of the coastal zone of The Netherlands. These deposits consist of sands and clays with marine shells, shell fragments and shell concentrations (breccias).

The Eemian deposits are located between 10 to 90 metres below mean sea level NAP (Amsterdam Ordinance datum = mean sea level). The top of most of the Eemian deposits was eroded during the Weichselian, either by periglacial levelling or by fluvial reworking.

The thickness and distribution of Eemian deposits is highly irregular due to the morphology of the pre-transgressive surface. The thickest Eemian clay beds (up to 50 metres) are located in former Saalian glacial basins. The stratotype of the Eemian is situated in the so-called Amersfoort Glacial Basin. The proposed new parastratotype is a core in the Amsterdam Glacial Basin. The Eemian succession in the latter basin is better known because of a wealth of available borehole data.

The Eemian highstand in the Netherlands is reflected by sediments, now situated at 10 metres below NAP. As the basins had thresholds at about 30-40 metres below NAP, the Eemian marine and lagoonal succession of the stratotype and parastratotype represent deposition during the upper 20-30 metres of Eemian sea level rise and during its highstand and represent pollen zones E4 to E6. A condensed level of freshwater diatomites ranging in age from Late Saalian up to Eemian pollen zone E3, occurs at the base of the lagoonal and marine Eemian succession in the glacial basins.

Lithologically, the Eemian succession in the Amsterdam basin consists of three main lithological units.
- A thin, basal zone of organic-rich diatomites and clays, representing the transition from fresh-water diatomites to marine/lagoonal clays,
- up to 30 m of mud and clay which contains an increasing amount of sand layers towards the top,
- the upper unit which consists of up to 30 metres of medium to coarse sands with a shell breccia in its basal part.

Sedimentary structures in these sands are mega-cross bedding due to tidal currents. This sand body is onlapping towards the south, indicating a northerly provenance.

The transition from predominantly clay and mud to predominantly sand deposition illustrates the increasing importance of tidal currents as the basin is infilled.
THE EEMIAN OF EASTERN UKRAINE: VEGETATIONAL AND PALAEOSOIL SUCCESSIONS

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A characteristic feature of Ukrainian loess-soil sequences are two well developed steppe and forest soil complexes overlying the deposits of the Dnieper Horizon (including glacial and fluvioglacial deposits). The Dnieper unit is correlated with Saalian ice advance of central and western Europe. The two soil complexes are called the Pryluky and Kaydaky horizons in the Ukrainian Pleistocene stratigraphical scheme. TL dating of the top steppe soils of the Pryluky-Kaydaky complex allows the relation of this soil to the Brörup interstadial, while in the northern part of Ukraine, the pollen zones from the lower soils show a typical pattern of the Mikulino Interglacial. The latter unit is generally considered to represent the East-European equivalent of Eemian, and is characterized by two climatic optima (M4 and M6) separated by a stage of cooling (M5).

Pollen and palaeosol study of the Pryluky-Kaydaky horizons has been carried out in the northern part (Kyiv region, forest belt), central part (Donetsk region, steppe belt) and southern part (Crimean mountains) of Eastern Ukraine. The vegetational and soil successions in these three zones are as follows:

1. In the northern forest belt: *Picea* forest, ferruginous gley (kd a) - *Betula-Pinus* forest with admixture of broad-leaf species, later *Ulmus-Quercus* ecotones; grey forest soil (kd b1) - broad-leaf forest-steppe and steppe, meadow chernozem (kd b2) - *Quercus-Carpinus* forest, later *Picea - Pinus* ecotones; pseudogley (pl b1). The upper chernozem soil (pl b2), TL dated to 100 +/- 10, 100 +/- 13 kyr, has been formed under *Herbetum mixtum-Gramineae* steppe and forest-steppe with few broad-leaf species. In sequences of adjacent regions, a thin loess layer, the Tyasmin unit (ts) separates the chernozem kd b2 and pseudogley pl b1. Since it is characterized by pollen spectra of steppes, with no pollen of broad-leaf species, it can be related to the intra-Mikulino cool interlayer M 5, while the phases of *Ulmus-Quercus* and *Quercus-Carpinus* forests respectively to the optima M 4 and M 6.

2. In the central steppe belt: *Pinus* meadow steppe, turf soil (kd a) - *Quercus* forest, later forest-steppe; grey-brown forest soil, later meadow chernozem (kd b1) - *Gramineae* steppe, thin loess (kd b1-2) - *Tilia-Quercus* forest-steppe, later steppe; brown forest soils and chernozems (kd b2) - *Gramineae* steppe, few *Betula* sect. *Nanae*; loess (ts) - *Quercus-Carpinus* forest-steppe, brown forest soil (pl b1). The upper chernozem (pl b2) is overlain by loess, dated to 95 +/- 6, 97 +/- 7 kyr. This chernozem has been formed under *Herbetum mixtum-Gramineae* steppe with few broad-leaf species. A stage kd b1 can be related to the lower climatic optimum, while a stage pl b1 to the upper climatic optimum of the Mikulino. A significant deforestation accompanied by loess formation (ts) took place between the kd b2 and pl b1 stages, as well as within the Kaydaky Stage (kd b1-2). A climatic cooling between the first stages of the Mikulino has also been described by Bolikhovskaya (1995).

3. In the Crimean mountains (rockshelter Kabazi 2): *Carpinus-Quercus* forest-steppe (kd b2) - *Pinus* forest-steppe, decline of broad-leaved species (ts) - *Quercus-Tilia-Carpinus*, later *Carpinus* forest, *Juglans* is present (pl b1) - *Pinus* and *Carpinus* forests, *Abies* is present, *Alnus* is rather abundant (pl b1-2). The overlying turf soil, which has been ESR dated to 82.0 and 84.4 kyr, is characterised by *Carpinus-Quercus-Pinus* forest-steppe (pl b2).
27 THE EEMIAN OF THE DUTCH CONTINENTAL SHELF

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In the Dutch part of the Southern North Sea very fine to medium marine to shallow marine Eemian sands are widespread. The thickness ranges from several to 30 metres, but can be thicker in glacial valleys. In the northern part of the Dutch Continental Shelf the Eem Formation is underlain by Saalian glaciomarine and glaciolacustrine clays, aeolian sands and Holsteinian marine sands. It is overlain by Weichselian aeolian sands and glaciomarine clays. A glacial valley in this area is filled by late Saalian glacio-marine to shallow marine sands, that are overlain by Eemian lacustrine to lagoonal laminated sands and clays. They are in turn overlain by Eemian estuarine and open marine deposits. Towards the south the Eem Formation is underlain mainly by fluvial sediments of pre-Elsterian age. It is overlain by the Brown Bank Formation, lagoonal to lacustrine clays of late Eemian (E6) to early Weichselian (EW1) age, or Holocene marine sands. All palynological biostratigraphical units are represented.
28 LATE PLEISTOCENE PALAEOSOIL FORMATION IN THE Dnieper, Don and Middle Volga Rivers Basins of the Russian Plain

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On the basis of detailed palaeopedological data obtained from the most representative and thickest sections of the loess-palaeosol formations in the Dnieper, the Don and the Middle Volga rivers basins of the Russian Plain (Mihailovka, Chekalin, Korosteliovo, Uryv and Komintern), a multi-member stratigraphical subdivision and correlation has been proposed. The evolution of soil formation, dynamics of landscape development and climate of the East European glacial, periglacial and extraglacial zones of the Pleistocene have also been reconstructed. Detailed studies of the morphogenetic and geochemical characteristics of the fossil polygenetic post-Eemian Stage (= Mikulino) Mezin Soil complex have shown a resemblance of typological features to soil formed during the same time interval. Regional differences between these soils result from their geographical situation and local geological-geomorphological conditions. These results suggest that soils formed during the Eemian were replaced by more arid and continental types afterwards. The Eemian interglacial was characteristic in soil formation processes that its temperate were similar to those today. The soils of forest and steppe- types occurred widely during the period.
29  LATE WARTHIAN, EEMIAN AND VISTULIAN
PALAEOENVIRONMENTAL CHANGES IN THE LIGHT OF
PALAEOBOTANICAL STUDIES OF LACUSTRINE DEPOSITS OF
EASTERN POLAND

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The Quaternary sequence of lacustrine deposits at Horoszki Duze has been reinvestigated after more
than 35 years. For this purpose a 24 metre thick profile was drilled. Sands with gravel and pebbles (up
to 7 cm in diameter – of possible eroded marine origin) formed the bottom part of these lacustrine
sediments, overlain by a series of sand and silt. From a depth of 16 m upwards the following organic
deposits occur: calcareous gyttja, bituminous shale, peat, and silt with varying clay content. The site
lies beyond the maximum extent of the Last Glaciation.
The pollen diagram obtained represents the end of the Warthian Stage, the complete Eemian
succession, both interstadials of the Early Vistulian (with bipartite Brørup) and a portion of the Pleni-
Vistulian.
The vegetational succession of the Eemian has been divided according to Mamakowa’s division of the
interglacial in Poland which recognises 7 regional pollen assemblages zones.
In the portion of pollen diagram which covers the time span of the Early Vistulian seven
chronostratigraphical units have been distinguished.
The richness of the flora (pollen and macroscopic plantremains) have allowed a rather detailed
reconstruction of the vegetational and palaeoclimatic changes in the time span covered by the pollen
diagram.
30 GEOMORPHOLOGICAL EXPRESSION OF THE LAST INTERGLACIAL IN THE BELGIAN LOESS REGION

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Saale loesses are only exceptionally preserved as is the case of the thick late-Saale Lafelt loess, deposited on the Kesselt plateau in the SSW prolongation of the Meuse valley, which funnelled loess bringing NNE-winds. When preserved then it is always weathered into a grey-brown forest soil stronger than the Holocene soil by colour, clay content and decalcification depth (Rocourt Soil). All known sites are in very flat, mostly even slightly concave topography. Above the soil occurs always a humic horizon in which often several layers can be distinguished (Warneton Complex). Over a wide area coarse volcanic minerals are present, specifically characterised by the rather uncommon mineral enstatite (Enstatite or Rocourt Tephra).

Then follows in privileged concave situations the succession of autochthonous and reworked loess deposits, rich in periglacial phenomena. But most often this succession is deposited on a new topography where the previous deposits have been eliminated.

It must be concluded that after the penultimate glacial stage followed a period of geomorphological stability characterised by weathering and finally by accumulation of humic loams by increased run off in deteriorating climatic conditions. These culminate in a phase of excessive landscape instability representing the major break at the start of the periglacial conditions of the last glacial. This major instability can only be understood by the combination of a defenceless soil under the attack of excessive erosive forces. A complete killing off of the vegetation under new very cold harsh conditions with a migration lag inhibiting the colonisation by adapted species would leave the soil defenceless. The very cold conditions of the waxing glacial would still fall under western cyclic regime and bring large amounts of snow, the summer melting of which would deliver the erosive power. This major geomorphological break coincides with the beginning of MISS-4. Authors differ only in the attribution of the preceding phenomena to which phase of MISS-5. On geomorphological grounds however the end of the last interglacial must be placed at the beginning of MISS-5a.
31 REMICOURT (HESBAYE): A PEDOSTRATIGRAPHICAL RECORD FOR THE LAST INTERGLACIAL AND EARLY GLACIAL IN BELGIUM; A TESTCASE FOR NW EUROPE

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For more than 40 years the Rocourt Soil has been standing out as an important pedostratigraphic marker in Belgium and north-western Europe. Since the seventies the complexity of this Soil was well illustrated, though its pedological and stratigraphic evolution remained doubtful. Macro-, meso- and micromorphological data gathered along long variable sections in Remicourt finally provided the ‘missing link’ between the Hesbaye sections and the Haine Basin. Soil characteristics allowed to match the Rocourt Soil with three major soil forming processes belonging to the Eemian and the first half of the Saint Germain I (\(^{14}O\)-stages 5e and 5c). The overlying humiferous sediments and soils, which also incorporate the Rocourt Tephra, are linked with the second half of the Saint Germain I (\(^{14}O\)-stage 5c). The loess, stratified sediments and soil covering the humiferous layer are the equivalent of E.B.1, E.B.2 and Malplaquet Soil in Harmignies and belong to Melisey II and Saint Germain II (\(^{14}O\)-stages 5b and 5a).
32 BOREHOLE AMSTERDAM-TERMINAL: DINOFLAGELLATES OF THE EEMIAN TYPE AREA

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Borehole Amsterdam Terminal was cored in 1997 in order to serve as an additional source of information on the Eemian deposits in the type-area. Up till now borehole Amersfoort I (van Voorthuysen, 1958 and Zagwijn, 1961) was used as the stratotype for this chronostratigraphical unit. As shown by Zagwijn (1996) the record of the Eemian sediments in the Amsterdam glacial basin is more complete. In the present borehole an Eemian sequence, generally composed of very fine-grained deposits, reaches a thickness of at least 35 meter. The sediments have been studied by a wide range of disciplines.

The first, although weak marine indications are found at 62.07 and 61.73 m. At 61.26 m the marine influence is distinct based on an assemblage strongly predominated by heterotroph dinoflagellates of the *Brigantedinium* plexus, reflecting nutrient rich conditions. Samples from 61.03 to 32.65 m are characterized by lagoonal dinocyst associations (*Diplopetta symmetrica, Lingulodinium machaerophorum* and *Tuberculodinium vanampaee*). Moreover, the two last mentioned species indicate (sub-)tropical sea-surface temperatures. In this interval three subzones can be distinguished:

61.03 - 57.76 m: specimens of *L. machaerophorum* with small processes indicate decreased salinity. In particular around 60.50 m anaerobic bottom conditions prevail.
55.79 - 41.20 m: gradual increase of the marine influence as exemplified for example by *Bitectatodinium tepikiense*.
37.93 - 32.65 m: possibly more open-marine influence.

From 52.28 m and upward Tertiary reworking is noted, and thought to be introduced by North Sea near-coastal transport into the Amsterdam Basin.

A comparison with Eemian/Ipswichian assemblages from NW Europe is difficult because of uncertain age determinations, particularly from the British Isles. North Atlantic associations (Eemian or Isotope Stage 5) are characterized by colder and full marine dinocysts of oceanic aspect.
33 PALAEOECOLOGICAL, STRATIGRAPHIC, AND EVOLUTIONARY ASPECTS OF HOLARCTIC PLEISTOCENE HERPETOFAUNAS

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The Quaternary herpetofauna of Europe has been and is taxonomically impoverished compared to that of North America. Following the depletion of the Holarctic herpetofauna in the Oligocene, Europe became so isolated that it never became herpetologically enriched again as did North America, which had access to southern refugia with warm and equable climates. Nevertheless, comparisons of herpetological responses to the Pleistocene of the two regions is of considerable interest. In each region, Pleistocene herpetofaunas are palaeoecologically important, as certain species had limited ecological tolerances or indicated very specific habitats. On the other hand, several Holarctic Pleistocene species had such broad ecological tolerances that they are of limited interpretive value. Holarctic Pleistocene herpetofaunas may also be important in stratigraphic considerations, as they may indicate full glacial or interglacial conditions or various conditions in between. This is more evident in European than in North American Pleistocene herpetofaunas.

Along this same line, population movements caused by glacial and interglacial conditions are much more evident in Europe than in North America because much colder glacial climates occurred in central and northern Europe than in central and northern North America. In fact, more equable climates than today occurred in the Pleistocene of North America relatively near the glacial fronts.

On the other hand, the herpetofaunas in both regions showed a remarkable evolutionary stasis throughout the Pleistocene. Reasons for this stability probably include (1) several ectothermic adaptations to climatic change in both amphibians and reptiles, (2) their lack of involvement in the ecological interrelationships of megaherbivore-dominated communities, and (3) because amphibians and reptiles were less desirable as a human food resource than the endothermic taxa.
The reaction of fluvial deposition to climatic cooling is non-linear and marked by a considerable
resistance to change inherent to the fluvial system. This is clearly shown by a near-continuous record of
12 m of floodplain sediments of Eemian to Middle Weichselian age from the Dinkel valley in the
Eastern Netherlands. This paper presents the results of a sedimentological and geochemical study of
hydraulic cores of this sequence, spanning the transition from interglacial to full glacial conditions.
The sequence consist of clay and organic sediments, with intercalations of sand. Throughout the
Eemian and Early Weichselian, a continuous sequence of fine-grained and partly organic floodbasin
sediments is deposited by meandering or anastomosing rivers. Clear erosional breaks are lacking. Only
minor changes in facies occur: a tendency towards more widespread peat formation during the late
Eemian, followed by more frequent lacustrine conditions at the start of the Early Weichselian and
increasing deposition of sand toward the end of the Early Weichselian. A major change in fluvial facies
occurs at the start of the Middle Pleniglacial with deposition of fluvio-aerial sediments under
permafrost conditions.
While fluvial facies hardly changes throughout the Eemian/Early Weichselian, gradual changes in
drainage basin erosion and river discharge are recorded by geochemical characteristics of the sediment.
At the transition of the Eemian to the Early Weichselian, a change in C/N ratio of the organic deposits
shows changes in nutrient supply to more eutrophic conditions. This is promoted by changes in river
water geochemistry or flooding frequency. Later during the Early Weichselian, several parameters
(carbonate content, chemical index of alteration, grainsize) demonstrate a growing supply of freshly
eroded material to the basin.
The Early Weichselian stadials clearly did not impose a major change on the fluvial system. This
indicates the presence of geomorphic thresholds or time lags within the fluvial system that represent a
considerable resistance of the system to the effects of climatic cooling during an interglacial-glacial
transition.
35 STUDIES OF MARINE AND TERRESTRIAL EEMIAN (FELICIANOVA) INTERGLACIAL SEDIMENT SEQUENCE IN LATVIA

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Records of Late Saalian (Kurzeme)-Eemian (Felicianova)-Early Weichselian (Latvia) terrestrial and marine deposits have been found in Latvia. Marine sediments have been found into stratified between glaciolacustrine deposits. Diatom and pollen spectra indicate that these sediments are of Eemian Interglacial age.

The presentation demonstrates the litho- and biostratigraphical data from terrestrial (Felicianova, Rogali, Satiki, Ilukste, Subate and Kaitra) and marine (Grini and Gulf of Riga) sections. Important evidence for the reconstruction of climatic and vegetation history of the Last Interglacial/Glacial cycle have been obtained during geological mapping of Latvia at a scale of 1:50000.

Pollen preserved in the deposits provides a valuable record of vegetational changes and hence an insight into the palaeo-environmental change. Eight pollen zones have been distinguished in the pollen sequence corresponding to the Eemian (Felicianova) Interglacial. The composition of the pollen flora indicates a warm climate with some oceanic influence (presence of Hedera and Brasenia), which is characteristic of the Eemian Stage in this region. Despite varying sedimentation conditions (marine and lacustrine), the regional vegetational history shows the same general succession in the sequences studied. The regional pollen zones for the Felicianova (F)/Eemian Interglacial are as follows: Betula+Picea (F1)-> Pinus (F2)-> Ulmus+Quercus (F3) ->Alnus+Corylus (F4)->Tilia (F5)->Carpinus (F6)->Picea (F7)->Pinus+Betula (F8).

Shrub and herb dominant pollen zones occur both preceding and following the interglacial pollen assemblages in pollen diagrams, both in the eastern and western part of the mainland and in the Gulf of Riga area. After the Eemian, a long period of periglacial conditions followed during the Early Weichselian (Latvia), during which at least two interstadial warm events have been identified.
A LUMINESENCE AND AMINO-ACID DATED IPSWICHIAN (EEMIAN) SEQUENCE FROM DEEPING ST JAMES, LINCOLNSHIRE, UK

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Pollen, plant macrofossil, molluscan and coleopteran data from organic muds below the low terrace of the River Welland at Deeping St. James, Lincolnshire indicate deposition in the mixed oak forest phase of a Late Pleistocene interglacial. Coleopteran and molluscan data suggest summer temperatures up to 4°C warmer than at present in eastern England, and plant macrofossil material suggests a climate more continental than that of Britain in the Holocene. However, no direct analogue of this biota exists currently in Europe. Biostratigraphic indications from the pollen and Mollusca suggest an age in the Ipswichian (Eemian) stage. Thermoluminescence dates between 120 ka and 75 ka, and amino-acid ratios with a mean of 0.11 show that deposition of the sediments took place during Oxygen Isotope Stage 5. This dating of a partial Ipswichian succession allows discussion of the true ages of a number of other interglacial sites in eastern England of assumed Ipswichian age.
37 IPSWICHIAN INTERGLACIAL DEPOSITS AT SHROPHAM, NORFOLK, UK: MOLLUSCAN, COLEOPTERAN AND STABLE ISOTOPE RECORDS OF A COMPLETE IPSWICHIAN SEQUENCE

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Fluvial and lacustrine sediments from the valley of the River Thet at Shropham, Norfolk contain a record that spans, with short gaps, the whole of the Ipswichian Interglacial. Molluscan evidence using conventional environmental reconstruction techniques, stable isotope analysis of molluscan calcite, and coleopteran evidence using the Mutual Climatic Range method, allow the reconstruction of Ipswichian temperatures and thus part of the climate for the Interglacial.

The basal part of the succession contains arctic/alpine Mollusca, cold climate Coleoptera and δ¹⁸O values indicative of cold temperatures. The δ¹³C values suggest poorly developed vegetation, although some aquatic molluscan taxa dependant on macrophytic vegetation are present. Above the basal levels, rapid warming into the interglacial occurred. The evidence from Mollusca, Coleoptera and stable isotopes are all accord in registering this climatic amelioration, although the Mollusca indicate this by an increase in numbers of individuals rather than a change in species composition. Because of a decrease in stream flow accompanying climatic warming, the increase in coleopteran species diversity is attended by a decrease in numbers of fossils. The cause of this is indicated by a change in the molluscan species present, which become restricted to aquatic and marsh species which lived in or close to the channel showing that the recruitment of species from more distal environments in floods had nearly ceased. Enrichment values for δ¹⁸O are around 1.5‰, which although indicative of increased warmth are lower than values recorded at the last glacial/interglacial transition.

The middle of the sequence marks the optimum of the interglacial. At this level there is a contrast between the evidence from the Mollusca and the Coleoptera. Mutual Climatic Range data suggest summer temperatures of 18-20°C, but the appearance of the most thermophilous species of Mollusca such as Belgrandia marginata, is somewhat delayed beyond the establishment of fully warm conditions, probably due to the time lag accompanying immigration from refugia to the S. The full climatic optimum is however marked by accord of the evidenci from all three proxies.

The climatic deterioration at the end of the interglacial has a record which is not immediately easy to interpret. The first indications of cooling temperatures is registered by the stable isotopes, closely followed by the Coleoptera, but the Mollusca continue to indicate temperate conditions. Indeed even while δ¹⁸O values increase indicating cooling temperatures, the numbers of molluscan species rises to include many more land taxa, a feature which might be Qthought to represent a rise in temperature. As this rise in molluscan numbers is accompanied by sedimentological evidence for a more vigorous fluvial regime it is probable that an actual decline in temperature allows recruitment of molluscan fossils from a wider range of habitats during bigger floods. All three proxies are in broad agreement about the end of the interglacial with the first appearance of arcc/alpine Mollusca and northern Coleoptera being accompanied by stable isotope values indicative of severe climatic cooling.
INITIAL EVIDENCE OF THE SMALL MAMMAL FAUNA OF THE EARLY UPPER PLEISTOCENE IN FORE-BAIKAL REGION (RUSSIA)

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The first Eemian small mammal fauna in the Fore-Baikal region was obtained from the Igeteisky Log site (Bratsk reservoir of the Angara River) in Kazantzevsevo soil complex. The fauna includes Amphibia gen. et sp. and small mammal species such as Ochotona sp., Lagurus lagurus, Microtus gregalis and M. oeconomus. The species composition indicates a steppe landscape.

From the late Middle Pleistocene deposits at any other site of the Igetei archaeological complex - Igetei site - a different small mammal fauna of tundra-steppe character has been defined: Spermophilus sp., Dicrostonyx cf. simplicior, L. lagurus and M. gregalis.

In the late Pleistocene deposits (dated at 21,000 B.P.) at the Mal'ta site on the Belaja river the fauna of tundra-steppe has also been found. It includes: O. pusilla, S. undulatus, L. lagurus, D. cf. henseli, M. gregalis, M. oeconomus and M. middendorffii.

In the latest Pleistocene deposits (12,000-10,000 B.P.) of the Bolshoi Jakor site in the Vitim river the tundra-forest-steppe fauna includes: O. hyperborea, Marmota sp., S. cf. parryi, Clethrionomys rutilus, C. rufocanus, Lemmus sibirica, Myopus schisticolor, M. gregalis, and M. middendorffii.

Thus, there are four fossil small mammal associations known from the late Middle - Upper Pleistocene in the Baikal region; the Eemian fauna being the only one indicating the warmer climatic conditions.

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MARINE EEMIAN IN THE DANISH REGION

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Marine deposits spanning the Late Saalian through the Eemian and into the Early or Middle Weichselian are found at several sites in the northern part of Denmark, where a deep, SE-NW trending basin formed a branch of the Norwegian Trench during this period. This structurally controlled basin is mainly infilled by marine sediments from the Late Quaternary.

The extremely thick Eemian succession (Oxygen Isotope Substage 5e) found here, allows high resolution studies of the palaeoecological development of the area. Benthic foraminiferal assemblages and stable isotopes from three new boreholes provide evidence for major environmental and hydrographic changes during the Eemian. After an initial Younger Dryas-type climatic fluctuation, there was a gradual warming and the temperature conditions prevailed higher than at present in the area during most of the interglacial. However, these warm conditions were interrupted by two periods of decreased water temperatures. Similar rapid climatic fluctuations within the Eemian (substage 5e) have also been registered both in the Norwegian Sea and in the southern Greenland Sea. The Eemian climatic fluctuations seem to be closely related to changes in the North Atlantic circulation pattern, and they were probably caused by variations in the strength and/or the position of the North Atlantic Drift. A possible marine connection from the Baltic through to the White Sea during the Eemian may also have contributed to a modified regional circulation system.

Low-lying coastal areas of Denmark were flooded during the maximum transgression of the Eemian. In contrast to the complete Eemian record, which is represented in the deeper water shelf deposits in northern Denmark, these shallow water deposits only represent part of the interglacial. The deposits occur in situ in SW Denmark and NW Germany, while they are found dislocated by glacier ice in coastal cliffs along the Baltic coasts. Some of the sections represent an early stage of the Eemian including the transition from non-marine to marine deposits, while others represent a final stage of the interglacial. The palaeoenvironmental changes and the stratigraphy are described on the basis of foraminifera, ostracods and pollen. Shallow marine Eemian is also recorded in borings from the North Sea.
40 A REAPPRAISAL OF THE DURATION OF THE EEMIAN STAGE IN CENTRAL RUSSIA USING LAMINATED LAKE SEDIMENTS: PRELIMINARY RESULTS

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The problem of duration of Eemian Stage interglacial can be estimated using laminated lake sediments. Outcrop of Eemian lake sediments at Cheremoshnik near Rostov (central Russia) was recently sampled. Cheremoshnik has already an Eemian pollen sequence that was published by Grichuk in 1948. The lake sediments comprise annually laminated gyttja deposits. These laminations have been counted to determine the duration of the interglacial event. The first results of age counting suggest a longer chronology for the Eemian in central part of European Russia than previously thought.
U-SERIES RADIOMETRIC DATING OF MOLLUSCS FROM EEMIAN DEPOSITS IN THE AMSTERDAM BASIN

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We present the results of a 238U-234U-230Th radiometric dating study on bivalve molluscs from the Eemian transgressive deposits in the Amsterdam basin. Our objective is to provide precise ages for the development of this part of the Eemian stratigraphy in the Netherlands. Fine lagoonal to inter-tidal sediments were deposited during the E4b to E5 pollen zones of the Eemian at the location of the Amsterdam Terminal drill-core. These sediments contain well-preserved specimens of the bivalve molluscs Corbula gibba between ~55m and ~37m below surface and Venerupis aurea senescens between ~33m and ~29m.

The 238U-234U-230Th isotope series is the only absolute means of determining mineral and fossil ages beyond the radiocarbon chronometric range over the period from 0 to 350 ka. Thermal ionization mass spectrometry allows to measure samples with concentration ranging from a 100 picogramme of 238U to femtograms of 234U and 230Th, e.g. <0.5 g of carbonate shells. As with other chronometric tools some prerequisites apply. Ideally, besides a significant quantity of 238U, the sample should contain near-zero initial concentration of the daughter isotope 230Th. Also the sample should behave as a closed system, i.e. no loss or addition of 234U, 236U or 232Th after formation of the sample. However, in most non-ideal cases corrections can be applied for detrital additions.

Several shell fragments of Venerupis aurea senescens from a sub-surface depth of 29.9 m were thoroughly cleaned by repeated agitation in ultra-pure methanol and milli-Q water using an ultrasonic bath, thereby removing organic matter and clay from the shell’s surface. Preliminary results from concurrent leaching and total-dissolution experiments on these shell fragments with 1N ammonium-acetate (pH 6.8), 2.5N acetic acid (HOAc) and 7N nitric acid (HNO3) indicate a heterogeneous, but systematic, distribution of uranium and thorium. The ammonium-acetate leach contains 1137 ppb 238U, the ensuing leach with 2.5N HOAc contains 305 ppb, and the final dissolution in 7N HNO3, 164 ppb. Conversely, 232Th concentrations range from 321 ppb in the ammonium-acetate step, 254 ppb in the HOAc-leach and 55 ppb in the final dissolution in HNO3. Total dissolution in 7N HNO3, without prior leaching resulted in a 238U concentration of 205 ppb and a 232Th concentration of 67 ppb, which agrees excellently with the total sum of the leaching results. Ongoing duplicate measurements on other shell-fragments from the same sample level show similar results.

The presence of 232Th indicates that the shells contain, additional to 230Th produced in situ, an amount of detrital 230Th (~10%). Furthermore, high initial 234U/238U (d234U=335) suggests that either non-marine conditions prevailed in the basin where the molluscs grew (since marine d234U=144), or that the shells underwent significant 234U addition during diagenesis. The negative trend between [234U] and d234U suggest that any diagenetic addition of uranium would lower the 234U/238U, therefore we conclude that the observed dis-equilibrium is original. Preliminary calculated ages for the measured sample range from 136.2 ka uncorrected and 117.2 ka corrected for the detrital 234U addition.
THE KAZANTSEVO (EEMIAN) EPOCH IN THE SHELF SEQUENCES OF THE FAR EASTERN SEAS OF RUSSIA

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Palaeogeographical investigations in the Far Eastern shelves of Russia are based on detailed stratigraphical study of the deep drill cores recovered at the depths of 16 to 85 m. The core length was up to 55 m. This allowed us to obtain abundant data used for correlation of palaeogeographical events within shelf areas of the Sea of Japan, Sea of Okhotsk and the Tartar Strait connecting these seas. In all shelf sequences sediments corresponding to the first Late Pleistocene interglacial are represented by marine beds accumulated during vast transgression (Kazantsevo=Eemian) under warm, warmer than present, climatic conditions. Initial stage of the transgression in the shelf sequences is manifested by the sediments of marine ‘cold’ formation of brown pebbles corresponding in age to the end of the Middle Pleistocene. The sea waters penetrated far inland along river valleys of the outer shelf.

Beginning of the Late Pleistocene was marked by considerable climatic warming and further sea level rise. In the optimum stage of the transgression sea level exceeded its present position by 3-7 m, and the coastal marine terrace was formed. Coastal vegetation was represented by birch and broad-leaved forests in Primorje and dark coniferous fir-spruce taiga in Western Kamchatka. Diverse and abundant diatoms and foraminifers indicate the average annual temperature of the surface sea water to be by 2-3°C higher than the modern one, and salinity to be normal (about 34). However, the optimum stage of the first Late Pleistocene interglacial was characterized by several climatic oscillations (coolings) which were practically simultaneously reflected by composition of pollen spectra as well as by diatom and foraminiferal assemblages of shelf deposits of the vast area stretching from Primorje to Kamchatka. The final stage of the Kazantsevo warming coincided with relative cooling (predominance of coniferous and broad-leaved forests in Primorje) and gradual sea level fall manifesting beginning of the first Late Pleistocene regression. Reconstructions of the palaeogeographical events of the main Late Pleistocene interglacial within the Sea of Japan and the Sea of Okhotsk shelves revealed them to be synchronous to the global processes. Hence, they are well correlated with continental and oceanic events.
43 GEOLOGICAL-PALÁEOECOLOGICAL EVENTS OF THE MIKULINO (EEMIAN) INTERGLACIAL IN EUROPEAN RUSSIA

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The Mikulino interglacial stage of European Russia was characterized by a range of palaeoecological events.

1. A vast land area was covered by the sea during the Mikulino transgression, which was caused by neotectonic movements in the northwestern area of the region. Along the line of the Gulf of Finland-Lake Onega-Lake Ladoga-White Sea there a system of grabens developed, which formed a strait connecting the Arctic and Atlantic basins. Scandinavia was a large island at this time. Oxygen-isotope analysis suggests the positive temperatures for the bottom water in the Arkhangelsk area. The mixed arcto-boreal marine fauna was dominated by marine biota of Atlantic origin.

In the south of the region, the Karagantian transgression of the Black Sea and the Late Khazarian transgression of the Caspian Sea.

2. In the central part of the European Russia, lacustrine-marsh deposits were widespread, thus indicating a highstand of ground water and intensive bog formation.

3. The submeridional and sublatitudinal profiles of vegetation changes show specific regional landscape successions during the climatic optimum.

4. The major part of European Russia was affected by Atlantic air masses, while the Arctic influence was minor. The penetration of the Iran-Turan air masses into the southeastern part of the region gave rise to desertification processes.

5. The Moustierian archaeological sites of Mikulino age, as well as specific faunal assemblages of large and small mammals are confined to the southern part of the region.

6. The global climate warming, extensive marine transgressions, active bog formation and palaeoatmospheric events were factors that promoted the unique natural environments.
FORAMINIFERAL FACIES OF THE EEMIAN IN THE TYPE AREA


Substantial thicknesses of Eemian sediments are found in the central part of The Netherlands, where the Saalian ice-mass had left behind a series of deep depressions. Three cored bore-holes from the Amsterdam basin were studied for their foraminiferal content and a comparison was made with the Eemian stratotype (Amersfoort-1), which is located in the adjoining Flevoland basin. Facies analysis shows that the depositional history is similar at all locations and that Amersfoort-1 represents a site of relatively shallow depositional depth. Marine sedimentation lasted from the Corylus phase (E4a) till at least a late stage of the Carpinus phase (E5). Open marine conditions never prevailed, and the faunas bear evidence of a restricted marine, quasi-lagoonal setting. The most detailed record is provided by the sites in the Amsterdam basin. The oldest fauna is a poor and heterogeneous suite of species, probably transported in by the sea. It is followed by autochthonous low-diversity faunas in which Elphidium albiumblicatum, E. excavatum selseyense and Buccella frigida alternately predominate. These associations are thought to record deposition in a salinity-stratified lagoonal setting. Higher up E. albiumblicatum and B. frigida successively disappear which reflects a change to more homogeneous and more saline waters. Depositional depth increased and in the lowermost part of the Carpinus Zone (E5) the faunas almost exclusively consist of E. excavatum selseyense. Higher up in the Carpinus Zone, a return to shallower conditions is recorded. The shallowing is coupled with a change of hydrodynamic regime as the sites came under the direct influence of the tides. The youngest faunas are similar to modern Waddensea associations and record deposition in an actual coastal lagoon.
BOREHOLE AMSTERDAM-TERMINAL: EEMIAN SEDIMENTS, FACIES AND DATING

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Amsterdam-Terminal is a cored bore-hole made in 1997 at the southern end of the Amsterdam basin. The basin is one of a series of depressions created by the Saalian ice-mass in the central part of The Netherlands and was a major area of deposition during Late Saalian and Eemian times. The bore-hole was made as an additional reference section for the Eemian. The sedimentary record was expected to be more continuous than in Amersfoort-1, the stratotype for the Eemian.

An odd forty metres of Eemian sediments were penetrated and core-recovery appeared to be exceptionally good. The cores are being studied by a wide array of disciplines. Age control is as yet only provided by pollenanalysis. The results of U-Th and stable isotope analysis are to be expected soon. Amino-acid and TL analysis is planned. The complete section is normally magnetized.

Integrated facies analysis resulted in a detailed reconstruction of the depositional history during Late Saalian and Eemian times. At the end of the Saalian a shallow lake existed in which diatom-rich silts and sands were deposited. The lake rapidly deepened at the beginning of the Eemian and slightly less than 1.5 m of diatomites were deposited during the E1-3 phases. Deposition of diatomite continued until the early Corylus-phase (E4a), but the environment was no longer strictly lacustrine because the sea occasionally entered the basin. Shortly after, the deposition of diatomites ended and the basin came under the permanent influence of the sea. A restricted marine, lagoon-type of environment came into being in which clays rich in organic matter were formed. Initially the watercolumn had a strong salinity-stratification which led to oxygen deficiency and adverse bottom conditions. As the influence of the sea increased, the salinity contrast gradually diminished, the conditions at the bottom improved and foraminifers and molluscs could live at least periodically on the basinfloor. Exchange of water with the open sea intensified and at the very beginning of the Taxus-phase (E4b) there is no longer an actual brackish water-layer at the surface. A weak salinity-stratification seems to have existed for some time, but well before the end of the Taxus-phase it had disappeared completely.

Hitherto the changes in the environment were coupled to an increase of waterdepth, the common cause of which is to be found in a rising sea-level. Depositional depth reached an apparent maximum early in the Carpinus phase (E5) and thereafter a shallowing trend set in which culminated in the deposition of sands in tidal channels during a late stage of the Carpinus-phase. The details of the depositional history during this part of the Eemian are as yet poorly understood.
RAPID, HIGH AMPLITUDE TEMPERATE OSCILLATIONS DURING THE EEMIAN?

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The Eemian (Oxygen Isotope Stage 5e) is the best known interglacial stage of the Pleistocene in Europe. There are more than a hundred Eemian sites in the Netherlands, Denmark, Germany and Poland. A large number of these sequences have been carefully investigated by pollen and macrofossil analyses so that our knowledge of the vegetation and climate history of the last interglacial in this region is unequalled in any other part of the world. Recent investigations of the ice cores from Greenland have led to some controversy concerning the palaeoclimatic development of the Eemian. The most spectacular features of the stable oxygen isotope record from the GRIP ice core at Summit are the rapid, high amplitude temperature oscillations reconstructed not only for the Early Weichselian Of Substages 5a to 5d but also for Substage 5e. However, it is noteworthy that the climatic shifts in the Substage 5e, found in the GRIP core, do not have close parallels in neither the GISP 2 ice core at Summit nor the deep sea oxygen isotope curve and the North Atlantic sediments. Furthermore, the Eemian part of the GRIP record sharply contrasts with combined palaeobotanical and oxygen isotope results from Gröbern (Germany) that indicate, apart from the beginning and the end, the last interglacial was characterized by a relatively stable climate. This is in accordance with most of the terrestrial pollen records from Europe that suggest that the Eemian was an uninterrupted warm period. It must be stressed that continental sequences, at least from north-west European Eemian sites, have the advantage over the ice core records by having clear biostratigraphical definitions of the pollen zones which can easily be correlated with each other.
47 OCEANOGRAPHIC CHANGES IN THE NORTH ATLANTIC DURING TERMINATION II - EEMIAN: COMPARISON WITH THE LAST DEGLACIATION

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Our study of sediments from 140-100 ka and the past 20 ka at two North Atlantic piston core sites (45N/25W and 53N/20W) is based on multispecies stable oxygen and carbon isotope records. It allows for a detailed palaeoceanographical reconstruction of Termination II-Eemian and Termination I-Holocene.

During Termination II, a Heinrich event occurred during its second (major) step, and the establishment of North Atlantic Deep Water (NADW) production and seasonal upper water column stratification are associated with the end of the deglaciation. During Termination I, these events are related to its first (major) step.

During the Eemian, NADW production remained stable. Surface waters reached maximum primary production, highest temperature and strongest stratification occurred after the Eemian Stage maximum. Oxygen isotope data show that the Eemian oceans were warmer than those of the Holocene. At about 119 ka BP, surface water began changing towards the glacial conditions of OI Substage 5.4 (decrease in primary production, isotopic temperatures, stratification index and corresponding changes in calcareous nannoplankton assemblage).
EEMIAN SMALL MAMMAL FAUNAS OF THE RUSSIAN PLAIN

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In last years the several localities of small mammal remains, connected with eemian deposits were found in the central and southern parts of Russian Plain (Agadjanian, Erbaeva, 1986; Kalinovski, 1983; Markova, 1975, 1986; Markova, Milhailesku, 199; Motuzko, 1985). These localities are found in the different taphonomical conditions: in the deposits of Mezin soil complex, which was formed during Mikulino (Eemian) Interglacial and the first Interstade of Valdai glaciation: Gadiach locality (Dnieper basin) and Mikhailovka 5 locality (Svapa basin); in fluvial deposits of Don-River (Shkurtlat locality), Seim-River (Malyutino locality), Neman-River (Timoshkovichi locality), Zapadnaya Dvina-River (Borisova Gora locality), etc.; in liman deposits of Black Sea (Novonekrosovka locality). The northern of the discovered localities are situated on the 58 N, the southern - on 45 N.

The typical features of the species composition of these faunas are the presence of bone remains which are very close by morphology to modern ones: Arvicola cf.terrestris (with slightly positive differentiated enamel), Clethrionomys glareolus, Lagurus cf.lagurus, Eolagus luteus, Microtus (Terricola) subterraneus, Microtus (Microtus) arvalis, M.(Microtus) agrestis, M.(Pallasimius) oeconomus, M.(Stenocranius) gregalis et al. The forest species prevailed in the northern part of Russian Plain, the steppe ones - on the south of Eastern Europe.

The evolitional level of diagnostic species permit to correlate the localities which have been found in the different part of Russian Plain and in the different taphonomical conditions. These materials could be the basis of the correlations between the Karangat marine deposits of Black Sea and the continental ones, first of all the time when the horizon of the Mezin soil was developed. So it is possible to correlate the principal event on the Russian Plain and the Black Sea basin.
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EEMIAN RIVER VALLEYS IN CENTRAL POLAND

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The fluvial pattern of the Eemian interglacial presented is the most complete and critically revised collection among the available information. It is reliably related to the assumed water level of the Eemian Baltic Sea in the Lower Vistula region. Previous information on fluvial sediments of the Eemian Interglacial in central Poland has only occasionally been mentioned in regional monographs and short communications. A little more data have been however supplied by geological mapping during the last 30 years.

Most Eemian interglacial fluvial sediments in central Poland are located close to and within the present Vistula valley. They fill an ancient river channel that widens in vast basins at the mouths of larger tributaries e.g. the Pilica River. In the Vistula gap, 120 km upstream of Warsaw, the depth of fluvial erosion during the Eemian was considerably dependent on the bedrock lithology. Where the bedrock is composed of Upper Cretaceous gaizes and limestones, the palaeovalley is relatively narrow (1-2.5 km) and is incised to about 115 m a.s.l. (i.e. 5 m below the Holocene bed) only at mouth of the Kamienna River and 105 m a.s.l. at Pulawy. The lithology of the bedrock changes downstream, firstly into the more easily eroded Palaeocene gaizes and sands, then into Oligocene and Miocene sands. Therefore, the Eemian river bed drops to 85 m at Dęblin and 80 m a.s.l. at Koźmin, where the palaeovalley continues to become even wider. Further to the north, the Eemian fluvial sediments are underlain by fluvial sands of Mazovian interglacial age but occasionally they also lie directly on Pliocene clays (especially beneath Warsaw and to the south of the city).

Below Warsaw, the buried Eemian fluvial sediments occur at 72-65 m a.s.l. Downstream of the city, the main river received a tributary of the pre-Narew River from the east. In the north-central Poland the bed of the Eemian sediments occurs at 60-54 m a.s.l. The general agreement of the modern and the Eemian fluvial network in this area is disturbed in the Plock Basin where no Eemian sediments of the pre-Vistula are found. The Eemian fluvial sediments appear however again in the Toruń Basin, where their bed is at about 58 m a.s.l.

The Eemian drainage pattern in central Poland is roughly reflected by that today, with its main northern watershed in the southwestern Mazury Lakeland. This pattern therefore follows the fluvio-periglacial drainage system developed at the end of the Warta Glaciation and only partly modified by the meltwaters from the last glaciation. No convincing evidence for neotectonic movements are provided, except for the Pulawy region where the Tertiary structural movement were presumably reactivated during the Quaternary.

Similar fluvial patterns developed during successive interglacials in the Polish Lowland and mid-central Poland acted as junction of a fluvial system during the Quaternary. The Eemian fluvial sediments are also present in tributary valleys to the Vistula, e.g. the valleys of the Węgrzyn, Pilica and Narew rivers. The present landscape of central Poland developed during the decline of the Warta Glaciation but was then subjected to considerable transformations, due to widespread ice-dam deposition and vast ice-marginal streamway erosion and deposition during the Vistulian Glaciation. Misunderstandings of the age and patterns of the Pleistocene rivers have resulted mainly because of the lack of credible dating methods but also from the varying opinions on the number of glaciations and interglacials during the Quaternary.
BOREHOLE AMSTERDAM-TERMINAL: MOLLUSCAN ANALYSIS OF THE EEMIAN TYPE AREA

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The Eemian stratotype is defined in The Netherlands in the Eem Valley in the city of Amersfoort. Obviously, the Eemian in Amersfoort is not complete and therefore it was necessary to designate one or more parastratotypes. The infill of the Amsterdam glacial basin was selected as one of these. After a preinvestigation the locality was selected for a cored research borehole which was successfully drilled in 1997. This borehole, named 'Amsterdam-Terminal-25E913' has been subjected to a multidisciplinary investigation. Between 28.00 and 62.00 meters below surface 43 samples were analysed for their molluscan content.

The molluscan analysis of these samples provided the following results:
All samples show assemblages from different marine environments, only in the upper three meters additionally several non-marine species occur in low numbers.
The sequence may be subdivided into three main zones, each of which can be subdivided into smaller units. The main zones are characterised by molluscan assemblages pointing to:
- well vegetated, shallow and lower saline conditions in the lower zone,
- less to non-vegetated, deep and euhaline conditions in the middle zone,
- well vegetated, shallow and lower saline conditions in the upper zone.
In the molluscan assemblages cold indicators are virtually missing, warm species on the contrary are present from bottom to top. Species considered to be characteristic of an Eemian age in the North Sea Basin are e.g. Acanthocardia paucicostata, Modiolus adriaticus, Mytilaster lineatus, Venerupis aurea senescens, Gastrana fragilis, Parvicardium exiguum, Bittium reticulatum, Turboella radiata balkei, Hinia pygmaea, Hyala vitrea etc.
The designated zones are the expression of the rise in sea level and the subsequent shallowing of the basin by sedimentation. The upper zone probably reflects also the lowering of the seal level in the second part of the interglacial.
The sequence investigated in borehole Amsterdam-Terminal is characteristic of the deeper parts of the Amsterdam glacial basin where a clayey facies predominates. Essentially the same assemblages were found in borehole Beursplein-25G943, although there only the upper part of the same sequence is present.
Near the margins of the basin the facies is more sandy and the encountered assemblages differ considerably from those described of Amsterdam-Terminal-25E913. In these places intertidal assemblages are found, even with elements living near high tide level and still higher from the supralittoral zone. This was found in boring Zunderdorp-25E344. Characteristic supralittoral to high sublittoral species found in the deposits of this boring are: Liatorina littorea, Peringia ulvae, Bittium reticulatum, Retusa obtusa, Ovatella myosotis, Acanthochiton fasicularis, Abra tenuis etc.
From this latter borehole amino acid razemisation data were published (Miller & Mangerud, 1985).
Additional ratios have been obtained last year from Macoma balthica. Of this species two different sets of ratios are present. Between 24.00-29.00 m a mean D/L-ratio of 0.116 was obtained, while between 35.00-29.20 m D/L-ratios vary between 0.176-0.189.
AMINOSTRATIGRAPHICAL DATA FROM LATE AND MIDDLE PLEISTOCENE DEPOSITS IN THE NETHERLANDS [POSTER]

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Amino acid D/L ratios are presented from the Netherlands. Datasets are given of the following marine and fresh water molluscan species: *Valvata piscinalis, Valvata naticina, Corbicula fluminalis* s.l., *Spisula subtruncata, Macoma balthica, Macoma calcarea* and *Macoma obliqua*. The largest dataset is provided by *Macoma balthica*, which set is used as the basis for an aminostratigraphical framework of the Netherlands. The different datasets are connected by samples from which more than one molluscan species was analysed.

Based upon frequency counts clusters of ratios are recognised which can be grouped into at least 6 'zones'. These zones are:

A: Weichselian and Holocene; several localities.
C: *Corbicula*-bearing deposits in the South-west of the Netherlands.
D: Belvédère Interglacial; localities: Belvédère and Fransche Kamp.
E: Holsteinian; locality: Neede.
F: Cromerian, 4th Interglacial; locality: Noord Bergum.

An important result is the assignment of Dutch *Corbicula* bearing beds to an interglacial older than Eemian. This species is present in parts of the 'Schouwen deposits' which were thought to date from the Eemian. Now it is clear that this deposit is, at least partly, older than this interglacial.
52 SOME FEATURES OF THE LOWER BOUNDARY OF UPPER PLEISTOCENE LOESS FORMATION IN THE UKRAINE

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The lower boundary of the Upper Pleistocene loess formation in Ukraine was fixed till now at either the base of Udaiskii (W1), or the Pryluki (R-W) horizons. The latest investigations of the loess formation profiles have allowed the solution a number of problems including that of the lower boundary of the Upper Pleistocene. The beginning of this phase is placed at the base of the Pryluki Horizon. From the north to the south in the Ukraine it is represented by the brown forest soils, meadow-steppe chernozems, rich chernozems, southern chernozems and chestnut soils. The soils have wellstructured vertical (genetic) profiles, sometimes with two fossil soils (Pedocomplex) being found. The thickness of the Pryluki soils varies from 0.8 m. to 1.2 m. They can be traced over vast areas being clearly distinguished from the other soils in a profile. These features make the Pryluki soils a clear marker horizon and they are widely used for a stratigraphic subdivision of the loess formation sediments.

The Pryluki Horizon has a diverse, characteristic pollen assemblage. In the northern part of Ukraine the pollen of tree-species are predominant, including Pinus sylvestris, Picea abies, Betula verrucosa, Alnus incana, Carpinus betulus, Tilia cordata, Quercus robur and Juglans regia, whereas in the southern part the pollen of grasses (Poaceae, Chenopodiaceae, Artemisia and Lamiaceae) predominate. Over 60 species of terrestrial molluscs have been found in the Pryluki fossil soils. They include warmth-loving species Bradybaena fruticum, Perforatella bidens, Pupilia sterri, Gastrocopta theeli, Truncatellina cylindrika, Cepaea vindobonensis, Helicella candicans, Zebrina detrita, and Helicigona banatica.

Physical methods indicate that the Pryluki Horizon was formed between 110-80.000 years ago, during a typical interglacial period with the climate of somewhat warmer and more humid than today. The zonality of the landscape (with the forest, steppe-forest and steppe zones) during the Pryluki time was rather a simular to that at present. The forest and steppe-forest zones were located slightly farther South than now.

The Pryluki Horizon (pl) possibly corresponds to the Mikulino Horizon in Russia, PK (Pedocomplex) III in the Czech Republic; soil complex MB (Mende-Basis) in Hungary and Gl 1 (Gleba interglacjaina) in Poland.
53 RECONSIDERING THE PEDO-CLIMATOLOGICAL SIGNAL OF THE LAST INTERGLACIAL AND EARLY GLACIAL IN THE EURASIAN LOESS BELT

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In order to reconstruct the pedo-climatological signal and chronostratigraphical sequence for the Last Interglacial and Early Glacial loess-palaeosoil deposits in continental and pre-atlantic regions, soil characteristics from 6 key-sites have exhaustively been examined. These 6 key-sites - from a total set of 18 studied sites - are situated in Belgium, Germany, Czechia, Russia, Siberia and Tadzhikistan. Examination of the spatial and temporal variability of the pedo-features at macro-, meso- and microscale added new data to the stratigraphical record.

In general variability of the soil forming processes increased at the preatlantic sites. Pedogenesis at these sites may fall within the range soil classes: Luvisol - Cambisol -Greyzem - Chernozem. Also a large dilatation of the profile improves the unravelling of the pedosedimentary evolution. Particular geomorphologic positions, such as dells, depressionS, bottom slope positions, are favourable, in contrast to the poor plateau positions.

Examination of the profiles allowed to postulate at least 14 pedosedimentary phases, which embrace the full 180-stage 5. The 14 pedosedimentary phases at these key-sites are summarised in Table 1.

<table>
<thead>
<tr>
<th>Phase</th>
<th><em>O</em>-stage</th>
<th>Belgium</th>
<th>Germany</th>
<th>Czechia</th>
<th>Russia</th>
<th>Siberia</th>
<th>Tadzhikistan</th>
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<td>Loess</td>
<td>Loess/River Terrace</td>
<td>Loess</td>
<td>Loess</td>
<td>Loess</td>
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<td>5e</td>
<td>Luvisol</td>
<td>Luvisol</td>
<td>Luvisol</td>
<td>Luvisol</td>
<td>Chernozem</td>
<td>Typical Cinnamon</td>
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<td>12</td>
<td>5d</td>
<td>Permafrost</td>
<td>?</td>
<td>?</td>
<td>Freezing and thawing</td>
<td>Loess</td>
<td>?</td>
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<tr>
<td>11</td>
<td>'Luvisol'</td>
<td>?</td>
<td>?</td>
<td>'Luvisol'</td>
<td>Kastanozem/ Phaeozem</td>
<td>?</td>
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<td>?</td>
<td>?</td>
<td>Erosion/ sedimentation</td>
<td>Frostcreep/ sedimentation</td>
<td>Sedimentation</td>
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<td>Greyzem</td>
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<td>Greyzem-like soil</td>
<td>Chernozem</td>
<td>Accretionary Serozem</td>
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<tr>
<td>8c</td>
<td>Erosion and local deposition</td>
<td>Local deposition</td>
<td>Local deposition</td>
<td>Local deposition</td>
<td>Surface crusting and local deposition</td>
<td>Serozem</td>
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<tr>
<td>8</td>
<td>5c</td>
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<td>Local deposition</td>
<td>Chernozem</td>
<td>Humiferous soil/sediment</td>
<td>Humiferous band</td>
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<td>Chernozem</td>
<td>Chernozem</td>
<td>Humiferous soil/sediment</td>
<td>Humiferous band</td>
<td>Accretionary Serozem</td>
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<td>6</td>
<td>Frostcreep</td>
<td>Freeze-thaw features</td>
<td>?</td>
<td>?</td>
<td>Local sediment</td>
<td>Erosion/ sedimentation</td>
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<td>5</td>
<td>Sub-Arctic soil</td>
<td>?</td>
<td>?</td>
<td>Humiferous soil/sediment (?)</td>
<td>Humiferous band</td>
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<td>1</td>
<td>5a</td>
<td>Faint clay illuviation</td>
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<td>Chernozem</td>
<td>Sub-Arctic soil</td>
<td>Serozem</td>
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</table>
54 STRATIGRAPHY AND CORRELATION OF THE LATE PLEISTOCENE CONTINENTAL AND MARINE SEDIMENTS FROM THE NORTH-WEST COAST OF THE BLACK SEA

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The hinterland of the north-west coast of the Black Sea (South Moldova and South-West Ukraine) is of great interest for investigations of the stratigraphy and Late Quaternary palaeoclimate. This region has important advantages for intercorrelation of marine and continental sequences. Numerous outcrops of the Late Pleistocene deposits and multilayer archaeological sites have provided very reliable palynological and palaeozoological data for the reconstruction of the Eemian and Last Glacial landscapes in the periglacial zone.

The principal task of the investigations presented here consisted of complex biostratigraphical studies of the lacustrine marine and subaerial sediments. In this region Quaternary deposits are accessible for investigation because there are abundant fine natural outcrops and boreholes. Over 30 outcrops and boreholes of marine, lito-marine, alluvial and subaerial deposits have been investigated. The main part of the sections are very representative because the involve a large number of fossil soils and also alluvial and lito-marine deposits rich in fossil remnants of stratigraphically important palaeontological groups, i.e. small mammals and molluscs together with brackish- and freshwater molluscs, and occasionally ostracods and foraminifera. The well-developed system of the Pruth, Danube and Dniester terraces, allows the subdivision of sediments not only using palaeontological remains, but also by their altitudinal position.

During recent years, an intensive field search has been undertaken for new localities of Late Pleistocene terrestrial and malacofauna in lacustrine and alluvio-deltaic deposits of the Danube, Pruth and Dniester lower reaches. This has resulted in the discovery of several rich small mammal and molluscan localities (e.g. the sites Novonekrasovka, Plavni, Cahul, Limanskoe and Dzyrdzuleshty) and has provided additional palaeontological material from the previous known sites. The richest molluscan and mammalian remains have been found in the Danube lower reach, where the Black Sea transgressions repeatedly penetrated. This has led to the formation of vast semi-isolated lagoons, the deposits of which are preserved in the Danube mouth terraces and in the shore-lines of the recent Danube lagoons. Lagoonal deposits represent a connecting link between continental and marine sequences. Thus, the palaeontological evidence is especially important for the correlation of the marine and continental sequences.

A great number of regional palynological evidence has allowed reconstruction of the regional vegetation of the Late Pleistocene. During the Eemian a wide diversity of mesophylyous grasses were present. Forests spread mainly on floodplains and slopes of the rivers valleys. The species of broad-leaved trees and shrubs such as Fagus, Quercus, Corylus, Tilia, Juglans, Ulmus, Zelkova, and Fraxinus predominated. During the Late Pleistocene cold periods xerophylyous grasses predominated. Arctic-alpine and boreal species also often occurred (e.g. Betula nana, Picea, Alnaster, Sphagnum, Selaginella selaginoides and Botrychium boreale). Some coniferous species such as Pinus s./g. Diploxylon, Picea, Betula and Juniperus also spread in the open forests.

Palynological and palaeozoological evidence from the region reflects the main regional changes of the environment during the Quaternary which are controlled by global climatic oscillations. These results have allowed the completion of the palaeontological characterisation of the main stratigraphical units.
and the reconstruction of the principal palaeoclimatic changes, the oscillations of sea level and salinity of the Black Sea. They have also allowed the correlation of the major Quaternary events on land and sea.
55 PLEISTOCENE HIPPOPOTAMUS FROM THE NETHERLANDS

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Two species of Hippopotamus are known from The Netherlands and from the floor of the North Sea (the Southern Bight between the British Isles and the European continent). The oldest is *Hippopotamus antiquus* Desmarest, 1822 (=*Hippopotamus amphibius antiquus*), that originated from the Early to Middle Pleistocene sediments. The remains of this species are recorded from beneath the North Sea. They are extremely large (about the size of the *Hippopotamus* from Untermassfeld, Germany, that is considered to be the largest *Hippopotamus* ever recorded), and the bones are always heavily mineralized. No remains of *Hippopotamus antiquus* have ever been found in situ.

A Late Pleistocene *Hippopotamus* species from The Netherlands is identified as *H. incognitus* Faure, 1984 (=*Hippopotamus amphibius incognitus*). Remains, including the dentition, have been dredged e.g. from the Westerschelde estuary (province of Zeeland), for example, and are known from the IJssel Valley (provinces of Gelderland and Overijssel). In the floodplain of the river IJssel near Giesbeek, Deventer, and the Zwolle region, remains of *H. incognitus* are also recovered by dredging activities. The bones that were found near Giesbeek can be dated to the Eemian Stage with certainty. Eemian deposits occur at Giesbeek near the surface. The northernmost finds of Late Pleistocene *H. incognitus* in The Netherlands are those from Haerst, near Zwolle (province of Overijssel), and also in the floodplain of the river IJssel.

Late Pleistocene *H. incognitus* is also known from the Maasvlakte (an artificial peninsula off the coast of the province of Zuid-Holland). Although these remains had been identified in earlier publications as Early to early Middle Pleistocene *H. antiquus*, the Maasvlakte *Hippopotamus* can be dated to a possible Eemian age on the basis of the state of fossilization and the presence of other faunal elements such as the straight-tusked elephant *Elephas antiquus*.

A third large Pleistocene species of *Hippopotamus* has been described as *H. tiberinus* Mazza, 1991. This *Hippopotamus* occurred in Europe during the Early, Middle and Late Pleistocene. Its ancestor is supposed to have been a middle-sized *H. antiquus*. This species is known from Italy and from other places, e.g., the Upper Rhine Valley in Germany. For the time being, it is not known from The Netherlands.

It appears that in both the Early as well as in the Late Pleistocene, *Hippopotamus* species conquered northwestern Europe by following the course of the River Rhine. They crossed The Netherlands on their way to the British Isles. What is now the Southern Bight of the North Sea was the connection with the Britain during the Early and Late Pleistocene. *H. incognitus* was common in the Upper Rhine Valley, it is known also from The Netherlands and it has been found in London (Trafalgar Square) and Barrington in England.
THE EEMIAN IN THE SOUTH-EASTERN PERIPHERY OF THE FENNOSCANDIAN SHIELD

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In the northern part of Europe and particularly in the south-eastern area of the Fennoscandian Shield Late Pleistocene transgressions left sediments which during the century have been comprehensively studied in many sections. These studies have produced a rich literature concerning stratigraphy and palaeogeography. But in spite of the great number of data available, present knowledge of the physical age of the sediments and their correlations is still incomplete. One of the reasons is the lack of geochronological data beyond the range of 14C dating and discrepancies about the Late Pleistocene history in the Northern Hemisphere. Therefore, a reliable geochronology is urgently needed to correlate marine events in the sequences studied.

Since the mid-1980s, a relatively new technique - the electron spin resonance (ESR) dating method - has been successfully applied at the Institute of Geology, Tallinn, to produce a mollusc-based chronology for the widespread deposits of the Eemian/Boreal transgression. The latter provides an important marker horizon all over Northern Eurasia. In the present paper is focused on the dating of marine deposits in the eastern part of the White Sea coast - a classical study area of Late Pleistocene transgressions. The latest ESR dating results were obtained on Portlandia arctica shells from glaciogenic and interglacial sediments from the SE district of the Gulf of Finland (from so-called Mga marine clays) and in the area SE of the Gulf of Riga, Central Latvia, are represented. Finds of Portlandia shells here had created a controversy in many publications with their age ranging from Holsteinian to the Late Weichselian. Some interesting results of Eemian age have also been derived from lacustrine interglacial deposits in the southern Baltic area.

Dating evidence gives ages of 137.6 to 71.5 ka BP derived from the south-eastern periphery of the Fennoscandian Shield that suggest correlation of Late Pleistocene transgressions with the whole Oxygen Isotope stage 5. The geochronological results do not provide much information about the duration of the last interglacial, but the dates obtained have enabled the authors to place the time of a relatively low global ice volume between 140,000 - 70,000 years.

Some authors believe that during the Eemian transgression the form of the seafloor closely coincided with the Holocene Litorina Sea limit. However, another group of scientists imply a much wider distribution of the last interglacial seas, their connection through the system of shallow sounds in the Ladoga-Onega depression. The results obtained support the latter hypothesis.
THE TIMING AND CLIMATE OF THE LAST INTERGLACIAL IN NORTH AMERICA


The timing of the last interglacial period (LIG) can be determined by U-series dating of corals from emergent reefs and terraces on coasts and islands and thermoluminescence (TL) dating of loesses that bracket LIG palaeosols in the midcontinent. Based on U-series dating of corals from Hawaii, California, Florida, and the Bahamas, sea levels were higher than present from ~132 ka to ~115 ka (Oxygen Isotope Substage 5e and possibly part of 5d) and near present from ~82 ka to ~78 ka (Oxygen Isotope Substage 5a). Based on TL dating of bracketing loesses, the LIG soil formed between ~130 ka and ~45 ka (all of OIS 5 and 4 and part of Stage 3). Shallow marine palaeotemperatures can be inferred from marine terrace faunas and oxygen isotope analyses of molluscs. Faunal assemblages from ~125 ka-old marine terrace deposits in protected settings on the Pacific coast of North America contain 'extralimital' southern species indicating warmer-than-present waters during the peak of the LIG. However, at open-coast localities, deposits of the same age commonly have more 'extralimital' northern species, and molluscs from these localities have oxygen isotope compositions indicating water temperatures that were 2-3°C cooler than present. These apparently conflicting results are still not understood, but may be explained by (1) a LIG characterized by widely varying water temperatures, (2) enhanced upwelling due to greater landward heating, which would cool only outer, open-coast localities, (3) a temporally biased geological record, with protected localities largely recording the peak of LIG warmth and open-coast localities recording the beginning of cooler ocean temperatures at the close of the LIG, or (4) mixing of fossils from two high sea stands (~125 ka, warm and ~100 ka, cool) that were both close to present levels. Although sea level appears to have been close to present during the ~80 ka high stand, both faunal assemblages and oxygen isotope data indicate that watertemperatures off the Pacific coast of North America were significantly (up to 5°C) cooler than present. LIG pollen and macrofossil records from North America are rare. Only about 40 localities have been found, concentrated on the Pacific coast, in Illinois (mid-continent), southeastern Canada, Alaska, and Arctic Canada. Almost all localities indicate peak LIG conditions as warm or warmer than present. British Columbia and Washington had cedar-hemlock-douglas fir forest similar to present, California was dominated by oak woodland, Illinois had deciduous forest/savanna, Alaska and Yukon had boreal forest over a greater extent than present, and in Arctic Canada, shrub tundra migrated north to areas now occupied only by herb tundra. At localities where particularly detailed records of the LIG exist, there is evidence for considerable complexity in vegetation changes. In Illinois, there were alternating periods of deciduous forest and savanna, indicating probable shifts in moisture balance throughout the LIG. In central Alaska, there were at least two periods of boreal forest separated by an interval of tundra vegetation, indicating a complex summer temperature history; in addition, the earlier period of boreal forest growth may have had higher precipitation than present. These shifts in vegetation within the LIG sensu lato may correspond in part to the complexity of the marine oxygen isotope record represented by substages 5e to 5a. Where pollen or macrofossil records are absent, the climate of the LIG in the North American mid-continent may be inferred from properties of LIG palaeosols, because soil geography is to a great extent a function of prevailing climate and vegetation. Modern soils in a transect from Ohio to Nebraska (a precipitation gradient from ~1000 mm/yr to ~500 mm/yr) show decreased amounts of leaching in drier regions, as reflected in carbonate content, ratios of soluble-to-insoluble elements and clay mineralogy. LIG soils in this same transect show similar trends, indicating that (1) the same precipitation gradient prevailed during the LIG, and (2) precipitation was not significantly greater than present during the LIG. The thicker, redder, and more clay-rich B horizons of LIG soils in contrast to modern soils, probably reflect a longer period of pedogenesis compared to modern soils.
Fossil remains of fishes have been selected from different caves in the South Urals. They include the Zapovednaya, Lemeza III and Nukatovskaya caves. Over 1300 bone and scale remains have been studied. A comparison is made with the modern ichthyofauna.

<table>
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<th>Lemeza III 15 strata</th>
<th>Zapovednaya 1 stratum</th>
<th>Nukatovskaya 2 strata</th>
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<tr>
<td><em>Thymallus th.</em></td>
<td>628</td>
<td>33</td>
<td>84</td>
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<td><em>Perca fluviatilis</em></td>
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<td>12</td>
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<td><em>Esox lucius</em></td>
<td>24</td>
<td>36</td>
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<td><em>Hucho taimen</em></td>
<td>28</td>
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<td><em>Gobio g.</em></td>
<td>73</td>
<td>2</td>
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<td><em>Leuciscus cephalus</em></td>
<td>19</td>
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<td><em>Phoxinus ph.</em></td>
<td>7</td>
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<td><em>Lota l.</em></td>
<td>90</td>
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<tr>
<td><em>Cottus gobio</em></td>
<td>16</td>
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59  SACCOPASTORE, A STAGE-5-SITE WITHIN THE CITY OF ROME, ITALY

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The Saccopastore locality is particularly well known for the discoveries, in 1929 and 1935, of the two important early Neanderthal crania. Later, the area was intensively urbanized – thus, the last available stratigraphic data are those collected in the 1950s. The mammalian fauna of the beds both under- and overlying those yielding the fossil hominids shows a modern-like character, suggesting mild climatic conditions and environments that ranged from wooded to more arid conditiones. On the basis of the stratigraphical and faunal data, the site may be correlated to the OI Stage 5, but it is not easy at present to refer the sequence to one (or more) precise substages. A critical revision of the biochronological, palaeoecological and palaeoenvironmental significance of the Saccopastore fauna has been carried out in order to reach a more definite arrangement within the late Aurelian mammal assemblages in Central Italy.

Ongoing researches concerning the two Neanderthal specimens from Saccopastore are reviewed in the new light of the spectrum provided by the recently enlarged fossil record, concerning human evolution during the Pleistocene. In particular, the Saccopastore Neanderthals exhibit a morphological pattern which, whether includes a series of traits in common with the so-called 'classic' or Wurmian Neandertals, it is also characterized by the retention of more archaic traits and the incomplete acquisition of some autapomorphic Neanderthal features.

Taken as a whole, the Italian fossil sample from the Middle and Late Pleistocene matches the European fossil record at several points, with affinities in general trends, but also with a certain number of peculiarities it contributes to support the idea of different evolutionary pathways followed by the Neandertals (in Europe and the Near East) and anatomically modern *H. sapiens* (probably in Africa) respectively.
EEMIAN DEPOSITS AND THE INTERGLACIAL RIVER NETWORK
WITHIN THE BALTIC SEA DRAINAGE BASIN (WESTERN AND
NORTHERN BELARUS)

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Eemian deposits in Belarus are well investigated by various methods including pollen analysis (in
comparison with older interglacial deposits). However, in spite of the abundance of sections and their
well-defined stratigraphical situation, there are different interpretations of the palaeogeographical
conditions under which the Eemian deposits were laid down. In particular this concerns the fluvial
network reconstructions within the Baltic Sea drainage basin area. Some reconstructions suggest the
inherited development of Eemian rivers. According to others investigations the Eemian river network
y
 differed markedly from the present one. This pattern caused the structure peculiarities of Eemian
alluvial and lacustrine deposits, which are widely-spread within the Baltic Sea rivers basins. Here, unlike
the interglacial deposits of the Black Sea drainage basin, accumulations are weakly differentiated by
facies. Most of sections comprise fine-grained sands and silts with layers of clays. The transition
between beds of different origin is gradual and indistinct, which makes it difficult to divide them and to
define their genesis. From the palaeogeographical point of view, it seems to be justified to consider the
Eemian deposits within the area as an unified lacustrine-alluvial complex.

Comparative analysis of Eemian sections with new drilling data have made it possible to obtain more
specific information about evolutionary aspects of their formation. The reconstruction has been carried
on the basis of the study of structure and geological position of sections containing interglacial
deposits, together with analysis of facies characteristics. The geological characteristics of the
underlying and overlying deposits are also taken into consideration.

The sediments of lacustrine origin predominate among the Eemian interglacial deposits within the
drainage basins of the largest Belarussian rivers, flowing towards the Baltic Sea. The generalized
sequence of lacustrine accumulations is characterized by the regressive development of lakes. There
were systems of lakes, connected by channels. The sediment thickness, the maximum for the all
Eemian deposits accumulated in these lakes. The characteristics of the structure and occurrence of
interglacial deposits indicate that the pattern of the Baltic drainage basin hydrographic network differed
significantly from the modern one and probably began to form in the second part of the Interglacial.
61 ZONAL CHANGES OF MINERAL COMPOSITION OF THE EEMIAN (PRILUKI) DEPOSITS IN THE UKRAINE

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According to Veklich M.F, the Eemian Stage interglacial may be correlated with the lower palaeogeographical stage (R3) of the Late Pleistocene and corresponds to the Priluki stratigraphical horizon.

The Priluki Stage (130-100 Kyr) deposits are represented by a suite of fossil soils of different types, that are widespread in the Ukraine. Stratigraphically, deposits of this stage are restricted. In the largest part of the country (except for its northern regions), they are underlain by loesses and loess loams of the cold Tyasmin Stage (R2), and overlain by deposits of the cold (loesses and loess loams) Udaj stage (W1).

Rather warm and wet palaeogeographical conditions during the Priluki Stage had favoured the intensive soil forming processes that led to the formation of thick (up to 3.5 m) soil suites that differ spatially and temporally. The alternations of soil covers of the Priluki period have a zonal character - from brown forest and brownish (northern part of the country); brown forest steppic soils, chernozems of meadow steppes (Middle Pridnieprovje); chernozems of mycelium-carbonate and meadow-chernozem soils (Porozhistoye Pridnieprovje); burozem-like chernozems (Donbass) up to brown steppic, chestnut, reddish- and cinnamon-brown soils in a complex with alkaline soils (Lower Pridniestrovje, Prichernomorje, Priaizovje).

Changes in the palaeogeographical environment of the Priluki Stage have found their reflection in the mineral composition of the argillaceous matter. The degree of sediments dispersity usually serves as an index of intensity of weathering and soil forming processes closely connected with local palaeogeographical conditions. As compared with the Tyasmin and Udaj loesses, the Priluki soils are more clay rich, they are notable for some differentiation of argillaceous matter 21 - 34% of fractions (< 0.001 mm) with a tendency to its decrease in the lower part of the horizon. In the Donbass and Prichernomorje regions, argillization increases up to 40%. Complex investigation of the argillaceous matter in the Priluki soils, as well as of the underlying and overlying loesses and loess loams, from 34 key sites and boreholes of different regions of the plain territory of the Ukraine (Middle and Porozhistoye Pridnieprovje, Pobuzhje, Donbass, Lower Pridniestrovje, Left Bank of the Lower Danube, Kerch Peninsula and the Prichernomorje) gives the possibility of obtaining a rather full range of the characteristics of mineral composition and to define its peculiarities and differences.

The thin, dispersed part of the Priluki Stage deposits is characterized by a polymineral composition. Argillaceous matter has traces of chemical weathering and reworking; it is represented by minerals of the smectite group, by mixed-layer hydromica-montmorillonite formations of different ratio. Hydromica, kaolinite, chlorite and quartz form the admixture. Minerals of the smectite group dominate in the Middle Pridnieprovje and Donbass, the content of mixed-layer formations considerably increases (evidence of warm moderately-wet conditions). The presence of thinly dispersed calcite and gypsum in the Priluki soils of the Prichernomorje, Lower Pridniestrovje and Kerch Peninsula testifies to more arid conditions of these soils formation.
THE EEMIAN PALAEOSOIL IN CENTRAL ITALY AND ITS STRATIGRAPHIC SIGNIFICANCE

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In many Middle-Upper Pleistocene coarse-grained sedimentary sequences of Central Italy a totally decalcified reddish argic B horizon is found, often overlying a K horizon. It denotes a period of longlasting Mediterranean/Tropical wet conditions, characterized by high slope stability. In places, where the parent material is constituted by fine sediments, a leached soil with pseudogley conditions is present. This soil is often preserved at the top of fluvial terraces as a relict soil, but it has also been discovered on slope, glacial and fluvioglacial deposits. Moreover, in places the soil is also buried under slope, fluvial and aeolian sediments. The horizons are commonly truncated revealing conditions of instability on the slopes. As a consequence of deposition of fresh material, CaCO₃, concretions, filling the cracks of the uppermost part of the soil, are present. Soils progressively less leached and enriched with calcium carbonates, are found on top of the argic horizon bearing witness of the progressive deterioration of the vegetational covering.

The litho- and pedostratigraphic association of the soil allows us to attribute it to the Eemian whereas fluvial sediments of the same age are not known in the area, suggesting that this period corresponds to a general phase of downcutting. From a morpho-stratigraphical point of view it always follows an important period of valley aggradation (Saalian/Riss terrace), in turn followed by an important phase of deposition (Weichselian/Würmian terrace).

The supposed Eemian age of the soil is also supported by 14C and U/Th dates of the younger sediments. Furthermore, the soil buries sediments containing Late Acheulean industries with handaxes and Levalloisian facies. Only at Erbarella, in the Marche region, the A2 horizon is preserved containing a Musterian industry of levallois tecnique and facies. In other cases similar industries are found on the overlying layers. Therefore, it constitutes a typical pedostratigraphical unit for Central Italy.
The studied area occupies a vast territory stretching from 59 to 52°N. It includes the Kostroma, Yaroslavl, Moscow, Tver' and Saratov regions. The modern vegetation is represented, from north to south, by a zone of southern dark coniferous taiga (Kostroma and the northern part of Yaroslavl regions), a zone of mixed coniferous-broad-leaved forests (southern part of Yaroslavl, Moscow, and Tver' regions), and by feather-grass steppes of the Saratov region. Palaeogeographical reconstructions of Mikulino (Eemian) interglacial are based on the detailed study of over 35 reference sections that allow the complete history of the evolution of vegetation during the interglacial period to be reconstructed. Analysis and generalization of the abundant lithological, mineralogical and palynological evidence, together with absolute age estimations allowed the establishment of both: the main characteristics of the evolution of palaeovegetation and palaeoclimate, as well as the peculiarities of the spatial variations of the natural complexes. Deposits of Mikulino age are widespread in the Upper and Middle Volga basins. They are represented by lacustrine, bog, and floodplain facies. Their thickness varies from 1 to 10 m. Age estimations are based on the stratigraphical position of the strati and palynological evidence, supported by TL date ranging that from 151±24 Ka to 95±11.5 Ka. The most representative sections of the Mikulino deposits are restricted to ancient lake depressions. Comparative analysis of palynological material has revealed clear zonal differences in plant cover of the region during the interglacial. Palynological diagrams from the northern regions of the Upper Volga basin (59°N, Kostroma and Yaroslavl regions) are characterized by the following composition and succession of tree species*: Pic © (B+Pic+P+Q) © (Q+Pic+P+U) © (Q+Ti+Co+Al+Pic+P) © (B+Pic+P) © Pic. In Moscow and Tver' regions (56°N) the succession was the following: Pic © (P+B) © (P+B+Q+U) © (Q+U) © (Q+U+Co+Al+Ti) © Car © Pic © (P+Pic+B). For the Middle Volga (Saratov region, 52°N): (P+B+Pic) © (Q+U+B) © (Q+U+Ti+Co+Al+B) © (B+P+Q+Ti+Car) © (B+P+Pic) (valley forests). Steppe associations occupied flat interfluvies. Palaeoclimatic and palaeobotanical parameters indicate higher temperatures and humidity during the optimum stage of Mikulino interglacial than at present. Numerous data on continuous sections indicate that there was only one optimum during Mikulino Stage interglacial.

* P-Pinus, Pic-Picea, B-Betula, Al-Alnus, Co-Corylus, Q-Quercus, Ti-Tilia, U-Ulmus, Car-Carpinus.
BOREHOLE AMERSFOORT I: MOLLUSCAN ANALYSIS OF THE EEMIAN TYPE AREA

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Data of the Eemian stratotype were published by Van Voorthuysen (1958) and Zagwijn (1961) from the boreholes Amersfoort-32B119 and -32B120. These publications dealt only with foraminifera and palynology. The rich molluscan and diatom assemblages, on which the Eemian was originally described by Harting in 1874 and 1875, were never published. Recently boring Amersfoort-32B119 was multidisciplinary re-investigated. Molluscan analysis was applied to sixteen samples between 13.60-27.50 meters below surface. In this section typical Eemian marine assemblages were encountered in which a.o. the following species occur: Bittium reticulatum, Haminaea navicula, Chrysallida emaciata, Cerithiopsis nana, Hinia pygmaea, Mochiolus adriaticus, Gastrina fragilis, Acanthocardia paucicostata, Venerupis aurea senescens and Lucinella divaricata. The general description of the succession from bottom to top is as follows:

1. Poor temperate fresh water assemblage characteristic of a quiet shallow lacustrine environment.
2. Assemblages pointing to a shallow sublittoral marine environment with lowered but upwards increasing salinity.
3. Rich assemblages pointing to deeper sublittoral marine with hypersaline conditions.
4. Poor assemblages pointing to low littoral to shallow sublittoral, strongly low saline conditions.

Besides the characteristics of the molluscan assemblages, the hypersalinity of zone 3 is based upon the number of ribs of Cerasoderma edule, which number is considered to be positively related to salinity. A salinity of about 43% is concluded in this way which is in accordance with other samples from the Eem Valley, but considerably higher than in Eemian localities elsewhere (about 25-30%). The hypersaline conditions are thought to be caused by high evaporation in shallow lagoonal conditions with restricted water exchange with open sea and without inflow of freshwater. The zone is considered to be formed at the highest Eemian sea level stand.

From this borehole amino acid D/L-ratios were published by Miller & Mangerud (1985) from several molluscan species. D/L-ratios of Spisula subtruncata from this locality are 0.173 and 0.189 which are comparable to those of other Dutch Eemian localities.
65 MOLLUSCAN FLUVIAL ASSEMBLAGES FROM THE LAST (IPSWICHIAN) INTERGLACIAL IN BRITAIN AND THEIR DIFFERENTIATION FROM THOSE OF EARLIER INTERGLACIALS

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In Britain, fossiliferous silts and sands are commonly found within or at the base of Pleistocene gravel aggradations, which overlie calcareous bedrock, such as the Chalk. Fossils recovered from such contexts demonstrate that some of the organic sediments accumulated during temperate stages. Mapping of the gravels shows that they form terrace staircases, allowing the establishment of a relative chronology. The River Thames is one of the most intensively studied river systems that has a history extending back into the Lower Pleistocene. However, two views have recently emerged regarding its history since the Anglian/Elsterian. One suggests that in the Lower Thames region all the known interglacial deposits, with the exception of those at Swanscombe, accumulated during the last interglacial. The second view recognizes four separate interglacials within the staircase of terraces in the London area, only the lowest of which is of last interglacial age. Molluscan assemblages from sediment of comparable facies beneath the different terrace surfaces provide support for the longer chronology. The later part of the Swanscombe aggradation (Middle Gravels) has yielded the so called ‘Rhenish fauna’, that includes species such as *Theodoxus serratiliniformis* and *Viviparus diluvianus*. In Britain these are known only from this immediately post-Anglian stage. Apart from these no other species is unique to any particular stage but various combinations of taxa impart a distinctive character. Last interglacial deposits, for example, are characterized by the presence of *Belgrandia marginata* and *Patomida littoralis* and the absence of *Corbicula fluminalis* and *Pisidium clessini*. 
PECULIARITIES OF THE LAST INTERGLACIAL HERPETOFAUNA FROM EASTERN EUROPE

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Analysis of the herpetofauna from 11 localities of Eastern European platform, formed during the last interglacial, have made possible the following conclusions:

1. All the localities only contain the species now living on Eastern European platform. These are Pelobates fuscus, Bufo bufo, Bufo viridis, Rana temporaria, Rana arvalis, Rana ridibunda, Rana (?), dalmatina, Emys orbicularis, Anguis fragilis, Lacerta cf. agilis, Lacerta cf. viridis, Natrix tessellata, Natrix cf. Natrix and Vipera ursinii. Some of species, such as Bombina bombina, Rana lessonae, Vipera berus and all the species of tailed amphibians, have not yet been discovered. However they have been found in older and younger localities. Very likely their absence is result from taphonomic processes.

2. The absence of extinct forms and species now inhabiting distant territories distinguishes the last interglacial herpetofauna from previous ones. Moreover Bufo viridis appears here for the first time. Reliable finds of this species from older localities on the Eastern European platform are absent. It is of great importance for stratigraphy as characteristic of Upper Pleistocene-Holocene interval.

3. The localities of most of species are situated in boundaries of their present distribution areas. However, the finds of Rana (?) dalmatina and Lacerta cf. viridis are beyond their areas. The evidence of wider area of distribution of these species in the Eemian can be used in stratigraphy for corresponding areas.

4. The ecological appearance of herpetofaunas (forest, forest-steppe, steppe) does not often correspond to the present situation in localities and points to a different position of natural zones in the past.

5. There are localities which are not far from one another in the same natural zone but were formed under different ecological situations. They point to the order of formation of localities during the interglacial.
THE FIRST FIND OF A WATER BUFFALO (ARTIODACTYLA, BOVIDAE) IN THE NETHERLANDS

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In 1996, two amateur collectors discovered a fossil horn core on the spoil heap of a sand and gravel pit near Netterden, province of Gelderland, The Netherlands. The remains were found in sand or gravel layers that were largely deposited during the Weichselian. The horn core most probably originates from a young individual; it is only slightly curved backward. The fragment is well preserved and does not show signs of transport or resedimentation. The triangular shape of the core is characteristic of the genus Bubalus, the water buffalo. Two species of Bubalus are known from the European Quaternary: B. marathousae from the Early Bioharian of the Peloponnesos (Greece) and B. murrensis from Holsteinian and Eemian localities in Germany (including B. wanckeli from Schönebeck on the River Elbe). Our fossil most closely resembles the Holsteinian and Eemian material, so it can be ascribed to B. murrensis with a high degree of certainty.

In the Netterden pit, gravel and sand are dug up to a depth of 20 m below ground level. It is, unfortunately, not quite clear from which depth the B. murrensis horn core originates. As for stratigraphy, we therefore have a choice between Middle (Holsteinian) and Late (Eemian) Pleistocene for its age. The first find of the European water buffalo was described from a quarry in Steinheim an der Murr (Baden-Württemberg, Germany). It originates from sediments of Holsteinian interglacial age. Quite a number of Bubalus skull fragments have since become known from the Upper Rhine area between Ludwigshafen and Mainz. All Bubalus murrensis remains from the Upper Rhine are normally attributed an Eemian last interglacial age. Apart from the well-dated Steinheim skull, which is of Holsteinian age, most of the northwest European water buffaloes are of Eemian age. Therefore, we tentatively attribute the Netterden horn core an Eemian age as well.

As for taxonomy, three lineages can be observed within the genus. In the lineage B. platycerus - B. murrensis the posterior part of the skull protrudes beyond the posterior edges of the horns. Furthermore, the flattened dorsal surfaces of the horns are oriented in one plane. There is also a lineage that leads to the recent B. arnee. Here, the occipital region of the skull does not protrude beyond the horns, and the dorsal surfaces of the horns are not in one plane, but they bend downward, thus forming a blunt angle. It is generally agreed that the recent domestic water buffaloes stem from B. arnee. Yet another, third, lineage is found in China, leading from B. brevirostris to B. mephistopheles. This lineage is characterised by shorter and more curved horns.

We are indebted to Mr I. van Dam who kindly put the horn core at our disposal.
68 PALAEOLIMNOLOGICAL CHANGES DURING THE TRANSITION BETWEEN THE EEMIAN AND THE LAST GLACIAL PERIODS IN THE FRENCH MASSIF CENTRAL AS INFERRED FROM HIGH-RESOLUTION STUDY OF SEDIMENTARY DIATOM ASSEMBLAGES

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First results of diatom analysis of the lacustrine sediment of Ribains crater (Massif Central, France) show major biostratigraphic variability in diatom assemblage composition during the transition between the Last Interglacial (or Eemian, OIS 5e) and the Last Glacial (or Early Würmian, OIS 5d). These results correlate well with the pollen results presented by Beaulieu and Reille (1992). The end of the Eemian is marked in the terrestrial community by the maximum development of Abies and Picea and by a diatom community dominated by summer blooming planktonic species of Cyclotella indicating low nutrients level and strong thermal stratification of the water column.

The following phase is characterized by the expansion of Pinus and by a diatom community dominated by winter blooming planktonic and eutrophic species (Stephanodiscus spp.) indicating nutrient enrichment and changes in lakelevels.

The early Würmian begins with severe climatic deterioration, characterized by the sharp decline of the forest and increase in steppe species, and by the probable shallowing of the lake as indicated by the development of a larger littoral diatom community and the dominance in the planktonic community by Aulacoseira subarctica, species which requires a relatively turbulent environment to remain in suspension. Both pollen and diatom analyses appear to indicate changes in the precipitation/evapotranspiration ratio as the main cause for lake-level change.

This study, which combines results obtained from different palaeoecological approaches, provides a synoptic view of fluctuations in the aquatic and terrestrial palaeoenvironments.
THE EEMIAN SEA-LEVEL HISTORY OF NORTHWEST EUROPE: A REVIEW

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Marine deposits of Eemian age occur extensively in northwest Europe, both in the offshore sector and in low-lying coastal regions. A total of 341 marine Eemian site records were recently collated as part of the EU-funded ‘SHELF Project’, aimed at investigating the palaeoceanographic, palaeoclimatic, tectonic and sea-level history of northwest Europe during the last 250,000 years.

Pollen stratigraphical data, partially constrained by annually laminated varve chronologies provide a framework for examining the dynamics of Eemian sea-level change. The Eemian marine transgression is most fully documented in the Southern North Sea region. Offshore and coastal sediments from the Netherlands, Germany, Belgium and southern Britain record an abrupt rise in sea level during pollen zone E 3b, the time of Corylus expansion. A maximum rate of rise of 4 m per century has been inferred. High-resolution foraminferal stratigraphies from northern Denmark and the Kattegatt record a parallel increase in water depth during this interval and the immigration of warm, Lusitanian faunal elements into Danish coastal waters. This period was followed by a more gradual sea-level rise during pollen zone E 4b. By the time of maximum flooding during pollen zone E 5 sea-level had risen by over 70 m from its early Eemian position. The coastal palaeogeography at this time was locally very different to that of the present day; wide areas of coastal lowland were flooded and the Baltic became linked to the Arctic Ocean.

The regressive limb of the Eemian sea level curve is less well represented than other parts of the sea-level cycle. Regressive sea-level tendencies are nevertheless recorded in the coastal sediments of Germany, the Netherlands, Belgium and northern France. These indicate that sea level began to fall during pollen zone E 6a and continued to fall steadily during E 6 b. Uncertainties over the duration of these pollen zones preclude accurate estimates of the rates of sea level fall.

The detection of relatively minor scale sea-level changes within the Eemian marine records of northwest Europe is hindered both by the fragmentary nature of the deposits and the lack of precise dating control. Intra-Eemian sea-level fluctuations have nevertheless been proposed from the Belgian Coastal Plain and the Thames Estuary, Britain. The regional significance of these records and their associated forcing mechanisms have yet to be established. Minor sea-level oscillations of the type widely recorded in the Holocene coastal sediments of the North Sea region are not observed.

The considerable height variability shown by deposits assigned to Eemian sea-level maximum (a range of c. 18 m) has important implications for assessing long-term trends of regional subsidence.
HIGH RESOLUTION PALYNOCOLOGICAL RECORD OFF THE IBERIAN MARGIN: DIRECT LAND-SEA CORRELATION FOR THE LAST INTERGLACIAL

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The climatic variability is a global phenomenon which involves changes in the atmosphere, continents and oceans. This variability, its mechanisms and consequences, therefore, need to be discussed on the basis of the comparison between marine, ice and terrestrial climatic data. However, the absence of sufficient chronological control in the land-based sequences prior to 35,000 yr makes the detailed correlation of climatic fluctuations reflected by the ice, ocean and continental records difficult. Pollen-rich marine cores, such as the core that will be presented here, provide an excellent opportunity to establish a direct correlation between European climate and North Atlantic environments for the last 200,000 years. Core MD952042 (southwestern margin of the Iberian Peninsula; 37°48'N; 10°10'W, 3146 m depth) was collected within the framework of the international programme IMAGES (International Marine Global Change Study), associated with IGBP-PAGES and SCOR. Only the results concerning the Last Interglacial section of this core will be discussed here.

Direct land-sea correlation in core MD952042 shows that the Eemian corresponds not only to the lightest isotopic values of Oxygen Isotope Substage 5e but also includes the heavier values towards the 5d transition. During the Eemian, pollen and dinocyst data suggest a succession of climatic phases that the isotopic curve does not identify. Mediterranean vegetation is gradually replaced by Eurosiberian formations indicating a change from Mediterranean to oceanic climates. In the middle of the Eemian, warming conditions are interrupted by an event characterized by an increase in precipitation and a slight cooling over land and ocean. The re-establishment of the previous temperate oceanic climate corresponds to the last phase of the Eemian. The small amplitude, which characterizes this climatic variability, is therefore not equivalent to the abrupt Eemian climatic changes suggested by the GRIP ice record.
71 THE GEOLOGICAL AGE OF *SPELAEAARCTOS CF ROSSICUS* FROM THE VERCHNAYA CAVE IN THE SOUTHERN URALS

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During excavations in the Verchnaya Cave in the Southern Urals in 1995 the remains of bones of eight species of fossil mammals were recovered. Analysis of the colour of the remains and the extents of osseous substances have allowed the separation the material into three groups. The first group includes species inhabit is area at present: Martes martes, Vulpes vulpes, Meles meles. The second group remains of typical Late Pleistocene species such as: Marmota bobac, Spelaearctos spelaeus, Rangifer tarandus. The third group includes the bones of a relatively small bear Spelaearctos cf.; rossicus and a deer Cervus ex. gr. elaphus.

Further study of the cave has confirmed a mixed type of palaeotheriocomplex. The available part of the cave is small, but it is only part of a multistaged karst cavity. The floor of the accessible part of cave is infilled by brown loam which includes the remains of Marmota bobac, Spelaearctos spelaeus and Rangifer tarandus. The radiocarbon dating of the Spelaearctos spelaeus bones indicates to a period their burying -22750 (3714). The remains Spelaearctos cf. rossicus and Cervus ex gr. elaphus are associated with the large blocks formed as a result of the destruction of the roof and are older. Morphological particularities of the bones indicate that the small bear the Spelaearctos deningera of Central Asia. However remains of the smaller species are relatively rarely encountered in the Urals caves and are accepted as defining Spelaearctos rossicus. Evaluation of the age of remains is connected with their identification; Spelaearctos deningera is considered to be a Middle Pleistocene but Spelaearctos rossicus is a Late Pleistocene species. Further classification of this problem requires more material of the small cave bear, but opens prospects for the discovery of a Middle Pleistocene theriocomplex, which is still poorly known in the Southern Urals.
72 SEQUENCES OF THE EEMIAN INTERGLACIAL IN LITHUANIA WITH PARTICULAR EMPHASIS ON THE EEMIAN - WEICHSELIAN TRANSITION

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The Eemian always has particular significance for stratigraphical reconstructions of the Last Interglacial-Glacial climatic cycle. Furthermore, in the regions of the boundary of the maximum extension of the Weichselian ice sheet, the Eemian sections have crucial value for the determination of the glaciation limit. The present study deals with the Eemian sections in Lithuania analysing and comparing facies sequences of lacustrine sediments, that accumulated in basins of different size and located in various geomorphological situations.

The Merkine (Eemian) Interglacial sections have been studied in Eastern Lithuania both inside and outside of the boundary of the maximum extension of the Weichselian ice-sheet. However, the sections only having upper boundary of the interglacial and transition to Weichselian have been considered.

In the Medininkai highland (composed of Saalian age, glacial sediments, lacking a Weichselian glacial cover), sedimentation of the Eemian deposits took place in small kettles, scattered in the morainic topography. Eleven localities with Eemian interglacial deposits have been discovered and studied using borings. The data from the Medininkai highland show that the transition from the Eemian to Weichselian is expressed very clearly in pollen diagrams and less sharply - lithologically. However, organic matter sharply decreases with the first cryomer - Nemunas 1 (Herning Stadial). The same or an even greater amount of organic matter is characteristic of the Jonionys 1 (Brørup) and Jonionys 2 (Odderade) Interstadials, established in the same sections. It can be assumed that the sedimentational conditions in small lacustrine kettles have not changed significantly with the transition from Eemian to Weichselian. The same conclusion can be drawn from the Jonionys kettle (South Lithuania), where the Eemian-Weichselian palaeolake was 450-500 m in size.

The Mickunai palaeolake, located north of the Medininkai highland, occupied an area of ca. 200 km² area during the Eemian. Sediments of different environments - coastal, deep water, transitional and deltaic, have been revealed within the Mickunai basin. This big basin, according to data of more than 20 borings, was filled with the sediments by the end of the interglacial, and only peatland existed at beginning of the Weichselian. The regression of the Mickunai palaeolake and sharp change of sedimentational environment by the end of the Eemian was caused by the climatic changes.

It can be concluded that different sequences of sedimentation environments can be recorded from the lacustrine kettles depending of their size and location within the hydrographical network. Data from small, isolated kettles only display insignificant changes of sedimentational environment with the Eemian-Weichselian transition. However, the data from the large Mickunai palaeolake display sharp regression by the end of the Eemian.
FORAMINIFERA AND MOLLUSCS FROM THE EEMIAN OF WESTERN ARCTIC RUSSIA

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We have studied foraminifera and molluscs from river-cut outcrops in the Pechora and Severnaya Dvina drainages, in order to contribute to the climate and environmental history of the Last Interglacial in northern Russia. The sections are located approximately 100-120 km inland from the Barents Sea/White Sea coasts along the Pechora and its tributary Sula, as well as along Severnaya Dvina and its tributary Vaga.

The molluscs and foraminifera show that the major river basins were submerged during the ‘Boreal Transgression’ (Eemian/Mikhulinian). In all parts of the area, the Eemian sediments are characterised by mollusc faunas with a significant boreal element - i.e. species, which nowadays have their northern boundary at the Murman coast, where permanently ice-free areas border on areas with winter sea ice. This indicates higher influence of the North Atlantic Current than today. In contrast, the benthic foraminiferal faunas are represented by mainly arctic and subarctic species. However, the present SW-NE gradient of diminishing Atlantic water influence is clearly seen in both mollusc and foraminiferal faunas, which are richest and most diverse in the Severnaya Dvina basin.

In both river basins, the benthic faunas indicate a variety of shallow-water environments with a wide range in depth, exposure and salinity, probably due to migration of sandbars during a period of rise in relative sea level.
EEMIAN SEDIMENTARY ENVIRONMENTS IN LITHUANIA

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The sediments of the Merkine interglacial, which can be correlated with Eemian interglacial, are widespread in Lithuania. They are found in all areas except of the Coastal Lowland.

At the beginning of interglacial the forest is characterized by pine-birch domination. This was followed by a warming of the climate during which broad-leaved trees spread. The succession of the appearance of the broad-leaved trees was as follows: oak and elm spread first, lime followed and hornbeam arrived to replace the latter. At the end of interglacial the climate get colder and coniferous forests spread. They were dominated by fir trees, which were supplanted later by pine trees.

Abundant palaeocarpological remains have been found in the deposits and also characterize an environment of Merkine interglacial. Some extinct species - Brasenia holsatica, B. nehringii, Lycopus intermedius, as well as pliocenic relicts - Taxus sp., Stratiotes cf. intermedius, Humulus scabrellus, H. rotundatus, Pilea lithuanica sp. nov., Mitella nuda, Naumburgia subhyrisflora and Lycopus antiquus were present.

The Diatom floral assemblages indicate sedimentation in freshwater lakes under alkaline conditions.

The most common planktonic species are Aulacoseira ambiguа, A. italica, A. granulata, Cyclotella krammeri, C. ocellata, C. stelligera, C. comensis, C. radiosa and Stephanodiscus rotula. Epiphytic species are dominated by Fragilaria leptostauron, F. brevistriata, F. pinnata, F. construens, F. construens f. venter, Tabellaria flocculosa, Synedra ulna, S. parasitica, Opephora martyi, Achnanthes clevei, A. jentzschii, A. lanceolata var. rostrata, Meridion circulare, Cocconeis placentula var. euglypta and C. placentula var. lineata. Navicula scutelloides, N. diluviana, Gyrosigma attenuatum, Amphora ovalis, A. ovalis var. lybica, A. pediculus, Navicula hasta, Pinnularia borealis are widespread among benthonic species. Some relict species are also found.

Among the mammals water and field voles are dominant but the beavers were also abundant.

It is thought that average annual temperatures were two degrees higher than present and annual precipitation was much greater (up to 300-400 mm). The beginning of the interglacial was more continental than the end. The mildest climate corresponded to the spread of hornbeam. The most exotic plants were fixed. The highest amount of organic sediments was deposited during this time.
THE PLIO-PLEISTOCENE SMALLER MAMMAL FAUNA OF THE
PAMIR-ALAY

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During the Pliocene and Pleistocene periods systematically and ecologically different smaller mammal
faunas inhabited the Pamir-Alay territory. The oldest smaller mammal fauna is from the Late
Miocene deposits of the Afghan-Tajik depression. A right branch of a lower jaw with M₃, M₄ and
incisive of Pliospalax v sp. were obtained together with bones of Hipparion, Chalicotherium and other
members of the mammoidal megafauna material.
The following genera and species of small mammals: Leporinae gen. indet., Hypolagus sp., Ochotona
sp., Hystrix trofinovii, Ellobiidae sp., Prominimomys cf. baschkirica, Archidiskodon mesridionalis
meridionalis and Equus stenonis pamirensis were typical members of the megafauna at the Late
Pliocene (Middle Villafranchian) the Pamir-Alay region.
The Early Pleistocene (Biharian) was marked by the appearance of more evolved forms voles of the
genus Microtus, which included: Microtus (Phaiomys) lakhutensis. This fauna also included Crocidura
sp., Cricetulus sp., Meriones lakhutensis, Ellobius (Afganomys), Clethrionomys sp. and Allophaiomys
v sp. That period is typified by the occurrence of Palaeoloxodon cf. antiquus, Equus aff. namadicus
and Bison schoetensacki.
The later fauna of this period correlated with the Late Cromerian faunal unit (int. III), as found for the
first time in 1995 from soil complexes 5 and 6 on the right bank of Obimasar River (Lakhuti, 3). The
abundant remains of a Microtus l (Allophaiomys ?) sp and Ellobius ex gr. tancrei were identified from
soil complex 5, whilst only the remains of Ellobius sp were recovered from soil complex 6. The Late
Pleistocene (Torilgian) small mammal fauna is represented by modern species. The remains of
Cricetulus sp., Ellobius sp., Microtus juldachi and M. afganus were washed together with the
numerous shells of small molluscs from the loess of soil complex 2 of the Khonako III section of
Obimas River valley. On the basis of archeological data the age of this fauna is Middle Palaeolithic and
corresponds to the Oxygen Isotope Stage 7, which may dated be respectively 200 000 Ma.
The numerous remains of Erinaceus cf. aurator, Lepus tolyai, Allactaga cf. elater, Muridae sp.,
Rhomobomy sp.opus, Microtus afganus, M. carruthersi and Ellobius cf. tancrei were collected at the
Penjikent locality in the Zeravshan River valley. Mammuthus sp. (probably M. primigenius), Bos
primigenius and Bison cf. priscus are typical members of the megafauna. This fauna is similar to the
Upper Palaeolithic complex, which is found throughout Central Asia and Eastern Europe. It can
probably be correlated with the Saalian Stage of the Netherlands. The next fauna of this period was
obtained from the Ogzi-Kitchik Mousterian site in the Afghan-Tajik depression. This assemblage
includes of Hemiechinus aurator, Marmota cf. hymalayana, Hystrix leucure, Rattus rattoides, Nesokia
indica, Gricetulus migratorius, Meriones sp., Ellobius tancrei and Microtus carruthersi.
Dicerorhinus mercki is a typical member of the megafauna. The Holocene small mammal fauna is
similar to previous ones and includes Lepus tolyai, Marmota caudata, Hystrix leucura, Rattus
turcestanicus, Cricetulus migratorius and Microtus juldachi. The remains of these faunas are found at
Koythesek and Karadimir in the Eastern Pamir and at the Saiod Neolithic in the Afghan-Tajik
depression.
HUMANS IN THE EEMIAN OF NORTHWESTERN EUROPE: WHERE AND WHY WERE THEY THERE?

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The Eemian Stage is named after a small river in the Netherlands and here this stage is well represented in sea, coastal plain, river and bog sediments which contain both floral and faunistic remains. However, in an archaeological sense, the Netherlands appear to be empty. Although evidence of occupation by Neanderthals is found in various situations in northwestern Europe, dating from the early Eemian until the climatic optimum. Possibly during the last part of the interglacial, Neanderthals also roamed the European landscapes. This paper will address the location of archaeological remains and the processes that account for this distribution of sites in Europe.

Most archaeological sites are found in eastern Germany. In Thüringen there are four localities where traces of human occupation on the sandy shores of Eemian lakes are present. In the limestone regions artefacts are known from calcareous spring deposits along the valleys of the rivers Ilm and Tonna, and in the south of Germany along the Neckar. A concentration of four sites, which can probably be attributed to the Eemian, are found in beach deposits in Normandy. Whereas Great Britain, the Netherlands and northern France, in general lack any human traces. The archaeological sites are apparently unequally distributed across northwestern Europe.

In the first place the pattern of archaeological sites is formed by the landscape preference of Neanderthals. However, reconstruction of the landscape preferences of Neanderthals, based on the finds of archaeological remains alone, ignores the influence of differential preservation. Geological processes, such as erosion and sedimentation, play a major role in the preservation of archaeological sites. Before conclusions are drawn about the humans and their dispersion across the landscapes of north Europe, an analysis of the distribution of Eemian sediments together with their preservational characteristics is required.
EEMIAN DEPOSITS IN MECKLENBURG-VORPOMMERN, NEGERMANY

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Eemian Stage deposits are very rarely found above sea level in Mecklenburg-Vorpommern; they are invariably associated with Saalian age tills (presumably Warthe Substage) and are frequently disturbed by icepushing. Outcrops occur at Klein Klütz Höved (Mecklenburg Bay) and a marine Eemian deposit is known from the Lias claypit in the northeast of Grimmen. During routine operations in the Hinterste Mühle gravel pit near Neubrandenburg, a nearly complete section of Eemian lacustrine deposits was discovered on the flank of a Saalian (Warthe Substage) till wedge near the limit of the main Pomeranian advance.

A concentration of lacustrine to marine and truly lacustrine Eemian sections have been described from boreholes in the Rostock-Schwaan area (River Unterwarnow, Diedrichshäger Berge) and northwest Mecklenburg in the hinterland of Mecklenburg Bay, i.e. near Elmenhorst and Hernburg (River Trave). Recently they also have been found in Vorpommern, for example from Grimmen and the Isle of Usedom. In general, these deposits have been influenced by the Eemian marine transgression and only the base is lacustrine. The younger Eemian is represented by marine sediments with a fauna of molluscs, ostracods and foraminifers. Truly lacustrine Eemian deposits are only known from boreholes in the Schwerin area, some of which represent almost the whole interglacial period.

Pollen analysis of the Hinterste Mühle deposit shows that the lacustrine conditions began here at the end of the late Saalian. The sequence began with fine- and medium-grained glaciofluvial and glaciolacustrine sands that rest directly on Warthe till. The development of a local lake basin was probably a result of decay of dead ice. Within the depression, a short phase of mire formation (peat and peaty mud) was followed by accumulation of silty mud. Fully lacustrine conditions probably developed at this site at the end of the late Saalian and in the early Eemian (PZ I after Menke & Tynni 1984). Peat accumulation began in the second half of the pine-rich phase (PZ II). In general, the pollen diagram shows the vegetation sequence typical of the Eemian Stage. Regional peculiarities, such as the markedly lower frequency of Taxus (PZ IVb/V) and Abies (PZ V/VI), are connected with climatically controlled distribution limits of these genera. The typical interglacial conditions were interrupted during the birch and pine-rich phase of the Eemian (PZ VII). The actual end of the interglacial and the transition into the Early Weichselian is now identified in a new profile.

Further a natural outcrop in the Klein Klütz Höved cliff, from which sediments also belong to a Late Saalian – Early Weichselian sequence will be discussed. The lacustrine sediments of the Eemian, which are covered by sandy layers with marine fossils are very significant. Besides a rich microflora fruits, seeds, molluscs and ostracods can also be found. The origin of the sandy horizon can be traced to Early Weichselian periglacial processes. In contrast to other profiles in the Mecklenburg area, the transgression of the Eemian Sea is found in PZ IVa and/or IVb.
CLIMATIC INSTABILITY DURING THE KAZANTSEVO (EEMIAN) INTERGLACIAL IN THE MARINE RECORDS FROM NORTH WESTERN SIBERIA, RUSSIA

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Present there is much evidence of the stratigraphy of the marine Kasantsevo deposits in Siberia. Chronology of these sequences is based on ESR dating of marine Mollusca from a few sections in the lower Enisey river and on the Taymyr lowlands. Based on the number of species, the Siberian Kasansevo fauna was as diverse as the Danish Eemian fauna, although had a different zoogeographical structure. The area of Kasansevo sea, beyond the Urals, is termed the Siberian highly boreal province, its characteristics are its unique range of boreal fauna that penetrated into the Arctic Sea mainly from the West.

The Kasantsevo fauna shows the gradual decrease of marine water temperatures from +12°C at Daneman to +5°C at Gydan (North western Siberia). In general, the Kasantsevo sea water temperature was 3-6° higher than at present. In the north of West Siberia, the boreal temperatures increase was twice as great as that on the Western Europe coasts. There are two lithological sequences of Kasansevo deposits: lower Ob - Yamal and Enisey-Agania profiles. In the lower Ob bay, the Kasantsevo sea was shallow with reduced salinity. The top of these Kasantsevo strata is a facies transition sand-clay-silt deposits of the pre-Ob palaeodelta.

The enisey profile begins beyond the Artic Circle with sandy facies of shallow waters, near Igarka. Further north at Dudinka, Ust-Port, the Karginian Cape, Ladygyn, Pustyoe, Karepovskoe and Vorontsovo mainly sand facies have been described. The Kasantsevo deposits contain a rich marine fauna.

The most complete geological record of sandy-clay deposits occurs in the Agapa river valley of the Yasina river basin. They are closely similarly to the clay-sandy section of Pustyoe and Karepovskoe in the Enisey river mouth.

At the Agapa river reference section the author has identified five substages of the Kasantsevo transgression using statistical and cluster analysis of the lithology and palaeotology of the rocks. Among them Oxygen Isotope Substages 5e1, 5e3, 5e5 were warm and 5e2, 5e4 were cold with indicators reduced salinity. The assumed duration of the substages is 4-5000 years. The deposits formed during the warm substages contain typical boreal species of rock fractions whose correlation significance follows the series: sand - silt - clay. The cold substages are characterized by Arctic species of macro- and microfauna and the most significant fraction is either clay or silt. A relative difference in the sea and land temperatures has been established. The relationship between climatic and sedimentation fluctuations and the intensity of erosion and aeolian processes of the surrounding continent is considered. The record of the Kasantsevo transgression lacks the climatic deterioration, which implies rapid sea regression along with glacioeustatic sea-level drop and tectonic uplift of the northern lowlands.
79  THE EEMIAN IN THE PONTO-CASPIAN REGION

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The Eemian Stage is the most striking palaeogeographical period of the European Pleistocene. This was a time of vast transgressions and migrations of warmwater molluscs which together serve as a good datum-level for correlation of natural events. In the Ponto-Caspian region the Eemian is represented by deposits of the Karangat and Late Khazarian basins. The Karangat transgression resulted from influx of saline and warm waters of the Eotirrenian sea basin via the Bosphorus Strait. The Karangat basin marks the maximum extent in the Pleistocene history of the Black Sea. Its deposits, which includes a warmth-indicating Mediterranean fauna are widely distributed around the whole basin and form up to three marine terraces on the coasts. At this time, transgressive waters penetrated far eastward along the Manych, where marine deposits intercalate with the beds containing Late Khazarian brackish water fauna of Caspian origin. The Manych sections includes a three-layered sequence of Karangat and Late Khazarian deposits which indicates the interactions between the two marine basins. The following sequence is represented in the sections: beds with typical late Khazarian fauna (*Didacna surachanica*, *D. pallasi*) are overlain by sediments with Karangat (Mediterranean) euryhaline fauna (*Cardium edule*, *Chione gallina*, etc.). The latter are in turn overlain by beds with Caspian molluscan assemblages of different composition (including *Didacna subcatillus*, *D. cristata*). It is interesting that the Caspian fauna did not penetrate into the Karangat basin, and the Mediterranean fauna into the Caspian Sea. The Upper Khazarian deposits with fossil molluscs have only been recorded on the western and northern coasts of the Caspian Sea. They are represented by thin terrigenous and terrigenous-carbonaceous formations with specific assemblages of the *Didacna crassa* group which indicate a small dynamic marine basin.
MIKULINO (EEMIAN)-EARLY VALDAI (WÜRMIAN) CATENA
EVOLUTION OF THE MIDDLE RUSSIAN HIGHLAND

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The catena' evolution proceeds from increase of the energy of gravitational, soil, biotic processes in interglacial to them decrease in glacial. The catena' development characterizes by fluctuations, which manistates in repeated changes of morrholitogenic and pedogenic phases. The pricipal objects of my investigation are Mikulino (Eem)-Early Valday (Würm) catenas of Middle Russian Highland. They are observed in the walls of quarries between Dnieper (Riss) and Valday (Würm) loesses. Catenas remained in the depressions of eem palaeorelief. The branching net of Mikulino balkas were formed in the end of Dnieper (Riss) glaciation. Catenas take of the stratigrafical hosition of Mezin loess-soil complex, wich developments in Russian plain widely. In burried balkas this complex is presented by six different ages. The three early catenas were formed during tree optimums of Mikulino Interglacial. More late catenas were formed during Early Valday Interstades. In the first and late Eem' optimums the complex and contrast of catenas wre higher. The gray forest soil and soddy podzolic soil formedate on the slopes of balkas. The peaty podzols and secondary gley soils formedate on the bottoms of balkas. The dark gray forest-steppe soils on the interstreams. During the middle optimum of Mikulino Interglacial meadow forest soils were developed in the bottoms of balkas; chernozems – on interstreams. The pedogenetic phases alternated with the erosion' phases and accumulation of delluvial deposits. The local catastrophes apperred on transition period from Interglacial to Glacial. They show as the frequent fires, wich provoked of acceleration' erosion. The frost processes accelerated reconstruction of relief. The solufuction, eolian and colluvial deposits accumulated the Interglacial depressions and buried of Mikulino catenas. The balkas were broke up the reseved shallow depressions. The temperate zones of the broad-leaved forest and forest-steppe changed on the Early paraperiglacial forest-steppe.
In Early Valday (Würm) reliefformation processes feebled three times. In the Interstades meadow chenozem soils and meadow saline soils developmented in the reseved depressions, which formedate on the Mikulino balkas. In this time the forest-steppe soils formedate on the slopes and interstreams. The complex of catenas was decreaseedd. The formation of catenas in the Mikulino balkas was finished in the end of Early Valday.
81  THE EEMIAN IN THE NORTH-WESTERN PACIFIC

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Considerable climate warming of the temperate regions of the Northern Hemisphere and glacioeustatic transgression of the beginning of Late Pleistocene (Eemian epoch of Western Europe) are well displayed in marine coastal sequences of the North-Western Pacific, especially on Karaginskii Island, Eastern Kamchatka, and Alaska. On Karaginskii Island deposits of this age are represented by Attarman beds forming low coastal plain. They consist of shallow marine sands with abundant assemblage of boreal molluscs (Mytilus edulis, Cyclocardia crebricostata, Clinocardium californiense, Spisula voyi, etc.) including several low boreal forms (Protothaca adamsi) which are not typical of Kamchatka waters now. Deep-sea and arctic species are absent. In the coastal regions of Kamchatka deposits of this age form three marine terraces (35, 25-30 and 17-20 m). American scientists consider Pelukian deposits to correspond to the beginning of the Late Pleistocene. These beds form two marine levels being represented by shallow marine terrigenous sediments with thermophilic molluscan assemblage. The latter contains abundant low boreal (Protothaca adamsi) and boreal (Pododesmus macroshima, Mya japonica, Peronidia lutea, Macoma balthica) species. Most investigators date Val’katlen deposits of Chukotka by the beginning of the Late Pleistocene. Val’katlen deposits include specific molluscan assemblage with predominance of various Astarte and abundant Portlandia arctica siliqua at the base of the sequence and Mytilus edulis at the top of it. Carbonate shells from Val’katlen deposits of the Kresta Bay yielded radiocarbon age estimations of 27-33 Ka. If these dates are true, then the beginning of Late Pleistocene (Eemian in Europe) should be rather correlated with the shallow marine deposits of the Upper Kresta Formation, whose facial and faunistic characteristics are close to that of Val’katlen beds.
82 LATE PLEISTOCENE KARANGATIAN TRANSGRESSION IN THE BLACK SEA

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The Karangatian marine transgression in the Black Sea corresponds to Riss-Würmian interglacial (Eemian Stage). The Karangatian marine terrace on a tectonically stable coast is represented by nearshore and lagoon facies with rich fossils of molluscs, foraminifera, ostracods and nannoplankton. The stratotype of the Karangatian is at Cape Karangat (Crimea) but the best and the most complete section is the Eltigen cliff (south of Kerch). Karangatian fossils include more polyhaline thermophytic species than recent the Black Sea fauna, for example the molluscs Acanthocardia tuberculata, Paphia senescens and others total more 30 species, now absent from the Black Sea. This shows a higher salinity (30 permille) and water temperature of the Karangatian Basin, as well as sea level around +8-+10 a.s.l. This basin can be compared with the Strombus bubonis event in the Mediterranean.

The chronology of the Karangatian is based on U/Th dates and palaeomagnetic data. Three Karangatin terraces corresponded to three sea level oscillations developed on the Caucasian Coast: Ashe 40 m terrace (139 ka), Shahe 20-25 m terrace (100-120 ka) and the youngest, Agoy 10-15 m terrace (80-90 ka). The stratigraphical equivalent of the Karangatian Stage in the Sea of Marmara is the lowest 10-15 m marine terrace of Kaplan-Tepe (120 ka). The other higher terraces of Mediterranean are older than the Karangatian and Eemian ones.
83 THE TYRRHENIAN TRANSGRESSION IN NORTH AND NORTHWESTERN TURKEY

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New sections of Tyrrhenian terraces on Egeen Sea coast were first described in the Maritsa Valley (Gala Lake) and Saros Golf (Kavak, Bakla Burnu, Sugla Koyu). A marine mollusc fauna was found but no radiometric dates were available.

On the Anatolian coast of the Black Sea the Karangatian terrace which contains a rich mollusc fauna (Acanthocardia tuberculata, Paphia senescens) was dated by the U/Th technique. The wellknown Sinop-Kale terrace, 10-12 m, was dated as 100+/-7.5 ka BP and the Yoroz-Burnu terrace, 15 m, near Trabzon, is in the range of 106+/-9.1 ka BP. Two dates were also obtained from the Akcay terrace near Unie: at the bottom from shelly gravel 141+/-6.7 ka and in upper sands 98+/-4.9 ka BP.

In the Sea of Marmara and the Dardanelles three Tyrrhenian terraces are represented. The youngest and the lowest 10-12 m terrace in Kaplan-Tepe section was dated as 120+/-4.8 ka; this terrace corresponds to the Karangatian and the Eemian. 20-25 m terrace in Yelken-Kaya is 200+/-11 ka, the similar terrace in Kaytaz-Dere is around of 200 ka. The oldest Tyrrhenian terrace in Altinova was dated at 250+/-50 ka BP.
EEMIAN AND EARLY WEICHSELIAN VEGETATION AND
URANIUM/THORIUM AND THERMOLUMINESCENCE AGE
DETERMINATIONS FROM SECTIONS IN NORTHEAST-LOWER-SAXONY,
GERMANY

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In Lichtenberg (Lower Saxony, Germany) an archaeoalgeological horizon of Middle Palaeolithic age was
excavated and dated by geo-biological and chronostratigraphic methods (Veil et al., 1994). A depression
probably formed by Drenthe ice has been filled with fluvio-glacial sand and till of the Drenthe Stadial.
A sand of the Saalian Late Glacial on top of those sediments, is overlain by a sequence composed of
peat (Eemian) and silts and peat of the Early Weichselian. Peat growth started during the *cypripedium-
Zone and the profile reveals remarkably low amounts of *abies* (max. 1%) during the *pinus-picea-
abies-Zone of the Eemian interglacial. The Eemian deposits are conformably overlain by sediments of
Early Weichselian Stadial WF I, Brörup Interstadial, Early Weichselian Stadial WF III, Odderade
Interstadial and Weichselian Pleniglacial Stadial WP I. Peat of the youngest local pollen zone Li 9 of the
Odderade Interstadial provided a Uranium/Thorium minimum age of 60-64 ka (H. Heijnis, pers. comm.). The Odderade peat is covered by fluvial and alluvial sand and silty sand with gravels of a
solifluxion layer with thickness of about 2.5 meters. The archaeological horizon is within brownish
sand material at a depth of about 0.6 meters below the surface and overlies the silty sands and gravel.
The mean TL age of four samples gives an age of 57 +/- 6 ka (L. Zöller, 1994) and therefore reflects a
Lower Pleniglacial age.

The Eemian peat and travertine layers of the Schöningen open-cut coal mine (Lower Saxony,
Germany), situated at the ridge of the Elm, about one hundred kilometers south of Lichtenberg are, in
contrast to the Lichtenberg sequence, rich of *abies* during the *pinus-picea-abies* zone. The travertine
sediments were deposited during a period of about 6000 years, deduced from the reconstructed pollen
zones (after H. Müller). Local hydrological conditions during the late Last interglacial and Early Glacial
periods have been determined by pollen analyses and plant macro remains, specifically by moss
analyses. The Eemian peaty layers reveal a Uranium/Thorium age of 115-149 ka (H. Heijnis,
pers. comm.)
Spatial and Temporal Dynamics of the Eemian Climate in Northern Eurasia

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Determination of quantitative values for the main climatic elements (temperatures, precipitation, duration of the frost-free period) has been undertaken for Northern Eurasia (mainly on the base of palaeobotanical data). Two interconnected questions have been considered: 1) the climatic changes during the whole of the last interglacial and 2) the spatial differentiation of the interglacial climatic optimum. The course of temperature and precipitation changes within the Eemian interglacial was similar throughout northern Eurasia, allowing for variation due to continental climatic effects. The most considerable negative deviation of temperatures (especially of winter temperatures) and annual sum of precipitation, in comparison with the present-day conditions, was found in the initial phases of the interglacial, transitional from the previous cold stage. At the end of the interglacial temperatures, as well as precipitation, were also lower than their present-day values. Optimum climates were marked by increases in both summer and winter temperatures, in the duration of the frost-free period and by generally increased precipitation. In some regions, especially in the south, the proportional increases in precipitation during the interglacial were more significant than the absolute precipitation values, taking in consideration their influence on landscapes and biota.
THE EPPELSBERG: PRE-EEMIAN PYROCLASTICS WITH BIOLOGICAL REMAINS - A PRELIMINARY NOTE

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The tephra-sediments of the 'Eppelsberg' ash cone in the vicinity of the Laacher-See volcano, Eastern Eifel volcanic shield, Germany contain three soil horizons with layers rich in plant and animal remains (I-III). The oldest sediments (I) are considered to be 190,000 - 215,000 BP. The very top of the profile consists of Laacher See tephra aged ~13,000 BP. The horizons I and II yield macroremains of herbaceous plants, broad-leafed trees and shrubs and coniferous trees, and the imprints of various traces of molluscs and vertebrates.

Hollow erect standing trunks, fragments of branches and twigs within horizons I and II indicate woodland before imbedding by tephra began. Horizon I contains leaf-imprints of decidous broad-leafed trees in excellent preservation: Quercus sp. (leaves), Tilia sp. (leaves and fruits), Cornus sp. (leaves) and cf. Prunus sp. (leaves and fruits) have been identified yet, together with numerous leaf-imprints of Convallaria sp. These species clearly indicate interglacial conditions, the locality was semi-shady, moist with a slightly acidic substrate. No grassfragments can be observed here. It is not clear, when the tephra event during the vegetation period began.

Horizon II contains erect standing hollow trunks with diameters of ~50cm and a height of 8-10m. Some stems show a characteristic bark pattern, needled twigs and cones of different species: Pinus cf. sylvestris, Larix sp. and Abies sp.. The layer above the soil in horizon II yields well preserved imprints of Pteridium aquilinum indicating acidic conditions. The mixed forest here seems to have been dry and thin. It was inhabited by deer and birds. The inner imprint of a bird's nest probably built by Loxia sp., an imprint of a bird's feather and coprolithes of Cervus sp. are among the tephrofossils.

The Eppelsberg locality shows two very different types of forest within the horizons I and II, a broad-leafed community growing next to a fossil stream in a moist habitat, and a coniferous type responding to an exposed, well-drained position on tephra.
DIATOM FLORA IN EEMIAN (?) AND HOLOCENE SEDIMENTS FROM PUCK LAGOON, SOUTHERN BALTIC SEA - CORE KUZ –2, POLAND

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The material studied originates from a 15 m. long core (KUZ –2) which was taken by Polish Geological Institute at the Virgin Sands, the shallowest part of Puck Lagoon (Southern Baltic Sea). The core was subdivided according to the lithological changes. Each lithological division was sliced into 20 cm sections. Subsequently, quantitative and qualitative diatom analyses were completed in all the sediment sections. Next, diatoms were divided into groups according to their ecological requirements. Changes in the diatom species composition enabled the recognition of 7 diatom - stratigraphical zones and 8 subzones. The zones and subzones distinguished were statistically processed using the Bray-Curtis Similarity method.

1. An abundant and relatively well preserved diatom flora occurs in the core composed of sandy sediments with marine molluscs fauna
2. The diatom flora inhabited an highly variable environment.
3. There is a strong dominance of benthic diatoms that indicates the sediments were deposited in very shallow environment. Only in Subzone IVB was a mass appearance of planktonic form Cyclotella meneghiniana recording a deeper environment.
4. The salinity of the environment was subject to strong fluctuations. The sediment section dominated by brackish-water forms, is separated by sections with distinct content of freshwater taxa. Instability of environmental conditions is supported by cluster analysis.
5. C14 and pollen analysis of a peat layer shows the occurrence of a Boreal age peat bog. The above sandy sediments date Holocene Litorina (Zone VI) and Post-Litorina (Zone VII) stages of the basin development, whereas fine-grained sandy sediments underlying the peat were probably deposited during climate warming in the Late Pleistocene (Eemian Interglacial Stage).
BOREHOLE AMSTERDAM-TERMINAL: DIATOM FLORA OF THE EEMIAN TYPE AREA

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Over the last decade the results of multidisciplinary studies on sealevel change during the Holocene and the corresponding sedimentation patterns, processes and environmental changes offer a starting point for re-interpretation of data and the start of new investigations of the Eemian in the glacial basins at Amersfoort and Amsterdam.

The infilling of the Amsterdam basin starts in a fresh water environment under cold conditions in a periglacial landscape without trees, when the treeline had not yet passed this location. *Navicula jaernefeltii* is the dominant species in the lower assemblage at the base of the infilling. At the time the treeline passes, a freshwater lake with an *Aulacoseira italica* flora develops. Both diatom assemblages have not been found in the sediments of the Amersfoort glacial basin. At an early moment during the Eemian interglacial (pollen zone E3) the first marine influence occurs as shown by the *Fragilaria* bloom.

The following marine phase is characterized by three diatom floras, from bottom to top:

- a flora with *Hyalodiscus scoticus*, indicating clear marine-brackish waters without tidal influence.
- a flora characterized by allochthonous *Stephanopyxis turris* and *Chaetoceros* spores and *Cocconeis disculoides* which is autochthonous. The allochthonous flora element is indicative for cold oceanic water, the autochthonous flora for marine brackish, warmer and southerly waters. There is still no tidal influence in the basin,
- a flora characterized by *Cymatosira belgica* showing marked similarity to the holocene North Sea flora. In this phase the tidal influence is clearly present in the Amsterdam Basin.

The sediments in this core turn out to record a more extensive history than at Amersfoort.

The floras described here have also been found at locations elsewhere in the Eemian sediments of NW Europe; their distribution is not merely regional. These data give us the opportunity to deepen our insight in the climatological evolution of the Eemian in close relationship to changes in oceanic circulation patterns.
89   BOREHOLE AMERSFOORT I: DIATOM FLORA OF THE EEMIAN TYPE AREA

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The diatom flora of the glacial basin of Amersfoort was already investigated for diatoms by A. van der Werff about 40 years ago. These data were not used in the publications of Zagwijn (1961) and van Voorthuysen (1958), as these publications were focussed on pollen and foraminifera. In the lowermost part, the gyttja and clay-gyttja samples, no diatoms are found. On top of this gyttja and clay-gyttja layer two units are distinguished: The lower unit with species indicative of a marine-brackish lagoon with clear water and without any tidal influence. Most important species are Hyalodiscus scoticus, Grammatophora oceanica and Stephanopyxis turris. The flora is not autochthonous. Together with algal material from elsewhere in the basin, the diatom association is washed on the beach or into shallow coastal water. The upper unit shows a diatom flora which is almost identical with the flora we find in the present North Sea area. The most important species of this unit is Cymatosira belgica. This association is characteristic for a marine tidal environment.
PECULIARITIES OF THE MALACOFAUNA OF THE KARANGAT AND LATE KHAZARIAN BASINS OF THE PONTO-CASPIAN REGION

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The Karangat and Upper Khazarian deposits of Ponto-Caspian region, corresponding to Eemian and Tyrehenian Stages of Western Europe, contain specific molluscan assemblages. The Karangat fauna is distinguished by both: 1 - an absolute predominance and quantitative diversity of Mediterranean immigrants, and 2 - a considerable abundance of stenohaline and euryhaline Mediterranean species in reference sections of Karangat deposits (Karangat, Tobechik, El'tingen, and Chokrak). The sequence is represented by three beds. The lower bed is characterized by the predominance of euryhaline species (Cardium edule, Abra ovata, Chione gallina) with rare stenohaline forms (Paphia senescens). The middle bed represents the maximum stage of the transgression. It includes numerous stenohaline Mediterranean species (e.g. Cardium tuberculatum, Paphia senescens), which are now absent from the Black Sea, together with species inhabiting shallow open waters of the Black Sea (Donax trunculus). Decrease of the number of stenohaline molluscan species and their complete elimination occurs in the uppermost bed. As a whole, the Karangat fauna indicates the existence of the warmest and the most saline sea basin in the Pleistocene history of the Black Sea. The Late Khazarian fauna of the adjacent Caspian Sea characterizes the final stage in the evolution of Khazarian molluscan assemblages of the Didacna Eichw. genus. Molluscs of 'crassa' group predominate in them with the marker Didacna surachanica. Massive shells of this species are common in coarse grained shallow marine deposits which indicates the relative shallowing of the basin and the dynamic conditions. Like the Karangat fauna, the Late Khazarian molluscs characterize a relatively warm and brackish water basin. However, unlike the Karangat basin, it was a rather smaller and existed for short time period that represents the regressive stage in Pleistocene evolution of the Caspian Sea.
MACROSUCCESSIONAL PLANT SERIES OF THE EEMIAN IN EUROPE

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The evolution of the vegetation Eemian interglacial on the European plain is the most completely investigated of all the Pleistocene interglacials. The generalization of the palynological evidence on territory of a mean latitude of Europe (the Netherlands, France, Germany, Poland, Estonia, Latvia, Letuva, Belarus, Ukraine and Russia) has indicated the change of vegetation cover during the Eemian interglacial as a successional series of the palaeophytocenousis, which approximate to the changes of the pollen maxima of the principal forest trees. The results suggests:

a) The regular successional series from the end of Saalian Stage and to the beginning of Weichselian glacial stage comprises Not Aboreal Pollen→Betula→Pinus→Quercus→Corylus→Tilia→Carpinus→Picea→Pinus→Betula→NAP; b) Quercus predominates more often among of the broad-leaves trees; c) in most cases the Quercus + Ulmus maxima are at the same time, less often the change is Quercus→Ulmus; in the Netherlands, Vologda, sometimes in Estonia is change Ulmus→Quercus; d) on the east the Corylus + Alnus maxima are simultaneous, which change the Tilia predominates; in Poland and sometimes in Germany the Corylus→Taxus + Tilia→Alnus change is marked; in France and the Netherlands the successions Corylus→Taxus as a rule at the absence of the Tilia maximum; e) the Carpinus→Abies change with the consequent maximum Picea is expressed in Latvia, Poland, Germany and France; f) the suboptimal Picea maximum occurs in Estonia, Latvia, in northwest Russia (Vologda); g) the Picea maximum, with a high quantity of Betula, Pinus and NAP sometimes characterizes the Saalian lateglacial; h) in the east Osmunda cinnamomea, Tilia platyphyllos, Salvinia natans, Aldrovanda vesiculosa, Nuphiea alba and Picea obovata occur exotic elements, a role Ilex, Buxus, Myrica, Taxus, Hedera increases in the west; i) in separate sections in Belarus, Vologda and Petrozavodsk the two climatic optimums occur during interglacial that correspond the variations of an Oxygen Isotope curve in the oceans of the Northern Hemisphere.

The correlation of the Eemian interglacial vegetation by macrosuccessional series of the palaeophytocenousis from The Netherlands to Russia rather convincingly indicates that extreme western and eastern sequences show striking differences in the character of the pollen diagrams and structure of the exotic plants. It is necessary to take into account these variations by comparison only of the diagrams from most ancient sections of remote from each other territories. Perspective of such realization of researches for the Holocene and more ancient interglacial periods is obvious.
SEDIMENTATION CONDITIONALS DURING THE MURAVA (EEMIAN) INTERGLACIAL IN BELARUS

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150 sections in the Belarus have been studied palynologically. The sediments occur under tills of the Poozerje (Weichselian) gliation to the north of the glacial limit and beneath various equivalent fluvioglacial and periglacial sediments to the south from the limit. The Murava Interglaciation (120,000—80,000, Oxygen Isotope Substage 5a,b,c) as characterised by the UlanoVo early interglacial, the Chericov climatic optimum (complete macro succession series of the palaeophytocenosis, the development of the zones of the broad-leaved woodlands, the July temperature was 2-3° warmer than now, January temperature was more 3-6°C, the precipitation more 350 mm,) the borchovo cold snap (the zone of the mixed woods, the temperature of July less 2°, of January less 3-7°, the precipitation (less than 50-150 mm), the Komotovo climatic optimum (complete macro-succession series of the palaeophytocenosis, the development of the zones of the widebroad-leaved woods, the temperature of July was more 1-2° than now, of January - more 3-6°, the precipitation more 50 mm) and the Doroshevich late interglacial. Tilia platyphyllos, Osmunda cinnamomea, Brasenia sp., Betula sect. Fruticosae, Picea obovata, Ephedra sp. Larix sp. and Cornus sp. were exotic elements of the interglacial flora, Salvinia natans was a rarity.

The spectra of the principal climatic optima were characterized by the high content of the pollen of Quercus (60%), Ulmus (15%), Corylus (500%), Alnus (30-40%), Tilia (50-80%) and Carpinus (70-80%). The difference in the Picea maxima (20-60%) in the late interglacial in the north of the region and lack of it (less than 5%) in the south of Belarus is notable. The sediments comprise loam, clay, loamy sand, gytjja, sand, lime, marl and peat ranging from 2-22 m thick. The sections represent continous lacustrine sedimentation from the transitional cycle lake>swamp, the swamp cycle (with the 5 steps: the beginning of the interglacial, the beginning of the first optimum, the second half of the first optimum, the end of the first optimum, the end of the interglacial) and more complicated cycle of the sedimentation is also present.

The geochemical evidence indicates the distribution of the microelements in the sand sediments at the beginning of the interglacial; maximum concentrations Mo and rise Cu and Mn in the optimum, distribution of the microelements in the peat and minimum contents of Cu, Pb, Zr, decrease Cr, Co of the end of the interglacial. The fossil river sediments of the Murava interglacial contain more Ni and Mn in the second phase and less Ti in the 1,5 phase in comparison to the fossil soils of the Holocene. These changes in the concentrations of the microelements in the fossil soils are possibly connected to the palaeogeographical and geological peculiarities of the formation of the river soils and also to the processes of the hypergenesis of the organic substance after burial.
93  LATE PLEISTOCENE GLACIAL - INTERGLACIAL SEQUENCES IN DENMARK

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This poster presents the latest results of pollen analytical investigations of marine sediment sequences in Denmark. The work represents part of a large co-operative project with K.L. Knudsen and P. Kristensen (University of prhus).

Two cores from North Jutland, Nørre Lyngby 2 and Skagen 3, have been investigated. They have been correlated with the Eemian Interglacial Stage (Oxygen Isotope Substage 5e) and part of the Early Weichselian. Skagen 3 includes only the latter part of the interglacial. The pollen assemblages in both cores differ significantly from nearby terrestrial records; reflecting the nature of the depositional environment, taphonomic processes and current regime during a time of higher eustatic sea-level. The upper part of the Nørre Lyngby 2 contains an assemblage which is correlated with the Early Weichselian Brurup Interstadial; its first recognition in marine sediments of the type region. Nørre Lyngby 2 also includes a characteristic sub-biozone not seen in the Danish terrestrial sequence, which represents a climatic deterioration, similar to that observed in the foraminiferal assemblages from the same samples. This cooling event has been related to fluctuations in the strength of the North Atlantic Drift. The pollen sequences appear to have been influenced by changes in source area and surface water circulation, which supports the interpretation of the cooling events given by the foraminiferal record. The Ristinge Klint and Mommark cliff sections on Langeland and Als islands, southern Denmark respectively, expose glaciitectonically-disturbed fine sediments long known to contain marine mollusc shells. The sediments yield rich assemblages of foraminifera, ostracods and pollen and spores. The pollen analyses show sequences spanning the Eemian Stage interglacial. At Ristinge Klint, comparison with the Hollerup lake sequence (the Danish Eemian parastratotype) indicates that the profile represents the first half of the interglacial. Unlike the northern Jutland sites, the Ristinge sequence shows little modification by taphonomic processes, suggesting proximity to land and possibly only minor current activity. Comparison with the annually-laminated lake sequence at Bispingen, Lower Saxony demonstrates that the sequence represents c. 3.4-3.5 ka.

The Mommark sequence records fully temperate forest vegetation through the interglacial and again compares very closely to the Hollerup lake sequence. This comparison demonstrates that it spans the whole interglacial period. Comparison with the foraminiferan and ostracod assemblages indicates two marine transgressions, reflecting the interplay of eustatic sea-level rise and isostatic rebound effects. These sequences are of importance for our understanding the evolution of the Baltic basin through the Eemian Stage.