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The thematic focus on "Teleconnections between Eastern and Western Eurasia" was a perfect occasion to look back on our achievements during the last decade of NECLIME research. It was quite obvious from the contributions that the impressive data sets made available through the joint research of the NECLIME community as well as modelling studies using actual models really allow for the analysis of large scale Eurasia-wide patterns and the study of processes behind.

A second focus on "Pliocene climate and environmental changes" opened up a perspective for NECLIME to study include younger parts of Earth History including the onset of Pleistocene glaciation in order to study driving mechanisms and to refine the resolution of proxy data based reconstruction methods. A refined methodology could then be tested in older time slices.

We would like to express our appreciation to Funda Akgün, Serkan Akkiraz, and Mine Sezgül Kayseri and colleagues for a well-organized, very enjoyable meeting at a perfect location – Thanks again from all of us!

Abstracts

Palaeoflora and climate of lignite-bearing middle Miocene sediments in Seyitömer and Tunçbilek Basins, Kütahya, NW Turkey

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The study areas are located to the north and west of Seyitömer village and north of Tunçbilek village of Kütahya (Northwestern Turkey). Present elevation of the area is around 1000 m. The metamorphic and ophiolitic rocks and granites of the pre–Miocene form the basement rocks of the basins. The Early–Middle Miocene deposits in the Tunçbilek Basin are made up clastic sediments showing a decreasing grain size from bottom to top. Sediments of terrestrial and lacustrine environment contain half cemented conglomerates, clay, marl, siltstone, sandstone, lacustrine limestone, and of course lignite, located at lower and upper sides of the sequence. The main coal seam is interbedded in the clay–marl unit, which is several hundred meters thick. As the consequence of volcanic activity from the Upper Miocene till Pliocene lava, tuff and agglomerate were intercalated in the sediments.

In the Seyitömer Basin, the Early–Middle Miocene strata include, in ascending order: a lower clastic unit, a claystone–mudstone unit, a lower lignite seam, an organic shale unit, an upper lignite seam, a silicified limestone unit, clayey limestone unit and an upper clastic unit. In this study, two stratigraphical sections, around 35 m total thickness, were measured from the Seyitömer basin. Additionally, one section, around 12m total thickness was measured from the Tunçbilek Basin. The data from mammal indicate MN 4–8 (the late Early Miocene–Middle Miocene) age of the lignite–bearing sequences in these basins (Saraç, 2003). In contrast, late Middle Miocene (late Astaracian) is suggested on the basis of Moropus elatus by Kaya (1993). However, recent observations indicate that the coaly sediments in the Kütahya area were deposited during the early Langhian (Kaya pers. comm.) A total of 168 samples were collected for palynological analysis from the Seyitömer and Tunçbilek basins. 74 palynological samples were suitable for palynological counting. Pinaceae, *Picea, Pinus*, Cupressaceae and evergreen *Quercus* occur in the whole section in the Seyitömer Basin. In the lower lignite seam, the main components consist of *Polypodiaceae, Osmundaceae, Larix, Potamogeton*. In the organic shale and upper lignite seam, Ostrea, evergreen Quercus, Zelkova, Corylus, Fagus, Ulmus, Pinus silvestris type and Podocarpus, occur frequently. In the Tunçbilek Basin, the pollen content of the lignite seam is represented by high percentage of Polypodiaceae, Osmundaceae Pinaceae, Cupressaceae*, Alnus*, Arecaceae and lower percentages of Castanae, Cyrillaceae, *Engelhardia* that is represented lower percentages in the Seyitömer Basin as well.

In the Seyitömer and Tunçbilek basins, the vegetation was characterized by coniferous forests with seven different pine species, *Pinus haploxlyon* and *silvestris* types, *Picea, Cedrus, Cathaya, Keteleeria* and *Podocarpus.* An evergreen and deciduous mixed forest mainly composed of warm–temperate elements such as evergreen *Quercus, Corylus, Ostrya, Pterocarya, Fagus, Carpinus* and rare deciduous *Quercus, Carya*, Moraceae, *Acer*, Ericaceae, *Ilex, Betula, Tilia, Larix* and Cycadaceae, characterized areas of higher altitude. A riparian vegetation has been identified, composed of *Salix, Liquidambar*, Onagraceae and occasional abundances of Carya, Alnus, Zelkova, Ulmus and some ferns (Osmundaceae, Polypodiaceae). Palynological data reveals evidences for the existence of aquatic vegetation distributed in the lake system consist of *Potamogeton*, *Sparganium*, *Typha,* Nymphaceae and Cyperaceae.

In the course of the section in both basins, herbs and shrubs (mainly Poaceae, Amaranthaceae–Chenopodiaceae, *Artemisia, Ephedra*, Caryophyllaceae, Polygalaceae, Asteraceae, Ericaceae and Brassicaceae) are rarely represented. Organic shale also provides us well preserved leaves, consisting of Lauraceae, Taxodiaceae, *Fraxinus*, *Glyptostrobus*, Juglandaceae, *Momipites*, *Zelkova* and Betulaceae.

According to the results mean annual temperature of the Middle Miocene (mainly Langhian) flora is more or less comparable values between 17 and 20°C and do not show conspicuous differences from sample to sample. However, the coldest month temperature values are around 10°C that indicates the Mid–Miocene Climatic Optimum. Mean annual precipitation rates show some minor variations, commonly were on high level of more than 1000 mm. Lower precipitation rates, around 20–25 mm of the driest month are recorded, and well correlated with northern Spain, southwestern side of Central Europe and the Eastern Paratethys (Utescher et al., 2007).

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Flora and vegetation changes during the Late Pannonian-Early Pliocene in the Carpathian Basin.

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The Latest Miocene (Late Pannonian)-Early Pliocene deposits and inherent fossil assemblages attest significant palaeogeographic and consequent floral and vegetational changes in the Carpathian Basin. Lake Pannon, a large brackish water body, was isolated from the sea about 12 million years ago. The lake reached its greatest areal extent about 9,5 million years ago and flooded most parts of the Carpathian Basin. Filling up by progradation started during the Sarmatian (late Middle Miocene-early Late Miocene) and delta plains formed along the extensive northern shoreline prograded from the northeast and northwest. Fossil assemblages of Balatonszentgyörgy, Bükkábrány, Dozmat, Iharosberény, Rózsaszentmárton and Visonta depict the flora and vegetation of swamps and riparian habitats flanking the lake. Stratigraphic correlations and indirect stratigraphic considerations estimate a Late Pannonian age of the fossiliferous layers. Floral lists document uniformly a monotypic flora dominated by *Glyptostrobus*, *Alnus* and *Byttneriophyllum* species and intrazonal vegetation thriving in water, swamp or riparian habitats. During the Early Pliocene the lake shrank along its southern margin and withdraw from most parts of the Carpathian Basin. The fossil record from the Gérce and Pula assemblages documents this time slice also supported by radiometric data. Floral lists suggest diverse flora with re-appearing elements of the late Middle Miocene, zonal-type, mesophytic vegetation but no sign of the Late Pannonian characteristic swamp vegetation type. (The study is supported by the Hungarian Scientific Research Fund, OTKA 67644).

Hypsodonty humidity proxy revisited: precipitation and large herbivorous mammals during Eurasian Neogene

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Mammals have been used to describe and reconstruct environments in paleontology since its beginning. Apart from few studies (e.g. Andrews et al., 1979), only in recent few years the mammalian fossil record has been used to quantify environments using measurable variables. Here we use the novel application developed by us (Eronen et al. submitted) to quantify the changes and in habitats and environments during the Neogene. We apply our method to fossil

material, and compare the output to previous research results (Fortelius et al., 2002, 2003; Eronen, 2006) as well as to other proxy method results. The new method for predicting the precipitation based on large herbivorous fossil mammal communities can reproduce the patterns that have been published earlier (e.g. Fortelius et al., 2002, 2003; Eronen, 2006: Eronen et al., 2009). The method confirms earlier studies on the environmental development during the Neogene of Eurasia, and allows us to quantify the patterns. This opens possibility to analyse the environmental development in more detail and readily compare it to other quantitative proxies.

Our results show that during the Neogene the environmental change started in Eurasia around Middle Miocene times. The Late Miocene as a whole was a time of large changes, and there was continent-wide restructuring of distribution of environments. Most important drivers were the rise of the Tibetan Plateau, changes in the ocean currents and continentalization of Eurasian inland sea, the Paratethys. These resulted in redistribution of precipitation on continental scale, with some areas drying and others becoming more wet. The mammal proxy data is well in agreement with vegetation data, showing similar large-scale patterns and precipitation values. There are small scale differences, and these should be studied further.

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New plant type classification of the CARAIB model used to study the Middle Miocene vegetation

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The plant type classification used by the CARAIB (CARbon Assimilation In the Biosphere) dynamic vegetation model has been improved and our model takes now in consideration 26 groups. Among them, 3 groups are devoted to herbs and 15 to trees including cold/cool/warm temperate, subtropical and tropical types. The 8 remaining groups are new ones and concern shrubs from arctic to tropical conditions. This new classification allows a more precise modelling of the subtropical and tropical types of vegetations present in Europe during the Middle Miocene. This improved classification and the corresponding climatic tolerance parameters are based on the study of Laurent et al. (J. Veg. Sci., 15, 739–746, 2004) for the tree types currently present in Europe, on the distributions of analogue species in south-eastern Asia and on a set of a few other species distributions from other regions. In this study, simulations of the Middle Miocene vegetation over Eurasia are performed with the CARAIB dynamic vegetation model by using the outputs of the climate model PLASIM (PLAnet SIMulator). The modelled vegetation is compared with palaeovegetation data.

Modelling the Middle Pliocene warm climate and vegetation with PLAnet SIMulator and CARAIB. Comparison to pollen data over Europe

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In the Neogene long-term climatic cooling trend, the Middle Pliocene (about 3.3 to 3.0 Ma ago) represents the most recent warm period, similar in many aspects to the potential Earth climate of the late 21st century. Both terrestrial and marine palaeoclimate proxies suggest that high latitudes were significantly warmer, but that tropical sea surface temperatures and surface air temperatures were not very different from the present. The result was a substantial decrease in the latitudinal temperature gradient.

In this work, we simulated the Middle Pliocene climate using the PLAnet SIMulator (Fraedrich et al., 2005, Meteorol. Z. 14: 299–304 and 305–314), an Earth system Model of Intermediate Complexity. The PLAnet SIMulator was initialised with boundary conditions following the Pliocene Paleoclimate Modeling Intercomparison Project (PlioMIP) protocol (http://geology.er.usgs.gov/eespteam/prism/prism_pliomip.html). We then produced a Middle Pliocene vegetation distribution, using the dynamic vegetation model CARAIB (Galy et al., 2008, Quat. Sci. Rev. 27: 1396–1409), with a new classification of plant functional types and forced with the climatic outputs of the PLAnet SIMulator experiment. The CARAIB vegetation distribution was compared with pollen data over Europe.

Our results indicate a globally warmer Middle Pliocene climate compared to the preindustrial one, with a strong warming at high latitudes and a lower, but significant, cooling in the tropics. The forest ecosystems expand over the northern continents and desert areas are less prevalent during the Middle Pliocene, which is broadly consistent with the data.

Climatic and environmental significance of Pliocene Flora within Carpathian Area, Romania

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As a part of our NECLIME project “Neogene Climate Patterns and Flora Development in the Romanian Carpathians Area” we present here a critical synthesis of the published papers of a lot of authors, unfortunately already all in Romanian language. Newly revised lists of Pliocene Flora resulted and we discuss here their climatic and environmental significance. The results of complex evaluations based on physiognomic method combined also considering the arctotertiary vs. paleotropical relation, or tree vs. shrubs, are critically revised and compared with a new analysis by Coexistence Approach method.

Pliocene Coal Deposits in Carpathian Area

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Small or more extended Pliocene intra-Carpahian and extra-Carpathian Coal Deposits are known in Romania, either related with lacustrine environment or with the evolution of the Dacic Basin, one of the last remnants of Paratethys, representing the South Carpathian Foredeep. The most important Pliocene coal generating interval (from Early Dacian to Middle Romanian) covered already all the western part of the Dacic Basin with a huge quantity of brown woody coal (lignite). A cyclicity in the coal genesis was observed during a sustained subsequence, the vegetal material being accumulated during four steps: fluvial, fluvio-lacustrine, telmatic and finally, lacustrine, very similar to Ebisswalder Basin (see Nebert, 1983). And this was repeated of more times, because till 22 seams of coal, sometimes thicker than 2 m are known. The coal-generating vegetal associations around the marsh and lake areas comprised:

Marginally – forests with Conifers (*Sequoia*, *Glyptostrobus*, *Pinus*, *Sciadopytis*);

In the seasonally flooded areas – marshes with *Carex* and then with hygrophytes like *Alnus cecropiaefolia*, *Myrica lignitum* or, latter, with *Salix* sp., *Byttneriophyllum tiliaefolium*;

In the already permanently flooded areas – forests with *Glyptostrobus europaeus* and *Taxodium dubium*;

In the permanently flooded areas – vegetation with *Phragmites* and *Typha*;

In deep water areas aquatic – vegetation with *Stratiotes dacicus*, *Trapa* sp., *Nelumbo protospeciosa* and others

These associations, typical for each specific biotope made specific lythotypes with specific technical properties.

Analysis of ecosystem and palaeoclimate evolution in the late Miocene of South-western Bulgaria, based on pollen data from the Gotse-Delchev Basin

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Results of palynological studies on the late Miocene of the Gotse-Dechev Basin (SW Bulgaria) are presented. A 63 m thick profile was sampled for pollen analysis in the Kanina opencast mine. The exposed sequence comprises a basal unit with browncoal-clay cycles (app. 4.2 m) and clayey/siliciclastic cover layers partly representing a lacustrine facies. In the upper part of the section diatomites occur, overlain by sandy channels of a fluvial system. Besides a rich pollen flora including 106 pollen types, a diverse macroflora (fruits, seeds, leaf imprints) was collected in the same lithostratigraphic unit. A total of 86 pollen samples were analysed: 60 samples from the main section and 26 samples from a high resolution cycle in the browncoal horizon. Some samples were barren or contained very little pollen and were excluded from the analysis. Quantitative data are thus confined to 56 polleniferous samples.

The palynological analysis carried out on browncoal and the sediments above the coal horizon exposed in the open pit mine provides data about composition and structure of the fossil vegetation.

The ratios between main floristic elements and the composition of fossil flora are palaeoecologically analysed and discussed. The main vegetationial palaeocommunities that existed during the fossilization process are characterized as follows: Mixed mesophytic forests dominated by *Carya*, *Fagus*, *Betula*, *Quercus*, *Ulmus* formed the zonal vegetation that was wide-spread in the lowland and hilly areas surrounding the basin. A significant role in these forests also played species of *Magnolia*, *Corylopsis*, *Liquidambar*, *Eucommia*, *Zelkova*, *Ulmus*, *Castanopsis*, *Pterocarya*, *Juglans*, *Engelhardia*, *Platycarya*, *Symplocos*, Araliaceae, Vitaceae (incl. *Parthenocissus*), *Hedera*, *Cornus*, *Ilex*, Ericaceae, Theaceae, Pteridaceae, Osmundaceae, Polypodiaceae, Lycopodiaceae. Vegetation elements from the mid- and higher altitude such as *Pinus*, *Tsuga*, *Abies*, *Keteleeria*, *Picea*, *Cedrus*, cf. *Podocarpus*, *Juniperus* are also present. Palynological data reveals evidences for the existence of swamp vegetation with high proportion of *Alnus*, and minor percentages of Taxodiaceae (*Glyptostrobus*, *Taxodium*), Cyrillaceae, *Myrica*, *Planera*, Poaceae, Cyperaceae and some ferns (*Osmunda* and Polypodiaceae).

Species of *Platanus*, *Carya*, *Alnus*, *Ulmus*, *Ostrya*, *Pterocarya*, *Juglans*, *Salix*, *Staphylea*, *Liquidambar* played important role in the riparian vegetation. The aquatic vegetation distributed in the lake system consists of *Butomus, Potamogeton, Menyanthes, Sparganium, Typha* and Cyperaceae. Herbaceous palaeocoenoses had a delimited distribution – herbaceous plants (Apiaceae, Lamiaceae, Poaceae, Asteroideae, Cichorioideae, *Persicaria*, *Artemisia* and Chenopodiaceae) are well represented in all pollen spectra, but in comparatively low quantities.

The climatic data reconstructed by the Coexistence Approach indicate mean annual temperatures of ca. 15.6–17.1°C. For mean annual precipitation intervals from 1096 to 1347 mm are most common, but wider intervals of 823–1347 mm also result. The narrowest coexistence intervals for coldest month mean are 5 to 7.5°C, but in some cases the lower limit can go down to 3.8°C or even 0.6–0.9°C. Summer temperatures were between 24.7–26.4°C and 24.7–26.8°C, respectively. Especially the curve obtained for the means of summer temperatures cyclic changes, partly also observed for other temperature parameters. The dynamics of the reconstructed data indicate that the climate changes in the late Miocene of SW Bulgaria had a cyclic character. However, the presence of several unconformities in the sampled section does not allow for an unambiguous interpretation of these data.

The Late Miocene climate reconstruction from the Lincang flora, Yunnan, Southwest China

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The Miocene Lincang leaf flora is used in this paper as a proxy data to reconstruct the palaeoclimate of Southwest Yunnan (SW China). Three quantitative methods were chosen for this reconstruction: the Leaf Margin Analysis (LMA), the Climate-Leaf Analysis Multivariate Program (CLAMP), and the Coexistence Approach (CA). The reconstructed climate is similar to the subtropical modern one, with a higher seasonality in temperature and slightly warmer and wetter. The MAT (Mean Annual Temperature) is estimated at 21.4±1.36°C, 20.9±1.2°C, and 18.5–19.0°C, by LMA, CLAMP, and CA, respectively, compared to the present 17.3°C. The MAT calculated on an East Asian equation or a Chinese equation give different results (25.0±1.56°C and 21.4±1.36°C, respectively), confirming the need of a regional equation for more accurate estimates. The MAP (Mean Annual Precipitation) is estimated at 3698±336 mm and 1217–1394 mm by CLAMP and CA, respectively, compared to the modern 1178.7 mm. The rainfall results given by CLAMP and CA are inconsistent. The very high CLAMP estimates for MAP confirm the weakness of this method in reconstructing precipitation for warm/wet climates: the uncertainty of precipitation model is higher with increasing estimated values. Looking at the residuals of the CLAMP dataset, the leaf physiognomy of Lincang assemblage is compatible with lower precipitation than that estimated by the model. The reconstructed climatic parameters are in the range of those reconstructed from other Neogene palaeofloras of Yunnan, namely Xiaolongtan, Mangdan, Lühe, Longling, Eryuan and Yangyi. The monsoon is already established. Our results suggest that the South and East Asian monsoons were co-occurring during the Late Miocene in Yunnan. The Neogene climate of Yunnan, similar to the present one, lets us predict only slightly change in Yunnan climate due to Global Change.

Palaeovegetational and palaeoclimatıc interpretation during the Burdigalıan-Langhıan period in Turkey

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Results of the palynological studies of the Burdigalian-Langhian time interval are obtained from the previous studies which are Izmir-Sabuncubeli (Kayseri et al., 2007), Samsun–Havza (Kayseri and Akgün, 2008), Ankara–Beypazari (Güngör, 1991), Çanakkale–Çan and Balikesir–Gönen (Ediger, 1990); Çanakkale–Etili (Akgün et al., 2008); Aydin–Basçayir ve Kulogullari (Akgün and Akyol, 1999; Akgün et al., 2008), Milas–Kultak (Kayseri and Akgün (accepted). Numerical temperature values of these palynofloras are calculated by the coexistence approach an analysis method.

During the late Burdigalian-Langhian time interval, the temperature values of Turkey relatively higher than the values of certain localities in Europe. Turkey is located in southern latitudes throughout this interval and this palaeogeographic position of Turkey caused the palaeoclimatic differences. The CMT values of Turkey decrease from the late Burdigalian (average 10°C) to Langhian (average 8.5°C). The reason of this decline could be interested in the increasing of terrestrial condition in Turkey and/or transition of the late Serravalian cooling trend. For the Langhian time, temperature values of Europe higher than the values of Turkey. According to the palaeogeographic condition during the Langhian time, marine conditions are defined in the West Black Sea, Pannonian and Eastern Paratethys basins (Popov et al., 2004). These marine conditions could be caused the increasing the temperature values of the Europe. Besides the results of the CoA are generally high and these higher values of Turkish localities could be made up the effecting of the Middle Miocene Climatic optimum period.

Besides, temperature values of the some palynofloras of Burdigalian and Langhian in Greece (Spanokhorion and Evia "the latest Burdigalian", Kolivata "the Langhian" (Benda et al., 1982) are obtained. For the Sponokhorion area (western Greece) results are 9.1–10.8°C MAT, (–2.7)–1.1°C CMT (–0.8°C) and 5.0–13.3°C (9.15°C), 24.7–43.0°C (33.85°C) WMT, 34.65 and 24.7°C MART. For the Evia area (eastern Greece) 17.0–18.4°C MAT, 6.2–12.5°C (9.35°C) CMT, 26.5–32.0°C WMT and 19.9°C MART. According to MART values, presence of the high palaeotopographic conditions in the western Greece during the late Burdigalian time could be mentioned. The temperature values of Greece and Turkey resemble for the late Burdigalian time. The CoA analysis results of Greece for the Langhian time are 15.6–21.7°C MAT, 5.0–15.6°C (9.35°C) CMT, 24.7–27.9°C WMT and 16°C MART. In the western Greece from the late Burdigalian to Langhian time, the CMT values unchanged but the MART values are significant differences. These temperature results could be interpreted changing form the high to low palaeotopographic conditions could be said in this area. For the Langhian time, the CMT values of Turkey are higher than the values of Greece. Although Greece and Turkey in the Langhian time become approximately the same latitude, different temperature values indicate the diverse palaeotopographic conditions. In the Popov et al. (2001)'s palaeogeographic map of the Langhian time, marine conditions observe in Greece whereas terrestrial conditions generally seen in the western and central Turkey. Palaeoenvironmental results of obtaining in this study support Popov et al. (2001)'s results.

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Quaternay Palynoflora of the hydrothermal area Gülbahçe Bay (Aegea Sea): Paleovegetational and palaeoclimatic approaches

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Thermal hot waters have been known in the terrestrial areas in the vicinity of Gülbahçe Bay. The main target of this study is to examine the presence of these hot water sources in Gülbahçe Bay. For this purpose, it was used high-resolution shallow seismic study (3.5 kHz) to determine the high potential hydrothermal area in Gülbahçe Bay and collected by sediment sample by gravity corer in 14 points for palynological analysis.

According to palynological results obtained from sediment samples in Gülbahçe Bay, terrestrial and marine paleoenvironmental conditions determined for the Late Holocene period. High palaeotopographic and lowland areas surround the Gülbahçe Bay are covered by *Pinus*, *Castanea*, *Quercus* and Oleaeceae, *Ulmus*, Cyrillaceae. *Nyssa*, Taxodiaceae and Cupressaceae are grown in the narrow areas of freshwater marsh and between these areas there are defined the constricted open vegetation areas which are characterized by the Asteraceae, Cichorioideae, Greniaceae, *Artemisia*, Ephedraceae and Chenopodiaceae. Due to the rare presence of the certain dinoflagellate cyst (*Lingulodinium machaerophorum*, *Cymatiosphaera globulosa*, *Spiniferites ramosus* and *Spiniferites* spp.), existence of the Late Holocene period is supported. Additionally, *Pseudoschizaea* seldom and microforaminiferal test abundantly accompany with these palynomorphs and this cooperation could be suggested presence of hot water outlet in the Gülbahçe Bay during the Late Holocene period. According to the palynoflora defining in this study, it could be humid and hot palaeoclimatic conditions in the study area.

Detailed description of a Pleistocene palyno-assemblage from the Kathmandu Basin in relation to climate

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A detailed documentation of the palynoflora of a small part of the Lukundol Formation from the Kathmandu Basin in Nepal was performed to allow a better understanding of the plant taxa present in the latest Early or Middle Pleistocene of Nepal. The Lukundol Formation represents the oldest and major part of the basin fill of the Kathmandu Basin. Mountain valleys are very suitable for paleoecological interpretations based on palynological samples, because they are surrounded by high mountains, thus only a little amount of pollen can reach there from the hinterland except from the high altitude areas.

Altogether 78 different taxa were found, including 25 spores from ferns and mosses, 7 gymnosperms, 46 angiosperms and 1 freshwater cyst. The assemblage yields well documented elements of this area, such as *Pinus*, *Quercus* and Polypodiaceae, but also some rare elements, such as *Zanthoxylum*. The vegetation of the wetlands surrounding the shoreline is mainly represented by a high diversity of ferns. The area around the lake was characterized by a succession of vegetation belts due to the difference in elevation. Trees such as *Zelkova* or *Fraxinus* were possibly living around the lake, whereas *Quercus* and *Pinus* were more common in adjacent zones and higher up in the close by hills. *Picea* and *Abies* are also occurring, giving an example for the higher altitude vegetation.

The assemblage is an example for the vegetation of the comparatively drier late early to middle Pliocene Pleistocene phase in the Kathmandu Basin. There the climatic conditions in the valley had changed during the deposition of the Lukundol Formation. This phase is a result of the shift from moister and warmer climate with “tropical evergreen lower montane forest” to drier and cooler climate at c. 0.8 and 1 Ma. and the establishment of a “tropical evergreen upper montane forest. Many warm temperate taxa are abundant, such as *Engelhardia*, *Sapium*, *Symplocos*, Asteraceae or Rutaceae. Others, like *Betula*, *Carpinus*, *Juglans*, *Eleagnus* or Oleaceae, are also representatives of warm climate.

This is the first attempt to reconstruct absolute temperature and precipitation by means of the Co-Existence Approach for the Kathmandu Valley, which will give us further insight in the shift of the climatic situation in this intramontane Basin in the Pliocene/Pleistocene.

The study was supported by the FWF-grants P-21414-B16.

Pollen and in-situ mangrove roots indicate a mangrove associated vegetation in Burdigalian sediments of Kerala (South India)

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Miocene outcrops are extremely scarce along the south-western Indian coast. An exception are the c. 25 m height coastal cliffs at Varkala Beach, 22 km south-east of Kollam in the Kerala District of S-India, where marine and brackish sediments of the Burdigalian Warkalli Formation are exposed. A representative section was measured at a small creek (N 08° 43' 47'', E 076° 42' 30'') 420 meters south-east of the hotel "Hindustan Beach Retreat", where a more than 20 meters thick alternation of organic-rich clays with lignites and root horizons and sands with crustacean burrows is exposed. Distinct maker beds indicate that the sedimentary succession is laterally continuous over at least 100 m. Mangrove trees are massively documented in the clay facies by in-situ preservation of mangrove roots and pollen of Rhizophoraceae, Avicenniaceae, Bombacaceae, Sonneratiaceae and the Acecaceae *Nypa* in the diverse and well preserved palyno-assemblage. They indicate deposition in a tropical environment comparable to the present-day back-waters of Kerala. Peripheral mangrove species as well as mangrove associated backwater elements of the families Malvaceae, Caesalpiniaceae, Pteridaceae, Meliaceae are also frequent along with several representatives of Arecaceae. Although several studies have been published on the palynoflora of this section, no modern analysis is available so far.

Aside the possibility of reconstructing the palaeovegetation, the abundance of certain mangrove pollen may be used as proxy for the relative position of the sea-level in relation to the study site. Short-term back-stepping of the shore is reflected by fluctuating pollen spectra in the section.

As the tropical climate of the region today Early Miocene flora suggests similar warm conditions with high precipitation as well. In a next step more concrete climate data will be assumed based on the Co-Existence Approach.

The study was supported by the FWF-grants P-18189-N10 and P-21414-B16.

Millennial-scale vegetation dynamics in an estuary at the onset of the Miocene Climate Optimum (Korneuburg Basin, Austria)

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On the occasion of the construction of a motorway in the Korneuburg Basin a 1.8 km long section was documented in detail. The deposits, representing a paleoestuary aside the Paratethyan Sea, are dated into the latest Early Miocene corresponding to the lower part of the mammal zone MN 5, spanning a time between 16.5–16.7 my.

The here studied c. 120 m thick section comprises lignite, clay, silt, sand and rare pebble layers with abundant mollucs shell accumulations. Rootlets below the lignite indicate its in situ preservation.

Internally, it may be divided into at least 6 coarsening-fining upward cycles. The complete 1.8 km long section has been measured by a hand-held gamma-radiometer to evaluate the character of the cyclic changes in the deposition. Throughout the succession, the spectral analysis of the gamma-log data detected prominent, highly significant periodicities of 17.5 m to 22.5 m. The working hypothesis is that the observed cycles are expressions of the 21-kyr-precession signal, resulting in a sedimentation rate of roughly 0.8–1.1 mm per year. For this study a detailed palynological analysis of the lower 21 m of the c. 120 m thick section is provided, which is supposed to span roughly 21,000 years; the sample density should then account for a time resolution of c. 800–1000 years per sample.

The pollen spectra display several gradual trends as well as some shifts in the palyno-assemblages. A cluster analysis of the data set revealed several distinct and robust groupings, which suggest quite rapid changes in the paleoenvironment, related to cyclic marine ingressions into the estuary.

Local vegetation belts migrated within few centuries; even the expansion and demise of taxodiacean swamps, represented by a Taxodiaceae peak around the lignite, took place within few millennia (as also recorded for modern counterparts such as the Everglades).

The presentation will focus on the implications of such high-frequency vegetational shifts on the interpretation of pollen spectra and will discuss if such – probably astronomically driven changes – are only local phenomena within the estuary or if they may hint also to regional climate change at the onset of the Middle Miocene Climatic Optimum.

The study was supported by the FWF-grants P-21414-B16 and the Geological Survey of Austria.

Vegetation and climate during the Late Miocene (Pannonian) in the northern parts of Central Paratethys

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During Late Miocene, the Western Carpathian paleogeography started to change. The Lake Pannon retreated southwards, and the northern coast of the back arc basin was slightly elevated due to progradation of deltaic and alluvial facies, especially in the lowlands.

The studied „Pannonian lake" sediments come from the Czech and Slovak parts of Central Paratethys. Changes of the sedimentary environment from deep to shallow lake and deltaic environment, followed by development of alluvial plains were noticed. Salinity crisis due to Paratethys isolation led to development of total freshwater environment to the end of this period. Samples from 3 surficial localities and 15 boreholes were palynologically studied. Occasional occurrences of Dinoflagellates indicate a slightly higher salinity, whereas green algae *Pediastrum*, aquatic ferns *Azolla*, and aquatic and coastal plants (*Nelumbo*, *Nymphaea*, *Myriophyllum*, *Sparganium*, *Potamogeton*, Cyperaceae etc.) represent a freshwater environment. Due to paleogeographic changes and climatic oscillations the number of thermophilous taxa decreased and some of them disappeared completely from this area (f. e. Sapotaceae, Palmae). Mostly broad-leaved deciduous elements of mixed mesophytic forests (*Quercus*, *Celtis*, *Carya*, *Tilia*, *Carpinus*, *Betula*, *Juglans*) with some thermophilous elements admixture of *Engelhardia*, *Castanea*, *Trigonobalanopsis*, *Symplocos*, *Cornaceaepollis satzveyensis* generally dominate. Variously high relief of the uplifted mountainy chains created ideal conditions for higher presence of extrazonal vegetation (*Cedrus*, *Tsuga*, *Picea*, *Cathaya*) in the investigated area. Zonal type of vegetation including marshes, riparian forests with *Alnus*, *Salix*, *Pterocarya*, *Liquidambar*, *Betula*, *Fraxinus*, shrubs and lianas on dryer substrates associated riparian forest (*Buxus*, Ericaceae, Vitaceae, *Lonicera*, Rosaceae type *Rubus*), and coastal swamps with Taxodiaceae, *Nyssa*, *Myrica*, *Sciadopitys* were growing in the floodplain lowlands of Vienna Basin. Accumulations of the Chenopodiaceae in the interfluve areas probably indicate local saline swampy environments during sea level fall. The increasing amounts of herbs indicate the existence of wet prairie areas (*Thalictrum*, *Rumex*, *Valeriana*, *Dipsacaceae*, Lamiaceae, *Galium*) or steppes (*Artemisia* – up to 17%, Asteraceae, *Campanula*, Fabaceae, Daucaceae, Caryophyllaceae, *Plantago*).

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Vegetation and climate during the latest Oligocene to Miocene in Denmark based on palynological assemblages

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This ongoing study includes several Danish exposures and one drill core spanning the upper Oligocene-upper Miocene were palynologically investigated. The sediments were deposited in alternating deltaic, marginal marine and fully marine settings, and reveal a rich and diverse miospore flora, associated with abundant dinoflagellate cysts. The results consistently demonstrate that coastal areas in what is now Denmark were inhabited by *Taxodium* swamp forests that also hosted a range of terrestrial angiosperms, such as *Nyssa*, *Betula*, *Alnus* and Myricaceae. Further inland, mixed deciduous-evergreen forests prevailed and in drained soils, or in elevated areas, conifer-forests dominated by *Pinus*, *Sequoia* and *Sciadopitys* thrived. By employing the Coexistence Approach, the mean annual temperatures were calculated to 15.5–21.1° C for the late Oligocene-late Miocene. The warmest periods occurred during the earliest Miocene and the middle Miocene, respectively. The latter period represents a prolonged climatic warming event approximately 17–14 Myr ago. This warming is globally recognized and referred to as the middle Miocene Climate Optimum. Following this event, a marked climatic cooling occurred at about 11 Ma, which coincides with the beginning of the globally identified late Miocene Cooling phase.

Climate evolution of eastern North America in the late Neogene

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Contrasts with the situation in western North America, Neogene floras are unbelievably rare in the eastern part of North America. So far, there are five Neogene floras reported from this vast region. These include the early Miocene Brandon lignite in Vermont (~20 Ma), late Miocene Brandywine site in Maryland (10–6 Ma), latest Miocene-earliest Pliocene Gray Fossil Site of Tennessee (7–4.5 Ma), early Pliocene Pipe Creek sinkhole site in Indiana (4–5 Ma), and middle Pliocene Citronelle site in Alabama (3.4–2.7 Ma). In the present study, two of these floras, i.e. the Gray Fossil Site (GFS) and Pipe Creek Sinkhole site (PCS), are chosen for paleoclimate reconstructions by means of the Coexistence Approach. The results are shown in Table 1 as follows.

Table 1. Comparison of paleoclimates at the Gray Fossil Site and Pipe Creek Site and their modern climates. Quantitative paleoclimates are estimated by the Coexistence Approach, while the modern climates are retrieved from www.climate-zone.com.

Site	MAT (°C)	CMMT (°C)	WMMT (°C)	MAP (mm)	Wettest-P (mm)	Driest-P (mm)	Warmest-P (mm)
GFS	14.0–15.6	2.9–7.1	23.6–26.8	979–1520	148–225	9.0–24.0	120–149
Modern climate near Gray	13	1	24	1034	109	66	109
PCS	12.8–15.6	-4.1–4.4	19.3–25.4	735–1298	90–198	24–48	72–84
Modern climate near Pipe Creek	10	-5	23	884	91.4	48.3	88.9

The Gray Fossil Site, recently uncovered during a road project, has yielded many excellently preserved plant fossils, among which fossil fruits/seeds and pollen/spores are well present. In addition, charcoals are not uncommon. So far, we have recognized at least 35 genera, representing more than 25 families of seed plants. The dominant genera include *Carya* and *Quercus*. Based on the nearest living counterpart comparisons, these fossils are identified with certainty to modern genera. Seven climatic parameters are calculated (Table 1). A comparison with the modern climate in Gray is made, which indicates that the Gray region in southern Appalachian was under a climate different from the modern; especially its winter in the late Neogene was much warmer (2.9–7.1°C vs 1°C of today), which explains the occurrence of alligators in the fossil record. Furthermore, the much drier month at Gray in the past (9-24 mm vs 66 mm of today) might trigger intensive forest fires, which contribute the common occurrence of charcoals.

Twenty-three species of fossil plants recognized at the Pipe Creek Sinkhole site imply a different climate, not only from that of GFS, but also from that of today. It is clear that the early Pliocene PCS flora reflects a colder and drier climate than the latest Miocene-earliest Pliocene GFS (Table 1). This trend is well correspond with the global trend of climate change (Zachos et al. 2001).

Climate sensitivity on increased CO2 in the Late Miocene

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Various proxy data consistently document that the Miocene climate is a generally warm-humid phase. Some studies suggest that the Miocene is a possible analogue for the future climate change. However, there is a controversial debate about the carbon dioxide concentration in the Miocene. Some evidences support higher-than-present levels of atmospheric CO_2, some others seem to indicate low values of pCO_2. It appears to be enigmatic to understand warm polar regions with low CO_2 levels as well as it is paradox to have Arctic sea ice under conditions with high CO_2 concentrations. Climate models are tools to test different assumptions. We apply the atmosphere-ocean general circulation model COSMOS adapted to the Late Miocene and test different scenarios for atmospheric CO_2. First results indicate a seasonally ice-free Arctic Ocean in the Miocene with a carbon dioxide of about 600 ppm, and with a bit less than 800 ppm the Arctic Ocean is annually ice-free. In the Miocene model runs, the increase in CO_2 leads to a stronger climate response than under modern conditions.

Cenozoic plant record of Western Siberia - first results obtained from palaeoclimate and vegetation analysis

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Western Siberia has a comprehensive Cenozoic plant fossil record. As regards carpological materials, a first outline was presented by Dorofeev (1963) followed by numerous papers on single sites and taxonomical studies by the same author. The most significant contribution on the evolution history of flora and vegetation of Western Siberia and the Northeast of Russia from late Paleogene to Neogene was presented by Nikitin (2006). Herein, almost 400 floras from over 120 localities are analyzed. Their distribution mainly covers Novosibirsk, Tomsk, and the Omsk region. The palaeobotanical record is based on a collection of plant macro-remains comprising almost 20,000 specimens. According to botanical classification the fossil taxa represent 338 genera from 120 families, with over 100 morphotaxa present. Also, 11 new genera, 129 species, and 3 sections are described for the first time from this area. Boundaries of major floristic phases and specific stages of the vegetational evolution from the middle Eocene on are outlined and interpreted a succession of 10 floral zones.

The climate evolution in the Neogene of Western Siberia has been outlined by Nikitin (1988), but this reconstruction is based on qualitative interpretations of the floral record. While for Central Europe and Eastern Asia, detailed quantitative studies on Cenozoic palaeoclimate have been carried out in the frame of NECLIME (Neogene Climate Evolution in Eurasia) only little information is available for the continental interior of Eurasia. To close this gap, a project is initiated that aims at the reconstructions of palaeoclimate and –vegetation maps from the floral record published by Nikitin (2006) for various Cenozoic time slices using quantitative techniques. Thus, new insight in climate patterns and gradients in this key-area and their changes throughout the Cenozoic can be gained. Here we present first results of the analysis.

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Modelling the climate impact of high-latitude vegetation in the Late Miocene

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During the Cenozoic, global climate got successively colder. The Late Miocene belongs to the late phase of the Cenozoic cooling. The climate at that time was still warmer and more humid as compared to today. Especially, high latitudes were warmer. Corresponding to the climate situation, palaeobotanical evidences support that vegetation in the high latitudes changed significantly from the Late Miocene until today. Due to the pronounced cooling in polar regions, boreal forests of the Late Miocene were replaced by tundra and even glaciers nowadays. In fact, vegetation changes from the Miocene to today are caused by the global climate cooling, but vegetation changes themselves also had an impact of the climate evolution. For quantifying this impact, we analyse how strong vegetation changes in the high latitudes contribute to the climate evolution. From Late Miocene climate modelling sensitivity experiments, we analyse the role of vegetation changes in the high latitudes. We use the Earth system model of intermediate complexity Planet Simulator. Boundary conditions generally represent the Tortonian (Late Miocene, 11 to 7 Ma). For our sensitivity experiment, we introduce the modern vegetation in the high latitudes. As compared to the Tortonian reference run, the high-latitude experiment demonstrates cooler conditions and precipitation decreases. In addition, vegetation changes in the high northern latitudes leads to less precipitation and warmer conditions in the Sahara realm.

Regional climate modeling of Asian monsoon evolution in Late Miocene

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The late Miocene has been recognized as an important stage of Asian monsoon intensification. However, the knowledge on the spatial and temporal evolution of the Asian monsoon during that time is still limited, and the mechanisms for the change of Asian monsoon remain controversial. Most modeling studies on Asian monsoon evolution rely on global models with coarse horizontal resolution. This approach will miss the details of topography and climate changes. In this study, a regional climate model (CLM3.2) is used to investigate Asian monsoon evolution in the late Miocene. We use the existing late Miocene simulation results of a global atmosphere-ocean general circulation model (AOGCM) as the atmospheric forcing for our regional climate model. The topography (e.g. Tibetan Plateau) and vegetation are modified to represent the Late Miocene condition. With the higher resolution of our regional climate model, we will be better able to characterize the regional pattern of Asian monsoon changes in late Miocene, and to evaluate the contribution of topography, vegetation and global forcing to these changes. We are also interested in the question how the global forcing interacts with the regionally set boundary conditions in simulating the effect of Tibetan plateau uplift on the Asian monsoon.

Palaeotemperature estimates for selected leaf-floras from the Middle Pliocene of Central Europe based on different techniques

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To evaluate the “quality” of palaeoclimatic estimates derived from Cenozoic leaf floras it is necessary to test the reliability and comparability of different quantitative techniques under a wide variety of different “boundary conditions” (i.e. depositional setting, stratigraphic age, geographic source area). For this purpose we have chosen the (more or less) contemporary Pliocene leaf floras of Willershausen and Berga because the taxonomic composition of both floras is well known and both are relatively diverse. Additionally we analysed a third flora (Frankfurt am Main [the so called “Klärbecken Flora”]) which is also believed to be almost contemporary with the former two floras, but this flora has not been revised taxonomically since the monograph by Mädler (1939). We have

chosen this particular flora to test the influence of the "quality" of taxonomic revisions on the different approaches (assuming that many determinations by Mädler are probably not correct in the light of modern taxonomy).

For our comparison we have chosen the Coexistence Approach (CoA; based on comparison with NLRs) and three leaf physiognomic techniques; i.e. CLAMP (multivariate; North-American and E-Asian calibration), ELPA (multivariate, European calibration [to be seen as preliminary]), and leaf margin analysis (LMA; univariate; north-American and E-Asian calibration).

For all three floras temperature estimates obtained with CoA are very uniform with MAT around 14–16°C, WMMT around 25°C and CMMT around 1–4°C. CLAMP estimates for MAT and WMMT are consistently lower than CoA estimates for all three floras, whereas CMMT estimates of both techniques are in relatively good agreement with each other. LMA and ELPA estimates for MAT are lower than CoA estimates for the localities Willershausen and Berga, whereas they are warmer for Frankfurt.

These results are in agreement with previous observations: CLAMP produces cooler temperature estimates (i.e. MAT and WMMT) than CoA (and, in some of these previous cases, independent proxies) for many palaeofloras from the European Neogene. LMA derived MAT estimates show no such clear trend, but the reliability of this technique has to be questioned due to problems with taphonomic biases influencing the results obtained from this method. Leaf physiognomy based estimates for Frankfurt are somewhat warmer than for Willershausen and Berga and they show a larger variability between the different techniques, maybe reflecting problems with the taxonomy of this flora (leaf morphotypes [=taxa assigned by Mädler, 1939] may not reflect meaningful taxa as seen by modern taxonomy). Although the CoA results for all three floras are mostly in good agreement with each other, an observation that is especially interesting when considering the fact that the Frankfurt flora is in urgent need of a modern taxonomic revision, this is not the case for the estimates from leaf physiognomic techniques.

References

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Evidence of marine isotope signals in Cenozoic continental climate curves based on palynological data – quantification of climatic change

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Quantitative palaeoclimate records based on palynological data from continental and marginal marine sequences of the European Cenozoic are compared to the global oxygen and carbon isotope stratigraphy and eustatic sea-level change. The identification of marine cooling events and third-order sea-level lowstands in continental records evidences a distinct coupling of both environmental systems. Unlike the isotope data, continental records provide insight into the climate and its variability because different variables can be assessed. Persistent sedimentation over longer time-spans such as peat-forming during the Langhian/Serravallian and in the Tortonian allows for an analysis of the climate evolution during phases of global sea-level lowstand.

Regarding the different variables analysed (MAT; CMM; WMM; MAP; MPwet; MPwarm; MPdry), it is shown that climate change at the cooling events was non-proportional. In the time-span from Eocene to Oligocene, the Northern European records indicate that cooling is often combined with precipitation rates decreasing. From Oligocene to early Miocene the marine signals are well expressed while in the Mid-Miocene, phases of sea-level lowstands are characterized by minor cooling only, and annual rainfall rates and summer temperatures tend to be unaffected. Higher amplitudes of change point to decreasing climate stability from the late Miocene on. In Pliocene records from the higher latitudes cooling is mainly expressed as a decrease in winter temperature combined with increasing precipitation rates, in contemporaneous records from lower latitudes (Northern Tethys, Italy), in contrast, cool phases tend to be drier.

Pliocene palynofloras in correspondence to global changes: evidence from some areas in China

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Pliocene represents the final stages of a global cooling trend that led up to the Quaternary ice ages. It is also the last period of the Doubthouse world between Greenhouse world and Icehouse world (Barrett, 2003). Changes in the Pliocene pollen floras will possibly display some environment variations which would relate to global changes, and thus better understand the bilateral interactions during this important period in the earth history.

Palynofloras in the Pliocene of China show some distinguished changes. An extensive development of herb components is recognized, especial in East China, while some xerophytes are well represented in NW China. In the late period of Pliocene, there were some evident floral fluctuations in many places. This is indicated by a consistent representation of *Artemisia*, Chenopodiaceae, *Ulmus* and Pinaceae pollen, together with some minor thermophilic elements such as *Juglans* and *Carya*, which are periodically occurring in the pollen sequence in East China. Pliocene pollen floras in SW China show some similar fluctuations but in a different way, represented by a large amount of Pinaceae, some largely decreased broad-leaved forest, further developed Pteridophytes and a little increased herbaceous elements with their values displaying periodically expansion and retraction.

Evidence show these major changes are closely related to the uplift of Qinghai-Tibet Plateau and the worldwide climate cooling at ca. 3.5 Ma and 2.5 Ma respectively. Meanwhile, the ever increased winter monsoon might have an overall control to some local vegetations. Some newly developed data, along with other evidences are presented in the discussion.