

(SS09) Quantifying Cenozoic vegetation – new developments in standardized approaches (a joint ROCEEH and NECLIME symposium)

Date: August 30

Place: Room 5235 (oral)

Organizers: Angela A. Bruch, Elena Vassio & Johanna Kovar-Eder

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Purpose: Standardized methods for vegetation reconstructions are crucial tools to obtain comparable results for fossil floras from different regions and independent from the scientist using the method. Regional or global vegetation reconstructions are a base for as different objectives as landscape reconstructions or climate modeling. Depending on the scale of the objected vegetation unit to be reconstructed, a method has to meet special preconditions and therefore can vary considerably in its theoretical setting.

Several methods were developed during the last years which are based on different philosophies (taxonomic or physiognomic) and approaches (semi-quantitative to statistical), cover different spatial scales of the reconstructed vegetation units (local, regional, or global), or rely on different fossil plant remains (macro or micro floras). Each of those has specific advantages for specific scientific applications.

Our symposium aims to give an overview to the state of the art of methods available and their latest developments. It is NOT meant to be a competition to find “the best method” but to stress the necessity of standardized vegetation reconstructions, to promote their application, and to provide a tool box for various crucial scientific questions.

Oral Presentation

Aug. 30 [AM1] Room: 5235

Chair: Angela A. Bruch

9:00-9:20 **[Introduction] Quantifying Cenozoic vegetation – new developments in standardized approaches** SS09-O01

Angela A. Bruch

9:20-9:40 **Further steps towards a management of the bias between vegetation and sedimentary fruit and seed assemblages** [SS09-O02 \(542\)](#)

Elena Vassio, Edoardo Martinetto

9:40-10:00 **Integrated Plant Record (PR) vegetation analysis validated by application to modern vegetation types in China and Japan** [SS09-O03 \(252\)](#)

Johanna Kovar-Eder, Vasilis Teodoridis

10:00-10:20 **Palaeovegetation reconstruction in monsoonal regions** [SS09-O04 \(209\)](#)

Frédéric MB Jacques, Tao Su, Jianwei Zhang, Li Wang, Yongjiang Huang, Jinjin Hu, Shufeng Li, Mei Sun, Zhekun Zhou

Aug. 30 [AM2] Room: 5235

Chair: Elena Vassio

10:50-11:10 **Anomalies in Cenozoic vegetational gradients on both sides of the North Atlantic - induced by Gulf Stream intensity?** [SS09-O05 \(539\)](#)

Torsten Utescher, Madelaine Böhme, Boglárka Erdei, Thomas Hickler, Yusheng (Christopher) Liu, Volker Mosbrugger

11:10-11:30 **Quantifying openness of palaeovegetation with modern LAI data – an attempt towards a new approach** [SS09-006 \(53\)](#)

Angela A. Bruch

SS09-002 (542)

Further steps towards a management of the bias between vegetation and sedimentary fruit and seed assemblages

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In order to improve the reconstruction of local terrestrial palaeovegetation by means of quantitative and qualitative data from European Cenozoic carpological (fruit and seed) assemblages, actuopalaeobotanical investigations have been carried out in some small fluvial catchment basins (NW Italy), characterised by different vegetation and topographic contexts. The aim of these observations consisted in evaluating and quantifying the mismatch between fruit and seed assemblages and their source plant communities. The comparison of qualitative and quantitative floral data, obtained from vegetation relevés and deposit analysis has been carried out by means of the standardised and synthesised graphical approach of “*Plant Community Scenarios*” (*PCSs*). Modern diaspore contents allowed to distinguish assemblages originated in different basins, moreover, those sampled in the same basin provided homogeneous and peculiar signal. Comparison across all samples indicated a certain agreement between modern vegetation and the *PCS* reconstruction based on the analysis of fruit and seed assemblages. The last ones seem to better summarise – at least qualitatively - the whole basin area vegetation instead of that of the areas next to the sampling point. The fluvial accumulations of diaspores show similar frequency values for several taxa, which seem to indicate that bedload transport can produce some “homogenisation” of the fruit and seed mass. On the other hand, some samples taken in the same zone, display how much the frequency of taxa can change, within a uniform vegetation context, for the sole effect of sedimentary processes. The bias between each taxon’s proportion in standing vegetation and in the related sedimentary assemblages has been evaluated and some common patterns of over-/underrepresentation have been pointed out, as an indication of generalised determining factors. These include environmental processes and diaspore features that affect plant material from the production (diaspore size, shape, woodiness, abundance), through the transport, until the final deposition and incorporation in clastic sediments (environmental energy, grain size, slope morphology). Small dimensions, consistent woodiness and rounded shape appear to be connected to overrepresentation. In addition, the dispersal mode seems to be very important: a clear overrepresentation of anemochorous, endozoochorous and myrmecochorous diaspores has been detected. Moreover, the bias for some taxa has been quantified, thus allowing to propose some preliminary correction factors (*Bias-index*). These have been taken into account, and applied as a key to the interpretation of analogous fossil assemblages, thus obtaining corrected *PCSs* which should provide a less biased picture of ancient vegetation.

Keywords: diaspores, fluvial deposits, representation bias, actuopalaeobotany, quantitative vegetation reconstruction.

SS09-O03 (252)

Integrated Plant Record (IPR) vegetation analysis validated by application to modern vegetation types in China and Japan

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The Integrated Plant Record (IPR)-vegetation analysis is a semi-quantitative tool developed as a proxy to assess zonal vegetation classification. It is based on fossil plant taxa categorized into zonal taxonomic-physiognomic components reflecting key autecological characteristics. The proportions of these components in the fossil assemblages define main vegetation types. Modern vegetation studies in SE China (Emei Mt., Longqi Mt., Meili Snow Mt.) and Japan (Shirakami Sanchi, Mt. Fuji, Nara, Yokohama, Yakushima Island) are performed here to test this fossil-based technique and achieve fine-tuning and corroboration. Thirty-five different units of different vegetation formations generally defined as broad-leaved evergreen forests, mixed mesophytic forests, broad-leaved deciduous forests, and subhumid sclerophyllous forests have been investigated. The IPR-vegetation analysis results obtained from this modern vegetation largely support the originally defined proportions of the important zonal woody angiosperm groups, i.e., broad-leaved deciduous, broad-leaved evergreen, sclerophyllous and legume-type components, in the defined main vegetation types, and cluster analysis confirms these results as well. Nonetheless, it appears appropriate to define ecotones and to adapt the threshold value of the broad-leaved evergreen component for the definition of broad-leaved evergreen forests. The results reflect a distinct underrepresentation of zonal herbs in the fossil record, regardless whether leaf, pollen, or fruit assemblages. The vegetation scheme based on the IPR-vegetation analysis is therefore extended to properly reflect zonal herb diversity in modern vegetation. The results also confirm a higher diversity of zonal herbs in broad-leaved deciduous forests versus broad-leaved evergreen forests, as observed in the Neogene European record.

Keywords: Paleogene, Neogene, recent, methodology, Asia.

SS09-O04 (209)

Palaeovegetation reconstruction in monsoonal regions

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Recently, several methods have been developed to reconstruct palaeovegetation. Among them the Integrated Plant Record (IPR) and the biome reconstruction has been used at the regional scale both in Europe and in Asia. Because European Cenozoic floras show affinities with modern floras of South-East Asia, we think it worth to test these two methods in a monsoonal context. We focus our study on the Neogene of the Hengduan Mountains and the adjacent sites in Yunnan. This region is very important because it is one of hotspots of biodiversity around the world. This high biodiversity is

the consequence of the topography: high mountains separated by deep valleys. This topography is the result of the uplift of the Tibetan plateau and Himalayan Mountains. Therefore, it is very important to understand when the modern vegetation appeared in this region. At present day, this region also exhibits a broad range of vegetation types, from tropical forests to alpine meadows. We work on 14 fossil sites including leaf, pollen and fruit assemblages. The climate at that time as temperatures similar to the modern one, and the monsoon is already established, even if potentially weaker than now. The IPR vegetation analysis can reconstruct six vegetation types based on 15 phenological and autecological components. In China, 19 biomes can be reconstructed based on 76 Plant Functional Types (PFTs). This region was mostly forested at that time and the climate was warm; therefore, the contrast or the resolution of the IPR vegetation analysis is not high enough to discriminate between the different vegetation types. The reconstructed biomes show more differences and contrast. On the other hand, because the IPR has only a few components, it is easier to reconstruct a gradient in evergreen taxa or sclerophyllous taxa in a region. The PFTs on which the biomes are based are too detailed to study the gradual change in the vegetation between sites. We conclude that these two methods are complementary: the biome reconstruction gives a detailed and precise view of the past vegetation whereas the IPR vegetation analysis allows to study the gradual changes in vegetation between sites.

Keywords: biome reconstruction, integrated plant record, Hengduan mountains, Yunnan, Neogene.

SS09-O05 (539)

Anomalies in Cenozoic vegetational gradients on both sides of the North Atlantic - induced by Gulf Stream intensity?

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Today an effective Gulf Stream accounts for mild, maritime climate in Western Europe and causes significant longitudinal, climatic anomalies when comparing both sides of the North Atlantic, expressed in differentiated biome patterns. E.g. at ca. 40° northern latitude, evergreen broadleaved sclerophyllous woodland of the Northern Mediterranean corresponds to cold deciduous forest at the American East Coast, at ca. 55° cold deciduous forest to subarctic needleleaved woodland. Actually, the Gulf Stream topic is very active and a slowing-down or cessation of the thermohaline circulation in the North Atlantic and its consequences for Western Europe are discussed within the context of future climate change. To improve our knowledge on interactions between climate and biosphere we study finger prints of the North Atlantic circulation and its changing intensity on past vegetation patterns in the adjoining continental areas along the Cenozoic. Due to the unfavorable data cover in the eastern North America this is achieved not only by direct comparison of both regions, but also by detailed study of related gradient changes in Western Eurasia. Presently we analyze diversity gradients derived from the palaeobotanical record in a series of time slices using a system of 26 different herbaceous to arboreal plant functional types (pfts). First results indicate that Palaeogene to earlier Neogene vegetation of the mid- and higher latitudes of Western Europe do not have a

comparatively cool aspect as could be expected from a weaker Gulf Stream prior to the closure of the CAS. In contrast, thermophilous pfts such as broadleaved evergreen woody plants even tend to have a diversity centre in the latter region when compared to the American East Coast and other Eurasian mid-latitudinal areas. Being most striking in the Eocene, this persisting pattern is still visible in the late Miocene and might mirror the impact of warm and wet climate on the vegetation existing in the Tethyan Archipelago. Miocene biomes existing at about the same latitude on both sides of the Atlantic appear less diversified when compared to present, a fact that can be related to the shallower climatic gradients resulting for both continental areas. The analysis of diversity patterns of drought-tolerant pfts allow for assessing relations of Gulf Stream intensity, the spread of open environments in the late Neogene of Southwestern Europe, and potentially drier than present conditions along the East Coast of Northern America. [Grant: DFG MI 926 / 8-1]

Keywords: palaeobotany, Neogene, plant functional types, Gulf Stream, diversity.

SS09-O06 (53)

Quantifying openness of palaeovegetation with modern LAI data – an attempt towards a new approach

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Although widely used in palaeontological literature to describe fossil habitats of animals and early humans, terms like "open woodland", "savannah", or "open environment" are poorly defined in botanical and ecological sense. They tend to comprise all kinds of habitats that cannot be clearly assigned to closed forest (no open spaces) or open steppe (no trees). In an attempt to better distinguish the different types of open habitats quantitatively, a new quantitative method based on the principles of the Coexistence Approach is developed to exploit remotely sensed data as independent proxies of vegetation density for correlation and will use such numerical data as leaf area index (LAI), vegetation cover and greenness as provided by Masson et al. (2003). These parameters are so far widely used for vegetation modelling of open environments. However, their exploitation for palaeoenvironmental questions is not yet fully elaborated. To test this approach we apply the GIS-based Coexistence Approach (CA_{GIS}) on fossil plant material from an archaeological site in South Africa. Previous qualitative environmental interpretations of the fossil fauna and flora from the Middle Stone Age site Sibudu, KwaZulu-Natal, remain ambiguous. Because much of the material is anthropogenically introduced, it is difficult to distinguish between the effects of natural changes in the local vegetation and behavioral changes of the people that inhabited the shelter. CA_{GIS} can be applied to such biased assemblages and seems to be an adequate method to directly quantify not only palaeoclimate but also vegetation parameters at an archaeological site. Obtained data show a distinct increase of winter temperatures, summer precipitation, and vegetation density from 60 to 50 ka.

Keywords: palaeovegetation density, methodology, leaf area index, Coexistence Approach.