(SS17) Palaeoecology of Cenozoic conifers – limits of actualisms?

Date: August 28
Place: Room 5233 (oral)
Organizers: Lutz Kunzmann, Martina Dolezych & Wilfrid Schneider
Contact email address: Lutz.Kunzmann@senckenberg.de
Purpose: Cenozoic conifers are often regarded as crucial for reconstructing of ancient ecosystems including lignite-forming swamp vegetation and mixed broad-leaved polar forests. The purpose of this symposium is to elucidate methods for palaeocological investigations and to evaluate their validity for the reconstruction of palaeoecosystems. Special focus will be on:
(1) Taphonomical investigations: Plant taphonomy has a great potential for palaeoecological reconstructions. *In-situ* plants and (par-)autochthonous assemblages provide a direct insight into the structure of the ancient phytocoeneses.
(2) Vegetational reconstruction: Cenozoic conifers are common in zonal mesophytic forests of nearly all palaeolatitudes as well as in azonal vegetationtypes including swamps and riparian forests. Not all of the fossil conifers may provide decisive environmental information based on the ecological requirement of the next living relative species. Autecology of present-day species that are typical relics surviving in niches do often not match the habitat of their Cenozoic ancestors. The interpretation of autecology of extinct taxa is of particular interest.

Oral Presentation

Aug. 28 [AM1] Room: 5233

Chair: Lutz Kunzmann

9:00-9:40 **[Keynote] The Tertiary paleoecology of selected representatives of the Pinaceae and Taxodiaceae** SS17-O01 (275)

Ben A. LePage

9:40-10:00 **Fossil conifers in peat bog environments – results from the central European Neogene** SS17-O02 (102)

Martina Dolezych, Wilfrid Schneider

10:00-10:20 **Paleoecology of *Cunninghamia* from earliest Miocene Shichiku Flora of Northeast Honshu, Japan** SS17-O03 (582)

Atsushi Yabe, Chiyomi Yamakawa

Aug. 28 [AM2] Room: 5233

Chair: Martina Dolezych

10:50-11:10 **Palaeoecology of extinct conifer genera in the European Cenozoic** SS17-O04 (258)

Lutz Kunzmann, Wilfrid Schneider, Martina Dolezych, Dieter Hans Mai

11:10-11:30 **Study of extinct and extant major tree genera in Japan on the basis of late Miocene plant habitat** SS17-O05 (244)

Makiko Kobayashi, Susumu Okitsu

11:30-11:50 **Temperature niche shift during the Holocene** SS17-O06 (69)

Rachid Cheddadi

SS17-O01 (275)
The Tertiary paleoecology of selected representatives of the Pinaceae and Taxodiaceae

Ben A. LePage

The Academy of Natural Sciences, 1900 Benjamin Franklin Parkway, Philadelphia, PA, 19103 and PECO Energy Corporation, 2301 Market Street, S7-2, Philadelphia, PA 19103, ben.lepage@exeloncorp.com

Most genera of the Pinaceae first appeared in the high-latitude and high-altitude regions of North America during the early Tertiary. Of the eleven modern Pinaceae genera, six including some of the earliest known representatives of *Larix* Miller, *Tsuga* (Endlicher) Carrière, *Picea* A. Dietrich, and *Keteleeria* Carrière, are present in the middle Eocene deposits of the Buchanan Lake Formation at Napartulik on Axel Heiberg Island, Arctic Canada. Despite being widely distributed during the early Tertiary, the fossil record indicates the Pinaceae were rare elements in the generally Taxodiaceae-dominated floras. The early Tertiary fossil record of *Glyptostrobus* Endlicher, *Metasequoia* Miki, and *Taiwania* Hayata indicates a much wider distribution than that seen today. In many cases their distribution extended from about 30°N to 80°N indicating these genera grew under a much more diverse range of climatic and environmental conditions than that indicated by their modern, geographically restricted, native populations. Aspects of redwood ecology, physiology, and forest structure indicate these representatives were well suited to early Tertiary climate throughout their distribution range. However, global climatic cooling and increased aridity negatively impacted the redwoods and favored representatives of the pine family. The mycorrhizal relationships between these two families correlate well with the changing climate and appear to have had a significant impact on range reduction in the Taxodiaceae and range expansion in the Pinaceae.

Keywords: Arctic, climate, Cretaceous, evolution, land bridges.

SS17-O02 (102)
Fossil conifers in peat bog environments – results from the central European Neogene

Martina Dolezych[1], Wilfrid Schneider[2]

[1] *Senckenberg Natural History Collections Dresden, Germany, Martina Dolezych@senckenberg.de*
[2] *Hoyerswerda, Germany*

Conifers are among intensively investigated fossil plants in the central European Neogene. Several genera proven from lignites are relicts in the recent Asian floras. It has been also shown that certain genera probably had a diversification and spreading centre in Europe or Eurasia. This contribution summarizes knowledge on distribution and palaeoecology of some of the most important taxa. Both representatives of extinct genera as well as representatives of present-day genera will be mentioned. As a case study the conifer component of the lower to middle Miocene Second Lusatian Lignite Seam, a widespread lignite horizon in the southern part of the North German - Polish Tertiary Basin is introduced. The lignite complex is of paralic origin. Most species have been reconstructed as whole-plants often based on assembled occurrences of isolated organs in the respective taphocoenoses. As these plants are often found *in situ* in the respective lignite stratum a direct insight into the ecology and structure of the phytocoenesis is possible, and thus a detailed interpretation of the swamp environments and its changes in space and time. In particular, Neogene representatives of

the genera *Glyptostrobus* Endlicher, *Cunninghamia* R. Br. ex Rich. & A. Rich., *Taiwania* Hayata, *Cryptomeria* D. Don and *Sciadopitys* Siebold & Zuccarini were prominent elements of the Lusatian peat-forming vegetation. Moreover, extinct genera such as *Cupressospermum* Mai and *Quasisequoia* Srinivasan & Friis have contributed to peat formation. Characteristically, certain species did not co-occur in the same habitat, but replaced each other after slight changes of environmental conditions in the respective area. Most of the conifer species were adapted to ecological niches in the swampy environments. Autecology of these fossil species does often not correspond to that of the next living relative species. Moreover, habitats of the next living relatives do often not match the habitat of their Neogene ancestors. Fossil conifers provide important data for reconstructing the plant communities in the Miocene peat-forming vegetation in Lusatia (East Germany). These records also reflect a characteristic succession in the swampy vegetation starting with an eutrophic stage of the *Glyptostrobus* swamp-forest facies (K-facies) or of the *Cupressospermum* swamp-forest facies (X-facies); going on with a mesotrophic stage with *Cunninghamia* and *Taiwania* as elements of the Angiospermous bush-swamp facies (A-facies); changing into an oligotrophic habitat with of the *Cryptomeria*-conferta bog facies (C-facies) and *Sciadopitys* Siebold & Zuccarini as element of the *Sciadopitys* bog facies (M-facies). The last vegetation type is the climax of the succession.

Keywords: conifers, European Neogene, peat-forming vegetation, successions, whole-plant concept.

SS17-O03 (582)

Paleoecology of *Cunninghamia* from earliest Miocene Shichiku Flora of Northeast Honshu, Japan

Atsushi Yabe[1], Chiyomi Yamakawa[2]

[1] *National Museum of Nature and Science, Japan, yabeatsu@kahaku.go.jp*
[2] *Lake Biwa Museum, Japan*

Cunninghamia is a cupressaceous conifer genus that is now distributed disjunctly in China, Laos, Vietnam, and Taiwan. Fossil records suggest that the genus was distributed significantly more widely in the Northern Hemisphere during the early stage of its history since the Cretaceous, but the detailed history of its ecology is yet to be fully understood. Two modern species occur in mixed mesophytic and broad-leaved evergreen forests (*C. lanceolata* (Lamb.) Hook.) or in a mixed coniferous forest (*C. konishii* Hayata) and both grow in relatively well-drained substrates. However, the fossil species found in Central Europe occurring in the bog succession clearly indicate that it was one of the major components of swamp vegetation. Here, we report new evidence of this genus in northern Japan, which probably indicates the same ecological feature as in its European counterpart. Our materials were collected from the earliest Miocene Shichiku Formation in the northern part of the Joban area on the Pacific side of northeast Honshu, Japan. The Shichiku Formation consists primarily of laminated mudstone containing fresh water diatoms and fish. The facies is subsequently overlain by lignitic mudstone and coal with numerous plant fossils. The sedimentary facies and its change in the formation indicates an upward shallowing trend from a lacustrine to marsh environment. Isolated *Cunninghamia* foliages were collected from both the lacustrine and marsh deposits, but there were greater accumulations of the seeds and foliages of the genus in the latter facies. The co-occurrence of different organs assigned to *Cunninghamia* in the lignitic mudstone and their association with known riparian constituents such as *Alnus*, *Osmunda*, and *Metasequoia* suggest that the area in which these trees grew was in close proximity to the depositional environment. Hence, it is likely that *Cunninghamia* occupied the marsh environment surrounding a small lake. The *Cunninghamia* species that we report here was tentatively identified as *C. protokonishii* Tanai et Onoe, which was originally described from the Late Miocene Hoki Flora of western Japan. This species is distinct from the European species as it yields short, falcate leaves

with a blunt apex. The cuticle of the adaxial surface of the leaves shows no distinct stomatal bands, which is similar to the modern *C. konishii* in Taiwan. Our preliminary observation of the ecology of Japanese *Cunninghamia* indicates that the genus may have had different ecological features from its modern counterpart during the early stage of its evolutionary history.

Keywords: *Cunninghamia*, conifer, ecology, East Asia, earliest Miocene.

SS17-O04 (258)

Palaeoecology of extinct conifer genera in the European Cenozoic

Lutz Kunzmann[1], Wilfrid Schneider[2], Martina Dolezych[1], Dieter Hans Mai[3]

[1] *Senckenberg Natural History Collections Dresden, Germany, Lutz.Kunzmann@senckenberg.de*
[2] *Hoyerswerda, Germany*
[3] *Museum of Natural History Berlin, Germany*

Selected representatives of extinct conifer genera assigned to extinct and extant families have been proven from the Atlantic Boreal phytoprovince as well as the Paratethys phytoprovince in central Europe. This contribution emphasizes und summarizes knowledge on palaeoecology and palaeophytosociology of *Doliostrobus taxiformis* (Sternberg) Kvaček (Doliostrobaceae), *Quasisequoia couttsiae* (Heer) Kunzmann (Cupressaceae), *Cupressospermum saxonicum* Mai and *Chamaecyparites hardtii* (Goeppert) Endlicher (Geinitziaceae). Autecology of these conifers can not be directly deduced from respective living relative species or genera but from palaeoecological requirements of the plant communities in which they occur. These species have been frequently regarded as huge conifer trees occurring in a diverse range of fossil plant communities. Commonly they have been proven from intrazonal vegetation including riparian and swamp forests, and to minor extent from zonal forests. In particular, these species occupy often niches and frequently replace other conifer species if the environmental conditions of a particular habitat change and thus become unfavourable for the latter species, or vice versa. Especially in Miocene swamp facies, partly in more coastal environments, *Cupressospermum saxonicum* replaces *Glyptostrobus europaeus* and *Quasisequoia couttsiae* replaces *Sequoia abietina*. Whereas *Doliostrobus taxiformis* is a common accessory element in Eocene riparian forests in the Atlantic Boreal province this location is occupied in Oligocene forests either by *Taxodium dubium* or *Glyptostrobus europaeus* (Cupressaceae). Although these extinct conifers have similar autecological demands, they rarely co-occur in a fossil flora, in particular in a fossil plant community. Most of the species grew under humid and warm-temperate to subtropical climate. Thus they were more widespread in the Paleogene, in particular the Eocene, and became relicts in the Oligocene (*Doliostrobus taxiformis*, *Chamaecyparites hardtii*) or Miocene (*Quasisequoia couttsiae*, *Cupressospermum saxonicum*). The latter became extinct as last peat-forming swamp forests in coastal plains disappeared in the late Miocene caused by general cooling of the palaeoclimate.

Keywords: palaeophytosociology, *Cupressospermum*, *Doliostrobus*, *Quasisequoia*, palaeoclimate.

SS17-O05 (244)

Study of extinct and extant major tree genera in Japan on the basis of late Miocene plant habitat

Makiko Kobayashi, Susumu Okitsu

Chiba University, Japan, makikokobayashi@hotmail.co.jp

We reconstructed the plant habitats and vegetation on the basis of the plant macrofossils obtained from the Late Miocene Yagii Formation (10-8Ma). Plant macrofossils from massive sandstone indicated autochthonous vegetation; those from sandstone with lamination contained component species of autochthonous and allochthonous vegetation. Our study indicated that the extinct genus of *Metasequoia* dominated in Japanese lowlands such as fluvial back marsh near the fossil deposition area. Extinct taxa of genus *Glyptostrobus*, *Sequoia*, *Liquidambar* and *Proserpinaca* grew in and around the lowland *Metasequoia* forest. In areas around or higher than the *Metasequoia* forest, evergreen and deciduous broad-leaved mixed forests were distributed, and they contained extant taxa of the Kanto Plain, central Japan, including genera *Carpinus*, *Zelkova* and endemic species of *Berchemia racemosa* and cf. *Stewartia monadelpha*. Considering the plant habitat of extant species, cf. *S. monadelpha* were also distributed at higher altitudes of this forest. In the mountain area, *Fagus* subgenus *Fagus* and *Euptelea polyandra* were distributed. Sandstone samples contained abundant cupules and nuts of *F.* subgenus *Fagus* and seeds of *E. polyandra*. Considering plant habitats and the plant fossil occurrence of extant species, *F.* subgenus *Fagus* dominated on mountain slopes, and *E. polyandra* dominated in mountain valleys or landslide areas. These fossils were detected only in laminated sandstone samples. Abrasion flows of spiny scales on cupules of *Fagus* indicate the transportation of these fossils over a long distance. *Fagus* subgenus *Fagus* is presently a common component species of deciduous forest in the Kanto Mountains. *E. polyandra* grows mainly in mountain valleys or riparian areas and is characterized by pioneer species in landslide areas. The palaeovegetation based on this study suggests that extinct taxa such as *Metasequoia*, *Glyptostrobus* and *Proserpinaca* were lowland vegetation. This region experienced a macroscale disturbance such as sea-level fluctuation that exterminated plant habitats and caused extinction. On the contrary, extant taxa such as *Carpinus*, *Stewartia*, *Fagus* and *Euptelea* were distributed on mountains and in slope areas. Mountain slope vegetation experienced occasional disturbances such as landslides or volcanic eruptions. Such events were, however, relatively microscale. Plants distributed on the slope or mountainous area did not completely lose their habitats; most survived for long periods to withstand extinction. Our study indicates the importance of considering the palaeohabitat as a possible cause of species extinction.

Keywords: late Miocene, palaeovegetation, central Japan, plant macrofossils, fruits and seeds.

SS17-O06 (69)
Temperature niche shift during the Holocene

Rachid Cheddadi

University of Montpellier II, France, rachid.cheddadi@univ-montp2.fr

Have the European temperate tree species occupied a similar climatic range during the past thousand years or does their modern range represent only part of their niche? We have addressed this question for three species: *Abies alba, Picea abies* and *Fagus sylvatica*. We have reconstructed the mean January temperature (Tjan) over Europe every 1000 years for the past 10,000 years using a method based on the mutual climatic range of species identified in pollen samples. The climate reconstruction was performed without taking into account the three species of concern. Then we have collected from the literature the presence of the three species over the same time span, i.e. the last 10 ka. The reconstructed Tjan and past distributions allowed us to infer their temperature ranges at each time slice. The obtained temperature ranges of each species were then compared to their modern ones. When evaluating past and present Tjan ranges between 10ka and 5ka we found out that

the three species have occupied a narrower temperature range than today and afterwards it expanded towards the modern range. Throughout the Holocene, *Abies alba* and *Picea abies* remained more or less within their modern temperature range while *Fagus sylvatica* occurred outside its modern range. Such data tend to suggest that some species have a wider climate tolerance than we observe today.

Keywords: Holocene, climate reconstruction, niche, Europe.