(SS40) Tracing the history of extant angiosperm clades with paleobotanical data

Date: August 27
Place: Room 5336 (oral), Room 6318 (poster)
Organizers: Steven Manchester & Kathleen Pigg
Contact email address: steven@flmnh.ufl.edu
Purpose: Fossils showing the diagnostic characters of various living angiosperm families and orders provide important insights into such aspects of evolutionary history as character evolution, minimal ages of divergence and former biogeographic patterns. Although some families are well known from the fossil record, new evidence has only recently emerged for other groups that are rarely preserved or seldom recognized. Our purpose is to bring to light the results of recent and ongoing studies that trace the fossil history of angiosperm clades that have received only limited paleobotanical study in the past. Contributions to this symposium will emphasize such areas as new systematic data, new understanding of clade divergence time, paleobiogeography, and /or the particular obstacles inherent in the study of a given taxonomic group.

Oral Presentation

Aug. 27 [AM2] Room: 5336

Chair: Steven Manchester

11:10-11:20 **[Introduction]** SS40-O01

Steven Manchester

11:20-11:50 **[Keynote] Phylogenetic evidence for the presence of ANITA lines and relatives of Chloranthaceae in the Early Cretaceous** SS40-O02 (107)

James A. Doyle, Peter K. Endress

11:50-12:10 **Early diversification and palaeobiogeography of the Menispermaceae** SS40-O03 (210)

Frédéric MB Jacques, Wei Wang, Rosa Del C. Ortiz, Zhekun Zhou

Aug. 27 [PM2] Room: 5336

Chair: Steven Manchester

14:30-14:50 **The emerging Patagonian fossil record of Cunoniaceae and its biogeographical significance** SS40-O04 (144)

María A. Gandolfo, Elizabeth J. Hermsen

14:50-15:10 **Fossil record of the Anacardiaceae with particular attention to the widespread subfamily Spondioideae** SS40-O05 (187)

Fabiany Herrera, Steven R. Manchester, Susan K. Pell, John D. Mitchell

Chair: Maria Gandolfo

15:10-15:30 **New studies of fossil Rosaceae from the upland early-middle Eocene Okanogan Highlands floras of British Columbia, Canada and Republic, Washington, USA** SS40-O06 (96)

Melanie L. DeVore, Kathleen B. Pigg

15:30-15:50 **Fossil fruits of Engelhardioideae: Exploring the Patagonian-Northern Hemisphere**

connection in the fossil record SS40-O07 (184)

Elizabeth J. Hermsen, María A. Gandolfo

Aug. 27 [PM3] Room: 5336

Chair: Maria Gandolfo

16:20-16:40 **What have the Fagales been up to for the last 65 My? A synthesis of fossils, phylogeny & plant functional traits** SS40-O08 (576)

Yaowu Xing, Richard J. Carter, Renske Onstein, Tanja Stadler, H. Peter Linder

16:40-17:00 **Biogeography and fossil history of the tropical angiosperm family Icacinaceae** SS40-O09 (498)

Gregory W. Stull, Steven R. Manchester, Bruce H. Tiffney

17:00-17:20 **[Conclusions]** SS40-O10

Poster Presentation

Aug. 27 [PM1] Room: 6318

13:30-14:30 **Preliminary report on new plant mesofossils from the Klikov Formation, Cretaceous, Czech Republic** SS40-P01 (183)

Zuzana Heřmanová, Jiří Kvaček, Else Marie Friis

Morphological diversity of angiosperm pollen in the Early and mid-Cretaceous of Colombia SS40-P02 (106)

Gabriela Doria, Peter Crane

Fruits and leaves of *Cercis* (Leguminosae, Caesalpinioideae) from the Cenozoic of China and their biogeographic implications SS40-P03 (559)

Qi Wang, Si Shen

***Chamaerops humilis* L. in Mediterranean basin: current distribution associated with the Cenozoic and Quaternary history** SS40-P04 (55)

Elisabetta Brugiapaglia, Bruno Paura, Rossella Filigheddu

SS40-O02 (107)

Phylogenetic evidence for the presence of ANITA lines and relatives of Chloranthaceae in the Early Cretaceous

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Earlier phylogenetic analyses using morphological data and a molecular backbone tree of Recent taxa confirmed relationships of Early Cretaceous flowers and other fossils, mostly described by Friis, Crane, Mohr, and coworkers, to magnoliids, monocots, and basal eudicots. Here we report analyses of Early Cretaceous and Cenomanian fossils that appear to be related to basal "ANITA" lines and

Chloranthaceae. These analyses nest not only *Monetianthus* (early Albian, Portugal) but also *Carpestella* (Albian, Virginia) within Nymphaeaceae and place *Pluricarpellatia* (Aptian, Brazil) near the common ancestor of Cabombaceae and Nymphaeaceae. *Anacostia*, which produced *Similipollis* pollen, appears to be nested in Austrobaileyales. Our results confirm that plants with *Asteropollis* pollen were related to the chloranthaceous genus *Hedyosmum*, while *Canrightia* (early Albian, Portugal) was a stem relative of Chloranthaceae (with or without *Ceratophyllum*) that had reached an intermediate stage in floral simplification, with bisexual flowers and several carpels but the perianth reduced to a single whorl. *Zlatkocarpus* (Cenomanian), which had a reduced perianth, may be sister to *Ascarina*, *Sarcandra*, and *Chloranthus*, implying that the perianth, which also occurs in *Hedyosmum*, persisted further into Chloranthaceae. Plants that produced loosely reticulate *Pennipollis* pollen (Aptian and Albian) are more likely to be stem relatives of Chloranthaceae than monocots, implying that their exine similarities to Alismatales are due to homoplasy. However, the position of *Couperites* (Cenomanian), which had *Clavatipollenites* pollen and an anatropous ovule, is more ambiguous: it may be a stem relative of Chloranthaceae, a crown group member, or a member of the ANITA grade. This does not necessarily apply to all dispersed pollen identified as *Clavatipollenites*, which may be systematically heterogeneous. *Appomattoxia* (Albian, Virginia), associated with continuous-tectate *Tucanopollis* pollen, shares similarities with both Chloranthaceae and Piperales, but its most parsimonious positions are near the base of the ANITA grade, possibly linked with *Amborella*. Many uncertainties could be resolved with better evidence on the floral architecture of taxa that are known only as isolated stamens and carpels. These results indicate that the Early Cretaceous rise of angiosperms cannot be ascribed solely to radiation of magnoliids, eudicots, and monocots, but also involved diversification of more basal lines.

Keywords: paleobotany, angiosperms, fossil flowers, Cretaceous, phylogeny.

SS40-O03 (210)

Early diversification and palaeobiogeography of the Menispermaceae

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The Menispermaceae are a family of tropical lianas with a modern pantropical distribution and only a few species growing in temperate regions. The family includes 72 extant genera and approximately 520 extant species. 43 genera are present in the fossil record, among them 19 are still living. Menispermaceae fossils are recorded from all continents except Antarctica. Menispermaceae were present in Asia, Europe, North and South America, Australia during the Paleogene and are known in Africa only from the Neogene. The oldest potential record of Menispermaceae is a fossil endocarp from the Cretaceous of Central Europe. The Menispermaceae are therefore an interesting family because it is already widespread and diverse in the Paleogene. The recent development of molecular phylogenies of Menispermaceae indicates that taxa previously seen as derived are in fact basal groups, namely taxa with horseshoe-shaped endocarps. In this study, we analyze the diversification rate of the Menispermaceae through time based on five molecular markers: *rbc*L, *atp*B, *mat*K, *trn*L-F, *ndh*F. Molecular datings (penalized likelihood and Bayesian relaxed clock) of the family indicate a Lower Cretaceous diversification of the family. The palaeogeography of the family is analyzed by a

statistical dispersal-vicariance analysis, S-DIVA, based on extant taxa exclusively. The temporal dynamics of diversification in Menispermaceae is visualized with lineage-through-time (LTT) plots. A sliding window analysis was also conducted. Our results indicate an Indo-Malayan origin of the Menispermaceae with several migration events to the Americas, Africa and Australasia during a short time period between 70-60 Ma, i.e. near the K/Pg boundary. The diversification of Menispermaceae is greater at the K/Pg boundary, showing the importance of this time period for the family. The fossil record and the molecular analyses are congruent and both demonstrate that the Menispermaceae were already well diversified and widespread throughout the world during the Paleocene. The Indo-Malayan origin of the Menispermaceae is well supported by the molecular data; however, this region has a very complex geological history and might group some regions that were not adjacent during the Early Cretaceous. Because the biogeographic analyses were based only on extant taxa, the whole fossil diversity of European Menispermaceae is omitted. A better resolution of the results will be achieved by a further analysis taking the geological history (plate movements) and the fossil record into account.

Keywords: Paleogene, Asian relicts, DIVA, phylogeny, migration.

SS40-O04 (144)

The emerging Patagonian fossil record of Cunoniaceae and its biogeographical significance

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Iconic families considered fundamental for understanding the origin of Southern Hemisphere floras include Nothofagaceae, Myrtaceae, and Proteaceae. These three families have an extensive "Gondwanan" fossil record supporting the connection among Australia, Antarctica and South America. Recent paleobotanical studies are providing evidence, however, that several other Southern Hemisphere families are well-represented in the fossil record and may yield new biogeographic insights. This contribution is based on new evidence concerning the fossil record of one of these lesser-studied families, Cunoniaceae. Cunoniaceae include approximately 26 genera and 300 species that are found predominantely in tropical montane and wet temperate regions of the Southern Hemisphere, with a center of diversity in Australasia. The fossil record of Cunoniaceae reflects the extant distribution: they are well known from Australian fossil pollen, fruits, flowers, and leaves, but scarce in South America and Antarctica. In Patagonia, the oldest records are pollen from the Danian Salamanca Formation, and the only macrofossils previously attributed to Cunoniaceae include *Weinmannioxylon* wood and leaves of questionable affinities. Newly discovered macrofossils collected from caldera-lake deposits of the early Eocene Laguna del Hunco flora, Patagonia, Argentina, now definitively support the presence of the family in ancient Patagonia on the basis of reproductive macrofossil evidence, including impression fossils of infructescences and isolated fruits. The infructescences are similar to *Caldcluvia* and *Weinmannia*; they are characterized by a main axis bearing pedicellate capsules with two valves dehiscing septicidally. Extant species of both genera are found today in wet temperate forests of the Patagonian Andes. Isolated indehiscent fruits (pseudosamaras) with enlarged sepals exhibit a calycine venation pattern similar to that of extant *Ceratopetalum*, a genus with six to eight extant species found primarily in Australasia and four extinct species represented by Australian Cenozoic fossils. These fossils are not only important for understanding the morphological evolution of the groups they represent, but also for understanding the biogeographic evolution of the floras of the Southern Hemisphere. We will explore these themes in addition to the structural evidence for the affinities of the fossils in this presentation.

Keywords: infructescences, isolated fruits, Southern Hemisphere, Eocene.

SS40-O05 (187)

Fossil record of the Anacardiaceae with particular attention to the widespread subfamily Spondioideae

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The Anacardiaceae have an excellent Cenozoic fossil record that includes leaves, wood, fruits and pollen. Fruits are particularly informative in the recognition of genera in this family so their preservation as fossils provides useful insight into the evolution and biogeographic history of major clades. Fruits of the family vary from multilocular to unilocular drupes to samaras with conspicuous to inconspicuous wings. The drupaceous fruits have been categorized in two main types generally corresponding to the subfamilies Spondioideae and Anacardioideae, respectively. Recent phylogenetic analyses, based on molecular data (*mat*K, *trn*LF, and *rps*16), suggest that the Spondioideae, as traditionally circumscribed, is polyphyletic. Current revisions to our understanding of the composition of this subfamily still allow characterization of a fruit type typically including: fibrous stones with a relatively thick exocarp, endocarp composed of irregularly oriented sclerenchyma, often multilocular, and typically having elliptical germination pores near the apex of each locule, sometimes with specialized opercula. The distinctive morphology of the extant genera allows for recognition of fossil members. A review of this record and the description of new taxa reveal a rich fossil history of extinct and extant genera of Spondioideae with interesting biogeographic patterns. Early records of Spondioideae-type endocarps include occurrences of *Choerospondias* (today endemic to Asia) and *Lannea* (Africa to Indo-China) from the early Eocene London Clay flora; *Pleiogynium* (Indo-China, Australia, and Melanesia) and *Lannea* from the middle Eocene Messel flora, Germany; and *Dracontomelon* (India to tropical China, Papua New Guinea, and Malaysia) from the late Eocene of Panama. Miocene records of extant genera include *Antrocaryon* (Africa and South America) from Ethiopia and *Spondias* from Panama. The anacardiaceous fruit fossil species confirmed so far expand vastly the range of distribution observed today for extant genera. Extinct genera of spondioid endocarps were also abundant and widespread through the Eocene floras of North America and Europe, e.g. *Pentoperculum*. Available paleobotanical data on the Spondioideae, and also the presence of fossil fruits of *Rhus* and *Anacardium* of the Anacardioideae indicate that the family was well diversified by the early Eocene. Paleocene endocarps of Anacardiaceae are still unknown.

Keywords: Anacardiaceae, endocarp, paleobiogeography, Spondioideae, Eocene.

SS40-O06 (96)

New studies of fossil Rosaceae from the upland early-middle Eocene Okanogan Highlands floras of British Columbia, Canada and Republic, Washington, USA

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Rosaceae consists of approximately 122 genera and 3,370 species of trees, shrubs and herbs of worldwide distribution, with its greatest diversity in temperate regions of the Northern Hemisphere. This family has achieved considerable evolutionary success, with members thriving in environments ranging from mesic to xeric to arctic. Little is known about when and where the Rosaceae first appeared, however one of the finest glimpses we have of their early radiation occurs in latest early-middle Eocene upland floras of the Okanogan Highlands in British Columbia, Canada and Republic, Washington, USA. Among rosaceous leaf types represented in the Republic flora are members of all four traditionally recognized subfamilies: Prunoideae, Spiroideae, Maloideae and Rosoideae, with recognized genera including *Amalanchier, Prunus, Photinia, Malus/Pyrus, Rubus*, cf. *Spiraea*, cf. *Cratageus*; *Stonebergia* (an extinct genus), among a variety of unclassified rosaceous forms. The Republic flora contains suites of leaves with morphologies similar to those of extant hybrid complexes in such genera as *Cratageus* and *Sorbus*. This occurrence allows us a rare opportunity to consider evidence for hybridization in Rosaceae directly from the fossil record. Evidence of this sort is consistent with long-held views that varied breeding systems provided Rosaceae with the ability to generate novel genetic combinations and colonize new, open habitats. Many of the leaves at Republic have distinct types of leaf damage patterns that can be correlated quite accurately with specific predators. These damage patterns can superficially resemble a leaf's petiolar or laminar glands, that are often taxonomically diagnostic characters in such genera as *Prunus*. Along with taxonomic descriptions of *Prunus* and related forms we are considering the plant-pathogen interactions that occur within the Republic biome. This is of particular interest in that there is also the potential at Republic of matching at least some of these damage patterns to the rich insect fauna that co-occurs there. Additionally we have first floral evidence of *Prunus* and *Oemleria* at Republic. Several other rosaceous flowers currently under study, as well as an infrutescence quite similar to those of extant *Spiraea*. Other studies focus on biogeography: *Neviusia* (Kerrieae), a plant that today is disjunct between southeastern North America and Mount Shasta, northern California occurs in the Okanogan Highlands flora at One Mile Creek, central British Columbia. Together the Okanogan Highlands floras provide us several excellent opportunities to better understand pattern and process in the evolution of this important, mostly north temperate family.

Keywords: fossil flower, hybridization, leaf damage pattern, Okanogan Highlands, *Prunus*.

SS40-O07 (184)

Fossil fruits of Engelhardioideae: Exploring the Patagonian-Northern Hemisphere connection in the fossil record

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Engelhardioideae (Juglandaceae that usually have fruits with a trilobed wing) have a relatively well-documented Cenozoic macrofossil record, primarily based on fruits and leaves. Fossil Engelhardioideae are significant for understanding character evolution in the group both in light of the fact that at least some fossil engelhardioids have combinations of features not known in extant

taxa, and because most fossils are known from geographic areas where extant engelhardioids do not occur today. In this presentation, we will explore the utility of fossils for understanding the biogeography of Engelhardioideae and Cenozoic biogeographic connections between South America and the Northern Hemisphere. The extant engelhardioids display a trans-Pacific geographic disjunction, with New World representatives in Mexico to northwesternmost South America and Old World representatives in Eastern to Southeast Asia. The fossil record of Engelhardioideae matches a widespread Northern Hemisphere pattern recognized in extant taxa sometimes dubbed "Tertiary relicts." Fossil engelhardioids are most diverse in North America and most abundant in Europe; the East Asian record is limited, but reports are on the increase. Previously, a direct reading of the fossil record could have been interpreted as suggesting a North American origin and early diversification of the clade, with dispersal to Europe and East Asia over the North Atlantic and Bering Land Bridges, respectively. However, newly discovered winged fruits that have characters consistent with Engelhardioideae from the early Eocene (ca. 52 Ma) Laguna del Hunco flora of southern Argentina complicate this scenario, not only because the Engelhardioideae were previously not thought to have any significant presence in South America, but because this is among the oldest known occurrences of the clade in the fossil record. We will discuss how phylogeny may help us to better understand the development of the biogeographic range exhibited by this clade. The surprising occurrence of fossil Engelhardioideae in southern South America mirrors reports of other taxa that were previously cryptic in the Cretaceous to Paleogene of Argentina, such as Potamogetonaceae (*Baibiancarpus chubutensis*), *Nelumbo* (*Nelumbo puertae*), and the ferns *Regnellidium* (Marsileaceae). These taxa were previously known as macrofossils only from the Northern Hemisphere, suggesting that continuing work on Southern Hemisphere floras may yield interesting biogeographic results.

Keywords: Cenozoic, character evolution, Juglandaceae, biogeography, Tertiary.

SS40-O08 (576)

What have the Fagales been up to for the last 65 My? A synthesis of fossils, phylogeny & plant functional traits

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Angiosperms diversified through a series of adaptive radiations during the Cenozoic. We postulate that these resulted from the interaction between evolving plant functional traits (PFTs) and environmental change. We explore this interaction in the Fagales, which includes 1060 species in eight families. This order has possibly the best fossil record of any in the angiosperms. We compiled the largest known, global, database of fagalean fossil records for the Cenozoic, documented the salient plant functional traits, and built a dated phylogeny for the order. We used the fossil record to calculate the diversity, origination and extinction rates for each period during the Cenozoic. This showed increasing diversification until the Eocene Optimum, then a slowdown until the Oligocene, after which diversity increased rapidly to the mid-Miocene, followed by a dramatic collapse. The number of deciduous taxa increased sharply after the Eocene up to the Late Miocene; this might coincide with the stronger seasonal climate. These fluctuations are linked to shifts in the dominance of families with tropical or non-tropical affinities. In the Plio-Pleistocene, with climatic cooling, the diversity of Fagaceae decreased relative to Betulaceae.

SS40-O09 (498)

Biogeography and fossil history of the tropical angiosperm family Icacinaceae

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The Icacinaceae are a pantropical family with the *Lamiidae* comprising ~25 genera and 150 species of trees, shrubs, and woody climbers. Unlike most tropical angiosperm groups, the Icacinaceae have an extensive fossil record, consisting primarily of taxonomically informative endocarp remains. Here we provide a review of the fossil history of this family, incorporating new fossil data with detailed assessments of previously published records. Significant new fossils include endocarps from the Paleogene of Colombia and the Oligocene of Peru, representing groups (the tribes Iodeae and Phytocreneae) now confined to the Old World tropics; endocarps of *Natsiatum* (Iodeae), *Phytocrene* (Phytocreneae), and an extinct genus (*Croomiocarpon*; Iodeae) from the Eocene of southeastern North America; endocarps, pollen, and leaves of the extant genus *Iodes* (Iodeae) from the Eocene Blue Rim flora of southwestern Wyoming; and endocarps representing two taxa of the tribe Phytocreneae from the Oligocene of Egypt. We reject an early report of the modern genus *Phytocrene* from the Turonian of New York based on a morphological and anatomical reevaluation of the fossil fruits, making Paleocene fossils from Colombia and western North America the oldest records of the Phytocreneae. We also review fossils leaves from the Eocene of Hokkaido, Japan, placed in three extant genera (*Merrilliodendron*, *Phytocrene*, and *Pyrenacantha*) and two extinct genera (*Goweria* and *Huziokaea*) of Icacinaceae. These fossils and others indicate that the tribes Iodeae and Phytocreneae were previously much more widely distributed, with representation in the Paleogene of South America, North America, and Europe, well outside of their modern ranges in tropical Africa, Madagascar, and Indo-Malesia. Although the Icacinaceae probably had a Cretaceous origin, fossils of the family are relatively rare until the Eocene, when a number of modern genera first appear in the fossil record, suggesting that the family may have diversified with the expansion of tropical forests during the early Eocene.

Keywords: fossil endocarps, Icacinaceae, *Lamiidae*, Paleogene, tropical biogeography.

SS40-P01 (183)

Preliminary report on new plant mesofossils from the Klikov Formation, Cretaceous, Czech Republic

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A new mesofossil assemblage of charcoalified flowers, fruits, seed and other small fossil remains was discovered in 2007 at the Zliv-Řídká Blana locality, the Czech Republic, preserved in brown-grey sandy claystone of the Klikov Formation (Upper Cretaceous, upper Turonian - Santonian). 40 different taxa including ferns, conifers and angiosperms have been identified. Fern and conifer diversity is low and comprises a variety of young fern leaves of unknown affinity, conifer twigs similar to *Geinitzia reichenbachii* and a conifer cone scale of uncertain affinity. Angiosperms are the most diverse group with about 32 taxa. More than half of these can be assigned

to taxa already described from the Klikov Formation by Knobloch and Mai (1986, 1991). There are, however, also several new taxa and our investigations that also include synchrotron based X-ray microtomography of some of these fossils show that several of the previously described taxa are in need of revision. The most prominent angiosperm element in Zliv-Řídká Blana assemblage is related to the *Normapolles* complex and includes young fruits sometimes with remnants of stamens and styles and in rare cases attached to inflorescence fragments. Pollen grains were observed adhering to the apical part of some of the fruits. Two genera, *Caryanthus* and *Budvaricarpus*, are particularly well-preserved. In addition to the Normapolles complex there are also a variety of capsular fruits derived from flowers with a superior ovary. Most of these are probably related to the Ericales and include four different types with a pentamerous gynoecium and two different types with a trimerous gynoecium. Another capsular fruit is formed from seven carpels. The assemblage also includes a number of fleshy fruits, one monocarpellate fruit and many round fruits with reticulate surface. Eight different types of small isolated, mostly anatropous seeds were observed in the new material from Zliv- Řídká Blana. The assemblage also includes other than plant fragments. Of particular interest are fragments of *Palaeoladrovanda splendens* that based on comparison with recent insects is interpreted as an insect egg.

Keywords: mesofossils, fossil flower, fossil fruit, fossil seeds, Upper Cretaceous.

SS40-P02 (106)

Morphological diversity of angiosperm pollen in the Early and mid-Cretaceous of Colombia

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Neotropical forests are among the most botanically diverse terrestrial ecosystems on Earth. However, whether the diversity of modern floras in the Neotropics was already evident during the early stages of diversification of flowering plants, the main components of modern tropical forests, is not clear. Although it is known that the Early and mid-Cretaceous (142-80 Ma) witnessed a remarkable acceleration in the amount of morphological variation and taxonomic diversity in the angiosperm clade, the details of the timing and geographic patterns of the early radiation of angiosperms through this critical interval are still uncertain. Moreover, the pollen morphological series from the Early and mid-Cretaceous known to date come mostly from temperate regions, in consequence, whether the patterns observed in the tropics followed those in temperate regions during the first stages of angiosperm evolution, remains unclear. So far, Early and mid-Cretaceous angiosperm pollen from northern South America have been studied only using standard light microscopy techniques, which are insufficient for detailed characterization and comparison of angiosperm pollen with fossil pollen described from elsewhere and the pollen of potential living relatives. Here we characterize selected angiosperm pollen from Aptian to Cenomanian sediments of Colombia using electron microscopy. Pollen samples come from the Aptian-Albian Caballos Formation and Cenomanian Oliní section, both from the Upper Magdalena River Valley in Colombia. Angiosperm pollen grains during the Aptian-Albian account for the 7.3% of the palynoflora and are represented mostly by inaperturate and monoaperturate types. On the other hand, during the Cenomanian, angiosperms account for the 48% of the palynoflora and triaperturate forms reach 29% of the total. This research complements existing and ongoing biostratigraphic and floristic analyses based on traditional light microscope analyses of Cretaceous palynological sequences from Northern South America.

Keywords: Aptian, Albian, Cenomanian, northern South America, Neotropics.

SS40-P03 (559)

Fruits and leaves of *Cercis* (Leguminosae, Caesalpinioideae) from the Cenozoic of China and their biogeographic implications

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Cercis contains about 8–11 living species disjunctly distributed among the warm-temperate zones of the Northern Hemisphere (i.e., the eastern United States to northeastern Mexico, western North America, the Mediterranean region to central Asia, and eastern Asia). This genus belongs to the tribe Cercideae of the subfamily Caesalpinioideae, which is one of the basalmost clades in the molecular phylogenetic trees of living Leguminosae. Hence, the fossil history of *Cercis* is very important in understanding the legume phylogeny, early evolution and diversification, and biogeography. However, the majority of species of the previously reported *Cercis* leaf impressions from the Cenozoic of Eurasia and North America have been questioned, rejected, or need further re-investigation because of lacking detailed studies on the leaf architecture (including the pulvini and epidermal characters) as well as the fruit morphology. In China, fruits and leaves of *Cercis* have been reported from the Oligocene, Miocene and Pliocene of Yunnan, Shandong, and Qinghai Provinces, but some of the fossil record (e.g., *Cercis miochinensis* Hu et Chaney), desperately need reinvestigation. On the basis of the type specimens and newly collected materials, we confirmed the existence of the leaves of *C. miochinensis* from the Miocene Shanwang Formation of Shandong, eastern China. In addition, the detached fruits from Shanwang (Shandong), Zekog (Qinghai) and Jinggu (Yunnan) as well as the leaves from Tengchong (Yunnan) and Ningming (Guangxi) may belong to *Cercis*, and an elaborated study is doing. Overall, *Cercis* appears to have first occurred in the low-latitudes (e.g., Yunnan and Guangxi) of South China since the Oligocene. Together with the additional fossil record of *Cercis* from the Paleogene of the Northern Hemisphere, the recently putative hypothesis (i.e., a Tethys Seaway origin of Leguminosae) seems plausible, but need more reliable fossil evidence to support.

Keywords: Biogeography, Cenozoic, *Cercis*, China, fossil record.

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***Chamaerops humilis* L. in Mediterranean basin: current distribution associated with the Cenozoic and Quaternary history**

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Chamaerops humilis L. is the only autochthonous Mediterranean palm which grows around the western Mediterranean basin. In general the current communities of *Chamaerops* are accompanied by *Juniperus phonicea* subsp. *turbinata*, *Pistacia lentiscus*, *Rhamnus alaternus* and *Phillyrea angustifolia*, but the communities have floristic differences related to the biogeographical context. They are attributed to different associations that belong to *Oleo-Ceratonion siliquae* or *Asparago-Rhamnion oleoidis.* The current populations seem to be direct descendants of the ones that existed in earlier periods: in fact according to Beguinot (1922) *Chamaerops* appeared in the

Oligocene (macroremains) and three species were identified: *Ch. kutschlinica* in northern Bohemia, *Ch. celasensis* in lime stones of Celas in the basin of Marseilles, *Ch. helvetica* in Saxony. From Oligocene to Pliocene according to Beguinot, *Ch. humilis* or similar species, were present in the South of France and along the ligurian coast. Many researchers speak about Palmae, Arecaceae, *Palmoxylon* div. esp. in Europe of older periods, but it is impossible to attribute them to *Chamaerops*. However the fossils of leaves, stems and roots are difficult to understand because researchers did not define samples up to the level of species, but they stopped at family, or described several species attributed to *Palmoxylon*. For sure however, during the Miocene *Chamaerops* was present in Sardinia, in the Pliocene was present in Spain and Greece. In order to find Holocene traces of *Chamaerops* we analyzed a diagram pollen obtained from around the Mediterranean basin, in particular in Italy and Spain. In Sicily its presence starts at around 8500 cal BP at Gorgo Basso, at 6000 cal BP (Biviere di Gela) its presence is continuous after 4300 cal BP and alternates with *Pistacia*. Its percentage decreased from around 500-600 cal BP. In Spain (Sierra de Gabor) it is present from at least 6850 cal BP. It seems that in Spain, in the Almeria region, during the last full glacial period many species found shelter including *Chamaerops*. Based of current data, it seems that in Italy there was not any shelter but the non observation of pollen and macroremains does not necessarily indicate the absence of the species, but rather the lack of suitable sites for their conservation. In order to verify the hypothesis to explain the current fragmentary distribution, the analysis about population genetics is in progress.

Keywords: *Chamaerops humilis*, phytosociology, pollen and macroremains, Cenozoic distribution, Quaternary distribution.