crown Pinaceae, including the stem lineage taxon *Schizolepidopsis*; other Pinaceae cones include *Pityostrobus* and one the oldest records of *Picea* (spruce). Three additional taxa show affinities with the subfamilies Cunninghamioideae (*Elatides*, *Pentakonos*) and Taiwanioideae (*Stutzeliastrobus*) of the Cupressaceae s.l. The new Mongolian fossils also reveal that the enigmatic ginkgophyte *Umaltolepis* has a peltate, cupulate seed-bearing organ, unlike any other ginkgoalean fossil and extant *Ginkgo biloba*. *Umaltolepis* bore simple, strap-shaped *Pseudotorellia* leaves on well-developed short shoots. The new interpretation of *Umaltolepis* reveals that early ginkgophytes showed considerable morphological diversity as well as adaptations for wind pollination and ovule protection during the Early Mesozoic. Other major plant groups from Mongolia include corystosperms (*Umkomasia*), filmy ferns and bryophytes. However, conifers dominated the lignite floras. The deposition and taphonomic conditions of the lignite deposits suggest that these plants inhabited permanently flooded systems (e.g., forest-moor swamps), however, the presence of charcoal in the same sedimentary sequences suggest that fire events were also part of the Early Cretaceous landscape in Mongolia.

## T2-23-03

## Cretaceous/Paleogene angiosperm floras from Patagonia, Argentina

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The southernmost area of South America, Patagonia, is considered to be critical for understanding South American modern floras as it had a fundamental role in the origin and diversification of seed plants in the Southern Hemisphere. In this contribution, we will discuss the evolution of angiosperms in Patagonia from their first appearance during the Barremian (Early Cretaceous) to the Cretaceous/Paleogene boundary. Data was gathered from three major Patagonian basins: San Jorge Gulf, Deseado Massif, and Austral, and from the Chubut Extra Andean Region, representing 26 formations that were deposited during the earlier Cretaceous (Late Barremian, 130 MA) to the Cretaceous/Paleocene (Danian, 61.6 MA) which offer a wealth of fossil angiosperm pollen and leaves. We will report on the taxonomical components of the floras, dominating groups, the development of plant communities, and the environments in which they lived. As expected, during the Cretaceous the angiosperms went from being a minor component of the paleoecosystems that were dominated by gymnosperms and pteridophytes to be the dominating clade at the end of the Cretaceous (Campanian-Maastrichtian)/Paleocene (Danian). The fossil record confirms the presence of members of the ANITA grade, Chloranthales and several monocotyledons during the Aptian-Albian, while the eudicots and the rosids become more diverse and the ones dominating the paleoecosystems at the end of the Cretaceous. The first appearance of angiosperms in Patagonia dates from the Barremian Springhill Fm (Austral Basin), and they were represented by pollen grains assigned to the *Clavatipollenites* complex. Angiosperm leaves appeared later at the Early Aptian Anfiteatro de Ticó Fm (Deseado Massif Basin) as three morphotypes show clearly angiosperm characteristics. At end of the Cretaceous, the angiosperms from La Colonia (Campanian-Maastrichtian) and Lefipán (latest Maastrichtian) formations were undoubtedly the dominant components of the paleocommunities confirming the declining of the gymnosperms and pteridophytes and the rise of the angiosperms at the Cretaceous/Paleogene boundary in Patagonia.

## T2-23-04

## The early angiosperms of the Primorye region, Russian Far East

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Recently we discovered new localities of Aptian–Albian age with angiosperms in the Razdolnaya River, Partizansk, and Alchan River basins in Primorye region, Russia. The plant-bearing deposits have alluvial, sometimes volcanogenic origin. Hence it appears that the environments inhabited by these first angiosperms were high-stress and unstable. For the first time we have revealed in the Aptian coaliferous deposits and the Cenomanian red beds of the Razdolnaya River Basin the remains of the flowering plants. They are represented by extremely rare leaf fragments of unidentifiable monocots and dicots, as well as by dispersed cuticle of probable Platanaceae. The angiosperm pollen *Tricolpites* sp., *T. vulgaris*, *T. micromunus*, *Clavatipollenites hughesii*, *Quercites sparsus, Retitricolpites georgiensis* were obtained from these Aptian deposits. The Albian angiosperms are represented by *Sapindopsis variabilis*, *Laurophyllum* sp., *Cercidiphyllum sujfunense*, *Menispermites* sp., and unidentifiable dicots. The palynological assemblage has increasing numbers of angiosperm pollen including the new taxa *Asteropollis asteroides*, *Fraxiniopollenites variabilis*, *Rouseia delicipollis*, *Polyporites clarus*. The abundant leaves of platanoids are recognizable in the Cenomanian. The angiosperm pollen *Tricolpites micromunus*, *Fraxiniopollenites variabilis*, *Rouseia delicipollis*, *Polyporites clarus* were found. In the Partizansk Basin the early angiosperms were collected in the Albian deposits. These are rare isolated leaf fragments of *Laurophyllum* sp., *Sassafras ussuriensis*, *Sapindopsis* cf. *angusta*, *"Aralia" lucifera*, *Cissites* sp., *Sapindopsis* sp., *Artocarpidium* sp., and unidentifiable dicots. Recently in the south-western and central parts of the Partizansk Basin we have found imprints of early flowering plants, which are represented by entire plants, including rhizomatous stems with tubers and adventitious roots, branches terminating in fruits, and pinnatisect leaves, intact solitary flowers and heads of achenes or follicles. These angiosperms were described as *Achaenocarpites capitellatus* and *Ternaricarpites floribundus*. The Albian angiosperm pollen is represented by rare *Asteropollis asteroides, Cyclusphaera psilata*, *Clavatipollenites incisus*, *Fraxiniopollenites variabilis, Tricolpites micromunus*. In the Cenomanian of this basin the following flowering plants were found: *Araliaephyllum* spp., *Cercidiphyllum* sp., *Magnoliaephyllum* sp., *Platanophyllum* spp., *Menispermites* sp. In the Alchan River Basin the early angiosperms appear in the middle Albian. These are very rare fragments of small leaves of *Laurophyllum* sp., *Sapindopsis* sp.,

and unidentifiable dicots. During the late Albian the diversity and abundance of the flowering plants increase. They are represented by *Magnoliaephyllum* sp., *Sapindopsis variabilis, S. brevifolia, Cinnamomoides* ex gr. *ievlevii, Cissites* sp., *Sassafras* aff. *ussuriensis, Quercophyllum* sp., *Celastrophyllum* ex gr. *oppositifolius*, *C.* cf. *serrulatus*, *Lindera jarmoljukii*, *Menispermites* sp., *Kenella harrisiana, K. filatovii*. The extremely rare tricolpates *Tricolpites* sp. and monocolpates *Clavatipollenites incisus* occur in the Albian deposits. In the Cenomanian the platanoids mainly occur along with aquatic angiosperms. Among angiosperm pollen, including *Tricolpites* sp., *Clavatipollenites* sp., the new taxa *Tricolpites micromunus*, *Tricolporopollenites* sp., *Polyporites clarus*, and *Triporopollenites* sp. appear.

## T2-23-05

## Early Cretaceous vegetation and the emergence of angiosperms in Europe and North America

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The Early Cretaceous was marked by the initial rise of angiosperms, and also by the diversification of modern lineages of conifers (e.g. Pinaceae) and ferns (e.g.water ferns) that became important in later plant communities. The Early Cretaceous also saw the decline of ancient conifers, ferns, ginkgophytes and cycads, that were characteristic of earlier Mesozoic vegetation, as well Bennettitales, Erdtmanithecales and other seed plant lineages that are now extinct. This large-scale floristic transition is seen worldwide through the Early Cretaceous, although the details differ regionally as a consequence of palaeopalaeogeography and palaeoclimate. Most research on this transition has focused on the emergence of angiosperms, but changes in other elements of the vegetation through the Early Cretaceous are also important. Here we focus on the fossil flora collected at a large clay pit near Torres Vedras, northeast of Forte de Forca, Portugal, and illustrate the vegetational changes that took place in Europe and North America during the Early Cretaceous by comparisons with other mesofossil floras that range in age from Berriasian to Albian (ca. 145 to 100 myr BP). The Torres Vedras flora is likely the oldest of the Portuguese mesofossil flora so far described that contains angiosperms remains. There are many earlier mesofossil floras, all of which are devoid of angiosperms, and there are many later floras in which angiosperms are more common. Fossil assemblages from Torres Vedras are dominated by twigs and seeds of extinct conifers and fragments of fern foliage, some of which are fertile. Megaspores of Isoetaceae and Selaginellaceae are also common, as are chlamydospermous seeds (assigned to the extinct genera *Tomcatia, Quadrispermum* and *Ephedrispermum*). Angiosperms are not common in the Torres Vedras assemblages compared to remains of other groups of plants, suggesting that they did not dominate the local vegetation. However, the diversity of angiosperms is relatively high, with about 50 different species, represented mainly by forms with no clear modern relatives, or by forms related to early diverging lineages, such as ANA-grade angiosperms and Chloranthaceae. Other than pollen grains of probable Araceae there is no evidence of monocots at Torres Vedras and there are only few taxa of possible magnoliid affinity. Eudicots are extremely rare and are represented in the mesoflora only by two types of tricolpate pollen grain, one known from a single coprolite and the other (with irregular apertures) known from a single pollen sac. There is also one (perhaps two) kind (s) of pantoporate grains that could be of eudicot affinity. There is no evidence of any extant group of early diverging eudicot, or of later branching lineages of core eudicots, such as rosids or asterids. In mesofossil floras from later in the Early Cretaceous, from both Portugal and North America, angiosperms are more common, taxonomic diversity is higher, and there are several fossil species that can be assigned to various groups of extant magnoliids and early diverging eudicots. Unequivocal core eudicots are know only from about the latest Albian-earliest Cenomanian onwards (ca. 100 myr BP).

## T2-23-06

## The Early Cretaceous seed plants from Crato Flora, South America Brazil

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The Early Cretaceous (Aptian/Albian) Crato Formation from the Araripe Basin (Brazil) contains one of the best known paleofloras from low palaeolatitudes from this important time interval in the history of angiosperms. The flora is diverse characterized primarily by pteridophytes and non-angiospermous seed plants including many taxa related to the Gnetales. The gnetalean component includes stems and twigs with opposite branching, reduced or absent leaves and compact cone-like reproductive structures. Angiosperm macrofossils are also diverse in the Crato Formation, sometimes preserved as whole plants with roots, stems, leaves and reproductive organs organically connected. Many of the angiosperms were clearly herbaceous and several were interpreted as aquatics. However, the non-angiospermous component of the Crato flora shows structural features consistent with arid environments (fibrous leaves, sunken stomata, well-developed indumentum, possible deciduous branches). The Crato Formation (lacustrine-carbonatic) together with the upper part of the underlying Barbalha Formation (deltaic) constitutes the lacustrine Aptian/Albian sequence of the post rift phase of the Araripe Basin. The plant fossils occur in laminated limestones that were developed under tropical, arid and semi-arid climatic conditions, with long intervals of dry climate and periodic precipitation. Some of the fossils possess sufficient characters for a systematic assignment at the family or higher level, and many taxa have already been described including taxa assigned to Nymphaeales and Magnoliales as well as other eumagnoliid angiosperms and several types of monocots. Other plant fossils are less informative systematically, but provide useful information on habit and diversity of early angiosperms in the palaeoequatorial region. New data on angiosperms from Crato Formation will be presented together with a floristic analyses showing the diversity and taxonomic composition of the flora.