

# ADAPTATIONS OF EARLY CRETACEOUS FLORAS TO DIFFERING CLIMATE REGIMES

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## ABSTRACT

In general, the Early Cretaceous was a time period with globally warm, more or less ice free climates, but with episodes of cool climate culminating even in icehouse episodes. Thus vegetation stretched much further north and south than today. Several distinct vegetation belts were developed based on the differences of the climate regime. Climate models for the Late Jurassic to Early Cretaceous suppose a tropical belt at low latitudes extending relatively far to the north. Cold temperature zones were limited to the North and South Polar Zones. The Early Cretaceous was a time period of unusually high tectonic activity, especially sea floor spreading, combined with volcanic outgassing. This phenomenon increased the CO<sub>2</sub> levels that had an effect on the vegetation at large, characterized by high productivity. The highest productivity was in the northern area, while the low latitudes belonged to an arid belt with a less complete vegetation cover. A comprehensive overview on Mesozoic climate models is given in Sellwood and Valdes (2007).

European Lower Cretaceous vegetation is known since more than a century, especially from strata in Great Britain (Wealden strata) that comprise sediments of Berriasian to Barremian age. The composition of these floras that stretch from England to northern Germany is clearly different from the one in more southern areas (Mediterranean area, northern and Central Africa and northern part of South America). In these Wealden strata the floral composition differs dramatically from the one to the south. Three groups dominate clearly: Conifers, Ginkgophytes and Bennettitales/Cycadales. The distribution of these groups varied according to their habitat and ecology. Based on their general habit, drought and/or water stress was most likely not a condition to which these plants had to adapt to in a major

way. Yet, various aspects of ecological adaptations have not been studied in detail.

Early Cretaceous floras from Northern Gondwana, in contrast, were adapted to seasonal drought. First of all, the composition was rather different from northerly sites. Ginkgophytes were missing, and the Cycad/Bennettitales group was relatively rare. Conifers were clearly present, but not diverse, Gnetophytes played a major role in these floras, and angiosperms also seem to have developed much more rapidly, as seen in the Crato Flora of Brazil or floras of northern Africa. Many of the adaptations to this specific environment are seen in the morphology and anatomical features as well. Coriaceous leaves were developed in various groups. Leaf size was reduced and many taxa of various taxonomical groups, such as conifers and angiosperms produced glands and trichomes, plus sunken stomata.

Floras from Southern Gondwana, especially Patagonia were dominated by ferns and gymnosperms (pteridosperms and conifers, among them a high amount of Cheirolepidaceae). Angiosperms were still less prominent during the Early Cretaceous. Typical (palaeo)tropical (palyno) elements such as *Dicheiropollis*/*Afropollis* and *Elaterates* are missing. Nevertheless these floras shared several typical elements with those of northern Gondwana, seen in the palynological (Barreda & Archangelsky 2006) and macroscopic record. One element is for example the conifer taxon *Tomaxellia* (Kunzmann *et al.*, 2006), a cheirolepidiacean conifer. The southern most continents Antarctica, Australia and India belonged to the so called „Trisaccates Province“ with its own distinct vegetation, dominated by ferns, various Podocarpaceae, Araucariaceae and very few angiosperm taxa

**Keywords:** Cretaceous Floras, paleoclimate, Crato Flora

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