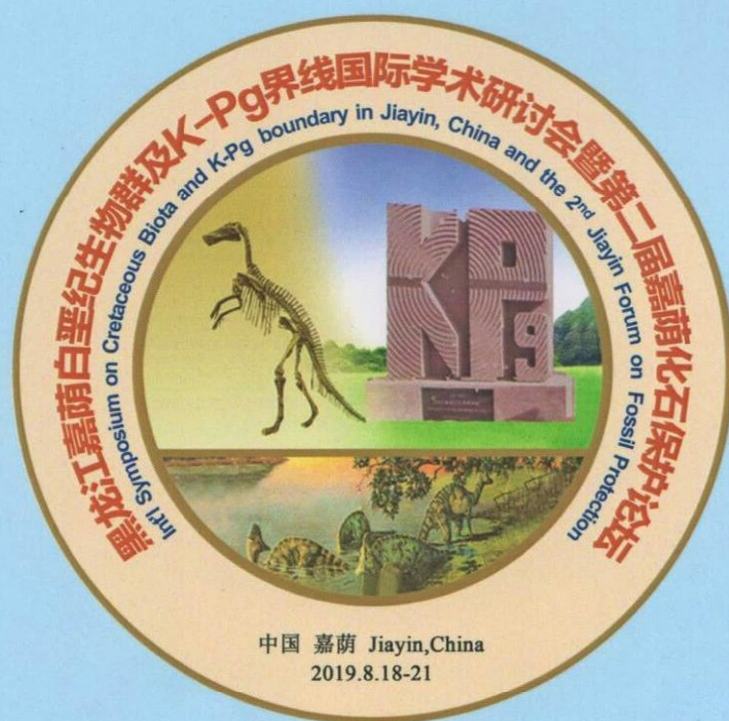


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ABSTRACT VOLUME



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## Early Cretaceous flora of Primorye region (Russia)

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Lower Cretaceous deposits cover more than 40 % of area Primorye, and composing a significant part of folded structure Sikhote-Alin. Early Cretaceous flora of Primorye is one of the most representative floras in the East of Russia. The study of it taxonomic composition, diversity, evolution in time was involved famous Russian paleobotanists: A. N. Kryshfovich, V. D. Prynada, B. M. Stempel, V. A. Vakhrameev, V. A. Samylina and V. A. Krassilov.

**Berriasian.** Shallow marine and non-marine deposits with fossil remains of plant are common on the eastern slope of Sikhote-Alin and locally in the south-eastern part of Primorye region and also in the Partizanskaya River Basin. The floral assemblage (FA) includes 70 taxa. It is dominated by ferns and cycadophytes. Among the ferns, the most numerous are *Coniopteris arctica*, *Cyathea tyrmensis*, *Klukia tyganensis*, *Alsophilites nipponensis*, etc. Among the cycadophytes often found *Zamiophyllum buchianum*, *Otozamites klipstenii* and *Nilssonia schauburgensis*. *Ussuriocladus racemosus* there is characteristic species for conifers. *Lycopodites*, *Equisetum*, *Ctenozamites*, *Sagenopteris*, *Sphenobaiera*, as well as gymnosperms of unclear systematic position is rare. The flora of this stage is characterized by high taxonomic diversity.

**Valanginian.** The flora bearing layers interbedded with the marine deposits were studied on the Eastern and South-Eastern Sikhote-Alin, and their synchronous continental deposits in the Partizansk River Basin on the South of Primorye. In FA established 43 taxa. Ferns are still diverse. Among them are *Alsophilites nipponensis*, *Dicksonia concinna*, *Coniopteris* ex gr. *saportana*, *Adiantopteris sawamurae*, *Lobifolia novopokrovskii* and etc. A variety of cycadophytes declined, but there are new genus - *Cycadites*, *Ctenis* and *Sphenozamites*, while characteristic species are *Dictyozamites kawasakii* and *Nilssonia* ex gr. *brongniartii*. Among the conifers are *Podozamites*, *Elatides*, *Elatocladus*, *Coniferites* and *Conites*, the most characteristic of *Elatides* ex gr. *curvifolia*. At this stage, there is a decrease in species diversity, although ferns still dominate.

**Hoterivian.** This horizon includes marine sediments with bivalves. No fossil remains of plant were found.

**Barremian.** For this horizon are established two floral assemblages. Early Starosutschan assemblage is studied from Partizansk River Basin. *Polypodites verestchagini*, *Lobifolia novopokrovskii*, *Sagenopteris petiolata*, *Pterophyllum sutschanense*, *Nilssonia schauburgensis* etc. characterized it. Ussury assemblage established for Razdolnaya River Basin. *Nathorstia dunkeri*, *Weichselia reticulata*, *Adiantopteris yuasensis*, *Nilssoniopteris rhitidorachis*, *Araucariodendron oblongifolium*, *Elatocladus dolychophyllus* and etc. are the most common. In general, at this stage, ferns are diverse with the same participation of conifers and cycadophytes.

**Aptian.** Fossil remains of plant were studied in detail from Alchan, Razdolnaya and Partizansk river basins then there was the formation of industrial coal accumulation. In the Alchan Basin, the assemblage is not very diverse (18 taxa). Dominant are cycadophytes (6 taxa) of genera *Pterophyllum* and *Nilssonia*, the most abundant species *Pterophyllum sutschanense* and *Nilssonia* ex gr. *brongniartii* included. Subdominant ferns (5 taxa) include genera *Birisia*, *Onychiopsis*, *Polypodites*, *Coniopteris* (*Dicksonia*), and *Cladophlebis*. The ginkgoales are rare, represented by *Ginkgoites* cf. *coriacea*. Among of conifers are *Elatides asiatica*, *Athrotaxites berryi*, *Pityophyllum* sp. and *Podozamites* sp. In





the Razdolnaya River Basin (Lipovtsy FA) has the same dominant and subdominant, but among of cycadophytes predominated bennettitaleans. In Lipovtsy FA has identified nearly 100 taxa. *Gleichenites porsildii*, *Gleicheniopsis suifunensis*, *Nathorstia pectinata*, *Polypodites polysorus*, *Onychiopsis psilotoides*, *Sphenopteris suifunensis*, *Cycadites sulcatus*, *Zamites borealis*, *Zamiophyllum ivanovii*, *Torreya nicanica*, *Tomharrisia florinii*, *Athrotaxopsis expansa*, *Athrotaxites berryi*, *Araucariodendron heterophyllum*, *Mirovia orientalis*, *Elatides asiatica* there are the most characteristic species of FA from the Basin. Angiosperms appear for the first time in this assemblage and are represented by *Dicotylophyllum* spp. In the Partizansk River Basin studied late Starosutschan assemblage, which includes nearly 60 taxa; ferns and conifers prevail, and they are accompanied by cycadophytes, among which cycadaleans are the most diverse. *Gleichenites gieseckianus*, *Onychiopsis psilotoides*, *Dicksonia concinna*, *Birisia onychioides*, *Elatides asiatica*, *Athrotaxopsis expansa*, *Sequoia reichenbachii* are most common.

**Early Albian.** Marine sediments occupy up to 80% of the territory of Primorye. Only in the West and South-East of the region are non-marine deposits, which widespread in Razdolnaya and Partizansk rivers basins, there is a continuation of coal accumulation. Ferns dominate in the Severosutschan FA from the Partizansk Basin, including *Osmunda denticulata*, *Gleichenites porsildii*, *Birisia onychioides*, *Coniopteris asplenioides*, *Teihardia tenella*, *Cladophlebis virginensis*, etc. Conifers are accompany; among them are *Athrotaxopsis expansa*, *Elatides asiatica*, *Taxites brevifolius*, *Araucariodendron oblongifolium*, etc. *Nilssonia canadensis* is prevailing of among cycadophytes. Angiosperms appear for the first time in this assemblage and are represented by *Araliaephyllum luciferum*. Early Galenki FA from the Razdolnaya Basin is dominated of ferns coeval species as in Partizansk Basin, and there are also cycads (*Nilssonia*) and bennettitales (*Dictyozamites*, *Pterophyllum*, *Leptopterophyllum*). The specificity of the assemblages is the reduction of diversity.

**Middle Albian.** At that time marine and shallow marine deposits accumulated on the North, East and South-East of Primorye; shallow marine and nonmarine deposits occurred on the West and South-West. Floral assemblages in the Alchan River Basin is more diverse (66 taxa), containing abundant fern species *Onychiopsis psilotoides*, *Anemia dicksoniana*, *Gleichenites porsildii*, *Birisia onychioides*, *B. alata*, and representatives of genera *Ruffordia*, *Dicksonia*, *Osmunda*, *Adiantopteris*, *Alsophilites*, *Coniopteris*, *Arctopteris*, *Lobifolia* and *Cladophlebis*. Species of frequently occurring conifers and cycadophytes are *Elatides asiatica*, *Podozamites* ex gr. *lanceolatus*, *Athrotaxites berryi*, *Sequoia reichenbachii*, and *Nilssonia* ex gr. *brongniartii*. Representatives of genera *Zamiophyllum*, *Pterophyllum*, *Ptilophyllum*, *Taeniopteris*, *Athrotaxopsis*, *Sphenolepis*, *Torreyites*, *Taxites*, *Ginkgo*, *Baiera*, and *Desmiophyllum* occur as single specimens. The first appearing angiosperm genera are *Sapindopsis*, *Laurophyllum*, *Dicotylophyllum*, *Quercophyllum*, *Nyssidium* and *Onoana*. Remains of czekanowskiales, caytoniales and horsetails are rare. Middle and late Galenki FA from Razdolnaya River Basin is characterized by considerable taxonomic diversity (more than 70 taxa), with predominance of the ferns, among which *Birisia alata*, *Anemia dicksoniana*, *Lobifolia novopokrovskii*. The subdominants are conifers, among which *Podozamites tenuinervis*, *Taxites brevifolius*, *Sequoia reichenbachii* are common in this assemblage. Cycadophytes are represented by abundant remains of *Neozamites denticulatus*, *Pterophyllum sutschanense*, *Nilssonia canadensis*, *N. ex gr. orientalis*. The presence of dicots *Sapindopsis*, *Dicotylophyllum*, *Cercidiphyllum*, *Laurophyllum* is typical in this assemblage. The Frentsevo FA from the Partizansk Basin and eastern coast of the Ussuri Bay consist of 55 taxa. Assemblage is dominated by ferns, including their abundant species *Osmunda denticulata*, *Anemia dicksoniana*, *Birisia onychioides*, *Vargolopteris rossica*, *Teihardia tenella* and *Lobifolia novopokrovskii*. The group of subdominant conifers includes *Athrotaxopsis expansa*, *Athrotaxites berryi*,





*Sequoia ambigua* and *S. reichenbachii* occurring frequently and associated with less frequent *Podozamites tenuinervis*, *Elatides asiatica*, *Elatocladus obtusifolius* and etc. Bryophytes, horsetails, cycadophytes and ginkgoales are rare. The angiosperm includes *Achaenocarpites capitellatus*, *Ternaricarpites floribundus*, *Jixia pinnatipartita*, *Asiatifolium elegans*, *Sapindopsis* aff. *belviderensis*, *Araliaephyllum ussuriensis*, etc. and several new species.

**Late Albian.** At that time marine deposits accumulated on the East part of Sikhote-Alin Mountains and nonmarine deposits occurred in the Alchan, Razdolnaya and Partizansk river basin. FA from the Alchan Basin includes more than 150 taxa. Dominant ferns (40 taxa) include the most representative genera *Gleichenites* (*G. porsildii*, *G. aff. porsildii*, *G. zippei*, *G. gieseckianus*, etc.), *Birisia* (*B. onychioides*, *B. jelisejevii*, *B. alata*, etc.), *Coniopteris* (*C. asplenioides*, *C. setacea*, *C. ex gr. arctica*, etc.), *Arctopteris* (*A. kolymensis*, *A. aff. heteropinnula*, etc.) and etc. The group of subdominant conifers consists of abundant Pinaceae (*Pseudolarix*, *Pityophyllum*, *Pityocladus*, *Pityospermum*, *Pityostrobus*, *Pityolepis*, "Picea") and Taxodiaceae (*Elatides*, *Athrotaxites*, *Athrotaxopsis*, *Sequoia*). Angiosperms are represented by genera *Sapindopsis*, *Sassafras*, *Quercophyllum*, *Araliaephyllum*, *Cinnamomoides*, *Vitiphyllum*, *Cissites*, *Celastrophyllum*, *Lindera*, *Menispermites*, *Magnoliaephyllum*, etc. Cycadophytes are dominated by subtropical *Cycadeoidea bikinensis* and *Zamiophyllum ivanovii*. Ginkgoales, czekanowskiales, caytoniales, horsetails, lycophytes, and bryophytes are rare. Two assemblages are known from the Partizansk River Basin. These assemblages consist of 50 taxa, where ferns and conifers in equal proportions. The dominant species of ferns are *Birisia* aff. *alata*, *B. onychioides* and *Onychiopsis psilotoides*. Prevailing species of conifers are *Pityophyllum* sp., *Athrotaxopsis expansa* and *Elatides asiatica*. The group of flowering plants includes *Sapindopsis*, *Menispermites* and *Tetracenton*. Among of cycadophytes identified *Otozamites* and *Dictyozamites*. The early Korkino assemblage from the Razdolnaya Basin was studied on the Muravyov-Amurskii Peninsula, as well as in the Amba River (South part of Primorye). Its taxonomic diversity is low (25 taxa). Conifers dominate in this assemblage (11 taxa), accompanied by ferns (*Gleichenites*, *Onychiopsis*, *Osmunda*, *Arctopteris*, *Birisia*, etc.), single cycadophytes (*Nilssonina ex gr. brongniartii* and *N. ex gr. orientalis*) and angiosperms (*Sapindopsis* sp. and *Dicotylophyllum* sp.), as well as by plants with unclear taxonomic position (*Carpolithes* sp.).

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