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The Early to Middle Jurassic Flora from Primorye Region (Russian Far East)

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The Early and Middle Jurassic floras are known from Partizansk and Razdol'naya Rivers Basins in South Primorye (Krassilov and Shorokhova, 1975; Volynets, 1999, 2008).

The Early Jurassic flora (the Hettangian) is collected from the Shitukhe Formation. This flora includes 39 taxa. The Shitukhe floral assemblage consists of horsetails (*Equisetum, Neocalamites*), ferns (*Cladophlebis*, *Marrattiopsis*, *Phlebopteris*, *Clathropteris*, *Hausmannia*, and *Todites*), caytonialeans (*Sagenopteris*), cycadophytes (*Pterophyllum, Ctenis, Nilssonia,* and *Taeniopteris*), conifers (*Podozamites, Cycadocarpidium, Pityophyllum,* and *Elatocladus*), ginkgoaleans (*Ginkgoites, Baiera,* and *Sphenobaiera*), czekanowskialeans (*Czekanowskia* and *Phoenicopsis*) and plants of unclear affinity (*Linguifolium, Carpolithes*). Ferns are dominants, and they are accompanied by cycadophytes and conifers.

Cladophlebis (5 taxa) are most diverse among ferns; *C.* ex gr. *haiburnensis* (L. et H.) Brong., *C.* ex gr. *denticulata* (Brong.) Font. and *Cladophlebis* sp. are common; *C. scoresbiensis* Harris is rare. *Marratiopsis hoerensis* (Schimp.) Thomas and *Phlebopteris angustiloba* (Presl) Hirm. et Hoerham. are abundant; *Clathropteris elegans* Oishi, *Hausmannia* sp., *Todites* sp. are single.

Pterophyllum cf. *subaequale* Harts, *Ctenis sulcicaulis* (Phill.) Ward and *Nilssonia acuminata* (Presl) Goeppert are abundant among cycadophytes; *Taeniopteris lanceolata* Oishi is typical; *Ctenis* cf. *yokoyamae* Krysht., *Nilssonia spinosa* Krassil. and *Taeniopteris* sp. are rare.

Pityophyllum ex gr. *nordenskioldii* Heer is abundant among conifers; and *Podozamites* is most diverse (*P. schenkii* Heer, *P. latifolius* (Schenk) Krysht. et Pryn., *P. lanceolatus* (L. et H.) Schenk).

Marratiopsis hoerensis (Schimp.) Thomas, *Phlebopteris angustiloba* (Presl) Hirm. et Hoerham., *Cladophlebis scoresbiensis* Harris, *Ctenis sulcicaulis* (Phill.) Ward are guide fossil plants for the Lower Jurassic deposits.

The plants of Shitukhe assemblage such as *Clathropteris, Phlebopteris, Marratiopsis* evidence about the humid subtropical climate during the Hettangian.

The Middle Jurassic (the Bathonian) plant remains have been found in the Ananyevka (Razdol'naya River Basin) and Monakino (Partizansk River Basin) formations. The floral assemblage is represented by 81 taxa (Volynets, 2008): bryophytes (*Thallites*), horsetails (*Equisetum*), ferns (*Sphenopteris, Cladophlebis, Klukia, Cyathea, Osmundopsis, Phlebopteris, Ruffordia, Dicksonia, Coniopteris, Onychiopsis, Adiantopteris,* and *Acrostichopteris*), conifers (*Podozamites, Araucarites, Cunninghamia, Pityophyllum, Brachyphyllum, Elatocladus, Coniferites,* and *Conites*), cycadophytes (*Otozamites, Dictyozamites, Cycadolepis, Anomozamites, Ptilophyllum, Zamites, Nilssonia,* and *Pseudocenis*), pteridosperms (*Thinnfeldia),* caytonialeans (*Caytonia, Sagenopteris*), ginkgoaleans (*Baiera* and *Pseudotorellia),* czekanowskialeans (*Czekanowskia* and *Leptostrobus*) and plants incertae sedis (*Carpolithes, Taurinia, Schizolepis, Machairostrobus, Radicites*). Ferns are dominants, and they are accompanied by conifers and cycadophytes.

Among ferns diverse *Sphenopteris* (*S. gracilis* Oishi, *S.* cf. *mclearnii* Bell, *S.* aff. *latiloba* Font., *S. kiselevae* Volynets, *S.* sp.) and *Cladophlebis* (*C. naitoi* Kimura et Ohana, *Cladophlebis toyoraensis* Oishi, *C.* cf. *argutula* (Heer) Font., *C.* cf. *williamsonii* (Brongn.) Brongn., *C.* sp.) occur. *Coniopteris bella* Harris, *Cladophlebis toyoraensis* Oishi, *C. naitoi* Kimura et Ohana, *Onychiopsis psilotoides* (St. et W.) Ward are common; *Acrostihopteris naitoi* Kimure et Ohana, *Acrostihopteris* sp., *Phlebopteris* sp., *Ruffordia* sp., *Coniopteris hymenophylloides* (Brongn.) Sew., *Dicksonia* sp., *Cladophlebis* cf. *argutula* (Heer) Font. are rare; *Adiantopteris toyoraensis* (Oishi) Vassilevsk., *Klukia exilis* (Phill.) Racib., *Cyathea* sp., *Osmundopsis* cf. *prynadae* Delle, *Sphenopteris kiselevae* Volynets are single.

Among conifers *Podozamites* ex gr. *lanceolatus* (L. et H.) Schimp., *P. angustifolius* (Eichw.) Heer, *Elatocladus subzamioides* (Moell.) Tur.-Ket. are most numerous in burials; *Elatocladus* (2 taxa) is common. *Brachyphyllum* cf. *toyoraensis* Takah., *Brachyphyllum* sp., *Conites* sp. and *Coniferites* (*C. marchaensis* Vachr., *Coniferites* sp.) are rare; *Cunninghamia* and *Araucarites* are single.

Nilssonia (6 taxa) and *Dictyozamites* (5 taxa) are most diverse among cycadophytes. *Dictyozamites nevolinae* Volynets and *D. tateiwae* Oishi are abundant; *D. doludenkoae* Volynets is rare; *D.* cf. *reiniformis* Kimura et Ohana and *Dictyozamites* sp. are single. *Zamites, Ptilophyllum, Otozamites, Anomozamites, Ps-*

eudoctenis and *Cycadolepis* occur rarely in the localities of these formations.

Among the caytonialeans it was revealed three species of *Sagenopteris* (*S. mantellii* (Dunk.) Schenk, *S. phillipsii* (Brong.) Presl., *S.* cf. *petiolata* Oishi).

Ginkgoaleans, czekanowskialeans, bryophytes, horsetails, pteridosperms and plants of unclear affinity are rare.

The taxa *Coniopteris bella* Harris, *Cladophlebis toyoraensis* Oishi and *Dictyozamites nevolinae* Volynets have been found only in beds of these two formations.

These floral assemblages strengthen the case for a warm and moderately humid climate.

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Key words: Jurassic; Flora; Floral assemblage; Primorye region; Russian Far East

References:

Krassilov V.A., Shorokhova S.A. Triassic geofloras and some basic phytogeographical principles. In: Fossil floras in Far East. Vladivostok: DVNC AN SSSR, 1975: 7-16 (in Russian).

Volynets E.B. New data on the age of the Monakino Unit from the Partizansk Basin, Primorie. Geology of Pacific Ocean, 1999, 14: 1007-1014.

Volynets E.B. Flora of the Jurassic terrigenous complex. In: Triassic and Jurassic of the Sikhote-Alin. 2. Volcano-sedimentary complex, paleobiogeography, Vladivostok: Dalnauka, 2008: 175-185 (in Russian).