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Late Cretaceous climate signal of the Northern Pekulney Range Flora of northeastern Russia

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Abstract

Plant-bearing continental deposits from the northern Pekulney mountain range in the Anadyr-Koryak subregion of northeastern Russia (approximately 66°N, 175°E) represent a rich and diverse flora growing close to the Late Cretaceous North Pole at a palaeolatitude of ~78°N. The Early Coniacian age of this flora is based on biostratigraphic correlation of the plant-bearing beds with underlying and overlying marine units. The Northern Pekulney Range Flora comprises two large plant macrofossil assemblages, one from the Tylpegyrgynai Formation on the western slopes of the northern Pekulney Range and the other from the Poperechnaya Formation on its northeastern slopes. The flora is dominated by angiosperms followed by conifers, ferns, cycadophytes, ginkgophytes and sphenophytes, in decreasing order of species diversity. Dicotyledonous angiosperm leaves (57 morphotypes) from the Northern Pekulney Range Flora were subjected to a Climate Leaf Analysis Multivariate Program (CLAMP) physiognomic analysis. Separate analyses of the constituent assemblages from the Tylpegyrgynai and Poperechnaya formations yielded 27 and 39 morphotypes, respectively. Results suggest that the Northern Pekulney Range Flora experienced a mean annual temperature of 8.1±1.2 °C, a cold month mean temperature of −1.5±1.9 °C, a mean monthly growing season precipitation of 78.8±36.9 mm and a growing season of 5.3±0.7 months. This suggests a warm temperate climate lacking pronounced drought, in which the polar light regime constrained the length of the growing season. CLAMP results for the Tylpegyrgynai Formation Flora suggest slightly higher temperatures, with a mean annual temperature of 9.4±1.2 °C and a cold month mean temperature of 0.9±1.9 °C, whilst estimates for the Poperechnaya Formation Flora are cooler, with a mean annual temperature of 7.3±1.2 °C and a cold month mean temperature of −2.7±1.9 °C. Because the floras from the Tylpegyrgynai and Poperechnaya formations also exhibit differences in their taxonomy and physiognomy, they should be considered as two distinct floras. The overall taxonomic composition of these floras, their foliar physiognomy and estimated palaeoclimate parameters suggest a deciduous phenology with a few evergreen elements. Comparisons with other Arctic Coniacian floras are consistent with the high latitudinal position of the Northern Pekulney Range Flora and its proximity to the northern proto-Pacific Ocean.

Keywords: Late Cretaceous; Northeastern Russia; Palaeobotany; Palaeoclimate; Leaf physiognomy

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1. Introduction

The Cretaceous is widely recognised as a time of pronounced global warmth and therefore a useful source of data on how Earth systems operate and interact under so-called 'greenhouse' conditions (Skelton et al., 2003).

In northeastern Russia, the Cretaceous sediments contain an abundance of plant fossil remains providing evidence of a rich flora thriving at a high latitude (Vakhrameev, 1991; Spicer et al., 2002). Fossil floras from this area have been studied together with other floras from northern Russia and Alaska to provide data that can be used to reconstruct Arctic climate and vegetation patterns during the Cretaceous and to improve our understanding of greenhouse world Earth systems. This study concentrates on climate signals derived from angiosperm leaf physiognomy because these provide a quantitative method of determining a wide range of palaeoclimate variables (Wolfe, 1993).

One of the richest and most diverse floras from the Upper Cretaceous lies in plant-bearing continental deposits at the northern end of the Pekulney mountain range within the Anadyr-Koryak subregion of northeastern Russia. Until now the flora has been known collectively as the Tylpegyrgynai Flora (Terekhova and Filippova, 1983, 1984) and is found at a present day latitude of approximately 66°N (Fig. 1a,b). The plant-bearing deposits were discovered in 1956 by staff of the USSR Geological Survey. The resulting collection of plant fossils was examined by Yefimova but was never formally published, Yefimova's observations existing only as an internal report of the Northeastern Geological Survey, Magadan. A more detailed study of the locality was carried out by Terekhova and Filippova (1983, 1984), who examined the stratigraphy of the western and eastern slopes of the northern Pekulney Range, including the continental plant-bearing beds and the bounding marine units. Late Cretaceous plant fossils were found in the Tylpegyrgynai Formation on the western slopes and in the Poperechnaya Formation on the eastern slopes. The Poperechnaya Formation is dated as Early Coniacian, on the basis of biostratigraphic constraints of overlying and underlying beds containing marine molluscs. For the Tylpegyrgynai Formation, the upper age limit is constrained as Early Coniacian based on the composition of a marine biota in an overlying

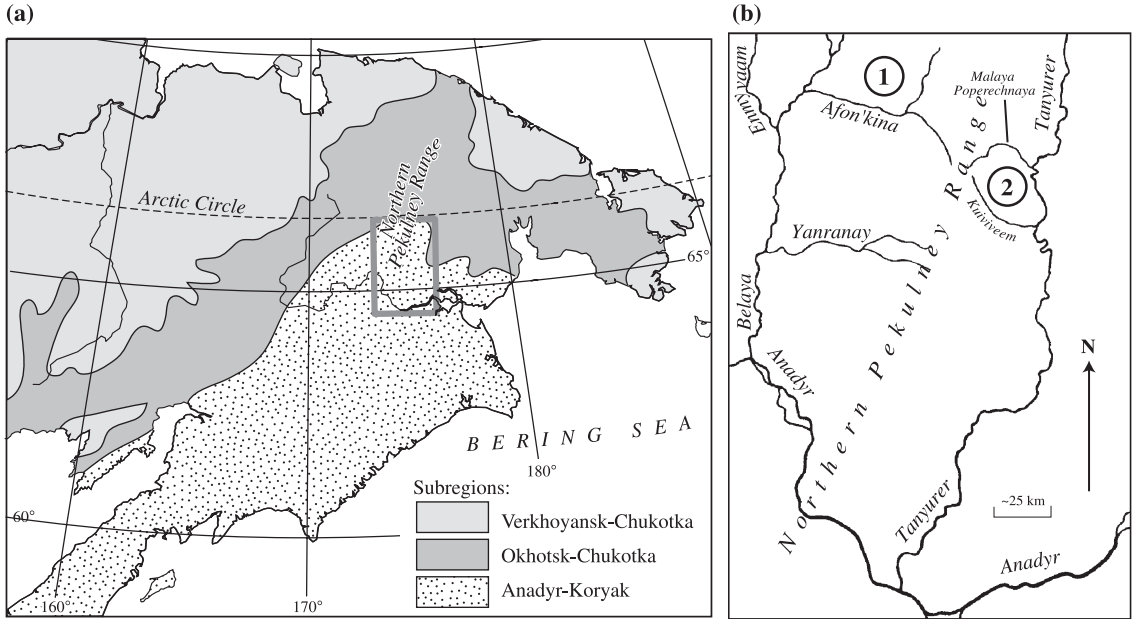

Fig. 1. Locality map for plant-bearing deposits in the Northern Pekulney Range. (a) Northeastern Russia with subregions, (b) Northern Pekulney Range with the plant fossil sites: (1) Tylpegyrgynai Formation floral locality (shown in detail in Fig. 2), (2) Poperechnaya Formation floral locality (shown in detail in Fig. 4) (modified from Herman, 1999).