Temperate/boreal conifer pollen as orbital-scale palaeoclimate proxy based on 250m Choshi core, Boso, Japan

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Based on worldwide accumulation of modern surface pollen, the validity of fossil pollen as a proxy of palaeotemperature in terrestrial region is being accepted (Nakagawa et al. 2003, etc). By contrast, the Middle-Late Pleistocene has not given a sufficient pollen-based proxy due to possible occurrence of extinct plants, with some continental-scale differences. In Europe, the arboreal/non-arboreal ratio has traditionally been used as an indicator of the glacial/interglacial cycle, accepted as a good proxy during the past 430 kyr (Tzedakis et al. 1997). In Japan, the time-equivalent standard pollen profile has been from the uppermost 250m T-bed of the 1400m core from Lake Biwa (Miyoshi et al. 1999). In that work Castanopsis and Quercus subgen. Cyclobalanopsis have been suggested as indices for MIS1-11 interglacial periods. However, these occurred only in the interglacial peaks, with very low values (2-5%) in MIS7 and 9. This meant that some non-homogeneous nor continuous sediments could lack such less prominent interglacial signals, requiring commonly applicable climate indices.

Here we discuss the significance of temperate/boreal conifer ratio as a palaeoclimate proxy based on pollen results from the Choshi core, northeastern Boso Peninsula (Okuda et al. submitted). The 250m-long Choshi core (CHOSHI-1), which was drilled in 1998 by the Ocean Research Institute, Univ. of Tokyo, has penetrated the Inubo Group (equivalent of the Kazusa Group) deposited near the margin of the Kazusa forearc basin. The upper 169m of the core has been correlated with 400-780 ka based on abundant marker tephras and palaeomagnetic reversals associated with multiproxy records (El-Masry 2002). Particularly a joint analysis of pollen and oxygen isotope (d18O) permits extraction of orbital-scale palaeotemperature variations from fossil pollen records.

Results show distinct variations within the coniferous pollen assemblages, with Picea dominating high d18O phase (i.e. glacials) alternating with Cryptomeria in low d18O phases (i.e. interglacials). The latter is associated with slight increases of Castanopsis and Cyclobalanopsis. These are also consistent with AP/NAP plus spore as well as carbon isotope, planktonic foraminifers (composition and concentration) and magnetic susceptibility, etc.

In order to explore the temperature preferences of Cryptomeria and Picea, the Japanese surface pollen data set (Gotanda et al. 2002) is consulted. Results show that the two pollen types separate from each other with a threshold of 7-10 C in annual mean temperature, which agrees with their modern vegetation distribution also. Although Cryptomeria has a broader temperature resistance with a preference to extra-humid climate with 1500-1800 mm/y in precipitation, it is almost certain that the Cryptomeria certainly represents the glacial/interglacial cycle when the ratio form to the Picea is taken.

In order to the see the matching to climate changes during the Middle-Late Pleistocene comprehensively, the identical pollen ratios are extracted from the 430-kyr Lake Biwa record, connected with this 400-780 kyr Choshi record. Results show a good agreement between the both records despite their geographical and chronological differences, verifying their validity as proxies at least in central Japan during the past 700,000 years. The Cryptomeria/Picea ratio generally shows clear changes but is sometimes too variable, suggesting the Temperate/boreal conifer ratio (i.e. Cryptomeria + Sciadopitys + TCC / Picea + Abies + Pinus + Tsuga) instead, excelling at its wider use. Prior to 780 ka, the pollen-climate relations above were not necessarily guaranteed because of possible elements of the Metasequoia flora extincting stage (i.e. Metasequoia sp., Picea koribai, etc) surviving the Early Pleistocene.