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ORIGINAL PAPER

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Palaeoclimate estimates for the Middle Miocene Schrotzburg flora (S Germany): a multi-method approach

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Abstract We present a detailed palaeoclimate analysis of the Middle Miocene (uppermost Badenian–lowermost Sarmatian) Schrotzburg locality in S Germany, based on the fossil macro- and micro-flora, using four different methods for the estimation of palaeoclimate parameters: the coexistence approach (CA), leaf margin analysis (LMA), the Climate-Leaf Analysis Multivariate Program (CLAMP), as well as a recently developed multivariate leaf physiognomic approach based on an European calibration dataset (ELPA). Considering results of all methods used, the following palaeoclimate estimates seem to be most likely: mean annual temperature ~15–16°C (MAT), coldest month mean temperature ~7°C (CMMT), warmest month mean temperature between 25 and 26°C, and mean annual precipiation ~1,300 mm, although CMMT values may have been colder as indicated by the disappearance of the crocodile *Diplocynodon* and the temperature thresholds derived from modern alligators. For most palaeoclimatic parameters, estimates derived by CLAMP significantly differ from those derived by most other methods. With respect to the consistency of the results obtained by CA, LMA and ELPA, it is suggested that for the Schrotzburg locality CLAMP is probably less reliable than most other methods. A possible explanation may be attributed to the correlation between leaf physiognomy and climate as represented by the CLAMP calibration data set which is largely based on extant floras from N America and E Asia and which may be not suitable for application to the European Neogene. All physiognomic methods used here were affected by taphonomic biasses. Especially the number of taxa had a great influence on the reliability of the palaeoclimate estimates. Both multivariate leaf physiognomic approaches are less influenced by such biasses than the univariate LMA. In combination with previously published results from the European and Asian Neogene, our data suggest that during the Neogene in Eurasia CLAMP may produce temperature estimates, which are systematically too cold as compared to other evidence. This pattern, however, has to be further investigated using additional palaeofloras.

Keywords Neogene · Palaeoclimate · Taphonomy · Leaf physiognomy · Nearest living relatives

Dedicated to Prof. Dr. Harald Walther, Dresden, on the occasion of his 75th birthday.

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Introduction

Dealing with Global Change may become one of the major challenges for humankind in the 21st century (e.g. Steffen et al. 2004). A critical assessment of the possible impacts of Global Change must not only refer to the reliability of model predictions for the future, but also to information about past climate and environmental changes. In the terrestrial realm the reconstruction of past climatic and environmental conditions and changes is largely based on fossil plant remains. A large number of different methods have been developed to derive environmental data from these plants (e.g. Kershaw and