Pollen records and climatic cycles in the North Mediterranean region since 2.7 Ma

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Abstract: This synthesis incorporates the 16 most important pollen records available across the North Mediterranean region *sensu lato* for the last 2.7 Ma. Their location is discussed with respect to the present-day bioclimatic Mediterranean realm. A special effort has been made to redraw, where necessary, the pollen records in terms of modern cyclostratigraphy. The complexity of the evolution of the Mediterranean flora and vegetation as forced by the climatic cycles is evident. The influence of the latitudinal thermic (and xeric) gradient is confirmed, and the superimposition of a longitudinal gradient, forced by the Asian monsoon, is considered. The Mediterranean flora and vegetation were not altered by any important event during the Early–Middle Pleistocene transition between 1.2 and 0.7 Ma.

This paper presents a synthesis of the vegetational and climatic evolution within the bioclimatically defined Mediterranean realm for the crucial time-window of 1.2–0.7 Ma. During this interval, 40 ka obliquity-forced climatic cycles were progressively replaced by *c*. 100 ka glacial–interglacial oscillations paced by multiples of 20 ka precession cycles (Ruddiman 2003; Maslin & Ridgwell 2005). The aim is to document changes that occurred, or did not occur, in this region in response to this global upheaval in climate pattern, known as the mid-Pleistocene revolution. In order to gain a broad insight based on pollen records, it is necessary to widen the spotlight beyond 1.2–0.7 Ma and include pollen data from 2.7 Ma to the present day. This record starts at the beginning of pronounced climatic cycles in the northern hemisphere, and provides a long chronological record from the Praetiglian Stage to the Holocene (Zagwijn 1975) during which time the effects of successive types of climatic cycle have been experienced.

The bioclimatic Mediterranean realm is today defined using the seasonal distribution of temperature and precipitation, summer (the warmest season) being dry (Quézel & Médail 2003). This realm is clearly delimited (Fig. 1), and is subdivided into several belts according to temperature namely the thermo-Mediterranean ($m > 3$°C), meso-Mediterranean (0°C $< m < 3$°C), supra-Mediterranean (-3°C $< m <$ 0°C), mountain-Mediterranean (-7°C $< m < 3$°C) and oro-Mediterranean (m < -7°C) belts, where '*m*' is the mean of the minima of the coldest month (Quézel & Médail 2003). The thermo-Mediterranean belt is characterized by a plant association rich in *Olea europaea*, *Ceratonia siliqua*, *Chamaerops humilis*, *Pinus halepensis*, *P. brutia*, *Juniperus phoenicea*, *Myrtus communis*, *Pistacia lentiscus, P. terebinthus and Lygeum spartium*, while the meso-Mediterranean belt also includes *Olea europaea*, several evergreen species of *Quercus* (e.g. *Q. ilex*, *Q. coccifera*, *Q. suber*), *Pinus halepensis*, *P. brutia*, *Phillyrea and Pistacia*. The supra-Mediterranean belt is rich in deciduous *Quercus* with *Ostrya* and *Carpinus orientalis*; the mountain-Mediterranean belt comprises *Pinus nigra*, *Cedrus*, *Abies*, *Fagus* and *Juniperus*; and the oro-Mediterranean belt consists mainly of *Juniperus* and prickly xerophytes (Quézel & Médail 2003). In addition, types of vegetation depend on the superimposition of the amount of rainfall: desert (perarid bioclimate: mean annual precipitation (MAP) < 100 mm); steppe rich in *Artemisia* and other herbs (arid bioclimate: 100 < MAP < 250 mm); forest-steppe with *Artemisia*, *Pinus halepensis*, *Juniperus* and scarce evergreen *Quercus* (semiarid bioclimate: 250 < MAP < 600 mm); evergreen forest with sclerophilous oaks, *Pinus pinaster* and *P. pinea* (subhumid bioclimate: 600 < MAP < 800 mm); and mixed forest with deciduous oaks, *Fagus* and conifers such as *Cedrus* and *Abies* (humid bioclimate: MAP > 800 mm) (MAP values: if $m = 0$°C; Quézel & Médail 2003). However, *Artemisia* steppes are significant in several contexts: they generally correspond to dry environments (steppes with xeric forcing), but others can develop at high Mediterranean altitude under elevated precipitations (steppes with thermal forcing; Quézel & Barbero 1982).

The modern bioclimatic Mediterranean realm is known to have existed since 3.6 Ma (Suc 1984), i.e. the mid-Pliocene, at a time when the Alpine massifs, such as in the French Southern Alps, Calabria, Peloponnesus and South Anatolia, were less elevated than today. For example, a reconstruction based on pollen data and geomorphology indicates that the

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