the intrinsic relationship between both disciplines and have shown how they are, indeed, two lenses in one telescope.

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symposium summary

Mediterranean biogeography: where history meets ecology across scales

A symposium at the 5th International Biogeography Society Conference – Heraklion, Greece, 7–11 January 2011

The Mediterranean Basin looks almost designed as a model system for biogeographical research. It is a semi-closed sea offering coast to three continents and 24 countries, with a marine surface area of some 2,500,000 km^2, a maximum depth of 5,121 m, and a coastline of 46,500 km. 24,600 km of this coastline belong to the 11,879 Mediterranean islands, 243 of which host permanent human populations. Even though there has been some disagreement on the precise definition of what constitutes the terrestrial Mediterranean Region, the dominant view includes some 2,300,000 km^2 of land around the basin (Blondel et al. 2010).

An important aspect of the Mediterranean Region is its long history of human presence that spans several millennia, with agriculture being practiced in the region for approximately 10,000 years, and the sequential rise and fall of many important civilizations, especially during the past 5,000 years. Another crucial feature is the intensive tectonic activity caused by the subsidence of the African plate beneath the European plate, and the strong east-west pressures to Asia Minor exerted by the Arabian plate. The palaeogeography of the Mediterranean Region is also complex, and highly marked by the Messinian Salinity Crisis. During this key event the Gibraltar strait closed and the Mediterranean Sea was reduced to a series of saline lakes for some 630,000 years (5.96-5.33 Ma), leading to large-scale changes in both marine and terrestrial biota. The unique combination of geological and climatic factors has led to the development of a characteristic and highly diverse biota, as reflected by the inclusion of the Mediterranean among the most important biodiversity hotspots. The vast biotic diversity and the complexity of processes shaping Mediterranean biodiversity are reflected also in the diversity of approaches to the biogeography of the region, a small sample of which were covered in this Symposium.

Hans Peter Comes from the Paris-Lodron University of Salzburg (Austria) explored processes of plant speciation in the Mediterranean, contrasting patterns of adaptive and non-adaptive radiations. Ecological speciation plays an important role in Mediterranean plant radiations, both old and young, with radiation often accompanied by niche differentiation amongst lineage members. Nevertheless, at least one case of purported 'non-adaptive radiation' in plants has been suggested, with mutation and genetic drift being the primary factors causing divergence of populations occupying ecologically similar habitats: the *Nigella*

arvensis complex in the Aegean. *Nigella* phylogeny reveals rapid radiation in the Pleistocene, starting from the central Aegean and proceeding to the periphery. The speciation rate accelerated during the late Quaternary due to range fragmentation triggered by sea-level changes in the Holocene. Genetic drift is in this case shown to be a major cause of differentiation and development of post-mating reproductive isolation among lineages, i.e. suggesting non-adaptive radiation.

Chronis T. Tzedakis from University College of London (UK) built on his recent paper (Tzedakis 2009) and the work by Médail and Diadema (2009) to focus on the role of glacial refugia as both 'museums', conserving plant diversity during glacial periods, and 'cradles', producing new diversity due to their long persistence, in contrast to previous beliefs. He presented detailed and new data on climatic changes during the Pleistocene that, when combined with palaeogeographic reconstructions, show that glacial refugia around the Mediterranean could have persisted for long periods of time, allowing for extensive diversification of several taxa. These refugia thereby offer a mechanism for the Mediterranean as a source of diversity for temperate Europe.

Oliver Rackham (Cambridge University, UK), focused on the role played by humans and their activities in the distribution of Mediterranean plants, especially the endemics on the many islands of the Aegean. Various aspects of human history and prehistory, such as the extermination of native mammals, the introduction of domestic animals and plants, as well as exotic wild plants and animals from the mainland, and the various uses of endemic plants by humans, have affected modern plant distributions. Rackham provided a comprehensive view on past and present human impacts on the environment of Mediterranean islands, addressing also possible future threats to island endemics, including those from the globalization of plant diseases and/or global warming.

Rocío Santos-Gally and colleagues from the Universidad de Sevilla (Spain) reported on the phylogeography of mountain and lowland groups of the plant genus *Narcissus*. The ancestor of *Narcissus* originated in the Iberian Peninsula far earlier than the onset of the Mediterranean climate. Then, it expanded its range, colonizing several mountain ranges in northern Africa. Three key historical events in *Narcissus* diversification are recognized: the Messinian Salinity Crisis, tectonic shifts of the Alboran Domain, and the establishment of the Mediterranean climate, followed by repeated glaciations.

The presence of early humans in the Mediterranean coast during the Plio-Pleistocene, as revealed *inter alia* by findings at Gibraltar Rock, was discussed by Clive Finlayson from the Gibraltar Museum, who emphasized the time dimension in biogeographic studies. Finlayson focused on the biogeographic significance of the successive fragmentation of the once extensive and continuous 'mid-latitude belt', a temperate/subtropical zone of savannahs and wetlands between 30º and 50º N, whose western end is formed by the Mediterranean basin. The break-up of this belt during the late Tertiary led to the diversification and expansion of species adapted to rocky and arid habitats. Early hominids exploited the new opportunities in a process that provides important clues to the occupation of Europe by the genus *Homo*, as well as to the evolution of modern Mediterranean biota.

Maria Rita Palombo from Università di Roma 'La Sapienza' (Italy) used evidence from fossils of animals living on western Mediterranean islands to provide a detailed overview of the palaeogeography of this region. The Western Mediterranean basin, with an age of some 30 Myr, has always hosted a high level of biodiversity including numerous remarkable island endemics, mostly reflecting repeated events of isolation and connection of insular and mainland areas. Land mammal fossils offer substantial information for the reconstruction of the complex history of the Western Mediterranean. The progressive depletion of endemic mammals during the Holocene was linked to the interplay of climate change and human impacts.

An important feature of the Mediterranean region is its strong environmental and geographic heterogeneity at all spatial scales, from the very local to the regional. This environmental and geographic complexity has not only been a key driver of Mediterranean biodiversity, but also resulted in

a similarly high heterogeneity in the research approaches to Mediterranean biogeography. In addition to the lectures described above, more than 35 poster contributions addressed various aspects of both marine and terrestrial Mediterranean biogeography, ranging from phylogeographic analyses to studies of fossil faunas and floras. Thus, one take home-message from this Symposium is that the Mediterranean can be also designated as a 'hotspot of biogeographic research'.

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symposium summary

New perspectives on comparative phylogeography: novel integrative approaches and challenges

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Phylogeographic inference reveals that many species, as recognized by current taxonomy, are comprised of multiple genetically divergent lineages that are morphologically cryptic yet represent terminal branches on the tree of life and are relevant to understanding evolutionary processes in relation to environmental change (Avise 2000, 2008). Comparative phylogeography endeavors to reveal how whole communities or assemblages become structured into co-distributed sets of divergent lineages by shared responses to past environmental changes as well as histories that are unique to specific species. In so doing, comparative phylogeography makes the link between traditionally separate ecological and evolutionary processes thereby leading to ecosystem-level understanding about how climate change and geography interact with aspects of species ecology and natural history to drive geographic patterns in biodiversity, community assembly and natural selection. The symposium "New perspectives on comparative phylogeography: Novel integrative approaches and challenges" brought together researchers who are using multi-taxa phylogeographic data sets to answer these questions while allowing the idiosyncrasies of particular systems to guide specific questions, hypotheses being tested and level of detail at which inference can be made.

Highlighting that conservation is one of the most pressing applications for comparative phylogeography, Moritz et al. demonstrated how divergent lineages within species can inform land resource management strategies. Spatial bioclimatic modeling and phylogeographic inference across wide assemblages in tropical Australia and coastal Brazil strongly demonstrate that non-adaptive and allopatric divergence can drive species diversification and that narrow-range phylogeographic lineages will be concentrated in climatically stable landscapes (Schneider et al. 1998; Carnaval et al. 2009). This result aligns with emerging consensus on the need to protect present climatic refugia in the context of rapid global