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CLIMATE AND ITS HISTORICAL & CURRENT IMPACT

With environmental issues becoming an increasingly acute concern for countries worldwide, Turkey is a country of prime interest in the field of climate studies. Due to its location, it presents an area ripe for exploring and understanding climate development and the history of global environmental change within the context of contemporary international relations. Lake sediments, tree-rings, speleothems and peat deposits represent valuable natural 'archives' of environmental change which have been under-explored in both Turkey and the wider Black Sea region. This Institute research programme into the vegetation and climate history of the region focuses on changes in vegetation, water resources, landscape stability and hazards in Turkey, the Black Sea area and much of the wider Middle East over time. It also provides a key context of interaction concerning human use of the landscape from prehistory to the present day.

Quantitative vegetation modelling in southwest Turkey

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Grove and Rackham in their 2003 book *The Nature of Mediterranean Europe* assert that '... plants are not just the environment, part of the scenery of the theatre of historical ecology, the passive recipients of whatever destiny mankind's whims inflict upon them. They are actors in the play' (45). Their statement reaffirms the importance of the study of vegetation and vegetation change in any discourse on human-environment interactions and why it is crucial to investigate the effects of human activities on vegetation and *vice versa*. Research into vegetation change strives to elucidate the drivers and triggers of vegetation changes as part of a wider discourse on landscape studies. Clearly, these drivers and triggers may have natural causes – for example changes in climate affecting and impacting upon vegetation distributions – or be human-induced – for example clearance of woodland for crop growing and pastoral activities. More often than not, explanations of vegetation and landscape change include combinations of both natural and human-induced triggers.

Pre-historical changes in vegetation can be reconstructed using a range of archaeobotanical and palaeoecological techniques, but one of the most useful is pollen analysis. Analytical pollen data from waterlogged deposits (for example lake/marsh sediments) allow the reconstruction of vegetation histories across a range of spatial and temporal scales. However, accurate interpretation of pollen data is dependent upon detailed knowledge and understanding of modern vegetation assemblages and how these are represented in the modern pollen rain; this is essentially a calibration exercise that can be achieved chiefly through two techniques: the analysis of moss cushions and pollen trapping apparatus.

Extracting pollen from cushions of moss growing on rocks and boulders is relatively quick and 'easy' to undertake; most pollen sequences in Turkey have been interpreted using modern pollen from moss cushions. However, ascertaining the actual age of the moss cushion is very difficult (due to inherent growth rates and environmental/local micrometeorological conditions), so moss samples provide only an 'average' of the pollen rain for an unspecified number of years. Other limitations include the fact that there may be differential deterioration and hence preservation of some pollen grains due to the predominantly aerobic environment of the moss cushion.

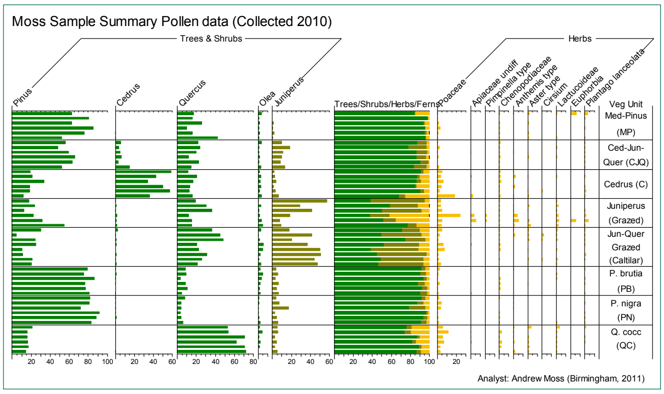
The other principal method for calibrating pollen sequences involves the analysis of pollen 'trapped' or captured over one calendar year using a container complete with a pollen-absorbent medium that is buried in the ground. The addition of glycerol effectively 'captures' the pollen grains and limits evaporation. Of the two types of pollen-trapping apparatus available, we opted for the Tauber pollen trap. Adoption of this trap ensures that our resultant pollen data can be compared on a like-by-like basis more widely with continental European pollen deposition rates via the European Pollen Monitoring Programme (http://www.pollentrapping.net/pmp.html).

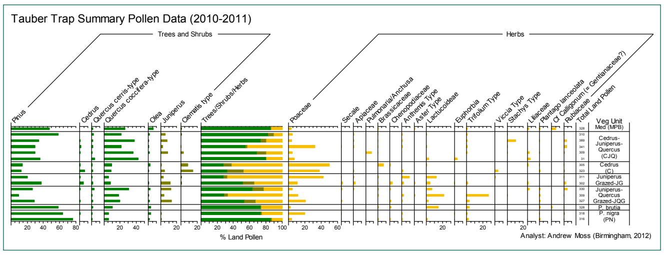
The study of modern pollen-vegetation relationships is crucial for greater accuracy of reconstructed vegetation sequences. However, very little systematic research has been undertaken in Turkey. Apart from Vermoere et al.'s (2000) Sagalassos study, we are aware of only one other modern pollen-vegetation study; namely, Efe et al.'s (2010) project in the Istıranca and Belgrade Forests of Thrace/Trakya. Thus, our project aims to address the paucity of systematic modern pollen-vegetation research in southwest Turkey and our data will be used to transform published pollen-count data from sedimentary basins (lakes and marshes) into quantified vegetation cover.

Our project commenced in 2010 with a reconnaissance and pilot study which included the collection of moss samples and the deployment of Tauber traps in the various vegetation units or belts that lie on an arc-shaped transect from the coastal town of Finike inland to near Afyon. Collected moss samples were subsequently processed and counted and the Tauber traps were recovered during the summer 2011 field season. Although recovery for 2010–2011 was disappointing (33%), at least one trap survived from each vegetation unit.

Generally, moss pollen data are well delineated for each vegetation unit. For example, the data for the *Cedrus* (cedar) vegetation unit shows that cedar pollen is only deposited at high percentage values at sites where it is locally abundant (i.e., it is not far travelled). However, the Tauber trap pollen data appear to suggest that cedar is under-represented even within its own vegetation unit. Likewise, both moss and Tauber trap data suggest that *Juniperus* (juniper) tends to be under-represented where it does not grow locally. *Olea* (olive) is expressed at low percentage values in the moss samples from nearly all vegetation units; Tauber trap data however, show very low percentage values for all units apart from the Mediterranean *Pinus brutia* unit (MPB) which is where olive grows locally. *Pinus* (pine), as expected, finds expression in all vegetation units due to its tripartite nature (produced abundantly, well dispersed, good preservation) and attains percentage values of ~80% where it is locally abundant. *Quercus* (oak), both evergreen and deciduous, is well expressed where it grows locally and finds expression in the other vegetation units, presumably where it grows as a shrub. The Tauber trap pollen data also show that herbs tend to be well represented in the modern pollen rain, particularly in more open woodland habitats that are heavily grazed; this may be an artefact of the Tauber trap design as its burial in the ground means that it is closer to the source of herbaceous pollen. Similarly, Tauber traps tend to have an over representation of entomophilous- or insect-pollinated plants because they act as pitfall traps for insect fauna.

Following the low recovery rates for 2010–2011, some Tauber traps were relocated to more inaccessible locations; additionally we attempted to conceal and 'camouflage' the traps better and attached mesh to minimise faunal input. To date, these actions appear to have been particularly successful; for 2011–2012 we achieved recovery rates of 80%. Future work will include the recovery and redeployment of traps over a timeframe that allows us to examine issues of inter-annual variability. We will also deploy new traps in newly reconnoitred vegetation units, along woodland-to-open habitat transects and in areas that are currently sustaining higher levels of human impact. A primary aim will be to undertake vegetation surveys around each Tauber trap and moss sample in order to establish translation relationships between modern pollen and vegetation and link these quantitatively to produce pollen productivity estimates (PPEs), which are a measure of the relative pollen





productivity of different plant species. PPEs will then be compared with modern pollen data collected from surface sediment samples from lakes and reservoirs located in our study area using models that are able to convert pollen data to regional vegetation. The modelled vegetation will then be compared with actual vegetation cover and, once these model comparisons are validated, it will be possible to transform fossil pollen data from sequences in the wider region to generate absolute or quantitative vegetation cover through time for comparison with archaeological and historical data on landscape change.

In conclusion, the study of quantitative pollen-vegetation relationships together with the implementation of novel suites of models can help to improve our knowledge and understanding of vegetation distributions and dynamics. This is central to important archaeological and palaeoecological debates and will also allow us to engage with many of today's key research questions, such as the potential impact of climate change on vegetation and anthropogenic activity, and the impact of anthropogenic activity on vegetation species distribution, as well as longer-term views, for example an examination of the *longue dureé* of human-environment interactions within this region.

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