are expected to far exceed any changes that have occurred to date. Even in the absence of marked changes in climate, atmospheric CO_2 may have dramatic effects on agriculture and water resources. To support rational planning for this eventuality, we require more studies like those discussed here to increase our quantitative knowledge of the influences of CO_2. But much more groundwork is required before we can make predictions that have practical value. We may have only a decade or so in which to make the step from speculation to application. □

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Palaeoecology

Hampstead Heath clue to historical decline of elms

from Peter D. Moore

LIKE human history, palaeoecology can be a frustrating occupation. How can one hope to construct a satisfactory, scientific explanation for an event which appears to have taken place on only one occasion in the fossil record? The whole basis of uniformitarianism begins to totter at this point. On the other hand, such events can fuel endless speculation, the pleasures of which tend to offset the frustrations. One of these has become a recurrent theme in the Quaternary palaeoecology of Europe: the decline in elm pollen which occurred quite abruptly across much of northern Europe, some five thousand years ago. It was this theme which reared its enigmatic canopy over a recent conference of botanists and archaeologists at Oxford*.

In the past few years, the debate has lost something of its vigour simply because no new evidence has come to light. It has been established that the collapse of the elm pollen in the stratigraphic record is widespread, relatively synchronous (within a 300–400 year period over a very large area, as indicated by dates which themselves, however, have broad inherent error margins). There are some isolated locations where the elm decline is less marked, but even in the extreme north of Europe, far beyond the limits of elm, it is often possible to detect a drop in the elm pollen that had been transported over considerable distances.

One of the major controversies has centred around the coincidence of the first clear indications of agricultural activity by Neolithic peoples with the elm decline, which has led to interesting speculations about primitive forestry practice and contemporaneous human population levels. Models advanced to explain the elm decline have evolved over the decades in a punctuated manner, each quantum leap being dependent on the acquisition of some new item of circumstantial evidence which permits further elaboration, or even a complete restructuring of the theory. Climatic change gave way to soil deterioration, which was overthrown by the radical proposition that man stripped the elm trees of their branches in order to feed stockaded domestic herbivores.

After a period of equilibrium, if not stagnation, the topic seems set to make another leap, and the evidence is coming from a number of directions. In the first place, it has become apparent that agricultural activity in Britain was widespread prior to the elm decline. This fact was demonstrated at the Conference by the data of J. Innes and I.G. Simmons (University of Durham). Their work on the North York Moors clearly shows that there were episodes of forest clearance during what are presumed to be Mesolithic times. Evidently the advent of agricultural ideas and practices in northern Europe was not a sudden, revolutionary event. In a recent analysis of the first occurrence of cereal-type pollen grains, Edwards and Hirons (*J. archaeol. Sci.* **11**, 71; 1984) showed a wide geographical scatter of records in Britain prior to the elm decline. Whether these derive from Mesolithic or Neolithic cultural activity is impossible to say and may in any case be a rather meaningless question. What is important is that the earliest agriculture was underway before the elm decline, which was therefore not the outcome of any large-scale invasion of innovative, agricultural techniques.

A similar conclusion has been drawn by J. Turner (University of Durham) who displayed pollen diagrams based on contiguous 1 mm microtome slices of a frozen peat core from the North Pennines. These showed a progressive decline in elm, evidently related to the succession of clearance events which had been taking place in the region over a period of several hundred, possibly a thousand years. Since the elm decline is also accompanied by falling levels of lime (*Tilia*) and ash (*Fraxinus*), Turner is inclined to the idea that the cumulative effect of centuries of Mesolithic wear and tear on the vegetation has resulted in the depletion of soil nutrients, leading to a decline in all three species. She has also proposed, on the basis of the pore numbers in the fossil elm pollen, that the elm in question in the area was not he wych elm, *Ulmus glabra*, as expected, but was more probably *U. minor* (see Stockmarr, *Danm. Geol. Unders.* IV R 4, No. 11; 1970). Since this taxon is climatically more sensitive than the wych elm, the suggestion could cause the entire debate to return to its starting point of some forty years ago.

It was at this point, however, that fuel was added to the fire from an unexpected quarter. M. Girling (English Heritage) announced the discovery of wing cases from an interesting beetle in sediments just 10 cm below the elm decline at a site on Hampstead Heath, London. The beetle she identifies as *Scolytus scolytus*, the carrier of the fungus, *Ceratocystis ulmi*, that is the cause of Dutch elm disease.

The proposal that the decline of elm 5,000 years ago was the product of a disease is not in itself new (see W.A. Watts, *Proc. Linn. Soc. Lond.* **172**, 33; 1960). It has become increasingly attractive, even compulsive, as we have observed the recent effects of Dutch elm disease on elm populations. But healthy speculation feeds upon circumstantial evidence and here, at last, we seem to have it. If the beetle vector was here 5,000 years ago, perhaps the disease was too. Was the sudden onset of the disease the result of early forestry? And how do we explain the concurrent decline in some other trees, such as lime? The answers are still not clear, and can never be entirely testable, but the new evidence will provide the necessary momentum for renewed vigour in an old debate. □

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*Joint meeting of the Botanical Society of the British Isles and the Association for Environmental Archaeology, Oxford, 21-23 September, 1984.

100 years ago

NATURAL SCIENCE IN SCHOOLS

HOWEVER fully it may be admitted by the few that it is important, nay essential, that all members of the community, whatever their station or occupation should during their school career receive some instruction in the elements of natural science, the general public have not as yet had brought home to them with sufficient clearness that, just as a knowledge of foreign languages is essential to all who are brought into intercourse with foreigners, so in like manner is a correct knowledge of the elements of natural science of direct practical value to all in their daily intercourse with Nature, apart from the pleasure which such knowlege affords. In fact, from a purely utilitarian standpoint, the advantages to be derived from even most elementary acquaintance with what may be termed the science of daily life are so manifold that, if once understood by the public, the claims of science to a place in the ordinary school course must meet with universal recognition. To quote Huxley: "Knowledge of Nature is the guide of practical conduct. Any one who tries to live without attention to the laws of Nature will live but a very short time."