

Palynology as a predictive tool in archaeology

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ABSTRACT

Environmental approaches contribute to the methodologies available to archaeologists. Too often, however, their perceived function leads to a relegation to post-excavation study rather than providing direction to archaeological investigation. Unlike many monument- and artefact-dominated data sets, those of an environmental nature (particularly if obtained from off-site depositional contexts) are often continuous and can be employed predictively. Using the results of a pollen-analytical study from eastern Scotland, it is shown how such data can provide not only a fuller picture of environmental and cultural change (eg by producing evidence for the degree of exploitation of the prehistoric and later landscape in terms of vegetation types and change, the extent of cultivation, the arable/pastoral mix, soil erosion, the length of occupation, or even the degree of nomadism), but they also highlight lacunae in the archaeological record (the immediate vicinity of the pollen site is virtually devoid of monuments and finds). Palynology can produce plausible and challenging data which help to pose and isolate problems for the archaeologist.

INTRODUCTION

It is in the nature of archaeology that much of its empirical work is site-centred. In so far as the archaeologist does turn to science, it is usually in the hope of widening or confirming knowledge of a site. Archaeologists have a number of discovery methods at their disposal – aerial photography, field walking, physical prospecting and excavation – each of which operates at a variety of scales and can yield valuable information. Such procedures may be pursued within a broader context, as in site-catchment studies, or as part of a theoretical approach. Environmental methods are also well established and their role ‘is one of the most impressive aspects of modern archaeological enquiry’ (Barker 1985, 15). Too often, however, their place is one of relegation to post-excavation study, or the examination of any likely organic deposit in the vicinity of the excavation site. This explains, perhaps, why many environmentalists feel that archaeologists regard their skills as ancillary. This has led to a situation whereby scientific methods are not seen as directive and barely even as complementary (which environmentalists have not bemoaned the relegation of their reports to the fished appendix?); furthermore, they are strongly in danger of not fulfilling their potential. Yet palaeoenvironmental studies could be used proactively in archaeology – in a manner which enables direction to be imparted to archaeological investigations. It is the purpose of this paper to present data from a project in eastern Scotland to show how such work can

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advance archaeological inquiry. In particular, it sets out to show how palynology can provide one tool to test the relationship between the broad picture which it can reveal and the distribution and nature of known sites in an area.

RATIONALE

Archaeological data sets are likely to suffer from a number of limitations, some of which are particularly severe. Thus, archaeological distributions are subject to the vagaries of survival; data sets frequently involve a broken time series; material under study is often qualitatively deficient (eg what significance or meaning can be ascribed to a carved stone ball or an axe which may simply have been dropped?); and it is practically impossible to know how deficient data sets are. Such problems are patently universal and influence adversely any certainty attached to archaeologically derived conclusions.

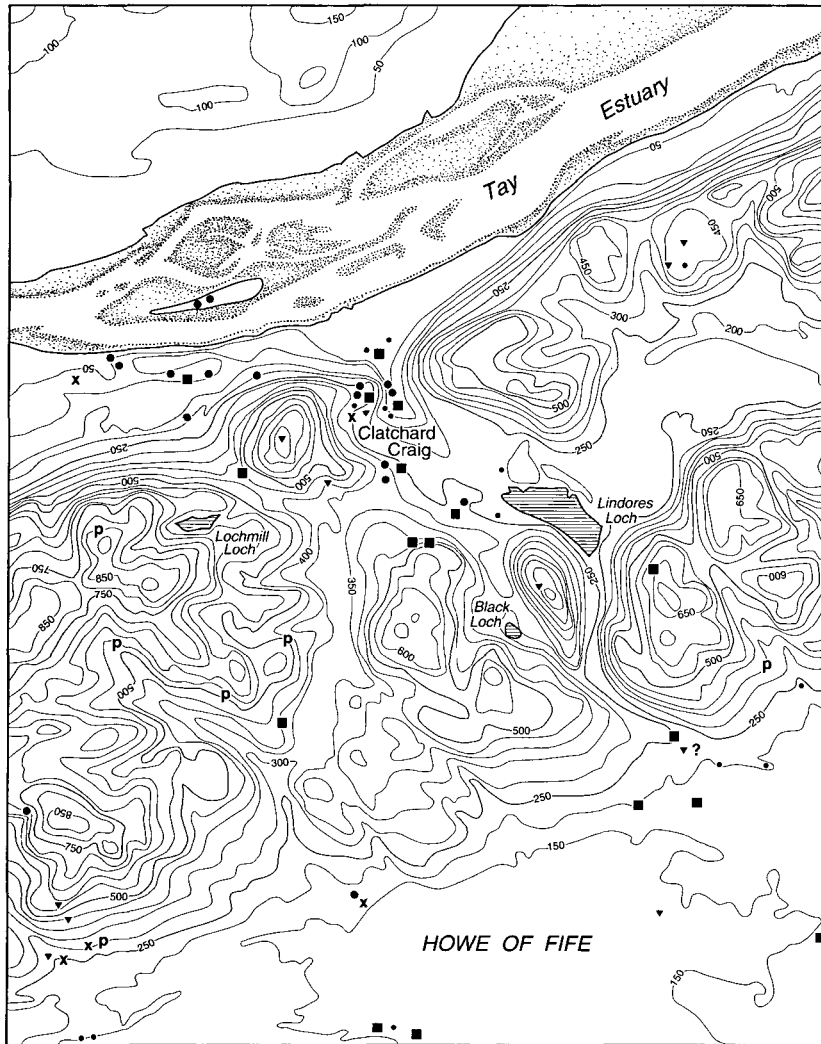
Some of these deficiencies may be remedied by using the results of palaeoenvironmental study. Evidence derived from accumulating deposits, such as lake sediments and peat, can provide a continuous time capsule which may be opened by appropriate methodologies (for example, chemical, magnetic, granulometric and, in the case presented here, pollen analyses). These augment the orthodox monument and artefact records with data concerning environmental change, the human impact on the landscape, and economic exploitation. They also provoke questions. The intentional use of pollen analysis (palynology) as a *predictive* tool is largely unknown in archaeology (eg see Finlayson *et al* 1973; Cloutman & Smith 1988), although other environmental methods, such as phosphate analysis (Bethel & Máté 1989), have been used for such purposes.

EXEMPLIFICATION

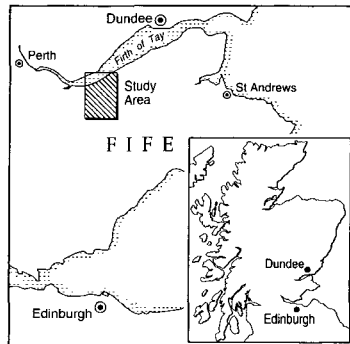
BACKGROUND

Black Loch (NGR NO 261149) is a rock basin loch in the Ochil Hills of northern Fife (illus 1). It was chosen for study because its small size (200 x 75 m) and catchment were likely to preserve a sensitive record of local environmental change. A restricted area of slopes to the north and east of the site is suitable for arable cultivation at the present day, while slopes to the south and west are currently used for rough grazing or are forested. The precise pollen catchment area is difficult to determine for past times. A reasonable working assumption might be that the greater part of the Black Loch record reflects the vegetation within the hydrological catchment (ie within a radius of ~1 km of the site).

The distribution of prehistoric and protohistoric sites and finds (illus 1) indicates that the surviving material culture record in the immediate vicinity of Black Loch is rather meagre, although the wider area provides more information. No Mesolithic finds are recorded but axes and carved stone balls attest to a Neolithic presence. A number of burial cairns and cists of the Bronze Age are known, and three Gündlingen bronze swords ascribed to the early Iron Age Hallstatt culture (Burgess 1968) were found in the north-east of the area. An Iron Age presence, in general, is more unequivocal with three hilltop enclosures, a souterrain and two hut circles close to Black Loch. It is uncertain as to whether these monuments belong to early or late stages of the Iron Age, which itself was broken by the Roman incursion, here represented by camps and weapons. Iron-using Dark Age Fife was an important centre for Pictish settlement (Whittington 1977) which is reflected in place-names and symbol stones.



- Neolithic — Axes or stone balls
 - Bronze Age — Cairns and cists
 - ▼ Iron Age — Forts and hut circles
 - x Roman — Camps and weapons
 - } Dark Ages — Symbol stones and ecclesiastical establishments
 - p } — Pictish place-names
- Contours at 50 ft intervals

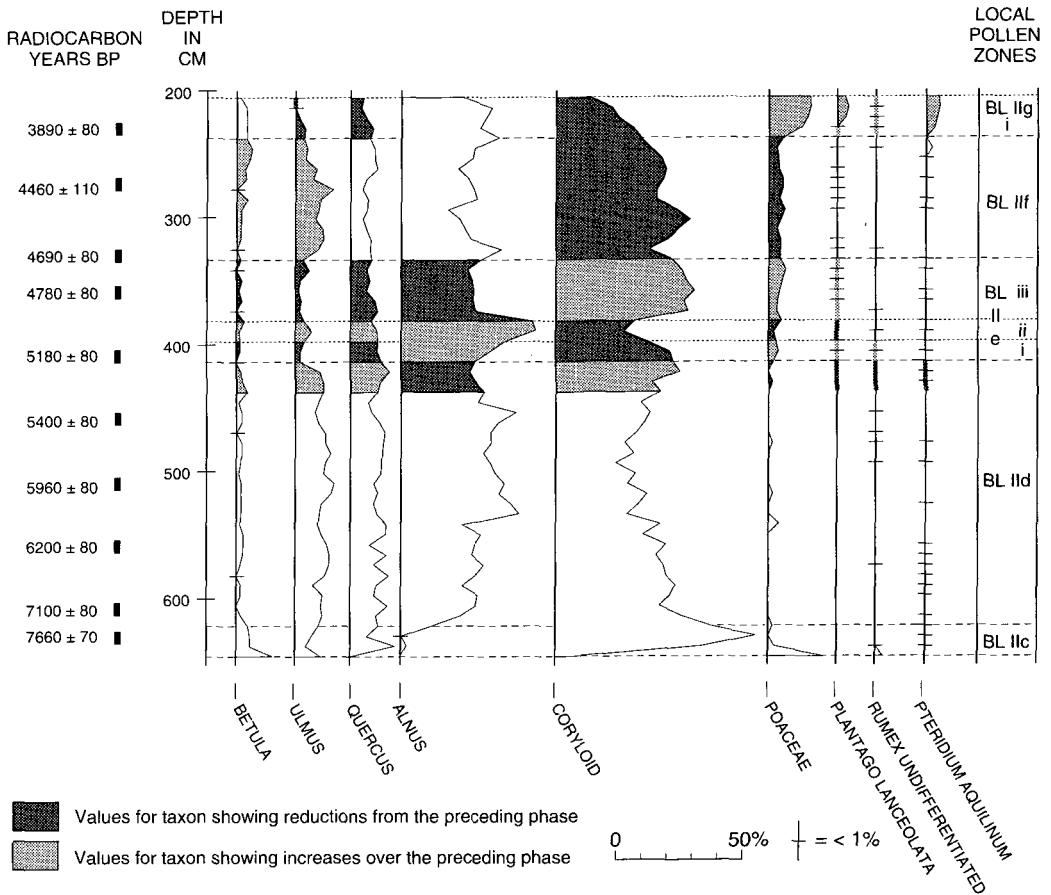


ILLUS 1 The location of Black Loch, and archaeological sites and finds in the study area (source: Fife Archaeological Index, University of St Andrews). Based upon the Ordnance Survey map © Crown copyright

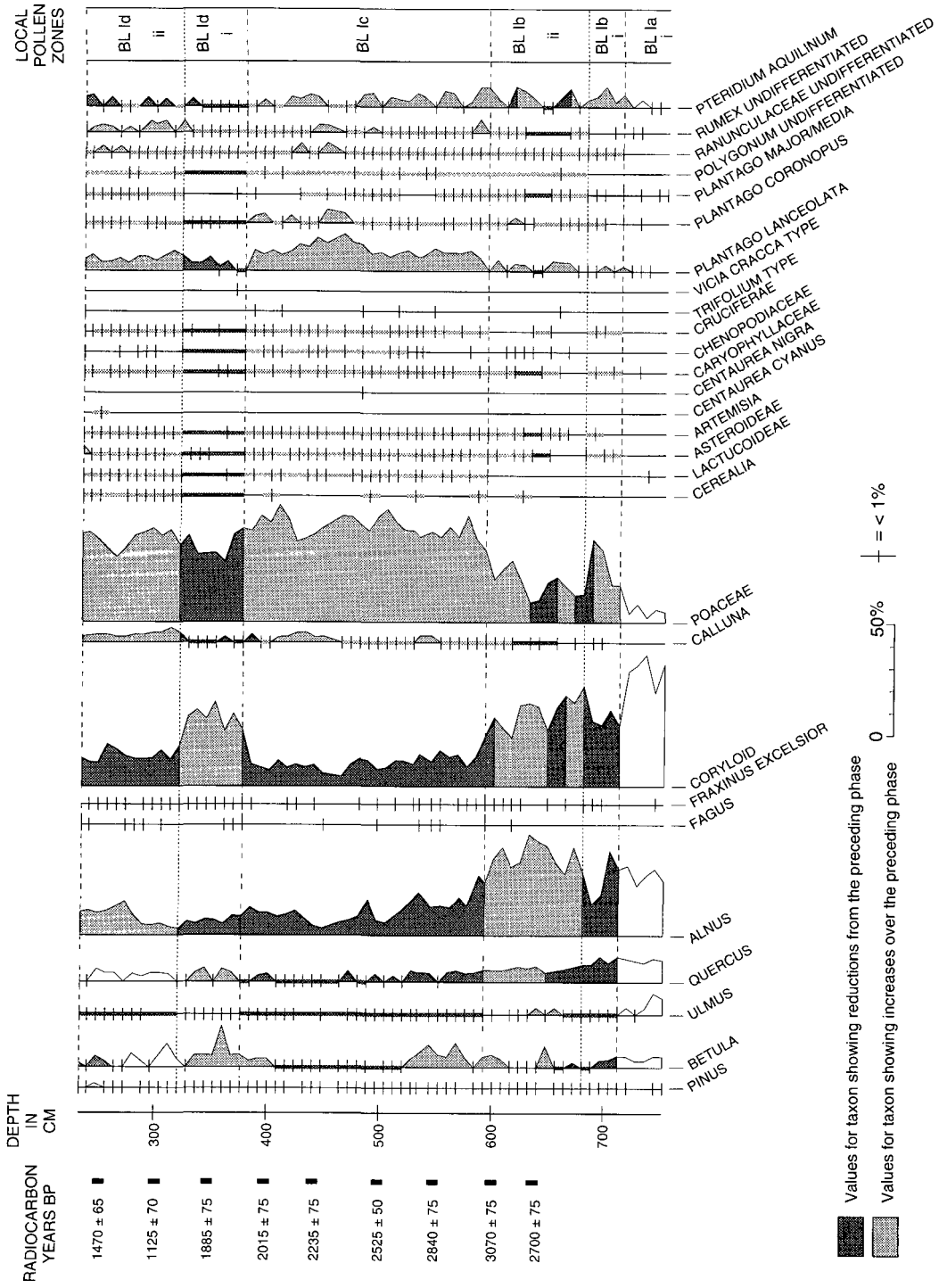
THE PALAEOENVIRONMENTAL INVESTIGATION

A total of four sediment cores were obtained from Black Loch, as a key methodological aspect of the research programme was to examine the within-site variability of environmental evidence (Whittington *et al* 1990 & 1991a). In exemplification of the topics under discussion here, selected palynological (pollen and spore) data will be presented from two cores only, BLI and BLII (there was a high degree of palynological agreement between all four cores from the site). BLI is a 7.52 m long core from the centre of the loch. In spite of its length, the basal samples date back only to an estimated 3800 radiocarbon years before present (BP) (1850 BC uncal), which makes this profile a promising one for high-resolution investigation. Edge core BLII extends into the late-glacial period and provides information on conditions prior to the late Neolithic.

Percentage diagrams of selected pollen and spore types are shown (illus 2 & 3) together with radiocarbon dates expressed as uncorrected years BP. Nineteen radiocarbon dates for the two cores provide a temporal framework for the period covered here (10,300–1000 BP [8350 BC–AD 950 uncal]) (see Whittington *et al* 1990 for details of laboratory codes and calculations of site chronologies).



ILLUS 2 Selected pollen curves (based on total land pollen percentages) from core BLII for the period c 10300–3280 BP (8350–1330 BC uncal)



ILLUS 3 Selected pollen curves (based on total land pollen percentages) from core BL.I for the period c 3750–1000 BP (1800 BC–AD 950 uncal)

A summary of the data concerning pollen zones, their ages and durations, vegetation and land-use characteristics is presented in Table 1. Dates are shown as uncalibrated estimated radiocarbon years BP and BC/AD to the nearest five years, based upon straight-line extrapolation between adjacent radiocarbon dates.

The suggestions of general types of agricultural practice (arable and pastoral) represent one level of inference. Further detail is provided elsewhere (Whittington *et al* 1990; 1991a), but the potential also exists to exploit even more fully the utility of such pollen analyses (cf Birks *et al* 1988; Whittington & Edwards, *in press*). Ultimately, the value of the pollen record is constrained by such factors as taphonomy and sampling resolution. In the case of Black Loch, the high level of within-core pollen variability has been noted, thus providing confidence in the basic data set and its genesis. The average sedimentation times for BLI and BLII of 6.5 and 9.4 years per cm of deposit, respectively, for the greater parts of the periods covered by each profile here, is highly respectable. The duration of the zones and subzones (Table 1) is such as to indicate prolonged activity of the type(s) indicated, though not necessarily in the same locations within the pollen catchment area (cf Edwards 1979; 1991).

Mesolithic times (c 10,300–5200 BP [8350–3250 BC uncal])

The Mesolithic age sediments at Black Loch are contained within the local pollen assemblage zones BLIIc and d. The rise of the curves for Coryloid (cf hazel) and *Alnus* (alder) in these zones, signifying the spread of these woodland types into the Black Loch basin, is not accompanied by any major expansions of open land pollen taxa or of charcoal (not shown here) which might have suggested human involvement in their behaviour (Smith 1970; Edwards 1990). An increase in sedimentation rates for BLIIc and d is difficult to interpret but suggests that, in some parts of the catchment, soil is being eroded at increasing rates. This may not be a response to anthropogenic pressures, but, in the absence of palynological indicators, is possibly a reflection of other processes, such as soil disturbance consequent upon increased wetness, frost action, or animal activity.

Neolithic, Bronze and Iron Age times (c 5200–1000 BP [3250 BC–AD 950 uncal])

The classic elm decline in pollen diagrams can no longer be assumed to mark the start of Neolithic times (Edwards & Hirons 1984; Edwards 1988; Peglar 1993). However, given the lack of indicators of a precocious farming presence at Black Loch, the first elm decline at the site (which begins at the end of zone BLII d and is estimated to date to 5200 BP [3250 BC uncal]) is the only certain indication that environmental changes were occurring. The fall in *Ulmus* (elm) pollen values in zones BLII d and BLII e(i), lasting an estimated 130 radiocarbon years, is also accompanied, but to a lesser extent, by declines in *Betula* (birch) and *Quercus* (oak) and an increase in Coryloid frequencies. There are expansions of Poaceae pollen values together with those of herbaceous taxa characteristic of open habitats, such as *Plantago lanceolata* (ribwort plantain), *Rumex* (sorrel/dock family) and *Pteridium aquilinum* (bracken). Collectively, these changes suggest that woodland decline was matched by the spread of pastureland and the secondary regrowth of hazel scrub (possibly in unshaded areas at the edges of clearings or as a cover in abandoned clearings); hazel may even have been coppiced (cf Göransson 1986). The shading on *illus 2* for subzone BLII e(i) reflects the notion of predominant woodland reduction over the preceding phase. Although the typically rare cereal pollen is not present in BLII at the elm decline, it does appear at possibly related levels in another core from Black Loch. Assuming that

TABLE 1: Summary data of pollen zones and inferred land use from cores BLI and BLII for the period c 10,300–1,000 BP (8350 BC – AD 950 uncal)
The pollen zones are displayed on illus. 2 and 3.

Local pollen zones and subzones	Estimated age range in 14C years (and duration), to nearest 5 years	Vegetation	Predominant inferred land use	Human activity high (++), low (+) or not evident (0)
BLId(ii)	1430 - 985 (445) BP AD 520 - 965	Woodland sparse; barley wheat/oats present; cultivation weeds well represented	Open landscape of arable and pastoral; diversified cereals	++
BLId(i)	1955 - 1430 (525) BP 5 BC - AD 520	Recovery of woodland, especially birch, oak and hazel; grasses decline, no cereals; fewer cultivation weeds	Decline in farming activity, especially arable; reversion to woodland	+
BLIc	3035 - 1955 (1080) BP 1085 - 5 BC	Severe reductions in woodland; grasses increase; cereals and cultivation weeds well represented	Open landscape of arable and pastoral	++
BLIb(ii)	3440b - 3035 (405) BP 1490 - 1085 BC	Fluctuations in woodland taxa; first-appearance of cereal-type (barley)	Pastoral and arable	++
BLIb (i)/BLIIg(i)	3965 - 3440 (525) BP 2015 - 1490 BC	Renewed decline in elm, hazel reduced; grasses, bracken and plantain increased	Pastoral	++
BLII f	4695 - 3965 (730) BP 2745 - 2015 BC	Recovery of elm and increase in birch	Reversion to woodland; possibly some pastoral	+
BLIIe(iii)	4940 - 4695 (245) BP 2990 - 2745 BC	Elm and alder decline; hazel and grasses increase; plantain reappears	Pastoral	++
BLIIe(ii)	5070 - 4940 (130) BP 3120 - 2990 BC	Recovery of elm and alder; falls in hazel and herbs	Reversion to woodland	+
BLIIe(i)	5190 - 5070 (120) BP 3240 - 3120 BC	Woodland clearance starts; classical 'elm decline'; grasses rise, plantain appears	Pastoral farming initiated	+
BLII d	7360 - 5190 (2170) BP 5410 - 3240 BC	Woodland cover of elm, oak, alder and hazel	No land use indicated	0
BIIf	10,300 - 7360 (2940) BP 8350 - 5410 BC	Transition from open landscape of early postglacial to a woodland cover of elm, oak and hazel	No land use indicated	0

human activity is occurring, then this would support the idea of mixed arable and pastoral farming at this time.

At c 5070 BP (3120 BC uncal: the start of subzone BLIIe(ii), duration 120 ¹⁴C years), *Ulmus* pollen partly recovers, *Alnus* increases sharply, Coryloid and Poaceae (grasses) are reduced and *Plantago lanceolata* is absent. A resurgence in elm is suggested and this may mean that agricultural land had been abandoned or, conceivably, that elm coppicing was now occurring within a system of forest farming (Göransson 1986). The shading in illus 2 for subzone BLIIe(ii) reflects the notion that, compared with the preceding phase, there was an overall recovery in the extent of woodland.

From this point onward, illus 2 (to c 3600 BP [1650 BC uncal]) and the more detailed illus 3 (c 3800 BP [1850 BC uncal] to the present), show recurrent patterns of episodic woodland change with concomitant expansions or reductions in herbaceous pollen taxa. These are clearly demonstrated by the shading scheme and the commentary provided by Table 1. It is not intended to labour either the description or the interpretation of such cyclical patterns, and the treatment of subzones BLIIe(i) and BLIIe(ii) serves as exemplars of gross vegetational change evident in the pollen profiles. Of special note, however, are the multiple reductions in elm, rather than the single classic *Ulmus* decline of c 5100 BP (3150 BC uncal) (cf Hiron & Edwards 1986; Smith & Cloutman 1988; Whittington *et al* 1991b); the prolonged Late Bronze Age and Early Iron Age phase (zone BLIc, c 3030–1950 BP [1080–0 BC uncal], duration estimated at 1080 ¹⁴C years) of woodland recession and evidence for a regime of pasture and cereal cultivation; and the cessation or diminution of agricultural activity during a time which included Roman incursions (subzone BLId(i), c 1950–1430 BP [AD 0–520 uncal]).

DISCUSSION

It is clear from illus 1 that the immediate vicinity of Black Loch is virtually devoid of conventional artefact material. It is only for an area which is, in all probability, much wider than the pollen catchment area, that an intermittent prehistoric and later human presence can be demonstrated. In contrast, the palaeoecological record is nearly continuous; from Neolithic times onward, vegetational changes, consistent with human impacts in many cases, have been a feature of the landscape.

The palynological and archaeological record are in accord for the Mesolithic period: neither suggests the presence of hunter-gatherers in the area. For most of the Neolithic and much of the Bronze Age periods, a relatively closed woodland cover, albeit probably of a regenerated type, persisted for longer than did the phases displaying open or cleared vegetation. If the evidence from Neolithic artefacts derives from periods when the vegetation was of an open nature (suggesting agricultural land use), then these represent relatively minor segments of time when the scale of early farming in the immediate area was not great. From the Late Bronze Age, the scale of clearance is considerably extended. The Bronze Age archaeological record is limited to funerary monuments of uncertain age (and located almost 2 km distant). This sparse representation compares with a stronger palynological signal which might, arguably, indicate a permanent population; as a corollary, archaeologists might profitably concentrate on methods to optimize the discovery of settlement sites.

The Late Bronze Age has become embroiled in a possible environmental event of some magnitude, with the contentious suggestion that catastrophic climate change may have led to settlement abandonment in marginal areas (Baillie 1989; Burgess 1989; Edwards *et al* in press). If this did occur, then the Black Loch area does not seem to have been affected, as, for the period in

question (c 1170 calendar years BC onwards, corresponding to the first half of zone BL1c), woodland reduction and mixed agriculture actually expanded. Conversely, although any evidence for this would appear to be lacking, the area may have received peoples displaced, either directly or indirectly, from more agriculturally marginal localities, thus leading to the intensification of agriculture evident in the palynological record.

The palynological and archaeological evidence for the Iron Age are in accord. The palynology, moreover, appears to suggest an unbroken occupation from the end of the Bronze Age. The pollen data from Black Loch indicate considerable activity there during the Iron Age, and suggests that the distribution of unenclosed settlements of round timber houses proposed for Fife by Maxwell (1989, his Fig 6.5) is too restricted. The extension of woodland and the apparent reduction in the area of farmland during and after the Roman period provokes questions as to why this should have occurred. There were at least three Roman camps in northern Fife (the nearest at Auchtermuchty, 7 km away); perhaps the native Venicones were not compliant (cf Maxwell 1989) and found it necessary to abandon the area (cf Edwards 1978; Whittington & Edwards 1993). Maxwell (1989, 126) felt that there was a possible equation between the presence of unenclosed settlement and of potentially dangerous indigenous groups in the Fife peninsula. At Clatchard Craig, 3 km from Black Loch, there was only limited occupation in the second and third centuries AD, with an absence of detected subsequent construction until perhaps the seventh century AD (Close-Brooks 1986); a case where there is some conformity between the archaeological and palynological records. The lack of archaeological finds of Late Iron Age or Pictish date in the vicinity of Black Loch contrasts with a clear indication of clearance and crop cultivation in the pollen record, and suggests the incompleteness of the archaeological evidence.

The recurrent nature of the phases of woodland reduction and regeneration, and indications of their longevity, could not possibly, of course, be revealed by traditional archaeological methods. The duration of periods when the landscape presented an open aspect varied between about 120 radiocarbon years in the Early Neolithic and more than a millennium for the Late Bronze/Early Iron Age clearance episode of zone BL1c. (Although dendrochronological calibration would extend some of these intervals, it would not significantly alter their temporal magnitude.) Such events also prompt questions as to the nature of land use activity: for instance, is shifting agriculture, with its attendant suggestions of temporarily decreased soil fertility, and of land abandonment, being reflected in the pollen assemblages (Berglund 1986); or was there an element of forest farming in which the restoration of woodland did not mean the cessation of local agricultural activity, but, rather, that woodland management for grazing purposes, with coppicing and even garden plots, may have begun (Göransson 1986; Edwards 1993)? If there was a nomadic element to the Neolithic in Fife, with land abandonment over long periods as crop yields fell, then does this suggest that regional population densities were low? If Bronze Age farmers were more sedentary, were population pressures and soil deterioration more severe, thus necessitating the intake of larger areas of agricultural land to compensate for lower crop yields or poorer grazing?

Such questions as have been raised provide not only a challenge to the archaeologists, but also something more complementary. They serve to highlight problems in the human record and may provide direction, or at least informed speculation, for more specifically archaeological inquiry. Archaeological finds should ideally be placed in a more extended temporal and environmental context than that often revealed by on-site work, where organic remains may have disappeared in acid soils or limited excavation may have uncovered an equally restricted or even unrepresentative artefact and environmental record (Edwards 1991).

CONCLUSIONS

Archaeologists are often faced with the inconvenient fact that their sites alone may give little idea of the extent and intensity of human activity in prehistoric and later times. Questions such as 'Who were these people?' or 'Why are so few sites known?' are archaeological rather than palynological. The results of palynological inquiry, however, may readily reveal aspects of environmental and cultural change which would be very difficult to assess using conventional archaeological means: these include the degree of exploitation of the cultural landscape in terms of vegetation types and change, the extent of cultivation, the arable/pastoral mix, soil erosion, the length of occupation, or even the degree of nomadism. Black Loch is merely one example of the many sites where pollen sequences show strong evidence for early human impact in areas where there are few known archaeological sites, or where the finds and monuments do not cover the period in question. Others in Scotland include Kinloch, on Rum (Hirons & Edwards 1990), Arran and Kintyre (Edwards & McIntosh 1988; Robinson & Dickson 1988), and Loch Dee in the Galloway Hills (Edwards *et al* 1991). The results of palynological study may not allow the palaeoecologist to pronounce unequivocally upon such matters, but plausible and challenging data can certainly be produced, thus helping to pose and isolate problems for the archaeologist which other techniques have yet to supply.

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