2. The palaeoenvironmental potential of waterlogged deposits and their contribution to archaeological investigations

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Illus. 1—Peat sample extracted using a Russian corer (Tim Mighall).

The current road scheme developments throughout Ireland are unveiling new and exciting sites, which are providing fresh opportunities for archaeological study that is adding to our understanding of past societies. It is not just traditional excavations that are now taking place, however. The increasing number of wetland sites being excavated has allowed for more innovative methods and sampling strategies, with an adoption, in particular, of geoarchaeology to focus on the palaeoenvironmental history of sites. By understanding what the past environment was like we can begin to get an idea of the landscapes that past people moved through and lived in. Looking at the interaction between people and the environment then helps in our interpretation of the archaeological finds we uncover.

Wetland sites and waterlogged deposits

Wetland sites are important to palaeoenvironmental studies as they contain waterlogged deposits (e.g. peats and clays), which preserve organic remains (e.g. seeds) so well that they look like they were deposited yesterday rather than, in some cases, thousands of years ago. This is due to the anaerobic conditions within these deposits, meaning that oxygen cannot penetrate them and start the onset of decomposition, whereas material lying exposed on the ground surface would decay and rot away to nothing.

Wetland sites can vary in nature from intertidal coastal sites to inland raised or blanket bogs. Access to and excavation of these sites can often be problematic: for example, coastal sites only permit working within a short tidal window. As anyone who has had the privilege to work on these sites will confirm, the archaeological finds and the palaeoenvironmental data that can be retrieved make such hardships worthwhile.

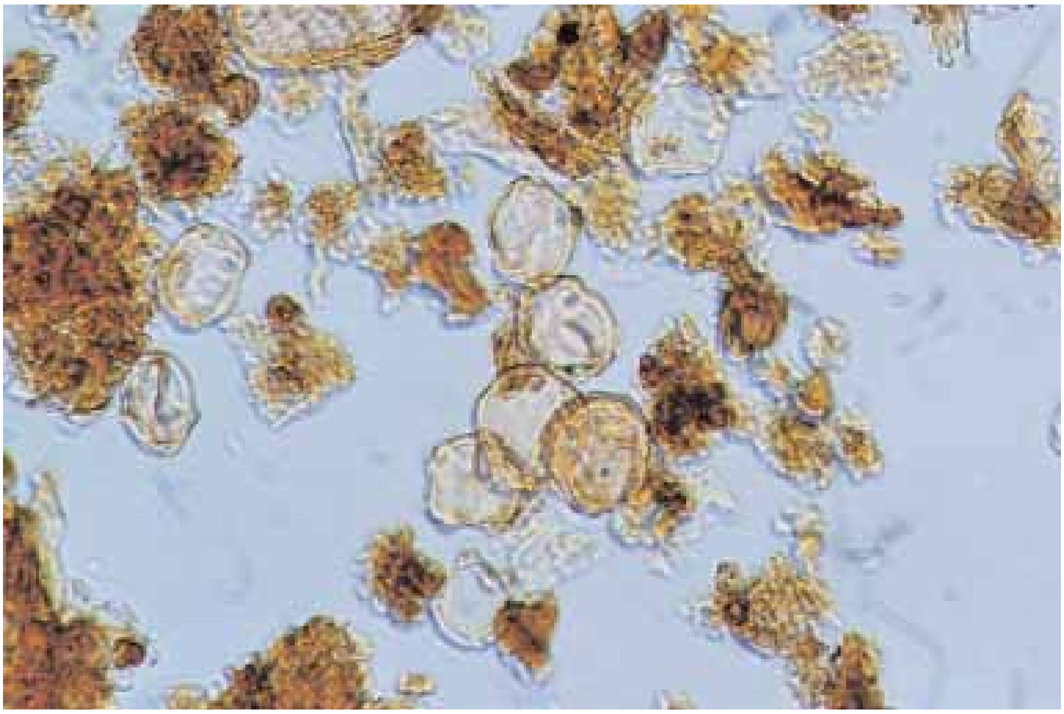
Sampling methods

There is a variety of ways to take palaeoenvironmental samples. On an exposed section monolith or kubiena tins are used: these are literally hammered into a section face in an overlapping series, ensuring that the entire sequence is sampled. Once removed from the section, the tins are wrapped and labelled. In a raised or blanket bog a Russian corer is used to sample deposits that can extend to great depths. For example, during assessment work in Annaholty Bog, Co. Tipperary, as part of ongoing work along the N7 Nenagh–Limerick High Quality Dual Carriageway, the peat deposits were found to be over 9 m deep. The corer is pushed into the ground manually and turned 90°. The chamber of the corer is designed to close and trap sediment so that it can be removed without any contamination or smearing of the material. Once extracted, the sample or core is removed from the chamber and placed onto plastic guttering (Illus. 1), then wrapped and labelled. Other sampling methods include bulk sampling of material, hand-sampling and using chain-saws, for example to take dendrochronological (tree-ring dating) samples. Once in the laboratory, samples can be subsampled without risk of contamination and made ready for different types of palaeoenvironmental analysis. Some of the types of analyses that can be performed are described below.

Pollen and non-pollen palynomorph analysis

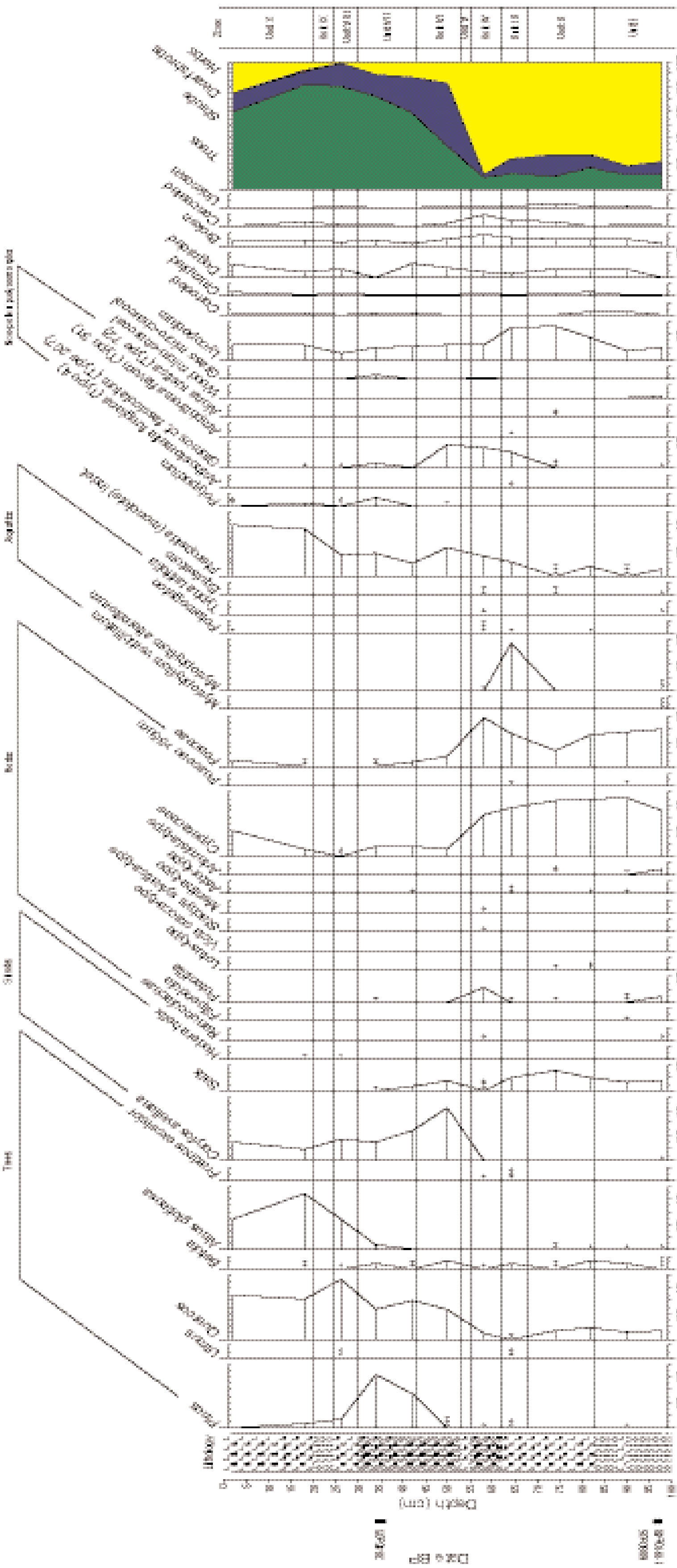
Pollen analysis is used to provide information on vegetational communities over time, from regional to local level. This type of analysis involves the identification of pollen grains produced and dispersed by flowering plants in order to fertilise and reproduce (Illus. 2). Traditionally, pollen analysis has been used to reconstruct the vegetational history of areas to get a sense of what past environments were like and how they change over time. Pollen, however, can also be used as a tool to look for evidence of people in the landscape through focusing on deposits of particular interest—e.g. sediments lying immediately below and/or above a wooden trackway. Indicator species are looked for in the pollen diagram to show such past human activities (e.g. the presence of cereal pollen accompanied by a suite of plants associated with agricultural activity can be readily interpreted as evidence of farming).

Non-pollen palynomorphs, such as fungal spores, provide local environmental data to supplement information gained from pollen analysis. For example, fungal spores (Illus. 3) can indicate the presence of plant species that may not be present in the pollen diagram, together with episodes of burning and the former presence of rotting vegetation and animal dung. At Kinsalebeg, Co. Cork, on the N25 Kinsalebeg Realignment, the pollen assessment



*Illus. 2—Alder (*Alnus glutinosa*) pollen grains, x400 magnification* (Scott Timpany).

Illus. 3—Fungal spores present on wood can also be found within pollen samples, x400 magnification (Scott Timpany).



Illus. 4—Selected taxa pollen diagram (100 grain count) from Kinsalebeg, Co. Cork (Headland Archaeology Ltd).

showed the presence of *Cercophora*-type spores (Type 112) within Units II, III and VII (see right side of Illus. 4), which are linked to animal dung (van Geel et al. 2003). The presence of animals in the landscape, particularly in Zone VII, representing the Early Bronze Age, may be linked to the presence of people and animal husbandry close to the site.

Plant macrofossils

Owing to the larger size of plant macrofossils, such as seeds and fruit stones, in comparison to pollen grains, they will have travelled less distance from their source, providing information on the local environment. This information can supplement data from pollen analysis by, for example, representing species that are not present in pollen diagrams either because they are not prolific pollen-producers or because they are insect-pollinated. For example, poplar (*Populus*) is often under-represented or absent in the pollen record, but its buds and bud-scales can be found preserved within waterlogged contexts.

Plant macrofossils can also provide information on local fauna. Nuts and fruit stones preserved in the archaeological record sometimes show traces of animal markings, such as gnaw-marks or peck-marks, which can show what animals and/or birds were present. For example, gnaw-marks on nuts from a submerged forest site at Goldcliff East in Wales showed that voles, squirrels and mice were present, together with birds such as the great tit.

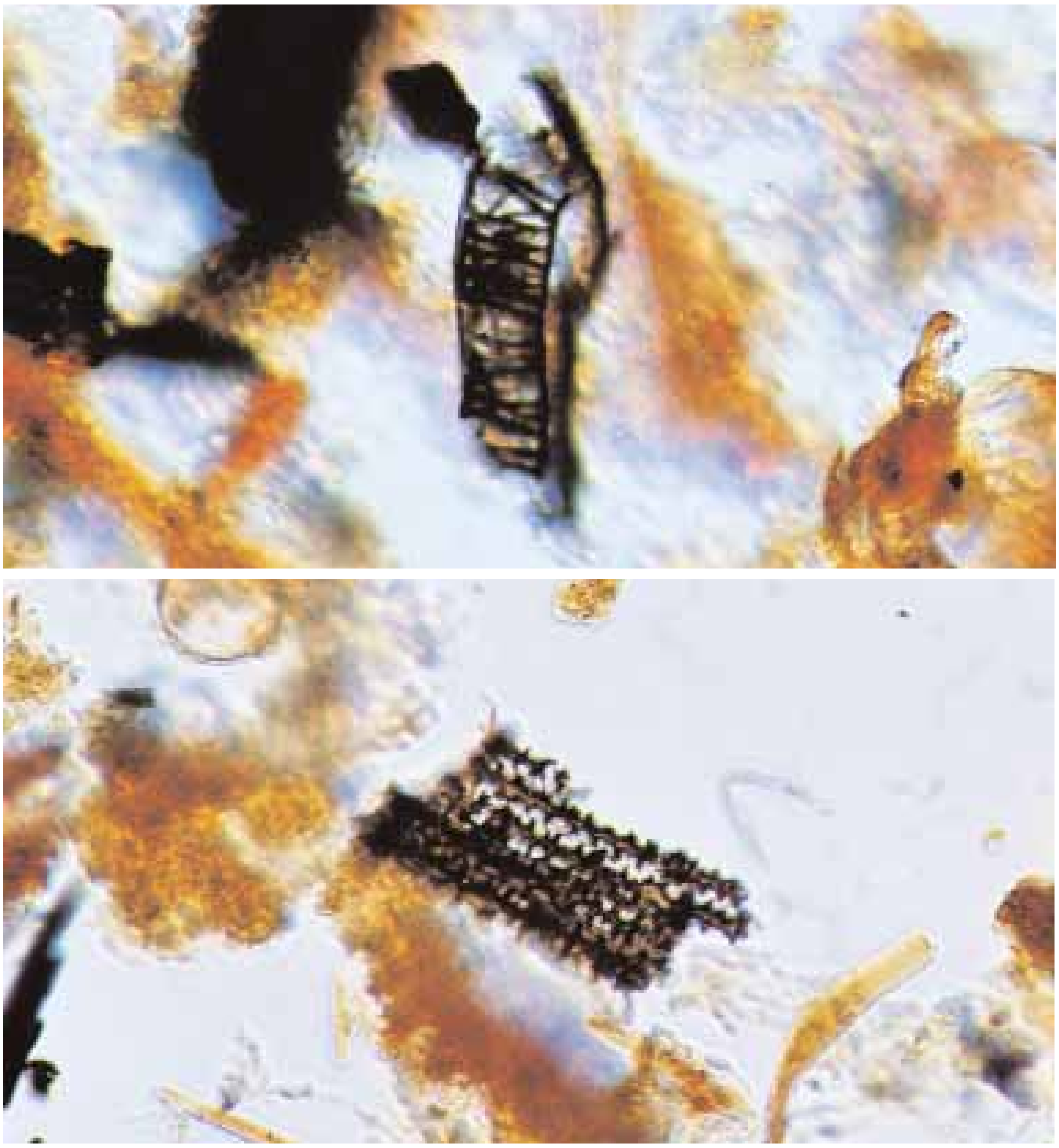
Wood and charcoal

Within waterlogged deposits there is great potential for the preservation of wood remains, from small twigs and trunks of former woodlands to withies (wooden ropes) and timber posts from archaeological features. Wood was an important resource in the past (as it still is today) and had a wide range of uses, from fuel to construction material, and through identification of the wood species we can see what types of trees were being used. Oak (*Quercus* sp.) and pine (*Pinus* sp.) can be used for dendrochronological dating, which can give an exact calendar date for the wood and thus for associated structures and deposits. Tree-rings can also be examined to provide information on growing conditions and possible woodland management (e.g. coppicing).

Wood used for fuel is often represented in the archaeological record as charcoal. Similarly, remains of buildings or other structures that were burnt can survive as charred material. As with waterlogged wood, analysis of these charcoal fragments can provide information on the types of wood used for fuel and construction. Occasionally it is possible to supplement the macroscopic charcoal evidence with microscopic evidence. On pollen slides microscopic charcoal can sometimes retain enough of its structure for the analyst to be able to differentiate whether wood and/or grasses (Illus. 5) were being burned.

Diatoms and Foraminifera

On waterlogged sites in intertidal locations (now or in the past), the analysis of diatoms and Foraminifera can provide valuable information on sea-level rise. Diatoms are microscopic,



Illus. 5—Microscopic charcoal of wood (above) and grasses (below) (Scott Timpany).

mostly unicellular algae and are one of the commonest types of phytoplankton (a microscopic plant). They can be identified by the variation in the form of the silica cell wall that encases the diatom. They inhabit the full range of aquatic conditions and thus can be used to differentiate fresh, brackish (slightly salty) and marine waters—important in sea-level studies—as well as providing information on temperature and acidity.

Foraminifera are unicellular organisms that live in predominantly marine environments. They have distinctive tests or shells that are used for identification purposes. Foraminifera are used in the reconstruction of palaeoclimate and in sea-level studies, particularly in relation to a site's position in the tidal window. Different Foraminifera inhabit different locations within the tidal window—for example, Mean High Water Spring Tide (MHWST).

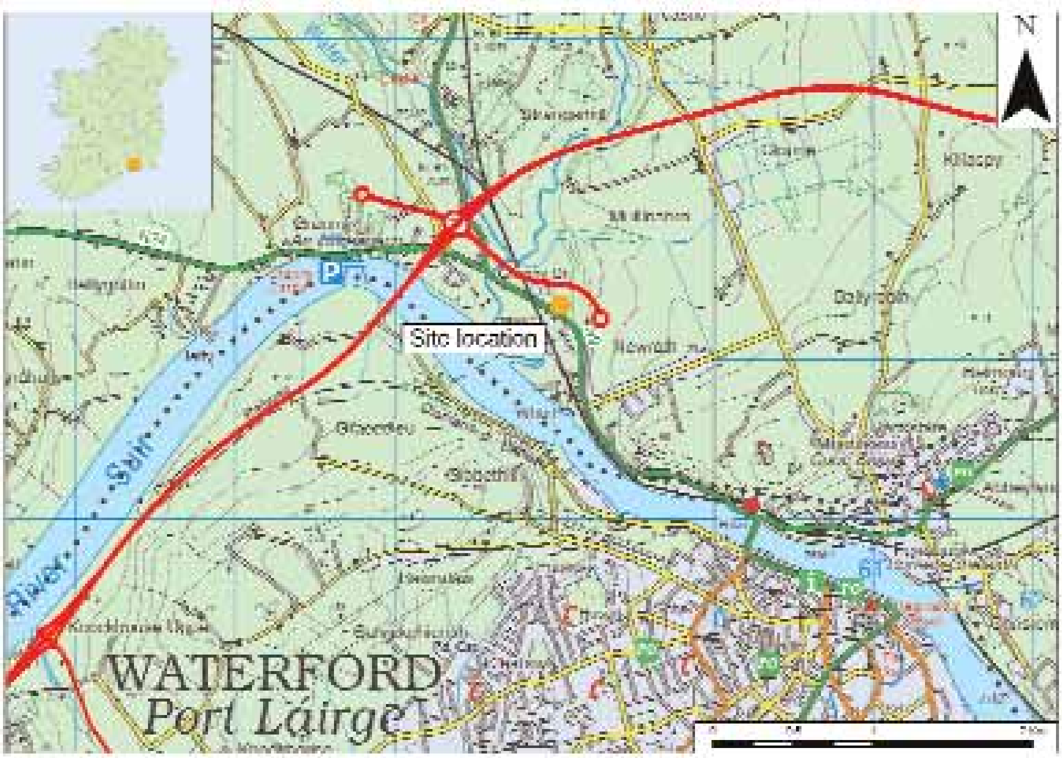
Insects

Insect remains can provide important palaeoenvironmental information in addition to pollen and/or plant macrofossil studies, with different insects living in different ecological niches (e.g. aquatic compared to woodland). Insects can also be used as tools for palaeoclimate reconstruction and as indicators for the presence of people and/or animals in the vicinity of sites—for example, by the presence of lice that may relate to people or cattle, and by the presence of specific species of beetles that are attracted to either human or animal dung.

Case-study: Newrath on the N25 Waterford City Bypass

One archaeological site where a number of the above methods have been used, therefore making it a multi-proxy study, was Site 34 at Newrath, Co. Kilkenny (Illus. 6). Using a combination of techniques rather than just one ensures that the greatest possible amount of information is gathered from the site.

Following preliminary investigations in 2003, this wetland site was fully excavated between June and December 2004 by Brendon Wilkins of Headland Archaeology Ltd on behalf of Waterford City Council, Waterford County Council, Kilkenny County Council and the National Roads Authority (NRA).[1] Excavations revealed a wealth of archaeological material and showed the site to be multiperiod, ranging in date from the later Mesolithic



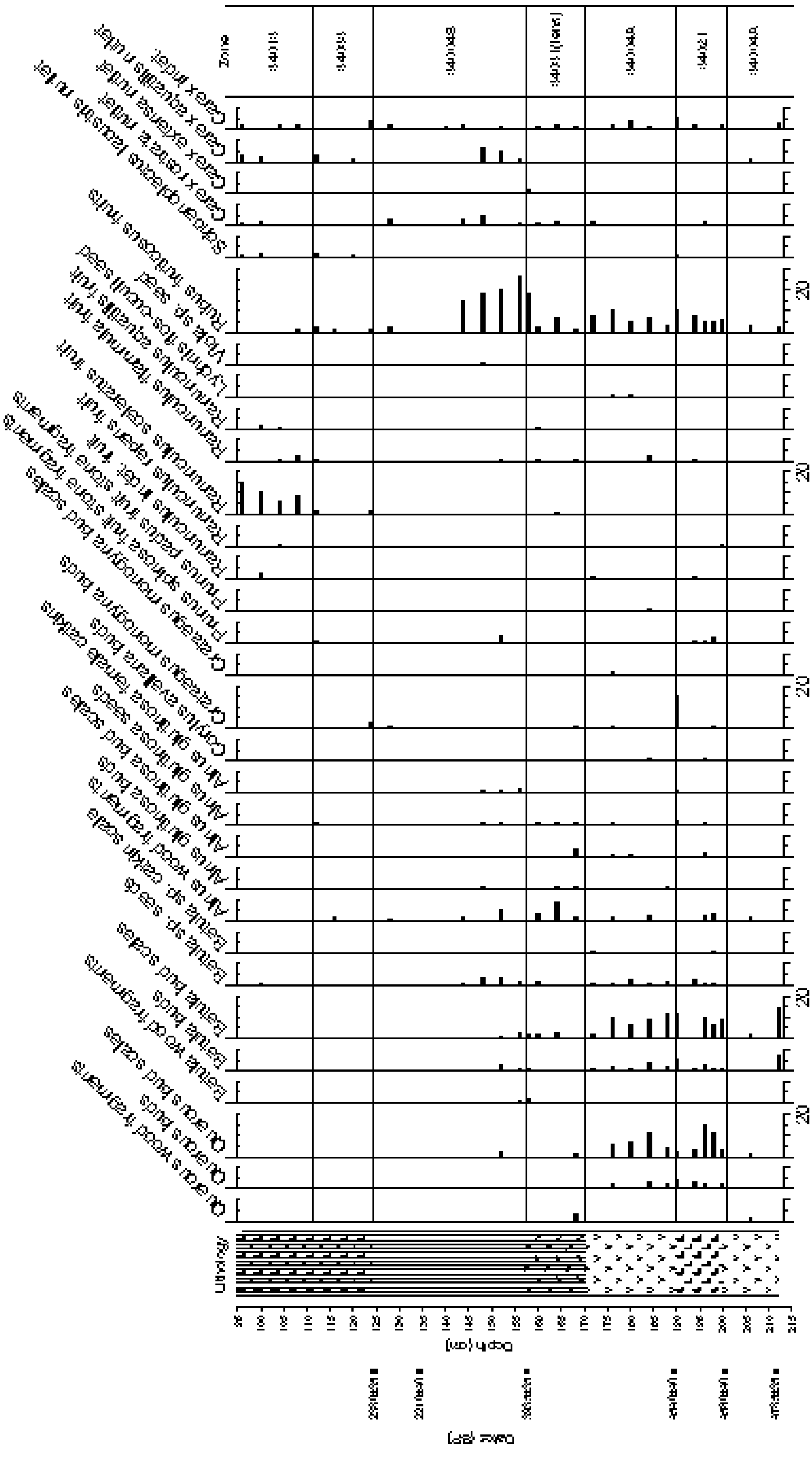
Illus. 6—Location of Site 34 at Newrath, Co. Kilkenny, on the route of the N25 Waterford City Bypass (based on the Ordnance Survey Ireland map).

Illus. 7—One of the main trackways excavated at Newrath (Headland Archaeology Ltd).

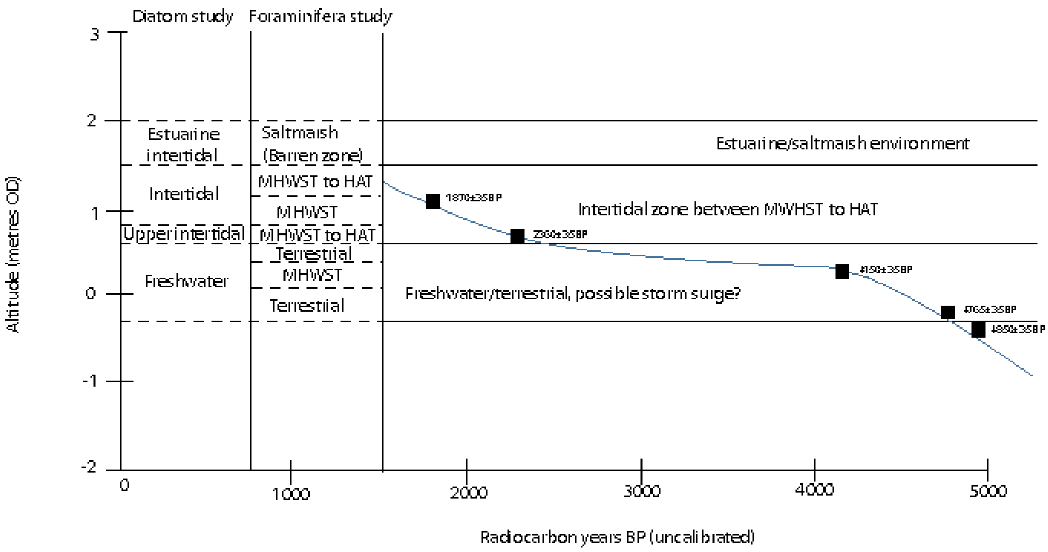
to the medieval period (Wilkins 2007). The site was sampled for pollen, plant macrofossils, diatoms and Foraminifera using monolith tins, and bulk samples were also taken from around archaeological features for further plant macrofossil data, together with wood species identification samples from archaeological features such as trackways and structures (Illus. 7) (see Carter 2007 for a discussion of the preliminary results of this work).

During the Late Mesolithic period the environment around Newrath would have been dryland woodland. Pollen studies indicate that this woodland would have consisted primarily of oak (*Quercus* sp.) and hazel (*Corylus avellana*). Archaeological evidence in the form of Bann flakes (leaf-shaped stone tools characteristic of the period) recovered from the site shows that people were present in the area and moving around within this woodland. This early woodland is often referred to as primeval woodland (e.g. Peterken 1996) and would have looked different to the woodlands of today. Without the large-scale effects of people, which mean that much of today's woodland is in some degree managed, this woodland would have contained trees that grew to vast sizes. This has been seen from studies of submerged forests (Bell 2007), where oak trees have been recorded that indicate that dense canopies existed within such woodlands, allowing little light penetration, with trees competing for space. Therefore people in Newrath during the Mesolithic period would have walked through a woodland of giant trees, at times quite dark owing to the dense canopy.

From around 3430–3380 BC (SUERC-10128; see Appendix 1 for details) the environment at Newrath began to change, with the dryland becoming wetland, indicated by the development of peat. This change is related to a rise in sea level in the area, raising the level of the water-table and making the environment more attractive to damp-loving plants. This can be seen in one of the plant macrofossil diagrams (Illus. 8), where buds and



Illus. 8—Selected taxa plant macrofossil diagram from Newrath (Headland Archaeology Ltd).



Illus. 9—Diatom and Foraminifera results for Newrath, with reconstructed sea-level curve from radiocarbon dates (Headland Archaeology Ltd).

seeds of alder (*Alnus glutinosa*) and birch (*Betula* sp.) are present together with oak. This woodland would have been more open than the previous oak woodland, with trees such as alder tending to grow in clumps and thus providing areas on the ground for herbaceous plants. The plant macrofossil information also shows evidence of damp ground plants such as sedges (*Carex* sp.) and brambles (*Rubus fruticosus*). Together with the pollen record, this indicates that this woodland would have been swampy underfoot, with pools of water often present on the ground surface, making it hard going for people to walk through this woodland. This may explain why there is a dearth of archaeological material of Neolithic date at Newrath, with people avoiding walking through this swampy, wooded location.

By 390–180 BC (SUERC-14688) this environment had changed once more, from wet woodland to a reed-swamp, and again this is linked to rising sea level in the area. This change is shown in the pollen record by an increase in grass pollen (Poaceae), which includes reeds, and a decline in alder pollen, signalling a decline in wet woodland. The plant macrofossil diagram also records this change (Illus. 8), where the representation of trees such as oak, alder and birch is seen to decline. The majority of the wooden structures found at Newrath, constructed in the Bronze Age and Iron Age periods, relate to this reed-swamp environment. These structures are likely to have been built to provide access through the reed-swamp, making it easier for people to traverse this landscape. Making these areas more accessible would have aided activities such as fishing, fowling and the collection of plants for food and construction materials; for example, reeds can be used for thatch and their rhizomes (the underground stem of the plant) are edible (Law 1998). Wood species identification results indicate that the wood used to construct the trackways and structures came from trees growing within the woodland on the wetland, largely alder, showing that people were using local resources available to them for construction materials.

At around AD 60–240 (SUERC-10124) the site became a saltmarsh environment. This is particularly well shown by the Foraminifera and the diatom evidence, which demonstrate that the site had become intertidal and lay in the area of Mean High Spring Tide to Highest

Astronomical Tide within the tidal window (Illus. 9). The pollen shows evidence of saltmarsh vegetation at this time, with the presence of plants such as Michaelmas daisies (*Aster*-type) and goosefoots (Chenopodiaceae). The plant macrofossil data (see Illus. 8) also record this change, with an increase in aquatic plants such as celery-leaved buttercup (*Ranunculus sceleratus*), water sedge (*Carex aquatilis*) and common club rush (*Schoenoplectus lacustris*). Such saltmarsh environments are a good resource for grazing cattle and as such would have been important locations for people. There is archaeological evidence in the form of a brushwood hurdle dating from this period at Newrath, and although its function is still somewhat unclear it provides confirmation that people were present in the landscape. Further evidence of people in the landscape following the Iron Age is sporadic, with only potential wooden constructions dated to the medieval period present in the archaeological record. Nevertheless, this scant evidence still shows that the wetland site of Newrath, rich in resources through time, was an important location for a wide range of activities from the later Mesolithic period onwards.

Further reading

For more information on the techniques described above, a good introduction is provided in *Late Quaternary Environmental Change: physical & human perspectives* (Bell & Walker 1992). For further details on pollen analysis, two valuable texts are *Pollen Analysis* (Moore et al. 1991) and *Textbook of Pollen Analysis* (Faegri et al. 1989). For non-pollen palynomorphs and, in particular, fungal spores, consult *Microfungi on Land Plants: an identification handbook* (Ellis & Ellis 1997) and the work of Bas van Geel, who has been championing this technique since the 1970s (e.g. van Geel et al. 2003).

Acknowledgements

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Note

1. NGR 259040, 114340; height 8 m OD; excavation licence no. 03E0319.