PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

# The Contribution of Radiocarbon Dating to Archaeology in Britain

H. Godwin

*Phil. Trans. R. Soc. Lond. A* 1970 **269**, 57-75
doi: 10.1098/rsta.1970.0086

*Phil. Trans. Roy. Soc. Lond.* A. **269**, 57–75 (1970) [ 57 ]
*Printed in Great Britain*

# The contribution of radiocarbon dating to archaeology in Britain

By H. Godwin*, F.R.S.
*Botany School, University of Cambridge*

Radiocarbon dating has been particularly advantageous to British archaeology in establishing coordination of isolated cultures or artefacts with one another and with known systems inside and outside Britain, in the chronological placing of structures (for example trackways and boats) for which typology is inadequate, and in the relation of cultural stages to geological, climatic and vegetational changes in the environment, including those induced by activities of the cultures themselves.

It offers solution to the problems of 'sloping horizons' associated with time lag and overlap in the outward spread of cultures. A major achievement has been the revision of Mesolithic and Neolithic chronology, but many more cultures and facies of cultures currently are being illuminated by carbon dating as suitable material becomes available. After correction of radiocarbon to sidereal years by the bristle-cone pine based calibration curve it becomes possible to relate medieval timber buildings directly to the historical record. In conjunction with pollen-analysis of lake-muds and peat deposits it is now possible to date and characterize the spread of disforestation and attendant pastoral and arable agriculture. Finally the whole environmental scene of prehistoric man is brought into coordination by carbon dating. It has even played some part in the disclosure of frauds and errors.

## 1. Introduction

The qualification that has encouraged me to undertake a survey of the contribution made by radiocarbon dating to British archaeology is merely that of a scientist involved since its earliest days with the development of radiocarbon dating in Britain, and one concerned to see archaeology as part of the even wider field of Quaternary Research.

My information has been derived from data published in *Radiocarbon* and in recent issues of British periodicals, but beyond this I am much indebted to the carbon dating laboratories at Belfast, Birmingham, the British Museum and the National Physical Laboratory for allowing me to use results in their forthcoming date-lists, and equally to many colleagues who have very kindly allowed me to use as yet unpublished data and conclusions. A large proportion of the available dates are presented in figures 1 to 8 and tables 1 to 4 which represent the distribution of radiocarbon dates thus far available within various periods and areas of British archaeology. They are not suitable as a basis for deducing any but the broadest generalizations. The dates employed in figures and tables are precisely as given in *Radiocarbon* or other publications, in radiocarbon years before 1950 and I have avoided reference to sidereal years save for a brief necessary comment in the section on medieval timber architecture.

## 2. Mesolithic and earlier cultures

Table 1, which records radiocarbon ages for British Mesolithic sites, spans the 5 millennia between the Late-Weichselian/Flandrian boundary and the opening of the Neolithic period. The significance of several sites has been heightened by the fact that the culture has been found stratified into organic deposits so that it has been referred to a stage in the British pollen zonation scheme that serves not only as a basis for recognizing the natural Mesolithic vegetation but as an important ancillary chronology. At Freshwater West, Stump Cross and Westward Ho! the culture falls in zone VIIa, at Shippea Hill and Toome Bay in zone VI, while at

* Now Sir Harry Godwin.

Star Carr the extensive Maglemosian industry was at the zone IV/V boundary. At Thatcham the careful research of Churchill and Wymer traced the occupation, long known from the terrace of the Thames into the lacustrine deposits of the adjacent valley where artefacts were found throughout zones IV, V and early VI, corresponding with radiocarbon ages between about 10300 and 9500 years ago. Many of these sites carry evidence of a land to sea-level relation different from that of today and the site at Ringneill Quay is indeed from the top of the northern Irish raised beach that formed during the culmination of the main eustatic rise of ocean levels. It should be noted that independent radiocarbon dating of the British pollen-zones and of relative movements of land- and sea-level give results concordant with the direct datings now considered.

TABLE 1. BRITISH MESOLITHIC SITES

| | | | | | |
|---|---|---|---|---|---|
| BM-449 | Wawcott | 5 260 ± 130 | BM-65 | Thatcham | 8 100 ± 150 |
| Q-770 | Ringneill Quay | 5 380 ± 120 | Q-707 | Ickornshaw | 8 100 ± 150 |
| BM-40 | High Rocks | 5 660 ± 150 | C-353 | Star Carr | 9 488 ± 350 |
| Q-530 | Freshwater West | 5 960 ± 120 | Q-652 | Thatcham | 9 490 ± 160 |
| GaK-1601 | Barralloch | 6 000 ± 110 | Q-14 | Star Carr | 9 557 ± 210 |
| BM-89 | Blashenwell | 6 450 ± 150 | Q-650 | Thatcham | 9 670 ± 160 |
| Q-141 | Stump Cross | 6 500 ± 310 | Q-677 | Thatcham | 9 780 ± 160 |
| Q-672 | Westward Ho! | 6 585 ± 130 | Q-651 | Thatcham | 9 840 ± 160 |
| †Q-586 | Shippea Hill | 6 695 ± 150 | Q-658 | Thatcham | 10 030 ± 170 |
| BM-473 | Culverwell | 7 150 ± 135 | Q-659 | Thatcham | 10 365 ± 170 |
| BM-447 | Cherhill | 7 230 ± 180 | | | |
| Q-587 | Shippea Hill | 7 610 ± 150 | Q-553/4 | Mother Grundy's Parlour | 6 810 ± 140 |
| Y-95 | Toome Bay | 7 680 ± 110 | Q-552 | Mother Grundy's Parlour | 7 602 ± 140 |
| BM-90 | West Hartlepool | 8 100 ± 180 | Q-551 | Mother Grundy's Parlour | 8 800 ± 300 |

† Terminus ante quem.

TABLE 2. CRESWELLIAN AND EARLIER SITES

| | | | | | |
|---|---|---|---|---|---|
| BM-440*b* | Anston Stones | 9 750 ± 110 | Q-66 | Flixton, site 2 | 10 413 ± 210 |
| BM-439 | Anston Stones | 9 850 ± 115 | BM-374 | Paviland Cave | 18 460 ± 340 |
| BM-440*a* | Anston Stones | 9 940 ± 115 | Q-66 | La Cotte de St Brelade | 47 000 ± 1500 |

Dr Kenneth Oakley's determined pursuit of the radiocarbon dating of prehistoric British human skeletons has yielded one substantial result to set alongside the numerous Upper Palaeolithic dates for the west European mainland. This is that for the human skeleton found in the Paviland Cave of the Gower Peninsula in association with the skull of mammoth and stone implements referred by Professor Garrod to the Aurignacian. The British Museum date (18460 ± 340 B.P.) confirms a late Weichselian attribution. For the rest, determinations of the age of human skeletal material have proved valuable in a contrary sense, in that unexpectedly recent ages have indicated that the skeletons have been intrusively buried (Braunston, BM-282; Caerwys, BM-255; Galley Hill, BM-86; Halling, BM-168; Kilgreany, BM-135) or more dramatically, have clinched other evidence of faking (Piltdown, GrN-2204, 2203). Though negative, these results are of great value. There have also been useful datings for skeletons of the early Christian period, e.g. Beckery, 1185 ± 80 (Birm 69) and Cannington, 1220 ± 110 (Birm 70).

The oldest radiocarbon date for a British prehistoric site was also submitted by Dr Oakley from deep in the cave of La Cotte de St Brelade, Jersey, Channel Islands, associated with a late Acheulian type industry and a cold temperate fauna. At a level much above that of the sample a 'Mousterian' level is reported, and the great depth might seem to be some guarantee of freedom from contamination. None the less, the date of 47000 ± 1500 B.P. clearly requires checking if opportunity allows.

As we move back in time from the Flandrian to the Weichselian reliable radiocarbon dates for prehistoric cultures become scarce. This is partly because in periglacial conditions during and at the end of the last glaciation, occupation must have been scattered, partly because suitable deposits for stratification of cultural remains were initially infrequent, and partly because the long time lapse has led to widespread destruction and contamination of organic materials.

We have indeed made disappointingly little progress towards dating the culture that has been best held to represent the Upper Palaeolithic in Britain, the Creswellian, described by L. A. Armstrong. Armstrong's own samples of charcoal proved too small for radiocarbon assay, and when, at one of his sites, Mother Grundy's Parlour, the talus slopes were re-excavated, the radiocarbon dates shown in table 1 were obtained. They are variable and recent and correspond with the presence of charcoal of shells of hazel-nut: they clearly have nothing to do with the cold conditions indicated by faunistic and geological evidence for the Creswellian itself, and the industry indeed is now held to be non-Creswellian. More recently, as shown also in table 2, three radiocarbon dates have been obtained from material secured by Dr P. A. Mellars at the Creswellian rock shelter, Anston Stones Cave. They are consistently around 9850 B.P., a date which corresponds with the middle of the Thatcham determinations, and is not far from that of Star Carr. Thus far we have then no radiocarbon evidence relating the Creswellian to any stage of the Weichselian glaciation.

## 3. Neolithic

In no part of British prehistory have the results of radiocarbon dating made more dramatic impact than in the Neolithic. Those who were themselves directly concerned with the production of the first radiocarbon dates for the British Neolithic will recall the dismay and indeed incredulity with which the first results were received by our leading archaeologists. The exquisite quality of their dilemma was clearly expressed by Dr Glyn Daniel in *Antiquity* (1959). Waterbolk's summary of the Neolithic in Europe was published in the following year, which also saw the review by Watts of the effective impact made by the Dublin radiocarbon dating laboratory upon the age of the Neolithic culture in Ireland. These papers cited evidence that made it impossible to reject an age of at least 3000 B.C. for the beginnings of Neolithic culture in Britain, and this view was very strongly reinforced by a substantial series of radiocarbon dates for a pronounced pollen-analytic horizon, the '*Ulmus* decline' throughout north western Europe. At this horizon, sudden and substantial decrease in the proportion of elm pollen is associated with the first appearance of pollen of several agricultural weeds and it is generally agreed that these represent disforestation and the initiation of plant and animal husbandry. It was soon shown that the elm decline was datable throughout this region to at least 3000 years B.C. (Godwin 1960*a*). By 1962, when radiocarbon dating had been applied to sites in the English Fenland already well known from research by older techniques, it had become possible to summarize the effects of carbon dating upon our concepts of the Neolithic in Britain in the following (abbreviated) terms (Clark & Godwin 1962).

(1) It must be conceded that the Neolithic culture was established in these islands by around 3000 B.C., while accepting the possibility that it might have begun as early as 3400 B.C., conclusions that offer a date at least 1000 years earlier than that given in the classic work by Stuart Piggott on *The Neolithic cultures of the British Isles*.

(2) Thus, instead of the four centuries or so previously thought to embrace the British Neolithic, we now had a duration three or more times longer.

(3) The spread of the earliest Neolithic dates seemed to make untenable a view of the primary status of a Windmill Hill culture centred on Wessex.

(4) The European pattern of Neolithic radiocarbon dates appeared to be consistent with a southern or southwestern origin for the earliest Neolithic settlement in Britain.

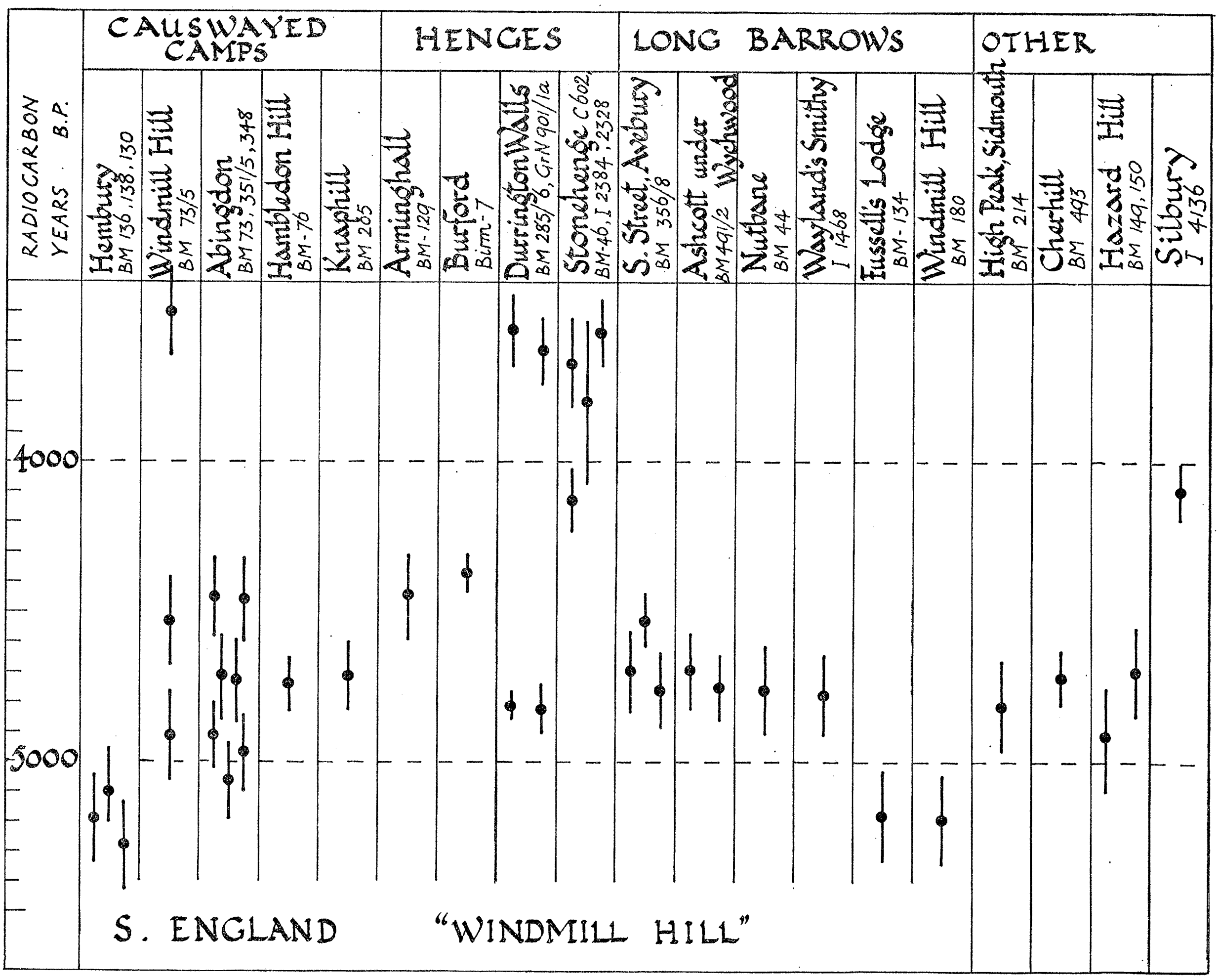


Figure 1. Radiocarbon dates at sites in the south of England associated with the Windmill Hill neolithic culture by Piggott (1954). The vertical line through each date gives the quoted probable error of the determination (1 s.d.).

Since these conclusions were published there has been a substantial increase in the number of Neolithic radiocarbon dates, a large proportion from the British Museum laboratory, whose policy has been to concentrate substantially upon one or two critical periods of British prehistory, particularly the Neolithic, exploiting the advantages of its own position and expert staff to secure material of high authenticity and relevance. I am very grateful to the Management Committee and Staff of the Laboratory for allowing me to quote in a general context their unpublished dates. The results are presented in the form of comprehensive diagrams roughly grouped in relation to the main archaeological features of the dated material (figures 1 to 4). There can be no doubt that they reinforce the conclusions drawn already in 1962 and have indeed led to extensive reinterpretation of the relationships between the major components of British Neolithic culture (see Clark 1965, 1966).

In figure 1 there have been assembled radiocarbon dates in the south of England for those features taken (after Piggott) to be characteristic of the Windmill Hill Culture. It is evident that Hembury is older than most of the sites so far dated, but it is accompanied by the long barrows of Windmill Hill itself and Fussell's Lodge. These apart the causewayed camps, henges, long barrows and sites with Windmill Hill pottery make a rather coherent group in the first half of the fifth millennium B.P. It is evident that Stonehenge is a much later structure. Radio-

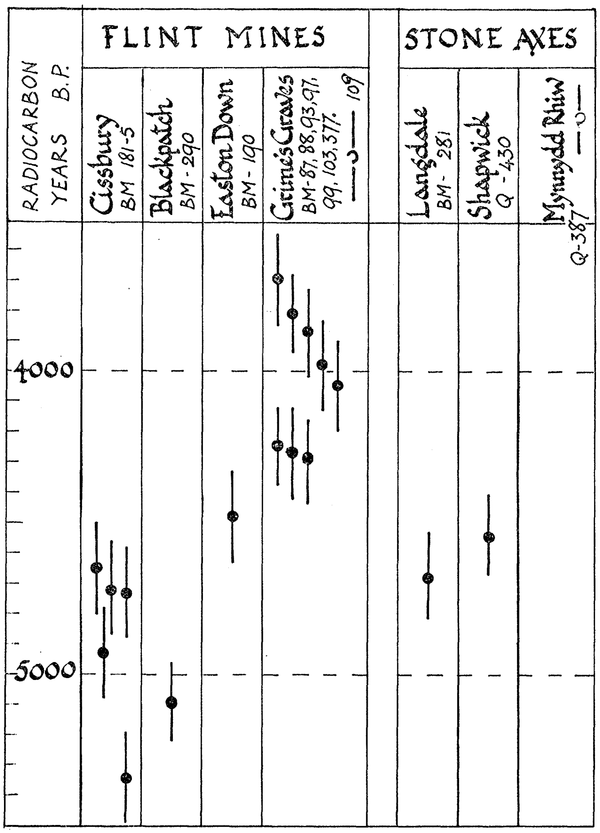


FIGURE 2. Radiocarbon ages secured and dated by the British Museum for flint mines in the south and east of England and three dates (one conjectural) primarily intended to date polished stone axes.

carbon dates from these laboratories have gone a long way to give definitive ages to its various phases, but I need not now do more than refer to the recent summary of the position (Atkinson 1967). He points out that only one piece of Windmill Hill pottery was found at Stonehenge and that in the earliest stage. The British Museum laboratory, responsible for most of the dates in figure 2, has concentrated also on the dating of flint mines which are so striking a feature of the British Neolithic. At Cissbury, Easton Down and Blackpatch they were clearly in the first half of the Neolithic, but the long series from Grime's Graves in East Anglia seems to extend through its second half. The polished stone axes have been dated at the Langdale axe factory site and by peat in which a Graig Llwyd axe was found in the Somerset Levels and they yield similar ages near the middle of the British Neolithic: the date from Mynydd Rhiw is presumably incorrect.

In figure 3 it will be seen that Long Barrows and occupation sites in England outside the area covered by figure 1 again show ages around 5000 B.P. Figure 3 also includes sites clearly and directly referable to the beaker culture. They form an age group between 4000 and 3500 B.P. and their coherence lends support to the accepted view of an invasive origin for the culture.

Taking together the evidence for figures 1 to 3 it seems that in England and Wales we have a strong concentration of dates in what may be called the Early Neolithic (say 5300 to 4500 B.P.): this includes the Hembury, Windmill Hill and other facies besides the clear first impact of disforestation and the initiation of plant and animal husbandry. Thereafter, until the beaker

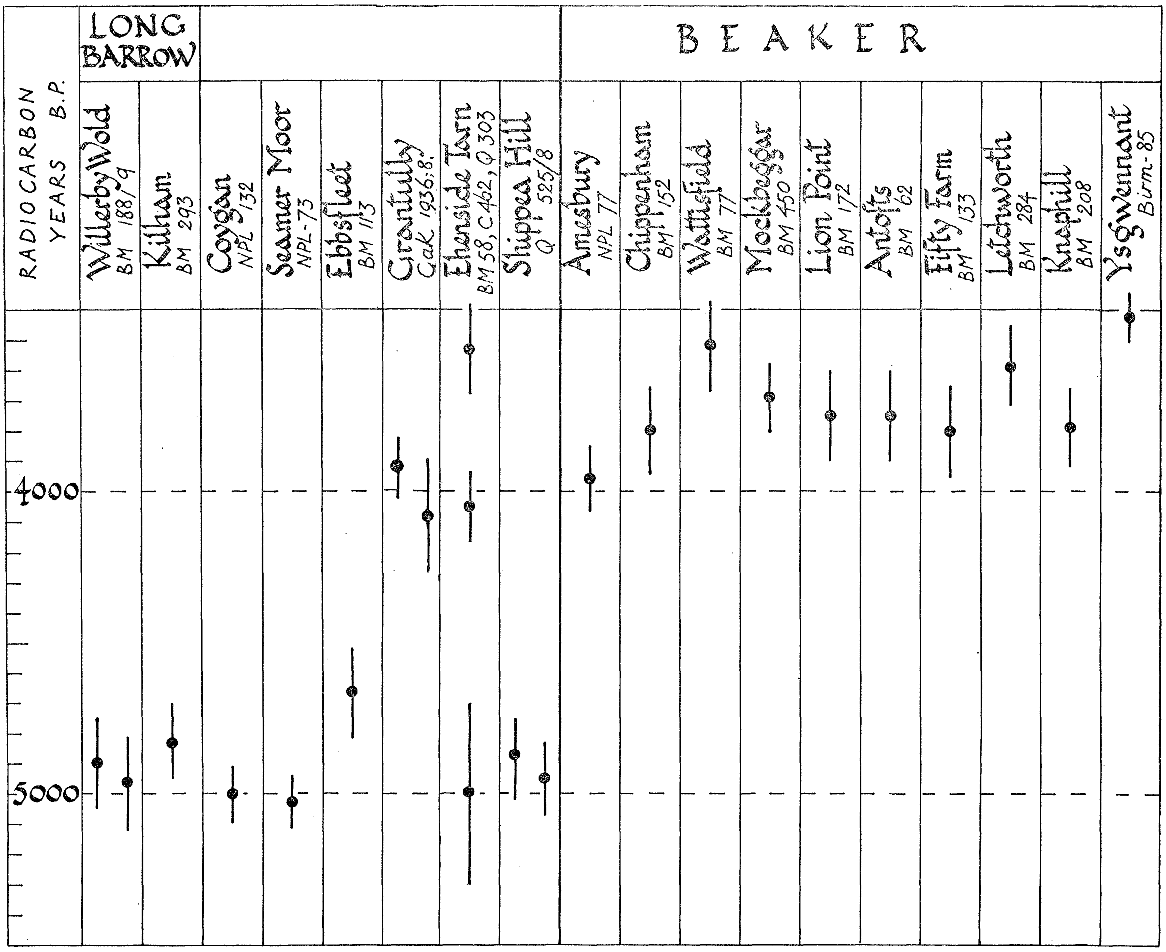


FIGURE 3. Radiocarbon dates for English Neolithic sites other than those in figures 1 and 2, together with nine sites primarily intended to date the Beaker Culture.

stage begins about 4000 B.P. there is a dearth of dates, pointing perhaps less to thinness of settlement than to evident cultural artefacts demanding dating. It has to be recalled that numerous wooden trackways already dated in the Somerset Levels seem to have been built in this time (see §6), while various palynological studies point to temporary forest clearances throughout the Neolithic (see §7).

As will be seen from later consideration there is evidence of Neolithic forest clearance in Ireland before 5000 B.P. At Ballynagilly, moreover, they have a radiocarbon date for timber from a rectangular wooden house of 5168 ± 50 B.P. (UB-201): this overlaid a pit containing early Neolithic pottery sherds and charcoal of pine with a radiocarbon age still earlier, 5624 ± 50 B.P. (UB-197). These dates, as will be seen in figure 4, overlap the dates for the Mesolithic–Neolithic transition, and the Knockiveagh Cairn is barely younger. The dates for the great passage graves of the Boyne culture fall between 4600 and 3800 B.P., thus tending to fall, along with several other Irish Neolithic sites, into the period sparse in radiocarbon dates in England.

Though few in number, the dates for Neolithic sites in Scotland (table 3) confirm the age

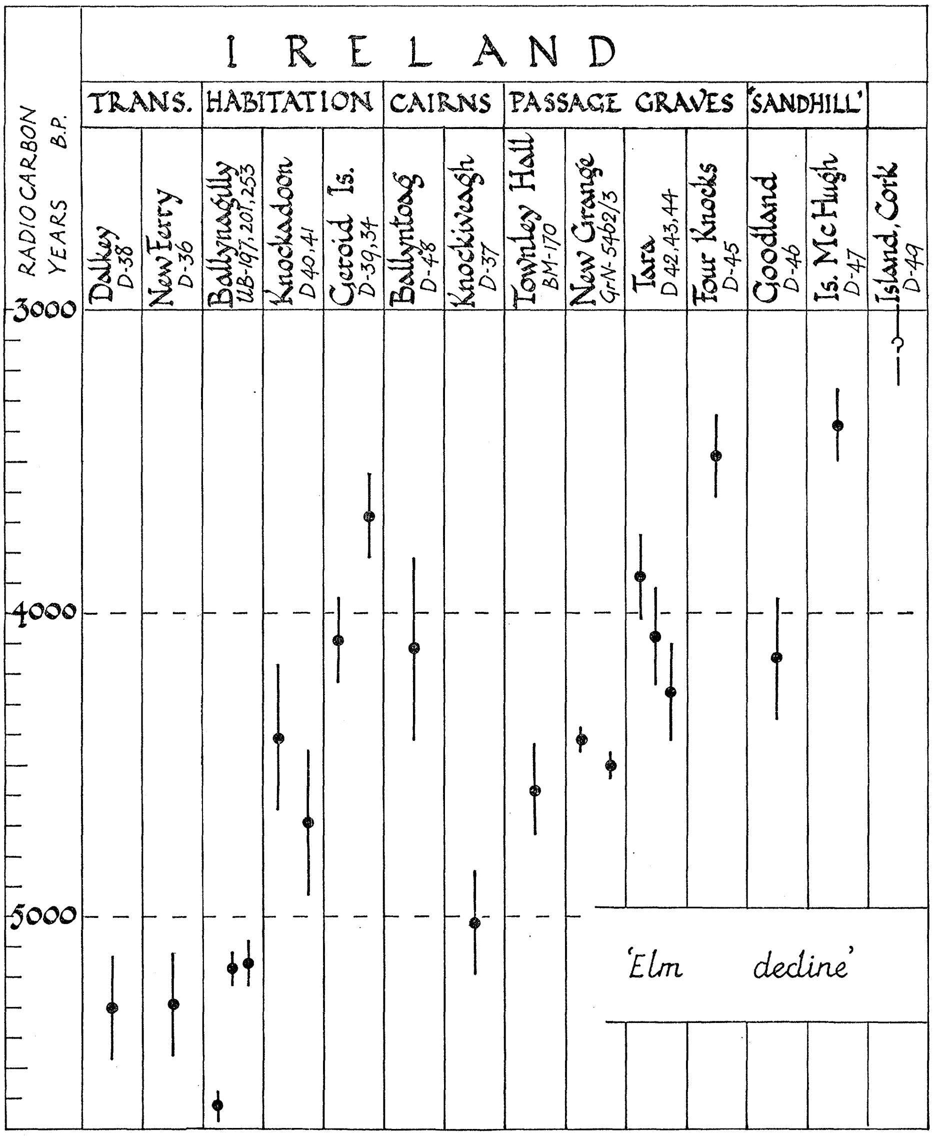


FIGURE 4. Radiocarbon dates for Neolithic sites in Ireland. The included panel showing the 'elm decline' is derived from figure 10 and indicates early Neolithic disforestation. The passage-grave dates embrace the 'Boyne' Culture: the Dalkey and New Ferry sites are transitional from the Mesolithic.

TABLE 3. NEOLITHIC IN SCOTLAND

| | | | |
|---|---|---|---|
| Q-675 | Monamore, Arran | 5110 ± 110 | chambered cairn |
| Q-676 | Monamore, Arran | 4190 ± 110 | chambered cairn |
| GaK-174 | Townhead, Rothsay | 4070 ± 100 | occupation site |
| BM-422 | Embo, Sutherland | 3870 ± 100 | passage grave |
| GaK-601 | Pitnacree, Perths. | 4810 ± 90 | round barrow |
| GaK-1938 | Grantully, Perths. | 4080 ± 190 | — |
| GaK-1936 | Grantully, Perths. | 3920 ± 100 | — |
| GaK-847 | Northton, Harris | 5030 ± 150 | midden |
| GaK-848 | Northton, Harris | 6050 ± 140 | midden |

spread seen elsewhere in the British Isles, and at Flanders Moss, Stirlingshire, there is a date 5014 ± 120 and 5192 ± 120 B.P. (Q-578) for the pollen-analytic index to the introduction of agriculture which thus seems to have been as early in Scotland as in Ireland or England. Only the last date on the Scottish Neolithic list can be queried as being improbably early, perhaps, it has been suggested, because the dated charcoal was from cut peat.

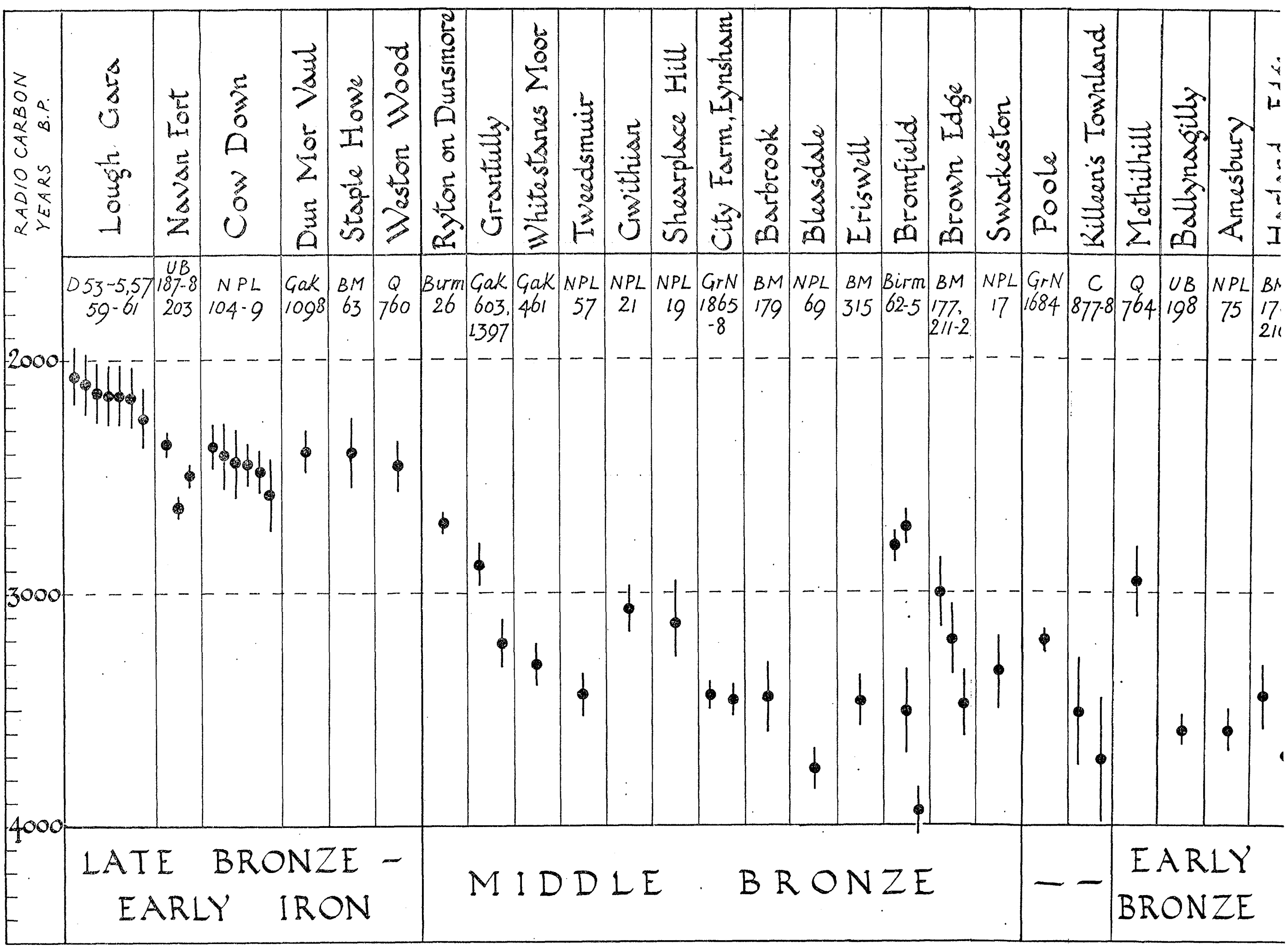


FIGURE 5. Radiocarbon ages for successive stages of the Bronze Age in the British Isles.

## 4. BRONZE AGE

Radiocarbon dates for the Bronze Age in the British Isles have been set out in figure 5, allocated to subdivisions on the basis of attributions made by the authors submitting samples and of the informed comments kindly given me by Dr J. M. Coles.

If we omit the one discordant Scottish site, Methilhill, the range between 3700 and 3400 B.P. for the Early Bronze Age will be seen largely to overlap that already defined for Beakers (figure 3) and, as is already well known, that of phases II and III of Stonehenge, and the two youngest dates for the ditch at Durrington Walls that did indeed yield beaker remains. Broadly speaking, samples referred to the Early Iron Age–Late Bronze Age transition fall between 2600


PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

and 2000 B.P. Samples from the Middle Bronze Age extend between 3900 and 2700 B.P. thus overlapping the Early Bronze Age range at the older end, and almost reaching that of the Late Bronze Age–Early Iron Age transition at the younger. Samples strictly related to the Late Bronze Age *per se* are lacking save possibly Weston Wood, but there is some indication of a gap in the date distribution between 3000 and 2500 B.P. that might be filled were such samples to become available.

It is possible that the overlaps we have noted are in some degree due to metachroneity in development within the British Isles, a conclusion suggested also by individual sites. Thus the very well-attested series from the Lough Gara Crannog includes three samples referred unhesitatingly to the Late Bronze Age, but they fall, along with those referred to the Late Bronze Age/Early Iron Age transition, within the span 2050 to 2250 B.P. Similarly, the lateness of the 'Early Bronze Age' date from Methilhill in Fifeshire may indicate metachroneity. In either instance of course there could perhaps have been an undetected misassociation of sample and culture.

It should be noted that prehistoric wooden trackways and boats of the Late Bronze Age are separately considered, and that the trackway dates appear in figure 7, while figure 5 does not include dates referred broadly to the Bronze Age, such as Carn, 3000 ± 140 B.P. (D. 50) and the stone circles at Penmaenmawr, 3080 ± 145 (NPL 12), 3470 ± 145 B.P. (NPL 11), although both are perfectly acceptable.

## 5. Early Iron Age

In figure 6 are assembled the more significant radiocarbon dates relating to the so-called 'Early Iron Age' in Britain. It is necessarily wide in the scope of cultures covered, since the period, well correlated with the continental cultures and terminated by the Roman occupation in England and southern Scotland, in Ireland, northern and western Scotland is broken by no Roman occupation and extends without interruption into the early Christian period. It is from the second of these regions that the greater number of radiocarbon dates have been obtained and they naturally follow from the excavation of such structures as the hill-forts, brochs, semi-brochs, timber-laced forts and stone circles, which, although highly characteristic, have proved extremely hard hitherto to set into correlation with one another and with cultures elsewhere in Britain.

It will be seen at once that in some sites the dates cover an extremely wide span of time (as much as 2000 years), and this certainly relates to long continued occupation of the site as well as the sensible inclusion on occasion of a date for the prestructural land-surface. It follows from this, as it must with all consideration of radiocarbon dates, that they can only be properly evaluated in relation to the known provenance of each sample and the opinion of the excavator and his professional colleagues as to its significance. An exemplary evaluation of this kind is the recent review by Dr Euan MacKie of the Hunterian Museum of Glasgow of radiocarbon dates in relation to the Scottish Iron Age (MacKie 1969) in which the radiocarbon dates give strong support to the coexistence, from about 2600 B.C. until after the birth of Christ, of three distinctive cultures, the 'Broch' culture with duns, semi-brochs and brochs in the Atlantic region of Scotland, the 'Abernethy' culture with timber-laced forts, stone longhouses, crannogs in North-eastern Scotland, and the 'Hownham' culture with palisaded enclosures in the Tyne–Forth area.

The sites at Raheennamadra, Druma Road, Larne, and Kilphedir all have souterrains, which on this limited number of radiocarbon dates are all in the period 2100 to 900 B.P. Of the

English dates, those from Chapel Point, Lincolnshire, are from a coastal peat bed upon which pottery of Halstatt affinity was found, and yielded dates expected on this evidence, but the dates from Grimthorpe are older than the evidence of the pottery there suggested, and those from Hod Hill much younger than the Iron Age A/B pottery indicated.

We have purposely omitted from the table determinations of material from Romano–British sites since such measurements have generally been undertaken primarily as checks upon the validity of radiocarbon dating.

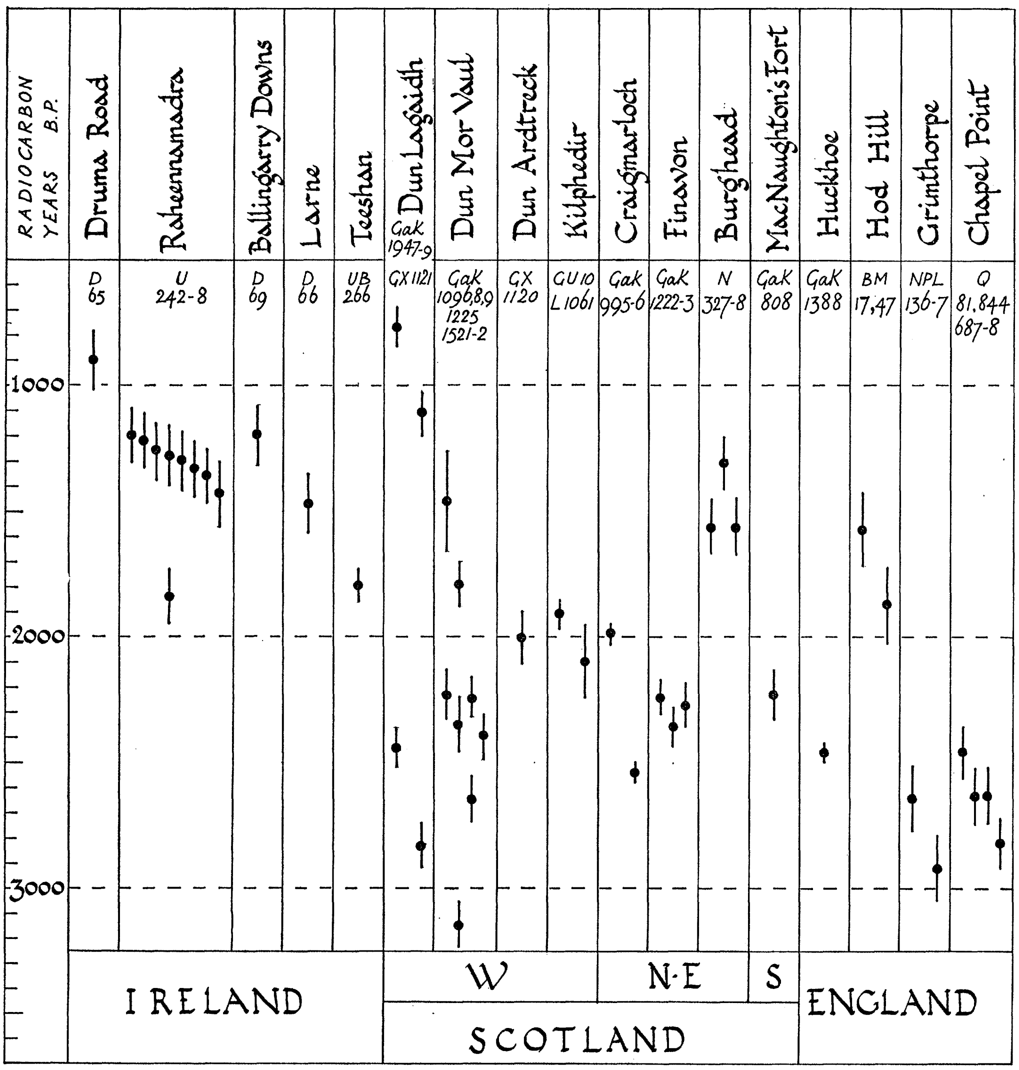


Figure 6. Radiocarbon ages for sites in different parts of the British Isles that have been referred to the Early Iron Age and succeeding Early Christian period in Scotland and Ireland. Note how in sites such as Dun Mor Vaul occupation is confirmed over a great length of time (see §5).

## 6. Wooden objects of uncertain typology

Radiocarbon dating has peculiar advantages with categories of artefacts for which other means of dating are inadequate, when the numbers found are small and when typology is immature and uncertain. We may particularly instance wooden trackways and wooden boats, structures that tend to occur in isolation and that are hard to preserve for subsequent study.

A large proportion of British prehistoric trackways dated by radiocarbon have come from the Somerset Levels where extensive peat cutting continues to disclose numerous examples. Those so far dated are represented in figure 7, from which it will be seen that dating of samples of timber from a trackway has been reinforced, in some instances, by dating also the enclosing, subjacent or overlying peat. It is at once apparent that the trackways fall into two separate age groups. The younger, built between about 2900 and 2400 B.P., have been already shown by pollen-analysis, by the axe cuts on the trackway timbers and by the free use of square-cut

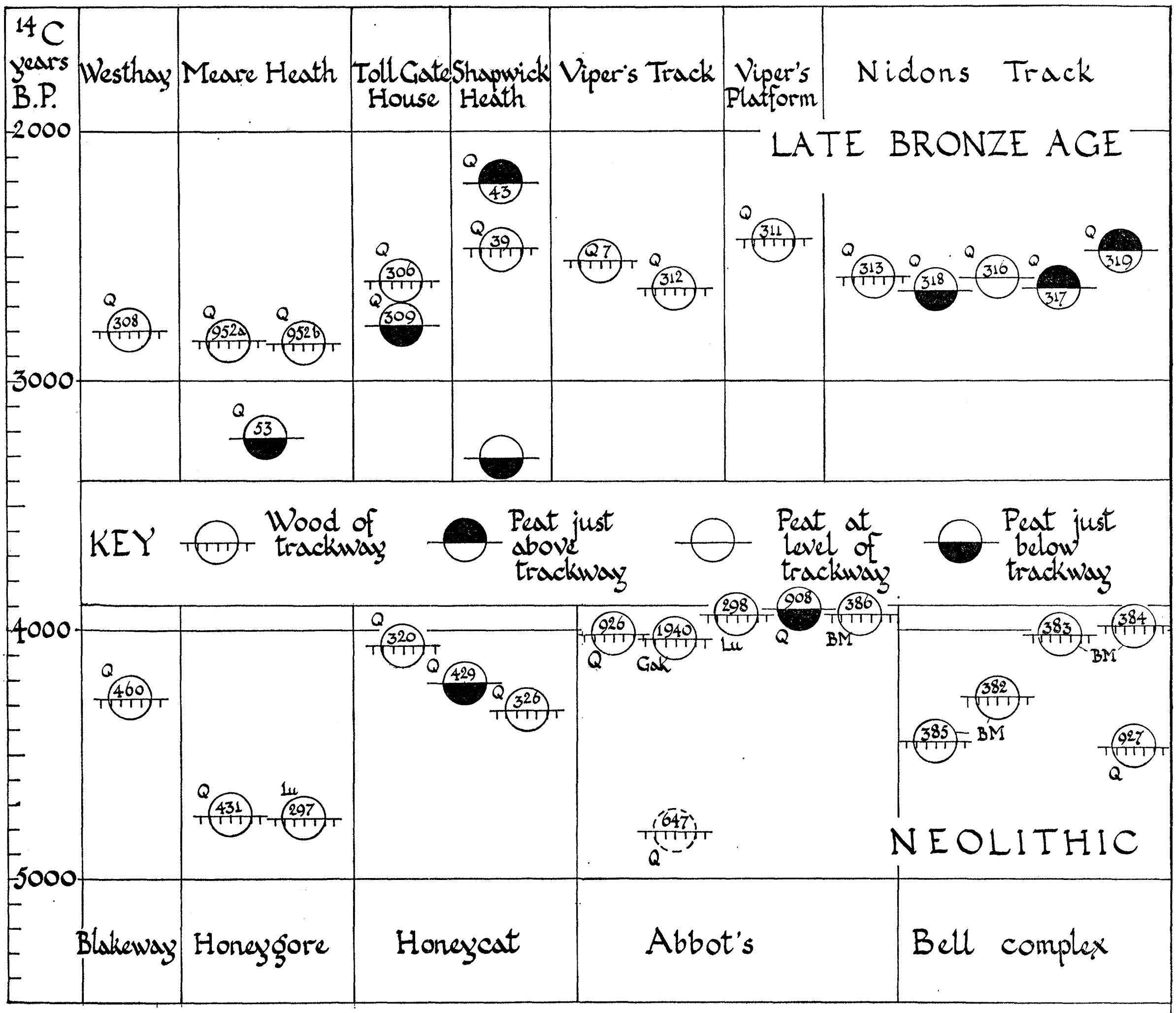


FIGURE 7. Radiocarbon dates for prehistoric wooden trackways excavated from the raised bogs of the Shapwick–Westhay region of the Somerset Levels. The dates fall into two clearly separate age groups.

mortice holes, to be of Late Bronze Age origin. This attribution is again confirmed by the evidence in the bog-stratigraphy that they were built during, and in response to, a climatic worsening that occurred at this time throughout northwestern Europe, at the so-called Sub-Boreal/Sub-Atlantic climatic contact. It is possibly significant that the very few wooden trackways dated from other English peat mires come also from this period when inundation may have been widespread. Thus Kate's Pad, Lancs. 2760 ± 120 B.P. (Q-68), Brigg, Lincs. 2552 ± 120 B.P. (Q-77) and Fordy, Cambs. 2560 ± 110 B.P. (Q-310). Dates for trackways found in Irish bogs





PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

include several that are younger, one also of the Late Bronze Age at Clonsast, 1910 ± 130 B.P. (D-26) and one older at Corlona, Leitrim 3395 ± 170 B.P. (Gro-272).

The remaining trackways displayed in the Somerset diagram (figure 7) fall between 4900 and 3900 B.P. Their evident Neolithic age is attested by their clear separation from the Late Bronze Age tracks at a lower stratigraphic level and an earlier pollen-analytic horizon. Their timbers show the marks of stone axes only and there is a weak association with flint and stone artefacts, as well as a clear association with a remarkable wooden hermaphrodite figurine (Coles & Hibbert 1968). These and other trackways recently discovered in the area are being currently investigated: they may be expected to yield further and closer dating for the track complex and more insight into the causes of construction.

TABLE 4. PREHISTORIC BOATS

| | | | |
|---|---|---|---|
| D-71 | Kentmere, Westmorland | 650 ± 120 | — |
| Q-357 | Shapwick Station, Som. | 2305 ± 120 | monoxylous |
| Q-79 | Fiskerton, Lincs. | 2796 ± 100 | monoxylous with separate sternboard |
| Q-78 | Brigg, Lincs. | 2784 ± 100 | monoxylous with separate sternboard |
| BM-58 | North Ferriby, Yorks. | 2700 ± 150 | sewn boat, no. 1 |
| Q-715 | North Ferriby, Yorks. | 3120 ± 105 | sewn boat, no. 3 |
| Q-837 *a* | North Ferriby, Yorks. | 3393 ± 210 | sewn boat, no. 2 |
| Q-837 *b* | North Ferriby, Yorks. | 3506 ± 110 | sewn boat, no. 2 |

It is interesting to note that from nearby in the Somerset Levels and the same stratigraphic level as the Neolithic trackways have come our only authenticated specimens of Neolithic long bows. Both are made of yew (*Taxus*) wood and yielded samples for radiocarbon dating, the one in the pattern retained in the English medieval long bow was 4625 ± 120 B.P. (Q-598) and the other, of a type unknown hitherto, with wide flat staves bound with leather, was 4650 ± 120 B.P. (Q-646). Two other wooden bows recovered from museums at Taunton and Cambridge yielded dates within the British Bronze Age. No method other than radiocarbon dating could have placed these four bows so clearly in age-relationship to one another, although the Neolithic attribution of the two oldest was already evident from stratigraphic and pollen-analytic study (Dewar & Godwin 1963; Clark 1963).

It is apparent that similar considerations apply to prehistoric wooden boats for until the advent of radiocarbon dating published accounts have almost wholly failed to attribute an age to such artefacts. The British date list is still small.

Clearly monoxylous boats can be of very different ages. That for the Shapwick Station boat places it within the pre-Roman Iron Age, to which it had already been attributed from knowledge of local bog stratigraphy.

The three boats from North Ferriby are of an elaborate construction of heavy oak planks sewn together by stitches of yew. They are all placed by radiocarbon dating within the Bronze Age and are so sophisticated and without precedent that they are held to be the result of cultural intrusion (Wright & Churchill 1965). There is great scope for an extensive programme of radiocarbon dating of the numerous prehistoric boats lying in British museums, and in relating results to the growing number of similar determinations along the western coasts of Europe as a whole.



PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

## 7. Agriculture

Archaeologists are now well accustomed to relying upon the results of pollen-analytic studies to provide them with information as to the environment in which prehistoric man lived, and to learning from this evidence the nature of past climatic changes that dominated natural vegetation and thus indirectly dominated the lives of prehistoric men. As pollen analysis has become more sophisticated it has become apparent that it can reveal not only 'natural' vegetational changes, but also those modifications produced by human disforestation and the employment of the cleared ground for plant and animal husbandry. Since Iversen first directed attention to such effects in clear relation to Danish Neolithic occupation sites (Iversen 1941) pollen-analysts in this country, as elsewhere, have repeatedly found evidence for such 'intakes' from the woodland and have made some progress in recognizing main categories of prehistoric land usage. There were naturally attempts to corrodinate this pollen-analytic evidence with the historical and prehistoric record (see Oldfield 1963; Pennington 1964; Mitchell 1965), but in the absence of an independent and objective time-scale these efforts were conjectural although plausible. It was apparent that the conjunction of pollen-analyses with radiocarbon dating should resolve such difficulty, and this aim has been pursued with increasing vigour and success over the last ten years. Figure 8 gives some idea of the total number of radiocarbon determinations of 'clearance phases' or other indications of agriculture that have been done by 1969 for the British Isles.

To begin with attention was concentrated upon determination of the so-called 'elm decline' to which Iversen had drawn attention and which Troels-Smith had insisted to have been a prior stage to Neolithic land utilization. Thus it was soon possible to produce radiocarbon dates for this episode in British deposits to set alongside several available in the adjacent continental mainland, all round about 5000 B.P. (Godwin 1960*a*). It was the recurrence of such dates, along with direct dating of organic material from early Neolithic sites that led, of course, to the great expansion of the time span allocated to the Neolithic culture. The Dublin radiocarbon dating laboratory, working on samples from Redbog, Co. Louth, established not only a first clearance phase as older than 5000 B.P. but dated two much later agricultural phases. A more deliberate and thorough investigation was made at Fallahogy, Co. Londonderry, where the close coordination of pollen-analyses and numerous radiocarbon dates showed not only the early absolute age of the first clearance (see figure 8), but that the forest regeneration after abandonment of the early clearance was of a pattern recognizable by ecologists and occupied the expected time span of 200 to 400 years (Smith & Willis 1961–2). Dr J. Turner now used radiocarbon dating to demonstrate the metachroniety of the *Tilia* decline in different parts of England, a result consonant with pollen-analytic evidence that this, like the *Ulmus* decline, was anthropogenic in origin (Turner 1962). Subsequently she was able to reconstruct by joint pollen-analyses and radiocarbon dates the time and character of land-usage in the valley at Tregaron, Cardiganshire, bringing finally a clear indication of land usage by the monks of the abbey of Strata Florida (Turner 1964). Similar work was extended to Flanders Moss and Bloak Moss in Scotland; at the latter site no less than five clearance phases were separately dated (Turner 1965). By a similarly coordinated approach Dr W. Pennington has secured absolute datings for pollen-analytically identified clearance phases in northern England, and at Devoke Water and other Lake District sites has been able to prove that a phase of mineral sedimentation in lakes and tarns was the product of an extension of late Roman land clearance and accompanying soil

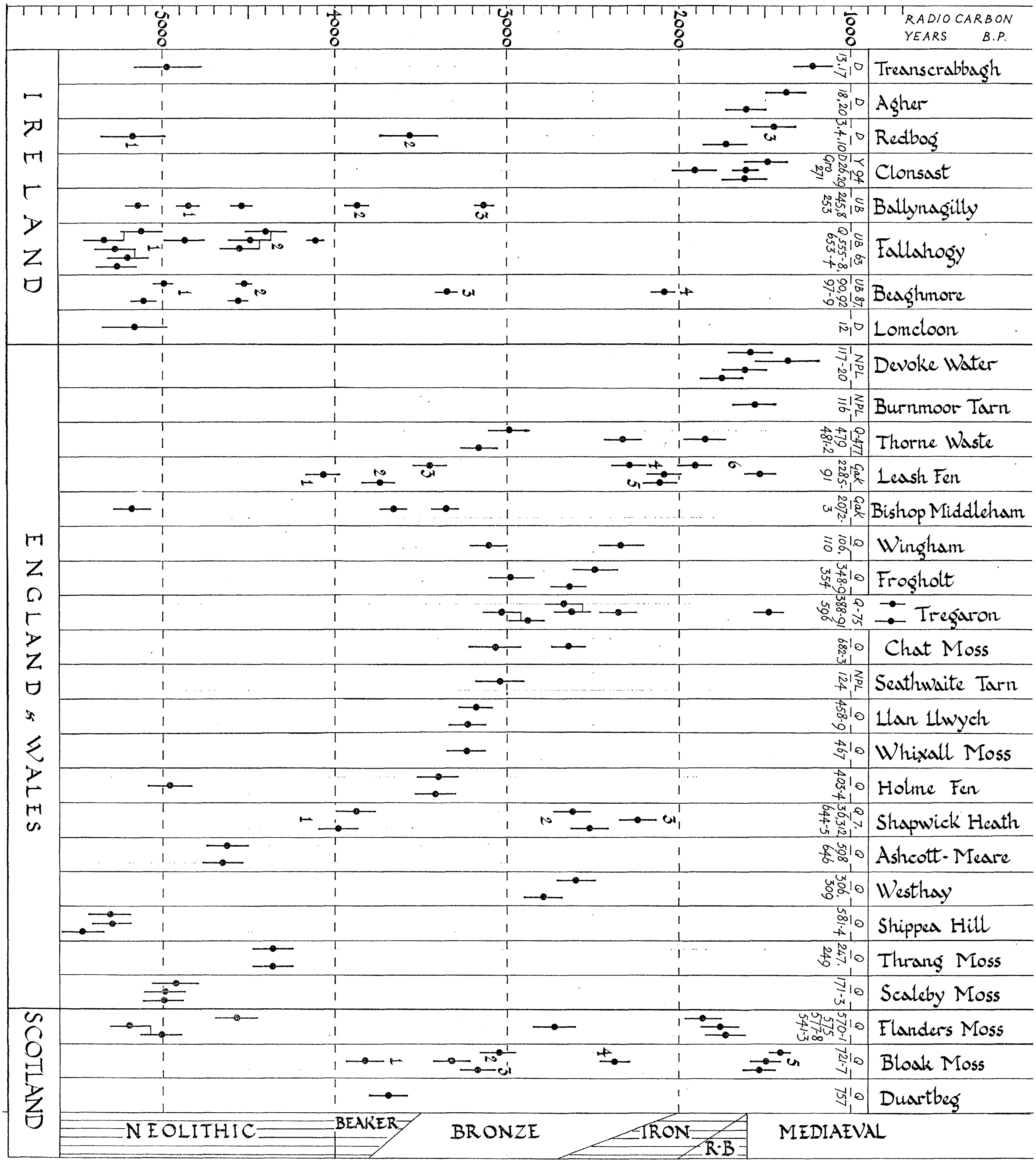


FIGURE 8. Radiocarbon dates for forest-clearance and agricultural phases identified pollen-analytically. Dates linked by horizontal lines indicate repeated determinations on one sample. At several sites successive indications of agriculture occur over a very long time span and can be referred roughly to the appropriate cultural stage by the radiocarbon dates. Note the consistently early onset in Great Britain and Ireland.

erosion. She has more recently been able to date a clearance phase at Sionascaig in Wester Ross, and thus to confirm late Neolithic agricultural activity in the northwest of Britain: 4020 ± 100 (Y-2362) B.P. By the courtesy of Dr Alan Smith I have been allowed to include in figure 8 the unpublished results of the Belfast radiocarbon dating laboratory for the two sites of Ballynagilly and Beaghmore, Co. Tyrone. At each site very detailed pollen-analyses have identified the progress of successive clearance episodes, three and four respectively in number and extending together over a range of 3000 years from the earliest Neolithic.

I am likewise extremely indebted to Dr D. Bartley of Leeds for permission to include unpublished dates obtained by the Gakushuin laboratory for long pollen series at Leash Fen, Derbyshire, and Bishop Middleham, Co. Durham. At Leash Fen there are six clearance stages between Neolithic and post-Roman time. We wait with interest the detailed publication of results from these four sites.

The diagram (figure 8) showing all dated clearance phases from the British Isles is limited in the information it can convey, showing neither the quality nor intensity of the successive induced vegetational events. None the less it makes clear that the earliest Neolithic clearances were before 5000 B.P. alike in Ireland, England and Scotland and that clearances have been intermittently pursued thereafter through all the main cultural stages. For more detailed conclusions one must refer to papers on the individual sites, as for instance those of the Shapwick Heath area of Somerset from which it appears that sporadic clearances in the Neolithic were succeeded by a substantial cultivation in the Late Bronze Age that was halted, and resumed even more strongly in the Early Iron Age (Dewar & Godwin 1963).

## 8. Medieval timber architecture

A project which Professor Libby's laboratory has made its own is that of applying radiocarbon dating to problems of European medieval architecture, concentrating initially upon the study of the aisled medieval timber hall. They pursued the double aim of checking the potentialities of the method against historically or stylistically dated material, and of reviewing 'monuments of uncertain or controversial date for correct placement into chronology'. A large proportion of the samples were from English buildings, and numerous dates have been secured spanning the last ten centuries or thereabouts. For the purposes in mind it has been essential to reduce all errors of dating, by avoiding contamination of samples, by determination through tree-ring study of the lapse of time between the tree felling and the deposition of the chosen sample, by careful preparation of the sample and correction for isotopic fractionation. Above all, however, the results have benefited greatly by the application to them of the calibration based upon bristle-cone pine dating. The advantage of this became strikingly apparent after the correction of five radiocarbon dates for the mid-thirteenth century barn at Middle Littleton, Worcestershire. The deduced probable historical dates were A.D. 1265, 1255, 1265, 1240 and 1265, an extremely satisfactory result. It is evident that the procedures now developed show high potential in this field of inquiry, where W. Horn, R. Berger and W. F. Libby have already published substantial archaeological results.



PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

## 9. Environment

It will be apparent that the reconstruction of the post-glacial environment of prehistoric man, although vitally important and substantially advanced by radiocarbon dating, is of such wide scope, especially if taken in a European context, that it would be impracticable to attempt catalogue or analysis of the radiocarbon dates that bear upon it. It must suffice merely to draw attention to the main areas of active research.

There are, of course, innumerable ways in which dating of environmental events can assist the reconstructions of archaeology. It may thus not only provide illumination as to the vegetation, climate and geological circumstances associated in different regions with prehistoric man, but a dated reference scheme of environmental changes having been established, this scheme may itself be employed to date prehistoric material that can no longer provide, or never did provide, means for more direct radiocarbon age determination.

This is nowhere more readily apprehended than in regard to the changes in former relative land and sea level, as indeed Case has recently emphasized in his reconstruction of the Neolithic scene (Case 1969). He draws attention to the importance of the timing of the inundation of the North Sea basin during the later stages of the Flandrian eustatic rise in ocean level. It was dry land when the North Sea moor-log enclosing a bone point of Maglemose type, was laid down on the Leman and Ower Bank. The date of 8425 ± 170 B.P. (Q-105) is younger than that for the classical site of the same culture at Star Carr in East Yorkshire (table 1), whose Mesolithic hunter-fishers were thus occupants of the wide Continental land margin. Conditions had altered so greatly by the Neolithic period that, as Case makes evident, archaeologists require to envisage the means of navigation of immigrant populations. Much effort has been devoted, first by geological and pollen analytic studies, and more recently by these in conjunction with radiocarbon dating, to give precision to the dating of the later stages of the eustatic rise. Without embarking upon analysis of the extensive evidence we may say that between about 14000 and 6000 years B.P. the ocean level rose eustatically by more than 200 ft (60 m) and that by 5000 B.P. all or nearly all of the restoration of sea-level had been accomplished. The building of the '25-foot' (8 m) raised beach of Northern Britain took place when eustatic rise of sea level and isostatic rise of land level roughly kept pace, and radiocarbon dates now place it about 8000 to 5500 B.P. in Ireland, although of course it cannot be altogether synchronous throughout northern Britain. Prehistoric middens of the Mesolithic–Neolithic transition in the uppermost layers of the beach have been carbon-dated at Dalkey Island and Ringneill Quay (figure 4) and the coastal mesolithic site at Westward Ho! (6585 ± 130 B.P.; Q-672) likewise relates to settlement near the top of the main marine transgression (Churchill & Wymer 1965). Much geological evidence makes it clear that at this time the Scottish Highlands were separated from the Southern Uplands by the Carse Sea, to be reckoned with, in archaeological terms both as an obstacle and a means of access.

Outside the area of isostatic uplift, and very likely within a region of down-warping, the East Anglian Fenlands represent in their stratigraphy two main phases of marine transgression (the Fen Clay and the Upper Silts) and two phases of retrogression or standstill (the Lower and the Upper Peat). At one site, Shippea Hill, no less than five archaeological horizons were effectively related to this geological sequence. By subsequently obtaining radiocarbon dates for the marine-freshwater contacts, a dated reference scheme has been established, into which not only new, but also former, archaeological discoveries can be fitted. Thus we can date objects found in association with the lowermost buried tree layer as likely to be not younger than 4500 B.P., the date when peat growth put an end to forest growth, and objects, such as the Early Bronze Age skeleton at Stuntney, lying just above the upper surface of the Fen Clay, can be given an inferred age of about 4000 B.P. (Willis 1961).

Outside the coastal areas it is lakes and peat bogs that primarily provide the kind of stratigraphic indices that so facilitate archaeological inquiry, and in so far as types of deposit in both are normally favourable alike to pollen analysis and to radiocarbon dating, their potential value is much enhanced. We have already mentioned the mineral layers identified in the lakes of the Lake District by Mrs Tutin and referred by carbon-dating to Late Romano–British time. We might add the evidence in many sites of a phase of solifluxion under cold conditions or of lowered lake levels in a dry climate.

Possibly the most favourable matrix of all for the registration of archaeological events is the ombrogenous peat-mire, the category that includes the domed or raised mosses and the blanket bogs. In both peat growth is primarily due to accumulation of the dead remains of *Sphagnum* moss, and both are limited to oceanic or suboceanic climates where the high precipitation/evaporation ratio allows peat growth on flat or even on gently sloping surfaces. The direct dependence upon climate is sharply reflected in the bog stratigraphy. Dry periods are indicated by layers of cotton-grass (*Eriophorum vaginatum*), ling (*Calluna vulgaris*), or even by the growth of trees, particularly pine (*Pinus sylvestris*) and birch (*Betula* spp.) and the resumption of active bog growth on the return of wetter conditions is marked by the abrupt return of the vegetation of open pools and active sphagnum growth. Such flooding surfaces or recurrence surfaces often occur with consistency across bogs or bog-complexes and afford reference horizons for prehistoric objects or structures found when the bogs are exploited for peat. This has been particularly well illustrated in the derelict raised bogs of the Somerset Levels: the Late Bronze Age trackways already described as dated between 2900 and 2600 B.P. show the most consistent relation to a major recurrence surface, and the local stratigraphy indeed forms an invaluable frame of reference for the many archaeological discoveries still being made through from the Mesolithic to the Romano–British period. It has been easy to attach radiocarbon dates to the stratigraphic bog-sequence and indeed to link this back to the last stages of marine invasion that filled the Somerset valleys with clay upon which fens, fen-woods and ultimately raised-bogs established themselves (Dewar & Godwin 1963).

Over big stretches of the north and west of the British Isles, particularly at higher altitudes, there is a cover of waterlogged blanket-bog. Often on the mineral soil below are artefacts of prehistoric man and sometimes, as in Co. Sligo, blanket bog may have grown over prehistoric monuments. It is evident how important therefore is the radiocarbon dating of the onset of blanket-peat formation in relation to the natural processes of soil development in humid climates, to former shifts of climate and to repercussions upon human settlement.

## 10. Conclusion

Some 500 radiocarbon datings have been made that bear directly upon British Archaeology and several hundred more affect the subject indirectly by coordinating the environmental circumstances of the last 10000 years or so.

By its means absolute ages have been attributed to each of the major cultural phases from the Mesolithic onwards, and many features or objects otherwise of unknown age have been put


PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

into exact position in the chronological record. The most remarkable achievement has been to enforce a substantial enlargement of the time span of the Neolithic and the acceptance that in western Britain it began at least as early as 5400 radiocarbon years B.P. This is a conclusion that conforms to an extended sequence of European radiocarbon dates. It would appear that between 4000 and 3500 radiocarbon years B.P. the Beaker culture marked the transition from the Neolithic to the Bronze Age. A similar substantial dating overlap occurs, not unexpectedly, between the Late Bronze Age and Early Iron Age, no doubt an expression of metachroneity in different areas. In neither the Neolithic nor the Bronze Age have the radiocarbon dates thus far helped with the definition of a middle stage.

Particular areas and periods, such as the Iron Age in Scotland have, with the help of radiocarbon dates and at the hands of archaeological specialists, yielded evidence of the parallel development of different cultures in different regions. There has been substantial achievement in dating prehistoric wooden objects such as trackways, boats and bows that are so far of uncertain or unascertained typology.

A tool of unexpected power has been provided by the conjunction of pollen-analysis and radiocarbon dating, which not only provide evidence of the natural vegetation in prehistoric time, but afford means of reconstructing the stages of man's disforestation of the landscape and creating in it the artificial new communities of pastoral and arable husbandry. From such studies to which already 100 radiocarbon dates or so are devoted, it is apparent that the earliest disforestation preceded 5000 years B.P. alike in England, Scotland and Ireland, and it is evident that character and magnitude of the exploitation changed through the Neolithic and subsequent Ages and as one would expect, produced different effects in different regions.

A particular role is played by radiocarbon dating within the last millennium, where, by making use of the calibration based upon bristle-cone pine dendrochronology, radiocarbon dates can be transposed to sidereal dates. This is currently permitting productive study of our medieval timbered buildings.

Finally, radiocarbon dates have been energetically applied to the coordination of all those environmental circumstances, geological, biological and climatic that more or less closely concerned the life of prehistoric man.

The achievement is important and continuing. It owes a great deal to the staffs of relatively few carbon-dating laboratories. It is owed to them to submit for dating only samples whose provenance is unexceptionable and importance assured. We owe also a great debt to the editors and publishers of *Radiocarbon*, the means of international and definitive publication of dates: the journal deserves more subscribers than it at present achieves. Moreover, all radiocarbon dating laboratories should, as many do, when accepting a sample insist upon receiving for publication in *Radiocarbon*, a statement of the provenance of the sample and the purpose of the determination, in sufficient detail to make the result comprehensible and useful to all specialists in the field concerned. The majority of laboratories maintain a suitable standard in response to the requests of the editors of *Radiocarbon*, but others could profitably demand fuller and more precise statements from their clients before accepting samples for dating.

By attention to these measures we can ensure that Professor W. F. Libby's remarkably productive discovery is permitted to develop its full potential power in manifold applications, not least of which is the study of Archaeology.

## References (Godwin)


Atkinson, R. J. C. 1967 Further radiocarbon dates for Stonehenge. *Antiquity* **41**, 63–64.

Barker, H., Burleigh, R. & Meeks, N. (unpublished). *British Museum Natural Radiocarbon Measurements*, VI.

Case, H. 1969 Neolithic explanations. *Antiquity* **43**, 176–186.

Churchill, D. M. 1962 The stratigraphy of the Mesolithic sites III and IV at Thatcham, Berkshire, England. *Proc. Prehist. Soc.* **28**, 362–370.

Churchill, D. M. & Wymer, J. J. 1965 The Kitchen Midden site at Westward Ho!, Devon, England: ecology, age and relation to changes in land and sea level. *Proc. Prehist. Soc.* **31**, 74–84.

Clark, J. G. D. 1963 Neolithic bows from Somerset, England and the prehistory of archery in northwest Europe. *Proc. Prehist. Soc.* **29**, 50–98.

Clark, J. G. D. 1965 Radiocarbon dating and the spread of farming economy. *Antiquity* **39**, 45–48.

Clark, J. G. D. 1966 The invasion hypothesis in British archaeology. *Antiquity* **40**, 172–189.

Clark, J. G. D. & Godwin, H. 1962 The Neolithic in the Cambridgeshire Fens. *Antiquity* **36**, 10–23.

Coles, J. M. & Hibbert, F. A. 1968 Prehistoric roads and tracks in Somerset, England; I. Neolithic. *Proc. Prehist. Soc.* **34**, 238–258.

Connah, G. 1969 Radiocarbon dating for Knap Hill. *Antiquity* **43**, 304–305.

Daniel, G. 1959 Editorial. *Antiquity* **33**, 238–240.

Dewar, H. S. L. & Godwin, H. 1963 Archaeological discoveries in the raised bogs of the Somerset Levels, England. *Proc. Prehist. Soc.* **29**, 17–49.

Godwin, H. 1960*a* The Croonian Lecture. Radiocarbon dating and Quaternary history in Britain. *Proc. Roy. Soc. Lond.* B **153**, 287–320.

Godwin, H. 1960*b* Prehistoric wooden trackways of the Somerset Levels: their construction, age and relation to climatic change. *Proc. Prehist. Soc.* **26**, 1–36.

Iversen, J. 1941 Landnam i Danmarks stenalder. *Danm. Geol. Unders.* R II, no. 66.

MacKie, E. 1969 Radiocarbon dates and the Scottish Iron Age. *Antiquity* **43**, 15–26.

Mellars, P. A. 1969 Radiocarbon data for a new Cresswellian site. *Antiquity* **43**, 308–310.

Mitchell, G. F. 1965 Littleton Bog, Tipperary: an Irish vegetational record. *Geol. Soc. America*. Special paper No. 84.

O'Kelly, M. J. 1969 Radiocarbon dates for the Newgrange Passage Grave, Co. Meath. *Antiquity* **43**, 140–141.

Oldfield, F. 1963 Pollen analysis and man's role in the ecological history of the South-east Lake District. *Geogr. Ann.* **45**, 23–40.

Pennington, W. 1964 Pollen analyses from the deposits of six upland tarns in the Lake District. *Phil. Trans. Roy. Soc. Lond.* B **248**, 205–244.

Piggott, S. 1954 *The Neolithic cultures of the British Isles*. Cambridge University Press.

Smith, A. G. & Willis, E. H. 1961–2 Radiocarbon dating of the Fallahogy Landnam phase. *Ulster J. Arch.* **24–5**, 16–24.

Turner, J. 1962 The *Tilia* decline: an anthropogenic interpretation. *New Phytol.* **61**, 328–341.

Turner, J. 1964 The anthropogenic factor in vegetational history. I. Tregaron and Whixall Mosses. *New Phytol.* **63**, 73–90.

Turner, J. 1965 A contribution to the history of forest clearance. *Proc. Roy. Soc. Lond.* B **161**, 343–354.

Waterbolk, H. T. 1960 The 1959 carbon-14 symposium at Groningen. *Antiquity* **34**, 14–18.

Watts, W. A. 1960 C-14 dating and the Neolithic in Ireland. *Antiquity* **34**, 111–116.

Willis, E. H. 1961 Marine transgression sequences in the English Fenlands. *Ann. N.Y. Acad. Sci.* **95**, 368–376.

Wright, E. V. & Churchill, D. M. 1965 The Boats from North Ferriby, Yorkshire, England, with a review of the origin of the sewn boats of the Bronze Age. *Proc. Prehist. Soc.* **31**, 1–24.