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CAMBRIDGE UNIVERSITY NATURAL RADIOCARBON MEASUREMENTS III

H. GODWIN and E. H. WILLIS

Cambridge University*

The dates and activity measurements given below have been obtained during the year 1960 (excepting only Q-9 held over from the previous year). They have been made with carbon dioxide at 3 atmospheres pressure in a proportional gas-counter similar to that used for the results given in Radiocarbon Supplement, volumes 1 and 2.

We have maintained our policy of directing our assays largely towards particular projects under investigation in the University Sub-department of Quaternary Research, and during 1960 particular attention has been given to problems of land-level and sealevel changes of British coastal areas.

We particularly wish to acknowledge the help of R. J. F. Burleigh, Technical Assistant in the Carbon Dating Laboratory.

SAMPLE DESCRIPTIONS

BRITISH ISLES

A. Coastal Series, Southwestern England and Wales

On the coasts of the British Isles there is abundant evidence of past changes in the relative positions of land level and sealevel: these take the form of submerged peat beds, raised beaches, and the alternation of freshwater and brackish-water deposits. Suitable samples, where possible formed close to the contemporary mean sealevel, have been collected from (A) areas of relative crustal stability in which it may be supposed eustatic changes of ocean level have prevailed; (B) areas (in the N) in which postglacial land elevation has taken place, presumably by isostatic recovery; (C) areas bordering the southern North Sea in which subsidence has occurred by some kind of tectonic movement.

Q-126. Tealham, Somerset, no. 2 **5620 ± 120**

Clayey *Phragmites* peat (51° 13′ N Lat, 2° 50′ W Long). Sample taken from North Drain excavation at junction of lower estuarine clay and *Phragmites* peat close to present sealevel. This sample came from just above Q-120 (5412 ± 130 B.P., Cambridge I), and was intended as a check on account of the importance of this horizon as marking the end of the main eustatic rise of ocean level (Godwin, Suggate and Willis, 1958). Coll. August 1955 by H. Godwin. *Comment*: the two determinations are in agreement.

Q-423. Shapwick Heath, Neolithic axe site, 284/7 cm 5510 ± 120

Clayey *Phragmites* peat (51° 9′ 13″ N Lat, 2° 38′ 37″ W Long). This site marks the upper surface of the estuarine clay beneath the raised-bog de-

*Radiocarbon Dating Laboratory, 5 Salisbury Villas, Station Road, Cambridge, and University Sub-department of Quaternary Research, Botany School, Cambridge, England.

posits, and like Q-120 (5412 ± 130, Cambridge I) and Q-126 (5620 ± 120, this date list) should date the conclusion of the main eustatic rise in ocean level. The horizon is 1 or 2 ft above present-day sealevel. Coll. 1959 by H. Godwin. *Comment*: date confirms the view reached on stratigraphic and pollen-analytic grounds that the marine contact is of the same age in separate parts of the levels. About 1000 yr were occupied by sedge-peat and wood-peat formation before the development of ombrogenous peat in Neolithic time (Q-430, 4540 ± 130, Cambridge II).

Q-35. Combwich, Somerset **6460 ± 140**

Wood (51° 10′ 20″ N Lat, 3° 3′ 25″ W Long) from trees (*Alnus* and *Taxus*) growing on an 8-in. peat bed at ca. + 6 ft O.D. which is overlain clay. 14 ft of clay extending to present ground level, and underlain by marine clay. Coll. 1939 by H. S. L. Dewar, Bridport, Dorset (Godwin, 1941). *Comment*: the stratigraphy at the marginal site of Combwich has not been related to that of the adjacent levels, and the significance of the date is not clear at present.

Q-265. Margam, Glamorgans, 0 to 4 cm **3402 ± 108**

Phragmites (brushwood peat) (51° 32′ N Lat, 3° 46′ W Long). Upper surface of a submerged peat bed, 2 ft 9 in. thick, overlain by gray sand and silty clays and underlain by gray silty clays. Clays are of marine origin. Level of sample: −7.7 ft O.D. Coll. November 1957 by Cementation Co. Ltd. *Comment*: dates the end of a considerable period of marine retrogression or standstill from about 6200 B.P. (Q-275, 6184 ± 143, this date list).

Q-274. Margam, Glamorgans, 37 to 42 cm **5605 ± 126**

Aquatic pool peat of Sphagna and Hypnaceae (51° 32′ N Lat, 3° 46′ W Long). From same borehole as Q-265 (3402 ± 108, this date list) and same peat bed, this sample is close to the boundary between a lower ombrogenous *Sphagnum-Calluna* peat and an upper aquatic peat passing over into eutrophic fen peat. Coll. November 1957 by Cementation Co. Ltd. *Comment*: the change to eutrophic conditions after this date is indicative of rising ground-water.

Q-275. Margam, Glamorgans, 48 to 52 cm **6184 ± 143**

Gray silty clay (51° 32′ N Lat, 3° 46′ W Long). From same borehole as Q-265 and Q-274 (5605 ± 126, this date list), constituting the base of same peat bed where it is transitional from brackish- to freshwater conditions. Level: −10.5 ft O.D. (core compressed during drilling). Coll. November 1957 by Cementation Co. Ltd. *Comment*: the three dates from this peat bed indicate 3000 yrs of freedom from marine transgression: it seems probable that it corresponds with peat bed described from dock excavations at Port Talbot (closely adjacent) at a slightly higher level, and which contained a broken polished stone axe (cf. Q-430, 4540 ± 130, Cambridge II). In comparison with data on the other side of the Bristol Channel in the Somerset Levels, Q-275 corresponds with the submerged peat at 15 ft below sealevel at Burnham-on-Sea (Q-134, 6262 ± 130, Cambridge I), and Q-274 corresponds with the three Somerset date (Q-120, 5412 ± 130, Cambridge I; Q-126, 5620 ± 120, and Q-423, 5510 ± 120; this date list) for the close of the estuarine-clay deposition around 5400 B.P.

Q-380. Ynyslas, Cardigans, 38 cm **6026 ± 135**

Betula wood (52° 30′ N Lat, 4° 3′ W Long). Birch grown *in situ* in brushwood peat at base of submerged peat bed exposed on the foreshore of Cardigan Bay near the Dovey Estuary. Peat bed overlies blue silt and has been shown (Godwin, 1943) to extend conformably inland as the base of a large raised bog (Borth Bog). It falls within pollen zone VII*a* and its growth indicates replacement of a period of marine deposition by one of standstill or marine retrogression. Coll. March 1959 by H. Godwin.

Q-382. Ynyslas, Cardigans, 65 cm **5898 ± 135**

Brushwood peat (52° 30′ N Lat, 4° 3′ W long) from same excavation as Q-380: a peat sample from the base of peat bed just overlying the marine silt at level assumed from earlier levelling to be about –1 to –2 ft O.D. Coll. March 1959 by H. Godwin. *Comment*: the basal wood-peat clearly grew very rapidly and it is not surprising that Q-380 (6026 ± 135, this date list) and Q-382 give similar dates. Together they indicate the end of a considerable marine transgression in the area, for marine deposits extend to substantial depths in the Cardigan Bay estuaries.

General Comment on the A Coastal Series

The results of coastal series A from the region of assumed crustal stability confirm the view that the extensive and rapid eustatic rise in ocean level now generally agreed to have been proceeding in Boreal time (Godwin, Suggate and Willis, 1958), had reached its full extent by ca. 5500 B.P. and was within about 15 ft of this already by ca. 6200 B.P.

B. Coastal Series, Northern Britain

The most conspicuous evidence of land elevation in northern Britain is the so-called "25-foot beach" which is plausibly attributed to a period when the decelerating eustatic rise of ocean level was for a time approximately equalled by isostatic uplift. Continuance of the latter, when the former had ceased, brought the beach to its present position. We here report one date for the late stage of building of the beach in northern Ireland, and three dates for the beginning of formation of the Scottish Carse Clays, which are a deposit conceded to have been laid down in the raised-beach episode. There are also samples from three other coastal sites, in northwestern England, that lie well within the region of isostatic elevation.

Q-373. Cushendun, County Antrim **4740 ± 110**

Wood (55° 8′ N Lat, 6° 2′ W Long). In banks of river behind raised beach at Cushendun, a layer of wood overlies gray silts of the marine transgression and is covered by about 3 ft of coarse gravel. The level of these silts corresponds with that of the "upper lagoon silts" described by Jessen (1949) as forming behind the beach in its last stage of accumulation. Coll. June 1958 by H. Godwin and A. G. Smith, Queen's University, Belfast. *Comment*: the date is concordant with Jessen's estimate that raised-beach formation ended at the pollen-zone boundary VIIa/VIIb, and that the upper lagoon silts themselves were laid down late in zone VI. It agrees also with the Dublin radiocarbon

date (D-38, 5300 ± 170), cited by Watts, 1960, and Dublin I) for charcoal of transitional Mesolithic-Neolithic occupation on the surface of the raised beach further S on this coast at Dalkey.

Q-280. Airth Colliery, Sterlingshire, no. 1 **8421 ± 157**

Peat (56° 4′ N Lat, 3° 47′ W Long). Uppermost layer of a thin peat bed that lies between the deposits of the Scottish 100-ft raised beach and the overlying Carse Clay. Present level of base of Carse Clay is ca. 25.5 ft O.D. Coll. April 1958 by Geological Survey, Edinburgh. *Comment*: pollen analyses indicate that the peat formed early in zone VI, and on the basis of the Scaleby Moss pollen-zonation dates (Cambridge I) the date of 8421 ± 157 is acceptable.

Q-281. Airth Colliery, Sterlingshire, no. 2 **11,024 ± 199**

Clay with peaty layers (56° 4′ N Lat, 3° 47′ W Long). This is the base of the same peat layer, 4 in. thick, assayed in Q-280 (8421 ± 157, this date list), and directly above the deposits of the 100-ft raised beach. Coll. April 1958 by Geological Survey, Edinburgh. *Comment*: pollen analyses indicate that the peat may have begun to form in zone V, but the radiocarbon date is much too old for this. Pollen analyses, however, show very large amounts of derived organic detritus and of spores from more ancient geologic formations; the content of derived inactive carbon is presumably responsible for the erroneous date. High values of pollen of Chenopodiaceae and a seed of *Atriplex* sp. throughout the peat bed, indicate proximity of the sea and suggest that peat formation was due to response by rising ground water to the onset of marine incursion over the much older beach.

Q-421. Eastfield of Dunbarney (Bridge of Earn) Perthshire **8421 ± 157**

Peat with wood (56° 21′ N Lat, 3° 25′ W Long). From peat bed below the Carse Clay exposed in the banks of the River Earn. Coll. 1945 (probably by J. Simpson), Geological Survey, Edinburgh (sample U-2931). *Comment*: pollen analysis of a sample of this peat collected by H. Godwin in 1945, and of the carbon-dated sample itself, indicates formation during pollen zone VI*a*, as with Q-280 (8421 ± 157, this date list) from Airth Colliery where, by chance, precisely the same radiocarbon date was obtained.

Q-422. Broombarns, near Forgandenny, Perthshire **8354 ± 143**

Quercus wood (56° 21′ N Lat, 3° 29′ W Long) from peat below Carse Clay exposed in S bank of the River Earn, 750 yd W 20° N of Broombarns. Coll. 1959 by Dr. Earp, Geological Survey, Edinburgh (sample U2934). *Comment*: pollen analysis of sample of peat from this bed, collected by H. Godwin in 1945, indicates formation during pollen zone VI*a* or VI*b*. The conformity of the three samples from separate sites, Q-280, Q-421 and Q-422 is striking; they are slightly older than Q-214 (8120 ± 135, Cambridge II), the peat below the raised beach at Ballyhalbert in N Ireland which was referred to pollen zone VI*c* (Cambridge II). This site is probably identical with that sampled originally by Erdtman (1928), and referred to as Forgandenny: he described the peat as of Boreal age and this is of course now confirmed.

Q-398. Brighouse Bay, Kirkcudbrightshire 9640 ± 180

Wood (54° 47′ N Lat, 4° 7′ W Long) lying horizontally in the upper surface of a thin peat bed (2 in.) over what appears to be boulder clay, exposed on the foreshore. Pollen analyses show that the peat formed when pine-birch-hazel dominated the vegetation, i.e., zone V. Coll. July 1959 by Dr. Martin Jope. *Comment*: radiocarbon date suggests origin so early in the post-glacial period that peat deposit may well be the early infilling of an interdrumlin hollow. There is nothing to link it with former sealevel. The date, however, falls within the age attributed to zone V at Scaleby Moss, which lies no great distance eastwards (Cambridge I).

Q-256. Silverdale Moss, N Lancashire, no. 5 5734 ± 129

Oxidized fen peat (54° 12′ N Lat, 2° 50′ W Long). At the eastern side of Silverdale Moss, a sequence of organic deposits extending from pollen zone IV to VII*a* is interrupted by a bed of marine clay which is also recognized in the near neighborhood. From a monolith brought back to the laboratory, radiocarbon samples were taken at the upper and lower clay surfaces (Oldfield, 1960). Q-256 is immediately below the marine clay. Coll. August 1957 by Frank Oldfield, Univ. Leicester. *Comment*: date agrees with the determination that the peat below the clay formed in pollen zone VII*a*.

Q-260. Silverdale Moss, N Lancashire, no. 9 6590 ± 144

Phragmites peat (54° 12′ N Lat, 2° 50′ W Long). From same sequence as Q-256 (5734 ± 129, this date list), immediately above upper surface of the marine clay. In main part of the Silverdale Moss basin surface of the marine clay lies at ca. + 15 ft O.D. Coll. August 1957 by Frank Oldfield, Univ. Leicester. *Comment*: pollen analyses show very similar character above and below the marine clay; both are referred to pollen zone VII*a*, but the radiocarbon dates are inexplicably different.

Q-261. Silverdale Moss, N Lancashire, no. 10 5865 ± 115

Alnus wood (54° 12′ N Lat, 2° 50′ W Long). From the same sequence as Q-256, 5734 ± 129, and Q-260, 6590 ± 144 (this date list), this alder wood was 30 cm above the upper surface of the marine clay, and still within pollen zone VII*a*. Coll. August 1957 by Frank Oldfield, Univ. Leicester. *Comment*: all three samples can be referred pollen-analytically to levels 325 to 350 cm in the long continuous freshwater deposits at Haweswater, only 0.5 mi away, and these levels constitute only a small section in the middle of zone VII*a*. This makes the big range of the three radiocarbon dates surprising. Stratigraphic studies show that only in its latest stages did the transgression bring clay over the outer rock bar into the Silverdale basin.

Q-85. Helsington Moss, Westmorland 5277 ± 120

Phragmites peat (54° 17′ 30″ N Lat, 2° 49′ W Long). The reed-swamp peat immediately above the estuarine clay that underlies the whole of the large raised bog, Helsington Moss, the stratigraphy of which has been described by Smith (1959). He refers the marine contact to early in pollen zone VII*a*: its level he shows to be ca. + 16 or 17 ft O.D. Coll. July 1953 by A. G. Smith,

Queen's Univ., Belfast: multiple-shot sampling by Hiller borer. *Comment*: date is somewhat younger than might have been supposed from the palynological evidence, and from the Silverdale Moss dates. Method of sampling might have led to some introduction of younger peat, and this would therefore be a minimal age.

Q-88. High Foulshaw Moss, Westmorland **4616 ± 112**

Peat (54° 15′ N Lat, 2° 19′ 30″ W Long). High Foulshaw Moss is alongside the upper reaches of the River Kent estuary and behind it lies Foulshaw Moss which has been investigated stratigraphically and pollen-analytically by Smith (1959): both are close to Helsington Moss, (Q-85, 5277 ± 120, this date list). Under all these mosses, at about 12 ft to 15 ft O.D., is the surface of an estuarine clay, representing the end of the latest large marine transgression on this coast. Sample is from upper surface of the estuarine clay which in Foulshaw Moss (but not High Foulshaw itself) was shown to correspond with an early part of zone VII*a*. Coll. July 1953 by A. G. Smith, Queen's Univ., Belfast. *Comment*: date is younger than would have been expected, but possibly lies too close to the estuary channel to be trustworthy as an index to the maximum of the transgression: the date is minimal.

General Comments on the B Coastal Series

The view supported by the dates of the A coastal series that the main eustatic rise of ocean level was almost ended by 6200 and quite finished by 5500 B.P. is not contradicted by evidence of deposits from within the region of isostatic uplift. Now raised to an elevation of about + 15 ft O.D., the surface of the marine clays of the last big transgression are shown to date from ca. 5800 years B.P. in Silverdale, N Lancashire, and from ca. 5300 years B.P. in Helsington Moss, Westmorland. The later date for High Foulshaw Moss is somewhat suspect.

Dates so far obtained for the deposits of the 25-ft raised beach suggest that it formed between ca. 8000 and 5000 B.P. It is interesting to find that the Carse Clays of lowland Scotland began to cover the valley peats also ca. 8000 B.P.; we do not yet know when deposition of the Carse Clays ceased. Both the beach and the Carse Clays represent a net transgression of some 10 or 15 ft during formation (ca. 0.5 ft per century). The net isostatic uplift of ca. 25 ft during the last 5000 yr (0.5 ft per century) is substantially less than the net rate of eustatic rise in the Late Boreal and Early Atlantic (of the order of 2.0 ft/100 yr). This latter figure would permit the necessary phase of first transgression and then equilibrium responsible for beach formation and Carse Clay deposition during the last stages of the eustatic rise of sealevel. Subsequently, of course, both features have been raised to their present heights by continued isostatic uplift.

C. Coastal Series, Fenland Basin

The shallow Fenland basin of East Anglia is filled with postglacial deposits of alternately freshwater and brackish-water origin. Their stratigraphy in the southern half of the basin was elucidated by the former Fenland Research

Committee during the 1930's (Godwin, 1940). Black fen peats that occupy the landward part of the basin are divided (save at the extreme margin) into an upper and a lower peat, by a "Fen Clay" or "Buttery Clay" laid down in brackish water. The upper peat, which contains Bronze Age remains in several places, is itself overlain on the seaward side by a deep deposit of silt laid down and occupied during the Romano-British period. Neolithic remains occur in the lower peat at one site (Shippea Hill). A broad general chronology for the postglacial evolution of the Fenland was derived from the convergent evidence of stratigraphy, archaeology and pollen analysis, and a scheme showing the changes of land level and sealevel in the area was related to that chronology (Godwin, 1940).

The present series of radiocarbon datings is designed to test and extend those earlier conclusions: in many instances the samples relate to geologic situations already explored in the earlier work. The enquiry essentially concerns the dating of the transgression that produced the "Fen Clay", and of the episode of marine retrogression (or less probably, of stability) that produced the "upper peat."

(*i*) *Fen margin sites*

Over much of the shallowest part of the Fenland basin peat formation only began when the Fen Clay transgression caused backing up of fresh water, and this was the time when the primeval forests of straight-boled giant oaks growing on the mineral soil were killed and entombed by the peat. At other places, although Fen Clay was not present, pollen analyses and stratigraphic studies indicate its horizon in the continuous peat deposition, by a pronounced turn towards local wetness.

Q-129. Adventurer's Fen, Wicken, Cambridgeshire, tree no. 1 4380 ± 140

Quercus wood (52° 18′ N Lat, 0° 17′ E Long). Roots of an oak tree growing in Gault Clay beneath the black fen peat, exposed in excavations for artificial mere. Coll. August 1955 by H. Godwin.

Q-130. Adventurer's Fen, Wicken, Cambridgeshire, tree no. 2 4605 ± 110

Quercus wood (52° 18′ N Lat, 0° 17′ E Long). Outer rings of prostrate oak from basal forest layer beneath fen peat, exposed alongside Q-129 (4380 ± 140, this date list). Coll. August 1955 by H. Godwin. *Comment*: at sites nearby in Wicken Fen, Reach Fen and at Upware, pollen analyses proved that the basal forest peat was succeeded by *Cladium* sedge peat formed under much wetter conditions, and that this wet episode corresponded with the Fen Clay deposition at sites slightly more seaward.

Q-589. Queen Adelaide Bridge, Ely, Cambridgeshire 4495 ± 120

Quercus wood (52°23′ N Lat, 0° 15′ 40″ E Long). Outer rings of an oak tree 7 ft in girth and of 70 ft straight trunk, almost certainly from the basal forest bed, found in the Fen Clay during river-drainage improvement. Coll. 1960 by E. H. Willis and W. E. Doran. *Comment*: date corresponds strikingly

well with that of the trees from Wicken (Q-129, Q-130; this date list) only a few mi distant.

Q-544. Wood Fen, Ely, Cambridgeshire **4195 ± 110**

Wood peat (52° 25′ 40″ N Lat, 0° 16′ 40″ E Long) from around roots of a pine tree (*Pinus sylvestris*) growing upon the fen peat at a site just beyond maximum extension of the Fen Clay. Pollen-analytic and stratigraphic studies showed the pine-tree layer to have grown immediately after deposition of the Fen Clay (Godwin, and Clifford, 1935). Coll. April 1934 by M. H. Clifford. *Comment*: in good agreement with Q-405 (4190 ± 130, Cambridge II) from Holme Fen, on the W fen margin, which also represents the resumption of wood-peat growth after a wet phase corresponding to the Fen Clay phase (Cambridge II).

Q-532. Flaggrass, March, Cambridgeshire, no. 2 **4055 ± 110**

Wood peat (52° 33′ 14″ N Lat, 0° 7′ 8″ E Long) from base of a peat bed resting upon the gravels of Island of March, slightly outside the range of the Fen Clay. Coll. August 1960 by H. Godwin and R. G. West from excavations organized by T. Potter. *Comment*: it seems likely that as at Wicken (Q-129, 4380 ± 140, and Q-130, 4605 ± 110, this date list) this sample represents the effects of general waterlogging induced by the Fen Clay incursion: the level of –1.5 ft O.D. accords with this.

Q-474. Glass Moor, Ramsey, Huntingdonshire **4345 ± 110**

Cones of *Pinus sylvestris* (52° 31′ N Lat, 0° 4′ E Long) from a layer of wood peat with pine trees *in situ*, underneath a thin layer of Fen Clay and with shells of *Cardium edule* (cockle), growing upon the peat surface. Coll. ca. 1938 by H. Godwin and M. H. Clifford. *Comment*: in good agreement with the Wicken and Ely dates.

Q-545. Woodwalton Fen, Huntingdonshire **3415 ± 110**

Thelypteris peat (52° 26′ 40″ N Lat, 0° 11′ 40″ W Long) from a monolith representing the initiation of ombrogenous peat growth from fen peat: sample includes the characteristic layer of rootlets of marsh fern (*Dryopteris thelypteris*). Must post-date the Fen Clay incursion which comes fairly close to this site. Coll. 1937 by H. M. Clifford (Godwin and Clifford, 1938).

Q-546. Ugg Mere, Green Dyke, Huntingdonshire **3260 ± 110**

Droppings of elk (*Alces alces*) in aquatic *Sphagnum* peat (52° 27′ 30″ N Lat, 0° 10′ 30″ W Long) found between the top of the Fen Clay and the calcareous shell marl of Ugg Mere, a marl possibly laid down as a consequence of the Romano-British marine transgression. Coll. ca. 1937 by H. Godwin and M. H. Clifford (Godwin and Clifford, 1938). *Comment*: date falls satisfactorily into the series of dates for the upper peat and establishes a Bronze Age date for elk in Britain.

(*ii*) *Central and seaward sites*

In general, upper peat of the Fenland basin is now well preserved (and free from intrusive living roots) only in those seaward regions where it has

been covered by the silts of the Romano-British transgression. Recent deep excavations of a flood-relief channel of the River Great Ouse, through the courtesy of the chief engineer, W. E. Doran, yielded several opportunities to sample this bed.

Q-549. Saddle Bow, King's Lynn, Norfolk, 0 to 2 cm depth **1875 ± 110**

Fen peat (52° 42′ 40″ N Lat, 0° 23′ 10″ E Long) from top of the upper peat bed that overlies Fen Clay, and just below the Romano-British silty clay. Exposed in new flood-relief channel of the River Great Ouse, about 0.5 mi N of Saddle Bow village. Nearby was the site from which bones of pelican were recovered from the peat (Forbes, Joysey, and West, 1958). Coll. 1955 by R. G. West and E. H. Willis.

Q-550. Saddle Bow, King's Lynn, Norfolk, 2 to 4 cm depth **2070 ± 110**

Fen peat (52° 42′ 40″ N Lat, 0° 23′ 10″ E Long) from top of the upper peat just below Q-549. Coll. 1955 by R. G. West and E. H. Willis. *Comment*: dates of Q-546 (3260 ± 110, this date list) and Q-550 agree quite well with one another and accord with the evidence that the upper silty clay was laid down in a marine transgression that began in the Romano-British period.

Q-489. Saddle Bow, King's Lynn, Norfolk, no. 1 **3905 ± 120**

Fen peat (52° 42′ 40″ N Lat, 0° 23′ 10″ E Long) from the transition of the upper surface of the Fen Clay to the brown 2-ft peat bed above. Sample taken from just below Q-490 (3915 ± 120, this date list). Coll. by R. G. West and E. H. Willis.

Q-490. Saddle Bow, King's Lynn, Norfolk, no. 2 **3915 ± 120**

Fen peat (52° 42′ 40″ N Lat, 0° 23′ 10″ E Long) from the transition of the upper surface of the Fen Clay to the brown 2-ft peat bed above. Sample taken from just above Q-489 (3905 ± 120, this date list). Coll. by R. G. West and E. H. Willis. *Comment*: dates for Q-489 and Q-490 are self-consistent and place the marine regression following the deposition of the Fen Clay at about 3910 B.P.

Q-547. Magdalene Bend, Runcton Holme, Norfolk **3305 ± 120**

Fen peat (52° 39′ 30″ N Lat, 0° 21′ 40″ E Long) from top surface of the upper peat at contact with overlying sandy silt presumed to be of Romano-British age. Shells of *Cardium edule* with joined valves common on the peat surface: they must have lived *in situ* on the peat surface. Coll. Oct. 1957 by H. Godwin, Vishnu-Mittre, and R. P. Suggate. *Comment*: the fact that the age of the marine contact here is so much greater than at Saddle Bow (Q-549, 1875 ± 110 and Q-550, 2070 ± 110, this date list) suggests that the encroaching tidal water may have scoured away some of the upper peat.

Q-263. Denver Sluice, Norfolk, no. 1 **4390 ± 120**

Wood (52° 35′ N Lat, 0° 20′ 40″ E Long) from the upper peat bed be-

tween Fen Clay and Romano-British silt, taken from just above the Fen Clay. Coll. October 1957 by H. Godwin and others.

Q-264. Denver Sluice, Norfolk, no. 2 **4085 ± 110**

Wood (52° 35′ N Lat, 0° 20′ 40″ E Long) from the upper peat near site of Q-263. Tree stem 7 in. in diameter, lying horizontally 3 in. above the upper surface of the Fen Clay, here with much *Phragmites*. Coll. October 1957 by H. Godwin and others. *Comment*: results for Q-263 (4390 ± 120, this date list) and Q-264 agree reasonably well; the "Bear's Muck" (i.e. tidal clay with *Phragmites*) defines the marine contact and represents the end of the Fen Clay transgression.

Q-31. Wiggenhall St. Germans, King's Lynn, Norfolk **4690 ± 120**

Oak wood (52° 41′ N Lat, 0° 21′ 35″ E Long) from a tree grown *in situ* in the "lower" peat bed. This is peat-bed C, which lies below the Fen Clay at a present height of 17 ft below mean sealevel. Pollen analyses show that the oaks grew in fen woods late in the hydroseral succession represented by the peat bed, and were killed as wet conditions returned with the onset of the marine transgression (Godwin and Clifford, 1938). Coll. 1932 by H. Godwin. *Comment*: pollen analyses indicate an origin in zone VII that accords with the radiocarbon date. This date must imply a net subsidence of this coast of at least 17 ft in the last 4600 yr.

Q-81. Ingoldmells, Lincolnshire **2455 ± 110**

Wood (53° 11′ N Lat, 0° 22′ E Long) from trees growing *in situ* in the upper peat exposed on the foreshore. This peat lies close to present mean sealevel and overlies a salt-marsh clay (*Triglochin clay*) with a brackish-water *Phragmites* peat transition. Halstatt-type (Early Iron Age) pottery was recorded from the upper peat by H. H. Swinnerton who described the stratigraphy of the deposits. On pollen-analytic and stratigraphic evidence Godwin and Clifford (1938) correlated this peat bed with the upper peat of the Fenland basin, but Smith (1958*b*) subsequently suggested that it was formed "in the period of the Roman occupation." Coll. March 1953 by A. G. Smith, Queen's Univ., Belfast. *Comment*: radiocarbon date accords with the date of the Halstatt-type pottery and falls within the range of dates covered by the upper peat of the main Fenland basin, to which Ingoldmells can be considered marginal.

Q-531. Flaggrass, March, Cambridgeshire, no. 1 **3065 ± 110**

Peat (52° 33′ 14″ N Lat, 0° 7′ 8″ E Long) from upper surface of deep peat bed at contact with overlying silt of a roddon, i.e., tidal deposits of a channel dating from the Romano-British occupation. Coll. August 1960 by H. Godwin and R. G. West from pit 5 of archaeologic excavations by T. Potter. *Comment*: the radiocarbon date is 1000 yr before the Roman occupation: probably the upper layers of the peat were removed by tidal water, and certainly the local stratigraphy shows abrupt transition between peat and overlying silt.

Q-401. Immingham, Lincolnshire **6681 ± 130**

Alnus wood (53° 11′ N Lat, 0° 22′ E Long) from root crown of an alder

tree grown *in situ* in a peat bed exposed in excavation for the new Henderson graving dock. Peat bed was about 30 ft below present sealevel: it was ca. 4 in. thick and contained wood, frequent hazel nuts (*Corylus*) and *Phragmites*. The peat overlies brackish-water clay with *Phragmites* some 4-ft thick above gravelly sand, and is covered also by similar clay up to ground surface. Coll. August, 1959 by H. Godwin. *Comment*: peat bed appears to represent a brief halt in the progress of marine transgression. Site lies close to the zero isobase for the 25-ft raised beach and seems unlikely to have been much affected by post-glacial land movements. Nonetheless, Smith (1958*b*) has shown that there was a marine transgression in the Humber region between the Early Iron Age and the Roman period. The situation of the dated Immingham peat bed no doubt reflects in part this transgression and in part the terminal stages of the main eustatic rise in ocean level. We have to note from Smith's evidence that this area has behaved differently in its land- and sealevel relationships from the Fenland basin (see notes on Q-79, 2796 ± 100, Q-78, 2784 ± 100, this date list).

(iii) The Shippea Hill site

Shippea Hill (52° 26′ 10″ N Lat, 0° 23′ 52″ E Long) was the site of important excavations made by the Fenland Research Committee and reported in a number of publications (Clark, G., 1933; Clark, Godwin, and Clifford, 1935; Godwin and Clifford, 1938). They showed that in Late-glacial time there existed a wide valley, cut down deeply below present sealevel and subsequently filled with alternating freshwater and brackish-water deposits. Consequently, at this site the lower peat beneath the Fen Clay was several ft thick and was shown pollen-analytically to have formed over a long period. One Mesolithic occupation and one Neolithic occupation of the sandy banks of the channel were traced outward into the fen peats of the channel, and referred to respective places in the pollen-zonation. In 1960 J. G. D. Clark reopened the site, and a column through the lower peat, secured by J. H. Dickson, was brought to Cambridge for pollen analysis, identification of macroscopic remains and selection of radiocarbon samples. In addition, charcoal from the Neolithic horizon was separately collected.

Q-499. Shippea Hill, Cambridgeshire, no. 100 4695 ± 120

Wood (52° 26′ 10″ N Lat, 0° 23′ 52″ E Long) from tree growing in the wood peat not far below the Fen Clay. Coll. 1960 by J. H. Dickson and J. G. D. Clark, Cambridge. *Comment*: the sample gives a date for the time just before deposition of the Fen Clay and closely conforms to that of Q-31 (4690 ± 120, this date list) from a comparable stratigraphic position. It is the uppermost and has the youngest date of the samples through the lower peat at this site.

Q-525/6. Shippea Hill, Cambridgeshire, nos. 1 and 2 4870 ± 120

Charcoal coll. from Neolithic culture layer in the lower peat: the amalgamation of two samples coll. at 18.55 W, 20.62 S and 18.49 W, 20.90 S respectively. Coll. 1960 by J. G. D. Clark.

Q-527/8. Shippea Hill, Cambridgeshire, nos. 3 and 11 4950 ± 120

Charcoal coll. from Neolithic culture layer in the lower peat: the amalgamation of two samples coll. at 18.37 W, 20.67 S and 18.71 W, 20.24 S respectively. Coll. 1960 by J. G. D. Clark. *Comment*: dates of Q-525/6 and Q-527/8 agree.

Q-580. Shippea Hill, Cambridgeshire, 4 to 5 cm depth 4800 ± 120

Clayey *Phragmites* peat, marking brackish-water transition from lower peat to Fen Clay: from top of monolith through lower peat.

Q-581. Shippea Hill, Cambridgeshire, 5 to 6 cm depth 5130 ± 120

Clayey *Phragmites* peat immediately below sample Q-580 and slightly less clayey. *Comment*: dates of Q-580 and Q-581 agree closely, and also with that of Q-499 (4695 ± 120, this date list), a wood sample from the same stratigraphic horizon.

Q-582. Shippea Hill, Cambridgeshire, 35 cm depth 5310 ± 120

Black sedge peat with small wood from monolith through the lower peat and midway between the top of the lower peat and the Neolithic-culture layer. In the pollen diagram this level marks maxima in the curves of *Quercus*, *Fraxinus* and *Hedera*, and the end of the continuous curve for *Plantago lanceolata*.

Q-583. Shippea Hill, Cambridgeshire, 50 cm depth 5295 ± 120

Black fen peat with small wood and a little fine sand from monolith through the lower peat and at the top of the Neolithic-culture layer.

Q-584. Shippea Hill, Cambridgeshire, 65 cm depth 5465 ± 120

Black fen peat with small wood and a little fine sand, from monolith through lower peat at a level presumed to be the base of the Neolithic culture: the first *Plantago lanceolata* pollen occurs at this level.

Q-585. Shippea Hill, Cambridgeshire, 70 cm depth 5330 ± 120

Black fen peat with small wood and a little fine sand, from immediately below sample Q-584 (5465 ± 120, this date list).

Comment on the Shippea Hill series

The 9 samples dated from the uppermost 70 cm of the lower peat bed at Shippea Hill form a generally self-consistent group within a space of only 750 yr. There is very close agreement between the 3 peat samples Q-583, 584 and 585 (this date list) that cover the Neolithic culture layer. In view of this, it is remarkable that the Neolithic charcoal samples Q-525/6 and Q-527/8 (this date list) (which agree reasonably well with one another) should be some 400 yr younger.

In both Britain and the continental mainland the opening of the Neolithic commonly corresponds with the *Ulmus* decline that indicates the pollen-zone boundary VII*a*/VII*b*, but at Shippea Hill this relation is not apparent. The Neolithic level is, however, marked by the earliest evidence of agricultural activity, in this instance by the consistent presence of pollen of *Plantago lan-*

ceolata. Although on present evidence it is impossible to choose between the charcoal dates of 4900 B.P., and the peat dates of about 5300 B.P., for the Shippea Hill Neolithic, they must be taken as confirming a much earlier date for the earliest Neolithic in Britain than had been supposed before the advent of radiocarbon dating. It is to be recalled that the palynologic evidence for the beginning of Neolithic clearance on the western margin of the Fenland at Holme Fen occurred at a level with a radiocarbon date of 5000 B.P. (Q-406, 4958 ± 130, Cambridge II).

After the Neolithic occupation, the river valley was occupied by fen-woods and the radiocarbon dates indicate a rapid formation of peat. The coincidence of three dates (samples Q-499, 580 and 581, this date list) shows that at this site brackish water invaded the valley close to 4700 B.P.

It remains to complete dating the samples from the lower half of the peat monolith (including the Mesolithic culture layer, which lies very close to the pollen-zone boundary VI/VII).

General Comment on the C Coastal Series

The C series of samples has provided a group of dates which place the Fen Clay deposition within the period 3000 to 2300 yr B.C. This agrees with the archaeologic evidence that Neolithic remains have been found below the Fen Clay, and that Early Bronze Age remains occur immediately above it. It seems as if the maximum extension was about 2400 B.C., at which time the buried-oak forests of the Fenland margin were destroyed.

At the same time, the series supplies a number of dates for the upper peat ranging between about 2400 B.C. and A.D. 100. It is noteworthy that in the Netherlands similar geologic and radiocarbon evidence points to a substantial marine transgression between 2900 and 2300 B.C., followed by a long period of marine retrogression.

If we consider the evidence from the Fenland in conjunction with that from southwestern England (series A) it will be seen that the radiocarbon dates support the conclusion already advanced on other grounds that since the end of the main eustatic rise in ocean level (ca. 3500 B.C.) there has been downward movement of the east of England. This agrees with the general picture already advanced of the southern North Sea basin as a region of post-glacial subsidence (Godwin, 1945).

From Shippea Hill we have the evidence of the first incidence of Neolithic agriculture in the area, close to 3000 B.C.

D. Archaeologic Samples

Q-79. Short Ferry, Fiskerton, Lincolnshire (boat) 2796 ± 100

Wood (53° 13′ N Lat, 0° 22′ W Long) from prehistoric dug-out canoe with separate stern board found in valley deposits of the old River Witham, near Lincoln. Coll. March 1953 by A. G. Smith. *Comment*: boat appears to belong to the Late Bronze Age, despite the suggestion of younger age deduced from the pollen analyses by Smith (1958*a*).

Q-78. Brigg, Lincolnshire (boat) **2784 ± 100**

Wood (53° 33′ N Lat, 0° 30′ W Long) from prehistoric monoxylous boat with separate stern board found in deposits of the old River Ancholme. From the same site came a structure "now thought to be part of a boat similar to the 'sewn' boats from North Ferriby on the northern shore of the Humber opposite the outfall of the River Ancholme" (Smith, 1958*a*). The boats apparently lay within the brackish-water clay that fills the valley and the base of which covers a brushwood-peat surface carrying objects of the Late Bronze Age and Halstatt-type pottery, as well as the wooden trackway already dated to 2552 ± 120 (Q-77: Cambridge II). Coll. 1952 by E. H. Rudkin; subm. by A. G. Smith. *Comment*: like the Short Ferry boat and the 'sewn' boats from North Ferriby (2700 ± 150, BM-58, British Museum II), the Brigg boat appears to be of Late Bronze Age construction. The clay in the valley must have been quickly deposited, not only because of the archaeologic objects found below it, but because of the Brigg trackway, likewise below it, but with a scarcely separable radiocarbon date. It might be conjectured that the boats were lost by a sudden insurge of tidal water into the valley.

Q-387. Mynnth Rhiw, Lleyn Peninsula, Caernarvons **3094 ± 90**

Charcoal (52° 49′ 40″ N Lat, 4° 37′ 30″ W Lat) from quarry pits on Neolithic axe-factory site, excavated for the Royal Commission on Ancient Monuments, in Wales and Monmouthshire. Tools and industry stated to match those of Graig Llwyd and charcoal stated to be from a fire pit, hearth II, site B, in use during occupation and to have filled in during the same time. Coll. April 1959 by C. H. Houlder, Aberystwyth, and Judith Turner, Cambridge. *Comment*: date appears too young by several centuries for a Neolithic date, and one supposes either that the sample was contaminated by younger carbon in some manner not detected, or that the charcoals came from a secondary and much later occupation and hearth-building inside a Neolithic pit after it had become partly silted up. There is no trace of any distinct post-Neolithic-material culture to support the latter idea, however.

E. Late-Glacial and Full-Glacial Deposits

Q-463. Dover Hill, Folkestone, Kent **11,944 ± 210**

Small charcoal (57° 5′ 12″ N Lat, 1° 11′ 20″ E Long) washed out from a dark gray band (residue of a fossil rendzina soil) in the cryoturbation layer which lies on the flank of the chalk downs between underlying Coombe Rock and overlying hill-wash of Roman or later date. Whereas molluscan evidence collected by M. P. Kerney indicates Late-glacial age for the cryoturbatic layer as a whole, the gray layer is characterized by molluscan species of entirely different character, indicative of warmer conditions, so that he tentatively identifies this phase with the mild Allerød period (Godwin, 1960). Coll. December 1959 by M. P. Kerney, Imperial College, London. *Comment*: radiocarbon date falls within the limits of zone II (the mild Allerød) as hitherto dated in western Europe. It confirms Dr. Kerney's expectation and demonstrates that freeze-thaw conditions were active in SE England in zones I and

III of the Late-glacial period. Fruit stones of *Empetrum* were present, a species prevalent in the British Late-glacial.

Q-473. Holborough, near Maidstone, Kent 13,190 ± 230

Black organic material (51° 20′ 30″ N Lat, 0° 25′ 40″ E Long) washed out from the lower and thinner of two darker layers within thick chalky solifluxion material overlying Coombe Rock on the slope of the North Downs. Both dark layers have a molluscan assemblage of species indicating milder conditions than those of the cryoturbatic material that encloses them. Dr. Kerney tentatively equates the upper of the two layers here with the single dark layer of Allerød age recovered in similar circumstances at Dover Hill (Q-463, 11,944 ± 210, this date list), and consequently regards the lower layer as indicative of minor interstadial oscillation in Late-glacial zone I, such perhaps as the Bølling. Coll. 1960 by M. P. Kerney. *Comment*: radiocarbon date confirms dating of this mild episode to the Late-glacial zone I.

Q-457. Loch Droma, Ross-shire 12,814 ± 155

Plant remains (57° 44′ N Lat, 4° 55′ W Long), National Grid ref. 252752, from a dark layer relatively rich in organic material in deposits of glacial melt-water silts formed in the bed of the lake during excavations for hydroelectric project. Altitude 845 to 880 ft O.D. Carbon-dating sample was taken at 46 to 50 cm from a monolith transferred to Cambridge. Pollen analyses through the deposit show that it was laid down in conditions such as those now encountered in the low-alpine region of N Scandinavia, close to the sub-alpine birch forest and the pre-alpine pine forest. Macroscopic plant remains isolated from organic layers in the silts by Mr. Durno of the Macaulay Institue, Aberdeen, carry similar implications. Bryophyta identified by J. M. Dickson indicate local snow-patch vegetation. Coll. 1959 by W. Kirk, Univ. of Leicester. *Comment*: Late-glacial age indicated by the radiocarbon date accords very well with the biological evidence. At the same time it is to be noted that this date indicates a pre-Allerød (zone I) origin, and that the valley lies in the center of the Highland Readvance glaciation which Donner (1957) has rather convincingly referred to the post-Allerød zone III. If such soft deposits as these could not have escaped destruction during a zone III glaciation, then some modification of Donner's hypothesis seems to be called for.

F. Problematic Dates

Various samples throughout this date list, provide, incidentally, radiocarbon dates for the British postglacial-pollen zones, but the following samples were secured primarily to obtain a date for a pollen-zone boundary. In each instance, however, the result is problematical.

Q-9. Hockham Mere, Norfolk, DB 5, 330 to 350 cm 3880 ± 90

Fine detritus nekron-mud (gyttja) (52° 30′ 55″ N Lat, 0° 50′ E Long) collected by multiple-shot boring with Hiller peat sampler, between 330 to 350 cm depth in borehole DB 5. The filled-in lake, Hockham Mere, in the N of the East Anglian Breckland has yielded a very long and comprehensive palynologic

record through the Late-glacial and postglacial periods (Godwin, 1944; Godwin and Tallentire, 1951). This sample comes from the *Ulmus*-decline horizon that marks pollen-zone boundary VII*a*-VII*b* in the British sequence and also the first indications of Neolithic forest clearance. Coll. October 1949 by H. Godwin. *Comment*: date is 2000 yr younger than would be expected from other W European determinations (Godwin, 1960). As pollen diagrams indicate freedom from disturbance, possibly multiple-shot sampling in the soft material may have led to incorporation of young material from upper layers. Yet the error is so large that one is not fully convinced by this explanation: the same situation held with regard to the Late-glacial sample from Hockham Mere, dated by Libby, 1952 (C-349), which was several thousand yr too young (Godwin, 1951).

Q-247. Thrang Moss, North Lancashire, no. 9 **4360 ± 130**

Sphagnum-Calluna peat (54° 16′ N Lat, 2° 47′ W Long) from the relict raised bog in Lowland Lonsdale described by Oldfield (1960). Part of a monolith brought back to Cambridge for analysis and tied palynologically by check samples to a continuous pollen diagram. Q-247 (26 to 29 cm lower series) was chosen to date the first and strongest *Ulmus* decline, here associated with the commencement of a continuous curve for *Fraxinus* and the earliest indications of forest clearance. This corresponds with the pollen-zone boundary VII*a*-VII*b* and Oldfield's horizon UF. Coll. May 1957 by F. Oldfield, the Univ., Leicester. *Comment*: see notes on Q-249, 4360 ± 130, this date list.

Q-249. Thrang Moss, North Lancashire, no. 11 **4360 ± 130**

Sphagnum-Calluna peat (54° 16′ N Lat, 2° 47′ W Lat) from same monolith as Q-247 (4360 ± 130, this date list), but slightly higher (20 to 23 cm lower series). Intended also to date the same VF horizon, and VII*a*-VII*b* zone boundary. Coll. May 1957 by Frank Oldfield, Leicester Univ. *Comment*: age determinations of Q-247 and Q-249 are identical, but both are about 600 yr younger than would have been expected on the assumption of general synchroneity of the VII*a*-VII*b* boundary in N. Europe (Godwin, 1960). The samples, unfortunately, had certainly been partially penetrated by present-day living plant rootlets, and despite every effort by Oldfield to eliminate this source of error by picking out all fresh rootlets, the possibility remains that undetected recent rootlets have contributed to the samples and caused too recent dates to be obtained.

GREECE

Q-491. Acheron Valley, Preveza region, Greece **667 ± 110**

Wood (39° N Lat, 20° 40′ E Long) from the alluvial deposits of the Acheron valley. Coll. 1960 by the Greek Institute for Geology and Subsurface Research, Athens; subm. by T. Papadimitropoulos. *Comment*: date has been of value to the Institute as affording a measure of the rate of infilling of the valley by mineral sediments.

References

Date lists:

British Museum II. Barker and Mackey, 1960
Cambridge I. Godwin and Willis, 1959
Cambridge II. Godwin and Willis, 1960
Dublin I. McAulay and Watts, 1961

Barker, H. and Mackey, C. J., 1960, British Museum natural radiocarbon measurements II: Am. Jour. Sci. Radioc. Supp., v. 2, p. 26-30.

Clark, G., 1933, Report on an Early Bronze Age site in the south-eastern Fens: Antiquaries Jour., v. 13, p. 266-295.

Clark, J. G. D., Godwin, H. and M. E., and Clifford, M. H., 1935, Report on recent excavations at Peacock's Farm, Shippea Hill, Cambridgeshire: Antiquaries Jour., v. 15, p. 284-319.

Donner, J. J., 1957, The geology and vegetation of Late-glacial retreat stages in Scotland: Royal Soc. Edinburgh Trans., v. 63, p. 221-264.

Erdtman, G., 1928, Studies in the postarctic history of the forests of north-western Europe. I. Investigations in the British Isles: Geol. fören. Stockholm Förh, v. 50, p. 123-192.

Forbes, C. L., Joysey, K. A., and West, R. G., 1958, On postglacial pelicans in Britain: Geol. Mag., v. 95, p. 153-160.

Godwin, H., 1940, Studies of the post-glacial history of British vegetation. III, Fenland pollen diagrams, IV, Post-glacial changes of relative land- and sea-level in the English Fenland: Royal Soc. London Philos. Trans., B, v. 230, p. 239-303.

———— 1941, Studies of the post-glacial history of British vegetation. VI. Correlations in the Somerset Levels: New Phytologist, v. 40, p. 108-132.

———— 1943, Coastal peat beds of the British Isles and North Sea: Jour. Ecology, v. 31, p. 199-247.

———— 1944, Age and origin of the 'Breckland' heaths of East Anglia: Nature, v. 154, p. 6-7.

———— 1945, Coastal peat-beds of the North Sea region, as indices of land- and sea-level changes: New Phytologist, v. 44, p. 29-69.

———— 1951, Comments on radiocarbon dating for samples from the British Isles: Am. Jour. Sci., v. 249, p. 301-307.

———— 1960, Radiocarbon dating and Quaternary history in Britain—the Croonian lecture: Royal Soc. London Proc., ser. B, v. 153, p. 287-320.

Godwin, H. and Clifford, M. H., 1938, Studies of the post-glacial history of British vegetation, I. Origin and stratigraphy of Fenland deposits near Woodwalton, Hunts.; II, Origin and stratigraphy of deposits in southern Fenland: Royal Soc. [London] Philos. Trans., ser. B, v. 229, p. 323-406.

Godwin, H. and M. E., and Clifford, M. H., 1935, Controlling factors in the formation of fen deposits, as shown by peat investigations at Wood Fen, near Ely: Jour. Ecology, v. 23, p. 509-535.

Godwin, H., Suggate, R. P., and Willis, E. H., 1958, Radiocarbon dating of the eustatic rise in ocean-level: Nature, v. 181, p. 1518-1519.

Godwin, H. and Tallentire, P. A., 1951, Studies of the post-glacial history of British vegetation. XII. Hockham Mere, Norfolk: Jour. Ecology, v. 39, p. 285-307.

Godwin, H., and Willis, E. H., 1959, Cambridge University natural radiocarbon measurements I: Am. Jour. Sci. Radioc. Supp., v. 1, p. 63-75.

———— 1960, Cambridge University natural radiocarbon measurements II: Am. Jour. Sci. Radioc. Supp., v. 2, p. 62-72.

Jessen, K, 1949, Studies in the Late Quaternary deposits and flora-history of Ireland: Royal Irish Acad. Proc., 44 B 10, p. 85-290.

Libby, W. F., 1952, Radiocarbon dating: Chicago, Univ. Chicago Press, vii, 124 p.

McAulay, I. R., and Watts, W. A., 1961, Dublin radiocarbon dates I: Radiocarbon, v. 3, p. 26-38.

Oldfield, Frank, 1960, Studies in the post-glacial history of British vegetation; Lowland Lonsdale: New Phytologist, v. 59, p. 192-217.

Smith, A. G., 1958a, The context of some Late Bronze Age and Early Iron Age remains from Lincolnshire: Prehist. Soc. Proc., v. 24, p. 78-84.

———— 1958*b*, Post-glacial deposits in south Yorkshire and north Lincolnshire: New Phytologist, v. 57, p. 19-49.

———— 1959, The mires of southwestern Westmorland: stratigraphy and pollen-analysis: New Phytologist, v. 58, p. 105-127.

Swinnerton, H. H., 1931, The post-glacial deposits of the Lincolnshire coast: Geol. Soc. London Quart. Jour., v. 87, p. 360-375.

Watts, W. A., 1960, C-14 dating and the Neolithic in Ireland: Antiquity, v. 34, p. 111-116.