The Thirteenth-century Roofs and Floor of the Blackfriars Priory at Gloucester

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THE BUILDINGS of the Blackfriars priory in Gloucester are in the course of restoration by the Ancient Monuments Branch of the Department of the Environment. This provides an unusual opportunity to examine in a dismantled state an important series of scissor-braced roofs, to compare many timbers and joints, and thereby to consider the finer points of the 13th-century carpenter's workmanship and engineering sense, and the ways in which he reacted to variations in the timber. The value of such a study is increased by the existence of contemporary records about the origin of the timber.

HISTORY OF THE GLOUCESTER BLACKFRIARS

WHILE THE EARTH was still settling over St Dominic's bones, the order which he had founded spread with great speed through western Europe. Between 1225 and 1250 the Order of Preachers or Blackfriars founded many houses in English towns. Being a mendicant order they were committed to owning no endowments but to living directly from benefactions. The Gloucester house, probably founded in 1239, was fortunate enough to secure a valuable site in the middle of the city. Its early history is closely paralleled by that of the sister house at Bristol, founded about ten years earlier. Both were several decades in building and received many gifts from Henry III.

On both external and internal evidence the Gloucester Dominicans had completed by about 1270 the plain and solid buildings that their rule required. The fortunes of the house slowly declined and the original buildings served without any major addition or alteration until the Dissolution. In 1539 the premises were granted to Sir Thomas Bell, who converted the church into a small mansion by demolishing both ends and inserting floors, windows, etc., and put the conventual buildings to commercial uses. By the 20th century the property had been subdivided into houses and workshops, the S. range being a mineral-water factory. Although it had come down in the world, much of the original fabric survived. In the early 1960s the greater part was acquired by the then Ministry of Works who began the present restoration.

THE EXTANT BUILDINGS (FIG. 1)

The Gloucester and Norwich Blackfriars are the only reasonably complete Dominican houses to survive in Britain, and in consequence have attracted the attention of antiquaries from Stukeley onwards. Accounts of the stonework as then visible were given by Palmer in 1882[1] and Knowles in 1932,[2] and this summary is largely based on their work.

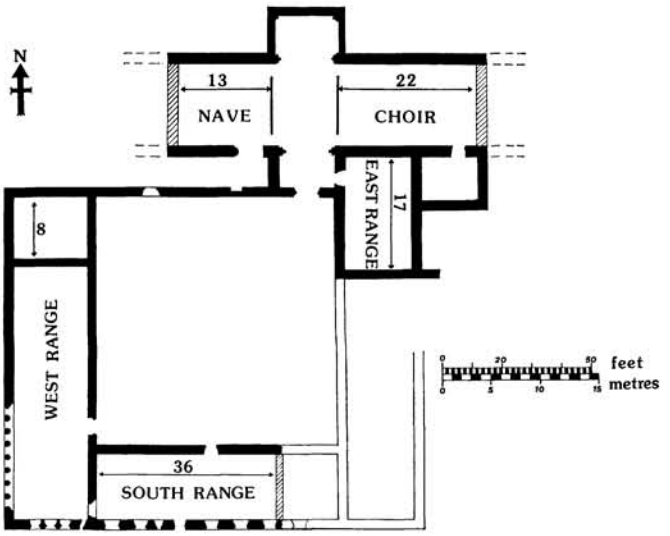

FIG. 1

GLOUCESTER BLACKFRIARS

Plan of site (after Knowles). Black — standing walls; white — known foundations; hatched — post-medieval additions. Numbers show how many original roof trusses survive in each range. The recently discovered N. aisle is not shown

The original *church* consisted of nave, choir, narrow nave aisles, and transepts not projecting beyond the aisles. The span of nave and choir roofs was 26 ft. 3 in. (7.46 m.) and that of the aisles was 10 ft. (3.05 m.). The length of the church is unknown (both ends were truncated when it was made into a house) but it was probably much smaller than in the otherwise similar house at Bristol. The crossing has been totally destroyed, and there is no trace of the heavy piers and arches which might have supported a central tower; this suggests that, as in some other friaries, the crossing was covered either by a continuous roof or by a timber steeple. The N. aisle was demolished and the N. transept was remodelled in the 14th century (information from P. R. White).

About half of the original scissor-braced roof-trusses of the church survive: they comprise thirteen in the nave and twenty-two in the choir. They have been taken down for repair and we have been able to examine nearly all the timbers at close quarters, either in store, in the workshop or from the scaffolding used to re-erect them. The 14th-century roof to the N. transept also survives. There is nothing left of the S. aisle roof.

The east range of the cloisters had a span of 22 ft. (6.71 m.) and a length of about 120 ft. (37 m.). In the northern part, supposed by Knowles to have contained the dormitory, the original scissor-braced roof survives, but we were unable to examine it closely as restoration had been finished before we arrived.

The south range, considered by Knowles to be the earliest purpose-built library in Britain, is almost intact; it is of two stories, spans 22 ft. (6.71 m.) and was 80 ft. (24.38 m.) long. Thirty-six scissor-braced trusses survive, not yet repaired, but accessible at close quarters owing to the insertion of a garret. Much of the original timber floor also remains.

The west range, with a span of 25 ft. 3 in. (7.70 m.) and 112 ft. (34.16 m.) long, has been converted into a jumble of buildings some of which are still private houses. During this investigation we discovered a roof of eight trusses, six of which have scissors, concealed above the garrets of an ostensibly Georgian house in the N. part of the range where Knowles locates the prior's quarters. No more of the roof of the W. range can survive *in situ* owing to post-medieval heightening, but the houses might conceal floors, partitions, and re-used roof-timbers.

The two cloister roofs that survive at Bristol are double-framed, more elaborate and probably later than those at Gloucester. Until the 19th century the S. range at Bristol had a floor very similar to its fellow at Gloucester.[3]

THE ROOFS

CONSTRUCTION

The surviving trusses in the church and S. range are identical in form (FIG. 2, a, b, and Hewett,[4] fig. 12); each has one collar and two scissor-braces. The sole-pieces rest on outer and inner wall-plates linked at intervals by cross-pieces to a batten set medially between them. In the choir and south range (though not in the nave) the inner wall-plate is decorated with a plain roll-moulding. The roofs of the E. and W. ranges are similar save that two trusses in the W. range have two collars and no scissors. None of the roofs ever had a collar-purlin. The trusses are closely set (average 2 ft. (0.61 m.) between centres in the S. range).

In all the roofs, mortise-and-tenon joints with one peg link the sole-pieces with the feet of the rafters and ashlars, and link the rafters with the tops of the ashlars and ends of the collars. The scissor-braces have lap-dovetail joints at their heads and notch-lap joints at their feet. At the apex the rafters are linked by mortise-and-tenon in the choir and are halved in the S. range.

Wind-bracing, illustrated by Hewett[5] and considered by him as perhaps the most important feature of the roof, is limited to the choir and consists of long straight battens fixed diagonally across the undersides of the rafters with large countersunk iron spikes. We agree with Hewett that it is original. In the nave and S. range, both presumably slightly later, the absence of such bracing caused the roofs to rack; it seems that further movement was then prevented by the insertion of small spacing-pieces between the trusses, knocked into rough chase-mortises cut in the edges of the rafters.

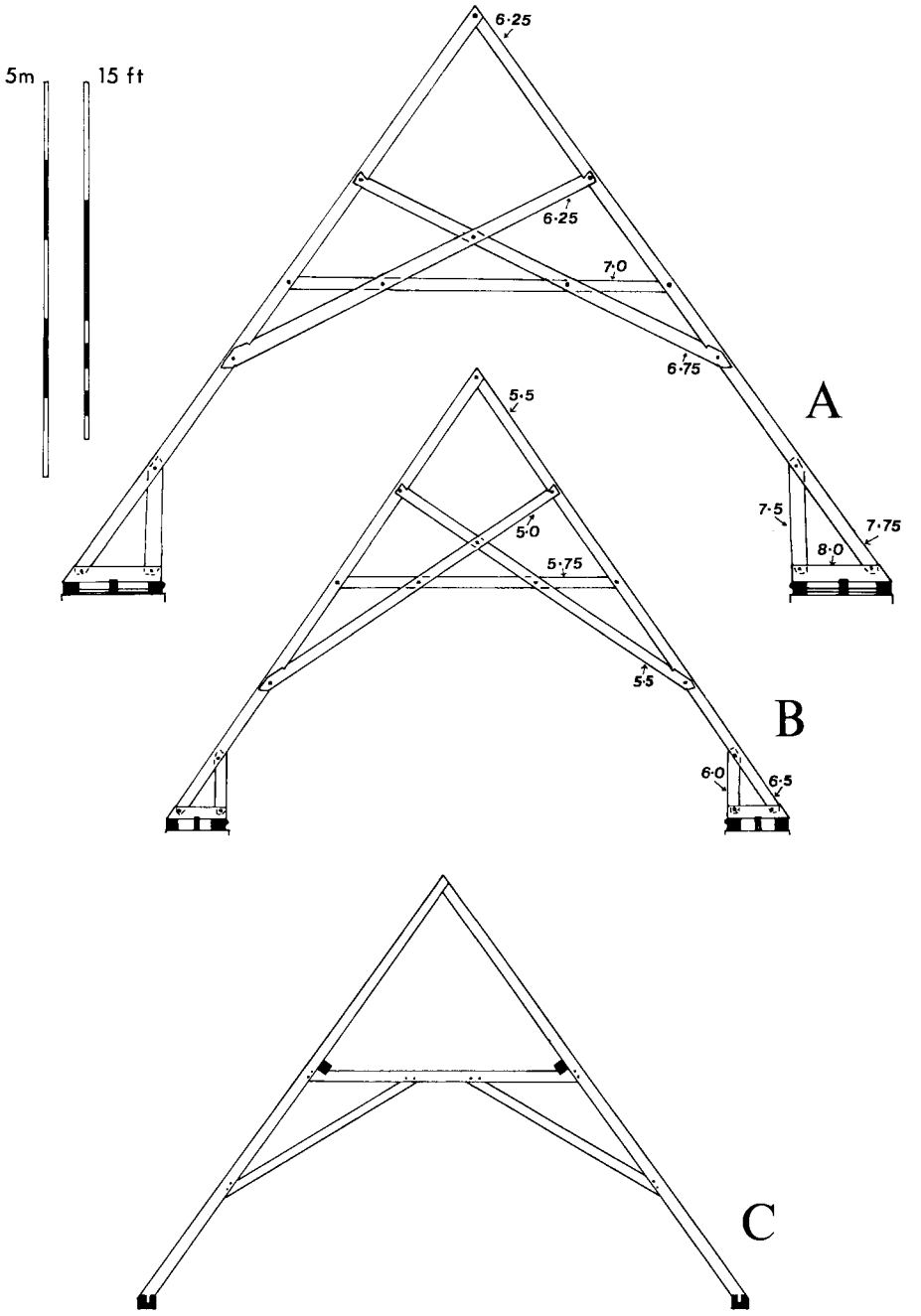

FIG. 2

GLOUCESTER BLACKFRIARS, ROOF-TRUSSES

A, choir and *B*, S. range, viewed from W.; *C*, N. transept. Numbers indicate average scantling in inches; all timbers are approximately square in section

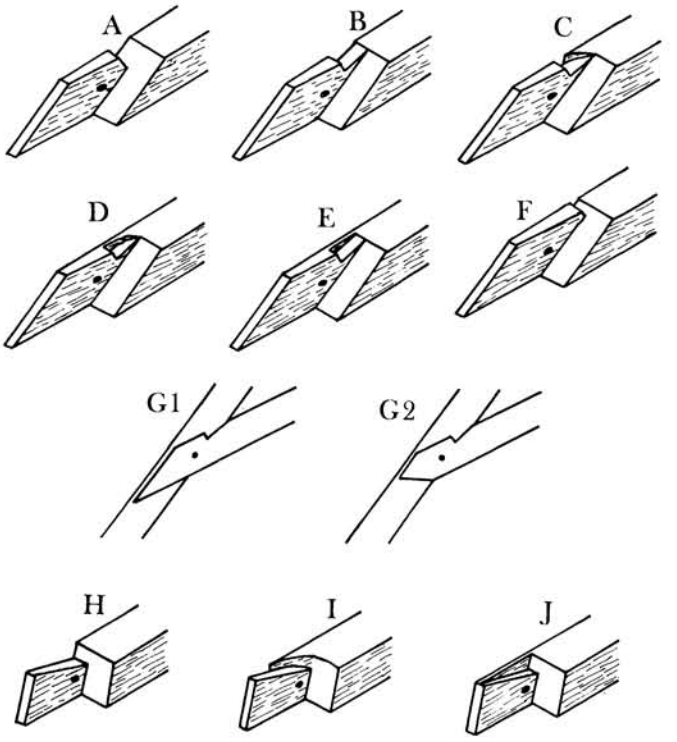

FIG. 3
GLOUCESTER BLACKFRIARS, ROOF DETAILS
Variants of side-entry joints. Notch-laps: *A*, 'early'; *B*, 'advanced'; *C*, *D*, transitions used with waney rafts; *E*, secret; *F*, 'mini-notch'. Different treatments of scissor feet: *G1*, *G2*. Lap-dovetails: *H*, open; *I*, transitional; *J*, secret

DETAILS OF JOINTS (FIGS. 3, 4)

The lap-joints are of particular interest because of the numerous variations which occur randomly intermixed in the roof. Those of the choir were examined in a dismantled state and those of the S. range by probing. The two commonest notch-lap variants are the open forms shown in FIG. 3, a, b. Mixed with them are a few secret notch-laps, some of the type usual in the 13th century (FIG. 3, e), but others cut with an unusual curved shoulder (FIG. 3, c, d). The size of the notch varies widely; in a few joints of the S. range it is so small as hardly to have any structural value (FIG. 3, f). The toe of the scissor also varies in shape (FIG. 3, g).

The lap-dovetails at the heads of the scissors vary in the same way: most are open (FIG. 3, h), some are 'semi-secret' and cut on a curve (FIG. 3, i), and a few are fully secret (FIG. 3, j).

In both notch-laps and lap-dovetails the thickness of the lap decreases by about a third from the base to the tip — a structural refinement visible only in the dismantled joint.

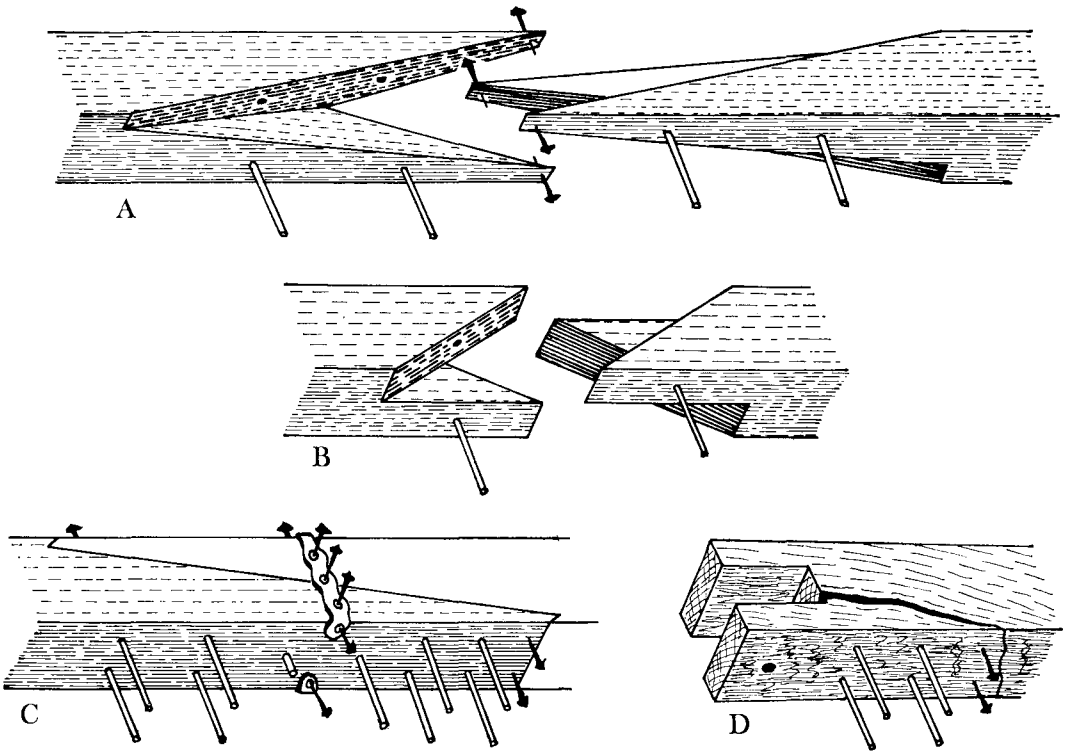

FIG. 4
GLOUCESTER BLACKFRIARS, ROOF DETAILS
Scarf-joints, etc. *A*, rafter scarf, 3 ft. 6 in. (1.07 m.) long; *B*, wall-plate scarf, 10 in (0.25 m.) long; *C*, rafter scarf, 5 ft. (1.52 m.) long; *D*, repair to rafter apex

Scarf-joints are few, but of three unusual types. One of the choir rafters is made from two short lengths of timber scarfed together by means of pairs of long, tapering prongs (FIG. 4, a). The two pairs of prongs interlock and are held with four pegs, and with a nail at each of the four points. This joint, which is easy to cut with the saw alone, occurs also in the S. range. A shorter and less elaborate version of the same joint (FIG. 4, b) was noticed twice in the outer wall-plate of the choir (one on each side) and was presumably repeated at intervals. The third scarf (FIG. 4, c) is the same as that described by Hewett[6] (FIG. 72) for the top-plates of a barn at Belchamp St Paul's, Essex; he calls it 'stop-splayed with under-squinted butts' and attributes it to a period before 1225. The Gloucester example, in a choir rafter, has ten face-pegs, four nails, and an iron strap attached by further nails countersunk into the thickness of the strap.

FIGURE 4, d, shows the reattachment of one cheek of the apex-mortise of a rafter, which had split away owing to the obliquity of the grain liable to occur in sawn timber (see below). Similar fractures have occurred with the base-tenons of rafters. Two cases of each type of repair, involving up to four pegs and up to four

nails, were noted in the church; there are others in the S. range. They appear to be original; failure no doubt took place under the unusual stresses imposed during erection.

Throughout the structure nails rather than pegs are used to attach a timber of an inch or less in thickness to the face of a more massive timber.

THE NORTH TRANSEPT ROOF (FIG. 2, c)

The 14th-century N. transept roof is as simple in conception as that of the nave but differs in many details. Only every fourth couple is framed. There are soulaces instead of scissors. Purlins are trapped above the collar-ends. The intermediate rafters are of the same scantling as the framed ones. All joints are mortise-and-tenon, usually with two pegs. There are no ashlars or sole-pieces; the wall-plates (no longer extant) would have had vertical longitudinal mortises receiving cranked end-tenons from the feet of all the rafters.

THE FLOOR OF THE SOUTH RANGE

The floor of the S. range (FIG. 5) has massive bridging-joists, built into the wall (and therefore original) and supported additionally by wall-posts resting on stone corbels and provided with braces. The braces are the only example in Blackfriars of the deliberate use of naturally curved timbers. Joints are mortise-and-tenon. The braces are chamfered, and the bridging-joists (which are slightly broader than deep) provide an unusually early example of stop-chamfering. The common-joists rest on the bridging-joists without any joint: whether they are pegged cannot yet be ascertained.

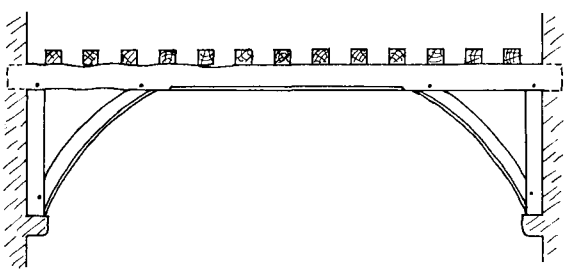

FIG. 5
GLOUCESTER BLACKFRIARS, S. RANGE
Section through floor. Span 22 ft. (6.71 m.); bridging-joist 13 in. by 12½ in. (33 cm. by 31 cm.); braces 13 in. by 9½ in. (33 cm. by 24 cm.); common joists 7 to 8 in. (18 cm. to 20 cm.) square, spacing uncertain

Originally there were probably six bridging-joists, of which one survives *in situ* and one has been re-used. A third joist, which has no framing, may also be original. The number of extant common-joists is unknown.

Other 13th-century floors with transverse principal joists like these, arch-braced to wall-posts, exist in the lower stage of the crossing-tower of Salisbury

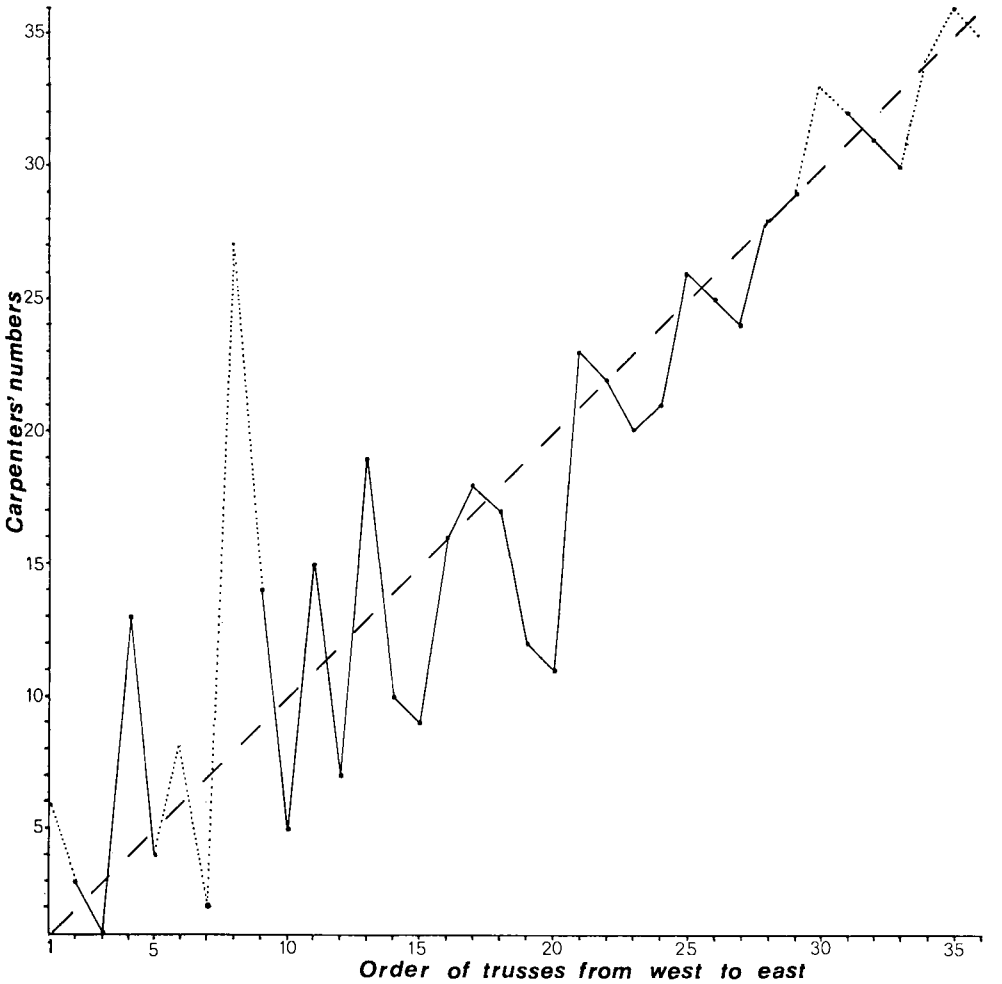

FIG. 6

GLOUCESTER BLACKFRIARS, ROOF-TRUSSES

Sequence of carpenters' marks on S. range. As numbers absent for trusses 1, 6, 8, 30, 34, 36, hypothetical numbers (based on lowest possible deviation) have been inserted and joined with dotted line to complete sequence

Cathedral[7] and formerly at Blackfriars, Bristol.[8] In contrast, in the domestic ranges at Little Chesterford Manor, Essex[9] and Bisham Abbey, Berks.[10] the principal joists are aligned axially and rest on free-standing posts.

TECHNIQUES OF DESIGN AND CONSTRUCTION

ASSEMBLY MARKS AND SEQUENCE OF ERECTION

Assembly numbers, roughly scratched with the corner of a chisel, can be detected on most of the roof-trusses. The truss-number normally appears on every

member and in roughly the same position. In the S. range there is an almost complete series from I to XXXVI running from W. to E., the numbers being consistent within each truss. The first twenty trusses are very much out of order whereas the rest correspond fairly closely to the numerical sequence (FIG. 6). This suggests that the trusses were made elsewhere and delivered to the site in at least two batches. I to XX became disordered, perhaps through being left for a time until the completion of the walls, and were erected as they came to hand; the order of numbering was regarded as immaterial. The others, XXI to XXXVI (and presumably more in the portion of the roof now destroyed), were used in an order closer to that in which they were made.

In the S. range (as in the nave) all the trusses are set with the scissor-brace joints on the E. side, which suggests that they were assembled and erected beginning at the E. end. Yet the sequence of numbers implies a W. to E. order of erection. These observations can be reconciled by supposing that erection began at the W. and that each truss was assembled face downwards minus its scissors, which were added after it had been reared. This procedure would have reduced the load to be hoisted in rearing each truss, at the cost of making it more difficult to coax the seven scissor-joints into place. Owing to the close spacing of the trusses it was necessary to arrange for the latter operation to be done on the face away from the trusses already reared.

TOOL-MARKS AND METHODS OF WORKING

All the medieval timbers are oak; the bridging-joists of the Tudor alterations to the church are elm, which by then was probably the commonest non-woodland tree of the Severn valley.

All the 13th-century roof-timbers are cut lengthwise from very large and somewhat crooked trees. The rafters are straight (apart from slight distortion under load). In section they are accurately rectangular — not quite square — and taper slightly towards the top. No attempt has been made to avoid sapwood or waney edges;[11] these are especially common on collars and scissors, a few of which follow the curve of the tree. The timbers are remarkably free from shakes and distortions of section, indicating that they were seasoned.

Some faces have saw-marks and others have adze-marks. Evidently each log was sawn into a number of timbers, which were later finished with an adze or a broad-axe, leaving some of the sawn faces untouched; cleaving with wedges would have been too inaccurate a method. The absence of shakes — cracks that arise when timber dries out in the round — indicates that the sawing was done soon after felling; the rectangular cross-section indicates that the final shaping was done after the timber had ceased to distort during seasoning. FIGURE 7 is a suggested reconstruction of the process.

This was an unusual practice for the period. The medieval carpenter normally selected the smallest trees that would serve the purpose in hand, and used them immediately without seasoning. Each timber was usually made by squaring up a whole log, or sometimes half a log sawn lengthwise, of larger or smaller

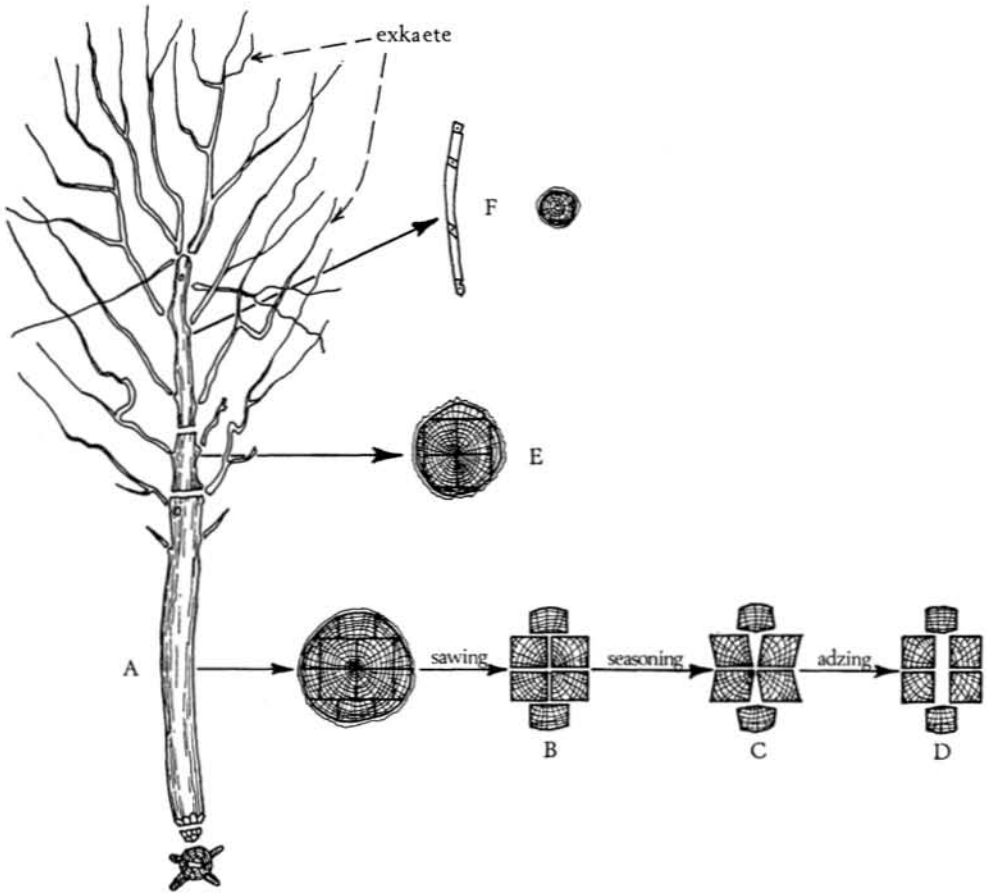

FIG. 7
GLOUCESTER BLACKFRIARS, TIMBER
Reconstruction of felled oak (*A*) showing how different lengths of it could be made into four rafters and two collars or scissors (*B*, *C*, *D*), four ashlars or sole-pieces (*E*), and one scissor (*F*)

diameter according to the scantling needed. This practice is attested by many documents and structures,[12] including the former 15th-century roofs of Norwich Cathedral and the great 13th-century roofs of Salisbury Cathedral (for which we have not only the actual rafters, since re-used, but also a record of a royal gift in 1251 of 20 oaks "to make ten couples out of"[13]). The unusual procedure at Gloucester may be explained by the fact that the friars were given the timber (they did not select it themselves) and that it was brought from a distance, so that transport would have been saved by drying the timber and by doing at least some of the carpentry at the place of origin. The 14th-century roof of the Blackfriars N. transept, in contrast, was built in the normal way, at least half the timbers each representing the whole of a small oak tree.

A few corrected mistakes were noted. Some, such as the saw-cuts indicating three stages of cutting back the shoulder of a lap-joint, suggest a cautious process of fitting by successive approximations. The omission of the peg-hole from the same joint looks like carelessness.

Peg-holes are drilled with a spoon-bit of about $1\frac{1}{4}$ in. (3 cm.) diameter. A common and mysterious occurrence, visible in the dismantled joint, is one or more abortive holes on the inside of the lap; occasionally these go right through, but usually they have been abandoned when less than $\frac{1}{2}$ in. (1.25 cm.) deep. Up to six unsuccessful holes have been noted in one joint (FIG. 8), placed up to 4 in. (10 cm.)

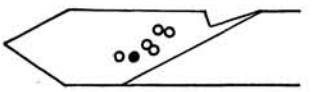

FIG. 8
GLOUCESTER BLACKFRIARS, ROOF DETAIL
Lap-joint with six unsuccessful peg-holes

from the final position. Such gross inaccuracy suggests some physical difficulty in positioning the drill-bit. The drill might have been fixed, possibly in some kind of bench-mounted drilling machine, and the timber have had to be moved up to it. The positioning of these heavy timbers would have been difficult and several trials might have been needed to find the right place.

DISTRIBUTION OF LOADS

The dismantling of a timber frame in good condition provides a valuable opportunity to measure the permanent distortions which the timbers have acquired under load. These give an indication of the distribution of stresses, which is difficult to predict analytically because the redundancy of the structure provides several alternative ways for the stresses to distribute themselves.

Two rafters from the nave, made of very uniform timber little affected by knots, wane, or decay, were measured for deflections in a vertical plane, which are plotted in FIG. 9, a. To a first approximation, the curvature at any point will be proportional to the bending moment. The rafters are bent into an s-shape; the biggest bending moment is where they are pushed outwards by the ashlars and the second biggest is where they are pulled inwards by the scissor-heads. The ashlars are strongly in compression and the scissors strongly in tension. The collars are bent downwards at the scissor passing-joints (FIG. 9, b) and are slightly in tension. The sole-pieces pull the rafter-feet inwards.

The usefulness of the collar — that by bending it relieves part of the tension in the rather weak scissor-head joint — is not obvious, and one might expect collars to be omitted from scissor-roofs more often than they are. Where a scissor-roof has a second collar above the scissor-heads (e.g. the roof over Peterborough Cathedral W. front[14]) this must act in compression to relieve the apex-joint.

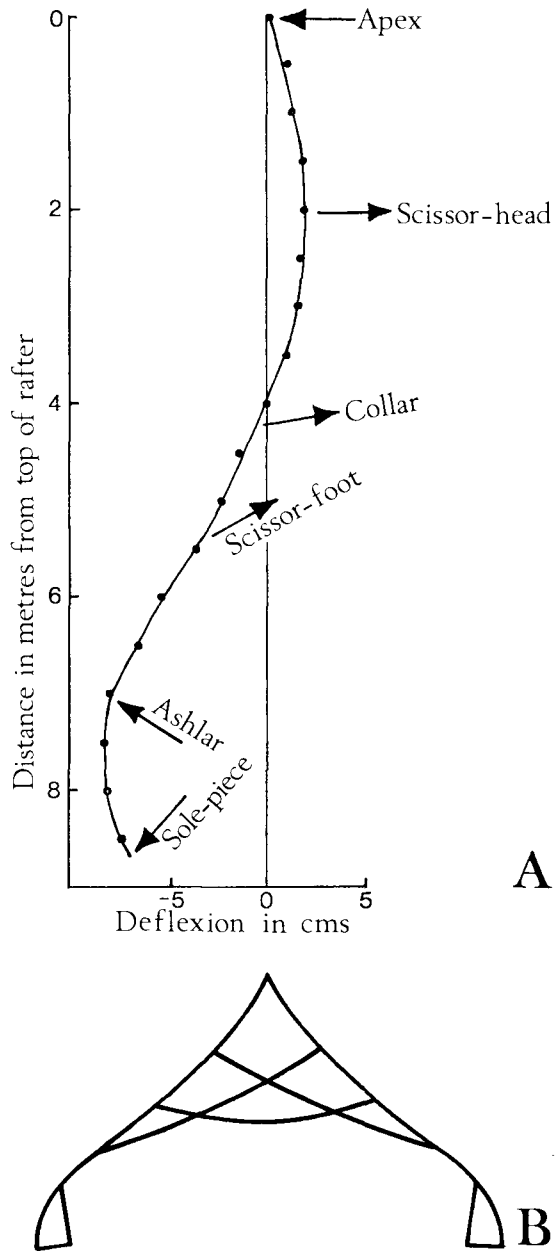

FIG. 9

GLOUCESTER BLACKFRIARS, ROOF-TRUSSES

A, distortion of rafter, measured relative to straight line passing through apex and collar joints. Directions of stresses imposed by other members are shown. Mean of measurements on two rafters, plotted with twenty-fold exaggeration. *B*, exaggerated sketch of how scissor truss distorts in use

THE INTERPRETATION OF JOINTS

It has been widely supposed that medieval carpenters varied their joints out of regard for changing fashion rather than for structural reasons. For instance, it is claimed that the 'early', 'advanced', and 'secret' lap-joints (FIG. 3, a, b, e) form a typological progression in which the secret variant is the latest in time and is intended purely for appearance. The Blackfriars roofs do not accord with this proposition. They form a utilitarian piece of carpentry in which several ways of joining timbers end-to-side are intermingled at the same time in the same roof. The choice of joint is strongly influenced both by the stresses expected and by the vagaries and imperfections of individual timbers.

With rare exceptions mortise-and-tenon is chosen for all joints in compression or (as with the collar-ends) in only slight tension. The scissors, in strong tension, have lap-joints at both ends. The carpenter evidently feared the shearing of the pegs of mortise-joints under tension, and for his lap-joints chose the type which best relieved the peg of this shear stress, namely a lap-dovetail for joints nearly at right angles and a notch-lap for very oblique joints. Some other pre-1300 structures, as at Lincoln Cathedral,[15] show equal discrimination in the choice of joints.

The choice of the three variants of notch-lap is connected with the properties of the timber. The strength of any notch-lap under tension depends on the integrity of the triangular tooth of the rafter's timber which engages with the notch on the scissor. With the variant of FIG. 3, a, this tooth is formed right on the arris of the rafter. In many cases this arris is formed of sapwood or oblique-grained, so that such a joint would be weak; in waney rafters the arris may be missing altogether, so that the joint could not be cut at all. Not surprisingly, most of the notch-lap joints are of FIG. 3, b type, in which the tooth is formed away from the arris on a part of the rafter more likely to be capable of bearing the stress; this variant, however, is more difficult to cut and weaker as regards the scissor.

Nearly all the secret and semi-secret notch-laps, and the parallel variants of lap-dovetails, occur in conjunction with waney rafters. Where there are internal curves they have been cut to fit the waney surfaces and to avoid gaps leading to structural weakness. The size of the web of timber left over the notch, and thus the degree of 'secrecy' of the joint, varies with the amount of wane on the rafter (FIG. 3, c, d, i).

The Blackfriars carpenters evidently adopted these devices from habit rather than necessity. Nearly every rafter has at least one sound arris in which they could, had they wished, have chosen to cut their joints. The fact that they did not avoid the problem merely by turning the rafters round suggests that they had become experienced in solving it through having worked with timbers, made from small trees, which were waney on *all four* arrises.

For the first time we thus have a logical explanation of how secret lap-joints may have been invented. Once devised, they have the structural advantage that the web of timber providing the 'secrecy' prevents the end of the scissor, beyond the notch or dovetail, from shearing off along the grain (FIG. 10, a). Such a failure is most likely to occur with 'advanced' notch-laps, and it is not surprising that the

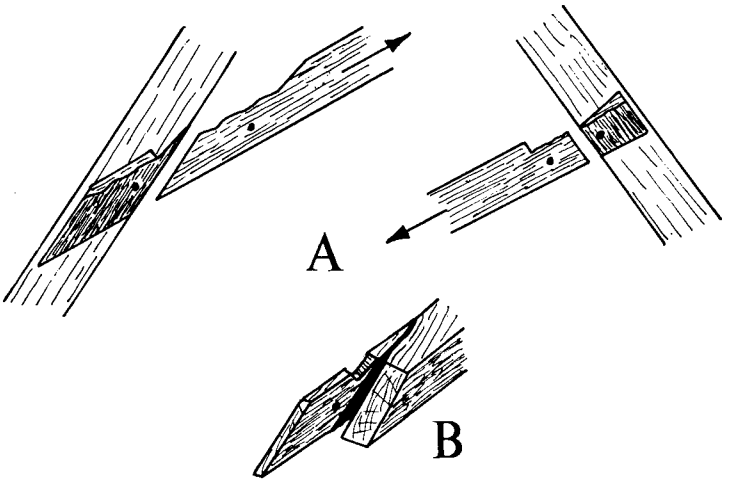

FIG. 10
GLOUCESTER BLACKFRIARS, ROOF DETAILS
A, mechanism of failures against which secret notch-laps and secret lap-dovetails are reinforced.
B, manner in which lap is liable to split off if grain of timber is oblique

secret form of this variant became widely used even where the arris is sound. One example has been found at Gloucester.

The tapering of the laps is a further refinement. The thick base makes the lap less likely to split away from the rest of the scissor (FIG. 10, b); the thin tip avoids weakening the rafter by cutting into it unduly on the compression side.

ORIGIN AND QUANTITIES OF TIMBER

NUMBER OF TIMBERS FROM EACH TREE

In the church roof, the majority of *rafters* (at least nineteen out of twenty-seven rafters examined) come from the butt logs of oaks sawn lengthwise into at least four pieces. Most rafters have no pith and only one radial section and must therefore represent less than a quarter of a log each. Usually they are knot-free for at least the lower 20 ft. (6 m.) and often right to the top, a total length of 30 ft. (9 m.). They are nearly always set so that the radial section is on a vertical face and the wane, if any, is on a lower arris. *Ashlars* and *sole-pieces* are typically quarter logs with one sapwood arris, though some represent whole logs. Often they are from crooked lengths. *Collars* and *scissors* consist of whole or half logs more often than do rafters. Out of twenty collars examined, five or six were whole and two halved; out of thirty-six scissors, twelve were whole and five or six halved. Over fifty per cent have a high proportion (a third or even half the section) of sapwood and wane. Waney collars and scissors often have large knots suggesting that they grew high in the crown of the tree.

These observations indicate that the typical tree used (FIG. 7, a) had a trunk some 30 ft. (9 m.) high to the lowest big branch and continuing reasonably straight, though diminishing in size, for a further 20 ft. (6 m.). It would have been about 2 ft. 3 in. (0.68 m.) diameter under bark at 15 ft. (4.5 m.) from the ground and something like 75 ft. (23 m.) in total height, and would have contained about 150 true cubic feet (42 cu. m.) of timber. The 30 ft. (9 m.) long butt log, weighing about 2½ tons (2.5 tonnes), was sawn (FIG. 7, b) usually into four rafters and a number of off-cuts, some of which were made into collars and scissors. The upper, more crooked and knotty, parts of the tree provided the ashlars, sole-pieces, and other timbers (FIG. 7, e, f).

The roofs of the S. and W. ranges differ little, but there are fewer waney timbers, especially among the collars and scissors. In all probability these roofs were cut from trees of the same shape and size as those of the church, but because the timbers are shorter and of smaller scantling, more could be got out of a tree and fewer were waney. The principal joists of the S. range floor are each cut from a whole tree slightly smaller than the average of those that went into the church roof.

NUMBER OF TREES USED

The analysis of the surviving timbers indicates that the average oak used in the church provided the materials for approximately two complete roof-trusses. By a similar argument we must allow three roof-trusses to an oak in the other buildings.

At a minimum estimate, the church must have had a choir somewhat longer than the present one of twenty-two trusses, plus a nave at least as long as the choir, plus a roof over the crossing — a total of not less than sixty trusses. The three cloister ranges, whose exact dimensions are known, must have had a total of about 170 trusses, a third of which survive. A reasonable allowance — three-quarters of the content of the roof — must also be made for the timber used in floor-joists, floorboards, and partitions. We must also allow for the vanished roofs of the aisles and transepts.

This list of buildings accounts for the following number of trees:

Nave, crossing, and choir roofs (60 trusses)	30
+ wall-plates, etc.	2
Roof of three cloister ranges (170 trusses)	57
+ wall-plates, etc.	3
Internal timbers of cloister ranges	42
Roofs of aisles and transepts	16
	150 trees

This is the minimum quantity of timber needed to complete the buildings that survive. In practice the church is unlikely to have been as short as we have

proposed, and there should in addition have been an infirmary range similar to the one that survives at the Bristol Blackfriars. A plan of Gloucester in 1782[16] and J. G. Buckler's plan of 'the Remains of the Black-Friars Monastery' in 1820[17] show a building in the position to be expected of an infirmary; it would have been large enough to have had about forty trusses. If we add twenty-four oaks for the timbers of the infirmary and fifteen for a longer church we get a more realistic total of 189 trees.

Taking into account the possibility of further structures, such as a crossing-steeple, for which no evidence survives, we conclude that the original permanent buildings are likely to have required between 160 and 210 oaks of the size proposed.

ORIGIN OF THE TREES

The Close and Liberate Rolls record the following gifts of oaks (*quercus*)[18] by Henry III to the Friars Preachers of Gloucester (entries in the Close and Liberate Rolls are distinguished by the letters C and L, followed by page-references to the published calendars for the appropriate years):

1241 5 oaks from the Forest of Dean for timber for the works of the friars' church (*ad maeremium ad operationes ecclesie sue*) (C, 310).

1242 6 oaks from the Forest of Dean for the works of their precinct (*ad operacionem claustri sui*) (C, 392). *Contrabreve* to the sheriff of Gloucester to carry them to the Friary (L, 107).

1242 6 oaks from the Forest of Dean, where they can most conveniently be allocated (*ubi commodius ipsis poterunt assignari*) (C, 425).

1243 15 oaks from the Forest of Dean for timber, with all their by-products, for the fabric of their church and the construction of their houses, where they can most conveniently be got (*xv quercus ad maeremium cum omnibus exkaetis suis ad fabricam ecclesie sue, et ad constructionem domorum suarum, ubi commodius et vicinius capi possint ad opus suum in predicta foresta*) (C, 133). *Contrabreve* to the sheriff of Gloucester to carry them to the Friary (L, 196).

1245–6 10 oaks from the Forest of Dean to be felled and transported to the Friary by the sheriff of Hereford (*contrabreve* cancelled because repeated the following year) (L, 318, 68).

1255 6 good oaks from *Syrelet* [Forest of Shirlet near Much Wenlock] for timber for the works of their church (*ad maeremium ad operaciones ecclesie sue*) (C, 92).

1256 5 oaks from the Forest of Dean for timber with by-products (*ad maeremium cum escaetis suis*) (C, 339).

1256 5 oaks from the Forest of Gillingham [Dorset] for timber with by-products (C, 339).

1257 10 oaks from the Forest of Gillingham for timber, where they can most easily be got because of the transport (*ubi commodius ad opus suum capi poterunt propter cariagium*) (C, 95–6).

1260 4 oaks from the Forest of Dean for timber, where they can most easily be got (C, 289–90).

1265 10 oaks from the Forest of Dean for timber with by-products (reduced from 12 oaks after the Battle of Evesham) (C, 57, 70).

The following other royal benefactions are relevant:

1241 20 marks for buildings (L, 27); 10 marks for the works of their church (L, 57).

1244 20 marks *ad se hospitandos* (L, 221); 20 marks for the fabric of the church (L, 274).

1246 41 marks to buy a plot to build their church and widen their churchyard and to have a way to the High Street of Gloucester (L, 65).
1252 5 marks for transporting timber (L, 90).
1254 (C, 61), 1262 (C, 71), 1280 (C, 10), 1284 (C, 267) Total of 24 *robora* [big trees unsuitable for timber] for fuel.

The main building work had evidently begun by 1241; it went on intermittently at least until 1265. The building of the church spanned at least the years 1241–1255.

Henry III was in the habit of bestowing oaks on his subjects and on corporate bodies out of piety or gratitude or for reasons of state. Between 1228 and 1267 the records appear to be fairly complete. The list totals eighty-two oaks, of which sixty-one came from the Forest of Dean, six from Shirlet, and fifteen from Gillingham. Gillingham is at least 60 miles away, mainly by road; such distances, common in transactions of the kind, show that medieval transport arrangements were not quite so bad as is sometimes supposed.

The eighty-two recorded oaks of the king's gift account for perhaps rather less than half the timber that the buildings are likely to have required. Of course the friars may have had unrecorded royal gifts and have got timber from elsewhere. They must also have had temporary buildings and falsework, but they are likely to have used the royal oaks for their more important and permanent structures, and especially for the great timbers of the church roofs.

The peculiarities which we have noted in the structure are readily explained if much of the timber came from the royal Forests, especially the Forest of Dean. In the 13th century big oaks were very expensive and were often transported long distances for special purposes.[19] The Forests, with their wood-pasture systems of land-use, were different from the woods and hedges that provided the timber for ordinary buildings. Some Forests, including Dean, were particular sources of outsize trees, and royal gifts often consisted, as here, of small numbers of large oaks.[20] The friars undoubtedly used trees of this kind because that was what the king chose to give them. Getting the timber and transport free, they would hardly have grudged the cost of lengthwise sawing: indeed a parallel benefaction to the sister house specifies that the oaks were to be felled, *carpentered*, and carried to Bristol at the king's expense.[21] But although the structure is made from needlessly large and costly oaks, it contains many indications of economy in their use. The presence of off-cuts and of very waney and crooked timbers suggests that the friars were obliged to get as much roofing as possible out of each consignment of timber. The occasional rafters scarfed together out of short lengths show that they eked out odds and ends to make an extra truss, not knowing when the royal bounty would favour them again.

The form of the Blackfriars oaks strongly suggests that they are *Quercus petraea*, said to have been formerly the common species of oak in the Forest of Dean.[22] They are the last evidence of Dean in its more or less natural state, before the iron industry of the later 13th century began a series of silvicultural changes which have continued ever since.

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NOTE

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NOTES

[1] C. F. R. Palmer, *Archaeol. Jnl.*, XXXIX (1882), 296–306.
[2] W. H. Knowles, *Trans. Bristol and Gloucester Arch. Soc.*, LIV (1932), 167–201.
[3] W. Leighton, ibid., LV (1933), 151–90.
[4] C. Hewett, *English Cathedral Carpentry* (London, 1974).
[5] Ibid.
[6] C. Hewett, *The Development of Carpentry 1200–1700* (Newton Abbot, 1969). A similar scarf (though with the butts splayed rather than under-squinted), once again strengthened with nails, occurs in the rafters of a 13th-century roof at Cogges Priory, Oxon. (J. Blair's observation).
[7] Oliver Rackham's observation.
[8] See note 3.
[9] Hewett op. cit. in note 6, Fig. 11.
[10] J. M. Fletcher and C. A. Hewett, *Medieval Archaeol.*, XIII (1969), 220–24.
[11] A worked timber normally has four plane surfaces meeting in four corners called *arrises*. If one or more arrises are rounded through meeting the curved outside of the log, the timber is said to be *waney*.
[12] O. Rackham in M. H. Morris and F. H. Perring, *The British Oak* (Faringdon, 1974), 62–79; O. Rackham, *Trees and Woodland in the British landscape* (London, 1976), 74–7.
[13] *Cal. Close Rolls 1247–51*, 462.
[14] R. Reuter, quoted Hewett op. cit. in note 4, Fig. 5.
[15] Hewett op. cit. in note 4.
[16] Hall and Pinnell, reproduced in Knowles op. cit. in note 2, Fig. 2.
[17] Reproduced in Palmer op. cit. in note 1.
[18] The word implies an oak suitable for structural timber.
[19] O. Rackham, *Hayley Wood: its history and ecology* (Cambridgeshire and Isle of Ely Naturalists' Trust, 1975); and see note 12.
[20] C. E. Hart, *Royal Forest: a History of Dean's Woods as Producers of Timber* (Oxford, 1966); and see note 12.
[21] *Cal. Liberate Rolls 1240–45*, 27.
[22] E. W. Jones, quoted in H. J. Riddelsdell and others, *Flora of Gloucestershire* (Cotteswold Naturalists' Field Club, 1948), p. lxx.