Ancient Monuments Laboratory
Report 10/99

TREE-RING ANALYSIS OF TIMBERS FROM BOYES CROFT MALTINGS, GREAT DUNMOW, ESSEX

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Summary

This building complex represents a rare survival of an early commercial urban maltings. The seven-bay timber-framed structure investigated in this study had been dated on stylistic grounds to the period AD 1525-1575. The ring-width sequences obtained in dendrochronological samples were, with one exception, less than 60 years in length, but four timbers were dated. The estimated felling dates for these timbers suggest a date of construction between AD 1557 and AD 1580, or within a few years thereafter. This greatly reduces the date range for the building assessed on stylistic grounds.

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TREE-RING ANALYSIS OF TIMBERS FROM BOYES CROFT MALTINGS, GREAT DUNMOW, ESSEX

Introduction

The Boyes Croft Maltings (NGR TL 629221) are a grade II* building-at-risk (English Heritage 1998, 20), awaiting a programme of grant-aided repairs and conversion. English Heritage commissioned the dendrochronological study reported here to help inform this programme of works. The building consists of four identified phases of construction detailed in a publication by the Essex Historic Buildings Group dedicated to this site (Essex Historic Buildings Group 1994), from which much of the following information in this introduction is taken.

This building represents a rare survival of an early urban commercial maltings, showing various stages of development from the original build (Fig 1), thought on stylistic evidence to be in the mid- to late-sixteenth century, through to the twentieth century. The dendrochronological survey was restricted to the earliest phase, now represented by a seven-bay timber-framed building of two storeys. The roof of this part of the complex is of crown-post construction with thin braces to the collar purlin (Figs 2 and 3). Some trusses have braces to the tie beam, but these occur on one side only. The wallplates contain face-halved and bladed scarf joints with both blades housed (Essex Historic Buildings Group 1994) and it is partly these, along with the thin braces to the crown-post, that suggest the date on stylistic grounds. Other evidence includes the use of cambered tie beams, and arch-braced to fully jowled-and-chamfered storey posts.

Methodology

The site was visited in September 1998, at which time the building was not in use but was awaiting a programme of repairs and conversion in the near future. The timbers were inspected to assess their suitability for dendrochronological study, although this was made difficult from external appearances as most timbers were covered in lime wash. Suitable timbers are those with sufficient rings, usually at least fifty rings are sought in the first instance, with traces of sapwood where possible, in order to derive an estimated felling date range (see below).

Core samples were obtained using a 15mm auger attached to an electric drill. The cores were glued to wooden laths, labelled, and stored for subsequent analysis. The samples were prepared for measuring by sanding using an electric belt-sander with progressively finer grit papers down to 400 grit. Any further preparation necessary, eg where bands of narrow rings occurred, was done manually. Those samples with more than 40 annual rings were examined further, along with a shorter sequence, BCM24, known to have come from the same timber as another sample. Those which were deemed potentially useful, ie did not have distorted growth patterns, had their sequences measured to an accuracy of 0.01 mm using a specially constructed system utilizing a binocular microscope with the sample mounted on a travelling stage with a linear transducer linked to an Atari desktop computer. The software used in measuring and subsequent analysis was written by Ian Tyers (pers comm 1992).

Samples with less than 40 - 50 rings can only very rarely be reliably crossmatched and are generally rejected from further analysis. The exception to this is when two samples were taken from different parts of the same timber, when shorter sequences can often be satisfactorily visually matched.

Ring sequences were plotted on translucent semi-log graph paper to allow visual comparisons to be made between sequences on a light table. This activity also acts as a measure of quality control in identifying any errors in the measurements. Statistical comparisons were made using

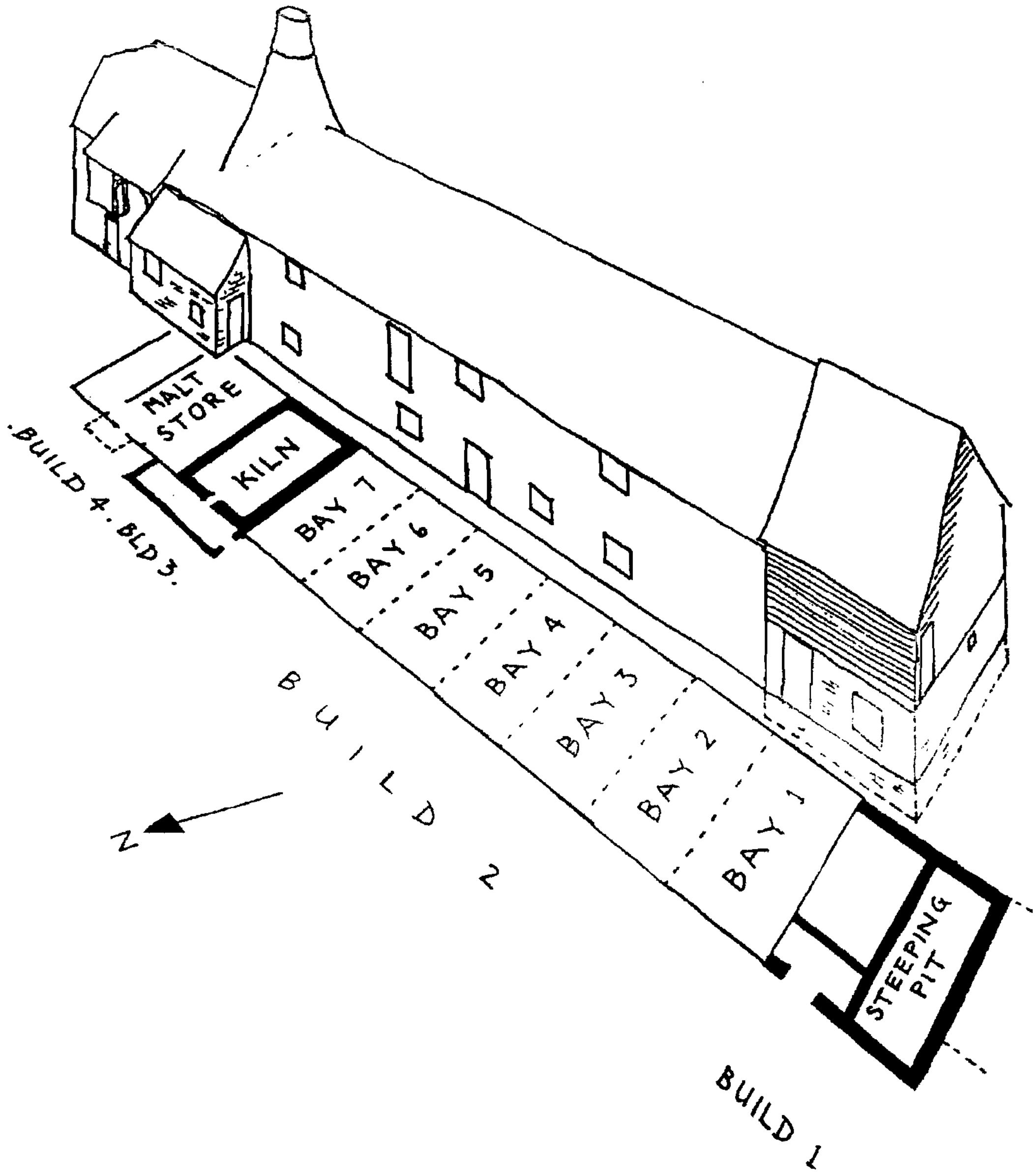

Figure 1: Key perspective and plan, Boyes Croft Maltings, Great Dunmow, Essex (Reproduced from Historic Buildings in Essex, No 8, 1994)

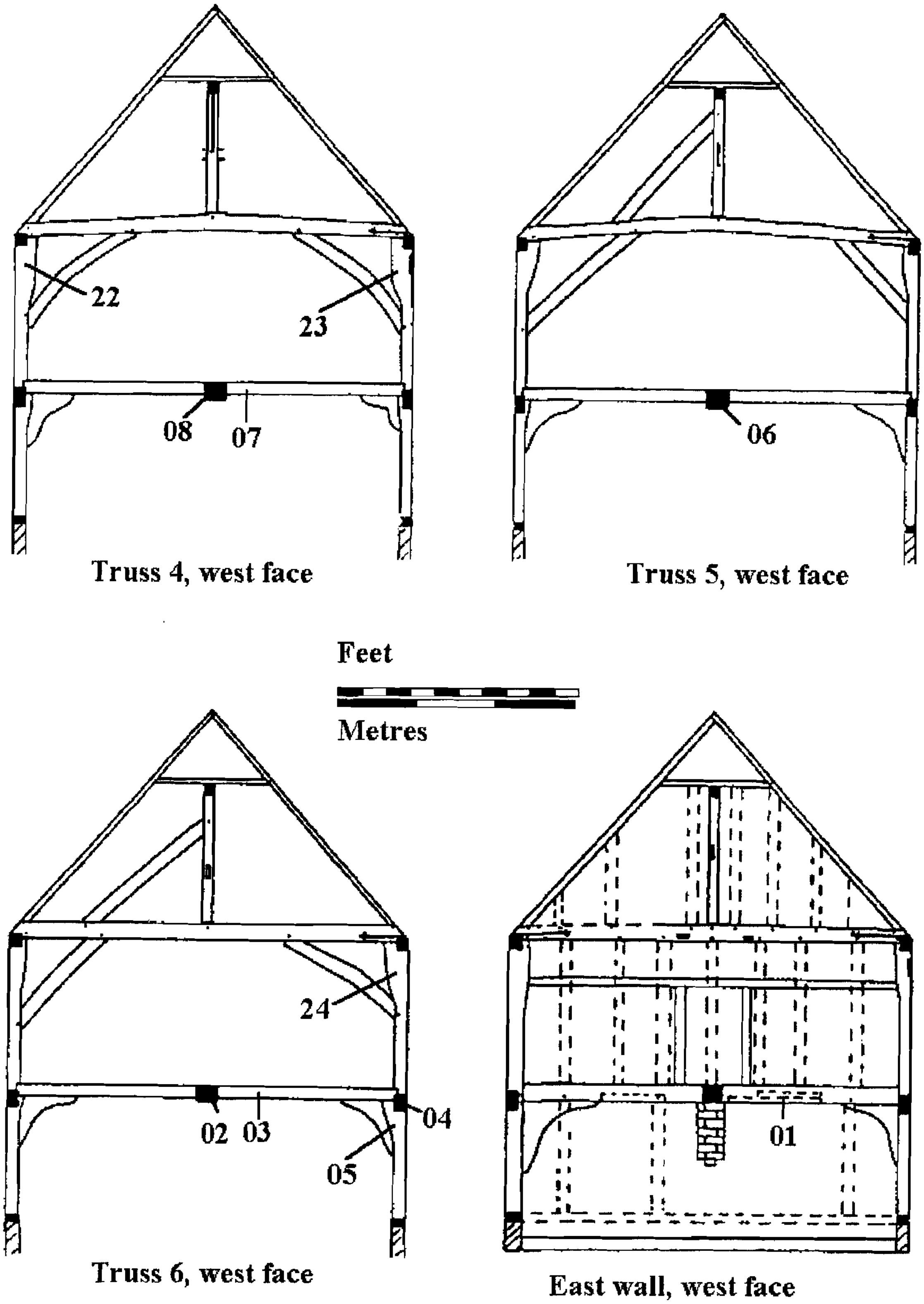

Figure 2: Drawings of the some of the trusses of Boyes Croft Maltings, Great Dunmow, Essex, showing locations of samples taken for dendrochronology (based on original drawings in Historic Buildings in Essex, No 8, 1994)

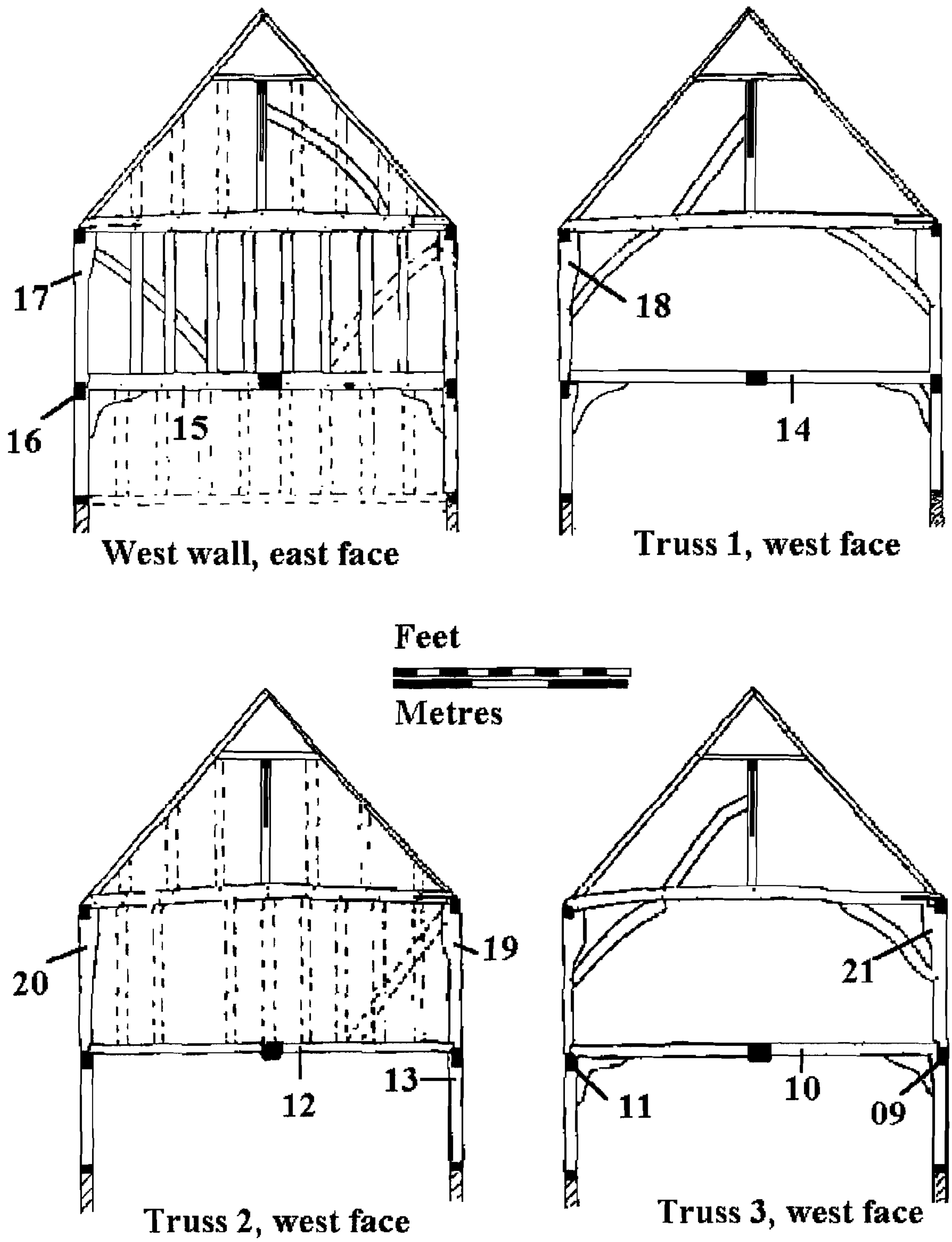

Figure 3: Drawings of the remaining trusses of Boyes Croft Maltings, Great Dunmow, Essex, showing locations of samples taken for dendrochronology (based on original drawings in Historic Buildings in Essex, No 8, 1994)

Student's *t*-test (Baillie and Pilcher 1973; Munro 1984). Any internal site mean sequences produced are then compared with a number of reference chronologies (multi-site chronologies from a region) and dated individual site masters in an attempt to date them. The *t*-values quoted below were derived from the original CROS program (Baillie and Pilcher 1973) in which *t*-values in excess of 3.5 are taken to be indicative of acceptable matching positions provided that they are supported by satisfactory visual matches (Baillie 1982, 82-5), and replicated at the same position against a number of independent sequences. Any timbers not included in the site mean are tested against it to see if they crossmatch, and are also compared with the reference material.

The dates thus obtained represent the time of formation of the rings available on each sample. Interpretation of these dates then has to be undertaken to relate these findings to the construction date of the structural phase under investigation. An important aspect of this interpretation is the estimate of the number of sapwood rings missing. In this instance, the sapwood estimates are based on those proposed for this area by Miles (1997), in which 95% of samples are likely to have from 9 to 41 sapwood rings. Where no sapwood is present, a date after which the tree must have been felled may also be of interest.

The dates derived for the felling of the trees used in construction do not necessarily relate directly to the date of construction of the roof or subsequent alterations or repairs. However, evidence suggests that, except in the re-use of timbers, construction in most historical periods took place within a very few years after felling (Salzman 1952; Hollstein 1965).

Results

Upon extraction of the cores it could be seen immediately that many of the timbers sampled had insufficient rings to be dated dendrochronologically using current methodologies. However, a number of cores did exhibit sufficient rings that it was considered worthwhile continuing with the sampling in the expectation of obtaining enough suitable cores to get some dating evidence.

All the timbers sampled were of oak (*Quercus* spp.) and details of their origin within the building, number of rings, and sapwood are given in Table 1, and illustrated in Figures 2 and 3. Two timbers were deliberately sampled at both ground-floor and first-floor level in an attempt to obtain the longest possible sequence. Although the sequences were relatively short, they were satisfactorily visually crossmatched, and the ring-width values for samples BCM05 and BCM24, and BCM13 and BCM19, were combined to produce new sequences for the south post to truss 6, and the south post to truss 2 respectively.

All sequences of more than 50 years were compared with a range of regional and individual site chronologies. Two sequences over 50 years in length yielded acceptable dates, the details of which are shown in Tables 2 and 3. The two sequences showed a low level of crossmatching (t = 2.7 with just 50 years of overlap). When the shorter sequences were analysed acceptable internal visual matches were found for samples BCM09 and BCM10. These sequences were also matched with the independent reference material (Table 4) and the consistent matches were deemed acceptable. Plots of these four sequences, showing their relative positions of overlap are shown in Figure 4. The four sequences from five samples were therefore combined into the 84-year site master (BOYES). This was also compared with a range of regional and individual site masters, the strongest matches being detailed in Table 5. The ring-width sequences for the dated series and those for undated series over fifty years long given in Table 6.

Table 1: Details of the samples taken from Boyes Croft Maltings, Great Dunmow,Essex. h/s = heartwood - sapwood boundary. Numbers in brackets after the total numberof years represent additional unmeasured rings. * The felling date range for BCM24 is based on sample BCM05 from the same timber

Sample no	Origin of sample	Total number of years	Average growth rate (mm yr^{-1})	Sapwood details	Date of sequence (AD)	Felling date of sequence (AD)
BCM01	East wall, girder beam	50 (+7)	2.65	h/s	unknown	unknown
BCM02	Bay 7, axial beam	37	not measured	-	unknown	unknown
BCM03	Truss 6, girder beam	25	not measured	-	unknown	unknown
BCM04	Bay 7, south middle rail	38	not measured	-	unknown	unknown
BCM05	Truss 6, south post	50 (+8)	2.45	h/s	1491 - 1540 (+8)	1549 - 1581
BCM06	Bay 6, axial beam	27	not measured	-	unknown	unknown
BCM07	Truss 4, girder beam	84	1.90	14	1470 -1553	1553 - 1580
BCM08	Bay 5, axial beam	20	not measured	-	unknown	unknown
BCM09	Bay 4, south middle rail	44	2.15	5	1510 - 1553	1557 - 1589
BCM10	Truss 3, girder beam	46	3.02	5	1502 - 1547	1551 - 1583
BCM11	Bay 3, north middle rail	37	unmeasured	7	unknown	unknown
BCM12	Truss 2, girder beam	52 (+9)	2.26	h/s	unknown	unknown
BCM13	Truss 2, south post	38	2.06	-	unknown	unknown
BCM14	Truss 1, girder beam	34 (+17)	not measured	17	unknown	unknown
BCM15	West wall, girder beam	23	not measured	-	unknown	unknown
BCM16	Bay 1, south middle rail	28	not measured	-	unknown	unknown
BCM17	South west corner post	24	not measured	2	unknown	unknown
BCM18	Truss 1, south post	34	not measured	6	unknown	unknown
BCM19	Truss 2, south post (= BCM13)	52	2.81	*c*9	unknown	unknown
BCM20	Truss 2, north post	23	not measured	-	unknown	unknown
BCM21	Truss 3, south post	*c*48	not measured	11	unknown	unknown
BCM22	Truss 4, north post	18 (+12)	not measured	12	unknown	unknown
BCM23	Truss 4, south post	42 (+6)	4.12	10	unknown	unknown
BCM24	Truss 6, south post (=BCM05)	36	2.55	-	1502 - 1537	1549 - 1581*

Table 2: Dating evidence for the oak sequence from the south post to truss 6 (BCM05/24M), Boyes Croft Maltings, Great Dunmow, Essex

	BCM05/24M AD 1491 - 1540	
Dated reference or site master chronology	***t*-value**	**overlap (yrs)**
Broomfield (Bridge 1997)	6.7	50
Gosfield (Bridge 1998a)	5.7	50
Wimpole 1 (Bridge 1998b)	5.1	50
Bruce 4 (Bridge 1998c)	4.9	50
Windsor kitchen (Hillam and Groves 1996))	4.7	50

Table 3: Dating evidence for the oak girder beam to truss 4 (BCM07), Boyes Croft Maltings, Great Dunmow, Essex

	BCM07 AD 1470 - 1553	
Dated reference or site master chronology	***t*-value**	**overlap (yrs)**
London 1175 (Tyers pers comm)	6.0	84
Bruce 4, London (Bridge 1998c)	5.4	84
Gosfield, Essex (Bridge 1998a)	4.1	68
Fenny, Bucks (Bridge unpubl)	3.7	83

Table 4: Dating evidence for series BCM09 and BCM10, Boyes Croft Maltings, Great Dunmow, Essex

	BCM09 AD 1510 - 1553		**BCM10 AD 1502 - 1547**	
Dated reference or site master chronology	***t*-value**	**overlap (yrs)**	***t*-value**	**overlap (yrs)**
London1175 (Tyers pers comm)	4.1	44	-	-
Sinai Park, Staffordshire (Tyers 1997)	6.3	44	4.7	46
Sutton House, London (Tyers and Hibberd 1993)	3.2	44	5.1	46
Wimpole, Cambridgeshire (Bridge 1998b)	4.7	44	4.1	46
Gosfield, Essex (Bridge 1998a)	4.6	44	-	-
Mamble, Hereford and Worcester (Tyers 1996)	4.5	44	4.0	46
Bruce 4, London (Bridge 1998c)	4.2	44	-	-

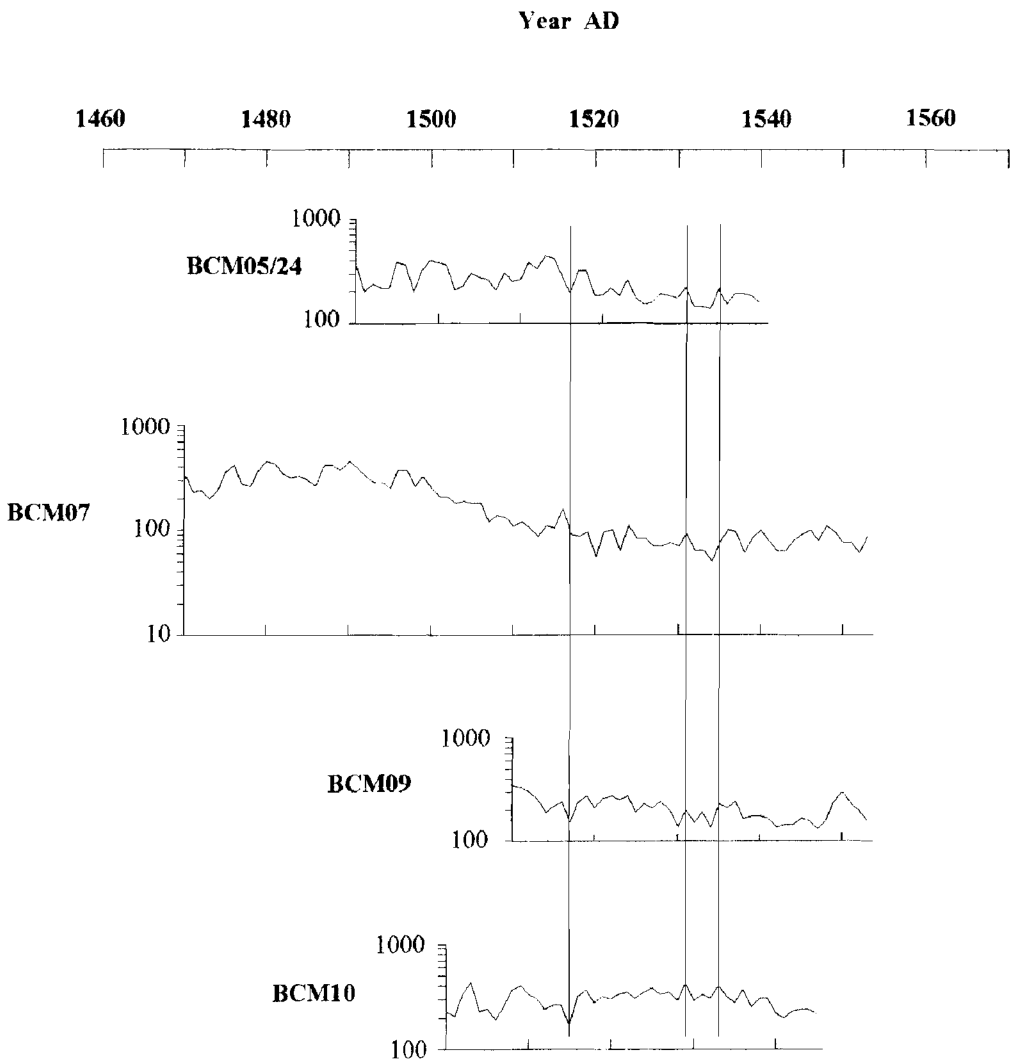

Figure 4: Plots of the dated oak series from Boyes Croft Maltings, Great Dunmow, Essex, showing their relative positions of overlap.

Table 5: Dating evidence for oak sequence from the site chronology (BOYES), Boyes Croft Maltings, Great Dunmow, Essex

	BOYES AD 1470 - 1553	
Dated reference or site master chronology	***t*-value**	**overlap (yrs)**
Hereford and Worcester (Siebenlist-Kerner 1978)	7.4	84
Hants 97 (Miles pers comm)	7.2	84
London 1175 (Tyers pers comm)	7.1	84
East Midlands (Laxton and Litton 1988)	6.6	84
Kent (Laxton and Litton 1989)	6.1	71
Sinai Park, Staffordshire (Tyers 1997)	9.1	84
Mamble B, Hereford and Worcester (Tyers 1996)	7.5	84
Mary Rose refit (Bridge unpubl)	7.1	66
Magdalen Laver, Essex (Tyers and Boswijk 1998)	6.7	84
Gosfield, Essex (Bridge 1998a)	5.9	84

Interpretation and Discussion

This building is unusual in that a number of sequences of less than 50 rings have been satisfactorily crossdated, although longer sequences help to anchor the dating. The internal crossmatching statistics are not strong, although very sound visual matches were made, and additional supporting evidence for dating the short individual sequences came from their consistent crossmatching with a number of independent chronologies. These results represent some of the shortest sequences datable by current dendrochronological methodology.

All the timbers sampled appeared to come from a single phase of construction with no evidence of timbers having been re-used in any way. Applying the sapwood estimate produced by Miles (1997) which is applicable to this region, the most likely felling date ranges of the two timbers coincide closely and cover the period **AD 1557 - 1580**. Assuming that construction took place within a short period after felling, this range, perhaps extended by a year or two into the 1580s, is likely to coincide with the date of construction. This information is valuable in that it narrows the previous dating on stylistic grounds, which covered a period of half a century, placing the date of construction in the latter end of that range.

One always has to express caution in interpreting a date for a small subset of samples as being truly representative of the whole population of samples taken; in this case, four timbers were dated, and it seems likely that their felling date range is representative of the remaining timbers because of the integrity of the building.

The timbers for a building of this type are most likely to be of local origin, and this is partially supported by the crossmatching evidence, some of the strongest matches with site chronologies being obtained with material from the region (Tables 2 and 3). This in itself should not be taken as proof of origin however (Bridge forthcoming), and good matches are also demonstrated with chronologies from a wider area. Many previous studies have shown that trees in this region are often of suitable size for constructional use within 50 to 70 years, and many of the timbers sampled here show proximity to the pith, as well as sapwood, within this age range.

Acknowledgements

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Table 6: Tree-ring data from the oak series from Boyes Croft Maltings, Great Dunmow, Essex

Year	ring widths (0. 01mm)	No of trees
BCM0524M		
AD1491	373 205 243 220 225 393 372 204 329 402	1 1 1 1 1 1 1 1 1 1
AD1501	391 379 209 235 314 279 266 218 310 261	1 2 2 2 2 2 2 2 2 2
	270 384 334 452 426 298 197 320 327 184	2 2 2 2 2 2 2 2 2 2
	185 220 186 270 174 152 161 195 189 181	2 2 2 2 2 2 2 2 2 2
	222 151 146 140 217 155 191 192 187 160	2 2 2 2 2 2 2 1 1 1
BCM07		
AD1470	362	
	233 242 203 244 379 434 282 266 388 478	
	449 358 327 338 312 265 422 428 388 467	
	400 340 298 294 260 382 385 269 346 263	
AD1501	212 210 184 199 185 190 122 141 133 110	
	121 108 90 111 106 160 93 88 99 55	
	98 100 64 112 86 84 72 70 77 71	
	95 64 66 52 76 102 97 63 84 100	
	81 65 64 83 95 102 83 113 98 78	
AD1551	77 62 89	
BOYES AD 1470 - 1553		
AD1470	363	1
	234 243 204 245 380 435 283 267 389 479	1 1 1 1 1 1 1 1 1 1
	450 359 328 339 313 266 423 429 389 468	1 1 1 1 1 1 1 1 1 1
	387 273 271 257 243 388 379 237 338 333	2 2 2 2 2 2 2 2 2 2
AD1501	302 302 204 254 314 245 225 193 253 273	2 4 4 4 4 4 4 4 4 5
	283 303 265 292 291 254 163 258 281 186	5 5 5 5 5 5 5 5 5 5
	214 229 206 256 186 198 199 209 205 174	5 5 5 5 5 5 5 5 5 5
	235 163 177 157 229 191 203 197 179 186	5 5 5 5 5 5 5 4 4 4
	185 143 137 155 171 171 146 139 173 192	3 3 3 3 3 3 3 2 2 2
AD1551	159 135 126	2 2 2

Table 6 continued: Tree-ring data from the dated short sequences and undated oak series of more than 50 years, Boyes Croft Maltings, Great Dunmow, Essex

Year	ring widths (0. 01mm)	No of trees
BCM09 AD 1510 - 1553		
1510	361	
1511	341 305 252 195 229 247 157 243 287 216	
	269 287 252 277 192 238 212 241 208 144	
	204 158 194 144 230 215 245 166 181 180	
	169 139 146 146 169 162 132 163 247 304	
1551	239 206 162	
BCM10 AD 1502 - 1547		
1502	239 214 346 443 233 247 192 259 369	
1511	412 333 314 250 267 268 168 317 364 288	
	330 314 341 351 304 361 388 342 361 291	
	429 292 332 308 404 325 288 364 263 304	
	304 224 200 235 248 248 221	
BCM01		
	356 490 347 299 377 284 253 337 295 349	
	282 247 177 215 257 458 806 421 330 308	
	321 246 170 180 228 177 166 198 141 229	
	139 136 192 157 140 142 236 152 163 195	
	285 261 264 292 268 277 202 202 338 257	
BCM12		
	286 190 153 164 199 296 223 273 206 254	
	315 251 172 92 135 165 279 241 178 110	
	92 77 127 323 300 287 312 163 232 399	
	258 231 326 237 239 235 186 190 308 444	
	316 251 213 215 193 167 166 213 196 180	
	209 259	
BCM13/19M		
	347 296 377 353 328 286 304 299 312 390	1 1 1 2 2 2 2 2 2 2
	548 503 353 221 222 165 189 164 187 128	2 2 2 2 2 2 2 2 2 2
	270 245 271 378 269 226 250 232 246 199	2 2 2 2 2 2 2 2 2 2
	165 123 140 165 105 103 113 120 191 178	2 2 2 2 2 2 2 2 1 1
	200 301 254 343 154 277 358 418 269 162	1 1 1 1 1 1 1 1 1 1
	167 204 295	1 1 1