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College Barn Mill Lane Chalgrove Oxfordshire

Tree-Ring Analysis of Elm Timbers

Martin Bridge and Cathy Tyers

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COLLEGE BARN
MILL LANE
CHALGROVE
OXFORDSHIRE

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SUMMARY
Nine elm timbers were sampled from the now converted College Barn, Chalgrove, Oxfordshire, as part of the *Developing the dendrochronology of elm in historic buildings* project. None of the ring-width series could be dated by comparison with oak reference sequences.

CONTRIBUTORS
Martin Bridge and Cathy Tyers

ACKNOWLEDGEMENTS
We are indebted to the owners for allowing the work to be carried out, and to the Oxfordshire Buildings Record, particularly David Clark, for assisting during fieldwork and for making their report on the building available for this study. Rachel Jacques made initial introductions to the owners.

ARCHIVE LOCATION
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DATE OF INVESTIGATION
2017–2019

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INTRODUCTION

The investigation of the elm timbers in College Barn contributes to an on-going research programme, *Developing the dendrochronology of elm in historic buildings*, funded by Historic England through its Heritage Protection Commissions programme, and led by Martin Bridge from the UCL Institute of Archaeology.

Developing the dendrochronology of elm in historic buildings

Ring-width dendrochronology of oak timbers from historic buildings in England is well established, with dating having been obtained on more than 3000 buildings (or parts thereof), with nearly one third of these having been funded by Historic England (and its predecessors). Dendrochronological evidence is a valuable component underpinning the discovery and identification of assets in the historic environment, aiding decisions relating to protection, management, and conservation, and enhancing appreciation and enjoyment of these buildings.

During this work on oak timbers, a significant amount of historic fabric constructed from timbers other than oak, most notably elm, has been identified, but this has previously been rejected as unsuitable for dendrochronological investigation. Elm in buildings has been identified in counties from Cornwall to Kent and up into the Midlands and beyond, but formal records of the presence of elm are scant as such buildings were generally dismissed for dating purposes and thus the presence of elm in the published record is rare. The inability to date historic buildings (or sections of buildings) constructed of elm by ring-width dendrochronology is seen as problematic in some areas of the country which have a comparatively high proportion of such buildings; buildings which nevertheless form a significant part of the historic environment but could not be afforded the same level of understanding in comparison to their oak counterparts.

Prior to the start of this project, only four instances of dating elm by ring-width dendrochronology have been successful (Groves and Hillam 1997; Haddon-Reece *et al* 1989, 1990; Bridge and Miles 2015). Each of these studies involved matching elm with oak from the same site, although the Ashdon, Essex example matched oak chronologies over a wide area (Bridge and Miles 2015). This project aimed to establish whether the use of standard ring-width dendrochronology could be extended to the dating of historic buildings in England where elm (*Ulmus* sp.) is the sole, or predominant species used rather than oak (*Quercus* sp.). A systematic approach was adopted concentrating on elm in the geographical areas where it is most commonly found. Buildings were thus sought that contained a significant number of elm timbers with sufficient numbers of rings that might be matched against either oak timbers in the same building or oak chronologies from the surrounding area (Fig 1).

An article will summarise the overall outcomes of the project (Bridge and Tyers forthcoming). However, each building sampled for dendrochronology has an associated building survey report or similar publication, whilst the primary archive of the dendrochronological analysis is reported in the Historic England Research Report Series.

College Barn

College Barn forms the southern end of the Grade II listed building (List Entry Number 1059741), the northern end of which is Great Barn (Bridge and Tyers 2019). It is one of several buildings dendrochronologically investigated as part of the *Developing the dendrochronology of elm in historic buildings* project. It sits on the western fringe of the village of Chalgrove (Fig 2). The barn has been converted for domestic use, but formed one of a group of agricultural buildings formerly belonging to Manor Farm. Both buildings have been studied by the Oxfordshire Buildings Record, and much of the following information comes from their report on College Barn (OBR 2017). The trusses (other than the south end truss) consist of a deep tiebeam supported by 'gunstock' jowled posts and straight arch braces (Fig 3). The apexes of the principal rafter pairs are hidden. The upper collars clasp the top tier of purlins, while the lower purlins are trenched into the backs of cranked inner principals and clasped by the outer principals. The inner principals are supported by raking struts from the tiebeam. The northern truss within College Barn forms the junction with the neighbouring Great Barn. It seems to be of queen-post construction and was weathered on its southern face, suggesting it was once the southern limit of Great Barn and indicating a later construction date for College Barn. A chimneystack was inserted at the junction between the two barns during the conversion to domestic use in the late twentieth century.

All timbers are of heavy scantling and there are chiselled assembly marks, which appear to number the joints rather than the trusses. The posts and tiebeams were shaped with an axe from whole trunks and have chamfered edges, while the braces are wide planks, pit-sawn from other trunks.

METHODOLOGY

Fieldwork was carried out in August 2017, following an initial assessment of the potential for elm dendrochronology some weeks beforehand. In the initial assessment, based on the general criteria used for oak timbers, accessible elm timbers with more than 50 rings and where possible traces of sapwood were sought, although slightly shorter sequences may be sampled if little other material is available. Those timbers judged to be potentially useful were cored using a 16mm auger attached to an electric drill. The cores were labelled, and stored for subsequent analysis.

The cores were polished on a belt sander using 80–400 grit abrasive paper to allow the ring boundaries to be clearly distinguished. The samples had their tree-ring sequences measured to an accuracy of 0.01mm, using a specially constructed system utilising a binocular microscope with the sample mounted on a travelling stage with a linear transducer linked to a PC, which recorded the ring widths into a dataset. The software used in measuring and subsequent analysis was written by Ian Tyers (2004). Cross-matching was attempted by a combination of visual matching and a process of qualified statistical comparison by computer. The ring-width series were compared for statistical cross-matching, using a variant of the Belfast CROS program (Baillie and Pilcher 1973). Ring sequences were plotted on the computer monitor to allow visual comparisons to be made between sequences. This method provides a measure of quality control in identifying any potential errors in the measurements when the samples cross-match.

In comparing one oak sample or site master against other samples or chronologies, *t*-values over 3.5 are considered significant, although in reality it is common to find demonstrably spurious *t*-values of 4 and 5 because more than one matching position is indicated. For this reason, dendrochronologists prefer to see some *t*-value ranges of 5, 6, and higher, and for these to be well replicated from different, independent chronologies with both local and regional chronologies well represented, except where imported timbers are identified. Where two individual oak samples match together with a *t*-value of 10 or above, and visually exhibit exceptionally similar ring patterns, they may have originated from the same parent tree. Same-tree matches can also be identified through the external characteristics of the timber itself, such as knots and shake patterns. Lower *t*-values however do not preclude same tree derivation. Threshold values for elm samples are as yet unknown, but are likely to be of similar value.

Ascribing felling dates and date ranges

Once a tree-ring sequence has been firmly dated in time, a felling date, or date range, is ascribed where possible. With samples which have sapwood complete to the underside of, or including bark, this process is relatively straightforward. Depending on the completeness of the final ring, ie if it has only the spring vessels or earlywood formed, or the latewood or summer growth, a precise felling date and season can be given. If the sapwood is partially missing, or if only a heartwood/sapwood transition boundary survives, then an estimated felling date range can be given for each sample. In oak, the number of sapwood rings can be estimated by using an empirically derived sapwood estimate with a given confidence limit. If no sapwood or heartwood/sapwood boundary survives then the minimum number of sapwood rings from the appropriate sapwood estimate is added to the last measured ring to give a *terminus post quem* (*tpq*) or felled-after date.

A review of the geographical distribution of dated sapwood data from historic oak timbers has shown that a sapwood estimate relevant to the region of origin should be used in interpretation, which in this area is 9–41 rings (Miles 1997). The equivalent values for elm are as yet unknown, but the results of this project suggest that the range of the number of sapwood rings in elm timbers is likely to be much lower. One problem that has been encountered in considering elm is that it has often proved very difficult to determine the position of the heartwood/sapwood boundary, even when it is known that the complete sapwood is present on a timber. It must be emphasised that dendrochronology can only date when a tree has been felled, not when the timber was used to construct the structure or object under study.

RESULTS AND DISCUSSION

Details of the samples taken are given in Table 1, with sample locations being shown in Figure 4. The measurements for the samples are given in the Appendix. Two samples were taken from each of timbers cbch04, cbch06, and cbch09, to extract maximum information with regard to sapwood and total number of rings. These were each combined to form a representative series for each timber before further analysis was carried out.

No acceptable cross-matching was found between the individual timber series, one statistical cross-match between cbch05 and cbch09 being dismissed as there were only 35 rings overlap, and the match, if accepted, would suggest very different felling dates for the two timbers. Individual series were compared with the oak database, but no consistent acceptable matches were found, and the timbers remain undated.

As in many other elm sites in this project, a number of timbers were noted as having complete sapwood at the time of sampling, but the heartwood-sapwood boundary was impossible to determine visually under magnification, so the number of sapwood rings could not be determined.

The Oxfordshire Building Record speculates that the likely date of this barn is mid-eighteenth century.

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TABLE

Table 1: Details of the samples taken from College Barn, Chalgrove, Oxfordshire (trusses numbered from the south end)

Sample number	Timber and position	No of rings	Mean ring width	Sapwood rings	Mean sensitivity
cbch01	Tiebeam, truss 3	102	1.87	+4CNM	0.35
cbch02	West post, truss 3	<30	NM	-	-
cbch03	West post, truss 4	47	2.89	+8CNM	0.34
cbch04	Tiebeam, truss 4 (mean of 4a, 4b)	33	3.80	-	0.32
cbch04a	*ditto*	33	3.28	-	0.32
cbch04b	*ditto*	24	5.11	-	0.36
cbch05	Tiebeam, truss 2	56	2.94	+2CNM	0.27
cbch06	Stud in west wall, bay T1-T2	114	0.92	?h/s	0.20
cbch06a	*ditto*	114	0.94	?h/s	0.24
cbch06b	*ditto*	101	0.93	-	0.20
cbch07	Tiebeam, truss 1	68	1.42	?h/s	0.41
cbch08	East post, truss 2	119	1.40	C	0.32
cbch09	East post, truss 3	100	1.20	?C	0.29
cbch09a	*ditto*	99	0.99	?C	0.31
cbch09b	*ditto*	73	1.70	-	0.35

Key: NM = not measured; C = complete sapwood, winter felled; h/s = heartwood-sapwood boundary

FIGURES

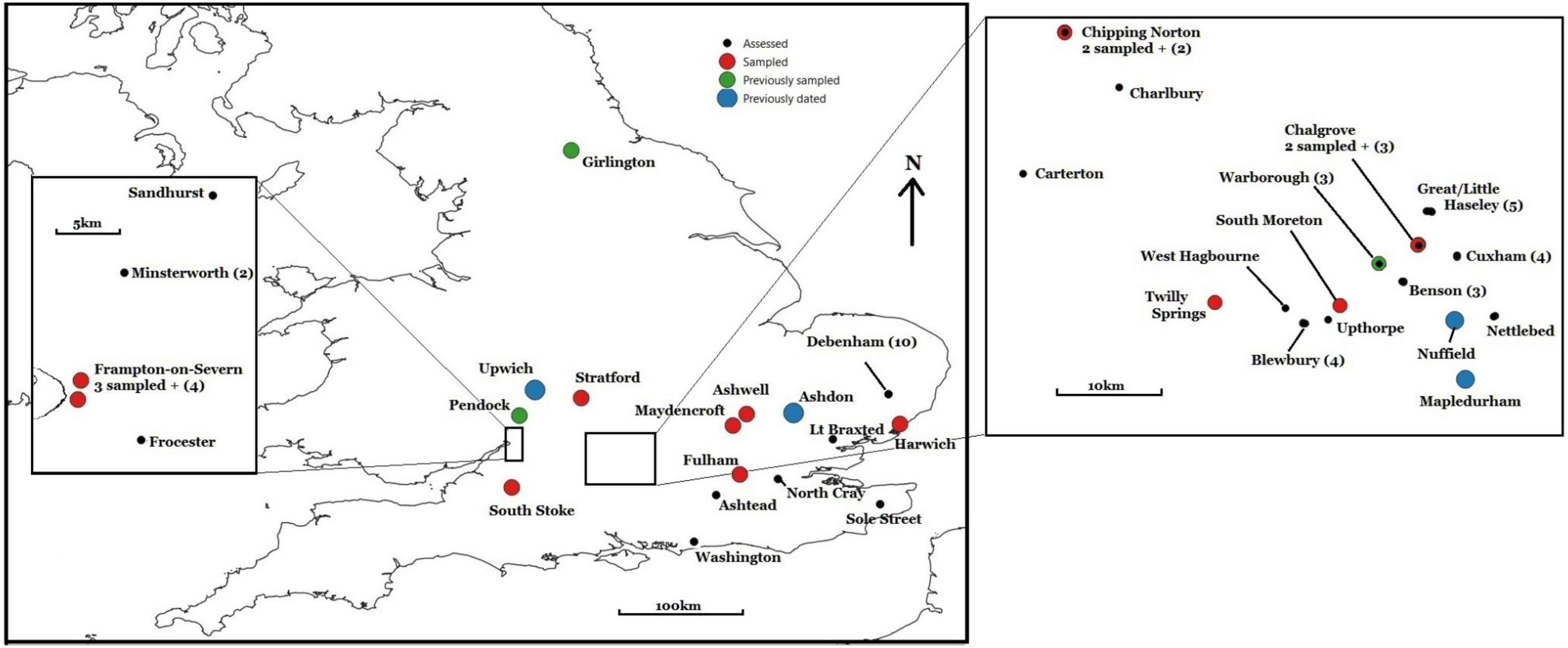


Figure 1: Map showing the distribution of sites sampled, some of which were dated, prior to the start of this project, and sites assessed and sampled properties for this project. Numbers in brackets after a place name represent the number of properties assessed in that location

Figure 2: Maps to show the location of College Barn (Barn at Manor Farm) in Chalgrove circled. Scale: top right 1:2000; bottom 1:1000. © Crown Copyright and database right 2020. All rights reserved. Ordnance Survey Licence number 100024900. © British Crown and SeaZone Solutions Ltd 2020. All rights reserved. Licence number 102006.006. © Historic England.

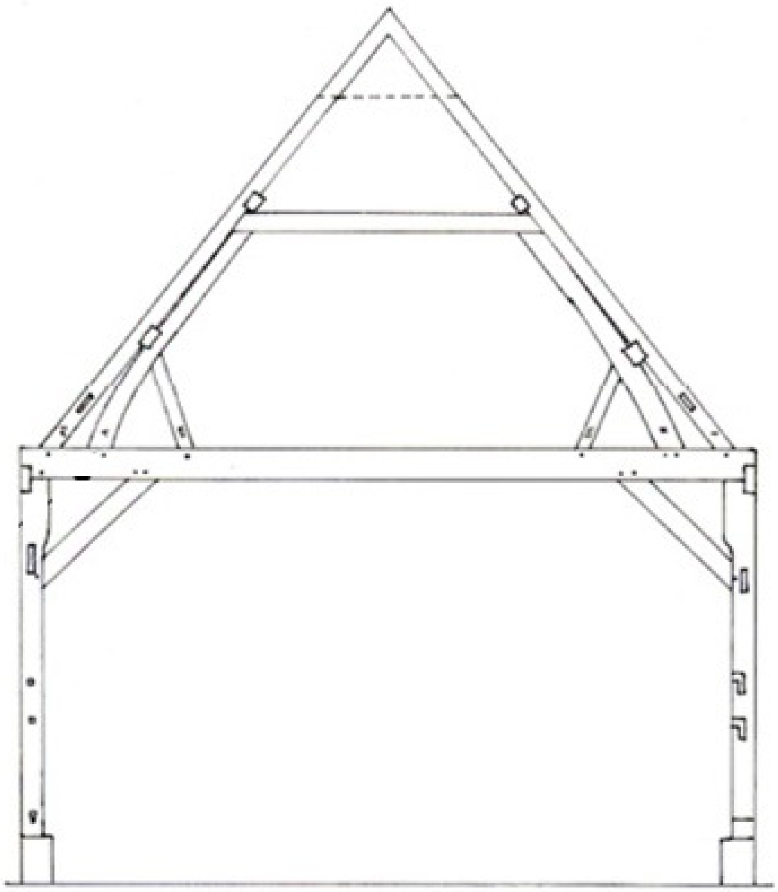


Figure 3: Drawing of a typical truss in College Barn, after Oxford Buildings Record report no.310 (2017)

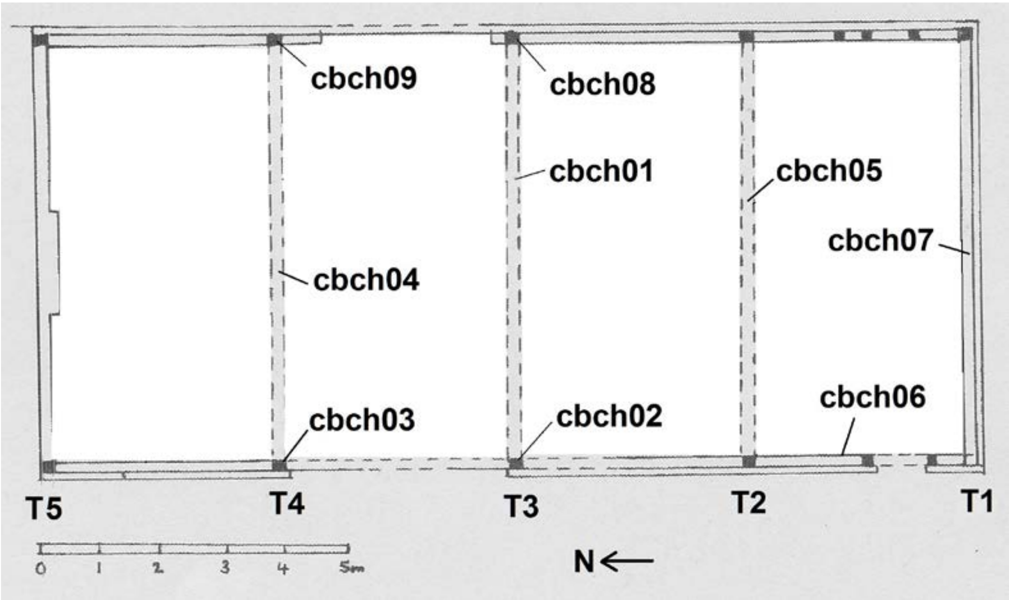


Figure 4: Sketch plan of the barn, showing the approximate locations of samples taken after Oxford Buildings Record report no.310 (2017)

APPENDIX

Ring width values (0.01mm) for the sequences measured

cbch01

306	346	293	200	173	247	109	140	157	165
275	186	141	169	226	425	432	322	267	463
387	283	362	281	141	91	161	177	288	265
121	60	48	42	143	187	247	184	244	196
242	301	427	369	137	103	106	64	51	66
71	86	82	175	239	188	421	98	42	44
70	131	76	114	118	336	570	324	524	469
79	52	53	64	60	76	74	64	92	53
68	37	31	45	27	33	64	35	36	40
41	81	365	259	338	300	273	183	225	291
268	349								

cbch03

499	388	526	371	439	347	284	325	272	420
348	615	363	281	267	213	90	69	74	145
179	270	229	115	144	317	240	208	249	170
298	238	250	138	288	451	298	518	677	781
265	90	95	165	162	158	241			

cbch04a

465	388	477	453	540	968	112	140	227	291
469	406	294	239	246	180	263	203	286	225
423	448	599	533	350	249	227	317	178	143
99	154	248							

cbch04b

469	262	566	591	576	709	176	141	171	294
425	485	137	267	384	270	316	582	719	671
939	823	1179	1119						

cbch05

519	286	254	171	173	163	135	143	126	284
355	381	360	357	359	327	312	322	71	88
287	197	188	227	250	267	140	227	99	114
149	262	302	426	297	341	273	379	217	140
205	181	183	253	227	289	365	461	402	602
763	732	679	535	277	323				

cbch06a

508	464	330	304	248	189	159	157	189	162
163	202	232	247	195	90	172	102	66	103
153	166	197	118	89	63	48	43	57	53
57	50	52	51	57	59	62	78	66	39
49	48	50	89	106	116	107	99	121	110
65	51	43	29	25	39	25	24	35	39
38	49	63	84	91	83	86	48	46	38
42	50	67	50	54	46	38	34	28	40
43	51	37	37	33	33	40	33	48	76

99	146	107	153	138	88	162	38	47	32
58	46	39	52	63	59	63	48	81	75
120	145	86	144						

cbch06b

566	522	348	276	241	196	130	143	186	152
106	129	156	166	106	111	170	98	58	120
155	148	228	96	96	40	39	39	36	38
35	37	35	33	35	34	44	82	80	54
75	78	92	92	95	84	92	72	94	67
52	53	34	39	39	28	26	35	35	42
47	60	62	83	116	74	84	69	53	57
52	60	71	51	68	66	58	46	53	63
62	49	42	41	51	53	50	49	56	95
95	84	65	97	109	86	138	77	67	67
55									

cbch07

75	83	286	288	544	540	243	196	53	55
113	148	330	273	87	120	309	337	504	337
384	403	101	82	46	42	50	37	41	60
108	95	58	52	30	29	70	37	30	56
84	103	126	110	101	96	58	62	41	49
90	353	208	234	52	44	49	68	108	91
67	57	96	86	181	53	50	205		

cbch08

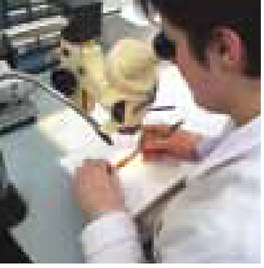
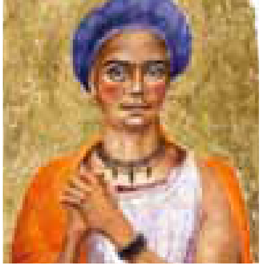
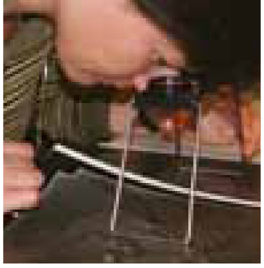
167	215	225	354	247	137	107	53	137	233
171	27	26	94	207	270	184	175	184	248
258	183	101	138	268	252	201	341	86	149
121	60	59	185	474	381	199	191	274	291
354	385	103	146	210	380	457	524	431	419
310	291	307	275	280	181	141	95	37	35
27	34	37	38	57	47	36	44	42	86
108	125	77	67	52	36	64	66	62	42
40	40	72	48	56	34	32	31	26	27
29	29	35	50	42	38	37	49	42	52
118	115	54	29	36	38	25	33	36	32
35	53	84	137	287	134	120	188	141	

cbch09a

89	142	79	145	102	100	110	75	126	170
263	192	149	171	96	91	145	71	55	52
95	110	50	81	90	64	75	95	103	256
134	133	60	95	68	83	279	145	105	167
254	160	157	153	92	67	161	122	192	190
262	277	166	124	224	84	50	44	36	37
36	29	29	37	48	51	34	44	47	56
39	32	40	44	37	33	34	34	55	87
79	118	44	39	168	54	68	64	64	67
56	56	47	56	69	69	73	96	116	

cbch09b

77	146	102	159	94	197	216	134	115	239
368	463	478	479	185	175	296	199	170	124
175	209	97	58	154	119	110	138	279	238
288	190	140	86	104	233	129	254	131	85
95	250	128	171	190	127	104	164	165	273
315	308	331	198	229	276	122	86	90	82
73	74	68	66	108	147	222	49	56	49
57	52	71							

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