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Apothecaries' Hall, 10–18 Blackfriars Lane, City of London

Tree-ring Analysis of Pine Timbers from the Hall Roof

Martin Bridge

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SUMMARY

Four large pine timbers from the roof over the Hall were sampled. Three of the derived ring-width sequences matched each other and were dated, the fourth timber gave a long sequence that was not dated. The resulting site sequence dated to the period AD 1382–1666. It seems likely that the timbers were derived from a Scandinavian source, and that all three were felled at about the same time, probably in the late-seventeenth century. The roof is known to have been lost in the Great Fire of AD 1666, and there are records of rebuilding having been completed by AD 1672, suggesting that the timbers are from this phase.

CONTRIBUTORS

Dr M C Bridge

ACKNOWLEDGEMENTS

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Front cover photo Apothecaries Courtyard © Historic England.

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INTRODUCTION

The Apothecaries' Hall in Blackfriars, London (Figs 1 and 2) is Grade 1 listed and a Scheduled Ancient Monument. It was originally part of the Dominican priory of Black Friars called Cobham House prior to its purchase by the Worshipful Society of Apothecaries in AD 1632. The building was destroyed in the Great Fire of London in AD 1666 and a new hall was built on the same site and completed in AD 1672.

A major restoration and external building programme was carried out in the AD 1780s. Although the hall underwent further redevelopment in the 1980s, its appearance has altered little since the late-eighteenth century.

The roof over the main banqueting hall is externally modern but some seventeenth-century elements, or earlier, may survive (Fig 3). The potential replacement of this roof led to a request for dendrochronological work by Jane Sidell, English Heritage Inspector of Ancient Monuments, to ascertain dates for any surviving pre-eighteenth century roof timbers over the main banqueting hall and to provide dates for the development of the building as a whole.

METHODOLOGY

The timbers of the main banqueting hall roof and limited other areas were assessed in February 2013. In the initial assessment, accessible timbers with more than 50 rings and where possible traces of sapwood were sought, although slightly shorter sequences are sometimes sampled if little other material is available. This assessment revealed that four large pine timbers forming part of the roof over the main banqueting hall had potential for dating and were readily accessible. The secondary roof timbers were judged not to be suitable for dating, having too few rings. Those building timbers judged to be potentially useful were cored in April 2013, using a 15mm auger attached to an electric drill. The cores were glued to wooden laths, labelled, and stored for subsequent analysis.

The cores were polished on a belt sander using 80 to 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 a computer monitor to allow visual comparisons to be made. This method provides a measure of quality control in identifying any potential errors in the measurements when the samples cross-match.

In comparing one sample or site master against other samples or chronologies, *t*-values over 3.5 are considered significant, although in reality with pine timbers it is common to find much higher values than this. In oak, where two individual 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. In pine timbers the threshold value is higher, and *t*-values of 15 or above have been suggested as potentially suggesting same-tree samples (C Tyers pers comm).

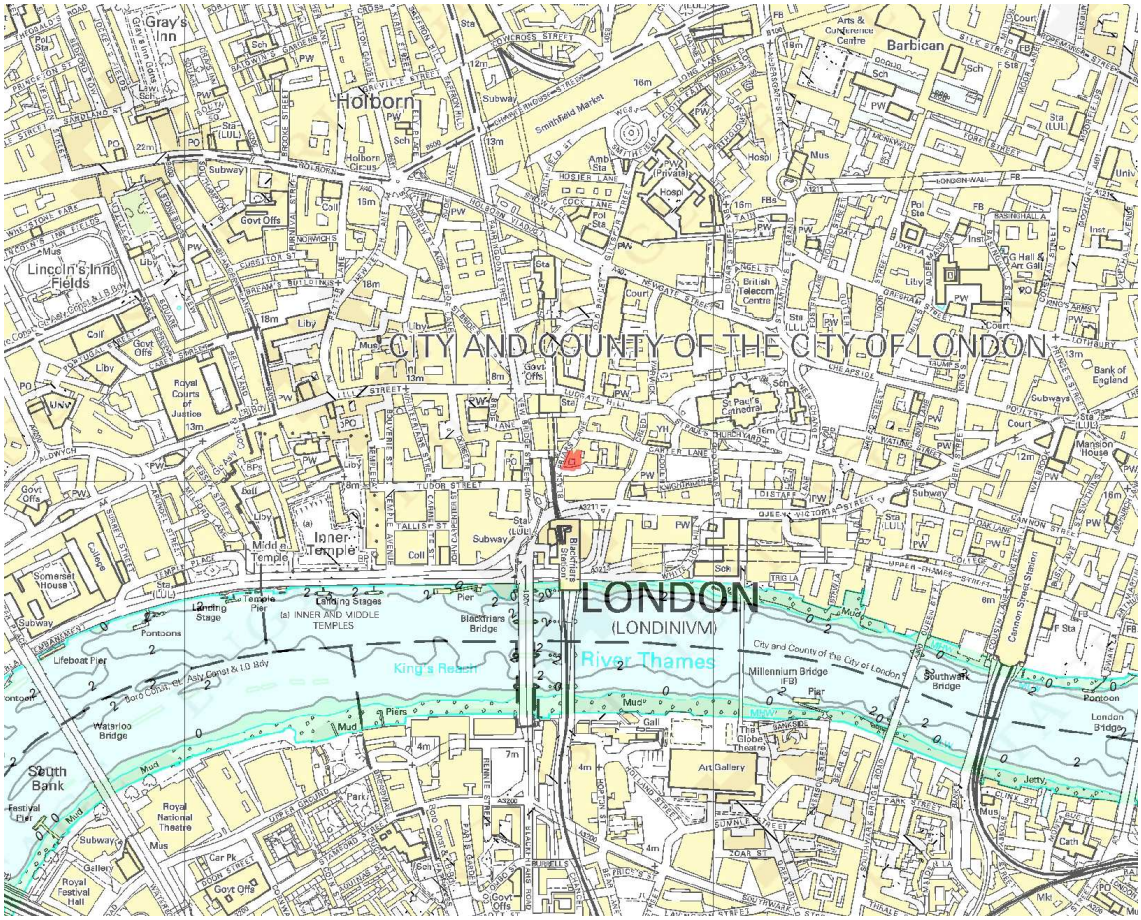

Figure 1: Map showing the location of the Apothecaries Hall – highlighted in red, in the wider London context. © Crown Copyright and database right 2015. All rights reserved. Ordnance Survey Licence number 100024900

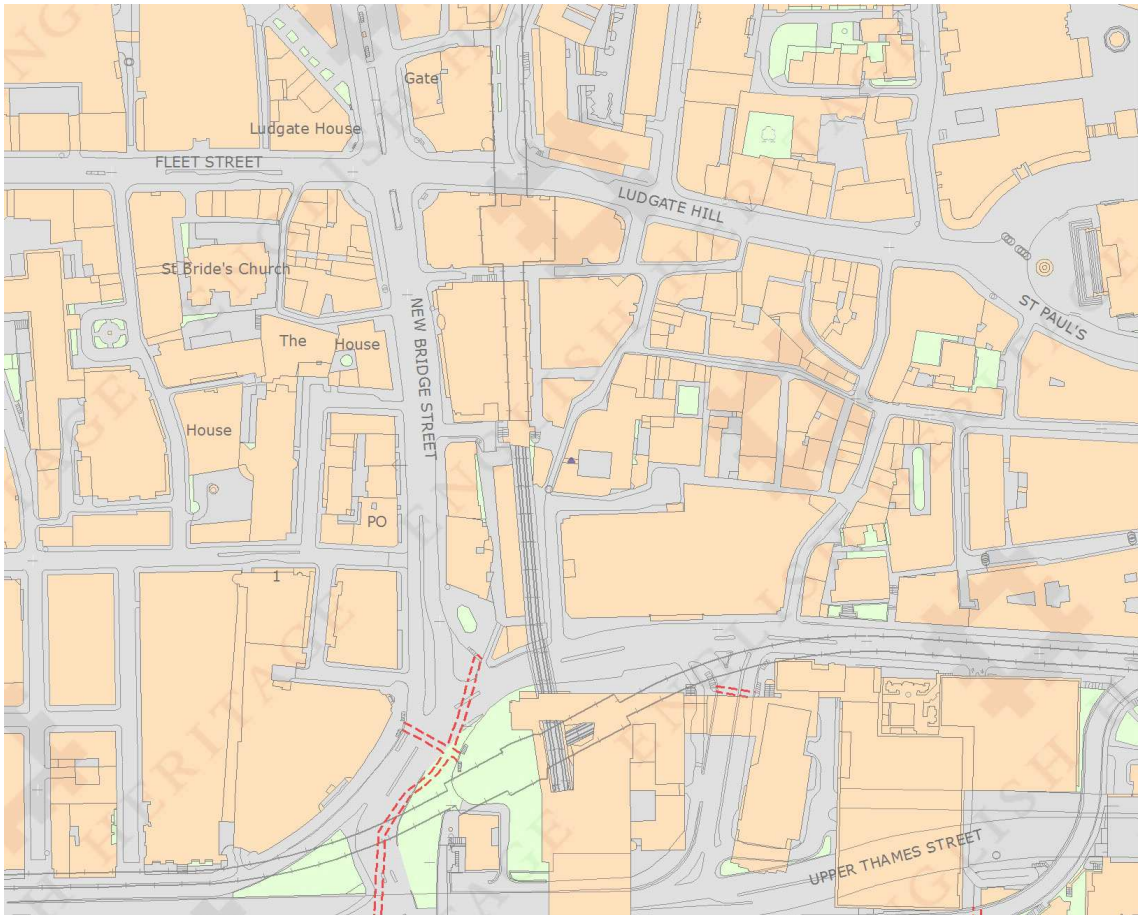

Figure 2: Map showing the location (centre) of the Apothecaries Hall. © Crown Copyright and database right 2015. All rights reserved. Ordnance Survey Licence number 100024900

Ascribing felling dates and date ranges

Once a tree-ring sequence has been firmly dated in time, a felling date, or felling date range, is ascribed where possible. With oak samples which have sapwood complete to the underside of, or including bark, this process is relatively straightforward. 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. 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.

Information gained by Cathy Tyers from European colleagues during the English Heritage pine dendrochronology project indicates that the number of sapwood rings in pines is highly variable between regions and periods and is strongly influenced by the age of the

trees (eg Zetterberg and Hiekkanen 1990). For instance, for pine the number of sapwood rings in northern Sweden tends to be over 100, but in the south (ie south of Stockholm) it is generally *c* 50±30 (Eggertson pers comm). In southern Norway it ranges from as few as 20 to over 100 depending on tree age (Bartholin pers comm), for example, a 100-year old tree has in the order of 30–70 sapwood rings, whereas a 200-year old tree has in the order of 45–110 sapwood rings. Alternatively if bark-edge survives, then a felling date can be directly obtained from the date of the last surviving ring. In some instances it may be possible to determine the season of felling according to whether the ring immediately below the bark is complete or incomplete. However the onset of growth can vary within and between trees and this, combined with the natural variation in actual ring width, means that the determination of felling season must be treated cautiously.

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. In the case of imported timbers there is as yet not much information about the periods involved between felling the trees, and their use in construction in buildings in this country, but the indications are that this period was actually remarkably short.

RESULTS AND DISCUSSION

All four timbers associated with the primary construction of the roof were sampled, two of them twice, in an attempt to maximise the length of the ring sequence (Table 1). All cores were measured. The timbers were not formally identified as pine, many softwoods having rather similar characteristics, but the later matching against reference chronologies strongly suggests that they are Scots pine (*Pinus sylvestris* L.).

The two series (apc04a and apc04b) from the beam at the northern end of the roof matched each other well (t = 11.4 with 93 years overlap) and these were combined to form a single 197-year sequence, apc04, used in the subsequent analysis. The two series (apc01a and apc01b) from the beam at the south end of the roof did not match conclusively and were therefore both used for subsequent analysis.

The series from all four timbers were compared with each other. The 224-year long series (apc02) from one of the timbers did not match the other series, and neither did it give acceptable matches against the dated reference material available, so this timber remains undated. Cross-matching was however found between the ring-width sequences from three of the timbers, although the level of matching was relatively low (Table 2). The dating of the individual sequences was therefore used to confirm this cross-matching by comparing each individual series with the available dated reference material, as well as comparing the 285-year long site chronology, APOTH, obtained by combining the series from these three timbers (Tables 3 a-d). The site chronology was dated to the period AD 1382–1666.

The relative positions of overlap of the dated samples are shown in Figure 4. The site chronology gives good consistent matches with Scot's pine reference chronologies from

Scandinavia, as well as other sites in Britain that used imported Scandinavian pine. The determination of sapwood in pines can be very difficult. One sample (apc04) had clearly distinguishable sapwood in its outer 36 rings, but this was less certain in the other timbers. As indicated above, sapwood numbers in Scandinavian pine can be highly variable, and thus interpretation of these findings is not straightforward, although it should be noted that whilst most of the outer edges of these timbers had been crudely fashioned, possibly with an axe, samples were taken in the most favourable areas where it was felt that there was a possible natural edge, representing the curvature of the outer part of the unconverted tree, or at least some sapwood. With sample apc03 having an outermost measured ring of AD 1666 and the presence of definite sapwood rings on sample apc04 (with a heartwood-sapwood boundary date of AD 1590, it would seem that these four large pine timbers are most likely components of the new roof constructed following the Great Fire of AD 1666. There are records that the new Hall was completed in AD 1672. For these timbers to be part of the later AD 1780s alterations, sample apc04 would have to have over 200 sapwood rings which is unlikely. These timbers, therefore, appear unlikely to be from the major restoration carried out in the AD 1780s, or subsequent alterations, although this remains a slim possibility.

Figure 3: View looking south showing three of the four large pine beams over the Hall (Martin Bridge)

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Table 1: Details of the samples taken from the roof of the Apothecaries Hall, City of London

Sample number	Timber and position	No of rings	Mean ring width (mm)	Dates spanning (AD)	Sapwood	Mean sens	Felling date ranges (AD)
apc01a	Southern-most major beam	200	1.31	1382–1581	?	0.16	after 1581
apc01b	*ditto*	73	0.56	-	?	0.14	-
apc02	Second beam from south end of roof	224	1.18	-	?	0.18	-
apc03	Third beam from south end of roof	196	1.03	1471–1666	?	0.19	after 1666
apc04a	Northern-most major beam	126	0.86	1501–1626	36	0.19	
apc04b	*ditto*	164	1.24	1430–1593	-	0.16	-
apc04	Mean of 04a and 04b	197	1.15	1430–1626	36	0.17	after 1626

Table 2: Cross-matching between dated samples

t-values		
Sample	apc03	apc04
apc01a	3.4	4.0
apc03		5.5

Table 3a: Dating evidence for the series apc01a AD 1382–1581

Reference chronology and origin	*t*-value	Span of chronology (AD)	Reference
Royal Academy - GB import	5.4	1393–1582	Tyers forthcoming
JemGrp03 - GB import	5.0	1367–1710	Groves and Locatelli 2005
Rangr-P1 - GB import	4.8	1246–1632	Tyers 2012
JemGrp02 - GB import	4.7	1328–1546	Groves and Locatelli 2005
SWED_HL1 - Sweden	4.5	1001–1861	Bartholin pers comm
SWED_UP1 - Sweden	4.4	1031–1638	Bartholin pers comm

Table 3b: Dating evidence for the series apc03 AD 1471–1666

Reference chronology and origin	*t*-value	Span of chronology (AD)	Reference
N007m005short - Norway	7.2	1479–1622	Daly pers comm
JemGrp03 - GB import	6.3	1367–1710	Groves and Locatelli 2005
SWED_UP1 - Sweden	6.1	1031–1638	Bartholin pers comm
JemGrp04 - GB import	5.9	1507–1700	Groves and Locatelli 2005
BromleyHall - GB import	5.7	1376–1686	Bridge 2015
99200010 - Norway	5.3	871–1986	Thun pers comm

Table 3c: Dating evidence for the series apc04 AD 1430–1626

Reference chronology and origin	*t*-value	Span of chronology (AD)	Reference
SWED_UP1 - Sweden	7.3	1031–1638	Bartholin pers comm
99200010 - Norway	6.0	871–1986	Thun pers comm
JemGrp03 - GB import	6.0	1367–1710	Groves 2005
BromleyHall - GB import	5.8	1376–1686	Bridge 2015
SWED_HL1 - Sweden	5.6	1001–1861	Bartholin pers comm
Rangr-P1 - GB import	5.5	1246–1632	Tyers 2012

Table 3d: Dating evidence for the site series APOTH AD 1382–1666

Reference chronology and origin	*t*-value	Span of chronology (AD)	Reference
SWED_UP1 - Sweden	8.7	1031–1638	Bartholin pers comm
N007m005short - Norway	7.2	1479–1622	Daly pers comm
JemGrp03 - GB import	7.0	1367–1710	Groves and Locatelli 2005
99200010 - Norway	6.7	871–1986	Thun pers comm
SWED_STK - Sweden	6.2	1127–1671	Bartholin pers comm
SWED_DAL - Sweden	5.8	1001–1852	Bartholin pers comm

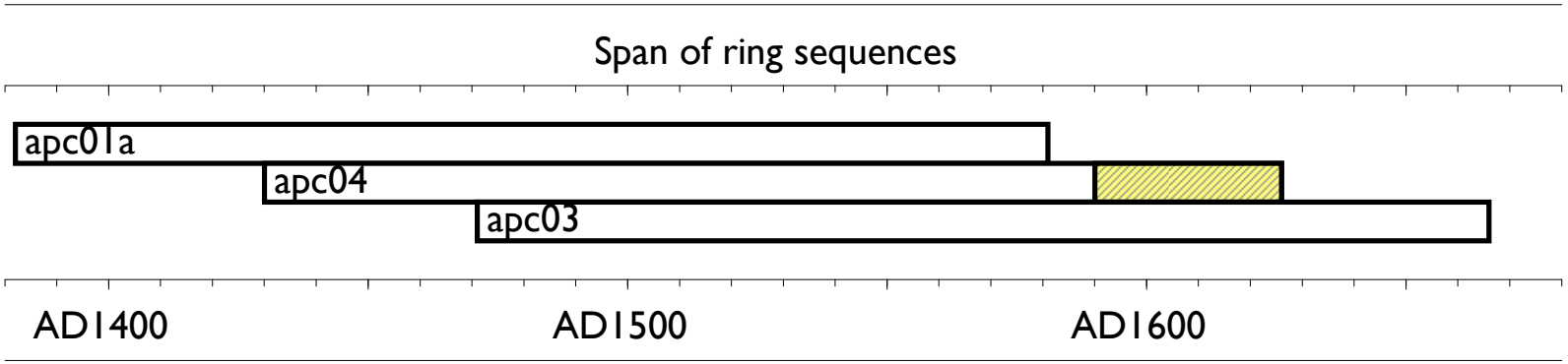

Figure 4: Bar diagram showing the relative positions of overlap of the dated pine sequences. White bars represent heartwood rings and the yellow hatched section represents positively identified sapwood rings

APPENDIX

Ring width values (0.01mm) for the sequences measured

APC01a

216	211	147	195	173	220	183	182	130	134
180	216	193	197	264	200	225	221	167	139
181	135	118	135	172	140	164	172	152	192
169	168	177	167	115	109	100	93	127	139
148	145	187	140	178	188	159	133	88	124
197	164	201	147	198	238	277	366	320	299
242	222	226	243	210	244	258	235	300	275
207	238	221	144	195	184	185	221	214	207
236	205	161	162	133	169	181	194	160	138
182	154	154	164	155	124	149	158	159	157
121	161	126	120	130	118	117	111	115	119
88	88	96	93	105	106	105	100	27	35
29	26	33	66	53	63	40	89	85	77
75	63	42	48	55	54	42	61	67	69
87	47	58	70	72	67	67	68	73	68
57	58	68	73	59	77	83	99	110	94
84	73	63	70	72	96	129	111	109	103
113	81	71	82	79	53	82	78	86	75
76	68	96	74	72	65	69	71	70	79
60	59	63	70	84	48	63	80	80	89

APC01b

70	81	73	69	65	56	55	60	59	58
64	73	64	77	70	63	57	43	56	47
54	41	40	49	60	60	48	66	47	35
31	33	47	53	41	49	89	93	70	71
62	61	59	50	47	54	59	52	54	42
47	45	45	54	46	52	54	61	53	52
53	54	67	59	48	54	59	44	49	62
44	70	62							

APC02

527	570	647	523	477	498	533	418	417	427
396	408	426	381	386	387	338	359	368	475
363	329	290	161	184	225	229	248	306	240
281	223	286	302	260	260	275	240	253	180
160	133	146	114	123	167	151	149	157	152
161	152	122	125	142	159	152	157	122	118
109	88	88	106	155	116	88	96	135	144
116	107	92	126	91	85	77	92	115	137
170	150	162	113	114	110	143	138	102	78
47	75	98	138	161	204	120	82	55	65
68	48	45	49	53	52	48	89	69	71
88	118	85	118	86	88	86	76	75	85
80	55	34	44	55	51	57	67	70	46
54	90	91	74	71	46	42	36	28	28
32	37	30	37	47	48	53	60	54	59
39	47	29	31	41	46	45	43	43	41
36	40	44	34	46	63	50	44	42	32
31	36	28	31	28	32	23	19	21	22
22	34	30	20	16	15	16	12	14	21
21	25	28	21	22	15	13	19	12	14
16	20	34	35	24	24	19	15	16	21
23	17	12	16	8	16	17	13	25	24
20	26	23	26						

APC03

296	364	259	267	240	217	181	154	406	371
328	315	313	204	259	233	310	277	214	210
224	167	233	195	160	165	137	183	129	134
136	202	165	110	128	147	148	138	111	134
120	151	152	104	199	187	191	139	113	114
147	154	114	137	231	216	164	169	141	161
72	71	90	105	109	70	96	127	121	95
137	134	109	116	156	179	195	210	154	134
124	91	81	64	60	69	38	53	54	69
80	83	111	124	108	77	68	65	55	76
66	85	67	68	77	87	96	92	92	90
89	57	85	78	100	57	62	57	51	34
35	44	32	40	49	51	57	57	54	51
41	55	44	50	40	31	35	30	37	32
45	29	34	37	45	55	56	30	38	50
47	41	37	31	45	27	28	37	48	42
42	44	43	53	35	30	37	39	39	35
31	40	41	31	37	27	41	35	29	33
40	34	29	43	59	42	30	24	18	25
43	41	32	35	35	36				

APC04a

128	146	152	124	162	163	151	134	128	137
82	127	125	76	115	126	126	111	89	73
92	73	68	76	118	84	78	87	69	102
94	106	121	125	108	118	135	125	124	125
124	137	109	85	72	78	70	72	74	76
96	116	96	80	124	113	97	85	71	82
87	105	115	114	114	126	128	97	72	47
109	77	62	62	73	59	58	79	93	81
88	83	42	75	74	63	46	41	31	40
45	52	34	55	54	53	45	36	58	57
49	77	76	72	39	41	53	66	47	46
71	51	37	72	73	72	89	57	55	85
93	77	65	66	63	41				

APC04b

365	373	324	277	354	305	251	251	210	264
259	215	159	168	155	167	182	186	222	180
179	169	133	116	105	69	67	74	80	113
147	171	203	239	186	162	149	153	125	193
154	161	164	115	124	159	118	138	164	194
241	223	203	219	161	189	154	169	154	126
110	116	101	129	81	84	91	83	89	75
92	123	127	133	108	146	148	126	104	123
126	96	108	105	56	106	114	105	88	61
52	63	51	56	69	90	91	61	69	76
117	101	98	114	120	126	110	137	117	120
117	135	118	83	79	74	65	64	67	70
85	105	113	91	82	114	106	87	80	83
90	87	103	97	112	98	105	133	100	76
58	89	66	60	63	76	53	58	76	60
69	75	87	61	78	74	52	44	42	24
39	42	48	39						

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