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Tree-ring Analysis of Oak and Elm Timbers from the North and North-West Ranges

Martin Bridge and Cathy Tyers

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Front Cover: Creeksea Place, Burnham-on-Crouch, Essex. Photograph: Tim Howson

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NGR: TQ 93449 96163

ISSN 2059-4453 (Online)

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SUMMARY
Eighteen timbers, 14 oak and four elm, were sampled for ring-width dendrochronology from the roof and first-floor frame of the north range, and from various elements of the north-west range. Eight oak samples from the north range matched and produced a site chronology, which dated very strongly against local reference chronologies but also strongly with reference chronologies across mid- and southern England. Three of these samples retained complete sapwood, one being from a tree felled in the spring of AD 1567, the other two probably felled at the same time, although one had very narrow rings that made the exact year of felling impossible to determine, whilst on the other the sapwood section of the sample had detached during coring with the possible loss of a small number of rings. The other dated timbers appear to form a coherent group most likely felled at the same time. Construction of the north wing is likely therefore to have been in AD 1567 or within a year or two after this date. The north-west wing could not be dated by this analysis.

CONTRIBUTORS
Martin Bridge and Cathy Tyers

ACKNOWLEDGEMENTS
We are very grateful to Ed Morton (Morton Partnership) for his advice and for supplying drawings adapted for use in this report, Claire Ashwell of the Creeksea Place staff who facilitated access, and Tim Howson (Maldon District Council) for his invaluable input in discussions about the site and providing his drawings and report for use in this report. We would also like to thank Malcolm Starr, Historic England Heritage at Risk Architect, who requested the work and for his advice and guidance about the historic development of the property, and to Shahina Farid (Historic England Scientific Dating Team) who commissioned the work and for producing Figure 1.

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DATE OF INVESTIGATION
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CONTENTS

INTRODUCTION

Creeksea Place is a relatively isolated domestic country house on the Dengie Peninsula, to the west of the town of Burnham-on-Crouch in Essex (Fig 1). The present building comprises the Tudor north range of a former courtyard house (Fig 2), the east wing of which was rebuilt on its old footprint in the nineteenth century. There is also a one-and-a-half storey range to the north-west of uncertain age, although it is clearly of some antiquity. It is a Grade II* listed building (LEN 1123776) on the Heritage at Risk Register. Access to historic timbers became possible because of major structural works being carried out to secure its future.

The two-storey brick structure of the north range has traditionally been dated to AD 1569, based on an inscription on a lead rainwater hopper. Historical studies by Jonathan Clark (2016 unpubl), however, suggested the possibility of an earlier date range of between AD 1540 and 1559, and noted a vertical join in the brickwork which could represent a separation of phases of building. Extensive investigation of the fabric by Tim Howson (Maldon District Council) described the roof of the north range to be of one build with seven bays and large principal-rafter couples with high collars, and tiebeams resting on the wall plates (Fig 3). There is a single tier of butt purlins, and curved wind-braces which are pegged to the principal rafters, with their tops trenched and nailed to the outer surface of the purlins (Howson 2020 unpubl).

The north-west range of one storey and attic rooms incorporates several different phases of fabric. From the east end, and attached to the original north range, an original sixteenth-century block extends to the west, where it originally terminated with a gable wall. There is then an infill under the same roofline, built around AD 1900, which connects what was a detached sixteenth-century block at the western end with the eastern section.

Dendrochronological analysis was requested by Malcolm Starr (Historic England, Heritage at Risk architect/surveyor) in order to inform the current repairs and elucidate the history of this building.

METHODOLOGY

An assessment of the timbers for dendrochronological study sought accessible oak timbers with more than 50 rings and where possible traces of sapwood, although slightly shorter sequences are sometimes 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 to 400 grit abrasive paper to allow the ring boundaries to be clearly distinguished. Samples which had 40 or more rings were considered suitable for ring-width analysis but, bearing in mind the potential for future radiocarbon analysis, all samples with more than 25 rings 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 process of qualified statistical comparison by computer, supported by visual checks. 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 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 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.

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. 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 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). 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

Ten samples were taken from the roof of the north range, and three from framing timbers on the first floor. A further five timbers were sampled in the north-west extension, where sampling was more limited because of the general low numbers of rings in the timbers there.

Details of the samples and their locations are given in Table 1, and their locations are illustrated in Figures 4–10. One oak (*Quercus* sp.) sample from the first-floor framing of the north range had too few rings and was rejected prior to further analysis. The remaining 13 oak samples were measured. Four timbers, a floor joist in the north range, and two mid-rails and a tiebeam from the north-west range, were found to be elm (*Ulmus* sp.). Both mid-rails had too few rings and were also rejected prior to further analysis. The measured ring-width series are given in the Appendix.

Comparison of the individual ring series showed that seven oak timbers from the north-range roof, and one oak timber from the first-floor framing cross-matched (Table 2; Fig 11), and these were combined to form a 91-year site chronology (CREEKSEA) that was subsequently dated to the period AD 1476–1566, the strongest matches being shown in Table 3. The series from the remaining timbers showed abrupt growth rate changes in their ring series, and could not be cross-matched or dated.

INTERPRETATION AND DISCUSSION

Three of the eight dated samples from the north range retained complete sapwood (Table 1; Fig 11) of which one (crkp07) represents a timber derived from a tree felled in the spring of AD 1567. Of the other two, one (crkp02) had approximately five extremely narrow outer rings making the exact year of felling difficult to determine reliably but allowing a narrow felling date range of *c* AD 1566–8 to be applied, whilst the sapwood had become detached during coring on sample crkp08, with it being possible that a small number of rings were lost at the break, again allowing a narrow felling date range of *c* AD 1566–71 to be applied. Hence it seems likely these two samples represent timbers derived from trees felled in, or around, the same year as the crkp07. The remaining samples all had likely felling date ranges spanning AD 1567, and appear to form a coherent group most likely felled at the same time (Fig 11).

Seven of the eight dated timbers are from the roof, whilst one is from the first-floor framing indicating that these elements are likely to be coeval. Construction of this range therefore appears likely to have taken place in AD 1567 or within a year or two after this date. This ties in with a reported date of AD 1569 on a lead water hopper, which may indicate when the build was completed.

The site master chronology gave very strong matches with other sites from East Anglia, and the timber used was probably of local origin, but it should be noted that

it matched very well with reference chronologies across mid- and southern England.
The samples from the north-west range all had short ring sequences, and none could be dated. Thus it has not been possible to elucidate the complexities of this range.

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TABLES

Table 1: Details of the tree-ring samples taken from Creeksea Place, Burnham-on-Crouch, Essex (trusses in the north range are numbered from the east end). All samples are oak unless otherwise stated

Sample No	Location	Number of rings	Date of sequence (AD)	Sapwood	Mean ring width (mm)	Mean sensitivity	Felling date range (AD)
North range: roof							
crkp01	North principal rafter T3	73	1490–1562	21	2.36	0.19	1562–82
crkp02	North common rafter, 2nd west from T2	52	1510–61	23+*c*5NMC	1.98	0.22	*c* 1566–8
crkp03	South principal rafter T2	39	1511–49	h/s+11NM	1.69	0.26	1560–90
crkp04	Tiebeam, T2	70	-	h/s	2.06	0.25	-
crkp05	North principal rafter T4	56	1498–1553	h/s	1.78	0.17	1562–94
crkp05a	*ditto*	56	1498–1553	h/s	1.78	0.18	-
crkp05b	*ditto*	56	1498–1553	h/s	1.77	0.17	-
crkp06	South principal rafter T4	56	1490–1545	4+11NM	1.80	0.22	1556–82
crkp07	South principal rafter T5	91	1476–1566	21¼C	1.96	0.23	spring 1567
crkp08	North principal rafter T5	63	1491–1553	2+*c*13NMC	2.18	0.21	*c* 1566–71
crkp09	North principal rafter T6	73	-	h/s+*c*12NMC	2.52	0.28	-
crkp09a	*ditto*	73	-	h/s+*c*12NMC	2.47	0.28	-
crkp09b	*ditto*	67	-	h/s	2.57	0.30	-
crkp10	South principal rafter T6	47	-	3+8NM	2.56	0.24	-
North range: first-floor framing							
crkp11	5th Floor joist from north wall, north-east room (elm)	49	-	-	3.15	0.23	-
crkp12	North mid-rail, partition wall, west side of north-east room	60	1496–1555	h/s	1.85	0.25	1564–96
crkp13	Post in stud wall, former bathroom	≤25	-	3	NM	-	-
North-west range							
crkpN01	Post, north side of corridor	26	-	h/s	4.01	0.30	-
crkpN02	Mid-rail, north side of corridor (elm)	≤25	-	?h/s	NM	-	-

crkpN03	Mid-rail, west wall next to stairs (elm)	≤25	-	h/s	NM	-	-
crkpN04	East jamb, doorway to flat	48	-	9+3NM	1.56	0.16	-
crkpN05	Tiebeam, west of stairs, first truss from west end (elm)	40	-	h/s	3.52	0.22	-

Key: h/s = heartwood/sapwood boundary; NM = not measured; *+nn* = estimated number of unmeasured rings; C = complete sapwood, felled the following winter unless on unmeasured core sections in which case felling season is usually indeterminate; ¼C = complete sapwood, felled the following spring

Table 2: Cross-matching between the dated series (values in excess of 3.5 are significant)

	t-values (years overlap)						
Sample No	crkp02	crkp03	crkp05	crkp06	crkp07	crkp08	crkp12
crkp01	5.8 (52)	2.8 (39)	2.9 (56)	3.6 (56)	3.9 (73)	1.4 (63)	2.3 (60)
crkp02		3.8 (39)	6.0 (44)	4.7 (36)	4.7 (52)	3.2 (44)	3.8 (46)
crkp03			2.1 (39)	9.4 (35)	7.7 (39)	2.7 (39)	7.8 (39)
crkp05				1.0 (48)	2.8 (36)	3.6 (56)	2.7 (56)
crkp06					7.8 (56)	1.8 (55)	6.7 (50)
crkp07						3.6 (63)	5.9 (60)
crkp08							3.0 (58)

Table 3: Dating evidence for the site chronology, CREEKSEA, AD 1476–1566

Source region:	Chronology name:	Publication reference:	File name:	Span of chronology (AD)	Overlap (years)	t-value
Cambridgeshire	St Andrew's Church, Wimpole	Bridge 1998	WIMPOLE1	1469–1615	91	11.3
Essex	Hill Hall, Theydon Mount	Bridge 1999	HILLHAL1	1425–1564	89	9.9
Essex	Magdalen Laver	Tyers and Boswijk 1998	MLAVER	1411–1534	59	9.8
Suffolk	Bedfield Hall	Miles *et al* 2007	BEDFLD2	1473–1627	91	9.5
Oxfordshire	Greys Court, Rotherfield Greys	Miles *et al* 2009	GREYSCTA	1319–1618	91	9.5
Essex	55-63 Stoneham St., Coggeshall	Miles and Bridge 2013	COGGS1	1338–1554	79	9.3
Essex	Moyns Park, Birdbrook, Essex	Tyers 1999	MOYNS	1431–1606	91	9.1
Essex	Cressing Temple Farmhouse, Essex	Tyers 1995	CRF94_T5	1514–1608	53	9.0
Oxfordshire	Wadham College	Miles *et al* 2010	WADHAM	1426–1610	91	9.0
London	White Tower, Tower of London	Miles 2007	WHTOWR7	1463–1616	91	8.9
Kent	Cobham Hall, Cobham	Arnold *et al* 2003	COBHSQ01	1317–1662	91	8.8
Suffolk	Crow's Hall	Miles *et al* 2007	CROWSHL1	1406–1559	84	8.7
Suffolk	12 Aspall Rd, Debenham	Miles *et al* 2009	DEBNHM3	1433–1574	91	8.7
Suffolk	7/9 Gracechurch St., Debenham	Miles *et al* 2009	DEBNHM2	1433–1588	91	8.7

FIGURES

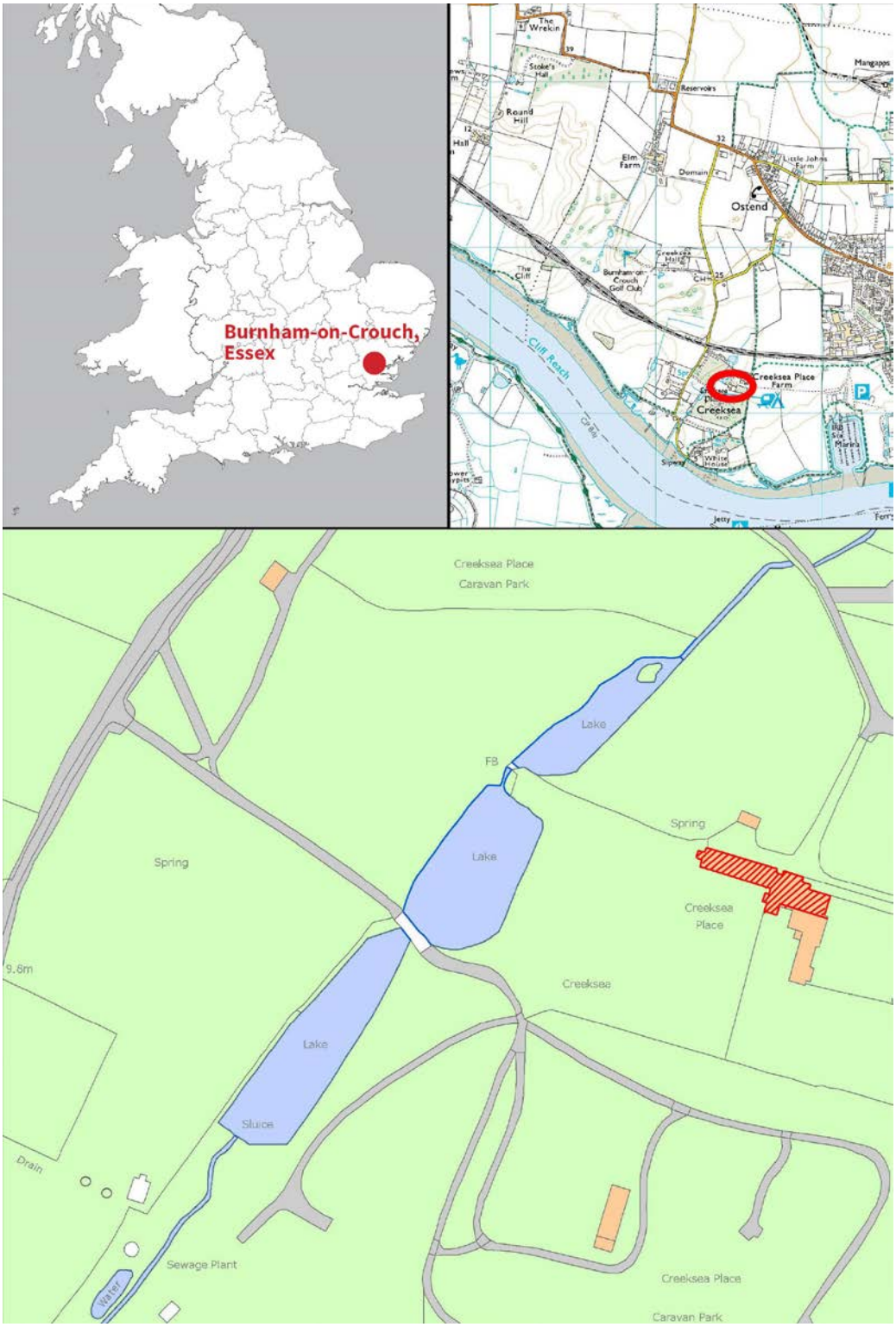

Figure 1: Maps to show the location of Creeksea Place, Burnham-on-Crouch in Essex, marked in red. Scale: top right 1:30000; bottom 1:1750. © Crown Copyright and database right 2020. All rights reserved. Ordnance Survey Licence number 100024900. © British Crown and SeaZone Solutions Ltd 2020. All rights reserved. Licence number 102006.006. © Historic England

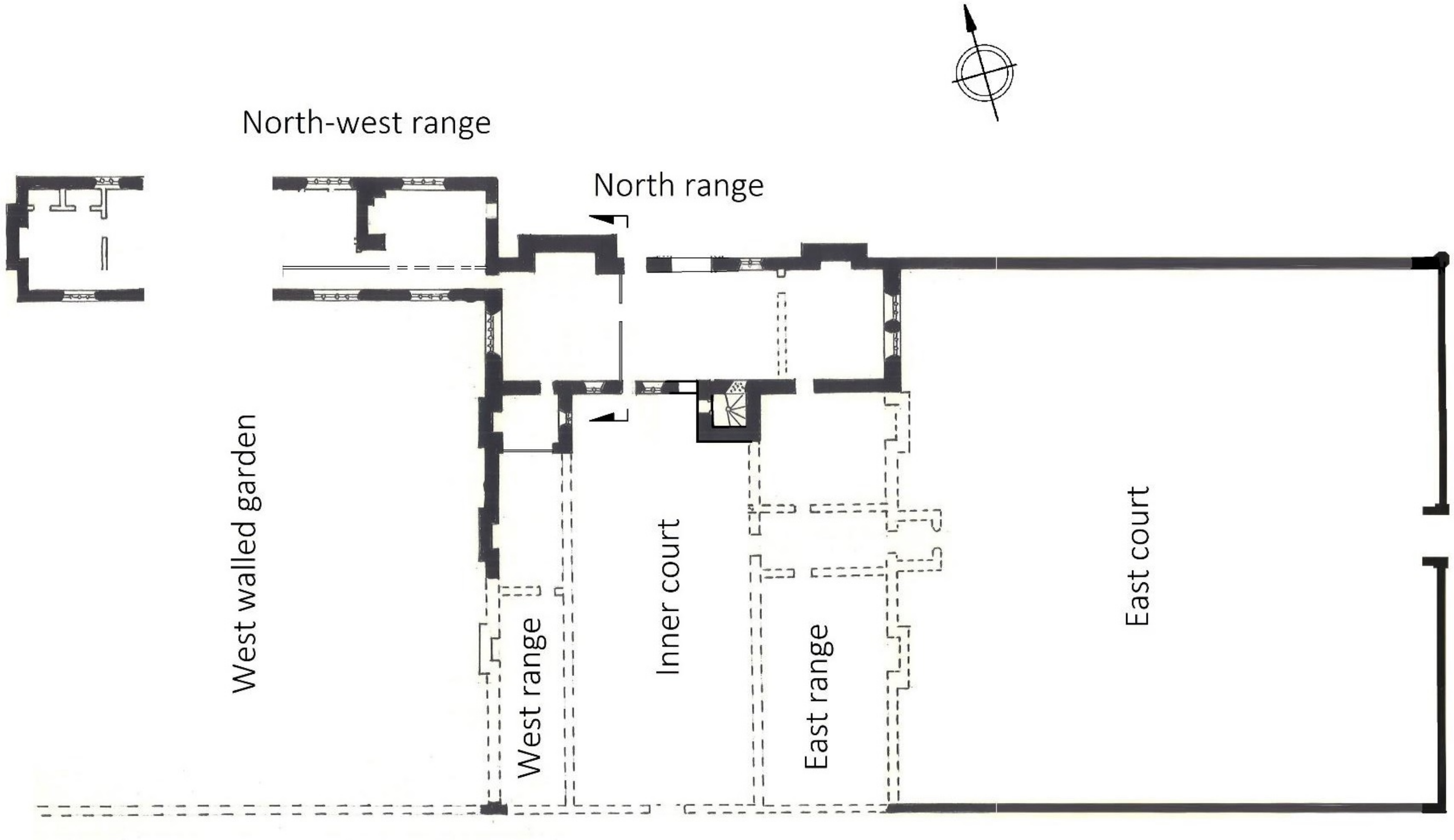

Figure 2: Plan showing the lay-out of Creeksea Place with extant walls shown in black; sampling for dendrochronology was undertaken in the north and north-west ranges (adapted by Tim Howson from a plan drawn for the RCHM in 1921)

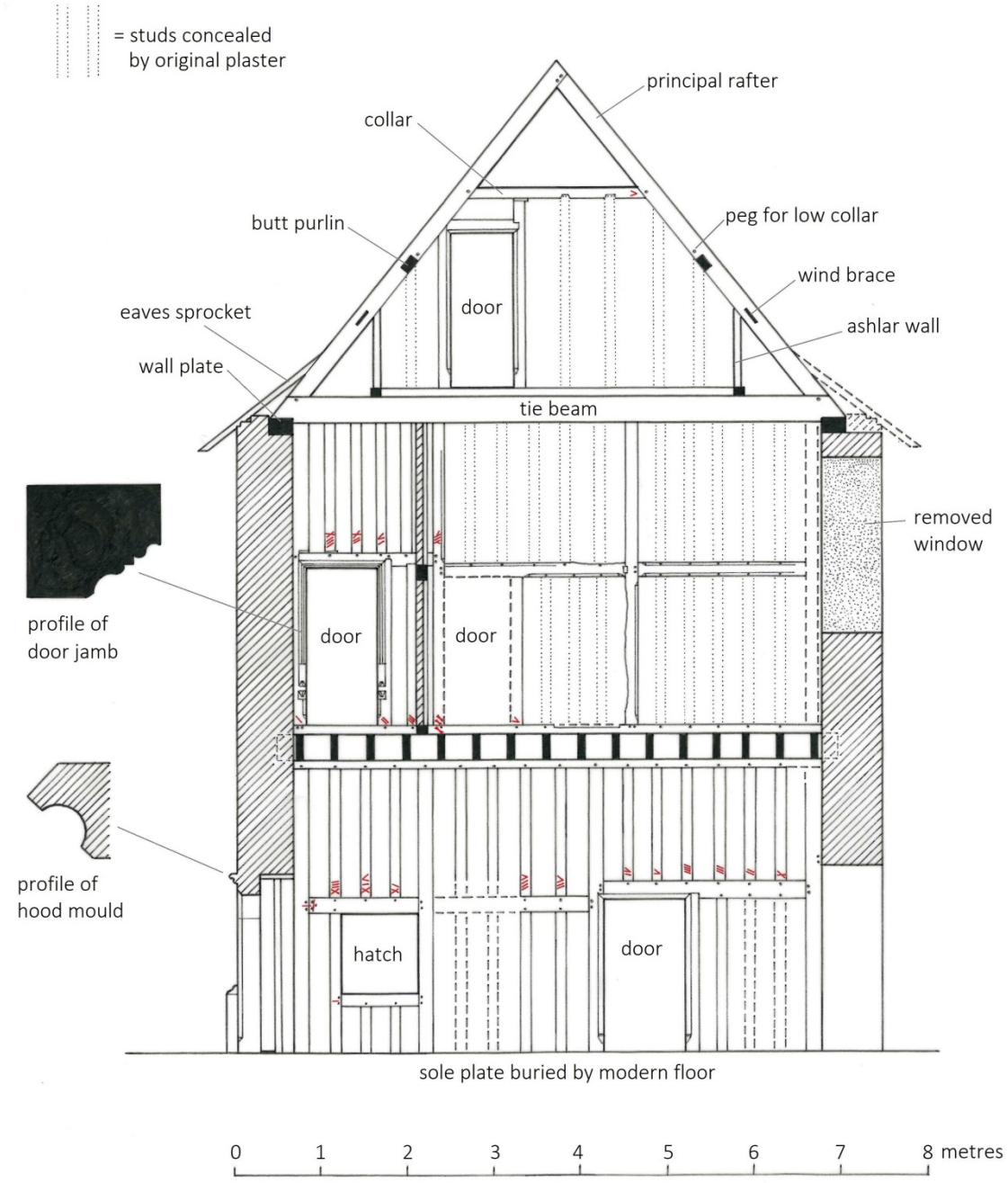

Figure 3: Section through the north range facing west (drawing by Tim Howson)

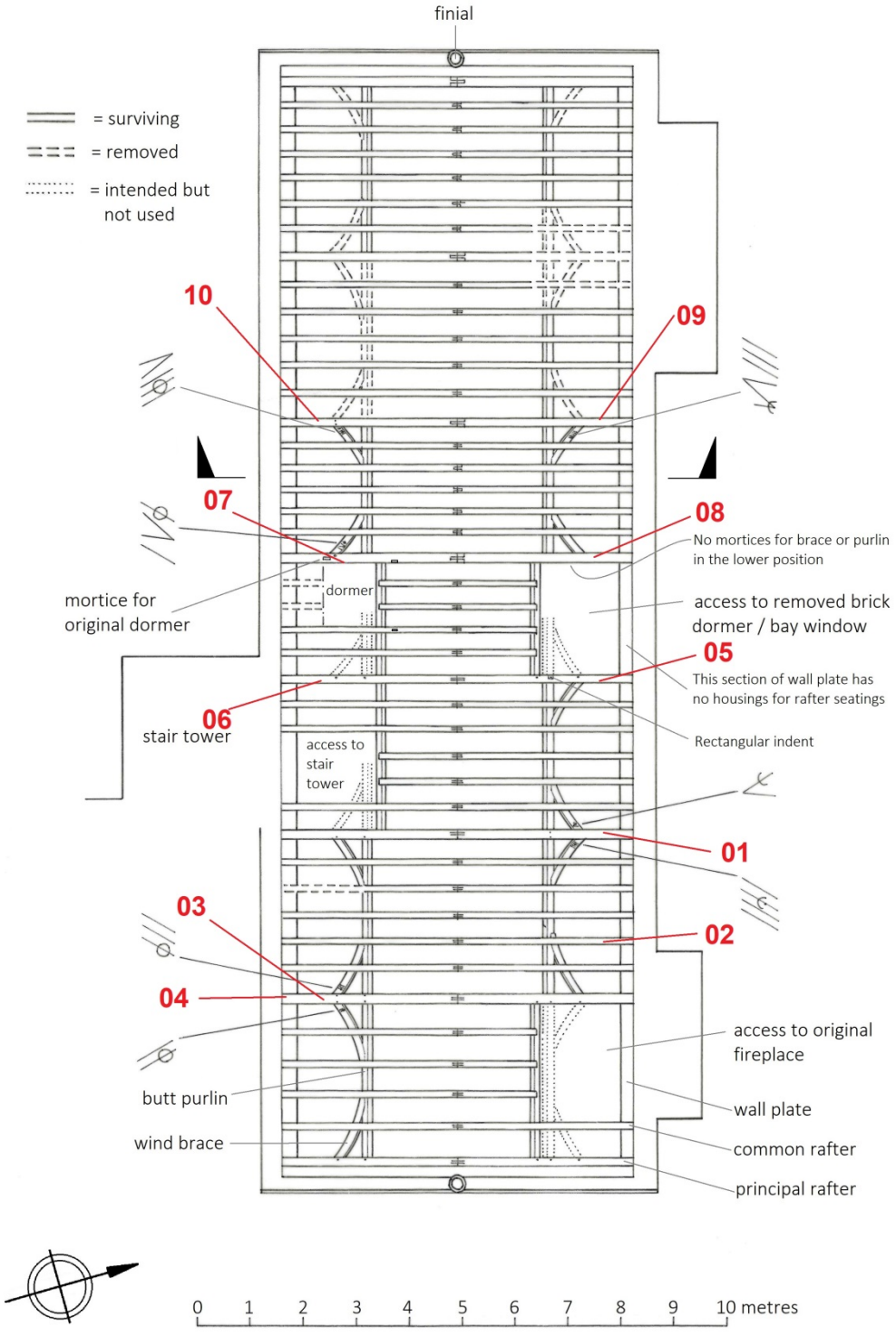

Figure 4: Plan of the roof of the north range of Creeksea Place, showing the approximate locations of timbers sampled (adapted from an original drawing by Tim Howson)

Figure 5: View of the east end bay of the north range, looking north, showing the south principal rafter sampled for dendrochronology (photograph Martin Bridge)

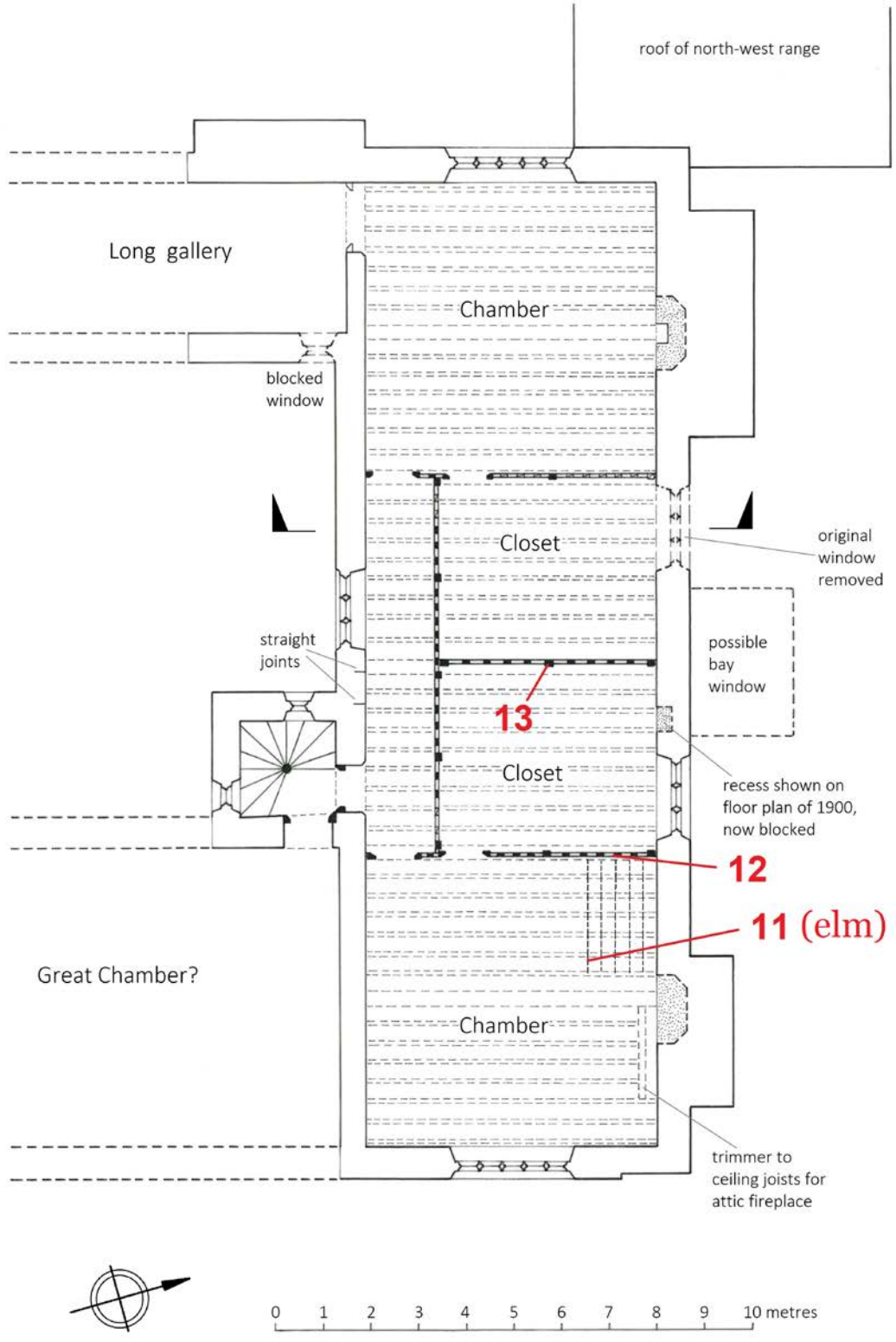

Figure 6: Plan of the first floor of the north range of Creeksea Place, showing the timbers sampled for dendrochronology (adapted from an original drawing by Tim Howson)

Figure 7: View of the north-west corner of the first-floor east-most room of the north range, showing the mid-rail sampled for dendrochronology (photograph Martin Bridge)

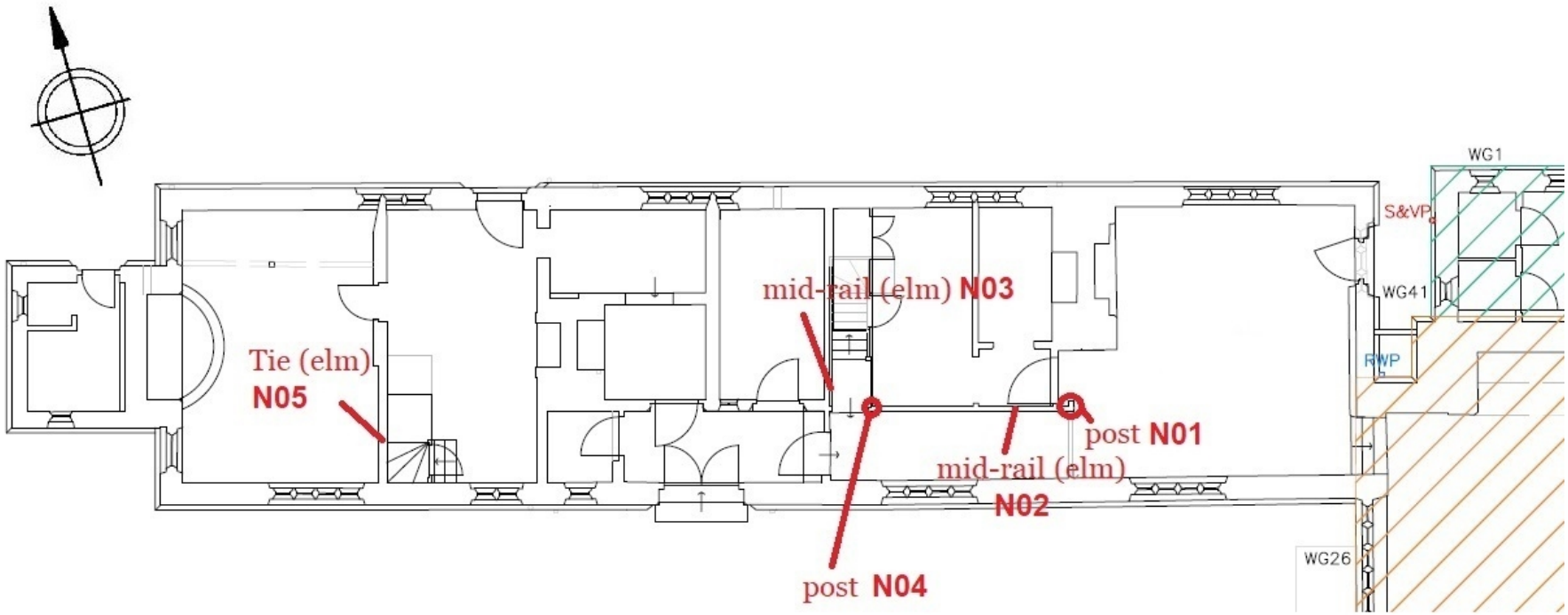

Figure 8: Plan of the ground floor of the north-west range, showing the locations of the timbers sampled for dendrochronology (adapted from an original drawing by The Morton Partnership)

Figure 9: View looking west along the ground floor corridor to the north-west range, showing the position of the timber sampled as crkp04 (photograph Martin Bridge)

Figure 10: View of the elm mid-rail at the west end of the east section of the north-west range, sampled as crkpN03 (photograph Martin Bridge)

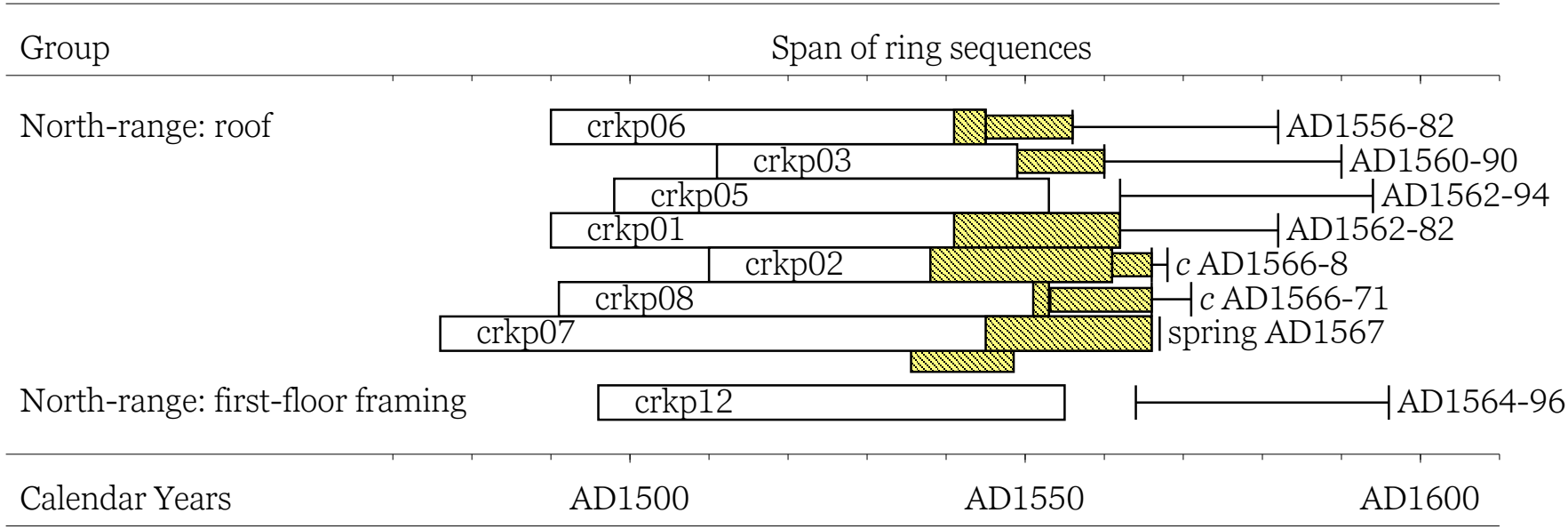

Figure 11: Bar diagram showing the relative positions of overlap of the dated samples, along with their actual felling dates or likely felling date ranges. White bars represent heartwood rings, yellow hatched bars represent sapwood rings, and narrow sections of bar represent additional unmeasured rings

APPENDIX

Ring width values (0.01mm) for the sequences measured

Oak

crkp01

322	309	418	415	427	322	365	322	195	265
280	247	264	169	186	225	274	231	314	346
271	204	186	219	174	187	142	147	213	204
137	192	188	225	131	167	270	235	251	198
194	295	175	239	202	369	314	279	289	341
339	321	260	207	167	154	163	194	226	256
208	196	174	191	188	222	170	157	175	202
140	187	202							

crkp02

497	481	348	367	268	320	285	221	282	229
155	196	185	176	156	143	182	146	164	152
151	192	143	144	130	205	149	204	156	225
195	238	188	154	114	166	125	176	205	310
153	191	136	137	145	195	117	121	107	156
184	113								

crkp03

170	136	132	144	136	165	72	149	170	144
116	138	164	141	103	234	231	265	204	159
251	195	160	158	234	182	199	159	211	178
215	143	140	157	222	151	95	142	243	

crkp04

362	284	375	241	353	402	244	212	256	427
431	407	268	214	224	184	151	219	249	230
278	170	188	189	301	189	320	337	179	199
142	127	164	147	131	158	244	158	143	200
173	249	163	197	173	80	103	128	87	78
139	164	188	122	187	203	185	158	160	216
162	101	121	171	158	208	179	184	172	134

crkp05a

331	307	275	211	220	152	190	144	155	159
140	180	193	164	161	171	135	176	194	190
175	155	118	216	180	157	149	133	141	141
139	145	137	217	188	227	190	259	139	146
120	151	165	190	176	206	154	187	139	152
221	250	162	209	144	169				

crkp05b

451	401	268	258	200	138	147	134	144	160
128	174	191	170	161	144	142	154	175	167
163	164	115	219	185	134	130	115	117	117
127	122	108	188	183	163	135	215	147	172

135 203 236 249 177 200 168 219 161 151
206 234 184 195 139 139

crkp06
360 261 165 224 204 153 269 222 165 172
179 149 109 137 99 124 162 130 174 173
190 254 226 210 210 231 224 108 208 233
179 175 174 184 143 129 174 156 179 164
148 211 141 113 120 194 153 190 168 202
162 193 130 184 150 227

crkp07
179 175 208 336 370 372 291 278 274 281
263 308 257 271 282 203 214 235 372 164
332 222 115 150 163 128 159 141 138 144
177 160 136 119 155 147 239 197 144 188
200 112 212 278 232 200 203 268 182 132
214 198 251 236 233 270 199 148 142 288
165 147 166 181 144 198 152 210 156 256
123 127 204 276 148 156 135 176 196 152
160 114 99 143 162 143 156 129 119 137
109

crkp08
154 227 263 337 247 380 397 297 207 192
234 322 227 273 211 252 296 250 240 273
243 229 165 186 193 214 157 208 156 133
131 110 96 71 73 68 53 73 63 53
66 77 106 81 133 140 192 265 290 258
335 269 326 302 408 323 283 347 401 299
343 219 335

crkp09a
284 292 218 263 301 188 268 217 202 238
148 81 69 122 385 597 405 258 218 215
423 293 223 146 230 242 270 260 339 242
268 307 394 235 215 298 207 237 188 164
207 134 124 102 135 253 218 255 289 209
433 333 452 360 514 364 339 248 306 275
258 172 118 74 98 97 134 197 296 232
202 186 295

crkp09b
220 261 216 261 192 122 69 132 558 742
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245 224 368 270 218 186 300 248 328 318
261 329 274 207 231 167 128 92 144 249
210 234 244 153 302 246 299 225 430 335
379 252 290 220 245 196 149 77 107 151
222 373 424 264 233 186 303

crkp10
433 413 446 330 306 261 400 398 439 388

178 218 218 248 181 156 106 96 83 119
144 222 230 180 403 395 449 287 527 326
379 304 324 188 255 152 163 107 127 100
187 217 206 163 173 157 254

crkp12
399 477 299 340 251 179 139 142 130 112
176 196 214 203 172 150 150 173 226 256
222 116 243 197 223 173 208 190 184 135
180 172 201 190 137 173 115 81 63 132
113 187 158 181 187 158 101 156 194 292
179 96 203 237 148 162 108 153 167 186

crkpN01
255 277 428 360 335 461 517 339 359 528
707 382 416 266 494 513 585 322 390 240
363 502 314 515 273 285

crkpN04
195 279 219 208 209 198 161 140 149 163
233 231 185 142 205 206 213 174 242 214
171 136 127 106 112 118 102 103 149 138
153 109 130 153 170 140 114 91 121 131
146 105 124 95 115 108 106 130

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451 367 367 381 385 283 400 348 285 365
286 259 256 242 356 428 418 245 302 468
359 319 254 449 495 330 331 444 296 342
335 414 439 271 282 224 318 246 166 325
206 174 172 303 230 176 191 276 192

crkpN05
365 230 221 308 341 261 291 352 425 488
466 452 477 481 443 230 115 213 301 384
308 292 320 341 398 246 309 257 249 383
419 747 516 318 339 356 333 381 431 277

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ISSN 2059-4453 (Online)