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RESEARCH REPORT

TREE-RING DATING OF THE KARR-KOUSSEVITZKY DOUBLE BASS: A CASE STUDY IN DENDROMUSICOLOGY

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ABSTRACT

Sergei Koussevitzky was one of the world's premier conductors and virtuoso bass players whose favorite instrument was an unusually-shaped bass reportedly made in 1611 by the Amati brothers, Antonio and Girolamo. In 1962, 11 years after Koussevitzky's death, his widow gave the bass to Gary Karr, currently considered to be the world's premier double bassist. In 2004, Karr donated the bass to the International Society of Bassists. Close inspection by a team of experts in 2004, however, revealed stylistic inconsistencies that suggested a later construction date. We used four reference tree-ring chronologies developed from treeline species in the European Alpine region to anchor the dates for the tree rings from the double bass absolutely in time. The bass yielded a 317-year long sequence, the longest sequence yet developed from a single musical instrument. Statistical and graphical comparisons revealed that the bass has tree rings that date from 1445 to 1761. Based on the strength of these correlations, the spruce tree harvested to eventually construct the double bass likely came from the treeline Alpine area of western Austria, not too far from Obergurgl at the Italian border. Our results demonstrate that the double bass was not made by the Amati Brothers, but likely by French luthiers in the late 18th Century.

Keywords: Dendromusicology, dendrochronology, musical instruments, double bass, Sergei Koussevitzky, Gary Karr.

INTRODUCTION

Dendrochronological dating to verify or disprove the year of construction of musical instruments (and therefore the attribution to a certain maker) is steadily gaining attention and application in the tree-ring sciences while gaining considerable acceptance by instrument appraisers, sellers, buyers, and players. This novel application of tree-ring dating, which we term ''dendromusicology,'' was first demonstrated by Lottermoser and Meyer (1958) who conducted simple comparative analyses of tree-ring patterns between violins. Corona (1980) analyzed two violins in the Museum L. Cherubini in Florence, Italy, and was able to attribute both to the violin maker G.B. Gabrielli, who worked in Florence between 1739 and 1770. Corona (1981) also was able to determine the possible source region for the ''Bimbi'' violin (likely in the Fiemme Valley in Trentino). Klein *et al.* (1984)

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demonstrated that 10 stringed instruments of the 75 that could be dated using tree rings yielded dates that postdate the years listed on the labels for those instruments.

Topham (2003a) analyzed 41 instruments, including violins, bass viols, guitars, and lutes, in three collections in Edinburgh, Paris, and London, providing valuable tree-ring reference chronologies dating back to the early 15th Century that could be used for the future dating of musical instruments. These data were later used by Wilson and Topham (2004) to demonstrate that a strong climatic signal exists in tree-ring data from violins that could prove useful for identifying source regions for the wood used to make the instruments. Grissino-Mayer *et al.* (2004) confirmed the 1716 label date of the famous ''Messiah'' violin made by Antonio Stradivari, first analyzed and dated by Topham and McCormick (1998). Grissino-Mayer *et al.* (2004) suggested the wood used to make the violin came from a lower-elevation tree growing distant from the high Alpine areas from where the Alpine reference tree-ring chronologies used to date the ''Messiah'' were developed. The ''Messiah'' violin age was ultimately determined by crossdating its tree-ring patterns with those from other instruments conclusively dated against the Alpine reference chronologies.

As with the ''Messiah'' violin, the provenance of a famous musical instrument may hold considerable historical significance that warrants a more in-depth dendrochronological analysis to prove attribution. The Karr-Koussevitzky double bass is one such instrument. Sergei Koussevitzky (1874–1951, Figure 1) was one of the world's premiere virtuoso bassists who demonstrated the orchestral qualities of the double bass instrument (Smith 1947; Brun 2000). In 1924, Koussevitzky accepted an invitation, amid much fanfare, to be musical director and conductor for the Boston Symphony Orchestra, a position he held for 25 years, garnering him a reputation as one of the world's premiere conductors. One of Koussevitzky's favorite instruments was a double bass reportedly made by the Amati brothers in 1611 (Figure 1). In 1962, Olga Koussevitzky, the widow of Serge Koussevitzky, attended the debut recital of double bassist Gary Karr in Town Hall in New York City who was performing with Leonard Bernstein and the New York Philharmonic. She related how she saw the ghost of Koussevitzky embrace Mr. Karr during the performance and was so moved that she gave him the 1611 Amati bass. Today, Karr is praised as the world's leading solo bassist (Karr 2001 and elsewhere) and is considered the first solo double bassist in history to make playing a full-time career. In 1967, Karr founded the International Society of Bassists (I.S.B.) and has done more than anyone else in history over the past 40 years to educate the world about the double bass. In 2004, he surprised the music world by donating Koussevitzky's 1611 Amati bass to the I.S.B. (Anonymous 2004).

Figure 1. Sergei Koussevitzky pictured with the bass he bought around 1901 (photograph courtesy of the International Society of Bassists).

All modern and popular accounts contend that the Karr-Koussevitzky bass was made in 1611 by the Amati brothers, Antonio (1560–1649) and Girolamo (1562–1630), of Cremona, Italy, the sons of Andrea Amati (1525–1611). (Andrea Amati founded the great Cremonese school of instrument makers.) The 1611 Amati bass, if authentic, would be the only known double bass made by the Amati

brothers of 117 instruments (77 violins, 27 violas, 12 cellos, and the Karr-Koussevitzky double bass) currently known (Cozio Publishing 2004), lending considerable additional value to an already historically valuable bass. Koussevitzky purchased the bass sometime around 1901 (Anonymous 2004) in France, but no written documentation exists concerning its previous ownership. Some have speculated that Koussevitzky acquired the Amati bass that was formerly owned by Domenico Dragonetti (1763–1846) (Brun 2000: 265). This speculation likely arose because only one double bass made by the Amati brothers is currently known to exist (the Karr-Koussevitzky bass now owned by the I.S.B.) and Dragonetti, the famed double bass virtuoso, is known to have owned and played an Amati double bass (Palmer 1997). However, the Amati bass owned by Dragonetti was not made by the Amati brothers, but was instead created by Nicoló Amati (1596–1684), the son of Girolamo and the mentor of such famed luthiers as Antonio Stradivari (1644–1737) and Joseph Guarnarius del Gesu (1698–1744). Dragonetti's close friend and legal advisor, Samuel Appleby (?–1880) later inherited the Amati double bass (Palmer 1997).

Rosengard (1992) and others have held the unusual 1611 Amati brothers double bass with high regard. The shape of the instrument is more like that of a viola da gamba, an instrument similar to the cello and played between the legs, considered a precursor to the modern double bass:

> Their [the Amati brothers] viola da gamba of the year 1611 embodies diverse traits which became standard in the double bass maker's vocabulary during the late 17th and 18th centuries: the round back with bevel, the gently sloping shoulders, and the ribs which diminish from the endpin to the neck block. This form is actually a composite, in part derived from earlier viols and partly their own innovations, but in any case, quite original, well composed, and beautifully synthesized (Rosengard 1992).

In late 2004, the Karr-Koussevitzky bass was carefully inspected and evaluated independently by four experts in bass design and style, and all agreed that certain stylistic inconsistencies suggested the bass was perhaps constructed later than 1611. For example, a transition from four-ply purfling (the decorative inlay around the edge of the instrument body) to three-ply purfling in the C-bouts (the narrowest portion of the bass body), supported by a change in the depression that normally exists before the purfling near the edge, suggests the upper and lower bouts were changed or cut down from a larger size. Differences in the varnish from the upper ribs and back compared to the C-bouts, lower bouts, and top suggest that the upper bouts may not be original to the bass. Inside the bass, the upper ribs appeared to have more damage than the C-bouts and lower bouts, and were made from a different type of wood that was not as fine as the wood on the lower half of the bass, again suggesting considerable alterations were made in the past. Finally, the shape of the bass resembles a form for a viola da gamba that Stradivari used, especially the F-holes (the sound holes) which resemble a Stradivari outline. Stradivari, however, would not be born until 1644. These observations called into question whether the Karr-Koussevitzky bass was indeed made by the Amati brothers in 1611.

Our research had two primary goals. First, we compared the tree-ring patterns from the spruce top of the bass with tree-ring patterns from European reference chronologies to anchor the tree rings firmly in time, thus providing information on the likely period of construction for the bass. Second, we used the matching reference chronologies to determine the possible location from which the spruce tree was harvested. This information could eventually help experts determine who likely constructed the bass if not made by the Amati brothers.

METHODS

All surfaces of the bass were first protected by fleece coverings, leaving only the widest areas of the lower bout exposed for measurement. We then delicately strapped the bass using cargo cinch straps across the C-bouts onto the movable stage of a Velmex measuring system that had been fitted with a larger 30 $\times$ 40 cm wooden platform. We visually inspected the spruce top using a jeweler's magnifying loupe to locate the transects that contained the most suitable and clearest rings for measurement. Narrow rings or areas that could potentially pose problems were identified with strips of colored adhesive tape (''Post-It Note'' arrows, Fig-

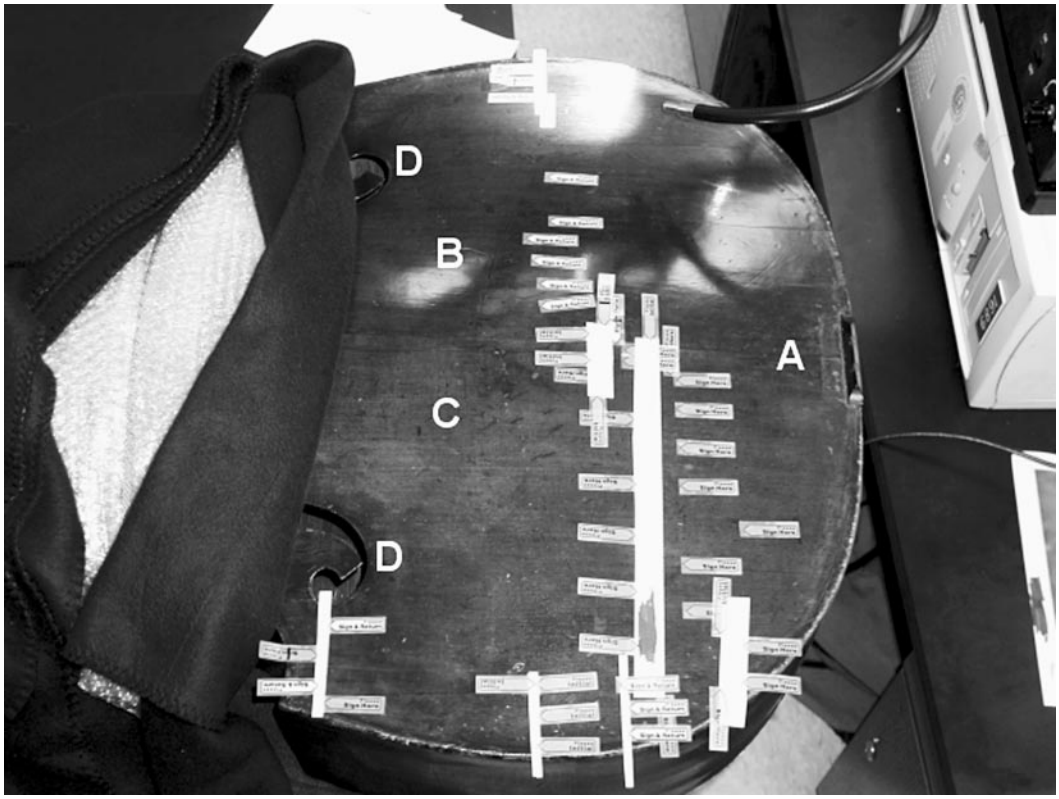

Figure 2. The Karr-Koussevitzky double bass strapped onto the measuring stage (A: centerline of instrument; B: treble side; C: bass side; D: F-holes). Along the lower bout, smaller strips of adhesive paper mark the locations of narrow or unclear rings while the longer strip of white paper contained the transcribed ring locations to aid the measurement process.

ure 2). Once the most suitable transects were located on each side of the lower bout, a strip of paper was placed along each transect and the locations of all tree rings were manually transcribed onto the paper strip using the magnifying loupe. The first ring was assigned year ''1.'' Every 10th, 50th, and 100th rings were then appropriately marked on the strip of paper using one, two, or three dots, respectively (Stokes and Smiley 1996). Measurements were made to the nearest 0.01 mm on both sides of the lower bout using a trinocular stereozoom microscope connected with a color CCD camera that projected the tree rings of the bass surface onto a high resolution color monitor. Measurements were also obtained for tree rings found in both wings on the outer edges of the lower bout. Such wings use extra pieces of wood to widen the lower bout. All measurements are provided in Appendix 1.

Double bass construction is similar to that of other stringed instruments. To obtain the desired symmetry on the top of the instrument, a wedge-shaped bolt of spruce wood cut from the trunk of the tree is first split down the middle from the inner most (near pith) portion of the trunk. The two half-wedges are opened (or ''butterflied,'' as the inner portion is opened out and downward), then glued together on the planed ends so that the innermost tree rings are now on the outside portions of the instrument top (Wake 1995; Chandler 2001; Topham 2003b). Therefore, identical (mirror-like) tree-ring patterns should be displayed on top of the two pieces of wood used to make the top of the instrument.

While we had the instrument in the laboratory, we checked the measurements from both sides of the bass using COFECHA (Holmes 1983; Grissino-Mayer 2001) to ensure that we had indeed

Table 1. Correlation coefficients for 40-year segments (20-year overlap) between the treble and bass sides of the Karr-Koussevitzky bass.

	Segment (ring numbers)												
	20–59	40–79	60–99	80–119	100–139	120–159	140–179	160–199	180–219	200–239	220–259	240–279	260–299
Corr.*	.50	.82	.78	.63	.85	.83	.74	.74	.75	.62	.55	.72	.62

*All correlations are significant at $p < 0.001$.

found and measured the same set of tree rings on both sides of the instrument. COFECHA uses autoregressive modeling techniques to minimize effects of autocorrelation when assessing the match of patterns between two tree-ring time series. High-frequency year-to-year patterns are therefore emphasized rather than low-frequency trends that may arise from autocorrelation that could result in one or more ''false positive'' matches. Only once did we fail to identify a ring boundary, resulting in one ring that should have been two separate rings. This ring was located using the diagnostic analyses in COFECHA (Grissino-Mayer 2001), and remeasured into the two correct rings.

We next standardized the series using CRONOL (Cook 1985) to remove the undesirable age-related growth trends and any trends possibly unrelated to climate (*i.e.* those that occur from stand-level processes, such as competition). To anchor the ''floating'' measurements in time, we used the standard index chronology created by CRONOL. The autocorrelation retained in the standard chronology was not problematic later in statistical crossdating using COFECHA because COFECHA removes such low-frequency trends prior to the crossdating tests (Grissino-Mayer 2001).

Because Koussevitzky bought the bass in France in the early 1900s, we assumed that the bass was made in Europe. To anchor the tree-ring dates firmly in time, we began by systematically crossdating the index chronology against all possible tree-ring chronologies for central Europe contained in the International Tree-Ring Data Bank (ITRDB) that extended back to at least AD 1500 created from species that grow at upper treeline: Norway spruce (*Picea abies* (L.) Karst.), European larch (*Larix decidua* Mill.), Swiss stone pine (*Pinus cembra* L.), and silver fir (*Abies alba* Mill.). We used COFECHA (Holmes 1983) to test consecutive 40-year segments of the double bass measurements lagged 20 years (1–39, 20–59, etc.) against 40-year segments from each candidate reference chronology (Grissino-Mayer 2001). Crossdating was considered achieved when the temporal placements suggested by COFECHA for all tested segments were identical and systematic (*i.e.* the highest or second highest correlations found for that segment). The result of the statistical crossdating was then visually confirmed graphically using skeleton plots and line graphs (Swetnam *et al.* 1985; Stokes and Smiley 1996).

RESULTS

The treble side of the bass contained 297 tree rings, whereas the bass side contained 298 rings, which initially suggested that the two halves of the spruce top contained identical tree rings. COFECHA revealed, however, that the two halves were offset by about 20 years, *i.e.* the treble side contained ring numbers 1 through 297 whereas the bass side contained ring numbers 20 through 317. The correlations between these two series were statistically significant for all 40-year segments tested (Table 1) and for the 278-year period of overlap ($r = 0.69$, $t = 15.84$, $p < 0.0001$). Together, the two series provided a continuous sequence 317 years in length, longer than any tree-ring sequence yet discovered on a musical instrument. The treble-side wing also dated significantly at relative ring position 206 to 240 ($r = 0.52$, $n = 35$, $t = 3.5$, $p < 0.0007$), whereas the bass-side wing section dated at ring position 215 to 251 ($r = 0.78$, $n = 37$, $t = 7.37$, $p < 0.0001$).

Using COFECHA, we found four candidate reference chronologies in the ITRDB from the Alpine region of central Europe that dated well against the Karr-Koussevitzky index chronology:

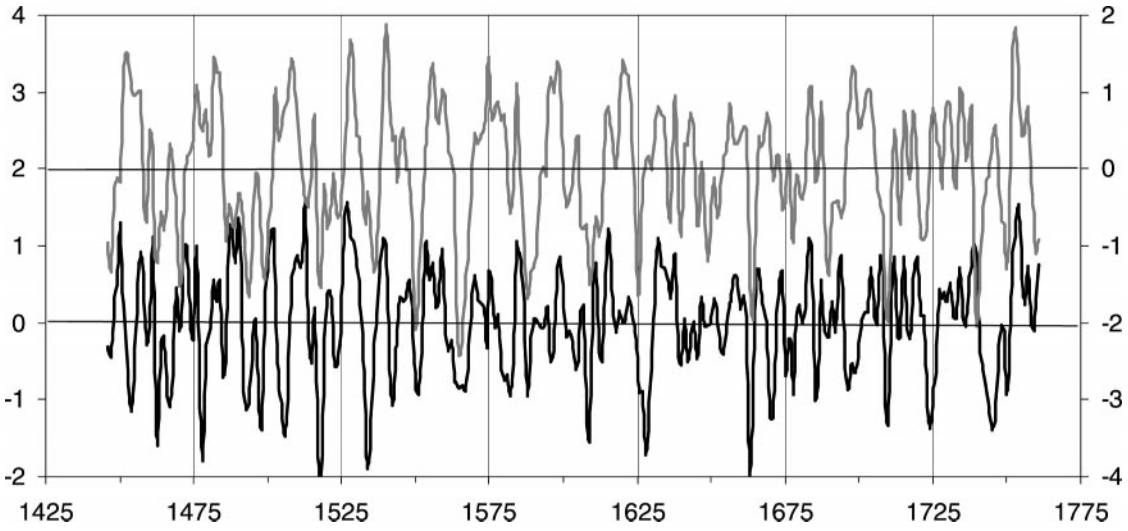

Figure 3. Comparison between the index chronology (upper) created from the Karr-Koussevitzky double bass and the combined chronology (lower) created from the four European Alpine chronologies ($r = 0.43$, $n = 317$, $t = 8.45$, $p < 0.0001$).

(1) Austria 101: Obergurgl, 46°52′N, 11°01′E, 2050 m, Norway spruce, AD 1276 to 1974, developed by Veronika Giertz-Siebenlist;
(2) Germany 019: Berchtesgaden, 47°40′N, 13°01′E, 1040 m, European larch, AD 1339 to 1947, developed by Bernd Becker;
(3) Switzerland 169: Simmental, 46°24′N, 7°26′E, 1900 m, Norway spruce, AD 1532 to 1986, developed by Fritz Schweingruber; and
(4) Italy 022: Pratomagno-Bibbiena, 43°40′N, 11°46′E, 1050 m, silver fir, AD 1539 to 1972, developed by Bernd Becker.

The index chronologies from these four sites were combined into one file, then entered into COFECHA as the dated series (COFECHA can read index chronologies and create a master dating series from these) and tested against the Karr-Koussevitzky undated index chronology. We found that fourteen of fifteen 40-year segments were significantly correlated with the combined chronology created by COFECHA from these four candidate chronologies, with an average correlation of 0.52 (average $t = 3.75$, $p < 0.0003$). For the entire 317-year period of overlap, the Karr-Koussevitzky index chronology correlated significantly with the chronology created from these four candidate chronologies ($r = 0.43$, $t = 8.45$, $p < 0.0001$). The results were confirmed by a convincing graphical match (Figure 3). The Karr-Koussevitzky double bass contains a 317-year tree-ring record that spans from AD 1445 to 1761.

DISCUSSION

The tree rings on the treble and bass sides of the double bass provide details on the possible construction of the instrument. Had the two halves been made from a single section of a quarter-sawn log that had been ‘‘butterflied’’ open, the ring measurements should have been near-identical and the correlations for the two sets of measurements should have shown considerable correspondence (*i.e.* coefficients that approach 1.0). The correlations for the tested segments are moderately high with a range from 0.50 to 0.85. We originally assumed that the two sets of rings would be identical, but because we measured along different radii on each side of the lower bout, the correlations could not approach 1.0. Nonetheless, because the correlations are statistically significant, we can conclude that the two halves did indeed come from the same tree, and possibly came from similar locations in the trunk of the spruce tree, but may not have come from the same billet of quarter-sawn wood. This conclusion is also supported by the 20-year offset of rings. Had the two halves been made

from the same billet of wood that had been ''butterflied'' open, no offset would have occurred.

The strength of the correlations between the ring measurements for the double bass and the reference chronologies strongly suggests that the source of wood used to make the instrument was the eastern Alpine region of Europe. The strongest relationship was found with the Obergurgl (Austria) Norway spruce chronology ($r = 0.44$, $n = 317$, $t = 8.7$, $p < 0.0001$), located at the Italian border, followed by the Simmental ($r = 0.33$, $n = 229$, $t = 5.3$, $p < 0.0001$) and Berchtesgaden ($r = 0.28$, $n = 317$, $t = 5.2$, $p < 0.0001$) chronologies. Based on these three sites, the likely location for the spruce tree harvested to make the Karr-Koussevitzky bass is the Alpine region of western Austria. The relationship with a site farther to the south in Italy (Pratomagno-Bibbiena; $r = 0.26$, $n = 222$, $t = 4.0$, $p < 0.0001$)) is unusual but not surprising. Although numerous tree-ring chronologies exist in the ITRDB for northern Italy, most did not extend far enough back in time to allow crossdating with the bass measurements.

The dates for the tree rings from the Karr-Koussevitzky bass do not support an attribution to the Amati brothers because the bass could not have been made in the early 17th Century. Based on its outermost ring of 1761, and because luthiers would necessarily remove some outer rings and sapwood during the planing process prior to joining the two halves of the spruce top, the spruce tree likely was harvested sometime after 1770. The year of construction also must factor in the seasoning of the wood, which usually takes about five years (Chandler 2001), giving a likely date of construction sometime between 1775 and 1790. Although the form of the bass resembled a form for a viola da gamba used by Stradivari, Stradivari died in 1737 and therefore could not be the maker, although the design was likely influenced by him.

If not made by the Amati brothers or by Stradivari, then by whom? The top arch, specifically the long arch that curves from top to bottom, is exceedingly long. Italian makers did not create such long arches, but Czech luthiers did. The cut of the F-holes is influenced by Stradivari but executed very much like the French. Furthermore, French luthiers were known to cut down instruments to make them more playable, and had this technique down to an art. This downsizing was very well done, better than most Czech work, while the design was inspired by Stradivari but was not Italian work. These observations suggest that the French most likely actually constructed the instrument. The French luthiers were masters at creating good copies of instruments made by the masters, an accepted practice that continues today. Furthermore, the bass was bought by Sergei Koussevitzky in France in the early 1900s. Based on these observations, attribution of the bass to a French maker is a logical choice.

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Appendix 1. Tree-ring measurements for the Karr-Koussevitzky double bass: treble side (karr03), bass side (karr06), treble side wing (trwing), and bass side wing (bawing).

karr03	1445	61	51	55	71	59					
karr03	1450	70	75	94	74	79	70	77	67	48	58
karr03	1460	64	49	43	45	48	44	46	43	48	36
karr03	1470	31	51	48	53	49	61	70	44	67	57
karr03	1480	53	70	75	62	65	45	46	46	46	48
karr03	1490	53	51	48	39	49	59	75	70	65	60
karr03	1500	67	84	107	103	83	118	116	135	139	119
karr03	1510	124	107	116	114	95	129	134	79	111	107
karr03	1520	93	109	107	110	92	131	117	130	148	111
karr03	1530	110	119	104	116	107	100	94	102	139	146
karr03	1540	159	115	126	112	96	122	100	98	89	79
karr03	1550	72	83	85	100	94	110	104	89	98	105
karr03	1560	94	80	85	72	58	54	61	62	82	91
karr03	1570	99	101	108	99	143	129	117	139	125	118
karr03	1580	125	96	88	109	127	91	99	53	63	66
karr03	1590	68	69	105	80	99	105	115	103	121	102
karr03	1600	82	91	89	105	101	102	84	98	75	84
karr03	1610	85	99	94	107	129	144	143	119	128	160
karr03	1620	163	156	155	135	122	99	117	147	117	135
karr03	1630	123	156	124	152	121	120	119	130	138	103
karr03	1640	107	127	107	136	100	98	103	115	91	89
karr03	1650	93	98	75	108	103	124	129	143	118	120
karr03	1660	106	111	104	74	71	88	86	84	99	77
karr03	1670	72	64	85	65	78	60	87	58	78	68
karr03	1680	66	64	68	130	105	89	112	85	83	54
karr03	1690	63	97	85	86	89	90	118	113	143	108
karr03	1700	109	124	117	127	114	85	90	78	78	50
karr03	1710	68	88	98	67	81	96	76	88	93	88
karr03	1720	90	72	81	73	112	83	91	74	71	90
karr03	1730	85	77	58	68	92	70	65	67	62	51
karr03	1740	42	49	999							
karr06	1464	44	33	59	51	44	50				
karr06	1470	39	44	49	52	53	55	60	58	59	56
karr06	1480	49	63	65	62	76	34	44	51	35	50
karr06	1490	47	45	55	45	47	67	72	70	44	76
karr06	1500	84	99	123	131	112	141	111	164	141	159
karr06	1510	144	132	120	132	119	145	136	80	108	125
karr06	1520	110	127	128	124	111	120	120	151	144	154
karr06	1530	130	145	106	127	123	122	81	122	106	154
karr06	1540	158	115	118	116	103	128	106	108	112	72
karr06	1550	70	86	97	101	101	126	117	99	110	108
karr06	1560	101	89	100	73	47	39	63	71	76	111
karr06	1570	115	96	127	116	150	120	105	123	105	120
karr06	1580	108	84	91	105	145	81	88	62	73	66
karr06	1590	69	79	92	83	90	130	104	114	133	105
karr06	1600	79	89	81	86	103	94	68	101	83	85
karr06	1610	94	102	84	121	123	110	114	118	114	136
karr06	1620	138	135	145	115	96	88	102	120	126	136
karr06	1630	106	151	120	140	116	102	88	129	122	79
karr06	1640	115	115	106	131	92	91	102	98	78	81
karr06	1650	77	89	82	122	118	129	146	127	124	121
karr06	1660	115	118	110	57	96	98	92	94	92	103
karr06	1670	80	88	99	91	80	78	95	60	90	81
karr06	1680	76	77	97	88	94	61	92	90	85	58
karr06	1690	78	82	69	69	60	79	95	96	106	92

Appendix 1. Continued.

karr06	1700	89	82	100	83	95	74	77	65	67	50
karr06	1710	58	66	83	53	67	96	53	71	78	65
karr06	1720	45	43	52	47	71	56	70	56	68	64
karr06	1730	67	71	60	66	65	53	53	61	58	30
karr06	1740	37	39	41	44	41	47	42	37	33	34
karr06	1750	26	40	52	44	38	33	36	34	25	27
karr06	1760	21	26	999							
trwing	1650	133	110	95	99	77	93	86	75	66	101
trwing	1660	95	90	78	59	69	94	142	99	113	118
trwing	1670	138	106	104	89	80	122	119	88	108	100
trwing	1680	99	102	113	146	110	999				
bawing	1659	100									
bawing	1660	94	123	103	72	89	107	103	95	104	108
bawing	1670	101	84	105	84	84	91	79	62	80	81
bawing	1680	98	77	99	91	86	65	84	99	83	53
bawing	1690	80	58	76	80	72	94	999			