

Understanding Rook Endgames

Article

Accepted Version

Haworth, G. (2017) Understanding Rook Endgames. ICGA Journal, 39 (2). pp. 145-150. ISSN 1389-6911 Available at <http://centaur.reading.ac.uk/65694/>

It is advisable to refer to the publisher's version if you intend to cite from the work. See [Guidance on citing](#).

Publisher: The International Computer Games Association

All outputs in CentAUR are protected by Intellectual Property Rights law, including copyright law. Copyright and IPR is retained by the creators or other copyright holders. Terms and conditions for use of this material are defined in the [End User Agreement](#).

www.reading.ac.uk/centaur

CentAUR

Central Archive at the University of Reading

Reading's research outputs online

Understanding Rook Endgames

Guy Haworth
Reading, UK¹

Understanding Rook Endgames (Müller and Konoval, 2016) or *URE* is the latest contribution of many to endgame lore by Gambit Publications, and is the first such work totally checked by 7-man and sub-7-man ‘EGT’ endgame table verification. It is available not only in paperback but on Apple/Android devices courtesy of the Gambit Chess Studio app, a particularly useful tool here for the mobile reader following the analysis.

Table 1
maxDTx data for the featured sub-8-man rook endgames.²

		maxDTx in winner's moves											
		1-0					0-1						
#	#m	w-b	Endgame	DTC	DTM	DTZ	DTZ ₅₀	DTZ ₅₀ '-fw	DTC	DTM	DTZ	DTZ ₅₀	DTZ ₅₀ '-fw
1	4	2-2	KRKP	16	32	13	13	—	11	43	10	10	—
2	5	3-2	KRPKR	60	74	35	35	—	7	33	7	7	—
3	6	4-2	KRPPKR	86	95	?	45	—	8	42	?	8	—
4	6	3-3	KRPKRP	41	116	?	37	11	41	116	?	37	11
5	7	4-3	KRPPKRP	79	217	?	?	?	41	144	?	?	?
6	7	4-3	KQRPKQR	82	137	?	?	?	94	145	?	?	?
7	7	4-3	KRRPKRR	135	295	?	?	?	27	82	?	?	?

The authors scarcely need any introduction. Karsten Müller is the major and most generous purveyor of endgame wisdom via magazines, training DVDs and books (2001, 2008, 2016). Yakov Konoval was the first computer scientist to create a program efficient enough to generate 7-man EGTs in reasonable time. His fruitful partnership with Marc Bourzutschky not only addressed all 7-man endgames but set new standards in the independence of EGT-verification. New depth records were repeatedly set, in this case to the Depth to Conversion metric *DTC*. New chessic knowledge and insights were also created and many games and studies were highlighted where optimal moves had previously been missed. Having said that, the existence of definitive EGTs benchmarks also highlights the excellence of endgame play at the top level. The 7-man findings of Bourzutschky and Konoval (2006-13) appeared often in the magazine *EG* and were reviewed in the *ICGA Journal* (Haworth, 2005-13). A page on the authors themselves would have been an interesting addition.

¹ 33, Alexandra Rd., Reading, Berkshire, RG1 5PG, UK. Email: g.haworth@reading.ac.uk

² DTM ≡ Depth to Mate. DTZ ≡ Depth to Zeroing of the move-count. The DTZ₅₀ metric considers the 50-move-draw rule and indicates possibly-modified depths: frustrated wins, *fw*, are ‘draws’. DTZ₅₀' also gives depths to frustrated wins. DTZ₅₀' and therefore DTZ₅₀ have been calculated for all 6-man endgames whereas DTZ has not.

Table 2
The structure of URE's KRPPKRP analysis.

#	§	Class	Configs.	pages	Games		Draws		Wins		Subsections (P-file configs., ...)
					Total	#	%	#	%		
01	4.3	No passed pawns, and pawns connected	7	28	67-95	24,007	13,144	55	10,863	45	7 hg-h/g, fg-g/f, ef-f/e, de-d
02	4.4	No passed pawns, and pawns isolated	3	4	95-99	4,487	2,753	61	1,734	39	1 fh-g, eg-f etc
03	4.5	The attacker has a connected passed pawn	6	29	99-128	12,358	5,478	44	6,880	56	6 hg-f, gf-e/h, fe-d/g, ed-f
04	4.6	The attacker has a nearby, isolated passed pawn 'apP'	25	20	128-148	25,510	13,962	55	11,548	45	6 hf-h, eg-g/h, eh-g/h, apP on c-f
05	4.7	One outside passed pawn	26	27	148-175	36,677	17,017	46	19,660	54	15 ah/cg-g/h, bg-f/g/h, af-f/g, ...
06	4.8	All passed pawns, connected and close	9	5	175-180	12,116	3,716	31	8,400	69	4 Assorted R/K/P properties
07	4.9	All passed pawns, connected and far apart	6	13	180-193	15,788	4,781	30	11,007	70	5 ab-f/g/h, bc-g/h
08	4.10	Attacker's pawns passed, isolated and close together	16	4	193-197	13,383	7,288	54	6,095	46	3 ac/bd-pP, (e.g.) eh-b
09	4.11	Attacker's pawns passed, isolated and far apart	14	7	197-204	13,902	7,326	53	6,576	47	1 Many cases and motifs
10	4.12	Doubled pawns versus pawn	32	5	204-208	5,765	3,869	67	1,896	33	1 Again, a variety of themes
Totals KRPPKRP			144	142		163,993	79,334	48	84,659	52	49

Some 10% of games arrive at a rook endgame, and the main focus of this new book is on KRPPKRP to which 160 pages are devoted. The preparatory material necessarily includes KRPKR (14pp), KRPPKR (23pp), KRKP (4pp) and KRPKRP (11pp), and refers to the earlier rook-endgame work of Müller (2001, 2008) and Nunn (1992, 2009, 2010). The last endgames highlighted are KQRPKQR and KRRPKRR (7pp). Each chapter is laced with history, corrections to past analysis, new discoveries and exercises for the reader. Closing out, there are chapters on principles of play, theoretical endgames, historic games and solutions to the exercises. There are comprehensive indexes on players, composers and analysts: all world champions across 130 years from Steinitz to Carlsen have contributed examples of play.

Examples of longest wins are listed as usual and will fascinate those interested in the most profound, subtle and inscrutable play, especially as the initial positions are unlikely to occur on the board. See Tables 1 and 3 here, and Haworth (2017) for extended statistics and lines of play. The practical player will be more assisted by the three tables of statistics, showing the distribution and win/draw profile of actual games across the various parts into which the endgames are divided. KRPKR for example is simply studied in terms of the four files for the pawn: a/h, b/g etc. The b/g files feature the most games (18,830 of 60,802) and the highest likelihood of winning (48%).

KRPPKRP is divided according to whether there are passed pawns or not. Winning chances are 31% on average with maxDTC (per Pp-file arrangement) varying from 25 moves for KRP(a)KRP(b) to 41 for KRP(a)KRP(c).

Devising a taxonomy for KRPPKRP is the data-mining grand challenge solved by this book. There are 144 configurations of the pawns³ and these are discussed under ten themes based mainly on the relative positions of the pawns' files, see Table 2 which is based on the book's p66. Sub-configurations are again

³ Exercise for the reader? Black pawn on files a-d; White pawns on aa/ab/.../hh; $4 * C(2+7, 2) = 4 * (9 * 8/2) = 144$.

usually in terms of specific files for the pawns – ab-a (the most common, 46% wins), bc-a (63% wins), gh-a (69% wins) etc. Even where pawn-files are not used, readers should easily be able to find the relevant part of the KRPPKRP chapter.

Table 3
Some highlighted rook endgame positions, with references to *URE*.

#	#m	w-b	Endgame	FEN	Pos. #	Val.	dtc	dtm	dtz ₅₀	Notes
01	4	2-2	KRKP	5K2/8/p7/8/k7/8/3R4/8 b	—	1-0	-16	-26	-7	a maxDTC KRKP win
02	5	3-2	KRPKR	6K1/3k2P1/8/8/8/7r/4R3 w	1.01	1-0	7	20	7	the 'Lucena' win
03	5	3-2	KRPKR	1r3k2/R7/8/5PK1/8/8/8/8 b	1.03	=	=	=	=	the Philidor draw (1777): wtm wins, dtm=24
04	5	3-2	KRPKR	5k2/R7/6K1/5P2/8/8/8/1r6 b	1.05	=	=	=	=	the Karstedt draw (1909): wtm wins, dtm=23
05	5	3-2	KRPKR	r7/4K1k1/3RP3/8/8/8/8 b	1.07	=	=	=	=	the Tarrasch (1906) draw: wtm also draws
06	5	3-2	KRPKR	R7/6k1/P4r2/8/3K4/8/8/8 w	1.17	=	=	=	=	the Vančura draw (1924)
07	5	3-2	KRP(a/h)KR	k7/8/8/K7/7R/8/7P/3r4 w	1.26	1-0	51	65	25	a maxDTC KRP(a/h)KR win
08	5	3-2	KRP(b/g)KR	k7/8/7r/8/8/4R3/6P1/1K6 w	1.25	1-0	60	74	33	a maxDTC KRPKR win
09	5	3-2	KRP(c/f)KR	8/2r4k/8/8/8/8/2P5/RK6 w	1.24	1-0	57	72	33	a maxDTC KRP(c/f)KR win
10	5	3-2	KRP(d/e)KR	k7/8/8/K6R/8/6r/1/4P3/8 w	1.23	1-0	59	71	33	a maxDTC KRP(d/e)KR win
11	6	4-2	KRP(e)P(g)KR	8/8/8/8/K4r2/8/1k2P1P1/4R3 w	2.36	1-0	70	89	9	a maxDTC KRP(e)P(g)KR win
12	6	4-2	KRP(e)P(h)KR	8/8/8/2K5/5k2/1R6/4P2P/5r2 w	2.35	1-0	75	91	26	a maxDTC KRP(e)P(h)KR win
13	6	4-2	KRP(g)P(h)KR	8/8/8/8/1k6/3r2P1/7P/K6R w	2.34	1-0	86	95	45	a maxDTC KRPPKR win
14	6	3-3	KRP(b)KRP(e)	8/4p3/1RK5/8/8/8/1P4r1/7k w	—	1-0	41	69	1	a maxDTC ('be/gd') KRPPKR win
15	6	3-3	KRP(h)KRP(f)	8/r4p2/8/4R3/8/K7/7P/k7 w	—	1-0	41	67	8	also 'ac': a maxDTC KRPPKR win
16	7	4-3	KRPPKRP	4R3/6p1/r2K4/k7/8/8/P4P2/8 w	4.15.01	1-0	79	114	?	a maxDTC KRPPKRP (af-g) win
17	7	4-3	KRPPKRP	8/8/5pP1/5P2/8/6k/5R2/K7 w	4.15.08	1-0	51	82	?	a 50-move-rule draw: 1. Rf1!! Rg2
18	7	4-3	KQRPKQR	6k1/5q2/8/8/4r3/2R5/1Q4P1/K7 w	4.17.03	1-0	82	104	?	a maxDTC KQRPKQR win
19	7	3-4	KQRKQRP	r6Q/8/4q3/8/2k5/8/p3R3/2K5 w	4.17.04	1-0	94	104	?	a maxDTC KQRKQRP win after 94 checks
20	7	3-4	KRPKRPP	2R5/p7/p7/2P5/8/rk6/8/2K5 w	4.18.06	1-0	41	63	?	a maxDTC KRPKRPP win
21	7	4-3	KRRPKRR	8/8/1r6/2R5/8/1k1K3P/1r6/2R5 w	8.06	1-0	135	154	?	a maxDTC KRRPKRR win
22	7	4-3	KRPPKRP	2r4k/7P/8/8/1p1K4/1P2R3/8/8 w	4.14.03	1-0	8	52	?	Komodo-Stockfish (2013), 71w. 71. Rh3?
23	7	4-3	KRPPKRP	6k1/5p2/1R6/8/8/8/P4P1r/5K2 w	4.15.09	1-0	61	92	?	Lauronen-Kivipelto, 34w. 34. a4? (34. Ke2)
24	7	3-4	KRPKRPP	k7/5R2/6Kp/2r3pP/8/8/8/8 b	4.18.05	=	=	=	=	Levenfish and Smyslov (1957). 1. ... Rc6+!!
25	11	5-6	KRP(3)KRP(4)	8/p1r4p/1p4p1/6k1/P7/5RKP/5P2/8 b	7.07	=	=	=	=	Botvinnik-Fischer (1962). 45. ... Rc5 46. Rf7
26	7	3-4	KRPKRPP	R7/8/P4ppk/8/r7/5K2/8/8 b	4.9.18	0-1	14	35	1	Euwe-Grünfeld: 3 mutual zugs in a variation
27	7	4-3	KRPPKRP	8/1k6/1P6/3p4/7r/1R1K1P2/8/8 b	Cover	1-0	-25	-50	?	mutual zugzwang: wtm draws
28	7	4-3	KRPPKRP	8/4k3/8/3P1R2/5K2/3r2p1/6P1/8 b	Cover	1-0	-13	-50	?	mutual zugzwang: wtm draws

The remainder of this review aims to capture the range and depth of research, and the flavour of the book's text, using just six Table 3 positions (#02 and #22-26) as illustrated in Figure 1.

No book on rook endgames is complete without the misnamed KRPKR 'Lucena' position which is traced back (Nunn, 1992, #179; Winter, 2016) to Salvio (1634) rather than to de Lucena (1497). This shows a common winning technique: the pawn when off the edge allows the king and rook to line up together behind it to exploit the opposing rook's lack of diagonal mobility. "**1. Re4**. The rook moves up the board to provide a shield for the king. **1. ... Rh1 2. Kf7 Rf1+ 3. Kg6 Rg1+ 4. Kf6 Rf1+** (4. ... Kd6 5. Re6+ Kd7 6. Re5 Rg2 7. Rg5 +-) **5. Kg5 Rg1+ 6. Rg4 +-**. This technique is often referred to as 'building a bridge', with White's king and rook forming the pillar in the middle. The Lucena win can also be used with a bishop's or central pawn."

KOMODO-STOCKFISH shows that even a top class chess engine can be confounded by a zugzwang. "**71. Rh3?** (71. Kd5! Rc3 72. Ke4! Rc5 73. Rh3) **Rc6 72. Ke4 Rc5** and now White is to move in the mutual zugzwang. **73. Rd3 Kxh7 74. Rd4 Kg7 75. Rxb4 [KRPKR] Kf6 76. Kd4 Rg5 77. Kc4 Ke6 78. Rb5 Rg1 79. Kc5 Kd7 80. Rb7+ Kc8 81. Rb6** and the game was later drawn." There are other examples in the 'computer games' §4.14 of engines struggling with fortresses and positional draws.

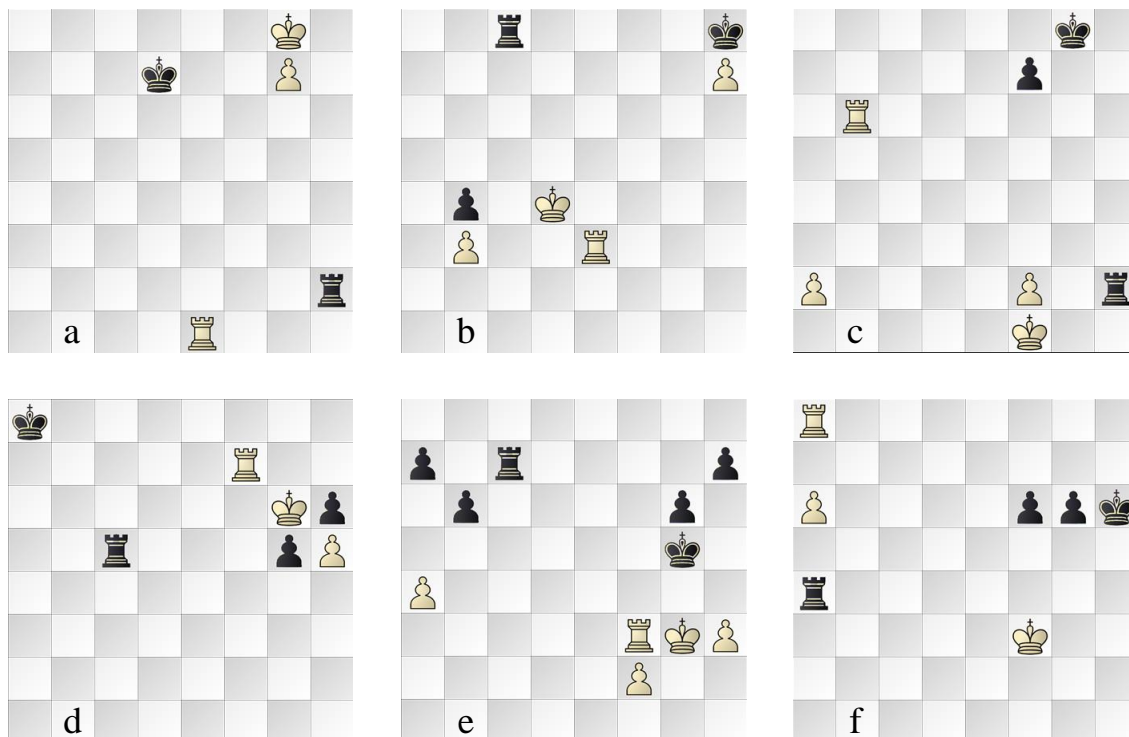


Fig. 1. Table 3 positions: a) #02 'Lucena', b) #22 KOMODO-STOCKFISH, c) #23 Lauronen-Kivipelto, d) #24 Levenfish and Smyslov, e) #25 Botvinnik-Fischer and f) #26 Euwe-Grünfeld.

Lauronen-Kivipelto includes the DTC-deepest KRPPKRP position which has occurred over the board: $dtc = 61$ compared with the $maxDTC$ of 79 moves.⁴ “**34. a4?** The win starts with 34. Ke2! Rh4 35. a3! Kg7 36. Rb2! Ra4 37. Ra2! **34. ... Rh1+?** (34. ... Rh5=) **35. Ke2 Ra1 36. Rb4 Ra3 37. f4?** (37. Rf4) **37. ... Kg7 38. Kd2 Kg6 39. Kc2 Kf5 40. Kb2 Rh3 41. a5 Kg4 42. a6 Rh6 43. Ra4 Rh8 44. Kc3 f5 45. a7 Ra8 46. Kd3 Kf3 47. Kd2 Rd8+ 48. Ke1 Re8+ 49. Kf1 Ra8 50. Kg1 Rg8+ 51. Kf1 Ra8 52. Ke1 Re8+ 53. Kd2 Rd8+ 54. Kc3 Ra8 55. Kd3 Kg4?** (55. ... Kg3=) **56. Ke3 Re8+ 57. Kf2 Ra8 5s8. Kg2 Kh4 59. Kf3 Kh5 60. Ra6 1-0.**”

The position from Levenfish and Smyslov (1986, 1989), originally published in 1957, has already been analysed by Nunn (2014) in his EGT-assisted revisit of that book. The URE text: "According to Levenfish and Smyslov, White wins, but Black has a nice draw: **1. ... Rc6+** (1... g4? **2. Kxh6 g3** (2. ... Rc6+ **3. Kh7 Kb8 4. Rf4 g3 5. Rg4 Rc3 6. Kg6 +-)** **3. Rg7 Rc3 4. Rg4 Ka7 5. Kg5 +-)** **2. Kh7 Kb8 3. Rg7 Kc8?** This move loses as does **3. ... Rc7?** **4. Kxh6 Rxg7 5. Kxg7 g4 6. h6 +-.** Black can hold by **3. ... g4 4. Rxg4 Kc7 5. Rg6 Rc5!! 6. Kxh6 Kd7!** = or **3. ... Rd6 4. Rg6 Kc7 5. Kxh6 g4 6. Kh7 Rd7+ 7. Kg8 Rd8+ 8. Kf7 Rd5!!** (Levenfish and Smyslov missed this tactical nuance) **9. h6 Rd7+ 10. Ke6 Rd6+ 11. Kf5 Rxg6** and White doesn't have **hxg6**. The move **8. ... Rd5!!** was also found by John Nunn. **4. Rg6 Kb7 5. Kxh6 g4 6. Kh7 Rc7+ 7. Kg8 Rc8+ 8. Kf7 Rc5 9. h6 Rc7+ 10. Kg8 Rc8+ 11. Kh7 Rc7+ 12. Rg7 g3 13. Kh8! +-.**”

From the Historic Games chapter, the only Botvinnik-Fischer confrontation. "One of the most famous adjourned games. Fischer had sealed **45. ... Rc5. 46. Rf7 Ra5 47. Rxb7**. The Soviet team had analysed all

⁴ #8.05, Dyckhoff-Eliskases (1930), 0-1: KRRKRRP, 4R3/3r4/8/8/2K1p2R/5k2/4r3/8 b - - 12 69, $dtc = 79$ moves. The 50-move rule might have intervened with best defence but White resigned on move 86.

night long and established that Geller's fantastic idea was sufficient for a draw. This concept of fighting against Black's queenside pawns had escaped Fischer's attention. **47. ... Rxa4 48. h4+ Kf5 49. Rf7+ Ke5 50. Rg7 Ra1 51. Kf3 b5?! After 51... Kd4 52. Rxc6 b5 53. h5 b4 54. h6 b3 55. Rg4+ Kc5 56. Rg5+ Kc6 57. Rg6+ Kb7 58. Rg7+ Ka6 59. Rg6+ Ka5 60. Rg5+ Ka4 61. Rg4+ Ka3 62. Rh4 b2 63. h7 b1=Q 64. h8=Q Qb3+ 65. Ke2 Qd1+ 66. Ke3 Rb1** Fischer claimed that Black wins in *My 60 Memorable Games*. But Botvinnik found that **67. Qf8+ Ka2 68. Qc5** draws and the 13-year-old Garry Kasparov even found a second drawing method in a session of the Botvinnik school: **67. Rc4! =. 52. h5! Ra3+ 53. Kg2 g5 54. Rg5+ Kd6 55. Rxb5 [KRPKRPP, =] h4 56. f4 Kc6 57. Rb8 h3+ 58. Kh2 a5 59. f5 Kc7 60. Rb5 Kd6 61. f6 Ke6 62. Rb6+ Kf7 63. Ra6 Kg6 64. Rc6 a4 65. Ra6 Kf7 66. Rc6 Rd3 67. Ra6 a3 68. Kg1** 'With a face as white as a sheet, Fischer shook my hand and left the hall with tears in his eyes' (Botvinnik)."

Euwe-Grünfeld (1921) features three mutual zugzwangs in a variation just off the played line. "This is a well-known theoretical position. **48. ... Kg5?** Black's king should not move in front of the pawns. One sample win is **48. ... f5 49. a7 Kg7 50. Kg3 g5 51. Kf3 Ra3+ 52. Kg2 g4 53. Kf2 f4 54. Rb8 Rxa7 55. Rb4 Ra2+ 56. Kg1 Ra1+ 57. Kf2 g3+ 58. Kg2 Ra2+ 59. Kg1 Rf2 +-. 49. a7 Kf5 50. Kg3?** This curious error also occurs in *Dvoretzky's Endgame Manual* (though corrected in the 4th edition of 2014), Levenfish and Smyslov's famous rook endings book and several practical games. The correct line is **50. Kg2 Ra2+ 51. Kg3 g5 52. Kf3 Ra3+ 53. Kg2 Kg4 54. Rf8 Ra2+ 55. Kg1 Rxa7 56. Rxf6 Kg3 57. Rf1 =. 50. ... Ra3+?** After **50. ... Ra2!** with mutual zugzwang, Black wins, e.g., **51. Kf3 g5 m2 52. Kg3 (52. Ke3 g4 m2) 52. ... g4 53. Rb8 Ra3+ 54. Kf2 Rxa7 +-. 51. Kf2 Ra2+ 52. Kg3 Kg5 53. Kf3 f5 54. Kg3 Ra3+ 55. Kg2 f4 56. Kf2 Kg4 57. Rg8 Ra2+ 58. Kg1 Rxa7 59. Rxc6+ Kf3 60. Rf6 Ra1+ 61. Kh2 Re1 62. Rf8 Re4 63. Kg1 Re1+ 64. Kh2 Rf1 65. Ra8 1/2-1/2."**

Players at all levels will benefit from URE's new approach and insights into rook endgames, particularly KRPPKRP. There are many mansions in the world of chess: the game, the study, the puzzle, the statistics and the historical heritage. Whatever one's interest, there is much to discover, savour, absorb and enjoy here. The Gambit team's professional editorial and production standards are well in evidence with an intriguing 'deus ex machina' cover, balanced coverage edited by Graham Burgess, typesetting by Petra Nunn and a perceptive foreword from John Nunn with his own choice of highlights. *Understanding Rook Endgames* is a major and definitive step forward on the topic, sets the bar high and will surely be the reference text for years to come. It entertains as much as it educates and is thoroughly welcome and recommended from all points of view.

My thanks to Yakov Konoval for tabular data which could not be accommodated in URE, to colleagues for supplementary information, and to Eiko Bleicher (2017), Ronald de Man and Niklas Feikas (2017), John Tamplin (2017) and Victor Zakharov (2017) for the service provided by their DTC, DTM and DTZ₅₀' EGT-query sites.

REFERENCES

- Bleicher, E. (2017). <http://www.k4it.de>. EGT-query service on Nalimov-style sub-6-man DTC/Z EGTs.
- Bourzutschky, M. and Konoval, Y. (2006-13) Findings from 7-man DTC EGTs. *EG* issues 11.162, 17.185/6, 18.188/190 and 19.191.
- De Lucena, L. R. (1497). *Repetición de Amores y Arte de Ajedrez con 101 Juegos de Partido*. Online copy at <http://preview.tinyurl.com/hojcn5v>.
- Dvoretzky, M. (2003). *Dvoretzky's Endgame Manual*. Russell Enterprises. 4th edition, 2014.

- Fiekas, N. (2017). <https://syzygy-tables.info/>. Query service on de Man's 'syzygy' DTZ₅₀' EGTs.
- Haworth, G. M^cC. (2005-13) Reviews of MB/YK 'EG' articles on 7-man DTC EGT discoveries. *ICGA Journal* issues 28.4, 32.4, 34.2, 35.2, 36.1 and 36.2.
- Haworth, G. M^cC. (2017). <http://centaur.reading.ac.uk/65694/>. This review plus supplementary data and pgn file.
- Левенфиш, Г., Смыслов В. (1986). *Теория ладейных окончаний*, (The Theory of Rook Endings), 3rd revised and extended edition. YoYo Media, Moscow.
- Levenfish G. and Smyslov, V. (1989). Rook Endings. 2nd revised edition. Batsford. ISBN 978071-3458091.
- Müller, K. (2014). Chess Endgames. DVD series. Chessbase.
- Müller, K. and Lamprecht, F. (2001). *Fundamental Chess Endings*, Gambit, esp. chapter 6.
- Müller, K. and Konoval, Y. (2016). *Understanding Rook Endgames*. Gambit. ISBN-13 978191-0093818.
- Müller, K. and Pajeken, W. (2008). *How to Play Chess Endgames*. Gambit. ISBN-13: 978190-4600862.
- MVL team (2017). <http://tb7.chessok.com/probe>. DTM-evaluation service for sub-8-man endgames.
- Nunn, J. (1992). *Secrets of Rook Endings*. Gambit. Second edition (1999). ISBN-13: 978190-1983180.
- Nunn, J. (2009). *Understanding Chess Endgames*, Gambit. ISBN-13: 978190-6454111.
- Nunn, J. (2010). *Nunn's Chess Endings Volume 2*, Gambit, esp. chapter 8. ISBN-13: 978190-6454234.
- Nunn, J. (2014). Discoveries in R+2P v R+P Endings. *ICGA Journal*, Vol. 36, No. 3, pp. 139-142.
- Salvio, A. (1634). *Il Puttino*. Online copy at <http://preview.tinyurl.com/h8ckttg>.
- Tamplin, J. (2017). <http://chess.jaet.org/endings/> DTC/Z/Z₅₀ EGT-query service.
- Winter, E. (2014). The Lucena Position. <http://www.chesshistory.com/winter/extra/lucena.html>.
- Zakharov, V. (2016). <http://tb7.chessok.com/>. The 'MVL' query-service on the Lomonosov sub-8-man DTM EGTs.