

---

## Contents

<b>Preface</b> .....	vii
<b>Contributors</b> .....	xi
<b>Abbreviations and Notations</b> .....	xiii
<b>1 Introduction</b> .....	1
1.1 Morphometrics Today .....	1
1.2 Shapes and Configurations .....	3
1.3 An R Approach to Morphometrics .....	5
1.4 Starting with R .....	9
1.4.1 Expression, Assignment and Other Basics .....	9
1.4.2 Objects .....	10
1.4.3 Functions .....	17
1.4.4 Operators .....	21
1.4.5 Generating Data .....	21
1.4.6 Loops .....	23
Problems .....	24
<b>2 Acquiring and Manipulating Morphometric Data</b> .....	25
2.1 Collecting and Organizing Morphometric Data .....	25
2.1.1 Collecting Data .....	25
2.1.2 Organizing Data .....	27
2.2 Data Acquisition with R .....	31
2.2.1 Loading and Reading R Datafiles .....	31
2.2.2 Entering Data by Hand .....	32
2.2.3 Reading Text Files .....	32
2.2.4 Reading and Converting Image Files .....	33
2.2.5 Graphical Visualization .....	35
2.2.6 Image Analysis and Morphometric Data Acquisition with R .....	41
2.3 Manipulating and Creating Data with R .....	48

2.3.1	Obtaining Distance from Coordinates of Points . . . . .	49
2.3.2	Calculating an Angle from Two Interlandmark Vectors . . . . .	50
2.3.3	Regularly Spaced Pseudolandmarks . . . . .	51
2.3.4	Outline Smoothing . . . . .	54
2.4	Saving and Converting Data . . . . .	56
2.5	Missing Data . . . . .	60
2.5.1	Estimating Missing Measurements by Multiple Regression . . . . .	60
2.5.2	Estimating Missing Landmarks on Symmetrical Structures . . . . .	61
2.6	Measurement Error . . . . .	63
2.6.1	Sources of Measurement Error . . . . .	63
2.6.2	Protocols for Estimating Measurement Error . . . . .	65
	Problems . . . . .	66
<b>3</b>	<b>Traditional Statistics for Morphometrics . . . . .</b>	<b>69</b>
3.1	Univariate Analyses . . . . .	69
3.1.1	Visualizing and Testing the Distribution . . . . .	70
3.1.2	When Data are Organized in Several Groups . . . . .	72
3.2	Bivariate Analyses . . . . .	80
3.2.1	Graphics . . . . .	80
3.2.2	Analyzing the Relationship Between two Distance Measurements . . . . .	81
3.2.3	Analyzing the Relationship Between Two Distance Measurements in Different Groups . . . . .	84
3.2.4	A Short Excursion to Generalized Linear Models . . . . .	89
3.2.5	Interspecific Measurements and Phylogenetic Data . . . . .	92
3.2.6	Allometry and Isometry . . . . .	95
3.3	Size: A Problem of Definition . . . . .	98
3.4	Multivariate Morphometrics . . . . .	105
3.4.1	Visualization of More than Two Distance Measurements . . . . .	105
3.4.2	Principal Component Analysis . . . . .	106
3.4.3	Analyzing Several Groups with Several Variables . . . . .	111
3.4.4	Analyzing Relationships Between Different Sets of Variables . . . . .	124
3.4.5	Comparing Covariation or Dissimilarity Patterns Between Two Groups . . . . .	128
	Problems . . . . .	129
<b>4</b>	<b>Modern Morphometrics Based on Configurations of Landmarks . . . . .</b>	<b>133</b>
4.1	The Truss Network Approach of Strauss and Bookstein . . . . .	133
4.2	Superimposition Methods . . . . .	138
4.2.1	Removing the Size Effect . . . . .	139
4.2.2	Baseline Registration and Bookstein Coordinates . . . . .	141
4.2.3	Procrustes Methods and Kendall Coordinates . . . . .	148
4.2.4	The Kendall Shape Space and the Tangent Euclidean Shape Space . . . . .	166
4.2.5	Resistant-fit Superimposition . . . . .	170

4.3	Thin-Plate Splines .....	181
4.4	Form and Euclidean Distance Matrix Analysis .....	189
4.5	Angle-based Approaches for the Study of Shape Variation .....	198
	Problems .....	203
<b>5</b>	<b>Statistical Analysis of Outlines .....</b>	<b>205</b>
5.1	Open Outlines .....	206
5.1.1	Polynomial Curves .....	206
5.1.2	Splines .....	207
5.1.3	Bezier Polynomials .....	209
5.2	Fourier Analysis .....	212
5.2.1	Fourier Analysis Applied to Radii Variation of Closed Outlines .....	213
5.2.2	Fourier Analysis applied to the Tangent Angle .....	217
5.2.3	Elliptic Fourier Analysis .....	221
5.3	Eigenshape Analysis and Other Methods .....	229
	Problems .....	232
<b>6</b>	<b>Statistical Analysis of Shape using Modern Morphometrics .....</b>	<b>233</b>
6.1	Explorative Analyses of the Shape Space .....	233
6.1.1	Landmark Data .....	234
6.1.2	Outlines .....	244
6.2	Discriminant and Multivariate Analysis of Variance .....	248
6.2.1	Outlines .....	248
6.2.2	Procrustes Data .....	251
6.3	Clustering .....	254
6.4	Morphometrics and Phylogenies .....	257
6.5	Comparing Covariation Patterns .....	262
6.6	Analyzing Developmental Patterns with Modern Morphometrics ...	267
6.6.1	Allometry .....	267
6.6.2	Developmental Stability .....	272
6.6.3	Developmental Integration .....	276
	Problems .....	279
<b>7</b>	<b>Going Further with R .....</b>	<b>281</b>
7.1	Simulations .....	281
7.2	Writing Functions and Implementing Methods .....	287
7.2.1	Generalities and Strategies .....	287
7.2.2	A Worked Example in R+C Programming: Contour Acquisition Revisited .....	289
7.3	Interfacing and Hybridizing R .....	293
7.3.1	Example 1: Creating an Animation with R and ImageMagick .....	293
7.3.2	Example 2: Using ImageMagick to Display High Resolution Images .....	296

7.4 Conclusion .....	297
Problems .....	298
<b>Appendix A: Functions Developed in this Text .....</b>	<b>299</b>
<b>Appendix B: Packages Used in this Text .....</b>	<b>301</b>
<b>References .....</b>	<b>303</b>
<b>Index .....</b>	<b>311</b>



<http://www.springer.com/978-0-387-77789-4>

Morphometrics with R

Claude, J.

2008, XVIII, 317 p., Softcover

ISBN: 978-0-387-77789-4