

Mathematics and Biosciences in Interaction

Managing Editor

Wolfgang Alt
Division of Theoretical Biology
Institute of Molecular and Cellular Botany
University of Bonn
Kirschallee 1
D-53115 Bonn
e-mail: wolf.alt@uni-bonn.de

Editorial Board

Fred Adler (Dept. Mathematics, Salt Lake City, UT, USA)

Mark Chaplain (Division of Mathematics, Dundee, Australia)

Andreas Deutsch (Center for Information Services and High Performance Computing (ZIH), Dresden, Germany)

Andreas Dress (CAS-MPG Partner Institute for Computational Biology, Shanghai, China)

David Krakauer (Santa Fe Institute, Santa Fe, NM, USA)

The Mathematics of Darwin's Legacy

Fabio A.C.C. Chalub
José Francisco Rodrigues
Editors

 Birkhäuser

Editors

Fabio A.C.C. Chalub
Departamento de Matemática
Universidade Nova de Lisboa
Quinta da Torre
2829-516 Caparica
Portugal
chalub@fct.unl.pt

José Francisco Rodrigues
Centro de Matemática e Aplicações Fundamentais
Universidade de Lisboa
Av Prof. Gama Pinto 2
1649-003 Lisbon
Portugal
rodrigue@ptmat.fc.ul.pt

ISBN 978-3-0348-0121-8 e-ISBN 978-3-0348-0122-5
DOI 10.1007/978-3-0348-0122-5

Library of Congress Control Number: 2011931958

2000 Mathematics Subject Classification: 92Bxx, 92B05, 92Dxx, 92D15, 92D25

© Springer Basel AG 2011

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in other ways, and storage in data banks. For any kind of use permission of the copyright owner must be obtained.

Cover design: deblik, Berlin

Printed on acid-free paper

Springer Basel is part of Springer Science+Business Media

www.birkhauser-science.com

*To Alice, who was born together with the idea of this book;
and Renata, without whom neither would be possible (FACCC).*

*To Mafalda and Francisco, who are beginning to read
while this book appears (JFR).*

Contents

Preface	1
<i>W.J. Ewens</i> What Changes Has Mathematics Made to the Darwinian Theory?	7
<i>P. Schuster</i> The Mathematics of Darwin's Theory of Evolution: 1859 and 150 Years Later	27
<i>R. Bürger</i> Some Mathematical Models in Evolutionary Genetics	67
<i>P. Jagers</i> Extinction, Persistence, and Evolution	91
<i>P. Taylor</i> Group Theory in Homogeneous Populations (Rescuing Darwin from the mud)	105
<i>J.M. Pacheco, F.C. Santos, M.O. Souza and B. Skyrms</i> Evolutionary Dynamics of Collective Action	119
<i>V.A.A. Jansen</i> On Kin and Group Selection, and the Haystack Model	139
<i>S. Mirrahimi, B. Perthame, E. Bouin and P. Millien</i> Population Formulation of Adaptive Meso-evolution: Theory and Numerics	159
<i>S. Méléard</i> Random Modeling of Adaptive Dynamics and Evolutionary Branching	175

<i>J.A.J. (Hans) Metz</i>	
Thoughts on the Geometry of Meso-evolution: Collecting Mathematical Elements for a Postmodern Synthesis	193
<i>M. Gyllenberg, J.A.J. (Hans) Metz and R. Service</i>	
When Do Optimisation Arguments Make Evolutionary Sense?	233
Bibliography	269
Index	289