

Paulo Célio Alves
Nuno Ferrand
Klaus Hackländer
Editors



Lagomorph Biology

Evolution, Ecology,
and Conservation

 Springer

Paulo C. Alves Nuno Ferrand Klaus Hackländer (Eds.)

Lagomorph Biology
Evolution, Ecology, and Conservation

Paulo C. Alves Nuno Ferrand Klaus Hackländer (Eds.)

Lagomorph Biology

Evolution, Ecology, and Conservation

With 78 Figures, 3 in Color, and 21 Tables

 Springer

Professor Dr. PAULO CÉLIO ALVES
Professor Dr. NUNO FERRAND
CIBIO
Centro de Investigação em Biodiversidade e Recursos
Genéticos and Faculdade de Ciências,
Universidade do Porto
Campus Agrário de Vairão
4485-661 Vairão, Vila do Conde
Portugal

Professor Dr. KLAUS HACKLÄNDER
Institute of Wildlife Biology
and Game Management
University of Natural Resources
and Applied Life Sciences
Gregor-Mendel-Str. 33
1180 Vienna
Austria

Library of Congress Control Number: 2007926606

ISBN: 978-3-540-72445-2 Springer Berlin Heidelberg New York

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, reuse of illustrations, recitation, broadcasting, reproduction on microfilm or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permissions for use must always be obtained from Springer-Verlag. Violations are liable for prosecution under the German Copyright Law.

Springer is a part of Springer Science + Business Media

springer.com

© Springer-Verlag Berlin Heidelberg 2008
Printed in Netherlands

The use of general descriptive names, registered names, trademarks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

Cover design: WMXDesign, illustrations by Jorge Coutinho
Typesetting and production: SPi

Printed on acid-free paper SPIN 11578802 31/3180/SPi 5 4 3 2 1 0

Preface

The idea to publish this book was born at the 2nd World Lagomorph Conference in Vairão, Portugal, in July 2004. Twenty-five years after the 1st World Lagomorph Conference, a vast amount of literature on this mammalian taxon had been published and it was time to bring together researchers from all over the world to present and discuss the latest knowledge about hares, rabbits, and pikas. After the first announcement for the meeting we received several encouraging e-mails, among them a very special one:

“We want to offer you and your committee congratulations and best wishes on holding the 2nd World Lagomorph Conference in Portugal 25 years after the 1st World Lagomorph Conference in Canada in 1979. The world’s lagomorph workers are a large, widely separated group with broadly different research programs, but, as Guelph showed, form a strongly united group with common interests when they get together like this. A statement on the present position of world lagomorphs, and its publication, are both timely and immensely valuable.

Good luck to you. Yours fraternally,

*Ken Myers, Australia, and Charles McInnes, Canada,
Convenors, 1st World Lagomorph Conference, Guelph, Canada, 1979”*

The approximately 150 participants from over 27 countries and all continents created a great atmosphere in Vairão, and the discussions promoted by the numerous talks, posters, and workshops certainly increased considerably the enthusiasm in working in such a fascinating mammal group. At the end of the conference, nearly all colleagues recognized that there is an urgent need to provide a comprehensive overview on the current fields in Lagomorph research. Therefore, we asked all participants in Vairão to submit manuscripts on their scientific work. As we did not intend to produce a classical conference proceedings, we also encouraged the participants to write reviews on some important issues, and we then made a peer-reviewed selection of the various topics. This book contains 26 contributions covering different topics in Lagomorph biology. All chapters are organized into sections. The first chapter, “Introduction to the Lagomorpha” by Joseph

Chapman and John Flux is an updated version of the introduction done in 1981 (Myers and McInnes 1981, Proceedings of the World Lagomorph Conference held in Guelph, Ontario, August 1979, University of Guelph). Here the reader will be introduced to the main aspects of taxonomy, ecology, behaviour, and conservation in Lagomorphs. In addition, the authors present a historical overview on the research activities in these fields.

Then, four chapters will highlight some reviews and aspects in *Palaeontology and Evolution* to understand how humans have contributed to the nearly world-wide distribution of rabbits and hares and to demonstrate the state-of-the-art in modern phylogenetics and phylogeography. In the section *Population Ecology and Dynamics* readers will gain insight into the general role of Lagomorphs in the ecosystems, how environmental conditions affect populations, and how scientists try to uncover the mechanisms of population dynamics. In the section that follows, *Physiology and Behaviour*, we will get deeper into Lagomorph biology and learn about reproduction and mother–young relationships as well as interspecific competition between Lagomorphs. Another major factor affecting population dynamics is covered in the section *Diseases*, in which the authors present all the current knowledge on important viral diseases and why these viruses are of interest for conservation and pest control. As some Lagomorph species are highly endangered while others are treated as pest, in the section *Conservation and Management* a number of chapters will contribute to a better understanding of this apparently antagonistic treatment of Lagomorph species. Here, readers will be updated on the current conservation status of each species and learn why some selected species should be managed and how this should be done.

We close the book by highlighting those aspects of Lagomorph biology that have been improved over the last 25 years, and then follow with some open aspects that should be, in our opinion, developed in the future.

This book evolved with the help of many colleagues who assisted in reviewing the submitted manuscripts. We want to thank Vilmos Altbäcker, David Hik, Karen Hodges, Robyn Hudson, Diana Pöttschacher, Toni Lavazza, John Litvaitis, Jérôme Letty, Pierre Mein, Dennis Murray, Greg Mutze, Benoist Schaal, Ferdy Rühle, Thomas Ruf, Andrew Smith, Becs Smith, Phil Stott, Jean-Denis Vigne, and Dan Williams. In addition, we appreciate the support of the team at Springer Heidelberg, especially Ursula Gramm and Dieter Czeschlik.

Paulo C. Alves, Nuno Ferrand, and Klaus Hackländer

Contents

Introduction to the Lagomorpha	1
<i>Joseph A. Chapman and John E.C. Flux</i>	
Palaeontology and Evolution	
Prehistoric and Historic Artificial Dispersal of Lagomorphs on the Mediterranean Islands	13
<i>Marco Masseti and Anna M. De Marinis</i>	
The Lagomorph Fossil Record and the Origin of the European Rabbit	27
<i>Nieves Lopez-Martinez</i>	
Inferring the Evolutionary History of the European Rabbit (<i>Oryctolagus cuniculus</i>) from Molecular Markers	47
<i>Nuno Ferrand</i>	
Phylogenetic Aspects of Nuclear and Mitochondrial Gene-Pool Characteristics of South and North African Cape Hares (<i>Lepus capensis</i>) and European Hares (<i>Lepus europaeus</i>)	65
<i>Franz Suchentrunk, Hichem Ben Slimen, and Hakan Sert</i>	
Population Ecology and Dynamics	
The World of Pikas	89
<i>Andrew T. Smith</i>	
When? Where? and for How Long? Census Design Considerations for an Alpine Lagomorph, the Collared Pika (<i>Ochotona collaris</i>)	103
<i>Shawn F. Morrison and David S. Hik</i>	
Weather Effects on Reproduction, Survival, and Body Mass of European Rabbits in a Temperate Zone Habitat	115
<i>Heiko G. Rödel and Dietrich von Holst</i>	
Ecosystem Engineering Effects of European Rabbits in a Mediterranean Habitat	125
<i>Lucía Gálvez, Antonio López-Pintor, José M. de Miguel, Germán Alonso, Marta Rueda, Salvador Rebollo, and Antonio Gómez-Sal</i>	

Forest-Fire Regime: The Missing Link to Understand Snowshoe Hare Population Fluctuations?	141
<i>Jean Ferron and Martin-Hugues St-Laurent</i>	
Introduced Lagomorphs as a Threat to “Native” Lagomorphs: The Case of the Eastern Cottontail (<i>Sylvilagus floridanus</i>) in Northern Italy	153
<i>Anna Vidus Rosin, Nicola Gilio, and Alberto Meriggi</i>	
Testing Multiple Hypotheses to Identify Causes of the Decline of a Lagomorph Species: The New England Cottontail as a Case Study	167
<i>John A. Litvaitis, Michael S. Barbour, Anne L. Brown, Adrienne I. Kovach, Marian K. Litvaitis, James D. Oehler, Brenda L. Probert, Douglas F. Smith, Jeffrey P. Tash, and Rafael Villafuerte</i>	
Physiology and Behaviour	
Many Common Odour Cues and (at Least) One Pheromone Shaping the Behaviour of Young Rabbits	189
<i>Benôist Schaal, Gérard Coureaud, Anne-Sophie Moncomble, Dominique Langlois, and Guy Perrier</i>	
Mother-Young and Within-Litter Relations in the European Rabbit <i>Oryctolagus cuniculus</i>	211
<i>Amando Bautista, Margarita Martínez-Gómez, and Robyn Hudson</i>	
Fertility and Infertility in the European Hare <i>Lepus europaeus</i> in Australia	225
<i>Philip Stott, Stephen Harris, and Nicole Wight</i>	
A Review of Competition between Rabbits (<i>Oryctolagus cuniculus</i>) and Hares (<i>Lepus europaeus</i>)	241
<i>John E.C. Flux</i>	
Diseases	
European Brown Hare Syndrome	253
<i>K. Frölich and A. Lavazza</i>	
How Many Caliciviruses are there in Rabbits? A Review on RHDV and Correlated Viruses	263
<i>Antonio Lavazza and Lorenzo Capucci</i>	
Geographic and Seasonal Variation in the Impact of Rabbit Haemorrhagic Disease on European Rabbits, <i>Oryctolagus cuniculus</i> , and Rabbit Damage in Australia	279
<i>Greg Mutze, Peter Bird, Brian Cooke, and Robert Henzell</i>	

Conservation and Management

Conservation of Endangered Lagomorphs 297
Andrew T. Smith

Managing the European Rabbit: Converging Interests Between Australian
 Research for Rabbit Control and European Research for their Conservation 317
Brian Cooke

Improving Rabbit Restocking Success: A Review of Field
 Experiments in France 327
Jérôme Letty, Jacky Aubineau, and Stéphane Marchandeu

Recovering the Endangered Riparian Brush rabbit (*Sylvilagus
 bachmani riparius*): Reproduction and Growth in Confinement
 and Survival after Translocation 349
*Daniel F. Williams, Patrick A. Kelly, Laurissa P. Hamilton,
 Matthew R. Lloyd, Elizabeth A. Williams, and James J. Youngblom*

Conservation of Critically Endangered Lagomorphs:
 The Tehuantepec Jackrabbit (*Lepus flavigularis*)
 as an Example 363
*Verónica Farías, Todd K. Fuller, Fernando A. Cervantes,
 and Consuelo Lorenzo*

A Review of the Biology and Conservation of the Amami Rabbit
 (*Pentalagus furnessi*) 369
Fumio Yamada

Concluding Remarks

Overview of Lagomorph Research: What we have learned
 and what we still need to do 381
Klaus Hackländer, Nuno Ferrand, and Paulo C. Alves

Appendix

Lagomorph Species: Geographical Distribution
 and Conservation Status 395
Paulo C. Alves and Klaus Hackländer

Subject Index 407

List of Contributors

ALONSO, GERMÁN
Departamento de Ecología, Facultad de Ciencias Biológicas
Universidad Complutense,
Madrid, Spain

ALVES, PAULO C.
CIBIO, Centro de Investigação em Biodiversidade e Recursos
Genéticos, Vairão
Departamento de Zoologia e Antropologia, Faculdade de Ciências,
Universidade do Porto
Portugal

AUBINEAU, JACKY
Office National de la chasse et de la Faune Sauvage,
Direction des Études et de la Recherche
Beauvoirsur-Niort, France

BARBOUR, MICHAEL S.
Department of Natural Resources, University of New Hampshire
Durham, USA

BAUTISTA, AMANDO
Centro Tlaxcala de Biología de la Conducta, UNAM-UAT
Tlaxcala, Mexico

BEN SLIMEN, HICHEM
Laboratoire de Génétique Moléculaire, Immunologie et Biotechnologie,
Faculté des Sciences de Tunis, Universitaire El Manar
Tunis, Tunisia

BIRD, PETER
Animal and Plant Control Group
Adelaide, SA, Australia

BROWN, ANNE L.

Department of Natural Resources, University of New Hampshire
Durham, USA

CAPUCCI, LORENZO

Istituto Zooprofilattico Sperimentale della Lombardia ed Emilia Romagna
"B. Ubertini"
Brescia, Italy

CERVANTES, FERNANDO A.

Laboratorio de Mastozoología, Instituto de Biología, Universidad Nacional
Autónoma de México
México

CHAPMAN, JOSEPH A.

President's Office, North Dakota State University
Fargo, ND, USA

COOKE, BRIAN

CSIRO Sustainable Ecosystems
Canberra, ACT, Australia
Present Address: Invasive Animals Co-operative Research Centre,
University of Canberra
Canberra ACT, Australia

COUREAUD, GÉRARD

Groupe d'Éthologie, Centre des Sciences du Goût
(UMR 5170 CNRS-Université de Bourgogne)
Dijon, France

DE MARINIS, ANNA M.

Istituto Nazionale per la Fauna Selvatica
Ozzano dell'Emilia (BO), Italy

DE MIGUEL, JOSÉ M.

Departamento de Ecología, Facultad de Ciencias Biológicas
Universidad Complutense
Madrid, Spain

FARÍAS, VERÓNICA

Department of Natural Resources Conservation,
University of Massachusetts
USA
Laboratorio de Mastozoología, Instituto de Biología, Universidad Nacional
Autónoma de México
México

FERRAND, NUNO

CIBIO, Centro de Investigação em Biodiversidade e Recursos
Genéticos, Vairão

Departamento de Zoologia e Antropologia, Faculdade de Ciências,
Universidade do Porto
Portugal

FERRON, JEAN

Vice-rectorat à la formation et à la recherche,
Université du Québec à Rimouski
Canada G5L 3A1

FLUX, JOHN E.C.

Ecological Research Associates NZ
Upper Hutt, New Zealand

FRÖLICH, K.

Institute for Zoo and Wildlife Research, Alfred-Kowalke-Str. 17
Berlin, Germany
Present Address: Tierpark Arche Warder, Langwedeler Weg 11
Warder, Germany

FULLER, TODD K.

Department of Natural Resources Conservation
University of Massachusetts
USA

GÁLVEZ, LUCÍA

Departamento de Ecología, Universidad de Alcalá. Edif. de Ciencias
Madrid, Spain

GILIO, NICOLA

Department of Animal Biology, University of Pavia
Italy

GÓMEZ-SAL, ANTONIO

Departamento de Ecología, Universidad de Alcalá. Edif. de Ciencias
Madrid, Spain

HACKLÄNDER, KLAUS

Institute of Wildlife Biology and Game Management
University of Natural Resources and Applied Life Sciences
Vienna, Austria

HAMILTON, LAURISSA P.
Endangered Species Recovery Program, Department of Biological Sciences,
California State University
Turlock, USA

HARRIS, STEPHEN
School of Biological Sciences, University of Bristol
Bristol BS8, UK

HENZELL, ROBERT
Animal and Plant Control Group
Adelaide, SA, Australia

HIK, DAVID S.
Department of Biological Sciences, University of Alberta
Edmonton, Canada T6C 2E9

HUDSON, ROBYN
Instituto de Investigaciones Biomédicas,
Universidad Nacional Autónoma de México
Mexico

KELLY, PATRICK A.
Endangered Species Recovery Program, Department of Biological Sciences,
California State University
Turlock, USA

KOVACH, ADRIENNE I.
Department of Natural Resources, University of New Hampshire
Durham, USA

LANGLOIS, DOMINIQUE
Unité de Recherche sur les Arômes
Dijon, France

LAVAZZA, ANTONIO
Istituto Zooprofilattico Sperimentale della Lombardia ed Emilia Romagna
“B. Ubertini”
Brescia, Italy

LETTY, JÉRÔME
Office National de la Chasse et de la Faune Sauvage, Direction des Études
et de la Recherche, CNERA Petite Faune Sédentaire de Plaine
Nantes, France

LITVAITIS, JOHN A.

Department of Natural Resources, University of New Hampshire
Durham, USA

LITVAITIS, MARIAN K.

Department of Natural Resources, University of New Hampshire,
Durham, USA

LLOYD, MATTHEW R.

Endangered Species Recovery Program, Department of Biological Sciences,
California State University
Turlock, USA

LOPEZ-MARTINEZ, NIEVES

Departamento Paleontología, Facultad Ciencias Geológicas,
Universidad Complutense
Madrid, Spain

LÓPEZ-PINTOR, ANTONIO

Departamento de Ecología, Facultad de Ciencias Biológicas,
Universidad Complutense
Madrid, Spain

LORENZO, CONSUELO

El Colegio de la Frontera Sur, San Cristóbal de las Casas
Chiapas, México

MARCHANDEAU, STÉPHANE

Office National de la Chasse et de la Faune Sauvage
Director des Études et de la Recherche
Nantes, France

MARTÍNEZ-GÓMEZ, MARGARITA

Centro Tlaxcala de Biología de la Conducta, UNAM-UAT
Tlaxcala, Mexico

MASSETI, MARCO

Dipartimento di Biologia Animale e Genetica,
Università di Firenze
Florence, Italy

MERIGGI, ALBERTO

Department of Animal Biology, University of Pavia
Italy

MONCOMBLE, ANNE-SOPHIE

Groupe d'Ethologie, Centre des Sciences du Goût
(UMR 5170 CNRS-Université de Bourgogne)
Dijon, France

MORRISON, SHAWN F.

Department of Biological Sciences, University of Alberta
Edmonton, Canada

MUTZE, GREG

Animal and Plant Control Group
Adelaide, SA, Australia

OEHLER, JAMES D.

Department of Natural Resources, University of New Hampshire
Durham, USA

PERRIER, GUY

Etablissement National d'Enseignement Supérieur Agronomique
Dijon, France

PROBERT, BRENDA L.

Department of Natural Resources, University of New Hampshire
Durham, USA

REBOLLO, SALVADOR

Departamento de Ecología, Universidad de Alcalá. Edif. de Ciencias
Madrid, Spain

RÖDEL, HEIKO G.

Department of Animal Physiology, University of Bayreuth
Germany

RUEDA, MARTA

Departamento de Ecología, Universidad de Alcalá. Edif. de Ciencias
Madrid, Spain

SCHAAL, BENÔIST

Groupe d'Ethologie, Centre des Sciences du Goût
(UMR 5170 CNRS-Université de Bourgogne)

Dijon, France

Ethology Group, Centre des Sciences du Goût (Center for Taste and
Smell Science)

Dijon, France