

A fluorescence microscopy image of sperm cells. The background is black. There are four sperm cells visible, each with a distinct head and tail. Two cells are stained green, and two are stained red. The cells are arranged in a roughly rectangular pattern, with one green cell at the top left, one red cell at the top right, one red cell at the bottom right, and one green cell at the bottom left. The text is overlaid on the image.

Animal Andrology

THEORIES AND APPLICATIONS

EDITED BY PETER J. CHENOWETH AND STEVEN P. LORTON

Animal Andrology

Theories and Applications



Peter J. Chenoweth

To my parents (deceased) who instilled the desire for knowledge, and
to Lee who has been my support and counsel.

Steven P. Lorton

To Lynn C. Lorton, my wife, best friend and my best supporter.

To Joseph Curtis (deceased), Neal First, James Mrotek and John Reynolds,
early mentors who sparked my interest in research and sperm in particular,
and who have been my friends for more than 40 years.

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A catalogue record for this book is available from the British Library, London, UK.

Library of Congress Cataloging-in-Publication Data

Animal andrology : theories and applications / [edited by] Peter J. Chenoweth, Steven P. Lorton.

p. cm.

Includes bibliographical references and index.

ISBN 978-1-78064-316-8 (hbk)

1. Domestic animals--Reproduction--Endocrine aspects. 2. Andrology. 3. Spermatozoa. I. Chenoweth, Peter J., editor of compilation. II. Lorton, Steven P., editor of compilation.

[DNLM: 1. Reproductive Techniques, Assisted--veterinary. 2. Semen Preservation--veterinary. 3. Sperm Retrieval--veterinary. 4. Veterinary Medicine--methods. SF 871]

SF871.A55 2014

636.08'24--dc23

2013042144

ISBN-13: 978 1 78064 316 8

Commissioning editor: Sarah Hulbert / Julia Killick

Editorial assistant: Emma McCann

Production editor: Lauren Povey

Typeset by SPi, Pondicherry, India.

Printed and bound in the UK by CPI Group (UK) Ltd, Croydon, ~~CR0 4YY~~

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Preface

Motivation for this volume on applied animal andrology derives from a number of sources. Firstly, the science of andrology (or male reproduction) is rapidly evolving. Fifty years ago, few would have envisaged today's capabilities, which include identifying specific genomic sites for factors directly affecting male reproduction including those associated with sex-related defects or disease. Reproductive technologies such as cryopreservation, *in vitro* fertilization (IVF) and intracytoplasmic sperm injection (ICSI) have become routine andrological procedures. In the animal world, these complement established technologies such as those used for oestrous detection and synchronization, artificial breeding and embryo transfer. Rapidly evolving technologies such as molecular and cell biology, proteomics and genomics are transforming animal reproduction and livestock production as well as our capabilities to conserve threatened and endangered species. Such progress becomes even more astounding when one considers that frozen semen AI (artificial insemination) has been routinely applied in livestock for only 60 years, the recognition of male factor infertility extends back scarcely 100 years and it is less than 250 years since Antonie van Leeuwenhoek used an 'advanced-magnifier microscope' to describe 'animalcules' within an ejaculate.

An outcome of this accelerating tsunami of knowledge is that it is becoming very challenging for experts in the field to remain abreast of relevant advances in andrology, let alone for those who should benefit from their practical application. Andrology itself is becoming so compartmentalized that the exchange of information across its different sub-disciplines is constrained and it is becoming more and more difficult to maintain an overview. Not too many years ago, there were several pertinent scientific journals only, while today there is a profusion of them. Indeed, Thaddeus Mann and Cecilia Lutwak-Mann could hardly have envisaged the scope of subsequent developments when they wrote the following preface to their landmark book, *Male Reproductive Function and Semen*, in 1980: 'To present a coherent and meaningful survey of scientific research endeavour in an area that has expanded so rapidly as physiology and biochemistry of reproduction in the male is no mean feat these days'. However, despite the accumulation of more and better knowledge, or perhaps because of the volume and complexities involved, it is apparent that practical implementation of many potential benefits is either not occurring or is being unnecessarily delayed. There is an evident need to facilitate the flow of information between animal andrological science and its potential end users.

Such considerations present both challenges and opportunities in attempting to produce a compendium that summarizes current knowledge and wisdom in animal andrology.

Experience from over 40 years of teaching animal reproduction to veterinary and animal science students in both the USA and Australia (PJC) indicates that such a text could represent a useful and relevant resource. Another thread comes from long experience with the livestock artificial breeding industries (SPL), in which warm support for such a book has been expressed.

An additional important consideration is the pressing need to boost animal protein production in developing countries, where a burgeoning human population is causing increased stress on food resources. Here, livestock productivity is often low; a situation compounded by poor reproductive rates. Although it is conceded that a number of factors are involved in this scenario, there is general acceptance of the need for widespread dissemination and adoption of the basic precepts of good reproductive management.

Similar sentiments to those above led to the formation in 1997 of the 'Association for Applied Animal Andrology' (4A; see <http://www.animalandrology.org/>), which aspires to improve networking and understanding in the discipline of andrology as applied to those animals that are of direct use to mankind. A major founding objective of 4A was to help provide an effective conduit so that current scientific knowledge in andrology can be translated into practices that can directly benefit animal reproduction. This objective is considered to be even more pertinent today, when artificial breeding of many species – e.g. cattle, horses, sheep, deer, dogs, pigs, camelids, chickens, zoo animals – has become so widespread, and superior animal genetics, in the form of liquid or frozen semen, are routinely transported across continents.

In this situation, relevant knowledge and expertise are at a premium, both in developed and developing countries. However, despite an increasing demand for competent animal reproduction/andrology expertise and services, opportunities for appropriate education and training are decreasing. Thus, this text aims to provide useful information for those teaching animal physiology at a tertiary level (and possibly at high secondary level), as well as a reference for those interested in male animal reproductive evaluation (and performance), and in semen evaluation, handling and use for artificial breeding. The book attempts to provide the necessary basic information, and this then leads to informed evaluation of male reproductive function in domestic and exotic species (including semen collection, preservation and evaluation) and newer developments in animal andrology, including advanced reproduction techniques (ART).

As editors, we would be extremely remiss if we did not acknowledge the immense contributions made to animal andrology over many years by dedicated scientists from a number of disciplines, including andrology, gynaecology, biochemistry, physiology, physics, and animal and veterinary science. The list of individuals who deserve appropriate recognition is indeed long, and in the current context we can only attempt to mention some who have made exceptional contributions in terms of applied animal andrology, in the sure knowledge that we have inadvertently omitted worthy candidates. This book is dedicated to several individuals who have had significant influence on either of the editors. Other names that should be duly recognized within this context include: J.O. Almquist; R.P. Amann; L. Ball; A. Bane; J. Bedford; W. Bielanski; A.W. Blackshaw; E. Blom; T. Bonadonna; B. Brackett; M.C. Chang; B.G. Crabo; H.M. Dott; P. Dzuik; D.W. Fawcett; R.H. Foote; D. Galloway; D. Garner; R.M.C. Gunn; J. Hammond; R.A.P. Harrison; A. Iritani; L.A. Johnson; R. Jones; N. Lagerlof; A. Laing; H. Lardy; T. Mann; W.G.R. Marden; D. Mortimer; H.G. Osborne; B.W. Pickett; C. Polge; L.E.A. Rowson; R. Saacke; G.W. Salisbury; B.P. Setchell; S. Solomon; M. Tischner; G.M.H. Waites; W.W. Williams; and R. Yanagimachi.

We believe that the contributing authors to this volume are cut from similar cloth, and represent today's animal andrology leaders in their respective categories. We are immensely proud that such a sterling team, drawn from North and South America, Australasia, Micronesia, Europe, the Middle East and Pakistan, has been assembled for the task. We are most appreciative of their efforts and patience in the preparation of this tome, as we are of the staff of CABL, Sarah Hulbert and Emma McCann, and Connie Clement, our Australian editorial assistant.

Peter J. Chenoweth and Steven P. Lorton