WORLD ANIMAL SCIENCE C

PRODUCTION-SYSTEM APPROACH

LABORATORY ANIMALS

World Animal Science, C2

LABORATORY ANIMALS

Laboratory animal models for domestic animal production

Edited by

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ELSEVIER SCIENCE PUBLISHERS B.V.

Amsterdam – Oxford – New York – Tokyo 1986

ELSEVIER SCIENCE PUBLISHERS B.V.
Sara Burgerhartstraat 25
P.O. Box 211, 1000 AE Amsterdam, The Netherlands

Distributors for the United States and Canada:

ELSEVIER SCIENCE PUBLISHING COMPANY INC.
52, Vanderbilt Avenue
New York, N.Y., 10017

Library of Congress Cataloging-in-Publication Data
Main entry under title:

Laboratory animals.

(World animal science, C ; 2)
Bibliography: p.
Includes index.
1. Laboratory animals. I. Ruitenberg, E. J.
(E. Joost) II. Peters, P. W. J. (Paul W. J.)
III. Series: World animal science. C, Production-
system approach ; 2.
QL55.L28 1985 619 85-20676
ISBN 0-444-42464-4

ISBN 0-444-42464-4 (Vol. C2)
ISBN 0-444-41836-9 (Series)

Printed in The Netherlands

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Laboratory animal models for domestic animal production

World Animal Science

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Concluding volume (and cumulative index)

General Preface

Several factors make it desirable at this time to collect and integrate existing knowledge in Animal Science in its widest sense.

Millions of people in the world are today suffering from starvation or malnutrition and the number will increase with the inevitable rise in the world population. This poses an inexorable challenge to all scientists involved in problems underlying the production of food for man. Yet the development of livestock industries does not only aim to improve the nutritional standards of the human population, important though that is. From man's point of view animals are multipurpose and their use can have different objectives: economic, social and ecological. In addition to being important as sources of food, clothing and certain forms of power, animals can also represent forms of wealth, recreation, means of employing labour, aesthetic enjoyment, and determinants of landscape.

Animal production must increasingly compete with other forms of production for resources, especially energy, but also for land, water, finance and labour. This creates a greater need than ever to develop systems which maximize efficiency. At the same time, these systems need also to meet other requirements. They must be environmentally beneficial, ethically defensible, socially acceptable, and relevant to the particular aims, needs and resources of the community they are designed to serve.

Rapid advances in knowledge within practically all areas of the animal sciences are now being made. Solutions to many of the problems which face the livestock producer, whether he is working in, say, a cattle feed-lot in the U.S.A. or in a traditional system of village goat production in West Africa, are now resulting from the research being carried out in the various disciplines of Animal Sciences. However, too often the results of this research remain confined to the specialized journals of different scientific disciplines when, increasingly, the approach of those working in animal production needs to be interdisciplinary and global. Furthermore, Animal Science has attained a new dimension in recent years. Whatever form it takes, animal production constantly influences and interacts with the other components of the total ecosystem within which it operates. New disciplines, like ecology, ethology and conservation have become important; new forms of production, such as aquaculture and the use of non-conventional feed resources are receiving increasing attention.

The scientists and planners in animal production have to work within the framework of these developments. Extensive inquiries among such specialists in many parts of the world have revealed the need for a comprehensive and up-to-date review of the Animal Science literature covering the entire range of technical knowledge that is now required in animal production and

development. Therefore, Elsevier Science Publishers has initiated this major work of reference under the title "World Animal Science". Inevitably, such a task must cover many volumes and involve the collaboration of a great number of editors and authors. Through an elaborate preparatory phase and with continuous editorial guidance from the Chief Editors and the Editorial Advisory Board, including scientists from all parts of the world, the aim has been to produce an integrated series of volumes which, although not encyclopaedic and not intended to be exhaustive in each branch of knowledge, does give appropriate emphasis to coherence and applicability. With this in mind the series has been divided into three parts: the volumes in subseries A provide information on the anatomical, genetical, biochemical, behavioural, physiological and microbiological bases of animal production; those in subseries B are each devoted to a particular discipline important to animal production, e.g. reproduction, breeding, feed science, bioclimatology and adaptation; and finally, in subseries C, production systems are described on a species basis, covering beef and dairy cattle, sheep, pigs, horses, buffaloes, poultry and some newly or partially domesticated animals.

Emphasis is laid throughout on the careful reviewing and integration of significant knowledge in the total field of animal production with the aim of reporting not only what is known but also of drawing attention to important gaps in our knowledge. Account is taken of current trends in thinking and development and controversial topics are also dealt with, e.g. ethical aspects of animal use. Traditional farm animals, i.e. cattle, horses, sheep, goats and pigs, are given major emphasis and their production systems are treated in special volumes. There are also separate volumes on the conservation and use of their genetic resources. Other forms of animal production, such as poultry and fur production, are given less attention in the early volumes but still have their special volumes dealing with production systems. Other topics of less over-all importance, or about which less is known, are treated in separate chapters within volumes. Because of the increasing importance of animal production in less developed areas of the world, attention is paid to domesticated mammals such as buffalo, camel, lama, alpaca, yak, reindeer and elephant, and to such newly or partially domesticated mammals as the eland, oryx, red deer and musk-ox. The series deals with both intensive and extensive animal production systems. In this way an attempt has been made to set the whole of world animal production into an appropriate and contemporary perspective.

Although, by editorial concept and by cross-referencing between volumes, the series functions as a single entity, each volume is nevertheless constituted as an independent unit, suitable for separate use. To achieve this and still avoid undue overlap, each volume only summarizes those essential elements of topics which are treated in detail in other volumes. Thus each volume aims to approach the breadth of World Animal Science from its own particular point of view, with supporting references to details in other volumes.

The series is written primarily for use by people who have a specialist interest in animal production as students, teachers, extension officers and consultants, policy-makers, and research scientists. The volumes are planned for world-wide use, which implies that the information presented covers systems and principles of more than local or national interest.

Preface to Volume C2

In planning this volume the editors realized that much has been written about laboratory animals but mostly in relation to the medical field, where laboratory animal science has been initiated. Thus, animal models have been used to understand the mechanisms of human disease and to improve medical treatment.

The goals and the scope of this volume of "World Animal Science" are different. Emphasis is now laid upon the use of laboratory animals in order to understand physiological and pathological processes with regard to animal production and its products such as procreation, breeding, health, nutrition, meat, milk, wool, leather, etc. Actually, these aspects may be studied in the farm animals themselves, but the intrinsic value of the use of laboratory animals lies in the standardized properties of the suitable model. Moreover, detailed and more complete knowledge about the (patho)physiology of laboratory animals is now at hand, originating from the laboratory animal science itself or from the use of laboratory animals in the biomedical field. Hence, the more confined goal of this volume is to demonstrate a reciprocity of the strict biomedical field and the agricultural sciences through the use of laboratory animals. Apart from the advantages of laboratory animals as models one should always realize that, due to interspecies differences, results from experimental studies have to be verified in the target species. An additional element with regard to laboratory animal testing are (supra)-national regulations involving, among others, ethical standards. Since the welfare and rights of laboratory animals are continuously and rightly in dispute, it is strongly recommended to have good arguments prior to starting an animal experiment for aspects of animal production. The constant search to replace, reduce and refine biomedical research on live animals should be kept in mind.

The editors have selectively asked authors for three different aspects of this volume. First, basic information is presented on the most used laboratory animal species, supplemented with physiological data and general references concerning the pertinent literature. Specific emphasis is given to zootechnical procedures and microbiological aspects relevant to standardization of the experiments (Chapter 1).

More detailed information on specific topics may be found in Chapters 2—7. The following areas have been selected: genetics and breeding; the gastrointestinal tract, its microflora, and immunological functioning; the endocrine system and its interrelationship with the immune system. Thus, we wanted to stress the importance of relatively new aspects of immunology, since this scientific area is of paramount interest to preserve animal health and its derivatives.

Finally, comparative studies are presented in which laboratory animals are used as genetic, nutritional, growth and disease models for domestic animals (Chapters 8—11).

The Editors take the opportunity to thank the contributors to this volume for their cooperation. We express the hope that their efforts have resulted in a comprehensive volume on a number of aspects of laboratory animal science which so far have appeared scattered in the literature or partially have been neglected. May this volume inspire more interest in laboratory animal science and particularly assist in creating a proper attitude towards the use of laboratory animals for experimental purposes. It should be realized that an in-depth knowledge of the possibilities and limitations linked to an awareness of the ethical aspects are essential prerequisites of the model when considering (laboratory) animal experimentation. We gratefully acknowledge the continuous support of Ms. Nienke de Jong during the preparation of this volume.

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Contents

Breeding, Housing and Care of Laboratory Animals

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1. INTRODUCTION

There is a large number of publications concerning laboratory animal care and it would not be possible here to either completely review the literature, or to fully describe all the procedures involved. Our aim is to outline the basic considerations which are necessary when designing a laboratory animal facility, obtaining animals, or embarking on breeding programmes and experimental procedures. In addition, attention will be paid to the microbial status of laboratory animals and to nutritional standards.

Many different species from both invertebrate and vertebrate phyla are used in laboratories, but the details here will be restricted to mammals.

2. ANIMAL HOUSING

2.1. Preconstruction considerations

The period of planning before construction of animal housing or modification of existing facilities is of the utmost importance. Decisions made at this stage will have far-reaching consequences for well-being of animals and staff following implementation.

The first stage in making a decision is to establish exactly for what purpose the facility is needed, and what species are to be housed. It is essential at this stage that all potential users be consulted, and that all requirements be clearly defined.

Once the requirements of the users have been firmly established, a thorough survey of local and national regulations should be undertaken. In addition to planning, building and fire regulations, many countries have specific regulations relating to animal housing and welfare.

Regulations relating to housing, health and the safety of staff should also be consulted and, if appropriate, discussions with employee associations or unions are advisable in order to avoid labour difficulties later.

Specific plans can now be drawn up. The advice of many professionals will be required at this stage, and it is wise to use the services of an architect with experience of designing animal houses who can not only draw the plans, but who will also have the necessary professional contacts. Specialists in construction, heating, ventilation, electricity, etc., will all need to be consulted. It is essential that all of the information on the requirements of the users is available to the construction advisors. Much of the equipment required will be unfamiliar to them, so they must have details of operational conditions,

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dimensions and special requirements. For example, many mobile cage batteries are wider or taller than standard door sizes, therefore, special doors and frames may be needed. A lot of equipment is heavy and difficult to move; therefore, stairs to different levels should be avoided, and slopes should be installed instead. Very precise environmental control may be needed for various species. As a result special equipment will be required in areas with climatic extremes.

For further information on basic animal facility design, the reader is referred to the publications of the Institute of Laboratory Animal Resources (1964, 1969, 1972, 1973a,b, 1978, 1979) and Lane-Petter (1969, 1970, 1972).

2.2. Basic construction

Animal housing should be constructed of high quality, strong and durable materials which will withstand the rigours of everyday use as well as the local climate. Care with respect to the choice of materials and basic design will reduce the need for subsequent repairs and will also lessen the general running costs for such items as environmental control. The construction should ensure that the chances of escape are negligible, and also prevent the entry of vermin.

Unless specifically required for experimental purposes, animal rooms should not have windows to the exterior. This is particularly important where controlled-lighting schedules are used, and it also helps to reduce heat losses and solar heat gains. However, it is advisable to install windows in the doors to animal rooms, as this prevents unnecessary entry when trying to locate staff or equipment, and also allows a check to be made for escapees before entering the room. Doors should be solid and well-fitting, preferably of waterproof or water-repellent construction, and with some form of protection against damage caused by the moving in and out of equipment. In the case of free-roaming animals, e.g., cats and dogs, the doors should also be protected from the animals (for example, cats will use unprotected wooden door frames as scratching posts). Wherever possible, door fittings such as handles should be recessed. There should be no interconnecting doors between animal rooms, especially if different species are housed. Doors should incorporate some form of anti-escape device. In the case of small animals, it is sufficient to have a barrier of wood or metal which slots across the width of the door on the outside of the animal room. If the barrier is about 45-cm high, it can be easily stepped over, but will prevent exit of an escapee. In the case of larger animals, particularly primates, a 2-door system should be used. Entry through the first door allows access to a small vestibule, and this door is closed before opening the second one, leading from the vestibule into the animal room. For the 2-door system it is essential to have a viewing panel from the vestibule into the room.

Floors for animal areas should be solid and made of materials that will withstand heavy equipment and frequent washing. Suitable materials include granolithic concrete, tiles, welded PVC sheeting and seamless polyurethane/polyester-coated concrete or cement flooring. Unsealed concrete or wooden floors should be avoided. Floor drains are advisable in areas where animals are free-running, and in such cases the floor should slope towards the drains.

All services to animal rooms (electrical, plumbing, ventilation and drainage) should, as far as practicable, be ducted through the walls, roof space and floors. Externally-mounted pipes, wiring and ventilation ducts collect dust and make cleaning and maintenance of hygiene difficult. They can also be easily damaged and may be dangerous to animals and personnel.

Basic construction will be influenced by the degree of health maintenance intended for the animals. The classification of health status is discussed in Section 13. However, for the present discussion it is sufficient to distinguish between non-barrier and barrier facilities. In non-barrier animal facilities, there is little control over the microbiological status of animals and therefore only limited requirements are imposed upon staff before being allowed access to animals. This does not obviate the need for clean, hygienic animal housing, but installation of decontamination equipment, differential ventilation systems and personnel showering and changing facilities is not obligatory. In a barrier unit, either used for specified pathogen free (SPF) animals or clean conventional animals, every attempt is made to prevent exposure of animals to incoming pathogens. This imposes a number of constraints on basic construction, because all finished surfaces within animal areas must be impervious, ventilation intakes must be filtered according to microbiological standards, facilities must be available for staff to shower before entry into the unit and to change into decontaminated clothing, and autoclaves, fumigators and dunk tanks should be installed (Bleby, 1972).

2.3. Animal area facilities

2.3.1. Walls and floors

The final finish on walls and floors should be waterproof and easily cleaned. If a floor covering is used, it is advisable to run it a short way up the wall so that there is no joint at the bottom of the wall. If mobile cage batteries or other mobile equipment is to be placed in the room, a protective rail should be installed around the walls to prevent possible damage to the surface of the wall. For free-ranging animals such as cats and dogs, a material such as sand should be incorporated into the floor seal to aid traction. If floor drains have been installed, they should be fitted with a cover to seal them when not in use, a grill that will not allow passage of the smallest mobile animal in the room and a strainer basket.

2.3.2. Lighting

The intensity of lighting in animal areas should not be below 275 lux at floor level. It is recommended that the lighting should be controlled by an automatic time clock situated outside the animal room, but this must be checked regularly. If a time switch fails to turn lighting off, and animals are exposed to constant illumination, sexual cycles will be altered or even abolished (Seegal and Goldman, 1975; Campbell and Schwartz, 1980). It is also important to have the correct ratio of light hours to dark hours to optimise breeding and prevent seasonality.

2.3.3. Animal room equipment

The fixed equipment installed in an animal room is dependent on a number of factors, such as animal species, type of experiments, etc. Normally, hot and cold water supply to a sink with a drain would be required and storage cabinets and a work surface should also be considered. These should be constructed of impervious, washable materials and be as free as possible from crevices or ledges in order to avoid accumulation of dust and to facilitate cleaning. Items stored in an animal room should be kept to a minimum. The food supply should be restricted to a maximum of one week's requirement. Food and bedding are stored most satisfactorily in rigid plastic containers with lids, preferably on wheels, so that the containers can be easily taken to the cages. If animals are kept under free-running conditions, such storage within the room is not possible.

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