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HEINZ MEHLHORN (ED.)

Encyclopedic Reference of Parasitology

Second Edition

Biology, Structure, Function

With contributions by

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With 371 Figures and 76 Tables



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Preface to the Second Edition

During the last decade since the appearance of the first edition, parasitology has made considerable advances and many new diseases have cast their shadows on life, on the welfare of man and his domestic animals. Although worldwide billions of dollars have been spent, in many fields the available control measurements are far from being satisfactory and in others they are completely lacking. The present status is characterized by mild optimism with regard to vaccines, an increasing resistance of parasites towards drugs and by the absence of measurements against several parasitoses on the one hand and decreasing funds for research on the other. Nevertheless parasitological research in total was very successful during the last decade, and new methods revealed new, hopefully promising, insights into the fight “*parasite against host*”. Thus this second edition intends to give a comprehensive review of the facts and trends in veterinarian and human parasitology, through contributions from distinguished specialists. In addition to the authors of the first edition, several internationally renowned colleagues joined our crew to help to reach a broad readership. The layout of the book has changed to an encyclopedic arrangement of rather comprehensive key words (chapters) along the subject index being included in the flow of the text. This will help to speed up the search for information when the book is used either in its present shape, as a compact disc or in a future electronic on-line version. The printed version is split into two volumes covering different head topics: Volume 1 – All biological aspects; Volume 2 – all clinical, pathological and therapeutical aspects.

We hope that this second edition will be as well accepted as the first one and will be able to contribute to our common goals in the struggle for a better life.

Düsseldorf, September 2000

For the authors
PROF. DR. HEINZ MEHLHORN (EDITOR)
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Preface to the First Edition

Although in recent decades many methods have been developed to control parasitic diseases of humans and animals, chemoresistance and reduction of budgets for control have caused the problems to increase worldwide. Efforts in the “*struggle against parasites*” must be redoubled if we are not to become overwhelmed by human health problems and problems of food production. This absolute need has led to the application of various new methods to classical parasitology. Thus the different fields of parasitological research are at present expanding so rapidly that it is impossible for an individual to follow the main problems and to evaluate and recognize recent progress.

The purpose of this book is to give a comprehensive review of the facts and trends in veterinary and human parasitology, through contributions from distinguished specialists in different fields. The authors have focused their contributions on the most important and promising results, in a way which it is hoped will inform students, teachers, and researchers (zoologists, veterinarians, physicians) about those topics, which may be far from their own working fields, but knowledge of which may be necessary to develop new ideas. Thus, all chapters, the length of which will surely change in future editions, are provided with references opening the literary entrance to each field of research.

We hope that the book will be fruitful and lead to the establishment of new ideas, trends, and techniques in the struggle against parasites.

Bochum, January 1988

For the authors
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All other micrographs are either from the authors of the particular chapter or from the editor.

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The Authors

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Biology, Structure, Function

The 1592 entries of this volume mainly cover the following topics:

- Arboviruses
- Behaviour
- Classification
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- Habitat selection
- History
- Hormones
- Host finding
- Host-parasite interface
- Immune diagnostic methods
- Invasion procedures
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- Metabolism
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- Nutrition
- Penetration
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- Ultrastructure
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Diseases, Treatment, Therapy

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 - Nemathelminthes (Schnieder)
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 - Ticks (Spielman, Mehlhorn, Voigt)

All these topics are presented in either a single, long entry, in several smaller, separate entries and/or as inserts in other longer entries. This cooperation of specialists contributes to a better understanding of the recent complex problems in parasitology.

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Introduction

Starting from the early beginnings of human culture, man became aware of parasites. In animals, which developed social contacts via coat-lousing, humans noted first the crucial activities of large amounts of ectoparasites such as ticks, lice, fleas, mosquitoes, flies, etc., as is shown in the earliest written reports of mankind. Furthermore, those endoparasitic worms that occurred in feces in larger numbers and were big enough to be seen with the naked eye were known. Thus the physicians of the Egyptians (~2000 BC), the Greek physician Hippocrates (460 – 370 BC) and the natural scientist Aristoteles (384 – 322 BC) knew very well ascarids, oxyurids, and of course tapeworms. Their knowledge was passed on to the Romans, who called the round worms *lumbrici teretes* and the plathyhelminths *lumbrici lati*, and from there it became transmitted to later human societies especially by propagation of manuscripts in Christian cloisters or by translations of Greek books that were being used and preserved by physicians in the Near East.

However, only a few remedies were available apart from combing (Fig. 1), catching of parasites (Fig. 2), bathing in water and/or hot sand or eating special plants or spicy



Fig. 1. Redrawn reproduction of a medieval engraving showing a housewife delousing her husband with a comb-like instrument.

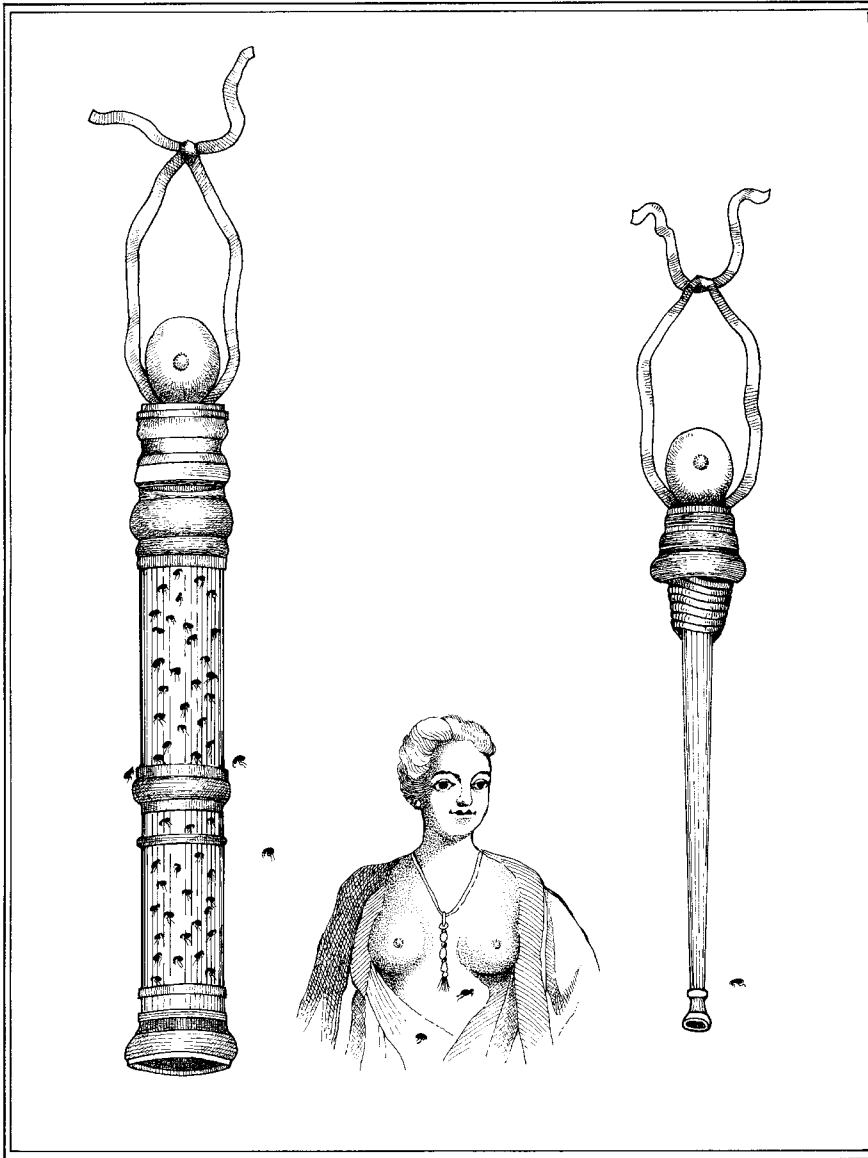


Fig. 2. Redrawn reproduction of a figure from a German book of the 18th century showing two types of lady's necklace used as glooming flea-catcher.

food, which were felt to decrease intestinal worm populations, as, for example, pepper does (Fig. 3). Thus the highly sophisticated physicians of the ancient Egyptian kingdoms surely did know the fatal symptoms of the schistosome-derived diseases, but the transmission pathways and methods of treatment were as nebulous as they were 3000 years later when the Holy Hildegard of Bingen (1098–1179) recommended that worms be treated with, for example, extracts of stinging nettles, dandelions and walnut-tree leaves, as described in her book *“Physica”* (1150–1160) – chapter *“De causis et curis morborum”* (i.e. “On the causes and cures of diseases”). The treatment of dracunculosis by removal of the whole worm from human skin was, however, much more successful. The use of a wooden splinter, onto which this so-called Medina-worm was wound by physicians in the Near East, probably gave rise to the Aesculap-stick of our days – the symbol of an increasingly successful caste – although it is



Fig. 3. Redrawn reproduction of an ambulant Renaissance pharmacist equipped with his main helper plants and therapeutical animals, including snakes and leeches.

not long ago that cupping and/or the use of leeches were universal remedies (Fig. 4, Fig. 5). At the end of the Middle Age, a new interest arose among educated people to study the natural world, and this newly awakened curiosity led people to make detailed investigations of plants and animals. Even human beings were a subject of investigation, provided religion did not prevent this (e.g. dissections of humans – even of executed and thus lawless people – were forbidden for centuries in Christian and Moslem countries). Thus at first, descriptions of the outer morphology of plants, animals and humans became available and later – after the development of microscopical techniques – structural ground-plans and histological insights into organisms were obtained. However, it was not until the middle of the 19th century that the theory of “de-novo creation”, (latin: *generatio aequivoca et spontanea*), the creation of organisms from dead or anorganic material (e.g. worms develop from intestinal slime) became replaced by the idea of cellular organisation and the self-reproduction of organisms as postulated in Virchow's thesis (1858): “*omnis cellula e cellula*” – each cell derives from a cell. This growing spirit of investigation led to the discovery of numerous species of plants and animals and to the differentiation into pro- and eukaryotic organization of organisms. The knowledge derived from the cell-dependent life of viruses or prions is a fruit of our century. According to their morphology and life cycles – the study of which is not completed even today – species of bacteria, fungi, plants and animals were characterized and *systematical classifications* and *phylogenetic trees* were established. Such investigations provided a basis for the establishment of phylogenetical theories such as those of Lamarck or Darwin.

Moreover, most of the species of parasites still valid today were described in those times (cf. *Historical Landmarks*) and the term *parasite* (greek: *parasitos* = eaters at the court = meal taster) became fixed as the word to describe those organisms that

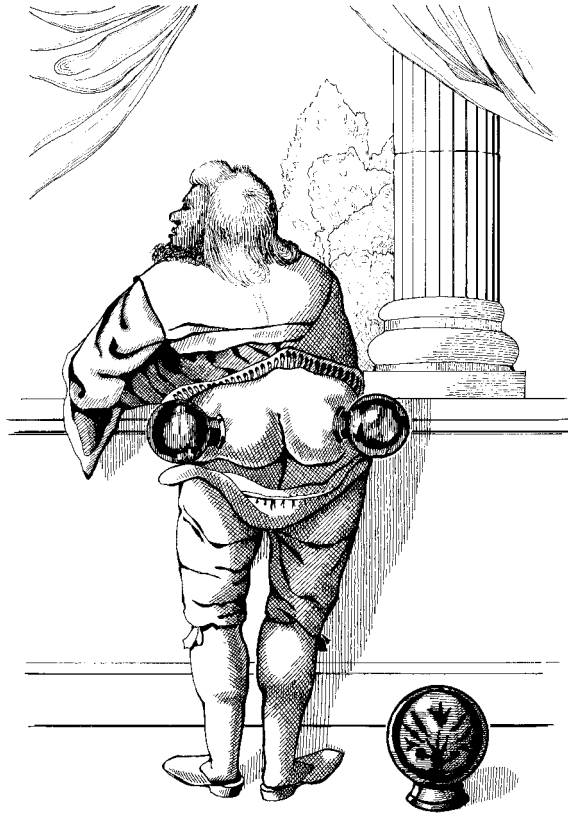


Fig. 4. Redrawn reproduction of a Baroque noble using cupping-glasses in order to be bled.



Fig. 5. Redrawn reproduction of a medieval engraving demonstrating the therapeutic use of the leech, *Hirudo medicinalis*, even in middle-class-households.

live on other animals or humans. According to the different life-cycle adaptations the latter may become:

- *final (definite) hosts* lodging the sexual stages of the parasite,
- *intermediate hosts* lodging asexually reproducing stages of the parasite,
- *transitory/accidental/paratenic hosts* lodging parasitic stages without further reproduction or
- *vectors* representing blood sucking parasites such as arthropods or leeches which transmit other pathogens and/or parasites during their blood meal.

The constant refinement of microscopical techniques (including the establishment of electron microscopy) and the development of a broad spectrum of molecular biological methods led (especially in the last 30 years) to an explosion of the knowledge on the organization of the parasites, on the parasite-host interface and on host immune reactions, which altogether were used to establish control measurements and to develop prophylactic strategies, drugs and/or vaccines. Thus the two volumes of the book presented here are based on the following pillars:

- life cycles (inclusive behavior and epidemiology),
- morphology (up to molecular insights),
- mechanisms of reproduction,
- metabolism and nutrition,
- host-parasite interactions,
- diseases and pathological effects,
- immune reactions,
- control measurements (inclusive drugs, vaccines, prophylactic strategies).

The key words of both volumes also intend to outline interactions with many other fields of interest and importance (see above: Contents and Topics).