

# BORRELIA

STRAINS, VECTORS, HUMAN AND  
ANIMAL BORRELIOSIS

OSCAR FELSENFELD, M.Sc., M.D.

# BORRELIA

STRAINS, VECTORS, HUMAN AND  
ANIMAL BORRELIOSIS

By

OSCAR FELSENFELD, M.Sc., M.D.,

*Chief, Division of Communicable Diseases*

*Delta Regional Primate Research Center*

*Professor of Tropical Medicine and International Health*

*Tulane University School of Public Health and Tropical Medicine*

*Visiting Professor of Microbiology*

*Tulane University School of Medicine*

*Member, International Taxonomic*

*Subcommittee on Spirochaetales*



WARREN H. GREEN, INC.

St. Louis, Missouri, U.S.A.



## DEDICATION

TO: Dr. M. Baltazard, Director Emeritus, Pasteur Institute, Teheran; Professor A. Rafyi, Director Emeritus, Hessarak Institute, Iran; Professor A. Geigy, Swiss Institute of Tropical Medicine, Basel; Dr. Charles M. Wheeler, Research Entomologist and the Memory of the late Professor E. Brumpt, Parasitology Institute, Paris whose patient instructions, friendly guidance, kind encouragement, competent support, and understanding criticism have made my studies of *Borrelia* possible and pleasurable during the past 35 years.

Published by

WARREN H. GREEN, INC.  
10 South Brentwood Blvd.  
St. Louis, Missouri 63105, U.S.A.

All rights reserved

© 2020 - LDF. with permission

© 1971, by WARREN H. GREEN, INC.

Library of Congress Catalog Card Number 72-127355

## PREFACE

**D**ESPITE PERIODIC REPORTS that tick-borne relapsing fever occurs sporadically over more than half the area of the entire Continental United States, the numerous deaths due to this disease in the drier parts of Asia and Africa including the thousands who become its victims in Ethiopia and the Sudan every year, the unknown toll in lives and suffering that the disease is still taking in Central and South America, and the ever-present danger of recurrence of epidemics should the louse-borne form burst out of its present confines if or when a disaster creates favorable conditions for such spread, only scanty notes on relapsing fever can be found in the medical literature of the United States today.

One is amazed at the confused nomenclature and the mass of misinformation concerning the transmission and vectors (some of which has managed to creep into even respectable textbooks). The considerable variations in the clinical picture during various outbreaks and in widely separated localities, and the unusual immunologic conditions that accompany the infection should be emphasized so that the medical profession can be alerted should an outbreak occur in this country.

The genus *Borrelia* that causes human relapsing fever includes some species that are of interest to the dentist (*Borrelia vincentii*), and to the veterinarian (*B. anserina*, *B. theileri*). *Borrelia* infections appear in man as relapsing fever and in animals as so-called fowl spirochetosis, or tick-transmitted spirochetosis in cattle, which are clinically defined entities. This monograph deals principally with human relapsing fever and fowl spirochetosis, while exploring other conditions in which borreliae may play a role. The discussion of

the borreliae and their vectors, the pathology caused by them, and other features will be presented in separate chapters discussing borreliosis as human relapsing fever, cattle and fowl disease, and Vincent's angina, respectively. Each of these chapters will deal separately with the species of *Borrelia* involved, and with the consequences of the infection. Borreliae that have been isolated from vectors only, and not from man or animals, will also be enumerated.

O. F.

## ACKNOWLEDGMENTS

THIS MONOGRAPH COULD NEVER HAVE GONE TO PRESS without the unselfish aid, help, and support of two persons. One of them, Dr. Addine G. Erskine, spent innumerable hours correcting, re-typing, editing, proof-reading, and indexing this volume. Busy as she was as Director of the Gradwohl School of Laboratory Technique and with numerous professional organizations, other editorial tasks, and ranching (unfortunately or fortunately, no *B. theileri* has been isolated from her stock), she has always found time to cooperate on my writing ventures, including this monograph. I am sincerely and deeply indebted to her for all her most valuable help.

The other, Dr. W. Burgdorfer, Senior Medical Entomologist of the U.S.P.H.S. Rocky Mountain Laboratories, has never hesitated to replenish my stock of *Ornithodoros* whenever my "tickorium" went out of gear. I am very much grateful to him for all support he has so kindly furnished during the years, in addition to admiring his elegant experiments and publications.

Dr. W. E. Greer, Director of Animal Resources, Gulf South Research Institute, New Iberia, La., kindly checked the chapters on animal borreliosis. Most of the entomological statements which appeared 5 years ago were reviewed by Prof. G. Anastos, University of Maryland, and Prof. A. Rafyi at that time.

I am much obligated and sincerely grateful to Dr. A. D. M. Bryceson and his colleagues for permitting me to read and to quote their outstanding clinical study of relapsing fever in Ethiopia before publication, and to Dr. H. Hoogstraal for his encouragement.

Dr. T. C. Orihel, Adj. Professor of Parasitology, Tulane University, spent much valuable time and great effort providing me



with and photographing arthropods for this book. His assistant, Mrs. B. van Duym, furnished several excellent drawings. Mrs. W. Martin of the Medical Illustration Service of this Center made additional valuable graphs. Dr. C. Jones, Smithsonian Institute, kindly selected and put at my disposal his photographs of Southeast African huts and rodent burrows. Dr. Jones also corrected and rectified the names of the mammals.

Dr. M. N. Wilderman, D.D.S., M.S., Professor and Head, Department of Periodontology, Louisiana University School of Dentistry, kindly furnished the photographs of Vincent's disease.

Mrs. M. LaCroix and Mrs. C. Bennett typed and retyped the numerous drafts as well as the final copy of the manuscript. Their diligence and help are appreciated greatly.

O. F.

|   | <i>Page</i> |
|---|-------------|
| <i>Dedication</i> .....                     | vi          |
| <i>Preface</i> .....                        | vii         |
| <i>Acknowledgments</i> .....                | ix          |
| <i>Chapter</i>                              |             |
| I. HUMAN BORRELIOSES (RELAPSING FEVER)..... | 3           |
| History .....                               | 5           |
| Causative Agent.....                        | 11          |
| Borreliae and Their Vectors.....            | 30          |
| Epidemiology .....                          | 77          |
| Pathology .....                             | 91          |
| Clinical Picture.....                       | 98          |
| II. BORRELIOSES IN DOMESTIC ANIMALS.....    | 137         |
| Borrelia Theileri.....                      | 137         |
| Other Borrelia.....                         | 138         |
| III. AVIAN BORRELIOSES.....                 | 139         |
| Borrelia Anserina and Its Transmission..... | 139         |
| Pathology .....                             | 141         |
| Course of the Disease.....                  | 141         |
| Treatment and Prevention.....               | 142         |

## IV. BORRELIÆ FROM MUCOUS MEMBRANES.....143

## V APPENDIX .....147

## KRAJIAN'S "20 MINUTE" RAPID STAINING METHOD OF

## TREPONEMATACEÆ IN FROZEN SECTIONS.....147

## Reagents .....147

## Procedure .....148

## VI REFERENCES .....150

## VII Index .....167

## BORRELIA