PREFACE

There is no comprehensive work in any language encompassing the area of our knowledge that can be defined as Economic Malacology. In fact the subject is just beginning to be recognized as a discipline in its own right. The mission of the present work is to bring together its widely scattered literature, which goes all the way from typewritten, mimeographed, or dittographed official reports to publications in obscure foreign journals. It has taken over ten years of searching, examining, evaluating, digesting, collating, and editing to bring this work to its present status. During this process many essentially unimportant or irrelevant papers were encountered, particularly in the area of snail control. In nearly every case these were not included in the bibliography because either they made little in the way of an original contribution or they contained information not relevant to the general problem of the economics of terrestrial gastropods. To this extent, the bibliography is a selected bibliography. And, in a broader sense, the subject of economic malacology embraces the problems presented by the freshwater snails. Such problems and the literature that treats of them, however, are vast indeedso vast that it is completely impractical to consider them here, except for an occasional reference. Also, the problems and their solutions vary so much between the two groups of snails that there is little in the way of common applicability or of comparative value. Further, because many of the problems involving freshwater snails have a distinct medical flavor, far greater attention has been given to themwitness, for example, the vast literature concerning the snail hosts of the schistosomiases.

Because the original sources of information will not be available to the greater segment of the readers, the essence of the contributions, in each case, has been incorporated in the text in so far as it has been practicable to do so. Some authors quoted or referred to in this work may be judged as not being truly qualified to make sound reports. It should be borne in mind, therefore, that the inclusion of certain of these works was for the completeness of the record; inclusion is not an indorsement. Where it is believed that a given author is in error, this is pointed out. But under no circumstances was any reference excluded simply on the basis of its being at variance with the conclusions set forth in this book.

The pertinent information in the literature has been combined with considerable field data which I collected in Africa, Asia, and Oceania. Supplemental information has been obtained from many correspondents who have had firsthand experience with terrestrial snail problems. Throughout this book, credit is given on the spot where credit is due; and sincere efforts have been made not to imply by omission that originality rested with me, even though I may have independently arrived at the same conclusion. The reader therefore can trace back to the original source almost any item of information.

No matter how hard one tries, inevitable errors, omissions, and misinterpretations will creep into any work of this size. These are as regrettable as they are unavoidable. Certainly every effort has been made to keep them to a minimum. New contributions in the field of economic malacology are continuing to appear in the literature just often enough that it has not been possible to keep pace with them right up to the last minute. As a compromise, reference to recent, pertinent works is made only in the bibliography. It has been a temptation to prolong the editing of the manuscript in the expectation that all points of difficulty would be removed. But it is much more realistic and practical to get all of this information as soon as possible into the hands of those who need it and have been asking for it for years. Hence, with a good measure of apprehension and with a full awareness of the shortcomings involved, this work is being released in the fond hope, not that it will serve the needs perfectly, but that it will serve them well.

During the years that it has taken to produce this work, there has accumulated a vast indebtedness in a multitude of ways; and the task of attempting to indicate here anything approaching the gratitude that is felt, seems overwhelming and irrevocably foredoomed to inadequacy.

Those for whom I feel the greatest gratitude, I would like to mention: Dr. Yoshio Kondo of the B. P. Bishop Museum, whose sound judgment has tempered many ideas presented in this book, and whose companionship in the field is without equal; Dr. Joseph C. Bequaert of Harvard University, whose interest, encouragement, and advice in Africa sixteen years ago provided a great turning point in my life; Dr. Harold J. Coolidge, executive director of the Pacific Science

Board, whose faith in my research, when others grew doubtful, gave me encouragement when I needed it most; Dr. George A. Baitsell of Yale University, whose advice precipitated two \$500 Sigma Xi—RESA grants-in-aid which made it possible to prepare the greater share of the original manuscript; Dr. W. Wayne Boyle of Pennsylvania State University, whose many months of help in Hawaii brought forth some of the most valuable data in this work concerning the great need for, and the value of, long-range studies on the giant African snail; Dr. W. Harry Lange, Jr., of the University of California, who critically examined the chapter on chemical control and offered many profitable suggestions and leads in this complex aspect of the subject; and A. P. Messenger and H. M. Armitage of the California State Department of Agriculture, who have been my constant guides in all matters involving quarantines.

Grant funds from several sources have permitted me to gather field data and conduct research without which the present work would not have been conceived. The Pacific Science Board of the National Research Council, through the National Academy of Science, provided ONR funds in 1948 to study the anatomy of a number of achatinids at Harvard University; and additional funds were allotted in 1957 to permit me to chair a symposium on the giant African snail at the Ninth Pacific Science Congress in Bangkok, Thailand. The Office of Naval Research (NR 161 472) paid for all expenses in an extensive survey of the problem of the giant African snail in the Trust Territory of the Pacific Islands during the three summer months of 1949. The National Science Foundation made one of its early grants (G-519) in 1953 in support of the successful search in Ceylon for a predicted disease in the giant African snail. Dr. A. D. Ross, Honorable Secretary of the Pan Indian Ocean Science Association, made it possible for me to attend the Second Pan Indian Ocean Science Congress in Perth, Australia, in 1954. The National Institutes of Health have provided funds (E-1245[C3]) since 1957 which have financed considerable research at the University of Arizona and the University of Hawaii on the disease syndrome in the giant African snail. Ada P. McCormick of Tucson, Arizona, furnished funds and secretarial help which were indispensable in the early stages of preparing the manuscript.

Edward A. Steinhaus and Yoshinori Tanada of the University of California patiently discussed at length with me my proposed research and hypotheses on the disease syndrome in the giant African snail. Chemical and bio-assays of the snail meal were conducted by Arthur R. Kemmerer, Mitchell G. Vavich, and Edward L. Breazeale; and the more complex mathematical computations were made by Donald L. Webb and Samuel R. Browning—all of the University of Arizona. In Hawaii, the following provided all sorts of help in many ways over a period of several years: Henry A. Bess, George D. Butler, Walter Carter, Q. C. Chock, C. H. Edmondson, Jim Kim, C. E. Pemberton, Alexander Spoehr, Alan D. Thistle, and the late Paul W. Weber.

Many investigators in foreign countries generously contributed, among other things, valuable information which helped tremendously in piecing together the otherwise exasperatingly fragmentary data in some of the literature. The following were of especial help: A. F. Caldwell of the University of Malaya in Singapore; Silverio M. Cendaña of the University of the Philippines; R. E. Dean, superintendent of gardens, Hong Kong; G. S. Dun of the Lowlands Experiment Station, New Britain; K. C. Ghose of the City College of Calcutta; John R. Hendrickson of the University of Malaya in Kuala Lumpur; Mr. and Mrs. Peter J. R. Hill of Koror, Palau Islands; Alan J. Kohn of Florida State University, who supplied information from the Maldive Islands during the 1957 Yale-Seychelles Expedition; J. C. van der Meer Mohr of the Deli Proefstation, Medan, Sumatra; and George D. Peterson, Jr., the entomologist of the government of Guam. During the five weeks that Yoshio Kondo, the late Dan Langford, and I were in the Bonin Islands in 1949, we became greatly indebted to the people of Chichi Jima and, particularly, to the head councilman, Roderick Webb, and the entire Savory family. For nine months in Ceylon, I received help from many more than I could possibly list here; but I must acknowledge help particularly from the following members of the Department of Agriculture in Peradeniya: Henry E. Fernando and Yasatileka Elikawela of the Division of Entomology, Dr. J. W. L. Peiris of the Division of Plant Pathology; and A. Bandaranyake and W. Fernando of the Veterinary Research Laboratory.

Assistance in translating from the Dutch was given by L. J. M. Butot of the Museum Zoologicum Bogoriense in Java and by H. Reerink, agronomist of FAO in Ceylon. M. Dale Arvey of Long Beach State College translated one long, important article from the Japanese; and William Osuga of the University of California East Asiatic Library gave considerable help in locating and translating portions of several other articles in Japanese. Donald M. Powell and Lutie L. Higley of the University of Arizona Library patiently ferreted out a number of elusive references.

I am indebted to several of my colleagues for the use of photo-

graphs. Specific credit has been given in each case where the illustration is not mine. I am especially indebted to Donald B. Sayner, who is the instructor in scientific illustration in the Department of Zoology at the University of Arizona, for the two excellent line drawings and to Robert Broder, the departmental photographer, for the greater share of the photographic work. For the jacket photograph, I wish to thank Drs. William J. Clench and Ruth D. Turner of the Harvard Museum of Comparative Zoology.

My sister Jennie S. Burnett and Virginia A. Miles typed the early drafts of the manuscript; and Ruth I. Spiller miraculously typed the entire final draft in just a few days. Charles D. Miles and Robert J. Drake cheerfully assisted in the long, monotonous task of proofreading the several drafts, copies, and proofs. The constant help of my wife and the willing hands and sharp eyes of Ruth and Jim in the field have been my greatest blessings in the long task that now lies behind me.