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*INVESTIGATIONS OF THE ICHTHYOFAUNA
OF NICARAGUAN LAKES*

Edited by

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This volume is
DEDICATED

to all of my Nicaraguan friends, but especially to

FATHER IGNACIO ASTORQUI, S. J.,



*scientist, educator and good friend, who
has inspired or aided more investigation of
Nicaragua's fish fauna than anybody else.*

Financial aid was provided by the Banco Central de Nicaragua through its Executive Council and its President, Dr. Roberto Incer Barquero.

Translation of summaries into Spanish was largely done by Jaime Villa.

Commentary on this Compendium

The real highlight of the 1973 Annual Meeting of the American Society of Ichthyologists and Herpetologists at San José, Costa Rica—the first to be held in Latin America—was the symposium brilliantly conceived and ably arranged by Dr. Thomas B. Thorson, of the University of Nebraska–Lincoln, on the fishes and fisheries of the great lakes of Nicaragua. In these days of ever expanding and diversely published reports on this, or on almost any complex subject, it was a bold and propitious stroke to organize, catalyze, and conduct this notable colloquium, and to arrange for the publication, under the same cover, of a very high percentage of the papers that were read at this meeting, plus the republication of a considerable number of highly pertinent papers previously published. The completion of the task is at once a tribute and a memorial to our respected colleague, and to his willing helpers.

It is clear from this assemblage of reports that much indeed has already been learned about the fishes and fisheries of these major inland seas, but also that a nearly virgin field remains to be cultivated. Toward this end, this survey will be a major stimulating factor, whether in pure science or in matters of concern to the local economy.

The broad lakes and connected streams of Nicaragua support a rich and distinctive aquatic resource, for scientific study and for economic development. This resource should be jealously safeguarded, for it represents the product of age-long adaptation and adjustment that fits each living creature to its particular ecosystem. These are delicate systems, that can be vastly, even disastrously, altered by unwise human activity, for instance by over-use of the water, by unwise diversions, by pollution, by drainage and damming, by overfishing, and, particularly, by the establishment of

exotic fishes, notably predatory ones, or carriers of disease against which the fine native fishes have developed no resistance.

The lakes have been the scene of considerable lacustrine speciation, of great scientific interest and concern, even though the extent of evolution is less extreme than in the Great Lakes of Africa, or in the Siberian Lake Baikal, or in the Andean Lake Titicaca, or in other lakes wherein evolution has been explosive. But even less extreme diversification will yield significant data on how species arise and how they come to interplay in the drama of evolution. These lacustrine fishes of Nicaragua are unique to this country, and deserve prime consideration. The best way to save these unique creatures is to preserve the natural environment, with its whole biota.

The history of developing countries is replete with ecological calamities that have resulted from the destruction of the fauna and by the introduction of exotic plants and animals either accidentally or by some seemingly good or safe reason, such as the control of some animal or plant that seems to be noxious; or simply for sport. I look with particular alarm on the possible introduction of *Tilapia* to control weed growth, to provide better fishing, or more food for hungry people. In this report, Riedel has indicated that the establishment of *Tilapia* has been into a completely landlocked lake, but that restocking in other waters is admittedly possible, and he has stressed the advantages of establishing the species in estuarine waters.

I strongly urge that any proposition to modify the aquatic environment or to alter the biota be approached with *extreme* caution, and be given very thorough consideration.

Carl L. Hubbs

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Preface

This volume is a direct outgrowth of a symposium held during the annual meeting of the American Society of Ichthyologists and Herpetologists on June 26 and 27, 1973, in San José, Costa Rica. That symposium was originally conceived with the objective of bringing together all investigators currently conducting studies on the fishes of Lake Nicaragua. The wide geographic distribution of potential contributors and lack of funds for transportation prevented full participation, but seven investigators were present and ten papers were presented.

The response to the venture encouraged me, after harboring some misgivings, to assemble for publication manuscripts from all prospective participants, whether they were able to take part in the symposium or not. Several of the investigations included more than Lake Nicaragua, so the coverage was extended, first to Lake Managua and finally to all Nicaraguan lakes.

When the idea first occurred to me, I wondered if there would be enough contributions to make the project worth pursuing, but as it evolved, it became evident that, not only

were more people currently interested in the fishes of Nicaragua than I first realized, but that 30 papers on the subject had already appeared since 1960. It was eventually decided to republish these papers, which, together with the reports on current investigations, added up to a collection of 52 papers.

Except for a few newspaper accounts, several popular articles, and a number of government reports, this volume includes virtually everything that has been done on the fishes of Nicaraguan lakes since 1960 and a summary history of what had been done before that.

The spectrum of coverage has been dictated strictly by the interests of the 39 investigators and is inevitably uneven. The gaps are clearly evident and the areas most in need of investigation are there for all to see.

It is my hope that this volume will provide a useful sourcebook for all who are interested in the Middle American ichthyofauna, and I especially hope that it will provide a stimulus to future investigators in Nicaragua, the fascinating Land of Lakes and Volcanoes.

Acknowledgments

It is a pleasure to acknowledge and thank the many organizations and individuals who have in so many ways helped to bring this rather extended project to completion. Their contributions have been invaluable.

The publication of this volume was assisted by funds from NIH Biomedical Sciences Support Grant RR-07055-09; the University Research Council, the School of Life Sciences and the College of Arts and Sciences of the University of Nebraska-Lincoln; and by the Banco Central de Nicaragua.

I received advice and help during the organization and conducting of the symposium, on which the volume is based, from Carl L. Hubbs, Douglas C. Robinson, Jaime Villa, Jaime Incer, Kurt W. Koenig and Richard J. Beatty.

Aid in translation of summaries into Spanish, largely done by Jaime Villa, was also provided by Marsha Villa, William A. Bussing, Myrna I. López de Bussing, Felisa Heller and Luis Larios.

Administrative aid and advice concerning the mechanics of publishing and distributing the volume were kindly provided by Adam C. Breckenridge, Vice Chancellor for Academic Affairs and Interim Chancellor; Melvin D. George, Dean, and Max D. Larsen, Interim Dean, College of Arts and Sciences; Richard E. Bennett, Director of Special Business Services; J. M. Daly, Interim Director, Gary L. Hergenrader, Interim Director, and Russel H. Meints, Director, School of Life Sciences; and James R. Rosowski, Associate Professor of Botany; all of the University of Nebraska-Lincoln.

The actual assembling and production of the book were made possible by the professional skill of Harold W. Bathel, Harold Wagner and Ted Hempel of the Printing and Duplicating Service and art work was by Kaz Tada and Jack Brodie of Photographic Productions, also at the University of Nebraska-Lincoln.

Terry Hubbell helped with many of the final details and was largely responsible for the indexing of scientific names. Various members of the secretarial staff of the School of Life Sciences also participated in various degrees in the many time-consuming chores that eventually added up to the final product.

Permission to republish thirty papers was granted by the authors, as listed in the table of contents, and by all of the publishers (except one, now defunct), as follows: The Wistar Press, Philadelphia (American Journal of Anatomy); E. Schweizerbart'sche Verlagsbuchhandlung (Nägele u. Obermiller), Stuttgart (Archiv für Hydrobiologie); N. V. Boekhandel en Drukkerij V/H, E. J. Brill, Leiden (Behavior); National Research Council of Canada, Ottawa

(Canadian Journal of Zoology); Pergamon Press, Oxford (Comparative Biochemistry and Physiology, International Journal of Biochemistry); American Society of Ichthyologists and Herpetologists (Copeia); the editor of Encuentro: Revista de la Universidad Centroamericana, Managua; Dr. W. Junk B. V., The Hague (Hydrobiologia); Society of Economic Paleontologists and Mineralogists (Journal of Sedimentary Petrology); University of Chicago Press (Physiological Zoology); University of Costa Rica (Revista de Biología Tropical); American Association for the Advancement of Science (Science); American Fisheries Society (Transactions of the American Fisheries Society); Verlag Paul Parey, Berlin and Hamburg (Zeitschrift für Tierpsychologie); the publishers of Archivio Italiano di Anatomia e di Embriologia and of Bollettino di Zoologia; and Instituto de Fomento Nacional, División de Pesca, Managua. I regret to report that the publishers of Medicina y Cultura went out of business as a result of the December, 1973, earthquake in Managua.

Without any doubt, the most important contribution to the authors and editor came from those who reviewed the papers and made suggestions for their improvement. In many cases a great deal of time and effort were expended and thoughtful criticisms and recommendations were offered. The papers are the better for the efforts of the reviewers, but responsibility for errors or weaknesses must remain with the authors and editor. My deepest appreciation is expressed to Reeve M. Bailey, George W. Barlow, John Brumbaugh, William A. Bussing, John G. Carlisle, Jr., Gerald A. Cole, Alfred W. Ebeling, David G. Frey, Perry W. Gilbert, Jeffrey Hazel, Gary L. Hergenrader, Carl L. Hubbs, Kurt W. Koenig, John D. Lynch, Connell L. Marsh, Robert R. Miller, Arthur A. Myrberg, Jr., Mary Lou Pritchard, Luis R. Rivas, C. Richard Robins, Donn E. Rosen, Richard Rosenblatt, Stewart Springer, Gerald D. Tharp, John H. Vandermeer and Jaime Villa.

Some words of thanks are also due the contributors of the fifty-two papers that appear within these covers. Having heard a great deal about the problems of editors, and having perhaps now and then contributed some of those problems myself, I approached this venture prepared for the worst. However, the worst never materialized. The contributors have been an unbelievably patient and understanding group and I truly appreciate their cooperation.

Thomas B. Thorson

Lincoln, Nebraska
November, 1975

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