This book provides a clear and concise account of the physiology and form of the fish circulatory system. Emphasis is primarily placed on the function of the system although details of structure have been included. Following some revisionary ideas on haemodynamics, attention is focussed on the heart as the primary pump in the fish circulatory system. The fine structure and the electrical and ionic changes in the cardiac myocytes are described and the major events of the cardiac cycle are outlined. This is followed by a description of the structure of the peripheral vessels and of circulation in certain special areas such as the gills, renal portal system and the secondary blood system. Further chapters are devoted to the blood and the haemopoietic tissues and include an account of the different types of retial system that concentrate oxygen or heat in various parts of the body.

This book is up-do-date, well illustrated and written in a style comprehensible to anyone with a basic knowledge of the biological and physical sciences. Both undergraduate and graduate students of physiology, zoology and marine science will find this an invaluable reference text.

Physiology and form of fish circulation

PHYSIOLOGY AND FORM OF FISH CIRCULATION

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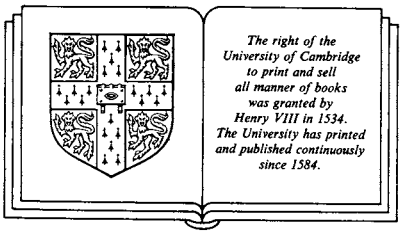

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This book is dedicated to
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Professor of Cardiac Surgery
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PREFACE

In recent years mankind has become increasingly aware of the finite nature of our natural resources. At least a third of the world's population is insufficiently nourished. At the same time much of the world's land suitable for farming is already under cultivation and it seems unlikely that the ever increasing shortfall of animal protein can be produced on farms. The oceans produce only 1–2% of the calories consumed by man and world fisheries too are fast approaching the point where all the well-defined stocks of fish are fully utilized. Perhaps an annual sustainable yield of 100 million tons of fish is a possibility; it seems unlikely that this catch can be doubled. Indeed, the growth of sea fisheries declined between 1975 and 1980. Today we still get most of our fish by hunting them with baited hooks and nets. More than a thousand years ago mankind realised that hunting was an inefficient way of obtaining meat, compared with farming it and in many countries the potential for aquaculture, i.e. the controlled cultivation and harvest of fish, is under investigation.

Aquaculture assumes that the proper management of systems, in terms of inputs of high quality water and feed, will give higher yields than unmanaged natural systems. An essential requirement of such management is an understanding of the physiology of the organisms to be cultivated. Established texts exist concerning the physiology of most of man's domesticated mammals and much of the success in raising meat from them is due to this; those wishing to know about the physiology of fish are less well provided. This book has been written to provide a comprehensive review of the physiology of the fish circulatory system. It is intended to serve the needs of students in Fisheries Biology but it will also be useful for courses in Comparative Physiology. The interrelation of structure and function are nowhere more evident than in the circulatory

system, and the text and illustrations include structural descriptions where these will help the student to grasp the physiology. This necessity is the greater in fish circulatory physiology because features such as the retia mirabilia which concentrate oxygen in the eye and swimbladder and the separate and partly independent secondary blood system, do not occur in higher vertebrates and are often unknown even to circulatory physiologists.

I have borne in mind that some readers, interested in general physiology, may be unfamiliar with the scientific names of the many species of fish that have been used in circulatory studies. For this reason I have used common names, and have included the latin name only when it is first mentioned in the text. The rainbow trout *Salmo gairdneri*, has been the species most frequently studied by physiologists and I have referred to it simply as 'the trout'; the brown trout *Salmo trutta*, and brook trout *Salvelinus fontinalis*, I have referred to as such. I have tried to spare my readers from the arcane scholarship of the fish systematists; I am aware that the rainbow trout has, by some authorities, been placed in the genus *Oncorhynchus*. I am also aware that in none of the 44 papers cited in the references, which include the scientific name of the rainbow trout in the title, is the name *Oncorhynchus* used. At the end of the book I have included an Appendix in which both common and scientific names are given.

This book would not have been possible without the help of many people. I am quite particularly indebted to my colleagues in the Physiology Department of the Otago Medical School who have been so generous with their time; I wish specifically to thank Dr E. R. Fawcett, Dr C. P. Bolter and Dr J. P. Leader for some valuable discussion. I am indebted to Jean Clough and Douglas Sanderson for technical help with the illustrations. Professor A. P. Farrell, of Simon Fraser University, Professor R. M. G. Wells of the University of Auckland, and Dr M. E. Forster of the University of Canterbury have read much of the manuscript and have been ever helpful with criticism. Thanks are also due to Professor H. A. Bern of Berkeley, Professor K. R. Olson of the Indiana University School of Medicine and Dr P. S. Davie of Massey University, who have helped me with specific points. None of these gentlemen is to be held responsible for what I have written, but to all of them I offer my sincere thanks for their advice and encouragement. Inevitably, in a book of this length, mistakes will have been made and I would be grateful to my readers if they will write to me and let me know of them.

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