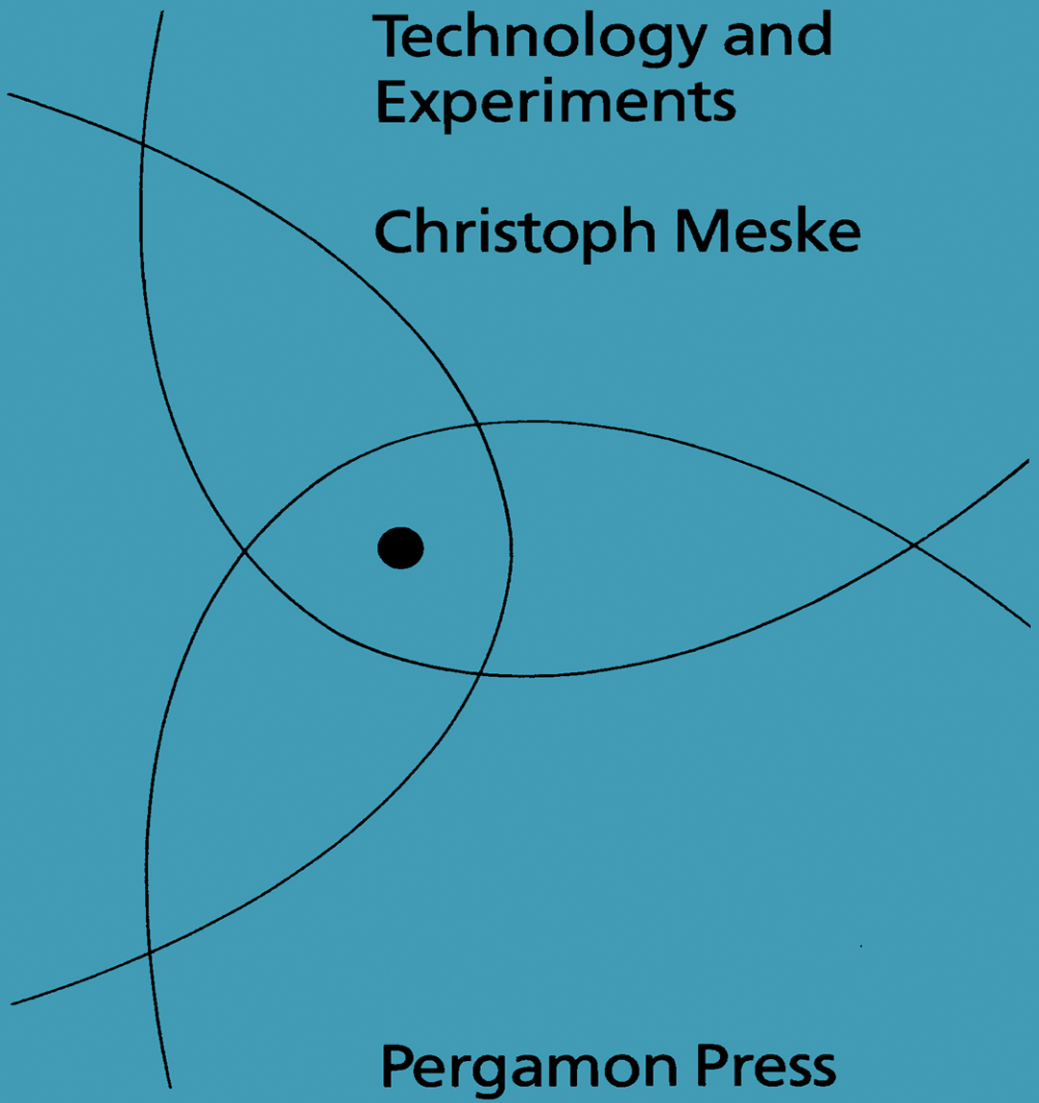
Fish Aquaculture

Technology and Experiments

Christoph Meske



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FISH AQUACULTURE
Technology and Experiments

by

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EDITOR'S AND TRANSLATOR'S NOTE

As an ex-farm manager I got into fish farming by accident while researching the use of renewable energies in the bio-industries as a member of Prof Ray Maw's Built Environment Research Group at the Polytechnic of Central London.

In the process I made a lot of friends: (Dr) Ann M Powell of the City Polytechnic; (Dr) Alan Starkie of the Severn and Trent Water Authority (who first brought Prof Meske's book to my attention) and (Dr) Colin Purdom of the Fisheries Laboratory (Ministry of Agriculture, Fisheries & Food). Unfortunately I met (Prof) John Bardach of the East West Centre and the University of Hawai too late to avail myself of his kind offer of help.

Without their willing help, advice and constant encouragement I would not have considered tackling Prof Meske's work nor would I have felt able to do so. I owe them a great debt.

Without Prof Maw's early encouragement this translation would never have gone beyond the initial stages.

Prof Meske's original book has been updated and augmented and it is fitting here to thank Pergamon Press, particularly Jill Price, Martin Richardson and John Cooper, for their support in getting it published.

As an agriculturist I found fish farming a primitive industry which could and should make a major contribution to the provision of protein for food and job creation for society. These aims can realistically only be achieved by fundamental changes in the structure of the industry along the lines of other livestock enterprises and certain arable crops where stock selection, management, marketing and financing developments have given large gains and stability to both producers and consumers.

F. Vogt

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PREFACE

Aquaculture has gained a momentum throughout the world during recent decades which is probably unparalleled in other branches of food production. Cropping fish and other aquatic organisms for food is to a large extent based on very old methods. All the traditional methods together with their modern counterparts are often of high technology and are now commonly described as aquaculture.

In most countries of the world there is a surge of activity in this field. There are new research centres, journals, textbooks and many international meetings. All of these confirm the topical interest in the subject of aquaculture. In recent years it has become clear that the problems of overpopulation, of food and raw material procurement and of environmental pollution demand major research work.

This book is an enlarged and updated version of my original work which was first published by Verlag Ulmer of Stuttgart in 1973.

It describes in Chapters 2 and 3 the methods currently used for the production of those warm water table fish which are of major importance. The main part of the book — Chapters 4, 5 and 6 — describes the experiments and procedures which may help to combat the growing food problem through new production methods for animal protein. The aim of the work presented here concerns the continuous production of warm water table fish independently of climate or environment within the least necessary space and even in regions with unsuitable weather or topography.

A large number of experiments were carried out to gain basic knowledge on the physiological reactions of fish to various environmental influences. In particular the investigations were concerned with the effect of abiotic factors and nutrition on the growth of carp. It is hoped that this book may be of practical use to commercial fish farmers. Perhaps it will also make a small contribution towards solving some of the problems of food production and environmental pollution.

Although the development of a closed cycle or re-circulation system was primarily designed for experimental work, there was an underlying thought of its possible use in large commercial enterprises.

All the work described in this book was undertaken at Ahrensburg, near Hamburg. During the early years up to 1970 it took place at the Max Planck Institute for Plant Breeding and from 1971 onwards at the Institute for Coastal and Inland Fisheries of the Federal German Fisheries Research Institute.

Although the work reported in this book refers solely to a closed cycle system using the activated sludge process, this system represents only one of several alternatives. Many centres throughout the world are working on the development of re-circulation systems and it is inevitable that this will lead to improved and more economic system performance. As the availability of clean water tends to decrease, if only regionally, it is difficult to see how fish farming can be carried on without re-circulation. Fish farming is a growing industry. It demands an uninterrupted supply of clean water. It would seem that re-circulation systems may be the only answer.

The work could not have been carried out without my co-workers' unstinting support and advice with the experiments and the construction and maintenance of the plant.

I thank them all most sincerely for their help, particularly when willingly carried out over week-ends and throughout the holidays. Without them the research work — and the publication of this book — would not have been possible. The photographs have been prepared by Mr K. Engelhardt to whom I express my special thanks.

Finally it is appropriate that I thank the editor and translator for his endeavours.

It is hoped that this book will make a small contribution towards easing the problems of food production and of pollution.

Ahrensburg 1982 Christoph Meske

CONTENTS

1. INTRODUCTION

Fish for human consumption – whether eaten directly, processed or fed to domestic animals as fish meal – is almost entirely harvested from the seas. In 1980 marine catches amounted to 64.7 million tons (Mt). Inland fishing provided an additional 7.6 Mt of which roughly half was produced by both salt and fresh water aquaculture. This figure can be broken down into 3.23 Mt of fish, 3.7 Mt of molluscs and 0.71 Mt of crustaceans.

The fishing industry has undergone considerable changes in recent times, relying increasingly on higher technology, improved methods and more effective gear. Nevertheless it has remained basically the same: hunting for wild fish in natural waters.

During recent years the problems of the fishing industry have grown considerably. Overfishing has resulted in restrictions and quotas. Almost all coastal states now operate 200 mile (320 km) limits. There are total bans on the fishing of some species, while other previously little or unknown species have appeared on the market. The bans have affected those countries traditionally engaged in high seas fishing. As a result joint ventures between the technically advanced nations and the underdeveloped countries have been inaugurated in the fields of research, processing and marketing.

Apart from overfishing there is also the problem of pollution of which oil slicks and toxic industrial waste effluent are examples. In recent oil rig disasters large quantities of oil were discharged into the sea. There have been several major tanker accidents. In Japan industrial discharge caused a new medical condition.

A number of other factors influence the fish crop adversely. Cannibalism, parasites, viral and bacterial infection occur naturally. As the natural balance is upset by man-made changes in the environment the consequential and cumulative effect may have serious repercussions on the world's food supply.

OVERFISHING

The history of post-war fishing is one of increasing catches. In the 11 years from 1957 to 1968 catches roughly doubled and rose from 40 Mt a year in 1960 to 63.3 Mt a year in 1968. The first sign of a turndown appeared in 1969 when there was a 1.2 Mt or 2% reduction in the catch on the previous year.

Up to this time it was thought that the global crop would continue to increase at the same rate as before. Catches rose as fishing fleets equipped themselves with more advanced technical aids and gear, while at the same time reducing the chances of the fish population to regenerate itself. Between 1969 and 1974 the fishing fleet grew by over 50%, consisting of larger vessels and factory ships. It is open to debate whether the arrest in the crop yield during this period is due to the expansion of the fleet, or whether even the greater number of ships were unable to raise the level of catches (Table 1).

TABLE 1.

World Catches 1956–1980 (FAO) in million metric tonnes

1956	30.5	1968	64.3
1958	33.2	1970	69.5
1960	40.0	1972	65.5
1962	46.9	1974	70.3
1964	52.8	1976	69.6
1966	57.4	1978	70.4
		1980	72.3

The FAO made an optimistic forecast of improving catches rising to 130 Mt a year in the year 2000. This figure is open to doubt, particularly as the increasing sophistication of the equipment is likely to expose the residual population in the coastal water of the developing countries to the dangers of overfishing. Table 1 shows that world fish catches have not risen to any extent during the last 10 years.

When Iceland first imposed its 50 mile (80 km) fishing limit there was considerable diplomatic activity followed by the cod war with the United Kingdom. The International Court at The Hague was unable to exert its authority. Since then 200 mile (320 km) fishing limits have become the norm and the smaller seas, like the Baltic, have been divided among bordering states. The stress caused within the European Economic Community (EEC) over national or traditional fishing rights gives an indication of the political importance now given to fishing. The freedom of the seas is being less frequently mentioned.

Fishing has until now been based exclusively on economic criteria while neglecting biology and the environment. The very profitable but biologically lethal exploitation of the cod spawning shoals is an example, as is the catching of immature herring for feeding to trout. It should be noted that it takes 6 kg of wet herring to produce 1 kg of trout. As a result of overfishing there was for a period a total ban on catching herring in the North Sea except for fish for direct human consumption in Danish coastal waters (Table 2). While total world catches