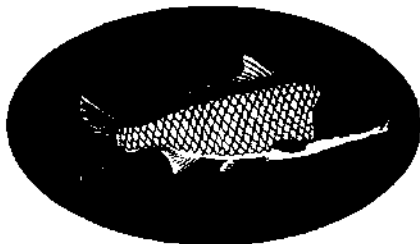
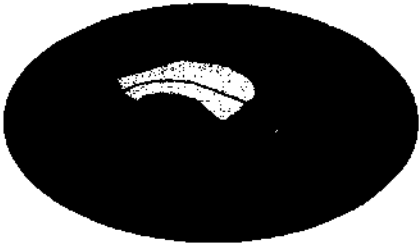
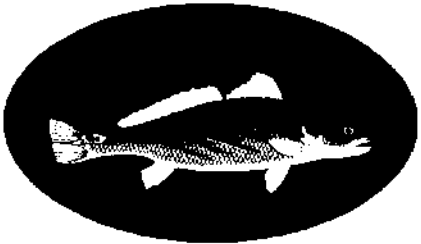
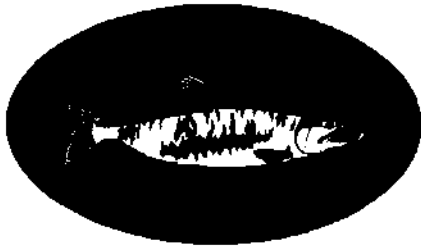


LOAN COPY ONLY

HAWAU-M-93-001 C3



Selective Breeding of Fishes in Asia and the United States

CIRCULATING COPY

Edited by
Kevan L. Main
and
Elizabeth Reynolds

The Oceanic Institute

LOAN COPY ONLY

Selective Breeding of Fishes in Asia and the United States

**Proceedings of a Workshop
in Honolulu, Hawaii
May 3-7, 1993**

Edited by

Kevan L. Main and Betsy Reynolds

THE OCEANIC INSTITUTE

Published by
The Oceanic Institute
Makapuu Point
P.O. Box 25280
Honolulu, HI 96825

Sponsored by
The National Oceanic and
Atmospheric Administration
United States Department
of Commerce

UNIHJ-SG-MR-94-04

Copyright © 1993 by The Oceanic Institute
All Rights Reserved

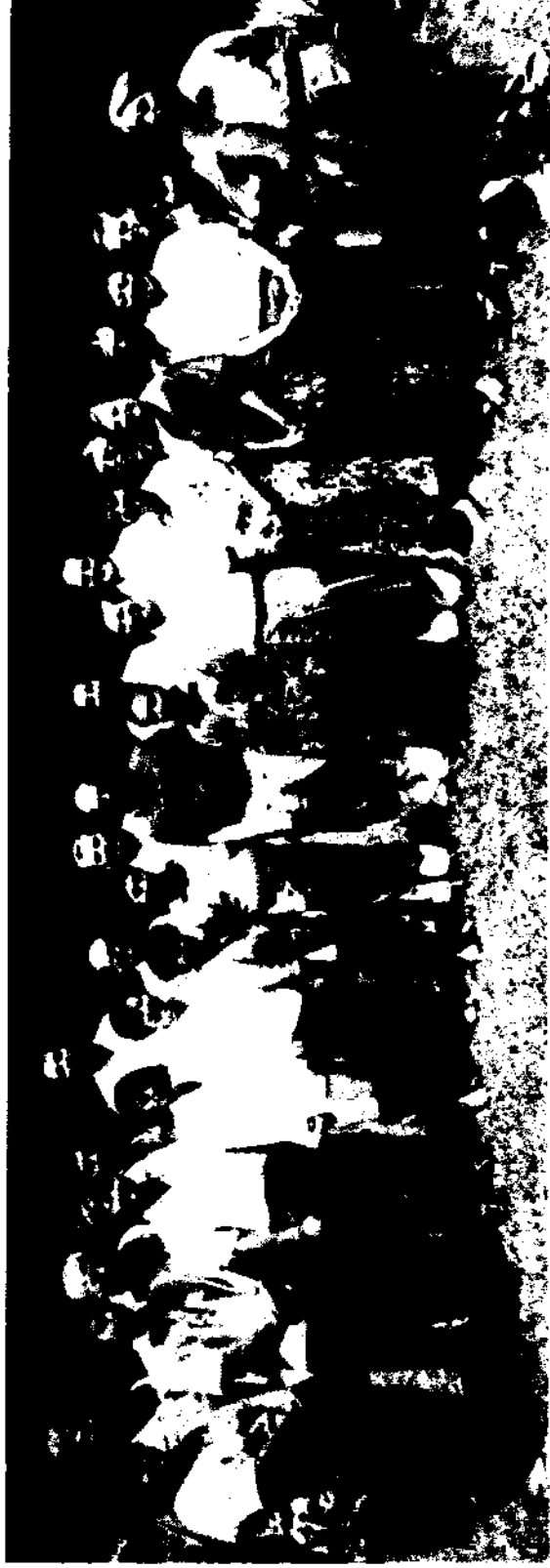
For additional copies, please contact:
The Oceanic Institute
Makapuu Point
P.O. Box 25280
Honolulu, HI 96825

ISBN 0-9617016-8-4

Table of Contents

Preface	vi
Part I: Introduction	1
Introduction	3
Part II: Aquaculture/Conservation	8
Development of Fish Breeding and Conservation Programs Graham A.E. Gall	10
International Selective Breeding Programs: Constraints and Future Prospects Trygve Gjedrem	18
Public Policies Regulating the Use of Genetically-Modified Aquatic Organisms: Current and Future Needs Internationally Eric M. Hallerman	32
A Review of Freshwater Fish Genetic Conservation Research and Practices in China Sifa Li	48
Breeding Programs for Ornamental Fish Production in Asia Violet P. E. Phang	60
Use of Chromosome-Manipulated Fish in Aquaculture and Related Problems of Conservation of Wild Stock Nobuhiko Taniguchi, Hyon Sob Han and Akio Tujimura	68
Channel Catfish Breeding and Selection Programs: Constraints and Future Prospects William Wolters	82
Enhancement/Conservation	96
Genetic Resources for Future Finfish Aquaculture William K. Hershberger	98
Conservation Genetics Programs for Pacific Salmon at the Washington Department of Fisheries: Living with and Learning from the Past, Looking to the Future James B. Shaklee, Craig A. Busack and Charles W. Hopley, Jr.	110
Pacific Salmon Management and Stock Enhancement Programs in Alaska William W. Smoker	142

Country Reviews	154
National Fish Breeding Programs in the Philippines	
Remedios B. Bolivar	156
A Review of Fish Genetic Research and Conservation Issues in Taiwan	
I-Chiu Liao, Mao-Sen Su and Su-Lean Chang	162
A Review of the Fish Breeding Research and Practices in Indonesia	
Sudarto	182
A Review of the Fish Breeding Research and Practices in Vietnam	
Tran Mai Thien	190
A Review of Fish Breeding Programs and Conservation Issues in Thailand	
Supattra Uraivan	198
A Review of Traditional Fish Selective Breeding Research and Practices in China with Emphasis on the Use of Genetic Markers	
Chingjiang Wu	206
A Review of Modern Fish Breeding Research and Practices in China	
Dequan Xia and Ting-ting Wu	214
Part III: Discussion Group Summaries	226
Aquaculture Production and Conservation	228
Stock Enhancement and Conservation	241
Appendices	252
Appendix I: Workshop Participants	254
Appendix II: Agenda	256



Workshop Participants: *Front row (from left):* Alcian Choy, Logan Duong, Cheng-Sheng Lee, Remedios Bolivar, Violet Phang, Supattra Uraivan, Dequan Xia, William Wolters, Sudarto, Nobuhiko Taniguchi, Kevan Main, Elizabeth Reynolds, Sifa Li, Lynette Shi, (Missing: Trygve Gjedrem); *Back row (from left):* William Smoker, Ernest Tresselt, James Kenney, James Parsons, Su-Lean Chang, Graham Gall, Eric Hallerman, William Hershberger, Chungjiang Wu, Kenneth Leber, James Shaklee, Tran Mai Thien

Preface

The Asian Interchange Program was founded at The Oceanic Institute in 1989. The program's purpose is to facilitate the exchange of applied aquaculture information and technology between the United States and Asia. This is accomplished through international workshops and distribution of workshop results to information networks throughout the United States and Asia.

This is the fourth workshop proceedings issued by the Asian Interchange Program. This years conference focused on three aspects of selective breeding of fishes: selective breeding to improve fish performance for aquaculture, genetic resource management for stock enhancement and conservation of natural genetic resources. Previous conferences and proceedings addressed culture of cold-tolerant marine shrimp, culture of rotifers and microalgae as a live feed for cultured fishes, crustaceans and molluscs and diseases of cultured marine shrimp.

The Workshop

The Selective Breeding of Fishes in Asia and the United States workshop took place in Honolulu, Hawaii from May 3-7, 1993, and included experts from eight countries in Asia (Indonesia, Japan, the Philippines, the People's Republic of China, Singapore, Taiwan, Thailand, Vietnam), the United States (Alaska, California, Hawaii, Idaho, Maryland, Mississippi, Virginia, Washington) and Norway (see photo). Formal papers were presented during morning sessions and in the afternoons participants shared information and ideas about selective breeding of fishes during informal discussion groups. Japanese, Vietnamese and Chinese interpreters were present to facilitate communications and simultaneous interpretation services were provided during the presentation and discussion group sessions.

The Proceedings

This volume is divided into three parts: the introduction, contributed papers and discussion group summaries. The introduction reviews and defines topics and terminology used throughout the proceedings. The discussion group summaries are divided into two sections: Aquaculture Production and Conservation, and Stock Enhancement and Conservation. They provide a group perspective on key topics related to selective breeding of fishes. The first section concludes with guidelines for selective breeding to improve fish performance and the second section concludes with guidelines for genetic resource management in stock enhancement.

The contributed papers are grouped into three sections: Aquaculture/Conservation, Enhancement/Conservation and Country Reviews.

In the *Aquaculture/Conservation* section, Graham Gall presents three strategies that have been used to conserve natural genetic resources and suggests the only viable conservation strategy is the management of specific populations. Strategic implementation is discussed. Trygve Gjedrem discusses the potential to improve performance in fishes through selective breeding. Genetic gains of 10-20% per generation have been demonstrated for Atlantic salmon. He briefly reviews breeding programs for several fishes, including Atlantic salmon programs in Norway, Iceland, Canada, Sweden and the United States; rainbow trout programs in the United States and Norway; channel catfish programs in the United States; carp programs in Israel, Japan and Russia; and the tilapia program in the Philippines. A mechanism to initiate a breeding program is also presented. Eric Hallerman reviews the potential economic benefits and environmental risks of biotechnology, as well as present and future public policies that will regulate the development and use of genetically-modified aquatic organisms. Sifa Li presents an example of genetic resource deterioration in cultured and natural fish species in China. The need to implement a genetic conservation program in China is discussed. Violet Phang reviews breeding program methods for ornamental fishes in Asia. Ornamental fish breeders continually introduce new genetic variation into their stocks to develop novel strains and avoid inbreeding depression. Traditional and modern genetic technologies for ornamental fish production are discussed. Nobuhiko Taniguchi et al. follows up on this topic with a review of Japan's research on genetically-modified fish and proposed policies to regulate the use of these fishes. Breeding and selection programs for channel catfish in the United States are presented by William Wolters. Research has shown potential for improved catfish stocks through traditional animal breeding, but these techniques are not presently applied by commercial catfish farmers.

In the *Enhancement/Conservation* section, William Hershberger discusses the importance of natural genetic resource conservation for future finfish aquaculture needs. The potential for aquaculture to enhance natural stocks and to produce genetically improved stocks for intensive aquaculture are discussed. James Shaklee et al. reviews the Washington State Department of Fisheries' conservation programs that protect Pacific salmon genetic resources. In Washington, natural salmon stocks are enhanced through hatchery production. The importance of genetic resource management is recognized and formal policies for genetics, stock management and conservation are in practice. William Smoker reviews the history of Pacific salmon stock enhancement and ocean ranching efforts in Alaska. As in Washington, Alaska's resource managers have been concerned about salmon genetic resource losses and have implemented a program to prevent overfishing of wild stocks.

In the *Country Reviews* section, Remedios Bolivar describes development of the Philippines national breeding program, which is to genetically improve tilapia stocks. The program, initiated in 1988, is modeled after the Norwegian salmon breeding program. In the Philippines, wild African Nile tilapia stocks were introduced to serve as a base population for the selective breeding program. I.C. Liao et al. reviews the history of Taiwanese fish genetic research, stock enhancement efforts and the need for conservation of genetic resources. Genetic research in Taiwan has been fragmented. Some successes have been

documented in tilapia hybridization and selective breeding, and more recently, in the production of genetically-modified fish. The effectiveness of releasing fish fry to enhance depleted fishery populations is not known, although enhancement has been practiced since the 1970s. Sudarto reviews genetic research on carp, tilapia and other species used to resolve Indonesia's inbreeding problems. The most commonly cultured fish in Indonesia is the common carp. Tran Mai Thien discusses the history of fish breeding research and deterioration of genetic quality in cultured Vietnamese fish populations. Fish breeding research has focused on carp and tilapia hybridization. Supattra Uraivan reviews genetic research and conservation issues in Thailand, and discusses selective breeding programs for tilapia, walking catfish, common carp and Java carp. Thailand is concerned about conserving the genetic diversity of natural fish stocks and is in the process of setting up a conservation program. Traditional selective breeding practices in the People's Republic of China are reviewed by Chingjiang Wu. As in other Asian countries, traditional breeding research has focused on hybridization of the carp species. The use of genetic markers or phenotypic differences, such as color patterns, to determine genetic differences is presented. Finally, Dequan Xia and Ting-ting Wu review the potential of biotechnology-based research to genetically improve fish stocks in the People's Republic of China.

Acknowledgments

The editors thank the University of Hawaii Sea Grant College Program for its administrative support throughout this project. The Asian Interchange Program is funded by the National Oceanic and Atmospheric Administration, United States Department of Commerce (Grant #NA90AA-D-SG483), which is administered by the University of Hawaii Sea Grant College Program.

A number of individuals contributed to this work. Most importantly, we would like to thank the authors who participated in the workshop and prepared the papers included in this volume. Graham Gall provided valuable guidance and technical assistance in the development of the meeting agenda and workshop details. Cheng-Sheng Lee, I.C. Liao, Roger Doyle and Graham Gall helped to identify and select workshop participants. Graham Gall, Kenneth Leber, William Smoker, Trygve Gjedrem, Eric Hallerman and James Shaklee reviewed the discussion group summaries. We thank Cheryl Rosenfeld for editorial assistance throughout the production of this proceedings. Esma Harper, Rose Marie Norton, Lana Pigao and Paula Steib proofread the manuscript. We also acknowledge our capable interpreters, Logan Duong, Hongja Harrison, James Kenney, Lynette Shi, Taeko Wellington and Shugiang Zhang.

The introduction and discussion group summaries were written by Kevan Main, with editorial support from Cheryl Rosenfeld and Elizabeth Reynolds. The final production of the proceedings and the cover design was done by Cheryl Rosenfeld, with assistance from Alcyan Choy. A special mahalo to Jan Dill for his support of the Asian Interchange Program.