Aquaculture in China

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This book, three years in the making, is in many ways long overdue. Given the overwhelming dominance of global aquaculture production by China (68 percent of the total), it is indeed puzzling why a book such as this took so long to be published. The book might be more aptly titled the Encyclopedia of Aquaculture in China because the general approach to the chapters was to describe the current status and practices used to produce the numerous species cultured in China. Indeed the book is reminiscent somewhat of the *Encyclopedia of Aquaculture* (2000) edited by Robert R. Stickney and even of the classic species compendium *Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms* by Bardach, Ryther and McLarney (1974). Chapters are generally concise summaries of the topic.

Despite the importance of China to global aquaculture production, species-specific technical information is not widely available outside of the country. No doubt this is due at least in part to the language barrier between China and the largely English-speaking world of science. This book goes a long way to bridging that gap. Nearly all of the references cited were written and published in Chinese journals and so this book brings that information to a wider audience. The book includes contributions from 120 scientists representing members of the Chinese Academy of Fishery Sciences and all prominent national universities and government research institutes and laboratories involved in marine and freshwater aquaculture.

The large-format (20 × 26 cm), 677-page book has 40 chapters that are organized into eight sections: recent developments (5 chapters), traditional species (6 chapters), emerging species (14 chapters), alien species (5 chapters), genetics (4 chapters), environmental issues (5 chapters), and development strategies (1 chapter). China cultures more than 90 species, more than any country by far. Nearly every species covered in the book has a genetic improvement program associated with it. Each of the species chapters is organized similarly, with sections on main culture areas, historical production trends, production systems, breeding, feeds and disease, marketing and future prospects. However, authors had considerable scope to vary this structure and emphasize certain aspects as appropriate for the species covered. Many chapters have helpful national maps indicating provinces with significant production of a species, most located in the fertile and temperate southeastern one-third of the country, although fish are produced throughout China.

An introductory chapter sets the stage by giving the big picture of China's contribution to national food security and global aquaculture. Chapters follow on the status of inland aquaculture, the status of mariculture and aquaculture's contribution to rural development. There is some overlap in these initial chapters and indeed throughout the book, especially regarding national production statistics, which are notoriously unreliable. China's aquaculture has undergone several major transitions in recent decades, but none more important than the shift from traditional inputs of organic wastes and agricultural by-products to pelleted compound feeds.

Next is an interesting chapter on the trophic relationships among species in Chinese aquaculture with the main point that the average trophic level has not changed very much since the mid-1980s. China is producing more higher trophic level fish, all from mariculture, but freshwater aquaculture is so dominant that its effect on overall trophic level is minimal.

In the section on traditionally farmed species, the chapter on grass carp is subtitled "the fish that feeds half of China." One interesting finding concerning grass carp is the discovery that feeding broad beans can improve the flavor and flesh characteristics, referred to as "crisped" grass carp, which has a market value twice that of ordinary grass carp. In the chapter on common carp, the section on the various breeding strategies and strains of common carp and the genetic improvement approaches to bream (*Megalobrama* and *Parabramis*) was fascinating, indicating a high level of effort using the latest biotechnological tools, leading to favorable outcomes. Rice-fish culture is at least 2000 years old but has been transformed only since the 1980s. The chapter describes a "leapfrog" development phase beginning in the mid-1990s. Although there are 19 models of integrated ricefield aquaculture, the most important systems use fish, crayfish, crab or turtle. Unexpectedly, in the section on traditionally farmed species, there were no chapters on two of the four "major Chinese carps" — bighead carp or black carp.

Pearl mussels, Chinese mitten crab, oriental river prawn, and mud crab lead the list of emerging culture species in China, each covered in a separate chapter. One of the newer species cultured in China is sturgeon, only farmed since the 1990s. The chapter on snakehead culture highlights the role of snakehead hybrids between *Channa argus* and *C. maculata* as the basis for commercial culture of this fish. With the growth of the Chinese middle class, consumption of the predaceous mandarin fish (*Siniperca chuatsi*) has increased steadily since the early 1990s. Chapters on yellow catfish, paddy eel, large yellow croaker, flatfish, rabbitfish, soft-shelled turtle, and hard-shelled turtle round out the section on emerging species.

A significant part of aquaculture production in China is based on what is described in this book as "alien" species. Although the red swamp crayfish was introduced in 1929, it was not until the early 2000s, with the development of rice-crayfish culture, that production increased. Now China contributes more than 90 percent of global production of this species. The complexity and sophistication of the farming systems for this species are impressive. Although white shrimp (*Litopenaeus vannamei*) were introduced into China only in 1988, it is now the world's largest producer of this species. About 85 percent of shrimp farmed in China is Pacific white shrimp. Despite

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the importance of emerging diseases such as EMS/AHPND and EHP, these are given only a passing reference in this chapter. Channel catfish were introduced in 1984 and China is now the world's largest producer of this species, accounting for about 60 percent of global production. Marker-assisted selection is being used to improve culture performance of this species. China is also the global leader in tilapia production, responsible for about 34 percent of the global production volume. Tilapia introductions have been made almost every decade since 1946. The main species produced are the Nile × blue tilapia hybrid, improved GIFT strains, and red tilapia and genetic improvement programs for this species are active. Seven farming models are described for tilapia in China. A chapter on largemouth bass culture completes the section on alien species. Although some tilapia producers in China are now growing Pangasius catfish, apparently production of the fish has not yet reached a level to warrant a chapter in the section on alien species in this book.

There is not too much insight to be gained from the chapters on feeds in freshwater and marine aquaculture. Since the early 1990s, there has been a direct relationship between fish production increases in China and aquafeed output, currently estimated to be around 20 million t. The overwhelming majority of aquafeeds are compressed pellets, with low levels of fishmeal (1-2 percent), used for production of low trophic level fish. The important topic of fishmeal and fish oil replacement in mariculture feeds earned a scant paragraph.

The chapter on genetic breeding biotechnologies is excellent. There is a table of improved varieties of a range of species that spans seven pages and another table of hybrid varieties that spans five pages. It is clear that China is active and on the cutting edge in terms of application of modern tools and biotechnologies to improve the culture performance of a broad range of species. This is exemplified by the following chapter that describes the whole genome sequencing of the half-smooth tongue sole (*Cynoglossus semilaevis*), ultimately leading to production of monosex female offspring. The next chapter describes a program for stock enhancement of the Chinese mitten crab (*Eriocheir sinensis*) that includes germplasm cryopreservation. This is one of the few chapters where stock enhancement is discussed specifically, despite the importance and application of this approach to increasing fish production throughout China. The following chapter addresses stock enhancement from the standpoint of fry and fingerling production and has a table that lists 79 government farms with responsibility for seed production of various species.

The next section on environmental issues begins with a chapter on multitrophic mariculture practices, describing two case studies of IMTA from Sungo Bay (Yellow Sea). The following chapter addresses pond effluents and various options for treatment, including "eco-slopes," ditches, "eco-ponds," "bio-floating beds" (a form of aquaponics with aquatic plants), "eco-channels," and constructed wetlands. This chapter presented some interesting concepts, although it could have benefited from more rigorous editing as there were numerous omissions, errors, odd units, and unclear arguments. The general engineering design approach could have been more thoroughly presented. It is not clear the degree to which these configurations and technologies are being taken up by producers, although clearly there is a pressing need to do so given the general deterioration of surface water quality in China. A chapter on "disease prevention and control" is more of a survey of the specific viral, bacterial, fungal and parasitic diseases of the species cultured in China, and many of these are common to aquatic animals cultured around the world. A chapter on lake and reservoir aquaculture includes discussion of stock enhancement, cage and pen culture in lakes and reservoirs, and an "eco-fisheries" management approach that uses stocking of piscivorous mandarin fish as a way to achieve top-down biomanipulation that results in water quality improvement. The last chapter in this section describes the national system of 464 National Aquatic Genetic Resources Reserves, each of which represents key spawning and nursery areas for one or more species that are designated for protection and conservation.

The final section of the book, consisting of one chapter, is about development strategies and prospects for aquaculture development in China. The major driving forces leading to the rapid development of Chinese aquaculture are identified as "correct" decision-making that created an aquaculture-centered development policy, progress in science and technology, especially application of biotechnology for genetic improvement, and characteristics of culture species, primarily those of lower trophic levels. The development philosophy has shifted from a focus on food production, food security and economic development to a more balanced "eco-harmony" approach that also considers resource use efficiency, environmental impacts and the ecological services provided and used by aquaculture. To achieve this vision, key tasks include accelerated establishment of hatcheries for genetically improved varieties and planning for the growth of modern practices such as IMTA, RAS and ecologically engineered production systems.

Overall, this book gives readers an overview of what may be possible for aquaculture development in other countries. In China, the necessary prerequisites were a long history and cultural acceptance of aquaculture, abundant aquatic natural resources and a commitment by policymakers to foster aquaculture development.

In a book with as sprawling a scope such as this, certain editorial decisions had to be made, and so any criticism should be tempered by the accomplishment of assembling this information, heretofore largely inaccessible, in one place. As the world's leader in seaweed production (48 percent of global production), other than a cursory overview in the chapter on mariculture, there were no chapters on the production of major seaweed species. Chapters on production economics and social aspects of aquaculture would have been interesting and useful. As one might expect of authors for whome English is not their primary language, the writing is occasionally unclear, although instances of this are few and far between.

Most of the editors of this book are likely not well known outside of China. The one exception is Sena de Silva, who is the author or editor of numerous books, including *Success Stories in Asian Aquaculture*, *Tropical Mariculture*, and *Fish Nutrition in Aquaculture*. Although not explicitly stated, it is clear that Dr. de Silva played a major role in coordinating the efforts of the authors, editing, and seeing the book through to publication. He and his fellow contributors should be commended for drawing back the curtain on aquaculture in China and giving the wider world a view of a major productive activity inside the world's preeminent aquaculture superpower.

— John A. Hargreaves, Editor-in-Chief, ***World Aquaculture***