Research Directions for Tilapia Culture*

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There is a growing consensus that tilapias can become the world's most important warm-water, cultured fishes and a large body of information is available on their biology and culture. Despite this there remain basic questions to be answered before tilapias can become widely available as domesticated fish and tilapia culture can advance to produce an internationally recognized and marketable food commodity. Prospective tilapia culturists with the time to sift all the published information find great difficulty in deciding which tilapias to culture, where to obtain pure stocks, which methods to use, and what yields and returns to expect.

Confused Status of Cultured Stocks

Much of the lack of agreement in the literature over tilapia growth rates, reproductive performance and other culture attributes probably derives from variability in the history and origin of stocks used. Stocks may become highly inbred, the descendants of original introductions of a few individuals. For example, only 3 *Tilapia zillii* constituted their original introduction to Japan from Egypt in 1962, while about 30 *Oreochromis aureus*[1] sent from Israel to the U.S.A. became the ancestors of widespread introductions to Latin America.

Existing identification texts or 'keys' are not widely available, particularly in developing countries, and are inadequate for coping with the aftermath of transfers and introductions and the consequent mixed and hybrid stocks. What is really needed is a new and comprehensive key for stocks in which external features are sufficient for identification, as well as a practical guide to the use of electrophoretic analysis (a technique which enables identification of stocks from properties of body tissues) for problematical stocks.

The serious consequences of contamination of experimental stocks have recently been demonstrated in the Philippines. A 'strain' of Nile tilapia *(O. niloticus)* termed 'FAC strain' (from the Freshwater Aquaculture Center of Central Luzon State University) which performed very well in manured pond systems (see ICLARM Newsletter, July 1982, p. 13) now grows poorly: 40% slower than another local strain termed 'SEAFDEC strain'. The likely cause is contamination with wild fish, probably *O. mossambicus.*

Even without such contamination, transplanted tilapias can differ markedly in appearance and culture performance

Red tilapia farm, Pingtung county, Taiwan.

from original stocks. A striking example is the difference between native or 'wild-type' *O. mossambicus* from the lower/middle Zambezi River system, which are attractive, deep-bodied fish and the descendants of *O. mossambicus* introductions to Asia and Latin America, which are widely regarded as pests because of their unattractive, dark, emaciated appearance, excessive reproduction and poor growth.

Towards Increased Availability of Domesticated Stocks

Stock improvement was a major theme at the international conference on the biology and culture of tilapias in Bellagio, Italy (see Newsletter, October 1980, p. 11)[2]. Three main objectives were identified:

1. the guaranteed supply of high quality pure strain or hybrid fry for farmers;
2. conservation of wild tilapia stocks; and
3. the necessity for the researchers to work with known material.

How can these objectives be achieved?

First, steps must be taken to document existing stocks, to establish collections of superior cultured strains and to conserve wild types for future genetic improvement work. Collections could be established at one or more tilapia research centers, constructed specifically for the purpose of leading genetic research efforts, following the approach used by the research centers of the Consultative Group for International Agricultural Research. The impacts of their genetic improvement programs, for example for rice, wheat and maize, are well-known. However, this is an unlikely development in the near future because of the high cost involved and the current worldwide scarcity of funds for research. An alternative is a continuation of the current situation in which research institutions and the private sector are pursuing largely independent genetic improvement programs, which creates difficulties in interpreting and comparing results and limits the flow of information.

A compromise approach is a network of existing institutions with the development of some additional facilities to maintain and improve tilapia broodstocks and a central registry to interpret and process information. The private sector

Tilapia cages, Wushantou reservoir, Taiwan.

*Condensed from a paper prepared for the International Symposium on Tilapia in Aquaculture, Israel, 8-13 May 1983.

[1] Most of the cultured tilapias are now in the genus *Oreochromis*—see Newsletter, January 1982, p. 19.

[2] Summary report available free from the Editor, ICLARM.

Typical *S. mossambicus* from lower/middle Zambezi. Photo by M.S. Caulton.

could link with such a network in commercialization and field testing of promising material. Using the network approach, the best cultured strains available now could *first* be distributed through the network to be used directly, or to improve local stocks. This can achieve rapid impacts. For example, imported Israeli carp (Dor 70 *Cyprinus carpio)* in Hong Kong produced hybrids with growth rates double that of the local stock within a few years. Such rapid impacts then justify greater investment in longer-term selection programs.

Towards a Consensus on Choice of Species

Peter Schoenen selected 8 tilapias as being important in aquaculture (see Table). Recent information suggests that *O. spilurus* and *T. rendalli* also hold considerable promise for culture. In addition, various hybrid colored tilapias, termed 'red' but very variable in color from near-albino through orange to red, are being raised commercially in Guam, the Philippines, Taiwan and the U.S.A.

From a wide variety of cage-culture reports from extensive (eutrophic lake), semi-intensive (some supplemental feeding) and intensive (near total-reliance on supplemental feeding) systems, species can be ranked as follows: extensive systems, *O. aureus* > *O. niloticus* > *O. mossambicus;* semi-intensive systems, *T. rendalli* >*O. mossambicus;* intensive systems, *O. aureus, O. niloticus* and *Oreochromis* hybrids.

It is more difficult to arrive at a synthesis from the experience of pond culturists. Production trials have predominated over analytical research and the many variables involved (stocking rates, feeds, fertilizers, age of ponds) make comparisons difficult. However, it appears that *O. aureus* and *O. niloticus* and hybrids are the best performers. An ongoing worldwide survey by ICLARM of the status of tilapia as a cultured food commodity is confirming the superiority of *O. niloticus* for many tropical situations. In fact, concentration on *O. aureus, O. niloticus,* hybrids and *T. rendalli* (a macrophyte-feeder) could accommodate just about every conceivable culture requirement. In addition, *O. aureus* is both saline-tolerant and cold-tolerant.

Culture Methods

Standardization of some aspects of intensive culture practice, particularly hatchery-nursery methods and feeding, is highly desirable. The key word is 'intensive.' One cannot easily standardize extensive or semi-intensive aquaculture in which the availability of natural food and numerous environmental factors are not controlled. For standardization of intensive culture, the main requirements are large-scale production of nutritionally-complete pelleted feeds and a consensus on the best hatchery-nursery methods.

Red tilapia, Fu Hai farm, Taiwan.

One area for further investigation is the refinement of polyculture methods. The most versatile microscopic-plant eating or microphagous species, such as *O. aureus* and *O. niloticus,* have yet to be cultured together with good stocks of a species which eats larger plants (macrophyte-feeders). Early work, for example, polyculture of *O. macrochir, O. andersonii* and *T. rendalli,* is hard to evaluate because of the many variables involved. It is clear, however, that the microphagous tilapias can take advantage of plankton, suspended and benthic detritus and a wide variety of natural foods while the macrophyte-feeders can consume supplemental vegetation. *T. rendalli* is generally reckoned superior to *T. zillii* as a macrophyte-feeder for culture. The key question is how far can the culture of a macrophyte-feeder be intensified? One further unanswered question is whether pelleted feeds in which expensive animal protein sources (usually fish meal) are replaced by plant proteins would give good results with herbivores. •

Important tilapias selected by Peter Schoenen in "A bibliography of important tilapias (Pisces: Cichlidae) for aquaculture.*

Oreochromis aureus
Oreochromis hornorum
Oreochromis macrochir
Oreochromis mossambicus
Oreochromis niloticus
Sarotherodon galilaeus
Tilapia rendalli
Tilapia zillii

*ICLARM Bibliographies 3, 336 p. Available from ICLARM. Price $18.00 surface or $32.50 airmail.

Left: Nile tilapia *(Oreochromis niloticus),* a species well-suited for tropical aquaculture. This strain was imported to the Philippines from Singapore. *Right:* An all-male hybrid tilapia *(Oreochromis niloticus* ♀ x *O. aureus* ♂). The female parent is from an Israeli strain, the male from Auburn U.S.A. Such hybrids show very fast growth.