



Topical issues in genetic diversity and breeding

Genes and Fish

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Supply of good quality fish seed for sustainable aquaculture

Deadlines are tight again and I'm drafting this column while traveling in the Philippines. Having lived in the Philippines from 1988 to 1997, when I was intimately involved with developments of improved breeds of tilapia, it's very interesting to get a snapshot each time I return on the changes that are taking place in the tilapia industry here. It seems now that the genetic advancements that have been made, particularly with the selectively bred Genetically Improved Farmed Tilapia (GIFT) and the monosex Genetically Male Tilapia (GMT), are starting to have significant impacts and may indeed be contributing to changing the very structure of the tilapia industry itself. I'll make this the topic of a future column but what the story of improved tilapia in the Philippines does highlight is the paramount importance that factors related to the supply of good quality seed have on the sustainability of aquaculture as a whole.

These issues were one of the foci for discussion at the ASEAN-SEAFDEC conference on "Sustainable Fisheries for Food Security in the New Millennium" held in Bangkok towards the end of 2001. At this meeting I sat on a panel that chaired an open forum on the supply of good quality seed in relation to sustainable aquaculture, and it is the outputs from this meeting that provide the basis for this column. The panel focused on four major elements:

Seasonality and inconsistency of seed supply

In the tropics most aquaculture species can be grown year round, subject to suitable availability of water (neither too little nor too much) and demand for cultured fish is also largely year round with seasonal troughs and peaks associated with availability of fish from capture fisheries and with cultural preferences. However, for the majority of species, spawning and thus seed supply is seasonal. This is a major factor behind the relative importance of multiple spawning species, which are often exotic to Asia, and I'm thinking here particularly of common carp and tilapia. Domestication of species and advances in induced

breeding have enabled us to breed fish in captivity and extend the spawning season to a limited degree but have not yet enabled us to produce seed substantially outside the normal spawning season for the species. A lot of seed supplied for aquaculture, particularly marine and brackish water aquaculture is still wild caught and thus supply is completely dictated by the natural breeding cycle of the species. Domestication and extension of breeding seasons, for example in shrimp production, could have profound influences on productivity and markets. Other factors that cause unpredictability of seed supply include flooding and other natural disasters, disease outbreaks and limited availability of feeds for broodstock and larvae. The major



Smaller scale, decentralized hatcheries may be more effective in overcoming inconsistency of seed supply and undoubtedly have an important role to play in the sustainable and equitable distribution of quality seed.

recommendations to address these constraints included research on domestication and fish reproduction including induced spawning, broodstock nutrition etc. A note of caution was sounded concerning the potential effect on marginal fisherman deriving income from wild seed collection whose livelihoods would be negatively impacted by a switch to dependency on seed from domesticated stocks.

Inadequate support for seed production

In most countries it is anticipated that the private sector will be the primary producers of seed for aquaculture. However, in newly introduced species or species with long generation times or for hatchery systems requiring large capital input, development of seed production for some species may require the joint effort of government and private sectors. Governments could be proactive in stimulating market demand and in supporting the initial development of seed production facilities. To better ensure consistent quality of seed, governments should also introduce systems of hatchery and seed certification. Furthermore governments and private sector could introduce cost-sharing schemes for introduction of new or improved varieties (with appropriate impact assessment) and advancing research. In promoting seed supply, consideration should be given to the fact that small localized hatcheries, whilst delivering seed locally, can be more responsive to changing trends in demand, more economically flexible, and have lower startup costs. They can thus play an important role in the sustainability and equity of seed supply and in many cases may be more appropriate media for seed distribution than larger centralized seed supply systems. Such a trend is currently evident in Cambodia for example. Trading networks can overcome some of the problems associated with centralized seed supply systems and traders can be effective agents for extension and thus such networks should be encouraged in certain circumstances.

As sectors mature, governments should work to avoid competing with the private sector in seed supply and take on a responsibility for supplying good quality broodstock including improved breeds.



Governments and NGOs will take the major responsibility to ensure that benefits of improved seed quality are disseminated equitably to ensure that small-scale farmers are not further marginalized.

Deterioration in quality of seed stocks

The potential negative impacts of genetics related broodstock management issues such as inbreeding, genetic drift, introgressive hybridization and unconscious selection have been discussed in a previous column and it is well established that many, if not the majority, of aquaculture stocks that have been negatively impacted by poor genetic management. I would however, again, sound a note of caution that there is a temptation to attribute genetic deterioration (usually inbreeding is the prime culprit) as the cause of declines in productivity, often over such short timescales (in terms of generations) that it would actually be very unlikely that inbreeding was a major contributor. We should also look for management or environmental factors that might be responsible for problems in seed quality.

During panel discussions it was recognized that it is of considerable importance to raise general awareness of the impacts of domestication and broodstock management practices on the genetic status of stocks in terms of both performance and potential impact upon natural biodiversity. In addition, to mediate some of the negative impacts of poor management, it was considered important to maintain in situ and ex situ gene banks, including sperm

cryopreservation, for conservation of genetic diversity and enhancement of broodstock management capacity. Research on embryo storage was also recommended due to the substantial management benefits that such a technique would bring. It was further cautioned that full consideration must be given to the issue of intellectual property rights over genetic resources held in gene banks. In addition to promoting awareness of genetic management issues, efforts should expand to improve our important commercially cultured stocks, with conventional techniques of selection being the primary method. It was agreed that there are lessons to be learned in this regard from other countries outside the region where aquaculture may be more advanced, for example the salmonid breeding programmes in Europe. Efforts to improve stocks should be accompanied by the development of practical criteria for assessing and certifying genetic and non-genetic aspects of both broodstock and seed quality. With the dissemination of improved breeds, efforts should be made to ensure that this is done equitably so that small-scale farmers are not further marginalized and to maximize benefits to poor fish consumers. The latter two points were both covered in some detail in a recent ICLARM-INGA sponsored expert consultation on “strategies/plans for the dissemination of improved fish breeds” issue surrounding which may be the subject of a future column.

Impacts of releases of cultured seed stocks

As anthropogenic effects on wild fish stocks increase, the need to replenish natural fish populations through stocking of seed from hatchery stocks (which are genetically changed by the processes listed above) will increase. There are, however, serious concerns to be addressed on the impacts of enhanced fisheries including a wide range of ecological and genetic effects on habitats and on wild populations. Some such effects arising through predation, competition, introduction of diseases and genetic introgression have been documented but surely many have not. There is a need to conduct more considered impact assessments before introductions and, subsequently, to conduct research to quantify actual impacts in order to broaden our knowledge base on this topic.

The advent of molecular methods for assessing genetic interaction between wild and introduced domesticated stocks should allow more detailed analysis of genetic impacts and there are now many examples of the power of this kind of study outside of the region. Breeding wild caught broodstock from the same population or releasing sterile fish are options that should be actively considered under the precautionary principle although the latter option of sterile fish could still have impacts on reproduction or ecological displacement of wild stocks. The panel went as far as to recommend that broodstock should be developed and maintained separately for aquaculture and for stock enhancement, with the former being genetically improved for enhanced efficiency while management of the latter stocks should strive to minimize genetic change. Whilst there is little doubt that such a recommendation is idealistically sound, there are clearly many logistical constraints to adopting such a recommendation.

My initial fear was that the panel sessions at the ASEAN-SEAFDEC meeting may simply echo many of the points raised at the earlier NACA-FAO sponsored conference on Aquaculture in the Third Millennium that then appeared in the Bangkok declaration. However, for me, the focus on seed supply issues rather than just genetics, ensured that original discussion was stimulated and I found some of my own views somewhat modified by the discussion, particularly with regard to the relative roles of centralized and decentralized seed supply systems.



Silver barb, Barbodes gonionotus, is a species in which natural population structure has been compromised by the widespread stocking of hatchery-produced seed in enhanced fisheries.



These fish were produced by a subsistence farmer in Nakhon Sawan, Thailand [and they tasted great ! Ed.]

Domestication gets the thumbs up



Following shortages of wild broodstock, Australian industry is now investing in domestication programmes. This is a broodstock rearing facility at a farm near the Gold Coast.

The Australian Fisheries Research & Development Corporation (FRDC) has approved an application by the Australian Prawn Farmers Association (APFA) to remove barriers to domestication of Black Tiger Prawn *Penaeus monodon*. The AUD\$ 1.8 million, 3-year project is a collaborative partnership between the FRDC, the Australian Institute of Marine Science, Commonwealth Scientific and Industrial Research Organization (CSIRO), Queensland's Agency for Food and Fibre Sciences and three leading Australian prawn farms.

Details are still being finalized however an early start to the project has been granted with broodstock collection hopefully to get underway this month.

According to APFA domestication has been the number one industry R&D priority for several years and is of international importance. Details of the project will be announced at the upcoming APFA Annual Conference in Sydney in July. For more information contact Martin Breen, Executive Officer of the Australian Prawn Farmers' Association, Email apfa@qff.org.au.