Policy Brief iAQUA

Background

The importance of the culture of fresh water animals in Southeast Asia can hardly be overstated. They present a major source of protein to human populations, and to both local and national economies. This is particularly true of Vietnam, which houses one of the largest and fastest growing aquaculture sectors in the world representing a multibillion-dollar industry. It is therefore of no surprise that the effects of climate change (both temperature and sea-level) on the aquaculture industry are of great concern in Vietnam.

Global change scenarios have predicted temperature rises for the region of between 1- 6ºC as well as substantial sea level rises that have the potential to significantly impact on the aquaculture sector. In industrialized nations, there is a vast body of knowledge on the fish species involved in aquaculture with strong theoretical paradigms. Thus, while there are of course knowledge gaps, the research apparatus is in place for policy decisions to be made in a timely manner. In the tropical freshwater aquaculture sector many of the important species are air-breathers, with fundamentally different morphology and physiology. Their reactions to common environmental stresses are often so different from those predicted from water-breathers that extrapolations using water-breather paradigms are often meaningless and the knowledge base in air-breathers is almost non-existent. The tradition in industrialized nations has therefore been to base policy decisions on a solid knowledge foundation composed of a combination of basic and applied research. This combined approach is not well developed in Vietnam and problems have therefore been tackled in isolation, which is inefficient due to the difficulties of extrapolation.

The project took outset in a paradigm that had been forcefully argued for in IPCC reports. It is argued that in aquatic animals, the proximal cause of organismal failure with temperature elevations is respiratory collapse. In other words, the ability to draw oxygen from the environment and deliver it to the consuming cells becomes compromised. There were therefore three overarching goals within the iAQUA project.

1. To put in place a capacity for holding fresh water animals in controlled conditions at Can Tho University (CTU) allowing for tightly controlled growth experiments.
2. To set in place a capacity for advanced respiratory physiology research at CTU.
3. To examine the effects of temperature elevations on the respiratory aspects of air-breathing fish from the Mekong delta, chosen for their importance in the aquaculture industry

What did we learn?

Our initial hypothesis was that we would either see no effect or a negative effect of elevating water temperature above the present level. We set into place an extensive range of experiments examining the effects of temperature and were met with very surprising results:

- We conclude that the temperature elevations forecast for the next century in the region are, in isolation, unlikely to negatively impact the chosen air-breathing fish species (*Pangasionodon hypophthalmus, Chitala ornata and Monopterus albus*). This conclusion was based on a wide range of studies spanning research into their circulatory system morphology and regulation, respiratory surface quantitative morphology, blood oxygen

binding and transport characteristics, and oxygen uptake and partitioning between air and water phase. In addition, growth and feed conversion efficiency (FCR) studies were performed over long periods in the same temperature regimes. The wide range of these findings, which all pointed to the same result and which were in many cases repeated to check for reliability, gives us considerable confidence in our overall conclusion. The only caveat we have, is that we were unable to check the larval stage. This is presently underway under the JICA ODA project. At the final farmer/advisor workshop it was particularly evident that the FCR available in clean warmer water of around 1.1 (rather than the 1.6 currently achieved), created great excitement. This potential economic benefit may well provide the incentive for technology investment.

- The establishment of advanced respiratory physiology facilities at CTU was rewarded with a number of exciting scientific findings that will have impact far beyond the project. Although these results may appear esoteric in isolation, it has been our experience that the farmers are very interested understanding how their animals' function. When such finding are used to explain the observed effects of temperature and oxygen on simple parameters such as growth and food conversion ratio, their belief in the latter is greatly improved. Highlights include:
    - The discovery of the extraordinary ability for blood pH control in air-breathing fish, a result that goes against the standard dogma and shows the existence of unusual mechanisms
    - Discovery of the first teleost fish showing convincing air-breathing control linked to blood carbon dioxide levels. This result highlights the transitionary position of these animals between water and air-breathers.
    - Discovery of the role of lactic acid in the stimulation of air-breathing.
    - A surprising plasticity in the respiratory surfaces linked to both environmental temperature, environmental oxygen and the activity level of the animal itself.
    - The discovery of the mechanisms underlying the extraordinary nitrite tolerance of these animals.

- Respiratory physiology is highly complex and its development is a long-term endeavor. The fact that the establishment of this respiratory physiology group represents the first of its kind in Vietnam highlights both its importance and the challenges it faces in gaining a permanent foothold. Towards the end of the iAQUA program we made the surprising discovery that the Post Doc employment category at Universities and research institutions does not exist in Vietnam. This category is seen in the English-speaking world and Europe, as being the corner stone of the endeavor to maintain institutional research profiles at the cutting edge.

How can these findings be used?

- The surprising finding that temperature increases from the present average 27 to as high as 36 °C (optimum 33°C) give great improvements in growth and FCR have great potential utility. Since feed costs are such a significant part of the farmers total crop outlay, improvement in FCR give an immediate economic benefit, that might for example be used to employ technology for water quality management. Several endeavors to this end are already occurring.
- Our arguments concerning the benefits of the introduction of water quality control technology, made in our application, have been born out in the data produced and present

the clear advantages both in survival, growth improvements and food conversion that can be achieved. Further effort in the application and adaptation of such technologies to Vietnamese systems should be encouraged.

- The project has provided clear support for our belief that policy decisions based on knowledge garnered from *combined* effort on basic *and* applied research. Such combined approaches should be encouraged in Vietnam.
- Fish physiology is a small field in Vietnam. However, we believe we have shown that it can have a great impact on the aquaculture sector. National support for this field should be provided at the government level.
- The introduction of a Post Doc employment category at universities and research institutes is an obvious “low-hanging fruit”, that could be introduced to aid these institutions in improving the quality of their research effort. The transition of Vietnamese research into the competitive international top tier still needs assistance. This would be an obvious and cost effective way of doing so.