PROPER BIOSECURITY CAN DETERMINE SUCCESS OR CONTINUED FAILURE IN SHRIMP FARMING (PART I)

Hoping to fully eliminate disease in shrimp or fish culture is not a realistic goal; rather, the aim should be to instill efficient biosecurity measures to minimise the impact of disease processes as far as possible. In this article (Part I), the author talks about biosecurity, focusing on the vital broodstock stage. Part II, to be published in our March/April 2017 Issue, will deal with biosecurity concerns on-site.

by Stephen Newman

When biosecurity protocols are not followed in the packing of PLs, disease is a likely outcome

The production of shrimp by aquaculture is a thriving global agribusiness. Despite many persistent problems, there has been a consistent increase in global tonnages over the last three decades. It is not unreasonable to expect that the continued growth in the years to come in shrimp farming will be characterised by the same pattern that has occurred over the last three decades: rapid growth in some areas followed by widespread disease problems and overall declines in regional production with the total global tonnage continuing to slowly increase.

Disease is a natural process and farming activities, which are all too often inherently unnatural and stressful, predispose animals to many different types of problems. Eliminating pathogens is not always the best approach to take (even if it were possible) although all and any efforts taken to lessen the overall impact of pathogens are prudent. Perhaps the biggest single issue affecting farmers everywhere is the failure to understand how important this is.

Proper biosecurity can be the difference between failure and success in shrimp and fish farming. What exactly does this term mean? There is no one definition that fits all categories of production but in general it refers to a set of practices, the goal of which is to minimise the impact of disease processes on the crop of concern. In other words, health security.

Broodstock: the biggest threat is the unknown

Biosecurity can be defined as "The sum of all measures taken to lessen the levels of potential pathogens and to minimise susceptibility to disease in production environments. This includes prevention, control and active management of the balance of the aquatic ecosystem. It also includes actively managing stress to further mitigate any potential imbalances that potential pathogens can exploit."

This does not just include focus on pathogens. The term in its broadest sense should also include controlling environmental parameters that contribute to susceptibility as well as nutritional and genetic elements. For many farmers though, the first place to start is with the use of tools to avoid the introduction of problems from the onset. The sum of all steps that can and should be taken is beyond the scope of such a short article. This article only highlights some critical areas.

Using pond reared broodstock may pose a serious biosecurity threat.

Perhaps the greatest single threat to shrimp farming is the use of adult shrimp as broodstock that are carrying uncharacterised pathogens.

Using farmed reared broodstock is gambling. PCR testing does not eliminate the risks regardless of what someone tells you, and the threat from the use of pond reared broodstock is from what we do not know is present. It is well documented that there is a carry-over of pathogens between different stages of production and that the failure to adequately address this is a major element in the spread of pathogens between countries and between farms within countries. The widespread movement of broodstock has ensured that diseases continue to appear in areas that have not had problems heretofore.

This is compounded by an unfortunate lack of understanding about what the real utility is of tools that are routinely employed to mitigate risks. Few people understand that properly run nucleus breeding facilities carry the least risk of introducing unknown pathogens into production systems.

There is no such thing as a biosecure facility that uses pond reared broodstock. This is a serious risk that far outweighs any perceived advantages that working with these animals might give. Carry over to the farm is only one issue; large losses of nauplii and post larval shrimp can also dramatically impact stocking schedules. Aside from the introduction of pathogens into areas where they are not already present, production of weak and poor quality PLs undermines the validity of genetics programmes and efforts to product high quality PLs for stocking. It is highly likely that the diseases that will cause serious problems tomorrow are already present in shrimp stocks and are being moved by companies and individuals who have convinced themselves and others that there are no risks.

The use of specific pathogen free (SPF) broodstock can mitigate this, in that animals produced in nucleus breeding facilities that are biosecure are not going to be carrying any of the known potential pathogens. As mentioned, the greatest risk is from what we do not know is present.

There are well established steps that can be taken to lessen the chances of a wide variety of problems occurring. They are unfortunately not routinely followed. In some areas of the world they are widely ignored and there is no doubt that this will continue to impact overall efficiency.

Controlling pathogens through maturation

It is well documented that adult shrimp can be carrying certain pathogens that can be moved through the production process, resulting in significant negative impacts on the farm production. Fouling of gills by filamentous bacteria is one of many possible problems that can be moved from the maturation stage to farms. Many viruses that affect farmed shrimp are not well enough characterised to be certain that they are transmitted in the egg, versus on the egg. It should be assumed however that all broodstock are carrying some potential viruses (and other pathogens) that can be readily passed to nauplii and PLs via surface contamination.

Failure to consistently take the steps needed to lessen the likelihood that known, and as of yet uncharacterised pathogens will pass from maturation to the farm continues to pose serious risks to farmers everywhere. Contaminated frozen feeds can be a major source of pathogens introduced into maturation facilities. Table 1 lists some of the risks, with suggested approaches towards reducing these risks such as using biosecure sources of raw materials.

Relying on PCR validation based on population samples of materials that are not from biosecure sources, is not adequate. Freezing, irradiation (UV, gamma, etc.) can reduce pathogen loads, although not all pathogens respond in the same fashion. It makes more sense to source from areas where this is not an issue.

Table 1: Possible problems with live and frozen feeds used in maturation and hatcheries

Feed	Problem	Solution
Artemia biomass	Vibriosis	Use only from biosecure natural sources (not pond reared)
Squid	Bacterial, viral, fungal, etc.	Use only coldwater squid
Polychaetes	Bacterial, viral, fungal, etc.	Use only cultured polychaetes from biosecure production facilities
Krill biomass	None	Highly biosecure
Mussels	Bacterial, viral	Use only coldwater sources
Algae	Vibriosis, fungi, other bacteria	Use pure strains and avoid extensive outdoor culture
Artemia cysts	Vibriosis, fungi	Use chemicals added to hatching tanks to dramatically reduce loads of contaminants

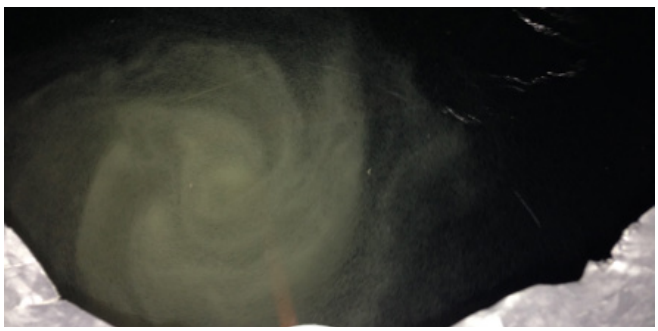
Table 2 summarises the way potential pathogens are moved between animals. The most common method is vertically through surface contamination and horizontally from animal to animals via water, cannibalism, etc. The only way to exclude pathogens that are in the egg is to keep them out of the system. Using pond reared broodstock is not consistent with this. Horizontal transmission can be thwarted in several ways and it is generally wise to assume that this will pose a problem if not addressed. Spawning large numbers of shrimp at one time in a single tank poses a biosecurity risk.

The more animals that are spawned at once, the greater the risk. It is impossible, using pond reared animals, to ensure that each shrimp is free of all known pathogens. Adults held indoors for multiple generations in truly biosecure nucleus breeding facilities pose the least risk. Many claim that their facilities are nucleus breeding facilities when they are not. Third party audits by qualified personnel are the only way to be ensure security.

Steps to ensure healthy eggs and nauplii

Eggs should be collected as soon as possible after spawning, washed and surface disinfected, and held in clean containers as they hatch. There are several devices which can be used to do this. After collection, nauplii should be surface disinfected, rinsed and washed (Table 3).

This is one of the ways eggs are collected for cleaning



Healthy nauplii are collected using a light source

When nauplii are placed into hatchery tanks, all live feeds must be prepared and handled in a manner that is consistent with reducing bacterial carryover. Algae and *Artemia* production are major sources of bacterial contaminants added to production tanks in ways that have been suggested in Table 2. These are critical control points. Table 3 summarises some of the steps that should be taken to wash and disinfect nauplii.

Table 2: Movement of potential pathogens from adults to farmed animals

Mode of transmission	Defined	Via	Examples
Vertical trans-ovarian	Movement from mothers to their offspring	Eggs contain viable pathogens in them	IHHNV*, IMNV?
Vertical surface contamination		Eggs have viable pathogens on them	TSV, WSSV, BP, IHHNV, YHV, IMNV
Horizontal	Movement through the environment	Contaminated faeces, ovarian fluids, feeds, external surfaces, cannibalism	Vibriosis, fusarium, various protozoa, filamentous bacteria, fungi
* Transmission of viruses through the eggs or sperm appears rare in shrimp. Transmission on the egg is much more likely.			

*Table 3: Suggested protocol for rinsing and washing of nauplii**

Step number	Action	Comments
1	Collect nauplii in a 50 to 100-micron net	Very fragile life stage. Can be damaged by harsh handling
2	Rinse carefully in clean seawater for approx. 3 minutes	Water should be clean, free of residual chemicals and organics
3	Dip for 30 seconds in 300 ppm of formalin	Do not exceed dosage and time suggestions
4	Rinse in seawater	Gently
5	Dip for 30 seconds in 50 ppm of Iodophor	Do not exceed dosage and time suggestions
6	Rinse as in Step 2	
7	Removal samples for quality control testing	QC is essential for validation of efficacy of protocols
8	Stock in larval rearing tanks	

**Source: "Guide to the Common Problems and Diseases of Cultured Penaeus vannamei, Brock, J. and Main, K.L. 1994*

Do not over-expose animals: more is not better. This is a suggested protocol only and there are many different approaches to take. What is important is that you do not harm the nauplii by excessive chemical exposure and handling and that you validate the efficacy of your protocols in eliminating external *Vibrio* loads and the presence of other common parasites.

Biosecurity does not stop here. It must carry over to the farm. Mixing batches of animals from various hatchery tanks is a common practice to make it appear that survivals are better than they are. It is also an excellent way to move problems between tanks! Proper monitoring of animals for health in larval rearing tanks and taking appropriate steps to minimise the movement of potential pathogens within the hatchery are also essential elements of successful biosecurity protocols.

All of this hard work can easily be undone by a few minutes of carelessness and a failure to minimise preventable risks.

A proper understanding of what constitutes biosecurity and a commitment on the part of government, producers and all affected by the linked chain of production to manage risks will lessen the overall risks to the industry. This requires all parties to work together. Failure in one component of the chain can result in the movement of problems across international borders with the subsequent financial devastation that accompanies this. I do not see that this will stop any time soon. Corruption, ignorance and apathy are all elements of this and it is clear that even with the tools at hand to prevent problems, there is little incentive from an individual standpoint to do so.

***Dr. Stephen Newman** is a marine microbiologist whose early career focused on the development of the first commercial fish vaccines. Since the early 1990s, he has been working closely with shrimp farmers in almost every country that farms shrimp. In 1996 he founded Aquaintech Inc., to provide a wide variety of products and consulting services to the international aquaculture community. He is an internationally recognized expert in aquaculture and has extensive experience in product development and sales and consulting with clients on a wide variety of topics ranging from business plan preparation and due diligence to auditing of operations with the goal of improving productivity. More details are available at www.aqua-in-tech.com and www.sustainablegreenaquaculture.com.*