# DOES PSEUDOSCIENCE NEGATIVELY IMPACT AQUACULTURE SUSTAINABILITY?

*By: Ph.D Stephen G. Newman**

The development of the philosophy that underlies the scientific method has forever changed the condition of the human animal. It has taken us from caves where even small cuts could kill us to a global civilization that is unraveling the mysteries of how the universe around us works. Life spans have increased and for many the quality of life is dramatically improved. The scientific method itself is elegant in its simplicity. Yet despite this, all too many twist things to suit their specific goals, typically sales of products to generate revenue, often at the expense of those who do not appreciate that not everything that is claimed to be determined as a result of the rigorous methods that science requires to establish facts is indeed real.

The generally accepted definition of the scientific method is: "a method of procedure that has characterized natural science since the 17th century, consisting in systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses."

Pseudoscience is broadly defined as a collection of beliefs or practices mistakenly regarded as being based on the scientific method.

The proliferation of pseudoscience in any arena can be extremely damaging. It can and often does lead to widespread financial losses, bankruptcies, injury and even death. There are innumerable examples of this outside of aquaculture. Perhaps one of the most visible current issues centers around immunization. There are many parents who unwittingly endanger their children and those of others by refusing to vaccinate children against any number of diseases. The rationale for this is based on pseudoscience. The fact that some instances of autism occur seemingly related to immunization has resulted in a massive fear of immunization that the facts simply do not support. Even if they did, the benefits from immunization to humanity as whole far outweigh any risks. This is one example out of hundreds where an apparent inability to understand the scientific method has stoked irrational fear and caused needless suffering and death as well as having a huge financial impact. Pseudoscience is everywhere in today's highly connected culture.

Shrimp Farm in Kalimantan, Indonesia.

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During my 40 year tenure working with many different species and aspects of aquaculture, I have witnessed far too often the deleterious impact of the widespread presence of pseudoscience on fish and shrimp farming. Given the litigious nature of our culture, I can only cite generalities. The reader should form their own opinions based on these comments.

Puffery is defined as exaggerated or false praise. Selling often engenders the use of some puffery. Sometimes it is benign and at other times it falls clearly into the realm of pseudoscience with the potential for resultant harm.

Some of the examples that I have observed over the years are:

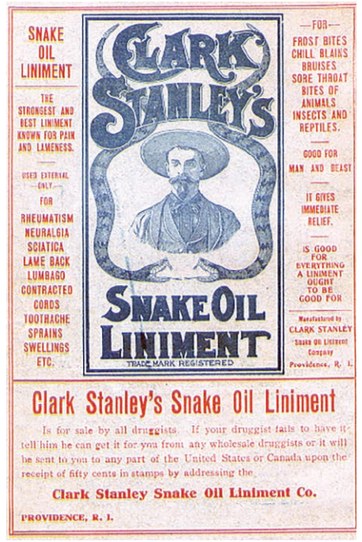
### 1. Using small scale laboratory-based studies to make claims of product efficacy in the field.

This is widespread as most people fail to appreciate the limitations in the lab as they relate to the real world. This is NOT to say that in every instance that data from laboratory trials is not of significance. The example I am going to use to make this point is for laboratory testing that is done in aquaria with shrimp. Shrimp typically grind their feed before they ingest it and then subsequently the gastric mill grinds what has been ingested again. A great deal of what is present in the feed, whether it is nutrients or additives (in or on) ends up in the water column. In lab studies the animals are often bathed in these materials as well as ingesting them. This affords entry through the gills as well as in the water itself. When shrimp are in shrimp ponds, dilution ensures that this typically will have little to no impact. Therefore something can appear to work great in aquaria trials (this assumes static or periodic water exchange) that in the field will not necessarily work. In fact this is common and many companies push their products based on laboratory trials that fail in the field. Some continue to do so even in the face of repeated failures in the field.

Perhaps the worst part of this that the scientific community publishes papers in peer reviewed journals that make claims about field performance based on poorly designed aquarium studies in the lab. This is unfortunately all too common. Most of us have seen catchy titles of papers claiming some incredible benefit to farmers when the lab studies are extrapolated to the field. Properly conducted field studies are needed to validate the effect.

### 2. Cherry picking data.

Statistical analysis of data is essential to being able to claim reproducibility. This requires proper experimental designs, multiple tests and choosing the correct statistical tools to validate the observed effect. One of the challenges facing the industry is the widespread failure to understand that correlation and causation are two distinct things (although some deliberately allow the confusion). Correlative statistics do not prove cause and effect. If correlative statistics do not show a correlation, than there is not likely

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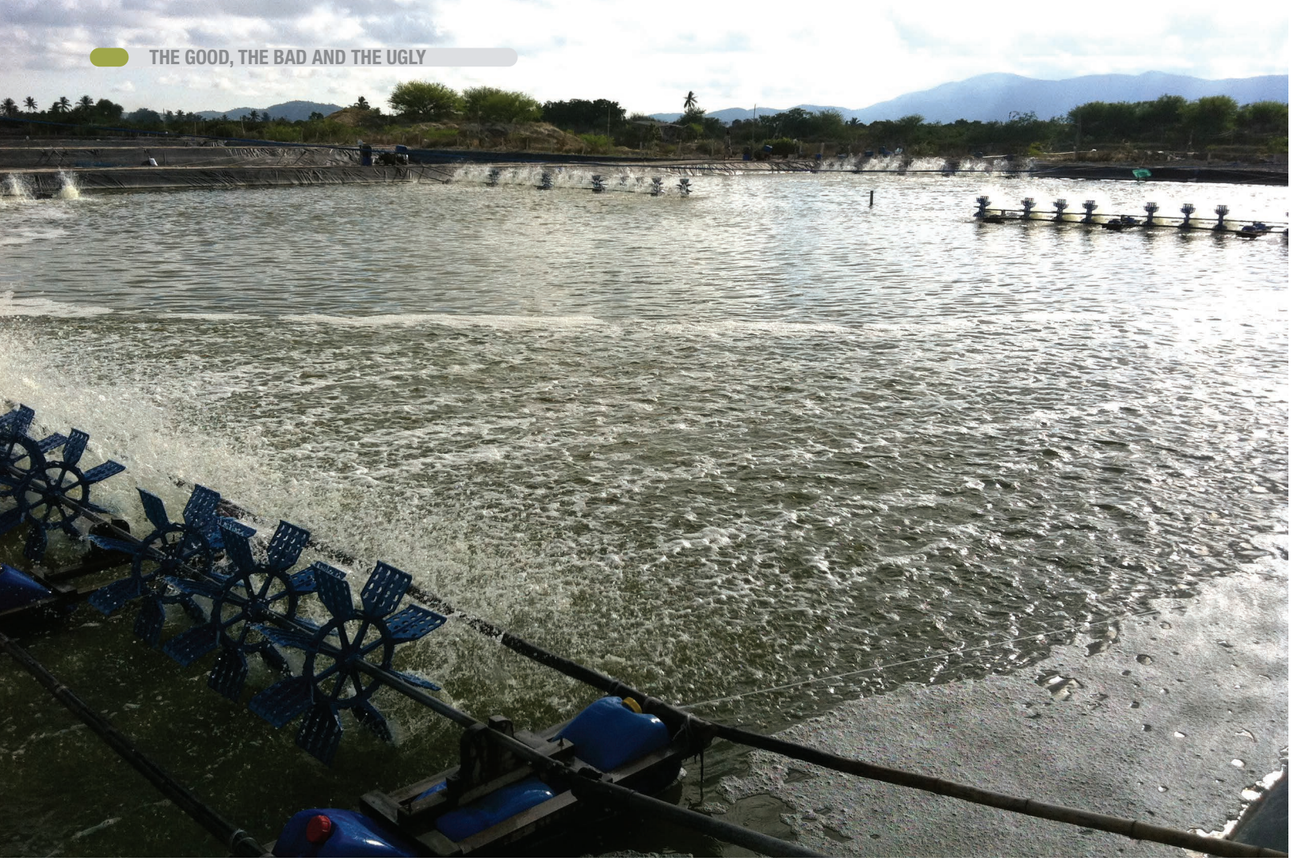
to be a cause and effect relationship. When there is a strong correlation, usually taken as $p < 0.05$, that is the observed results have greater than a 95% chance of not being random, all too often those trials that demonstrate this are put forth as "proof" and those that do not are not even considered. In other words, those with a vested interest may ignore data that does not appear to support the use of the product in the manner for which it will be marketed. Shrimp farming has an extreme degree of inherent variability that in of itself can obfuscate observations of correlation. For a cause and effect benefit to be certain, the mechanisms by which the specific product works should be understood well enough to be able to state that there can indeed be a relationship between the use of a given product and the observed impacts. All too often though this is not the case. The mechanisms by which a given product works may not be understood at all, be partially understood, or there may be aspects of shrimp life cycles, physiology and cultural conditions that ensure that there is no science-based explanation that could explain the results.



Shrimp Farms in Vietnam.

**Cherry picking data** and using non-science based observations are commonly used to sell farmers on the use of products such as vitamins, minerals, amino acids and others.

### 3. Hiding true product content by omission or by saying things are there when they are not.

Using terms like "developed specifically for aquaculture" or selling products that may be based on commonly available materials, such as yeast extracts, can readily be considered as legitimate puffery. However, when it is combined with other of the points that I am raising here, it typically falls into the category of pseudoscience. It is misleading and can be and is used by unethical individuals and companies to sell products with poor quality control or that do not contain what the label states. Again, I am not saying that this is ALWAYS the case. It is however quite common. In SE Asia a quick look at the products that are on many of the shelves reveals that some contain products that are labeled with claims of "proprietary ingredients" or claims that they contain things that could not possibly be viable or present at the levels claimed.

### 4. Extrapolating that products that work in one species will work in other dissimilar species.

This has been occurring with ever increasing frequency as the shrimp farming industry continues to grow and attracts companies that apparently had little to no interest in the industry until the lure of easy profits was brought to their attention. Shrimp are essentially aquatic insects. They are invertebrates, have chitinous exoskeletons and physiologies that are not even remotely akin to that seen in vertebrates. They have copper base blood, not hemoglobin. Their digestive processes are not based on an acidic pH. Automatically assuming that products that work or in some cases appear to work in terrestrial vertebrates appears to be a stretch when applied to shrimp. I am NOT saying that some of these products will not positively impact shrimp, only that for many there is simply no mechanism that could explain how they could work, and data from lab trials simply does not translate to the same benefit in the field.

### 5. Persuading naive and ignorant clients that they need things that they do not.

In SE Asia the sales of vitamins, minerals, amino acids, etc. for use in top dressing is widespread. Typically, top dressed materials diffuse very quickly into the water column and, again, the very nature of how shrimp feed ensures that most of these materials will not end up in the shrimp's circulatory system. Farmers spend vast sums on these products. For the most part properly formulated feeds contain adequate levels of these materials. While there are legitimate reasons for adding higher levels of some, such as ascorbic acid (Vitamin C), there is little to no evidence that shrimp are suffering from deficiencies of most of these materials in most feeds. While some would argue that this is insurance, there is little if any data from real world observations that confirms that this is the case. Cherry picking data and using non-science based observations are common components of sales pitches to farmers persuading them to use these products.

### 6. Advocating the constant use of non-specific immune-stimulants.

Shrimp are highly evolved animals and their immune systems reflect this. However, they are not vertebrates and their immune systems have much more in common with insects than with a typical vertebrate. While there are reports that they may have some memory of an exposure to a pathogen, the consensus is that they do not. They do not form antibodies and the mechanisms by which they resist the natural onslaught of micro-organisms appears to be largely non-specific. It does not appear to be proliferative in the same sense that vertebrate immune systems are. The specter of immune paralysis is real when animals are being constantly exposed to immunogenic materials. With shrimp the depletion of lymphocytes can result in increased susceptibility to various pathogens and even open the door for many opportunistic pathogens.

With the current gold rush to find substitutes for the use of fish meal, a natural substitute is microbial sources. These would be bacteria and/or fungi. These can contain very high levels of protein and provide many other critical nutrients. However, they also contain the structural elements of the cell walls, which includes lipopolysaccharides, glucans and peptidoglycans. These often highly immunogenic and it stands to reason that the constant exposure to levels that are far beyond what shrimp normally encounter as they feed on detritus poses the potential for over stimulation of the immune system. These products are likely best used in a pulsed manner to achieve the optimum potential of their use.

These are some of the highlighted areas where it appears that the scientific method is not being properly used in shrimp farming. For fish it is a bit different although the same issues are present in fish farming.

It is highly improbable that any of these things will change. Human nature is such that it will always be present. The Latin term "caveat emptor", i.e. let the buyer beware comes to mind. Maintaining a healthy degree of skepticism and asking the tough questions can go a long way as well. Bear in mind that regardless of the appearance of a benefit, if they are indeed real, there more than likely will be a plausible mechanism that can explain the observation and the benefits will be more or less consistent and reproducible.

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