

Increasing Aquaculture Productivity with Mobile Microscopes

The United Nations forecasts that the population of the world will reach 9.8 billion by 2050. Many experts are concerned about the earth's ability to feed so many people. Land-based agricultural resources increasingly struggle to meet this huge increase in demand and fish farming is growing dramatically to fill the gap.

More Fish in the Sea

The UN Food and Agriculture Organisation reports that the average amount of fish eaten per capita globally has more than doubled from 9.0kg in 1961 to 20.2kg in 2015. Of course, there are well-publicised cases of overfishing, but much of this growth has been from aquaculture which has grown from 25.7% of production in 2000 to 46.8% in 2016. These data includes finfish, crustaceans and molluscs.

As with any farming, growing large amounts of food in a small space increases the incidence of infection and disease can spread extremely rapidly through a stock of 90,000 fish confined to a pen. Fish farms work hard on hygiene and diet, and minimising stress, to ensure that fish are kept healthy, minimising losses and producing a high-quality product.

Rapid Diagnosis Fights Against Listed Diseases

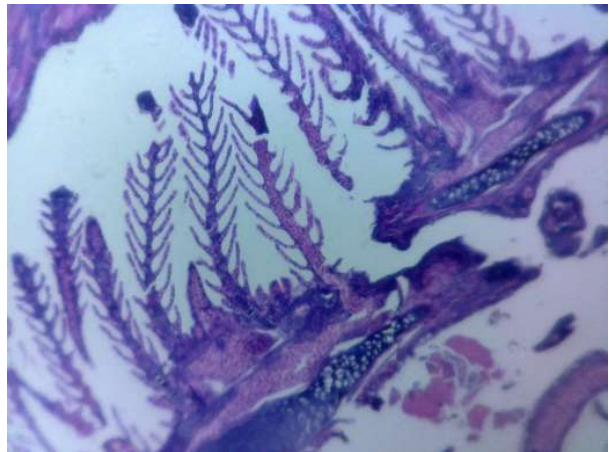
A key to keeping the stock healthy is the rapid diagnosis of disease and parasites. Large farms use continuous monitoring of the water, but there is no substitute for visual inspection of the fish, and early detection of small parasites means that facilities need a microscope.

Traditional compound microscopes are difficult to transport and use in remote environments and usually have no way of sharing images for records or a second expert opinion.

A new generation of portable microscopes can capture and share images and videos of parasites and other fish pathology instantly from a standard mobile phone. The image quality is now close to that of a laboratory microscope, but the digital product fits in a jacket pocket and has a flat wipe-clean surface. This new class of high-



Copepod parasite egg sacs found on a Striped Bass. Courtesy Paul Curtis, AquaSolver



A high-resolution image of Fish Gills. Courtesy of AquaSolver.

resolution, portable microscope dramatically improves the speed of diagnosis and therefore the productivity in aquaculture environments. It is now possible to sample, diagnose, and treat serious health conditions within a few minutes. Site staff can even get a second expert opinion in the time it takes to send and receive an email.

The importance of rapid diagnosis can be understood by looking at *Gyrodactylus salaris*, or salmon fluke, a microscopic parasite that feeds on the flesh and mucus of salmon and other freshwater fishes. It has caused mortalities of up to 98% in wild Atlantic salmon populations in Norway. Some stocks have been lost completely or destroyed by adding pesticide to infected rivers, killing parasites and fish, though this treatment is no longer common. *Gyrodactylus salaris* is so serious that it is classified as a listed disease that must be reported to the authorities. Rapid detection is vital in the removal of infected fish and the fight against these contagious diseases.

Pocket Digital Microscopes Ready to Go Anywhere

The step forward in digital microscopes has been enabled by using high-quality, low-cost parts designed for mobile phones to make highly compact, robust instruments. Originally these devices were low-cost, low-resolution, USB-connected devices, with limited application in the aquaculture market. However, more recent microscopes are pocket-sized and use a wireless connection to deliver 1-micron resolution images to a standard mobile phone. The newer products feature a robust stage and transmitted illumination, like a compound microscope. Best of all, high-resolution images and even videos can be shared instantly for a second opinion.

Portable high-resolution microscopes are meeting with approval from experienced aquaculture experts:

Bill Mancini is the President of Fisheries Technology Associates where he has specialised, since 1982, in fisheries management, characterisation and evaluation of wild fisheries, and technical and economic feasibility analysis



Salmon fish farm in Norway

of fish farming and aquaculture facilities. “Without a doubt, the portability and ruggedness of these units and the high quality of the images are the innovations that truly wowed me.” Mancini concludes, “For me, this was one of those moments when you say to yourself, ‘How did I ever get along without this device?’”

Dr. Rod Getchell works in the Aquatic Animal Health Program at the Cornell University College of Veterinary Medicine. “When examined side-by-side with pictures taken with my \$10,000 microscope/camera set-up in our laboratory, the images stood up pretty well – for 10 times less money. I think this instrument has value for our fish farming friends in the field who do not want to deal with a traditional microscope.”

For Getchell, the connectivity is a real winner: “The fact that you can immediately send your images to colleagues

adds to the kind of instant communication that the next generation of fish health professionals will appreciate.”

Productivity

If aquaculture is to continue its remarkable contribution to feeding the growing population of the world, fish farms need both new tools and new processes. Productivity and sustainability rely heavily on the ability to detect fast-moving diseases instantly, in remote locations. Referring samples to a laboratory back at base will be too slow and will result in significant stock losses and further spread of disease. Not only do microscopes and other tools have to be portable, but they must also have the performance required to make accurate diagnoses.

It will be interesting to watch how point-of-care diagnostics grows with the aquaculture industry, enabling the production of low-cost, high-quality food.



Portable microscopes can capture and share images and videos of parasites and other fish pathology instantly



Andrew Monk

Andrew Monk is passionate about getting scientific innovation to the forefront of animal health and into the veterinary community. With Richard Williams, he is a co-founder of ioLight Limited. Together, they realised that there was an opportunity for a high-quality portable microscope using the latest developments in smartphone technology. Previously Andrew was CEO of semiconductor fab Innos Limited and President of GLOphotonics SAS. He has a masters degree in physics from the University of Oxford.

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