Vol 6 Issue 1 2018

Hatcheryfeed

Advances in feeding early life stage and broodstock aquatic species

Shape analysis in the study of larval deformities

Potato starch in diets of tropical gar

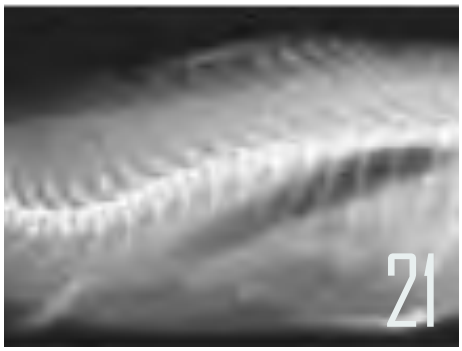
Intensive copepod production technology to establish marine hatchery production in Palau

Published by: Aquafeed.com LLC. Kailua, Hawai'i 96734, USA. ▪ www.aquafeed.com ▪ info@aquafeed.com

HATCHERYFEED
The Hatcheryfeed.com magazine

VOL 6 ISSUE 1 2018

Contents



** Cover picture: Marine hatchery production in Palau*

HATCHERYFEED VOL 6 ISSUE 1 2018

We are grateful to the following companies for sponsoring this issue of the magazine. Their support allows us to make our publications available without charge.

We thank them for partnering with us to support the development of our industry through education and information.

Index to advertisers

CONTACT US

Editorial:
editor@hatcheryfeed.com

Advertising:
sales@hatcheryfeed.com

Technical feed consulting:
consulting@aquafeed.com

SUBSCRIBE

Digital editions are free to industry.
You may also purchase print copies.

SUBSCRIBE

DOWNLOAD YOUR COPY

HatcheryFeed
The aquatic hatchery resource from Aquafeed.com

Hatcheryfeed magazine
is published by Hatcheryfeed, a division of Aquafeed.com LLC.

Aquafeed.com, LLC.,

Kailua, Hawaii 96734, USA.

www.aquafeed.com.
www.hatcheryfeed.com.

AQUAFEED HORIZONS

AQUAFEED.COM CONFERENCES

Aquafeed.com's 11th international technical conference

Aquafeed Horizons

March 27, 2018, BITEC, Bangkok, Thailand

An Aquafeed.com conference

In association with

VICTAM Asia 2018 FIAAP grapas

Supported by

Thai Dept of Fisheries; Thai Feed Mill Assn; The Feedstuff Users Promotion Assn; The Animal Husbandry Assn of Thailand; Thailand Convention & Exhibition Bureau

Welcome and Opening Remarks
Dr. Juadee Pongmaneerat, Thai Department of Fisheries, Thailand
Meredith Brooks, Associate Editor, Aquafeed.com LLC, Hawaii, USA

Extruded Aquafeed Quality Management; Relationship Between Technology and Extruded Aquafeed Quality
Thomas Ellegaard Mohr, Global Application & Sales Manager, ANDRITZ Feed & Biofuel, Denmark

Aqua Feed Production – How Extrusion Reliability affects Factory Performance
Rob Strathman, Vice President, Muyang USA Design & Engineering, USA

Optimizing design and operation of the pre-drying product transport process.
Anders Fjeldbo Haubjerg, Sr. Process Engineer, Graintec A/S; Assistant Professor, University of Southern Denmark, Denmark

Advancements in Micro Aquafeed Extrusion
Ramesh Gangatharan, Technical Sales Advisor, Wenger Manufacturing Inc., USA

Mycotoxin challenge in aquaculture feeds
Maarten Jay van Schoonhoven, Aqua Care manager, Olmix group, Netherlands

Balancing Nutrient Levels Through the Application of Functional Additives: Survey of Nutrient Levels in Commercial Shrimp Feeds in India
Alexander van Halteren and *Peter Coutteau, PhD., Business Unit Manager – Aquaculture, Nutriad International NV, Belgium

Comparing Novel Single Cell Protein Technologies For Economical Fishmeal Replacement
David Tze, CEO Novo Nutrients, USA

Insects: the missing link in aquaculture
Tarique Arsiwalla, Founder, Protix, The Netherlands

Aquafeed Probiotics - Challenges and Opportunities
Benedict Standen PhD, Product Manager, BIOMIN GmbH, Austria

Nucleotides and Bioactive Peptides: Boosting the Functionalities of Aquafeeds
Francisco González, Product and Export Manager for APAC in Bioiberica S.A.U., Spain

Immunity - The Next Frontier in Aquaculture Nutrition
Kabir Chowdhury PhD, Global Technical Manager - Aquaculture, Jefo Nutrition Inc., Canada

REGISTER at: http://feedconferences.com

Sponsored by:

ANDRITZ FAMSUN Integrated Solution Provider Jefo Life, made easier nutriad applying nature olmix for a better life WENGER f3challenge.org

NEWS REVIEW

Liposomes as nutrient delivery system under development

Fish fed live feeds without essential nutrient supplements (Control)

Fish fed live feeds enriched with microparticles containing essential nutrients

Researchers at Oregon State University are developing a new technology to deliver water-soluble nutrients to aquaculture-raised fish, oysters, clams and shrimp that will boost their growth rates and reduce the high rates of mortality that plague the industry.

As much as 80 percent of hatchery-reared larval marine fish die in their early life stages and researchers aren't exactly sure why, according to Chris Langdon, a professor of fisheries at OSU's Hatfield Marine Science Center and principal investigator on the project. One prevailing theory, he said, is that the critical water-soluble vitamins and amino acids rapidly leach from their tiny food pellets into the water.

"We're having some success by packaging water-soluble nutrients into liposomes that we use to enrich the live feeds – for example, brine shrimp – or put inside of food pellets," Langdon said. "The next step is to expand the project and look at how it affects different fish species, and whether we can make it cost-effective."

Langdon and his colleagues have received a three-year, $630,000 grant from the National Sea Grant program to conduct further tests. The study is important, scientists say, because the United States has a major seafood deficit, importing more than $11 billion of seafood products annually from other countries.

Aquaculture will be critical in the future to produce protein for the world's growing population because many wild stocks of fish have already reached their peak levels of sustainable harvest, Langdon noted. However, most marine fish hatcheries are not efficient models of production, he added.

"If we can halve that mortality rate – and I think we can – it would be a game-changer," Langdon said.

The key to the preliminary success by the OSU scientists, which include post-doctoral researcher Matt Hawkyard, lies in production of liposomes, which are tiny vesicles, or bubbles, made out of the same material as a cell membrane. These liposomes are very efficient in containing nutrients – and other products – despite their small size.

For example, the pellets used to feed larval aquatic animals are often smaller than a grain of sand,

making them difficult to enrich. Over the past 5-6 years, however, OSU researchers have done just that, by incorporating liposomes that are filled with nutrients. They also use those same liposomes to boost the nutrient power of live feeds, such as tiny "rotifers," which are planktonic organisms that larval fish consume.

That may just be the beginning, Langdon said.

"We also can fill the liposomes with other substances, such as growth-promoting agents, vaccines, or vitamins to boost the animals' immune systems and reduce stress," he said. "In addition to aquaculture for food species, there is a potentially huge opportunity to improve the survival and health of ornamental fish for the aquarium industry that is worth billions of dollars."

Langdon and Hawkyard are working with the Hubbs-SeaWorld Research Institute in San Diego to broaden the scope of their study, focusing on improving growth rates and reducing losses in California yellowtail, sea bass and ornamental fish.

OSU's Hatfield Marine Science Center is a research and teaching facility located in Newport, Ore., on the Yaquina Bay estuary, about one mile from the open waters of the Pacific Ocean. It plays an integral role in programs of marine and estuarine research and instruction, as a laboratory serving resident scientists, as a base for far-ranging oceanographic studies.

CMFRI develops breeding technology of Indian pompano (*Trachinotus mookalee*)

The Central Marine Fisheries Research Institute (CMFRI) has successfully developed seed production technology of Indian pompano (*Trachinotus mookalee*), which has high commercial value both in domestic and international markets.

CMFRI has developed seed production technology for cobia, silver pompano, orange spotted grouper and pink ear emperor. Indian pompano is the most suitable species for cage culture considering its fast growth rate, easy adaptability to culture conditions, quick acceptance of artificial feed, good meat quality and high consumer preference.

Breeding and seed production technology of the species was developed at the Visakhapatnam Regional Centre of CMFRI after two years of research, using a recirculating aquaculture system (RAS).

Indian pompano belongs to the *Carangidae* family, which is distributed in the Indo West Pacific region and is reported to be present in 15 different countries of the Asian continent. In India, the fish is reported from both the west and the east coasts. It is a marine fish with sporadic occurrences in bays and lagoons and the adult fishes prefer shallow coastal waters with rocky areas.

According to Dr A Gopalakrishnan, Director of CMFRI, this is the first report of successful mass scale seed production of Indian pompano in the world. "The achievement is a major break-through in Indian mariculture business which will help the farming community to use the hatchery produced seeds of Indian pompano for cage farming", he said adding that mariculture activities would be diversified with CMFRI developing seed production technology of one more high value marine fish.

"By 2050, India should produce at least 10.5 million tons of marine fish to meet the growing seafood demand. India's marine fish catch is only 3.63 million tons in 2016", Dr. Gopalakrishnan said, adding that CMFRI's efforts on developing seed production technology of high value marine fish was part of this objective.

Neovia acquires probiotics firm Epicore

Neovia has acquired Epicore, the larval feed and probiotics company. Through the complementary expertise of the two companies and Neovia's international R&D network, Neovia intends to develop its aquaculture business and offer new natural and sustainable solutions for livestock farming: probiotics.

Epicore manufactures feed and probiotics for the shrimp market and currently employs more than 35 people. Founded in 1987, the company's headquarters and its production facility are located in Eastampton, New Jersey, USA. The company has storage space and a key technical centre within its Ecuadorian subsidiary which facilitates the distribution of its products and services in the largest shrimp producing country in the Americas and the fourth largest producer in the world with 400,000 tonnes of shrimp feed produced per year.

Epicore has a leading expertise in manufacturing liquid feed for shrimp larvae and recognized global expertise in the production of probiotics.

With an estimated world production of 3.6 million tonnes, the shrimp market has been steadily growing for more than a decade. However, in recent years, the market has slowed or even stagnated in some countries due to the appearance of several diseases (Early Mortality Syndrome, White Spot Syndrome Virus). In response to these major health challenges, shrimp farmers have had to adapt their production model and adopt new measures to control their ponds more effectively: water quality control, biosecurity, better quality larvae, and the use of probiotics. As a result, Neovia says its acquisition of Epicore will bring the company leading-edge expertise in probiotics, fully in line with its holistic approach to aquaculture which ranges from feed to pond management.

This acquisition will allow the two companies to benefit from numerous synergies worldwide, particularly with regards to R&D and innovation. Neovia's aquaculture business will also benefit from an expanded portfolio of products and services as well as new expertise in the production of probiotics first for aquaculture species and then for the Group's other species.

William Long, CEO of Epicore said, "We are delighted to be able to share our expertise in probiotics with a large international group like Neovia. The strength of its R&D expertise and its international innovation network will allow us to develop new applications for the international aquaculture market and other markets together. It is a great opportunity for our company and a new adventure is beginning for all Epicore employees!"

Asia is one of Neovia's main development areas and aquaculture is one of its priority businesses. With Epicore, the Group has additional resources to accelerate its growth in the Asian shrimp industry. Four out of the world's top five shrimp producing countries are located in this region: China, India, Vietnam, and Indonesia.

"With the acquisition of Epicore, Neovia's aquaculture business will achieve its critical size to accelerate its international development, especially in Asia where we can rely on the Group's presence and our recognised aquaculture expertise in Latin America (Ecuador, Brazil, Mexico) and Vietnam," said Hubert de Roquefeuil, CEO of Neovia. "Epicore has a lot to offer to Neovia and I am pleased to welcome its teams of experts in probiotics to our company which will allow us to complement our portfolio of products and services and offer high-performance and sustainable solutions to farmers all over the world."

Dr. Thomas Zeigler honored with Lifetime Achievement Award

Dr. Thomas Zeigler was presented with the US Aquaculture Society's Lifetime Achievement Award at the opening ceremony of Aquaculture America 2018 in Las Vegas. With a vision for the future, Dr. Zeigler has been a leader in the development of nutritional technologies for aquaculture for over 50 years. Obtaining his Ph.D. from Cornell University in Animal Nutrition and Veterinary Pathology in the 1960's, he has since led the family business from a local manufacturer of farm animal feeds to an internationally recognized producer of aquaculture feeds.

Dr. Zeigler has authored or co-authored 19 scientific publications, and has served as officer or director of 8 scientific and/or trade associations, including President of the US Aquaculture Suppliers Association. In the 1980's, he led the development of ascorbyl-2-tripolyphosphate (Stay-C), a new patented stable form of ascorbic acid (Vitamin C). The commercialization of stable vitamin C technology had a highly significant impact on the industry, helping to significantly improve the performance and stability of aquafeeds.

In recent years, Dr. Zeigler has focused efforts on the development of high performance feeds and precision feeding strategies that have helped to positively impact operational profitability. He has also been instrumental in the effort to improve biosecurity through the development of feeds that replace or reduce the dependence on live or fresh frozen feeds for aquaculture. Through his continued vision, Zeigler Bros. continues to support a rigorous R&D program to advance nutritional technologies and solutions.

Dr. Zeigler has been one of the most familiar faces of US aquaculture for many decades. A network of current and former employees, collaborators, colleagues, and customers all consider him as a true friend. He retains a sincere passion for aquaculture and a continuing mission to build value to life through innovative nutrition.

Swiss company to source organic *P. Monodon* from India

The Marine Products Export Development Authority (MPEDA) of India has joined forces with Switzerland's Coop, a retail and wholesale business, to develop organic Black Tiger Shrimp (*P. Mondodon*) farming for the Swiss market.

The organizations will enable the certification of a shrimp hatchery and a small-scale feed mill as part of the start-to-finish operation. The memorandum of understanding was signed during the India International Seafood Show, earlier this week.

Following a model the Coop has already established successfully in Vietnam, Indian shrimp farmers and processors will receive technical input to enable them to follow procedures that conform with international standards for organic produce. The Coop will purchase the shrimp at a premium and cover part of the training to offset the higher costs of organic production. Initially a pilot project will be run in Kerala and if successful, expanded to other locations.

Employing some 85,000 people, the Coop has more than 10,000 supermarkets in Switzerland.

FAO to publish first comprehensive analysis of the world's aquatic genetic resources for food and agriculture

The conservation and sustainable use of aquatic genetic resources have crucial roles to play in order for aquaculture to grow sustainably and meet the world's increased food demands. To facilitate these roles the Commission on Genetic Resources for Food and Agriculture (CGRFA) requested FAO to prepare the first report on The State of the World's Aquatic Genetic Resources for Food and Agriculture. The scope of the report will be farmed aquatic species and their wild relatives within national Jurisdiction; the report will address inventories of aquatic genetic resources for food and agriculture, the drivers impacting them, in situ and ex situ conservation, stakeholders, legislation and policies, institutional capacities, research and international collaboration. Prepared by the Fisheries and Aquaculture Department under the guidance of the CGRFA, and with subsections from 89 contributing countries, the report will provide the first comprehensive analysis of the world's aquatic genetic resources for food and agriculture.

The report will enhance knowledge of aquatic genetic resources for food and agriculture by: Complementing the ongoing efforts of the Fisheries and Aquaculture Department to collect, analyze and disseminate information on the status and trends on fisheries and aquaculture; Documenting past, current and planned patterns of exchange of aquatic genetic resources for food and agriculture; Documenting the state and trends of the world's aquatic genetic resources for food and agriculture; Identifying major drivers and their direct and indirect impacts on aquatic genetic resources; Identifying key technologies that can enhance the contribution of aquatic genetic resources to food security and livelihoods; Identifying key stakeholders and the roles they play in the conservation, sustainable use and management of aquatic genetic resources for food and agriculture; Documenting the state of institutional capacity and measures/mechanisms in place to promote the conservation, sustainable use and management of aquatic genetic resources for food and agriculture; Prioritizing main needs and constraints encountered by countries for the conservation, sustainable use and management of aquatic genetic resources, including access and benefit sharing; Identifying significant gaps to be addressed in promoting the responsible use of aquatic genetic resources for food and agriculture; and providing information on activities that aim to contribute to the achievement of the Aichi Targets (particularly Targets 6, 7 and 13, and FAO's Strategic Objective 2).

The Report will further facilitate the implementation articles of the FAO Code of Conduct for Responsible Fisheries and specifically Article 9.3 Use of aquatic genetic resources for the purposes of aquaculture including culture-based fisheries.

A draft of the report is available for download here:
http://www.fao.org/3/a-bq584e.pdf

Poisonous creeper yields breakthrough In Tiger Grouper breeding

A yam known for containing a neurotoxin poisonous to various species of insects,and some unfortunate people, is proving to be an effective maturation treatment for tiger grouper (*Epinephelus fuscoguttatus*). Researchers at The Marine Aquaculture Breeding Technology Centre, at the Fisheries Research Institute (FRI), Tanjung Demong, have developed a method of extracting the alkaloid dioscorine from Intoxicating Yam (*Dioscorea hispida*), known locally as ubi gadong. When dissolved in water, it produces a phytosteroid sapogenin, diosgenin, that is being fed to replace synthetic hormone injections in the maturation process. Inconsistent supply of grouper seeds, the production of low-quality eggs from the female parent fish and the costly dependency of broodstock from outside, prompted the center to begin the research into a cost effective solution to breeding the fish.

Canadian salmon hatcheries hit by ISA

Nova Scotia Department of Fisheries and Aquaculture said in a statement March 1 that two 'land-based aquaculture facilities' in the province had been hit with virulent outbreaks of infectious salmon anemia (ISA), resulting in the destruction of 600,000 salmon smolts. Quoting unnamed sources, Undercurrent-news reported the facilities are Dartek and the Little Harbor Hatchery, growers for Northern Harvest Sea Farms, which is being bought by Marine Harvest. The report says the eggs were supplied by Northern Harvest's broodstock operation in Dover, Prince Edward Island.

Nova Scotia Fisheries Minister Keith Colwell told local news media it was almost a complete loss for one company, but the other lost only part of its stock. He said it is highly unusual to have an outbreak of infectious salmon anemia at a land-based facility.

Colwell said his department will be investigating how the smolts became infected.

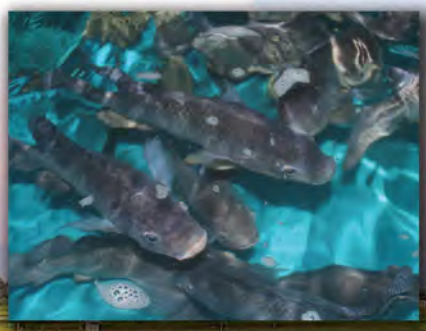
Asian Pacific Aquaculture 2018
Taipei - Taiwan -April 24-26

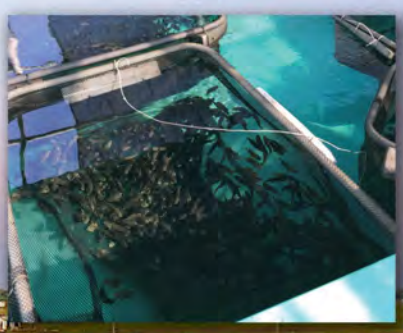
Innovation for Aquaculture, Sustainability and Food Safety

APA 18

WORLD AQUACULTURE Society

All info: www.was.org
Conference management: worldaqua@was.org
Trade show & Sponsorship: mario@marevent.com





NEW ON THE MARKET

Probiotic targets Virbrio and ammonia in hatcheries

Keeton Industries has launched Hatchery Prime Smart Pellets, an easy to use, stress reducing probiotic specifically formulated for fish and shrimp hatcheries.

The pellets were developed to reduce Vibrio and other pathogenic bacteria while eliminating ammonia and hydrogen sulfide. As a result, hatcheries have experienced increased growth and survival, improved feed conversion rates and higher yields. Other reported benefits include advanced harvest, more consistent growth, improved water quality and cleaner tank bottoms.

Ease of use is another key factor: Hatchery Prime comes in pellet form, so application is extremely fast and easy. The pellets can be simply tossed into the tank, with no need for mixing, measuring, weighing, activating or incubating.

All-in-one rotifer and Artemia enrichment

INVE Aquaculture has expanded its enrichment portfolio with a new product, Easy Dry Selco® (EDS). As a recognized reference and innovator in fish hatchery culture, INVE Aquaculture, part of Benchmark, has always dedicated special attention to early-stage nutrition to increase survivability and performance of marine fish and shrimp. INVE offers a range of liquid and dry enrichment products that support the development of healthy and performing fry by optimizing the nutritional value of live feed such as rotifers and Artemia. As a result of the continuous technical development of new products and protocols, INVE has now expanded its enrichment portfolio with a brand-new formulation: Easy Dry Selco®.

Easy Dry Selco® is a dry enrichment with a formulation that boosts rotifers and Artemia with balanced levels of fats, proteins, vitamins, key minerals, immuno-stimulants, essential amino acids and flavonoids, turning live-feed into a very functional enrichment.

Because it adds a lot more than just lipids content to the live feed, the protein-rich formula of EDS is specifically suitable for fast growing marine fish larvae and completes the nutritional balance of the early-stage fish feed, optimizing fry quality and robustness.

“Simple and reliable as it is, EDS provides the most advanced, complete and cost effective enrichment for rotifer and Artemia production,” said Alessandro Moretti, Product Manager Fish Hatchery

Easy Dry Selco® can be used in the traditional way after harvesting, or directly into the culture tank. Rotifers Enrichment is finalized in 6-9 hours.

For Artemia, INVE Aquaculture recommends harvesting 18-22 hours after the start of the enrichment.

Alltech Coppens collaboration yields new generation of starter diets

A good start for fish larvae is not only crucial to health and development, it also impacts producer profitability. Weaning on dry feeds with an unbalanced diet can result in deformities and high mortality rates. High-quality starter diets are therefore essential. Providing nutritional solutions for the specific needs of larvae in their most critical life stage benefits the fish during their entire lifecycle. Supporting the healthy development of all organs, including the skeleton, for an ideal start begins with optimal nutrition.

Extensive studies at the Alltech Coppens Aqua Centre have revealed the essentials for a weaning diet, which will significantly minimize deformations in sensitive fish species. This allows fish larvae to be weaned with confidence knowing that the vast majority will fully develop into healthy fry without any abnormalities.

There are three things producers look for in starter feeds: high survival rate and minimal deformities; optimal skeleton development as a foundation for future growth and high digestibility for optimal performance and water quality. By delivering nutrients in a way that can be handled easily by the maturing digestive tract of fresh water larvae, hatcheries can be offered more security when weaning freshwater larvae from Artemia onto a dry diet. Deformities can be scaled back to a minimum with a more even growth rate, thereby resulting in less frequent grading. The end results are healthy larvae and fry, more revenue, more efficiency and less work.

Alltech and Coppens International are working closely together to bring a new generation of fish feed to the marketplace. Coppens' Essence, designed with Alltech's Total Replacement Technology™ and gut health technologies containing Bioplex® and Bio-Mos®, reflects this approach. Through highly bioavailable, organically bound trace elements, the manufacturers say they can ensure optimal skeleton development with a special larval diet that can largely replace live Artemia. Essence also promotes optimal tissue development which reduces factors associated with deformity and low fry survival rates. Due to its high digestibility and excellent performance, this starter diet is ideal for recirculation aquaculture system farming conditions.

Essence is tailored to the specific needs of the early life stage of many freshwater fish, such as cyprinids, pikeperch, catfish, tilapia and koi.

ORNAMENTAL FEEDS

World Feeds launches Rift Lake Green Cichlid Flakes

Building on the success of its Vitalis Rift Lake Green Cichlid Pellets, World Feeds has launched a Vitalis Flake for the same species.

Also formulated for the herbivorous cichlid species of the African rift lakes, the new Cichlid Flakes boast the same tailored, spirulina rich formulation as the Pellets, but they are designed to provide a method of feeding small and juvenile Cichlids with lower protein requirements. The latest Vitalis Cichlid Flakes have the added versatility that they can be left large for feeding bigger fish when required. The balanced Flakes also deliver key nutrients from a blend of high quality algae, and incorporate natural pigments to achieve healthy fish coloration.

The Flakes will feed tropheus and many mbuna species, including *labeotropheus, labidochromis, melanchromis, metriaclima* and *pseudotropheus tropheus.*

The new Flake product from World Feeds is sold in three pot sizes 30g, 90g and 200g. World Feeds' Vitalis foods are not available in the USA.

Skretting's new Vitalis PRIMA marine broodstock diet

With Vitalis PRIMA, Skretting has developed a new diet aimed at establishing higher levels of performance, biosecurity, sustainability and compatibility among marine broodstock and their young fry.

Launching globally in the first-quarter of 2018, Skretting's Vitalis PRIMA is a new marine broodstock diet that supports the health of parent fish and young fry, thereby improving the performance of hatchery systems globally. Vitalis PRIMA, which replaces Vitalis CAL, incorporates some of the latest technology to come from groundbreaking dietary research as well as invaluable commercial input from broodstock and hatchery managers. It is the latest solution to come from more than 25 years of health feed development at Skretting.

With Skretting Aquaculture Research Centre (ARC) partnering in high-level research investigations into different dietary elements such as protein levels and amino acids, Vitalis PRIMA began with the finding that establishing a balanced amino acid profile with *seriola* (amberjack) can lead to a significant improvement in yolk sac fry survival and robustness without detriment to other factors, such as the number of eggs produced or the level of hatching.

"This was a big step forward because a major problem that has long plagued *seriola* production is that hatcheries would get eggs, they would get fertilization, the fry would hatch but then a lot of them wouldn't transition on to first-feeding. This is simply because the yolk sac fry would not provide sufficient energy reserves," explained Eamonn O'Brien, Product Manager for Skretting Marine Hatchery Feeds (MHF).

Skretting set about looking to utilize this information and incorporating it into trials and collaborative projects with other species, including turbot, cobia, seabass and seabream. At the same time, the breakthrough opened up discussions with many broodstock and hatchery managers about what additional attributes they would like to see in a marine broodstock diet.

As well as seeing increased fry survival through improved embryo vitality, hatcheries wanted diets that were much more compliant with the recirculation systems that they use, they also asked for the feed to be much more appealing to broodstock that can often stop feeding during the spawning window.

Skretting, meanwhile, wanted to support the appearance of marine broodstock by incorporating the same blend of marine algae ingredients used in all of its other broodstock diets. The algae plays many different roles, but particularly within broodstock it gives a naturally strong pigmentation to the fish. Bream, for example, develop the natural green tinge on the head and the red pigmentation around the gills and the stomach area.

Aligned with the algae content, Skretting also took the opportunity to increase the astaxanthin content of the feed. As well as supporting fish flesh pigmentation, astaxanthin is an antioxidant and a precursor to vitamin A.

Last but not least, through Skretting's commitment to reducing pressure on marine raw materials, it has introduced a new marine algae capable of providing a viable and sustainable alternative to the finite supply of the traditional fish oil raw material traditionally used in broodstock diets.

"We wanted to reduce that dependency on fish oil. First of all, it allows us to improve our sustainability rating within the feed; at the same time, it gives Skretting a lot more stability in terms of formulation and nutritional quality," said O'Brien.

In all, six new attributes have been included in Vitalis PRIMA, as well as closer alignment with Skretting's other Vitalis diets: Vitalis Clean for lumpfish broodstock, Vitalis 2.5 for shrimp and Vitalis Repro, which is

offered to marine fish outside of the spawning window to maintain their optimal spawning condition.

Other elements, including the level of squid content in the formula, remain unchanged. The diet also remains fully compliant with Protec, Skretting's leading health diet which supports fish and helps them cope with disease and recover faster following stress or injury.

"Vitalis PRIMA, together with Vitalis Repro, will provide a complete feeding program for broodstock fish and make a considerable contribution to Skretting's standing as market leader in the field of broodstock nutrition. We are very excited about the long-term benefits that this will bring for farmers of marine species throughout the world," Julio Docando-Valencia, Fish Health Diets Manager at Skretting South Europe said.

PE MYSIS Pellets

PE MYSIS Pellets are hand crafted in small batches at the Piscine Energetics feed laboratory in British Columbia Canada. PE Mysis Pellets provide superior nutrition for marine and freshwater fish as a starter, larvae and adult fish feed. Piscine Energetics formulation and manufacturing process of PE MYSIS Pellets facilitates the inclusion of fresh mysis shrimp as the leading ingredient. This production method is unique to the market place. The fresh ingredients are not dried into a meal, therefore avoiding the exposure to extreme temperatures and ensuring preservation of nutrients of fresh mysis shrimp in a convenient dry feed.

The palatability of PE MYSIS Pellets induces an energetic feeding response during the critical first feed of larval fish development.

PE Mysis shrimp are sustainably harvested at night while feeding on nutrient rich phytoplankton and zooplankton, ensuring they are naturally gut loaded.

PE Mysis Pellets are available in a variety of sizes ranging from 100 microns to 2,000 microns to meet the needs throughout the various stages of fish larviculture.

Piscine Energetics is committed to providing the world with environmentally sustainable, naturally sourced, and nutritionally complete aquatic food. For over 10 years, Piscine Energetics has been removing Mysis Diluviana, an invasive species, from Okanagan Lake in British Columbia. Mysis were introduced to the lake in the 1960's and began competing with juvenile salmon for the same food source: zooplankton and phytoplankton. By harvesting Mysis, Piscine Energetics is allowing native salmon populations to return to healthy levels.

Ingredients:

Mysis Diluviana, Deboned White Fish Meal, Wheat Flour, Antarctic Krill Meal, Brewer's Dried Yeast, Whey, Sodium, Alginate Molasses, Fish Oil, Astaxanthin, Spirulina, Choline Chloride, Lecithin, I-Asorbic acid 2 monophosphate (Vitamin C) Calcium Choloride, HexMetPhos, Vitamins (Vitamin A, Vitamin D3, Vitamin E, Vitamin K, Vitamin B12, Riboflavin, p-Panthothenic Acid, Niacin, Choline, Thiamine, Pyridoxine, Folic Acid, Ascorbic Acid, Biotin, BHT, Inositol), Minerals (Manganese, Zinc, Iron, Copper, Cobalt, Iodine, Selenium)

Guaranteed Analysis:

Crude Protein:	Min: 42%
Crude Fat:	Min: 8%
Crude Fiber:	Max: 2%
Ash:	Max: 6%
Moisture:	Max: 10%
Phosphorous:	Max: 0.75%
Omega 3:	Min: 2%
Omega 6:	Min: 1%
Vitamin A:	50000 IU/kg
Vitamin D:	2000 IU/kg
Vitamin E:	200 IU/kg

Turnkey automated algae production reactor

Victoria, British Columbia-based Industrial Plankton Inc. launched a turnkey algae production reactor at Aquaculture America, in Las Vegas, in February. The PBR - 1250L Industry Reactor is a biosecure, automated algae production unit with a small footprint: at just 5'x 5'x 7', it fits easily through a standard double door and can be set up in 4 hours.

The unit automatically stirs and adds water and nutrients to an algae starter culture, and controls the pH and temperature as it automatically scales up over 7-10 days. It can be operated to harvest automatically in continuous, semi-continuous or batch mode.

The automated cleaning cycle is run between batches to clean and sterilize the reactor.

The unit has touch screen controls and real time data logging and graphing, and can be accessed remotely.

CONTINUOUS CULTURE DENSITY
(~ 450L Harvest/Day)
Species Density x 102 Cells/mL)

Thalassiosira pseudonana: 25 million/ml

T-Iso: 24 million/ml

Nannochloropsis sp.: 115 million/ml

Tetraselmis sp.: 3.8 million/ml

Thalassiosira weissfloggii: 22 million/ml

Skeletonema costatum: 25 million/ml

Haematococcus pluvialis: 1.9 million/ml

Batch production densities are typically 2-3x that of continuous.

MORE INFORMATION ON PRODUCTS IN THIS SECTION

Coppens Essence
aquasolutions@Alltech.com or info@coppens.com

INVE Easy Dry Selco®
a.moretti@inveaquaculture.com

Industrial Plankton PBR - 1250L Industry Reactor
Ashley@industrialplankton.com

Keeton Hatchery Prime Smart Pellets
info@keetonaqua.com

Piscine Energetics PE MYSIS Pellets
www.mysis.com

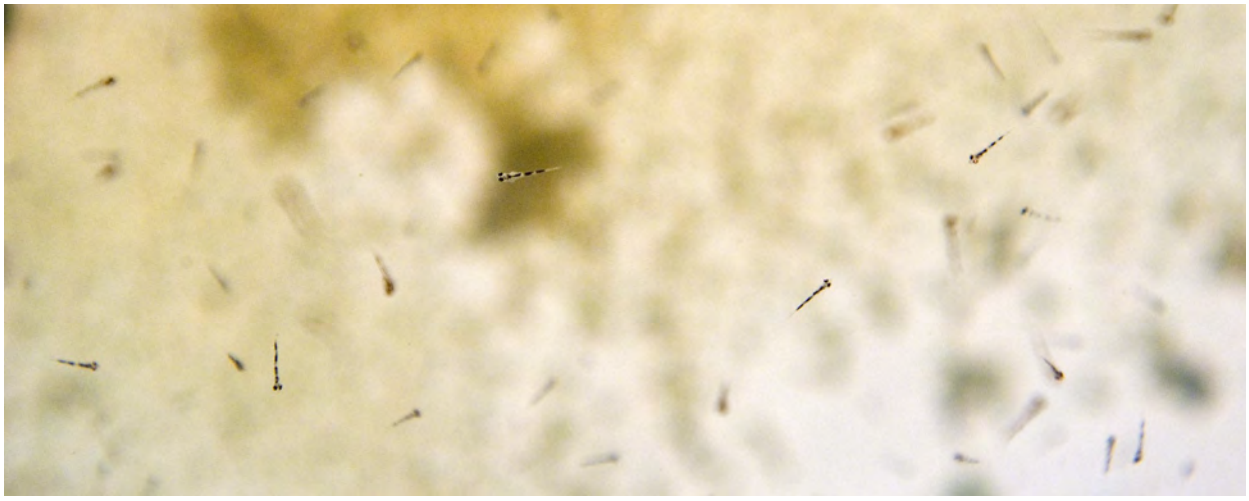
Skretting Vitalis Prima
www.skretting.com

World Feed Rift Lake Green Cichlid Flakes
www.vitalisaquatic.uk or www.worldfeeds.uk

Send your new product information to:
editor@hatcheryfeed.com

Hatchery season:
Future performance starts here

By Alex Tsappis, Alltech



The hatching season is fast approaching, and this is considered to be the most crucial stage of any aquaculture business. At these early life stages of the juvenile fish, it is very important to feed them the best quality feed. Compare your fish to Olympic athletes: If you want to bring home gold medals year after year, you start preparing early and provide them with excellent nutrition when they are young.

More than 20 years of experience and aggressively investing in research and product development has resulted in Coppens Top and Coppens Advance series starter feeds. Because of our dedication to on-farm performance and meticulous research, we can provide the best nutrition for juvenile fish, helping them to perform at their true genetic potential and bring home that "gold medal" at the end of each season. Remember, a good start is half the work.

Top five important factors we can address with our starter feeds

1. High survival rates

2. Excellent performance

3. Minimal deformities due to an optimally developed skeleton

4. Optimal water quality

5. Improved return on investment (ROI)

The combination of these five factors will be the foundation for the future growth of your fish, your business and, ultimately, your success.

The next generation of starter diets

The need for these revolutionary "complete" feeds comes from an extremely diverse industry with very progressive farmers, innovative technologies and conscious consumers. We see aquaculture as the protein provider of the future for a strong, growing world population. As a result, the aquaculture industry offers a great business opportunity for the 21st century, from on-land recirculating

aquaculture systems (RAS) farming to closed-containment farming and deep-sea farming.

How did we produce the next generation of starter diets? Through extensive studies at the state-of-the-art Alltech Coppens Aqua Centre as well as full-scale, on -farm testing, we have been able to identify the essential parameters for a great weaning diet that significantly addresses the five important factors mentioned above. This allows farmers to wean their larvae on dry feed with great confidence and success.

These new generation diets, which are now becoming available in the North American marketplace, have been designed with Alltech Aquate® technology as the core premix solution.

Alltech researchers collect data on the genetic responses of animals to different dietary conditions.

The Alltech Center for Animal Nutrigenomics and Applied Animal Nutrition.

Nutrigenomics: Exploring how nutrition affects gene expression

Through our research in animal nutrigenomics, we now better understand the link between our health and what we eat. Our nutrigenomics centre, based in Nicholasville, Kentucky, USA, is the first of its kind to study the effect of nutrition on gene expression.

In nutrigenomics, we analyze how nutrients and feeding strategies affect the animal genome. The use of “omics” technologies has allowed investigators to begin understanding how nutrition modulates gene expression, protein levels, metabolites and microbial profiles, and how this modulation relates to animal health and performance. These technologies generate vast amounts of data that allow the rapid evaluation of nutritional strategies with bioinformatics to identify functional and biological relevance.

The Alltech Center for Animal Nutrigenomics and Applied Animal Nutrition opened in April 2008 on Alltech’s Nicholasville research campus in Kentucky. There, we collect data on the genetic responses of animals to different dietary conditions. This microarray data is gathered from research conducted in the center itself and through various collaborative efforts with major universities and research centers globally. The resulting database is the largest of

its kind in the world, with more than 1,000 test samples from mice, chickens, pigs and cows. In 2017, Alltech developed a salmonid microarray that will be used to expand the database to include fish species.

Helping fish meet their genetic potential early in life

Aquate is Alltech's complete solution provision platform specifically designed for aquaculture. Our technologies have been successfully used in the aquaculture sector for the past decade and maintain a protective balance between fish species, their nutrition and the environment in which they live. Aquate technologies are proven to promote growth, strengthen barrier protection and immune response, optimize intestinal microflora and block pathogen access. By enabling animals to perform to their true genetic potential, we see improved on-farm performance and profitability, in a responsible way.

ΩHF

More information

Alex Tsappis

E: atsappis@Alltech.com

The importance of shape analysis in the study of larval deformities, and its application in the investigation of deformity-inducing bacterial mechanisms

By Spyros Nikolakakis, Peter Bossier and Dominique Adriaens, Ghent University

Deformities and their financial impact

Aquaculture increasingly focuses on upgrading larval fish quality, but its production nowadays is plagued by morphological abnormalities that produce a considerable economic loss. The minimum annual economic impact of abnormalities of all European aquaculture species is estimated to be more than 50 million € per year (Boglione et al., 2013).

Malformations can lead to fish that are not easily marketable, or even to mortalities at the larval stage or later. The early detection can be crucial, because deformed specimens exhibit a slow growth rate, compete for food and space with healthy fish, are prone to disease, and have poor marketability (Moretti et al., 1999). In the cases of sublethal abnormal development, the final product can be difficult or impossible to sell. As deformed fish are less acceptable to consumers, they must be either discarded or further processed - if possible - to save any of the meat. Additionally, even fish with lesser deformities may be difficult to fillet, resulting in lower fillet yields.

Methods of identification

In aquaculture, the most common methods for identification of abnormalities is visual examination of the body and swimming behavior. Other methods include the use of traditional morphometric analysis on meristic characters of size, radiography, and whole mount staining of cartilage and bone. These methods can provide information of high significance, but have also been known to present limitations: firstly, they are often subjective when the simple visual identification of deformed specimens is involved. The methods that rely on the subjective estimation of deformities by individual researchers or quality control personnel in aquaculture facilities may be adequate in the cases of easily detectable abnormal development, but bias might be introduced, especially when more than one researcher is scoring the deformities (Karahan et al., 2013). Additionally, they can also fail to find and objectively quantify more subtle abnormalities, especially in earlier stages when skeletal development is still basic or lacking. These subtle effects may be very important as precursory signs of sublethal or even lethal conditions that start to manifest at these early larval stages, or are fully manifested at the fingerling stage or later.

Furthermore, they also fail to provide information on the shape of the specimens, which can be

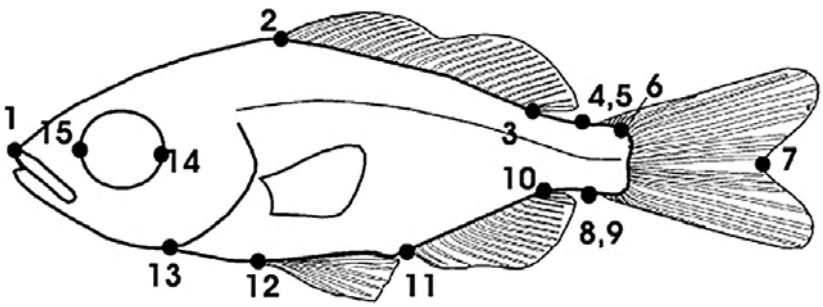


Fig. 1: Application of landmarks in sharpsnout seabream *Diplodus puntazzo* (Kouttouki et al., 2006)

crucial for the purpose of a complete identification and quantification of deformities. An answer to these shortcomings can be provided through the complementary application of geometric morphometrics. Two data types are generally used to describe shape in morphometrics: landmarks and outlines. The former (Fig. 1) involves the collection of two or three dimensional coordinates of biologically definable landmarks, preferably being homologous anatomical points, whereas the latter (Fig. 2) involves the tracing of the body outline. The latter is particularly useful in very early larval stages, where the position of landmarks changes rapidly, or they might be too few or even absent.

Time of application

The earliest time point of the focus of the vast majority of research studies and monitoring of deformities in the industry is the start of the juvenile (fry) stage when fingerlings are being sold in the hatcheries, or transferred to the growing tanks. Occasionally, it also happens earlier, together with the sorting of specimens with functional swim bladder. However, most of the deformity conditions have been known or strongly suspected to have their first manifestation and origins in the crucial first life stages, starting from hatching (Koumoundouros, 2010; Boglione et al., 2013). Hence, the early detection of deformities is crucial in order to avoid mortalities or slow growth rates, and consequently the waste of time, funds, energy and effort. Therefore, it is evident that there is a need to develop a size and shape quantification protocol for the larval stages that come earlier than the aforementioned time points.

Size and shape quantification protocol in early larval stages and its application in the study of bacterial phenotypic effects

Such a size and shape quantification protocol has been proposed by Nikolakakis et al. (2014) for European seabass *Dicentrarchus labrax* larvae from day-after-hatching (DAH) 0 until 15. It can be applicable in later larval stages of other species as well, and also deals with other limitations, such as the frequently overlooked issue of specimen distortion originating from handling, anesthetization, fixation and mounting. It involves fixation of the larvae in 3% phosphate-buffered glutaraldehyde, with no significant size or shape changes between the live and fixed specimens up to five months, which should be more than adequate for the data collection and statistical processing. It can be useful in studies that aim to demonstrate an effect attributable to any factor that can induce morphological changes, and it has been used in the investigation of the size and shape effects of egg disinfection, axenity, and antibiotics-induced difference in bacterial load on larvae of European seabass from hatching until DAH 15 (Nikolakakis et al., 2018 & additional submitted article).

Regarding the effect of these factors on deformities, there is, to the best of our knowledge, lack of evidence in literature about how these bacterial mechanisms work, and their specific phenotypic effects. There is some information on the effects of specific bacterial strains, but it is scarce on the bacterial load itself. Pathogenic bacteria can cause malformations in adult fish, such as *Mycobacterium neoaurum* and *Aeromonas salmonicida* in Atlantic

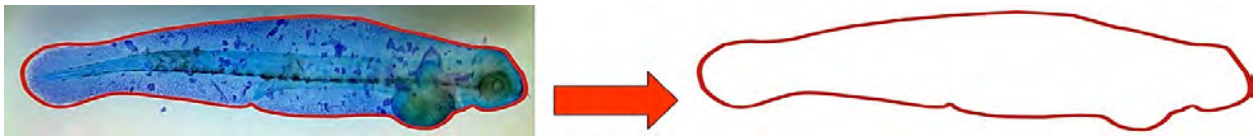


Fig. 2: Tracing of the shape outline of a European seabass *Dicentrarchus labrax* larva of DAH 5, stained with toluidine blue. Photo by Spyros Nikolakakis

salmon *Salmo salar* (Austin & Austin, 2007; Plumb & Hanson, 2011).

These deformity-inducing bacterial mechanisms can be quite complex, and this is illustrated by examples of the phenotypic effect of probiotic bacteria, which is sometimes beneficial and sometimes adverse: *Pediococcus acidilactici* has been associated with the reduction of the manifestation of deformities such as vertebral compression syndrome in rainbow trout, and spinal deformities of sea bass fry, specifically lordosis. However, *Lactobacillus casei* has been associated with a high incidence of spinal deformities in seabass larvae. It seems that these two lactic acid bacteria influence bone mineralization in different ways, possibly involving the mechanisms of Ca^{2+} absorption at the time of vertebral column ossification, which in seabass occurs around DAH 22 at 20°C (Lamari et al., 2013 and references therein).

Application in cases of real-time decisions

In the academic or commercial sector, the aforementioned protocol can provide interesting and detailed feedback on the size and shape effects of any biotic (such as deformity-inducing bacterial mechanisms) or abiotic factor (temperature, O2 levels, water quality, water current speed, nutritional parameters etc.), but it can be time-consuming and therefore not practical in the context of real-time decision making. For older fish with an advanced skeletal development that are towards the end of the larval stage or after it, a few automation procedures through the use of machine vision have been suggested in literature. However, until now there have been very few attempts to program these algorithms into machines that sort out fish deformities at hatcheries or in sea cages, and they have not been widely accepted from producers, likely due to their cost, or to not meeting the expected good performance.

Possible reasons might be the complexity of the image recognition and deformity classification procedures. The producers are also probably reluctant to accept major and costly changes in rearing methods that have been established from years of experience and technical know-how without concrete promising results. These would be necessary in order to convince them that there is a specific financial benefit from their use that would justify the associated expenses, personnel, training hours and the process of incorporating them into their long-standing protocols. However, reaching the full potential of the processes of machine vision, extraction of size and shape information, and deformity classification through modelling is just a question of optimizing and implementing procedures that already exist, and of better marketing campaigns that can present tangible benefits, associated with a proven financial profit.

References

Austin B. & Austin D.A. (2007) Bacterial Fish Pathogens - Diseases of Farmed and Wild Fish (4th edn), pp. 552. Springer, Netherlands.

Boglione C., Gisbert E., Gavaia P., Witten P.E., Moren M., Fontagne S. & Koumoundouros G. (2013) Skeletal anomalies in reared European fish larvae and juveniles. Part 2: main typologies, occurrences and causative factors. Reviews in Aquaculture 5 (Suppl. 1), 121-167.

Karahan B., Chatain B., Chavanne H., Vergnet A., Bardon A., Haffray P., Dupont-Nivet M. & Vandeputte M. (2013) Heritabilities and correlations of

deformities and growth-related traits in the European sea bass (*Dicentrarchus labrax, L.*) in four different sites. Aquaculture Research 44, 289-299.

Koumoundouros G. (2010) Morpho-anatomical abnormalities in Mediterranean marine aquaculture. In: Recent Advances in Aquaculture Research (ed. by Koumoundouros G.), pp. 125-148. Transworld Research Network, Kerala.

Kouttouki S., Georgakopoulou E., Kaspiris P., Divanach P. & Koumoundouros G. (2006) Shape ontogeny and variation in the sharpsnout seabream, *Diplodus puntazzo* (Cetti 1777). Aquaculture Research 37, 655-663.

Lamari F., Castex M., Larcher T., Ledevin M., Mazurais D., Bakhrouf A. & Gatesoupe F.J. (2013) Comparison of the effects of the dietary addition of two lactic acid bacteria on the development and conformation of sea bass larvae, *Dicentrarchus labrax,* and the influence on associated microbiota. Aquaculture 376, 137-145.

Moretti A., Pedini Fernandez-Criado M., Cittolin G. & Guidastri R. (1999) Manual on Hatchery Production of Seabass and Gilthead Seabream - Volume 1, pp. 194. FAO, Rome.

Nikolakakis S., Bossier P., Kanlis G., Dierckens K. & Adriaens D. (2014) Protocol for quantitative shape analysis of deformities in early larval European seabass *Dicentrarchus labrax*. Journal of Fish Biology 84, 206-224.

Nikolakakis S., Dierckens K., Bossier P. & Adriaens D. (2018) Effects of antibiotic-induced differences in bacterial load on growth and shape of early larval European seabass (*Dicentrarchus labrax L.*). Aquaculture Research 49, 988-1000.

Plumb J.A. & Hanson L.A. (2011) Health maintenance and principal microbial diseases of cultured fishes (3rd edn), pp. 492. Blackwell Publishing Ltd., Iowa, USA.

ΩHF

More information

Spyros Nikolakakis
E: nikolakakis.spyros@gmail.com

Applying intensive copepod production technology to establish marine hatchery production in Palau

By Dr. Chatham Callan, Oceanic Institute of Hawaii Pacific University and Meredith Brooks, CTSA

The small island nation of Palau recently made a big impact across the Pacific region with a complete ban on commercial fishing in its EEZ. The ban was enacted to address environmental concerns related primarily to overharvesting and climate change, and Palau is now embracing aquaculture to help achieve its goals for national food security and a sustainable economy. In an effort to increase local aquaculture production capacity, researchers at Palau Community College Cooperative Research & Extension (PCC CRE) together with support from partners including the Center for Tropical and Subtropical Aquaculture (CTSA) and the Oceanic Institute of Hawaii Pacific University (OI) have spent the last decade establishing hatchery production of several regionally important species.

Photo: Chatham Callan, Oceanic Institute of HPU

A female coral grouper broodstock being held at PCC CRE Hatchery showing a full abdomen of hydrated eggs.

At the PCC multi-species hatchery in the seaside village of Ngeremlengui, technicians currently produce rabbitfish, milkfish, mangrove crabs, and coral grouper seedstock and fingerlings for local farmers. An important factor in the larval rearing success they have experienced thus far is the hands-on training they continue to receive in essential hatchery technologies, such as microalgae and copepod production. In 2013 under the auspices of the CTSA-funded project "Broodstock Management, Seed Production and Grow-out of Rabbitfish, *Siganus lineatus* (Valenciennes, 1835) in Palau," Dr. Chatham Callan, Director of the OI Finfish Department, conducted the first training at PCC to produce copepods as an alternative live feed organism in a rabbitfish larval

"Current culture methods still face very low hatchery survival (~1%) in some of the most commercially important species, such as the coral grouper, largely due to inadequate larval feed items. Therefore, a significant need remains for development of intensive hatchery technologies to meet the ever-increasing demand for product."

rearing trial. During the trip, Dr. Callan assisted in setting up a prototype design for a copepod production system and initiated runs for *Parvocalanus* and local *Acartia*. Representatives from the Palau Bureau of Marine Resources also participated in the initial training, and continue to utilize copepod technology in their state-run hatchery production of rabbitfish.

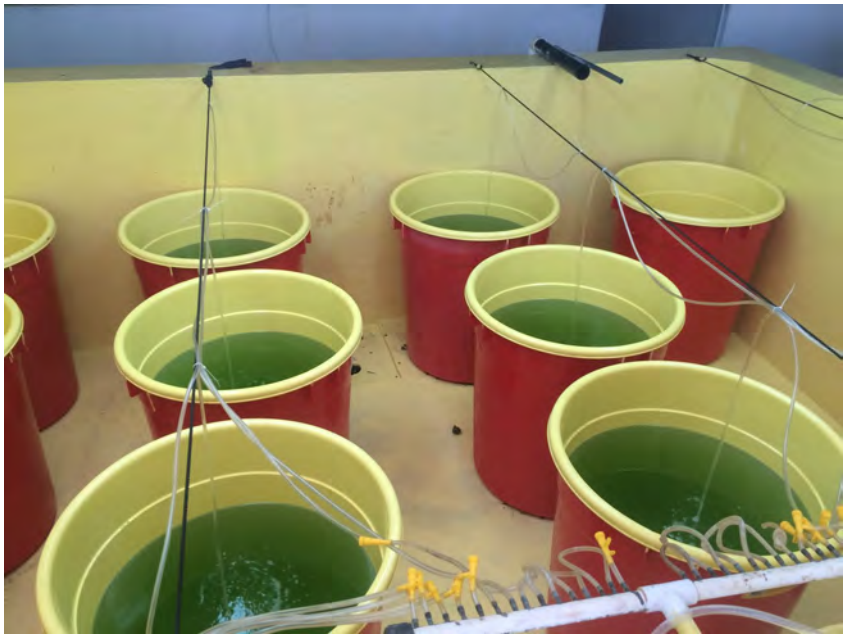
Fast forward a few years and an ongoing three-year project is focused on building upon existing copepod culture at PCC to support the larval culture of high value marine species, starting with coral grouper. In SE Asia, groupers have been cultured for over 30 years. However, current culture methods still face very low hatchery survival (~1%) in some of the most commercially important species, such as the coral grouper (*Plectropomus leopardus*), largely due to inadequate larval feed items. Therefore, a significant need remains for development of intensive hatchery technologies to meet the ever-increasing demand for product.

The first goals of the CTSA-funded project "Establishing Coral Grouper (*Plectropomus leopardus*) Production in Palau through the Application of Intensive Copepod Production Technology," now in its third year, were to establish coral grouper broodstock at the PCC hatchery, to improve copepod production capacity at the hatchery, and to identify suitable species of copepods for the culture of coral grouper larvae. In order to effectively improve copepod production capacity at PCC Hatchery, the existing algae lab needed to be significantly improved. Therefore, Dr. Callan and his team from OI assisted PCC staff in the necessary renovations and trained them in the essential protocols to dramatically improve their micro algae production capacity. Briefly, the lighting was significantly increased and a new blower was installed to supply considerably more air to the cultures, resulting in a dramatic increase in culture density. Cultures of *Tisochrysis lutea* and *Chaetoceros mulleri* were established and monitored for growth and production potential. At the same technicians were trained in the production methods necessary to intensively produce copepod nauplii that would be essential for rearing larval coral grouper and other marine species.

Copepods were isolated locally and scaled up to two 400 L production tanks and an average of 3 million nauplii per day were produced over a 4-month period. The successful demonstration and maintenance of this production capacity is a testament to the effective training of two local PCC staff technicians.

As a result of increased copepod production capacity at the PCC hatchery, researchers were able to successfully test the copepod nauplii as a first food compared to rotifers using grouper larvae. At the conclusion of the first feeding trial, grouper larvae fed with copepod nauplii had a significantly higher ($P<0.05$) survival rate of 64.25 ± 2.81% at day 7 compared to those that were fed with rotifers, which had a survival rate of only 7.13 ± 3.69 %. This result confirms that copepod nauplii are essential in the successful production of grouper and that the scaling up of copepod production capacity is imperative.

During year two, researchers conducted a training workshop where participants got hands-on experience in all facets of microalgae and copepod production methods. The workshop consisted of classroom activities to build math skills related to production methods as well as microscope skills for identifying and counting culture organisms. Following the classroom activities, participants were able to work in the hatchery



Experimental set-up at PCC Hatchery to test the effects of feed type on grouper larvae. Six 200L tanks were utilized in this experiment

7 day post hatch camouflage grouper larvae with full guts of copepods at the conclusion of the feeding trial.

and were trained in establishing and maintaining microalgae cultures, set-up and harvest of copepod production tanks and care and maintenance of copepod cultures. The workshop was co-taught by PCC Hatchery Technicians, demonstrating the effective transfer of knowledge and technology to this region.

Through this project, copepods have been effectively used to improve early larval survival of coral grouper, and a feeding protocol that utilized a mixture of copepods and rotifers was developed to demonstrate the successful production of late-stage larvae and juveniles. During the third and final year, the research group is refining larval rearing techniques and protocols for weaning larvae onto formulated feeds. Juveniles produced under the project are currently being distributed (as available) to farmers in Palau for grow-out trials. Researchers look forward to the successful completion of the work, which will result in the increased capacity for culture of high-value marine species in Palau.

ΩHF

More information

Dr. Chatham Callan, OI

E: ccallan@hpu.edu

Meredith Brooks, CTSA

E: mbrooks@ctsa.org

Use of potato starch in diets of tropical gar (*Atractosteus tropicus*, Gill 1863) larvae

Photo: Sandra Raredon/Smithsonian Institution

Aquaculture in México has great potential, especially of native freshwater species, such as the tropical gar (*Atractosteus tropicus*, Gill 1863) in the Southwest. Total fisheries production of this species was ~300 tons per year and it is decreasing every year. Commercial-scale production of finfish has been limited by several factors including reproductive performance to achieve constant production of high quality eggs and juveniles, zoo-technical management protocols during larval hatching, and nutritional requirements. Therefore, inclusion of specific food components, mainly during the larval stage, could contribute to maximize their growth and survival, and finally increase fry production in mass culture (Márquez-Couturier et al, 2006). Although it has been possible to include some digestible forms of carbohydrates in larval diets, the amount accepted and its utilization is dependent of the carbohydrate source and fish species (Li et al, 2016). The aim of this research was thus to assess the effects of increasing dietary levels of carbohydrates (potato starch) and decreasing protein content on growth, survival, cannibalism and digestive enzyme activities in *A. tropicus* larvae.

Larvae used for this study were obtained from broodstock held at the Laboratorio de Acuicultura Tropical (LAT), División Académica de Ciencias Biológicas (DACBIOL) of the Universidad Juárez Autónoma de Tabasco (UJAT). A total of 1350 larvae (5 days post-hatching) were distributed among nine 70 L circular plastic tanks (3 tanks per treatment).

Diets were designed to be isolipidic, with variations in caloric level, by modifying the carbohydrate content (potato starch, S) and decreasing the protein content (P) to evaluate protein sparing in *A. tropicus* larvae. Three experimental diets where designed as follows: 16% S (16% S–44% P), 22% S (22% S –40% P) and 28% S (28% S–36% P), which allowed for the reduction of caloric levels of the diets (17.75, 16.68 and 15.57 KJ g−1, respectively) (Table 1). Assignments of tanks to each treatment were randomized (n = 3 tanks per treatment at 150 organisms per tank). Moisture, protein, lipid and ash levels in the diets were determined using standard methods.

The experiment lasted 30 days from the start of exogenous feeding immediately after yolk absorption and opening of mouth/anus (5 days after hatching, DAH). Biometric measurements were

performed every 10 days, recording individual weight and total length of the entire live test population. At the end of the experiment, samples of the digestive tract were obtained to perform enzyme activity assays.

Assessment of Growth, Survival and Cannibalism

Growth of *A. tropicus* larvae showed significant differences ($p < 0.05$) among the three diets, such that larvae fed the 28% S diet exhibited a higher growth than larvae fed the 16% S diet, while the 22% S diets did not show differences with other treatments

Survival of *A. tropicus* larvae showed significant differences ($p < 0.05$) among diets: larvae fed the 28% S and 22% S diets exhibited higher average survival (22.8% to 16.1%) compared with larvae fed the 16% S (15.1%). Percent cannibalism did not show significant differences among treatments ($p > 0.05$).

Enzymatic Activities

The specific activity of alkaline proteases showed significant differences ($p < 0.05$) among treatments, with the following ranking: 22% S > 16% S > 28% S diet. In turn, the activity of acid protease differed significantly among diets ($p < 0.05$) and was highest for larvae fed the 16% S diet, and lowest for larvae fed the 22% S diet

Table 1. Preparation of the experimental diets used during the in vivo feeding trials of *A. tropicus* larvae

Ingredients	16% S	22% S	28% S
Fishmeal	40.00	38.50	36.60
Pork meal	10.00	10.00	5.00
Poultry by-product	20.00	15.00	15.00
Potato starch	16.00	22.09	28.90
Fish oil	6.97	7.41	7.50
Soybean lecithin	4.00	4.00	4.00
Gelatin	2.00	2.00	2.00
Vitamin C	0.50	0.50	0.50
Vitamin premix	0.30	0.30	0.30
Mineral premix	0.20	0.20	0.20
Nutrient	**16% S**	**22% S**	**28% S**
Carbohydrates	15.90	22.09	28.90
Energy	17.75	16.68	15.57
Protein	43.68	39.92	35.98
Fat	15.00	15.00	14.64
Fiber	1.21	1.06	0.91
Ash	15.04	13.45	11.82

Trypsin activity showed significant differences among treatments ($p < 0.05$), such that larvae fed the 16% S diet had the highest activity, while larvae fed the 22% S and 28% S diets showed no significant differences between them. The highest chymotrypsin activity was obtained for larvae fed the 22% S diet, followed closely by those determined in larvae fed the 16% S diet, while the lowest activity was recorded for larvae fed the 28% S diet. Larval leucine-aminopeptidase activity increased inversely with the starch content of the diet, following the ranking: 16% S diet > 22% S > 28% S diet.

Discussion

Results of the present study show that larvae fed a diet with 28% potato starch exhibited better growth and survival than those fed diets with a lower starch content. Previous studies indicate that the use of carbohydrates in formulations depends on the type and concentration included, the fish species and growing conditions, which can promote greater digestibility, improving the level of food intake and consequently growth and larval survival (Frias-Quintana et al, 2016 and Gu et al, 2014). Prior studies of *A. tropicus* larvae using diets based on

rendered proteins (poultry byproduct and pork), showed higher growth and survival than results of the present study. However, a combined feeding strategy (Artemia naupli, live Artemia and the experimental diets mix) was used until day 14 (Frias-Quintana et al, 2010), whereas experimental feeds in the present study were used as sole feed from the time of first opening of the mouth and anus. Furthermore, previous study findings of acceptance and utilization of corn starch as energy source (Frias-Quintana et al, 2016) and potato starch (present study) make it clear that *A. tropicus* larvae show a common pattern of higher growth with increasing starch levels.

In this study, the inclusion of potato starch in the diet significantly increased the activities of digestive enzymes such as α-amylase, α-glucosidase and lipase. Higher carbohydrase activity was related to the level of potato starch inclusion in the diets. Lipase activity also increased with the potato starch content of the diet. The higher activities of lipases associated with higher dietary inclusions of potato starch could modify the lipidic metabolism.

In contrast, the activity of proteases exhibited a more variable response to the percentage of dietary inclusion of potato starch. Previous studies evaluated diets with different levels of corn starch (Frias-Quintana et al, 2016), and found higher digestive enzyme activities (proteases, lipases and carbohydrases) with increasing starch levels in the diet (up to 15%) in *A. tropicus* larvae. The present study used higher starch levels (up to 28%), and inclusion of 16% and 22% of potato starch yielded the highest activity values for proteases (alkaline proteases, trypsin, chymotrypsin and leucine aminopeptidases). However, higher protein levels are included in these two diets, which are directly related to the highest protease activity found.

Conclusion

Results obtained in this study allow us to conclude that the diet formulated with inclusion of 28% potato starch for larvae of *A. tropicus* could achieve greater growth and survival than diets with lower potato starch, and promotes an increase in the digestive activities of carbohydrases and lipases. The latter serve as an indicator of food hydrolysis and assimilation of biomolecules from the diet supplied, ultimately allowing a decrease in the dietary protein level.

References

Frías-Quintana, C.A.; Alvarez-González, C.A.; Márquez-Couturier, G. Diseño de microdietas para el cultivo de pejelagarto *Atractosteus tropicus*, Gill 1863. Univ. Cienc. 2010, 26, 265–282. [Google Scholar]

Frías-Quintana, C.A.; Domínguez-Lorenzo, J.; Álvarez-González, C.A.; Tovar-Ramírez, D.; Martínez-García, R. Using cornstarch in microparticulate diets for larvicultured tropical gar (*Atractosteus tropicus*). Fish Physiol. Biochem. 2016, 42, 517–528.

Gu, M.; Kortner, T.M.; Penn, M.; Hansen, A.K.; Krogdahl, Å. Effects of dietary plant meal and soya-saponin supplementation on intestinal and hepatic lipid droplet accumulation and lipoprotein and sterol metabolism in Atlantic salmon (*Salmo salar L.).* Br. J. Nutr. 2014, 111, 432–444

Li, J.N.; Xu, Q.Y.; Wang, C.A.; Wang, L.S.; Zhao, Z.G.; Luo, L. Effects of dietary glucose and starch levels on the growth, haematological indices and hepatic hexokinase and glucokinase mRNA expression of juvenile mirror carp (*Cyprinus carpio*). Aquac. Nutr. 2016, 22, 550–558.

Márquez-Couturier, G.; Álvarez-González, C.A.; Contreras-Sánchez, W.M.; Hernández-Vidal, U.; Hernández-Franyutti, A.; Mendoza-Alfaro, R.; Aguilera-González, C.; García-Galano, T.; Civera-Cerecedo, R.; Goytortúa-Bores, E. Avances en la Alimentación y Nutrición del Pejelagarto *Atractosteus tropicus*. In Proceedings of the Avances en Nutrición Acuícola VIII, Mazatlán, Sinaloa, México, 15–17 November 2006; Universidad Autónoma de Nuevo León: Monterrey, N.L., México; pp. 446 –523.

From Carlos A. Frías-Quintana, Carlos A. Álvarez-González, Dariel Tovar-Ramírez, Rafael Martínez-García, Susana Camarillo-Coop, Emyr Peña, and Mario A. Galaviz, Biológicas, Universidad Juárez Autónoma de Tabasco. Use of Potato Starch in Diets of Tropical Gar (Atractosteus tropicus, Gill 1863) Larvae. Fishes 2017, 2, 3.

ΩHF

AQUA 2018

The joined meeting of the European Aquaculture Society and World Aquaculture Society

eas european aquaculture society

WORLD AQUACULTURE Society

For more info on the TRADESHOW : mario@marevent.com
For more info on the CONFERENCE : www.was.org and www.aquaeas.eu.

New research developments in aquatic animal larval feeding and nutrition—recent literature

Abstract excerpts compiled by Meredith Brooks, Hatcheryfeed

Growth performance, feed utilization and body composition of advanced nursing Nile tilapia (*Oreochromis niloticus*) fed diets containing Black Soldier Fly (*Hermetia illucens*) larvae meal

A study in Ghana, as part of the EU FP7 PROteINSECT project was conducted to evaluate the effects on the performance, feed utilization efficiency and body composition of Black Soldier Fly (*H. illucens*) larvae meal in a commercially formulated diet for advanced nursing Nile tilapia (*Oreochromis niloticus*).

When compared to the commercial fish feed control, there was no significant difference in acceptance, fish growth performance, feed utilization and body composition. However, the fatty acid profile of the fish reflected the FA profile of the insect meal. This is inconsequential at the juvenile stage and a finishing diet could be used prior to harvest.

Devic E, Leschen W, Murray F, Little DC. Growth performance, feed utilization and body composition of advanced nursing Nile tilapia (*Oreochromis niloticus*) fed diets containing Black Soldier Fly (*Hermetia illucens*) larvae meal. Aquacult Nutr. 2018;24:416–423. doi.10.1111/anu.12573

Full paper: http://onlinelibrary.wiley.com/doi/10.1111/anu.12573/full

You are what you eat? Differences in lipid composition of cod larvae reared on natural zooplankton and enriched rotifers

A laboratory experiment with larval cod fed natural zooplankton and enriched rotifers was carried out to investigate the effects of feed type on fatty acid (FA) and lipid composition. A divergence in FA composition was observed within a week of feeding on respective diets. The FA contents also varied between the main analyzed lipid classes, with relatively higher eicosapentaenoic acid levels in neutral lipids than in polar lipid classes.

Although zooplankton contained notably more polar lipids and less neutral lipids than enriched rotifers, the relative amounts of polar and neutral lipids in larvae from respective prey groups were similar, signifying that the larval composition only partly reflects what they have been eating.

Folkvord A, Koedijk R, Grahl-Nielsen O, et al. You are what you eat? Differences in lipid composition of cod larvae reared on natural zooplankton and enriched rotifers.
Aquacult Nutr. 2018;24:224–235. doi: 10.1111/anu.12550

Full paper: http://onlinelibrary.wiley.com/doi/10.1111/anu.12550/full

The effect of dietary DHA and taurine on rotifer capture success, growth, survival and vision in the larvae of Atlantic bluefin tuna (*Thunnus thynnus*)

The severe to complete mortality that occurs during the larviculture

of Atlantic bluefin tuna (ABFT; *Thunnus thynnus*) may be due, in part, to sub-optimal neural and eye development. The adult and larval ABFT eyes are rich in docosahexaenoic acid (DHA; 22:6n-3), which facilitates key intra-membrane reactions in the photoreceptors of the retina. Another critical nutrient is taurine, which plays vital roles that include bile salt conjugation as well as development and function of visual, neural and muscular systems.

The objectives of the study were to determine the pattern of conservation and loss of fatty acid groups and their constituent fatty acids during egg and pre-larval development; determine the effect of rotifer (*Brachionus rotundiformis*) DHA on hunting success, growth, and retinal opsin abundance in 2–14 dph ABFT larvae; and evaluate the effect of supplemented taurine in rotifers enriched on the most effective DHA level.

Results suggest that supplementing effective levels of DHA and taurine contributes to an array of physiological processes resulting in enhanced vision and prey acquisition to markedly improve ABFT larval performance during early development.

W. Koven, O. Nixon, G. Allon, A. Gaon, S. El Sadin, J. Falcon, L. Besseau, M. Escande, R. Vassallo Agius, H. Gordin, A. Tandler. The effect of dietary DHA and taurine on rotifer capture success, growth, survival and vision in the larvae of Atlantic bluefin tuna (*Thunnus thynnus*). Aquaculture Jan. 2018; 482: 137-145. doi.10.1016/j.aquaculture.2017.09.039

Full paper: https://www.sciencedirect.com/science/article/pii/S0044848617303976

European seabass (*Dicentrarchus labrax*) ability to discriminate between diets made with different dietary fat sources

The aim of this work was to determine whether juvenile and adult European seabass (*Dicentrarchus labrax L.*), fed ad libitum manually and with self-feeding demand feeders, respectively, were able to discriminate between a fish oil-based diet and a series of diets made with vegetable oils (soybean, linseed, rapeseed and sunflower oil), as well as a fat-free diet.

Juveniles (56.4 ± 11.2 g) displayed a preference for soybean (SYO) and fish oil (FO). A statistical difference in specific growth rate (1.37% ± 0.26% day−1) for juveniles was only observed for FO+ fish feed combination. Results from this study show that *D. labrax* can discriminate between diets where the only difference is the lipid source.

Luz RK, Boluda-Navarro D, Sánchez-Vázquez FJ, et al. European seabass (Dicentrarchus labrax) ability to discriminate between diets made with different dietary fat sources. Aquacult Nutr. 2018;24:65–73. https://doi.org/10.1111/anu.12534

Full paper: http://onlinelibrary.wiley.com/doi/10.1111/

Industry events

Send your meeting details to:
editor@hatcheryfeed.com

March		
12-14:	World Mycotoxin Forum, Amsterdam, Netherlands	https://worldmycotoxinforum.org/
21-23:	Gia 2018 - 5th International Symposium on Genomics in Aquaculture, Portugal	http://www.gia2018.com/
27:	Aquafeed Horizons Asia 2018, Bangkok, Thailand	http://feedconferences.com
27 - 29:	VICTAM Asia 2018, Bangkok, Thailand	https://victamasia.com
April		
23 - 26:	Aquafeed Extrusion Technology (Europe), Ås, Norway	https://fie.com.au/events
23 - 25:	Asian Pacific Aquaculture 2018, Taipei, Taiwan	http://www.was.org/meetings/default.aspx?code=APA2018
26 - 27:	Food & Feed Drying Technology (Europe), Ås, Norway	https://fie.com.au/events/drying-norway
May		
8 - 12:	International Abalone Symposium, Xiamen, Fujian, China	http://www.ias2018.com/en/index.html
15 - 17:	Offshore Mariculture Asia 2018, Singapore	http://www.offshoremariculture.com/asia
15 - 18:	Insects to Feed the World Conference, Wuhan, China	http://ifw2018.csp.escience.cn/dct/page/70008
20 - 22:	ONE: The Alltech Ideas Conference (ONE18), Lexington, Kentucky, USA	http://one.alltech.com
23 - 24:	Aquaculture UK 2018 Exhibition, Aviemore, Scotland, UK	https://aquacultureuk.com/exhibition/
24- 25:	Global Summit on Aquaculture and Fisheries in Japan, Osaka, Japan	https://aquaculture.global-summit.com
June		
4 - 6:	Aqua Conference 2018	http://www.aquacultureconference.org
11 - 14:	AquaVision 2018	http://www.aquavision.org

VICTAM Asia 2018

FIAAP grapas

27 – 29 MARCH 2018 · BITEC EXHIBITION HALLS, BANGKOK, THAILAND

Asia's largest feed and grain event

Your global marketplace – an international event in an international city being held in a country with large home markets

What's on show at VICTAM Asia 2018?

- Feed production technology • Packaging • Energy efficiency
- Auxiliary equipment

What's on show at FIAAP Asia 2018?

- Ingredients • Additives • Formulation • Laboratory equipment
- Quality control

What's on show at GRAPAS Asia 2018?

- Rice milling and sorting technology • Flour milling technology
- Flakers, extruders • Grain processing systems • Additives

Industry conferences

- The FIAAP Asia Animal Nutrition Conference 2018
- Petfood Forum Asia 2018 • Aquafeed Horizons Asia 2018
- GRAPAS and Global Milling Conference Asia 2018
- Third ASEAN Feed Summit

Supported by

- Thai Ministry of Agriculture & Co-Operatives • Thai Department of Livestock Development • Thai Department of Fisheries
- Thai Feed Mill Association • Thai Rice Milling Association
- Thai Chamber of Commerce
- Thailand Convention & Exhibition Bureau

Organized by

Victam International BV, PO Box 197, 3860 AD Nijkerk, The Netherlands
T: +31 (0)33 246 4404 F: +31 (0)33 246 4706 E: expo@victam.com

More information

Please visit our website: **www.victam-asia.com**

See us on Twitter, Facebook, LinkedIn and Google+ or scan the QR code: