
AGE OF PL TO STOCK PONDS

QUESTION:
I was wondering what is the best age of Vannamei PL' to stock ponds. I have heard conflicting statements between PL 8 to PL 12.
From: Sam Chew aeresources@yahoo.com
To: shrimp@yahoogroups.com
Date: 1 June 2006

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COMMENTS 1:
Can be very much situation-dependent. Salinity, pond fertility, not to mention hatchery willing to ship larger sizes and feeding them properly. Or giving you the "rejects". In one very particular case, I have hard data that 8 mg critters have better SR than 2 mg. Plus saving 6 days of pond time. You'll probably have to experiment and keep good records.

Julio Estrada julioe@ecutel.net

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COMMENTS 2:
PL gills, osmo-regulatory, and non-specific immune abilities may not be fully competent before PL 12. Regardless of the situation, the stress of transportation, acclimation and handling in general is usually minimized using older PL's assuming they have been fed and maintained properly at their hatchery. If you are receiving at the hatchery - once you have a little experience - visual examination of the PL's condition and activity should tell you how healthy they are before you accept them. Not receiving at the hatchery means buying from the hatchery with the best and most consistent reputations for high quality PL's. Local growers will usually be glad to let you know which hatcheries have done right by them.

Durwood M. Dugger duggerdm@bellsouth.net

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COMMENTS 3:
One of the most important factor for transporting larvae is how to transport. Normally for long time transportation (more than 5 to 6 hours) low age PL is better, and old one have more mortality during transportation. But for short distance, if you take old one you will have advantage of saving time of age, stronger larvae, and better feeding in hatchery. Sometimes farmer and hatchery come to result by negociation and hatchery will deliver in farm. In that case you may pay more per larva but the benefit is more at the end of culture.

Morteza Heraji
Po box 1357 Minab
Hormozgan Iran
zarabzi@yahoo.com

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COMMENTS 4:

In my experience over the decades I have found that PL14 is the ideal age to move your babies from hatchery to grow out. Any younger and they are too weak to survive in the ponds, and any older you do not get uniformity of size in the grow out ponds, resulting in shooters and runts. Don't just think of transportation, but think of the end result in the ponds. I have moved shrimp all over the world, sometimes on 30 hour aircraft journeys with little or no problems at PL14.

Alec Forbes aforbes@mfmr.gov.na

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COMMENTS 5:
Since 4 years I tried stocking vannamei PL's starting 8 to 25, acclimated between 5 and 10 ppt. The closest hatchery from my farm in Lebanon takes minimum 25 hours by airplane.The best result I had was with the PL's 12/13 acclimated to 10ppt.

Massaad M. Ejbeh
AQUAFARM s.a.r.l, Lebanon
mejbeh@hotmail.com

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COMMENTS 6:
By all your emails, I can reach to this result: transporting and acclimation from place to place species and other conditions is different. In my experience from 6 years transporting larvae of P.indicus as a hatchery man and stocking as a farmer, transporting even for 24 hours by road with air-conditioner, PL 10 to 13 is best, and for the older than this there is lower survival during transportation. In my hatchery we deliver larvae at the farm, thus transporting is very important, but even with these conditions normally survival is not below 75 %, and most of them is 80 % at the end of the period of culture in ponds. But for low distance it is preferable to take larvae from PL 12 till 15; in that case you will have survival near to 80 % in average. Thus I think local farmers by their experience can say the best condition for transport.
Morteza Heraji
Po box 1357 Minab
Hormozgan Iran
zarabzi@yahoo.com

CHEMICAL STOCK SOLUTIONS VS. NEW PREPARATIONS

QUESTION:
What are the disadvantages of preparing and using stock solutions of water treatment chemicals like EDTA and Treflan? The advantages are many: Ease of use, less likelihood of error in measurement and ease of dilution in the target medium. Some have expressed doubts that making stock solutions somehow decreases the efficacy of the compound. Is this true? We normally prepare 1-2 liters of the stock solutions and use them over a period of 1.5-2 weeks. Any feed-back would be greatly appreciated.
From: Ram Nieves jrinieves@yahoo.com
To: shrimp@yahoogroups.com
Date: 5 June 2006

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COMMENTS 1:

I would like to make use of this chance, to ask: is it possible to use alcohol to disinfect hatchery sea water? Instead of using chlorine powder?

Fredrick Poh fredpoh@starhub.net.sg

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COMMENTS 2:
Alcohol is not generally rated too well as a disinfectant. High concentrations are required, it's quite difficult to separate it from water afterward, and there's little information on behavior of drunken shrimp. Very often, stock solutions will degrade far more quickly than the original concentrated reagents. Or, they may become contaminated. You would need to look up recommended storage conditions and shelf life for the specific chemicals you use. These can usually be found in manufacturer's data sheets and / or lab manuals

Julio Estrada julioe@ecutel.net

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COMMENTS 3:
Thanks a lot. Your response was the same as what I received from others. It turns out we would get better value for our money if we prepare the stock solutions on a daily basis using unionized water or distilled water to avoid reactions between the compound (eg.EDTA) and the calcium in hard water.

Ram Nieves jrinieves@yahoo.com

MARINE CILIATED PROTOZOA

QUESTION:
I am facing a problem from marine ciliated protozoa in the larval rearing tanks in my shrimp hatchery. How to get rid of it without harming shrimp larvae, Tetraselmis and Chaetaceros algae ?
From: Moataz motazkat@yahoo.com
To: shrimp@yahoogroups.com
Date: 19 May 2006

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COMMENTS 1:
I would recommend the following:
1. Check the bottom of your larvae tanks. If there is a lot of food on the bottom of the larvae tanks, harvest the larvae and remove the remained food from the bottom. Then put the larvae back in the tanks with new water.

2. If they are more than PL 2, you can treat them with formaline to stimulate molting and then change water 100%.

3. Check your filtration system looking for hot spots. Most of the time, where the water is held back, there are the contamination points.

4. If you are not cleaning regularly your filtration system such as bag or cartridge filters, charcoal filters and sand filters, you are developing hot spots right there.

Robinson Bazurto buhocol@hotmail.com

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COMMENTS 2:
I agree with Robinson but am a bit confused. Are the protozoans in your algal carboys? This happened to me several times and I treated with formalin IN the carboys. Cleared the ciliates up very quickly. Of course you cannot do this in your LRT (Larval rearing tanks). Your LRTs should be siphoned on a daily basis to remove uneaten food and dirt. Simply using lights, bring your larvae up to the surface and rapidly siphon and clean the bottom of your tanks. Also as Robinson suggests, look for hot spots: hoses, dirty hands, filters, water source ... etc

To siphon a tank, wait until you have fed your larvae, give them time to eat, then flood the water surface with subdued lighting (a couple of guys with flashlights can help). The larvae will then rise to the light and at that time you siphon the tank bottom. Stick a hose (a clean disinfected one) into the tank to reach the bottom, take a big suck on the other end (every shrimpie knows the gagging, glorious taste of larval water, fecal matter, molts and algae....) and you will create a siphon effect. Put the end of the hose that is coming out of your tank thru a harvesting bucket so that in the event you do suck out some larval animals you will not lose them. Clean rapidly the bottom and lower sides of your tank, remove hose, turn off lights and sing the little critters to sleep..... It is also necessary to examine your babies under a scope to ascertain the extent of your ciliate invasion. What country are you in? Do you have access to any aquaculture students or techs who can assist you?

Alec Forbes aforbes@mfmr.gov.na

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COMMENTS 3:
For what it is worth, the existence of ciliates in larval fish tanks may or may not be a problem depending upon the species of ciliates. From the viewpoint of many larval fish and probably larval shrimp of the right size, ciliates are just another small live food item.There were ciliates in the probiotic cultures that I used to seed my larval fish tanks.

However, there are a lot of nasty ciliates and you can often tell them apart by observation of their behavior relative to your live and dead larval animals. If they avoid the live larva, they may just be food.

Dallas Weaver deweaver@surfcity.net

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COMMENTS 4:
In our South African shrimp hatchery we would get numerous species of ciliates. Our most troublesome ate Tetraselmis! We had outdoor tanks and this ciliate creature would appear and eat the whole culture. They did not harm shrimp, but on the biological conversion typically used (10:1 I think), the ciliates provided little nutrition and appeared to not be consumed by the shrimp.

We managed this by feeding or dumping any Tetraselmis tank in which these appeared and cleaning tanks well to prevent the spread of this critter.

Some ciliates would flourish on wasted feed as described by Alec, but they need a source or origin, so check your source water and cultures. Back-siphoning from an established tank or a small hole in a pipe can contaminate the whole water system.

The water treatment system may not be effective. Starter cultures also typically become contaminated with ciliates - especially the Chaetoceros. I have even seen amoebas munching away on my Chaetoceros cultures - doesn't say much for my hatchery hygiene! We check the test tube "mother

cultures" under the microscope weekly before use - looking for ciliates. Ciliates in the mother cultures will bloom along with the algae culture.

Laurence Evans ecotao@yahoo.com

MOLTING IN SHRIMP HATCHERIES

QUESTION:
I would like to know your experience about molting in hatchery .After PL age is it regular every day? Can full moon affect molting in hatchery? If you know larvae are just molted, is it any problem to transport them to farms ?
From: Morteza Heraji zarabzi@yahoo.com
To: shrimp@yahoogroups.com
Date: 17 May 2006

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COMMENTS 1:
For P. monodon at least, the PL's molt every day; yes the full moon triggers molts (you will get a lot of controversy on this statement) particularly inthe broodstock, but since the PL's molt every 24 hours or thereabouts it makes little difference, and if you have to transport the PL's at what age are you looking at? Best time to seed your ponds is with PL 14 in which case you pack them and transport them right after molt. How far is the farm, how long would they be in the packing boxes, are they going by air, road or what and can you acclimatize at the ponds?

Alec Forbes aforbes@mfmr.gov.na

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COMMENTS 2:
In fact we work with P. indicus and we send our larvae to short distance and long distance by road with truck with air conditioning, 23°C. Short distance means less than 100 km, and long distance is almost 1000 km. We packed them in PL 12 till 16. My question is whether it is possible that at full moon most of the larvae in the hatchery after PL 10 molt togethern and if it is right that mostly they molt during night time.

Morteza Heraji zarabzi@yahoo.com

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COMMENTS 3:
Yes, the animals will synchronize their molt. In other words, they will molt at the same time. With your short distances and air con trucks, you should have no problems at all. I did some P. indicus in Mozambique, nice animals and if I were you, I would wait until PL14 before moving them.

Alec Forbes aforbes@mfmr.gov.na

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COMMENTS 4:
Are you 100% sure that the animals synchronize their molt ? Is there any fact that proves it? It sounds dreamlike.

Robinson Bazurto buhocol@hotmail.com

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COMMENTS 5:
Just personal observation over many years. They all go at once. Mind you, I am unsure with P. indicus, but 100 % certain with P. monodon. The things to watch for in transport is the extreme drop in pH in the bags, how long they are in the bags for, temperature, DO and the usual. I never really worried about molting, just pack them a few hours after a large molt and hit the road to the ponds or to the airport. No big deal if all parameters are reasonable and the receiving water is same.

Alec Forbes aforbes@mfmr.gov.na

IMPACT OF POSITIVE RAMP SHORT-TERM OPERATING DISTURBANCES ON AMMONIA REMOVAL BY TRICKLING AND SUBMERGED-UPFLOW BIOFILTERS FOR INTENSIVE RECIRCULATING AQUACULTURE
Catherine Lyssenko, Fred Wheaton-2006
Aquacultural Engineering 35(1): 26-37
Abstract:
Biofilters are regularly used in freshwater aquaculture production systems to remove ammonia and nitrite and are the only economically feasible ammonia removal devices in saltwater systems. Six identical 5.23 l biofilters, i.e., three trickling and three submerged-upflow filters, were operated at predetermined baseline water quality conditions (pH 7.5, temperature 25 °C, salinity 5 ppt, TAN 1 mg/L), and then perturbed to simulate a number of possible operating disturbances, e.g. increased fish load, flushing of culture tanks, closing off of valves. Each disturbance was a controlled positive ramp short-term change in ammonia concentration (with other water quality parameters held constant) or temperature or pH or salinity. Ammonia removal across the biofilters was monitored during the disturbance and recovery period for loss and subsequent restoration of ammonia removal efficiency. Baseline water quality to the filters was resumed at the end of each disturbance and baseline ammonia removal occurred within 1 to 2 h after end of disturbance. Ranges of variation in water quality were pH 7.5–9, TAN 1.0–4.0 mg/L, temperature 25–35 °C, and salinity 5–35 ppt. Salinity increases over a 5–10 h period reduced biofilter removal efficiency (−12 to −30% TAN removal); temperature increases, over a 1.6–10 h period, offered about a 5% increase in TAN removal while gradual TAN increases, over a 3–12 h period, although providing an approximately extra 1 mg/L of removal did not significantly change removal efficiency; and gradual pH increases, over a 3–7.5 h period, did not change biofilter removal efficiency significantly.
(Department of Biological Resources Engineering, University of Maryland, College Park, MD 20742, USA; email of Catherine Lyssenko: cal25@psu.edu cal25@psu.edu)

IMPACT OF RAPID IMPULSE OPERATING DISTURBANCES ON AMMONIA REMOVAL BY TRICKLING AND SUBMERGED-UPFLOW BIOFILTERS FOR INTENSIVE RECIRCULATING AQUACULTURE
Catherine Lyssenko, Fred Wheaton-2006
Aquacultural Engineering 35(1): 38-50
Abstract:
Biofilters are regularly used in aquaculture production systems to remove ammonia and nitrite and are the only economically feasible ammonia removal devices in saltwater systems. Six identical 5.23 L biofilters, three trickling and three submerged-upflow filters, were operated at predetermined water quality conditions (pH 7.5, temperature 25 °C, salinity 5 ppt, TAN 1 mg/L), and then perturbed to simulate a number of possible operating disturbances, e.g. increased fish load, flushing of culture

tanks, closing off of valves. Each disturbance was a controlled impulse change in ammonia concentration, temperature, pH or salinity. The maximum water quality ranges were pH 6–9, TAN 0.5–4.0 mg/L, temperature 15–35 °C, and salinity 0–10 ppt. After each disturbance, the water quality was immediately returned to the predetermined (baseline) values. The ammonia removal across the filters was monitored during the disturbance and the recovery period for loss and subsequent restoration of biofilter removal efficiency. Baseline nitrification rates resumed within 1–2 h after cessation of the shock. Some impulse shocks were temporarily detrimental to both filter types—especially low pH (−29% efficiency), low salinity (−13% to −18% efficiency), and low temperature (−11% to −13% efficiency). Raising the temperature (+9% to +12% efficiency) and TAN concentration (+0.30 to +0.36 mg/L of filter additional TAN removal) appears to be beneficial to the biofilter.
(Department of Biological Resources Engineering, University of Maryland, College Park, MD 20742, USA; email of Catherine Lyssenko: cal25@psu.edu cal25@psu.edu)

NUTRIENT UPTAKE, CHLOROPHYLL A AND CARBON FIXATION BY RHODOMONAS SP. (CRYPTOPHYCEAE) CULTURED AT DIFFERENT IRRADIANCE AND NUTRIENT CONCENTRATIONS
Fabiola Lafarga-De la Cruz, Enrique Valenzuela-Espinoza, Roberto Millán-Núñez, Charles C. Trees, Eduardo Santamaría-del-Ángel, Filiberto Núñez-Cebrero-2006
Aquacultural Engineering 35(1): 51-60
Abstract:
The goal of this research was to study biomass production, nitrate and phosphate uptake and carbon fixation in batch culture of the marine microalgae Rhodomonas sp., which is used in aquaculture as food for commercially reared invertebrates. Cultures were grown for 7 days under four irradiance levels (52, 68, 103 and 142 μmol photon m−2 s−1) and at three nitrate and phosphate concentrations (661–29, 882–39, 1323–58.5 μM of NaNO3 and NaH2PO4, respectively) establishing 12 experimental treatments. During the exponential phase, growth was directly correlated with irradiance and the initial nitrate and phosphate concentrations. Significant differences were found in the low growth phase as a function of nutrient concentration, but not for irradiance. For the low nutrient concentration treatments, growth was limited after 2 days. Final cell density was influenced by the initial concentration of nutrients, independently of the irradiance level. The average maximum biomass production was reached in 7 days in cultures with high nutrients (1.53 ± 0.07 × 106 cells mL−1). The total chlorophyll a content was directly related to cellular density and indirectly to irradiance level and concentration of nutrients. In conclusion, the optimal growing condition for Rhodomonas was up to the fourth day. However, after this time the cellular density, chlorophyll content and carbon uptake changed with the nutrient concentration and irradiance. Therefore we suggest that Rhodomonas culture could be used at the fourth day, either as inoculums for higher volume or as nourishment for invertebrate animals in marine aquaculture program.
(Facultad de Ciencias Marinas, Universidad Autónoma de Baja California, Apartado Postal 453, Ensenada, Baja California, México; email of Roberto Millán-Núñez: rmillan@uabc.mx)

PERFORMANCE EVALUATION OF AN INCLINED BELT FILTER USING COAGULATION/FLOCCULATION AIDS FOR THE REMOVAL OF SUSPENDED SOLIDS AND PHOSPHORUS FROM MICROSCREEN BACKWASH EFFLUENT
James M. Ebeling, Carla F. Welsh, Kata L. Rishel-2006
Aquacultural Engineering 35(1): 61-77
Abstract:
As environmental regulations become more stringent, environmentally sound waste management and disposal practices are increasingly more important in all types of aquaculture. In many recirculation systems, microscreen filters are used to remove and concentrate the suspended solids from the process water, because they require minimal labor and floor space and can treat large flow rates of water with

little head loss. These microscreen filters generate a separate solids waste stream that can be further concentrated to reduce the quantity and improve the quality of discharge water. A Belt Filter System, Hydrotech Model HBF537-1H, from Waste Management Technologies Inc., Baton Rouge, LA, USA was evaluated for rapid thickening of sludge from the backwash water of a microscreen filter. When used in conjunction with coagulation/flocculation aids, significant reduction of suspended solid and phosphorus are possible. Testing of the system was conducted using the backwash effluent of a microscreen filter that treated water discharged from several large-scale recirculating aquaculture production systems growing artic char and trout. The system was tested using only alum as the coagulant aid, using only a commercially available polymer as the flocculation aid and the two coagulation/flocculation aids in combination.

Alum alone was moderately efficient in removing solids (82%), but was very efficient in sequestering reactive phosphorus (96%), with effluent concentrations less than 0.07 mg/L-P at the highest alum dosage tested, 100 mg/L. Several commercially available polymers used alone and at relatively low dosages (15 mg/L) were very effective in removing suspended solids, with a removal rate averaging 96% and with an effluent TSS concentration of less than 30 mg/L. The polymers were not as efficient as alum in removing reactive phosphorus, with a removal rate of approximately 40%. At the optimum combined dosage of alum (mg/L) and polymer (mg/L), the Inclined Belt Filter System increased the dry matter content of the sludge to approximately 13% solids, and reduced both the suspended solids and reactive phosphorus concentration of the effluent by 95 and 80%, respectively. The combination of coagulation/flocculation aids and the inclined belt filter show excellent potential to greatly reduce the volume of solids generated, and significantly reduce the concentration of suspended solids and phosphorus in discharged effluents. By eliminating the need for settling tanks or ponds, the leaching of nutrients (phosphorus, nitrogen) is minimized and the dewatered sludge is in a form for easy transport, storage, or disposal.
(The Conservation Funds Freshwater Institute, 1098 Turner Rd., Shepherdstown, WV 25443, USA; email of James M. Ebeling: j.ebeling@freshwaterinstitute.org)

THE EFFICACY OF OZONATED SEAWATER FOR SURFACE DISINFECTION OF HADDOCK (MELANOGRAMMUS AEGLEFINUS) EGGS AGAINST PISCINE NODAVIRUS
Kevin A.H. Buchan, Debbie J. Martin-Robichaud, Tillmann J. Benfey, Anne-Margaret MacKinnon, Linda Boston-2006
Aquacultural Engineering 35(1): 102-107
Abstract:
Piscine nodavirus, also known as viral nervous necrosis (VNN), is a lethal, vertically transmitted virus that causes severe mortality in fish. It affects primarily marine species, including cultured haddock (Melanogrammus aeglefinus). Ozone has been used successfully to disinfect Atlantic halibut (Hippoglossus hippoglossus) eggs against nodavirus. Fertilized eggs from different species of fish can tolerate varying levels of dissolved ozone, so specific exposure levels need to be determined for individual species. The objectives of this study were to investigate the tolerance of newly fertilized haddock eggs to dissolved ozone and to determine if this exposure is sufficient to disinfect against piscine nodavirus. Eggs were exposed to an ozone concentration of 3.0(±0.3) mg/l of total residual oxidants (TRO) of Cl2 for CT units (TRO × duration of exposure in min, mg/l/min) of 0, 5, 10, 15, 20, 25, 30, 40 and 50. A decrease in survival was observed when the exposure exceeded 30 CT units. Following this, other fertilized haddock eggs were submerged in nodavirus suspensions with densities of 102.5 and 103.5/0.1 ml TCID50 units for 30 min, followed by exposure to ozonated seawater at a concentration of 3.0 mg/l for CT units of 0, 10, 20 and 50. Viable VNN was detected by cell culture using striped snakehead (SSN-1) cell lines. The positive controls (exposed to 0 CT units) all tested positive for nodavirus, while all but one of 24 egg samples exposed to ozonated seawater tested negative. This indicates that ozone can be successfully used to disinfect haddock eggs against nodavirus at a concentration of 3(±0.3) mg/l TRO as Cl2 for 3.3–6.7 min.
(Department of Fisheries and Oceans, 531 Brandy Cove Road, St. Andrews, NB, Canada E5B 2L9; email of Kevin A.H. Buchan: kevin.buchan@unb.ca kevin.buchan@unb.ca)

COPPER SULFATE TREATMENT DECREASES HATCHERY MORTALITY OF LARVAL WHITE SEABASS ATRACTOSCION NOBILIS

Martin F. Chen, Jaye A. Apperson, Gary D. Marty, Yuk W. Cheng-2006

Aquaculture 254(1-4): 102-114

Abstract:
Culture of white seabass Atractoscion nobilis larvae was repeatedly limited by severe mortality during the first 18 days posthatch (dph). Affected larvae examined by phase-contrast and scanning electron microscopy, and by conventional histopathology had numerous bacteria on the epidermal surface, especially on the primordial fin. The bacteria were associated with microscopic epidermal lesions that progressed to fin fraying and ulceration. No other cause of death was found by histopathology. Bacteria cultured from the skin surface included Vibrio and Psuedomonas spp. White seabass at 12, 15, and 52 dph were given 2 h exposures of 0.1–1.0 mg l− 1 total copper ion to develop a disease treatment for larval and juvenile fish. Production lots of white seabass were experimentally treated with 0.1 mg l− 1 total copper ion as a 1 h static bath between 7 and 16 dph. Although all treatments significantly (P = 0.00) increased survival, a standardized treatment at 10 and 12 dph increased larval survival at 18 dph harvest from under 1% in untreated larvae to 32–66% in treated groups (P < 0.0001). Copper sulfate treatments significantly reduced bacterial colonization of the epidermis (P = 0.00) and treated fish had fewer microscopic lesions (P = 0.00). Fish had no microscopic evidence of toxicity due to treatment at 0.1 mg l− 1. One h bath treatments of 0.1 mg l− 1 copper sulfate increase survival of intensively cultured white seabass larvae.

(Washington Department of Fish and Wildlife, 600 Capitol Way N, Olympia, WA 98501, USA; email of Martin F. Chen: chenmfc@dfw.wa.gov)

AN INHIBITORY SUBSTANCE PRODUCED BY AEROMONAS MEDIA A199, AN AQUATIC PROBIOTIC

M.J. Lategan, W. Booth, R. Shimmon, L.F. Gibson-2006

Aquaculture 254(1-4): 115-124

Abstract:
Whether or not the probiotic activity of the Aeromonas media strain A199 derived from the production of an extracellular inhibitory substance was investigated. Ethyl acetate extraction of broth cultures of A199 and preparative thin layer chromatography methodologies revealed a fraction that contained inhibitory activity against bacterial and fungal indicators. Gas chromatography–mass spectrometry (GC–MS) and nuclear magnetic resonance (NMR) analyses identified indole (2,3 benzopyrrole, henceforth referred to as T1) as the major chemical component in this fraction. The presence of inhibitory activity in broth culture extracts of A199 was found to be entirely dependent on the production of T1 by the organism. The inhibitory activity of T1 in vitro against Edwardsiella tarda, Vibrio anguillarum, Yersinia ruckeri, Aeromonas salmonicida and Lactococcus garvieae was found to be concentration dependent (300–600 μg ml− 1). Antifungal activity (75–300 μg ml− 1) was obtained against the vegetative stage and cysts of Saprolegnia parasitica, with cysts showing a higher susceptibility. Morphological changes observed within hyphae suggested that T1 could be a potential cytoplasmic toxin. Equivalent inhibitory activity was obtained from commercial indole against the majority of indicators, but discrepancies were encountered consistently with failure to inhibit particular bacterial indicators as well as decreased antifungal activity. A comparison of the inhibitory activity of A199 and other indole producers, that included various strains of A. media and Escherichia coli, indicated that the ability of a bacterium to produce indole might not necessarily afford it with inhibitory activities.

(Department of Cell and Molecular Biology, University of Technology Sydney (UTS), Westbourne Street, St Leonards, New South Wales, Australia; email of M.J. Lategan: josielategan@bigpond.com)

ACTIVITY OF BRONOPOL (PYCEZE®) AGAINST BACTERIA CULTURED FROM EGGS OF HALIBUT, HIPPOGLOSSUS HIPPOGLOSSUS AND COD, GADUS MORHUA

T. Harry Birkbeck, Helen I. Reid, Beatrice Darde, Andrew N. Grant-2006

Aquaculture 254(1-4): 125-128

Abstract:
Bronopol (2-bromo-2-nitro-1,3 propanediol) is a broad spectrum bactericide that is the active ingredient of Pyceze®. To assess the potential of Pyceze® for use in marine fish hatcheries we have determined the Minimum Inhibitory Concentration (MIC) of bronopol for 13 bacteria isolated from eggs of halibut (Hippoglossus hippoglossus) and Atlantic cod (Gadus morhua), and Escherichia coli, Staphylococcus aureus and Vibrio anguillarum as control bacteria. Six Vibrio and Moritella spp. had MIC ranging from 1–2 to 8 μg ml− 1 bronopol (mean MIC approximately 3 μg ml− 1), but other bacteria tested (Tenacibacter ovolyticus, Pseudomonas sp., Pseudoalteromonas spp., Colwellia sp., Photobacterium phosphoreum and a Cytophaga/Flexibacter sp.) were more resistant with MIC in the range 8–16 to 32–64 (mean MIC approximately 25 μg ml− 1). E. coli and S. aureus both had MIC of 32 μg ml− 1. Although the MIC of bronopol for T. ovolyticus was 16–32 μg ml− 1, a concentration of 100 μg ml− 1 bronopol had no detectable killing effect on this organism within 1 h but at 200 μg ml− 1 bronopol 90% of T. ovolyticus were killed within 30 min and > 99.99% within 2 h.

(Division of Infection and Immunity, Institute of Biomedical and Life Sciences, Joseph Black Building, University of Glasgow, Glasgow G12 8QQ, Scotland, UK; email of T. Harry Birkbeck: h.birkbeck@bio.gla.ac.uk)

RESPONSES OF COBIA RACHYCENTRON CANADUM LARVAE TO ABRUPT OR GRADUAL CHANGES IN SALINITY

Cynthia K. Faulk, G. Joan Holt-2006

Aquaculture 254(1-4): 275-283

Abstract:
Cobia Rachycentron canadum has recently been recognized as a potential candidate for aquaculture because this species exhibits high growth rates during the larval and juvenile stages. A series of salinity tolerance tests were performed on larval cobia in order to identify the salinity requirements of this species during culture. The effect of spawning salinity on larval tolerance is also discussed. The 18-h survival of cobia larvae 3, 5, 7 and 9 days post-hatch (dph) following abrupt transfer to salinities ranging from 4 to 48 ppt was evaluated using logistic regression. The salinity range within which 90% of the larvae would be expected to survive appeared to be age-dependent and was narrowest at 3 dph (20.1–35.6 ppt) and wider at 7 and 9 dph (7.5–32.8 ppt). The 18-h tolerance of larvae to abrupt changes in salinity was unaltered by spawning salinities of 28.0 and 36.5 ppt. In the second part of the study, rearing salinities were dropped by 5 ppt day− 1 from 32–34 ppt (control) to 5, 10, 15 and/or 20 ppt beginning on 1, 4, 7, 10 or 13 dph. Larval survival from hatching through 10 days following the initial drop in salinity was significantly ($P < 0.05$) lower (< 2%) in the low salinity treatments than the control (12–15%) when the salinity drop was initiated 1 and 4 dph. No significant differences in larval survival were detected between the control (12.5%) and 20 ppt treatment (8.9%) when the salinity drop began on 7 dph but survival in the 10 ppt treatment (3.2%) was significantly lower than the control. When the salinity drop was initiated on 10 dph, no significant differences in survival (10.7–14.7%) were detected among treatments. Finally, no significant differences in survival (9.6–15.4%) were found when the salinity drop was initiated 13 dph and terminated 22 dph. However, when a similar study was extended to 28 dph survival from 13 to 28 dph was significantly lower in the 5 (49.4%) and 10 (72.5%) ppt treatments than the control (96.5%) due to disease. No significant differences in standard length were observed for larvae within each experiment irrespective of rearing salinity. The results of this study indicate that rearing cobia larvae in salinities as low as 15 ppt may be possible beginning 13 dph.

(University of Texas at Austin Marine Science Institute, Fisheries and Mariculture Laboratory, 750 Channel View Drive, Port Aransas, TX 78373, United States; email of Cynthia K. Faulk: cfaulk@utmsi.utexas.edu)

THE REPRODUCTIVE BIOLOGY OF THE MANILA CLAM, RUDITAPES PHILIPPINARUM, FROM THE NORTH-WEST OF IRELAND

Linda Drummond, Maire Mulcahy, Sarah Culloty-2006

Aquaculture 254 (1-4): 326-340

Abstract:
A study of the reproductive cycle of the Manila clam, Ruditapes philippinarum, was undertaken at two sites in the northwest of Ireland from February 2003 to May 2004. Histological evidence showed that gametogenesis began in February and most gametes were ripe by May. Spawning began in May and continued until September. Gametes, which were ripe in October and November, were resorbed. Minimum and maximum condition indices were attained in February 2003 and June 2003, respectively, and decreased from June to September, signifying the spawning period. Vesicular cells were evident in the later gonadal stages in males. From December to March, most individuals were either spent or in a gonadal resting period. One hermaphrodite was observed.

(Department of Zoology, Ecology and Plant Science/Environmental Research Institute, University College Cork, Lee Maltings, Prospect Row, Cork, Ireland; email of Linda Drummond: l.drummond@ucc.ie)

PREDATION OF HATCHERY-REARED SCALLOP SPAT (PECTEN MAXIMUS L.) BY THE BALLAN WRASSE (LABRUS BERGYLTA)—CONSEQUENCES FOR SEA RANCHING

Tore Strohmeier, Guri G. Oppegård, Øivind Strand-2006

Aquaculture 254(1-4): 341-346

Abstract:
Fish predation on scallops has received relatively little attention compared to the primary predators sea stars and crabs. Available knowledge of fish predation is mainly based on observations from scallop beds and fish stomach analysis. These are the first controlled experiments conducted to test if fish (Ballan wrasse, Labrus bergylta) prey upon on hatchery-reared scallop spat. Under laboratory conditions Ballan wrasse from 22 to 40.5 cm in length were offered spat from 15 to 34 mm in shell height at a density of 50–103 individuals m− 2. Predation was recorded in 15 out of 35 tanks. The mean predation frequency for all tanks was 0.10. The mean predation frequency for the 15 predation tanks was 0.17 and the mean size class predation frequency was 0.53 (15–19 mm), 0.16 (20–24 mm), 0.03 (25–29 mm) and 0 (30–34 mm) (n = 15). The mean predation frequency was significantly different between spat of 15–19 and 20–24 mm in shell height. No significant difference in predation frequency was found between larger spat. There was also indication of size-dependent predation from a field experiment, although this experiment was not conclusive. Results from this study indicate that farmers may seed spat larger than 30 mm in shell height for sea ranching with a minor risk of predation from Ballan wrasse.

(Institute of Marine Research, Shellfish Research Group, Nordnes gt. 50, N-5024 Bergen, Norway; email of Tore Strohmeier: tore.strohmeier@imr.no)

QUALITY EVALUATION OF ARTEMIA URMIANA GÜNTHER (URMIA LAKE, IRAN) WITH SPECIAL EMPHASIS ON ITS PARTICULAR CYST CHARACTERISTICS (INTERNATIONAL STUDY ON ARTEMIA LXIX)

Theodore J. Abatzopoulos, Athanasios D. Baxevanis, George V. Triantaphyllidis, Godelieve Criel, Erwin L. Pador, Gilbert Van Stappen, Patrick Sorgeloos-2006

Aquaculture 254(1-4): 442-454

Abstract:
Artemia urmiana cysts were collected from seven sites in Urmia Lake, Iran. Biometrical analysis revealed that the mean values for the untreated cysts ranged from 262.7 to 286.6 μm, decapsulated cysts from 258.6 to 273.9 μm, and the chorion thickness ranged from 1.2 to 9.3 μm. The cyst samples

were tested for their buoyancy at salinities of 35, 50, 100, 150 and 200 g/l. Two cyst batches from Great Salt Lake (Artemia franciscana) were also tested as reference material. It was found that the majority of Urmia cysts (over 60%) sank after 72 h even at the salinity of 200 g/l, while, GSL cysts reached a much lower figure (less than 10%) after the same time period. Transmission electron microscopy studies of the Urmia cyst chorion revealed a thinner alveolar layer and a thicker fibrous layer in comparison with the respective layers of A. franciscana cysts. A. urmiana instar-I nauplii biometry was also performed (total naupliar length: 466.3–505 μm). Six reproductive and four life span characteristics were investigated at salinities of 35, 50, 100, 140 and 180 g/l in order to evaluate A. urmiana performance at different salinities. A. urmiana individuals showed a preference for high salinity, since high mortality was recorded at 35 and 50 g/l. No significant differences were found between the three highest salinities (100, 140 and 180 g/l) tested ($P > 0.05$), with the exception of offspring per brood, reproductive period, and total life span. The analysis of highly unsaturated fatty acid (HUFA) profile of instar-I nauplii hatched from collected cyst batches resulted in low levels of eicosapentaenoic acid (20:5n-3) and high levels of linolenic acid (18:3n-3) ranging from 1.8 to 7.2 and from 32.7 to 54.7 mg/g DW, respectively. Only traces of docosahexaenoic acid (22:6n-3) were found.
(Department of Genetics, Development and Molecular Biology, School of Biology, Faculty of Sciences, Aristotle University of Thessaloniki, 541 24, Thessaloniki, Greece; email of Akis Abatzopoulos: abatzop@bio.auth.gr)

EFFECTS OF VARIOUS ALGAL DIETS AND STARVATION ON LARVAL GROWTH AND SURVIVAL OF MERETRIX MERETRIX
Baojun Tang, Baozhong Liu, Guodong Wang, Tao Zhang, Jianhai Xiang-2006
Aquaculture 254(1-4): 526-533
Abstract:
Effects of food availability on larval growth and survival of Meretrix meretrix were studied in two experiments by feeding the larvae with different algae diets and by starving the larvae for different periods of time. Newly hatched larvae of M. meretrix were fed with five different marine microalgae species, singly and in various mixtures. Best growth was with Isochrysis galbana as a single species diet. Nutritional value of the other single species diets was in the order of Dunaliella sp. > Phaeodactylum tricornutum > Platymonas subcordiformis > Pavlova viridis. Of the mixtures tested, 50% I. galbana / 50% Dunaliella sp., 50% I. galbana / 50% P. tricornutum, and 50% I. galbana / 50% P. subcordiformis, supported growth and metamorphosis equivalent to those of the I. galbana control. At 25 °C, larvae of M. meretrix were deprived of food for various days to study the growth compensation from the outset of development. The results showed that M. meretrix larvae could survive long feeding delays, and even reach metamorphosis without food added, although starvation had significant effects on growth. These results suggested that M. meretrix larvae had the capacity to survive 'starvation' using alternative sources of energy. It also showed that growth, survival and metamorphosis of M. meretrix were affected by many factors besides food quality and quantity.
(Institute of Oceanology, Chinese Academy of Sciences, Qingdao 266071, China; email of Baozhong Liu: bzliu@ms.qdio.ac.cn)

PROTEIN CONTENT AND AMINO ACID COMPOSITION OF THE LIVE FEED ROTIFER (BRACHIONUS PLICATILIS): WITH EMPHASIS ON THE WATER SOLUBLE FRACTION
Ashutosh Srivastava, Kristin Hamre, Joachim Stoss, Rina Chakrabarti, Sigurd K. Tonheim-2006
Aquaculture 254(1-4): 534-543
Abstract:
Rotifers are a commonly used live feed in fish larvae cultures. Two experiments were conducted on the rotifer Brachionus plicatilis to investigate the protein and amino acid composition. Based on the idea that soluble protein is more digestible to fish larvae, special emphasis was put on the rotifer soluble protein fraction. In experiment 1, the nitrogen to protein factor and the amino acid

composition of the rotifer crude fraction and the rotifer water soluble fraction were determined in rotifers fed with yeast, oil and live algae Chlorella (65:25:15 dry weight). The rotifer soluble protein constituted 50.6% of crude protein. The nitrogen to protein factor was different in the crude fraction and in the soluble fraction, 4.46 and 3.52, respectively. The amino acid compositions of the crude and soluble fractions, however, were almost equal, despite of small but statistical significant differences in some amino acids.

In experiment 2, rotifers were grown in five different diet systems: baker's yeast with cod liver oil (3.3:1 dry weight/volume, DYO), baker's yeast with Algamac 2000™ (3.5:1 dry weight, DYA), baker's yeast with live algae Chlorella (4.1:1 dry weight, DYC), Culture Selco 3000™ (DCS); baker's yeast with cod liver oil (10:1, weight/volume) with vitamin supplement and live algae Isochrysis, DCNT. On dry weight basis, total protein content was significantly ($P < 0.05$) lower in rotifers from the DCNT diet system (34.4%) as compared to rotifers from the DYO diet system (41.2%). Rotifers from the other diet systems were intermediate. On wet weight basis, however, total protein content was equal. Differences, thus, probably rely on differences in lipid accumulation rather than in different protein content per individual. The absolute contents of soluble protein in rotifers were almost equal between the different diet systems, however, in terms of percent of crude protein the soluble fractions were more different, ranging from 44.28% in rotifers from the DYC diet system to 52.32% in rotifers from the DCS diet system. The rotifers from experiment 1 contained the largest free amino acid pool (5.4% of dry weight), significantly larger than in all other diet systems. The rotifers from the DCNT diet system contained a significant larger free amino acid pool (3.2% of dry weight) as compared to rotifers from the other four diet systems tested in experiment 2 (2.2–2.4% of dry weight). The amino acid compositions of the free pool and the composition of the total soluble amino acids were similar in rotifers from the different diet systems, although small but statistical significant differences were found for a few amino acids. The size of the free amino acid pool and the soluble protein fraction may have nutritional implications for fish larvae, however, the similarity in amino acid composition between the free amino acid pool and the crude and soluble protein fractions diminishes the importance of separate analysis of the soluble fraction for evaluation of the nutritional quality of rotifers fed to fish larvae.
(National Institute of Nutrition and Sea Food Research (NIFES), Bergen, Norway; email of Kristin Hamre: kristin.hamre@nifes.no)

NUTRITIONAL VALUE OF SIX PAVLOVOPHYCEAE FOR CRASSOSTREA GIGAS AND PECTEN MAXIMUS LARVAE
E. Ponis, I. Probert, B. Véron, J.R. Le Coz, M. Mathieu, R. Robert-2006
Aquaculture 254(1-4): 544-553
Abstract :
Four unidentified new strains of Pavlovophyceae [Pavlova sp. AC 250 (Pfl), Pavlova sp. AC 248 (Psh), Pavlova sp. AC 251 (Pth), Pavlova sp. AC 538 (Psm)] and two known species [Pavlova pinguis (Ppi), Rebecca salina (ex Pavlova salina, Rsa)] were characterized (productivity, size, dry weight, ash, gross composition, fatty acids, sterols) and their nutritional value in bispecific diets were evaluated both on Crassostrea gigas and Pecten maximus larvae. All microalgae exhibited poor food value for C. gigas larvae. P. pinguis and R. salina did not sustain any growth, like the control starved larvae. No exo-toxicity of P. pinguis and R. salina was detected. These two species were weakly ingested by C. gigas larvae, while the four other pavlovophytes were effectively grazed. When used as food for P. maximus larvae, P. pinguis and Psh led to poor development. In contrast, a diet with Pfl resulted in significantly better growth than the control.
(UMR100 IFREMER – Physiologie et Ecophysiologie des Mollusques Marins, Laboratoire de Physiologie des Invertébrés Marins, Station Expérimentale d'Argenton, Presqu'île du Vivier, 29840 Landunvez, France; email of R. Robert :rrobert@ifremer.fr)

EFFECTS OF AGE AND DIETARY PROTEIN LEVEL ON DIGESTIVE ENZYME ACTIVITY AND GENE EXPRESSION OF PELTEOBAGRUS FULVIDRACO LARVAE

Chunfang Wang, Shouqi Xie, Xiaoming Zhu, Wu Lei, Yunxia Yang, Jiankang Liu-2006

Aquaculture 254(1-4): 554-562

Abstract:

The present research studied the effects of age and dietary protein level on pepsin, trypsin and amylase activity and their mRNA level in Pelteobagrus fulvidraco larvae from 3 to 26 days after hatch (DAH). Three DAH larvae were fed three isoenergetic diets, containing 42.8% (CP 43), 47.3% (CP 47) and 52.8% (CP 53) crude protein. Live food (newly hatched Artemia, unenriched) was included as a control. The effects of age on enzyme activity and mRNA were as follows: pepsin and trypsin activity in all treatment groups showed a significant ($P < 0.05$) increase at the beginning and decrease later although the timing of decrease was not the same among treatment groups and between the digestive enzymes. Pepsin and trypsin mRNA level followed the pattern of their respective enzyme changes. Age significantly affected amylase activity ($P < 0.05$) while age had no effect on amylase mRNA during the experimental period. The four diets significantly ($P < 0.05$) affected activity and mRNA level of pepsin and trypsin. Diets did not affect amylase activity or mRNA level. These results suggest that the effects of age on pepsin and trypsin gene expressions are at the transcriptional level. Dietary protein level does affect pepsin and trypsin gene expression in the early life of P. fulvidraco. There were no transcriptional effects on amylase gene expression.

(State Key Laboratory of Freshwater Ecology and Biotechnology, Institute of Hydrobiology, the Chinese Academy of Sciences, Wuhan, Hubei 430072, P.R. China; email of Shouqi Xie: sqxie@ihb.ac.cn)

EFFECT OF COLD STORAGE UPON EGGS OF A CALANOID COPEPOD, ACARTIA TONSA (DANA) AND THEIR OFFSPRING

Guillaume Drillet, Morten H. Iversen, Thomas F. Sørensen, Hans Ramløv, Torben Lund, Benni W. Hansen-2006

Aquaculture 254(1-4): 714-729

Abstract:

For most fish species raised in marine aquaculture, the use of live feeds cannot be replaced by formulated diets. Artemia nauplii and rotifers are still the most commonly used live feeds. A good alternative lies in the use of copepods which could lead to the cultivation of new fish species. Cold stored subitaneous eggs from the continuously cultured calanoid copepod Acartia tonsa were used to investigate the effect of storage upon the viability of the eggs, the development of the copepod community originating from the cold stored eggs. Finally a 3 days snapshot of the egg production of the first generation of females was followed. This was done in order to develop a database usable within copepod dependent hatcheries. The viability of cold stored A. tonsa eggs remained high (> 70% hatching rate) for 11 months of storage. Generally, the period of storage was observed to decrease the viability (hatching rate) of the eggs and no hatching was observed after twenty months of cold storage. Hatched populations of copepods experienced increased mortality rate with longer storage of the eggs from which they originated. This mortality ranged from 0.035 to 0.13 d^{-1} for non-stored (fresh) and 12 months stored eggs, respectively. However, all copepod communities originating from fresh to 12 months stored eggs reached adulthood. Additionally, the egg production from the stored generation was apparently normal and the viability of their eggs was not statistically different when compared to productions from non-stored communities. Contents of total fatty acids decreased during the storage period. Contents of free amino acids were not statistically different for eggs cold stored up to 12 months, but had decreased severely by 20 months. In conclusion, we consider it safe to store the eggs for up to one year at 2–3 °C during which the eggs retain their viability and biochemical composition. Cold storage of calanoid copepod eggs is relevant for aquaculture as inoculum for culturing live food.

(Department of Life Sciences and Chemistry, Roskilde University, Universitetsvej 1, P.O.Box 260, DK-4000 Roskilde, Denmark; email of Benni W. Hansen: bhansen@ruc.dk)

THE EFFECT OF TEMPERATURE ON GONAD, EMBRYONIC DEVELOPMENT AND SURVIVAL RATE OF JUVENILE SEAHORSES, HIPPOCAMPUS KUDA BLEEKER

Qiang Lin, Junyi Lu, Yongli Gao, Li Shen, Jin Cai, Junning Luo-2006

Aquaculture 254(1-4): 701-713

Abstract:

This investigtion examined the effect of varying temperatures on the gonad development and the reproduction efficiency of Hippocampus kuda Bleeker. We demonstrated that gonad development, gonadosomatic index (GSI), female and male fecundity, fertilization rate, hatching rate, and survival rate of juvenile seahorses varied significantly at different temperatures (18, 20, 22, 24, 26, 28, 30 and 32 °C). The periods of gonad development also differed significantly at different temperatures ($F_{7, 32} = 154.065$, $P < 0.01$). The optimal temperature was 28 °C based on the shortest developmental duration to stage V (mean ± standard deviation) (85.2 ± 6.37 days). The GSI peaked at 28 °C (16.60 ± 0.43%) and it displayed significantly higher than those of other seven trials ($P < 0.01$). The relationship between the GSI and the temperatures can be expressed by the following formula: $Y = -1.0737t2 + 8.0768t + 1.013$ ($r2 = 0.9894$, $n = 30$, $P < 0.01$). In contrast, the treatments could not develop successfully at 18 and 20 °C, ending before stage II and stage III, respectively. The range from 26 to 28 °C was suggested as the optimal temperature for fecundity and spawning of H. kuda because of the large number of eggs in the ovaries. The relationship between fecundity number and temperature can also be formulated: $Y = -30.536t2 + 209.24t + 237.8$ ($r2 = 0.886$, $n = 30$, $P < 0.01$). There were dramatic differences for fertilization and hatching rate among different treatments ($F_{5, 24} = 53.675$; $F_{5, 24} = 101.897$, $P < 0.01$). Compared with control seahorses, the results indicated that the condition indices such as the GSI, fecundity, spawning, fertilization, and hatching during the early development could affect in part the survival rate of the newborn juveniles (which was also an indirect effect of temperature). However, there were no marked differences at temperatures from 24 to 28 °C with the similar high survival rate. Based on this, the temperature range from 26 to 28 °C was recommended for gonad development and artificial reproduction of H. kuda.

(Institute of Aquatic Economic Animals and Guangdong Provincial Key Laboratory for Aquatic Economic Animals, Zhongshan (Sun Yat-Sen) University, Guangzhou 510275, The People' s Republic of China; email of Junyi Lu: ls61@zsu.edu.cn)

INGESTION, ASSIMILATION AND UTILIZATION OF RAW SPIRULINA BY LARVAL TILAPIA OREOCHROMIS NILOTICUS DURING LARVAL DEVELOPMENT

Jun Lu, Toshio Takeuchi, Hiroo Satoh-2006

Aquaculture 254(1-4): 686-692

Abstract:

Ingestion, assimilation and utilization of raw Spirulina by larval tilapia of varying sizes were examined to elucidate the effect of Spirulina on larval tilapia at different growing stages during the development. High initial concentration of 14C-labeled Spirulina was offered to larval tilapia from the onset of exogenous feeding to 3.8 cm SL to ensure ad lib feeding during 1 h feeding period. Ingestion efficiency (IE, %), assimilation efficiency (AE, %), utilization efficiency (UE, %), and metabolism efficiency (ME, %) were investigated by monitoring the fate of labeled food. IE increased with the development of larvae. Larval tilapia could ingest 2.6% to 90.0% of the available Spirulina biomass with larvae growing from the onset of exogenous feeding (0.8 cm SL) to 3.8 cm SL, and sharp increments of IE appeared at around 1.2 and 2.8 cm SL. However, the same pattern was not shown in AE and UE. Except for the rapid improvement in early stage larvae (0.8 to 1.2 cm SL), AE and UE did not show any significant increase with development of larvae. ME appeared independent of the larval development. These results demonstrate that ingestion rather than assimilation affected the acceptability of Spirulina in larval tilapia. Larval tilapia could efficiently assimilate and utilize the ingested Spirulina from onset of exogenous feeding. The so-called transition of feeding habit is the feeding strategy of the larval and early stage juvenile tilapia.

(Laboratory of Fish Culture, Faculty of Marine Science, Tokyo University of Marine Science and Technology, (formerly, Tokyo University of Fisheries), Minato, Tokyo 108-8477, Japan; email of Toshio Takeuchi: take@s.kaiyodai.ac.jp)

A DECREASE IN PHOTOPERIOD SHORTLY AFTER FIRST FEEDING INFLUENCES THE DEVELOPMENT OF ATLANTIC SALMON (SALMO SALAR)

I.K. Berrill, A. Smart, M.J.R. Porter, N.R. Bromage-2006
Aquaculture 254(1-4): 625-636

Abstract:
Four groups of Atlantic salmon fry (n = 2000) were exposed to continuous light (LD24 : 0) from first feeding on 18th April 2001, after which they were exposed to either an 8 or 12 week period of short days (LD10 : 14) starting on either the 21st May or the 18th June. Each group was then returned to LD24 : 0 until the conclusion of the experiment the following March. In August 200 fish per treatment were individually PIT tagged. All groups were maintained under an ambient temperature regime.

The highest levels of sexual maturation in 0+ male parr were recorded in the 12 week/May group (> 11% of the entire male and female population), with the lowest levels (< 1%) in the 12 week/June treatment and intermediate levels (> 6%) in the 8 week/May and 8 week/June groups ($P < 0.05$). Between mid August and late October mature parr were heavier than their immature counterparts, but subsequently both cohorts maintained similar sizes. Fish showing signs of silvering were found from mid October onwards. However, it was only in the 12 week/June group that silvered fish had a significantly reduced condition factor and an increased gill Na+, K+-ATPase activity, indicative of smoltification. At the conclusion of the experiment, fish showing signs of silvering were most prevalent (30%) in the 12 week/June group.

It is concluded that the initiation of maturation can be influenced by an 8 or 12 week period of short days (LD10 : 14) applied from mid May or mid June in the first growing season. The duration and timing of a stimulatory short day photoperiod during early development may also influence whether a fish undergoes smoltification in the coming year or whether it delays the parr–smolt transformation for at least a further year.
(aInstitute of Aquaculture, University of Stirling, FK9 4LA, Scotland, UK; email of I.K. Berrill: i.k.berrill@bangor.ac.uk)

NON-INVASIVE ASSESSMENT OF REPRODUCTIVE STATUS AND CYCLE OF SEX STEROID LEVELS IN A CAPTIVE WILD BROODSTOCK OF SENEGALESE SOLE SOLEA SENEGALENSIS (KAUP)

A. García-López, V. Anguis, E. Couto, A.V.M. Canario, J.P. Cañavate, C. Sarasquete, G. Martínez-Rodríguez-2006
Aquaculture 254(1-4): 583-593

Abstract:
Senegalese sole, Solea senegalensis, intensive culture is currently limited mainly due to the low control on reproduction in captivity. Comprehensive knowledge of reproductive biology and physiology for this species is needed in order to improve tank spawning success. This work describes for the first time the seasonal profiles of plasma levels of sex steroids (17β-estradiol, testosterone, 11-ketotestosterone, and 17,20β-dihydroxy-4-pregnen-3-one [17,20β-P]) in a S. senegalensis captive wild broodstock held under natural conditions, during two consecutive reproductive cycles. Changes in apparent maturation in females, dynamics of sperm release in males, and the condition factor (K) were monitored. Six maturation stages were established for females according to apparent size of the ovary and external abdominal swelling: early, intermediate and final ovarian development (F2+, F3+ and F4+, respectively), and partially spawned, mid spawned and spawned out or regressed (F3−, F2−, and

F1−, respectively). During summer, F1− and non-running males (NRM) were predominant in association with low K and plasma steroid levels. At the end of summer, a new cycle of gonadal development started, denoted by the increase in reproductive parameters (K and steroid levels) and the appearance of F2+. By middle autumn, some females reached advanced maturation stages (F3+ and F4+) while the proportion of running males (RM) showed a maximum. An occasional spawning could be registered during this season (November 2002). Towards the end of winter and beginning of spring, ovarian development reached its maximum. At this point, the proportion of F3+, F4+ and RM, K (specially in females), and steroid concentrations were the highest in concordance with the starting of the main spawning period (lasting from January to June 2003 and from March to June 2004). Throughout this period, concomitantly with oocyte and sperm release, the proportion of F3−, F2−, F1− and NRM progressively increased, while steroid levels and K progressively declined (concentration of steroids could fluctuate under a decreasing trend). The relatively elevated levels of 17,20β-P correlating with some parts of the spawning periods makes it a candidate for the role of the maturation-inducing steroid in S. senegalensis. Seasonal variations of measured parameters were consistent with the reproductive cycle of this species in the wild, and comparable to those found in other asynchronous multi-spawning fish.

(Instituto de Ciencias Marinas de Andalucía, Consejo Superior de Investigaciones Científicas (CSIC) Avenida República Saharaui, no. 2, Apartado de correos, 11510, Puerto Real, Cádiz, Spain; email of A. García-López: angel.garcia@icman.csic.es)
