
BIOFILTERS IN WATER TREATMENT SYSTEMS

QUESTION:
From: Ram Kumar ramsshrimp@yahoo.com
To: shrimp@yahoogroups.com
Date: 4 June 2006

I am presently working with P. indicus larval rearing units. I want to know the best water treatment system that could be used in recirculating the larval rearing tank water.

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COMMENTS 1:
For larval rearing I like a bead filter followed by a fine media fluidized bed biofilter. For biosecurity, I would then use ozone to about 500 mv ORP followed by activated carbon.

Dallas Weaver deweaver@surfcity.net
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COMMENTS 2:
I have found recirculating systems for shrimp larval rearing to be quite cost effective and biosecure too. The use of various unit processes such as beads, ozone, foam fractionation, bio-ball filters, activated carbon, settlers etc can be effective, if properly sequenced and sized. You would want to design your system to suit your larval rearing facility/protocols to get the best results.

Anil Ghanekar anilghanekar@yahoo.com

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COMMENTS 3:
Kindly vist web www.cfddm.org. This National Centre has developed one of the best recirculation systems for larval rearing and maturation for P. indicus and P. monodon.

Ranjit Suseelam ranjits55@yahoo.com

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COMMENTS 4:
I assume that you are working in the Middle East, possibly Saudi Arabia or Yemen - If so, try contacting ABT Arabia (www.abtarabia.com) in Jeddah as they have developed a really great membrane filtration system for intake water for hatcheries and various types of very cost effective recirculation systems for maturation and larval rearing units. They will definitely be able to assist you.

Matthew
AquaBioTech Group aqua@aquabt.com

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COMMENTS 5:
I have seen D. Weaver's reply regarding water treatment system. Could you please give me the details of fine media fluidized bed biofilters and its easy installation.

Saleem Haneefa s_haneefa@yahoo.co.in

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COMMENTS 6:

Basically they are an upflow fluidized bed using a very fine sand or glass bead media. The flow rates per sq ft are down around the 5 gpm/ ft^2 range (sorry about the dumb units we use in the USA). Aquaneering Inc. (www.aquaneering.com) manufactured units that I designed for my hatchery and sells them commercially. The trick is in the water distribution system and designing the system for reliability (I have run these filters for over 25 years without a shut down for maintenance -- they are designed to be maintained without shutdown). The fine media units have extremely high surface area per unit volume and the larger size units (2.5 to 3 m deep filters) consistently remove about 90+% of all input biodegradable material, including ammonia, in a single pass through the filter. Aquaneering also makes a higher rate unit that works well on higher strength waste (more manure and ammonia) that are more cost effective for growout system.

I also designed an ultra-fine fluidized bed system that can achieve 99.95% removal of highly refractory chemicals like MTBE (a gasoline additive) in a single pass through the reactor. You don't need that level of performance for aquaculture system, but it shows what can be done.

The installation is easy as long as the system was properly designed. The maintenance is minimal and the only condition that you have to watch out for is overloading the system to the point where the oxygen levels in the discharge water go to zero (under these highly loaded condition, the filter will reduce nitrate to nitrite and nitrogen).There is a much more detailed description of this design and related designs in a recent special edition of Aquacultural Engineering Journal.
Aquacultural EngineeringCopyright © 2006 Elsevier B.V. All rights reserved Volume 34, Issue 3, Pages 141-420 (May 2006) Design and Selection of Biological Filters for Freshwater and Marine Applications Honolulu, Hawaii 08-11 November 2004Edited by C.-S. Lee.

In looking at the economics of hatcheries, when you want to operate with reasonable to high biosecurity or are dealing with SPF type animals, it often costs more to clean up a natural water supplies from either direct intake or well water than it costs to recycle the water and have a very small raw water system with total sterilization and treatment. Recycle system have the advantage of temperature and salinity control.

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COMMENTS 7:
On the subject of biofilters, we have been rearing marine fish at very high densities (over 300 Kg/m3!) for several years in recirculation systems, and are now starting with shrimp (somewhat lower density) so getting the water quality required should not be an issue. However, my question is this - for keeping broodstock I have heard conflicting reports about using closed recirculating systems. Some say it is good as the pheromone levels in the water are kept high and therefore stimulate spawning - others say they are bad for mating / spawning for exactly the same reason.

Mark Rigby, Llyn Aquaculture Ltd. Wales, UK
mark.rigby1@tesco.net

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COMMENTS 8:
Keeping shrimp broodstock in recycle systems has become the standard with most of the hatcheries I know about. With recycle, you have temperature, salinity control along with photoperiod control. Most of the high performance recycle systems that I am familiar with should have lower levels of pheromones than the flow through systems (high performance fine media fluidized bed system can achieve about 90% removal per pass and the systems are usually designed for a higher number of turns per day that most of the flow through systems that are often treated water flow rate limited). Achieving salinity control is often critical in areas that have variable salinity.

I have also discussed situations where the conversion from flow-through to recycle resulted in very significant nauplii production increases. I have always used recycle and my experience with flow-through systems is limited to replacing them.

In the case of broodstock of both fish and shrimp, recycle makes economic sense.

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COMMENTS 9:
I am in total agreement with Dallas' views regarding the merits of recycle systems for broodstock tanks. After nearly two decades of using flow-through for broodstock tanks we can see the difference in broodstock health, feeding, as well as nauplii production using recirculation in the last few years. I would like to know what has been your experience regarding the use of ozone in these systems.

Anil Ghanekar anilghanekar@yahoo.com

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COMMENTS 10:
Regarding ozone in recycle marine systems, the guiding principal must be to do it carefully and with instrumentation. Adding ozone to seawater with normal bromide concentrations (about 65 ppm) can oxidize bromide ions forming hypobromous acid (HOBr). This is very toxic and is used as a disinfectant in swimming pools and cooling towers. If ammonia is present, it will form toxic amine compounds with the hypobromous acid.

I like a little ozone in a slip stream foam fractionator (if you have the money) where the ozone action improves the foaming action and it does remove the color from recycle water, so you don't end up with yellow water and very high COD's in highly recycled systems. In this case, I would use an ORP probe in the inlet and discharge of the system to make sure I am not adding too much. However, this is not a full flow disinfection system.

For disinfection, I will use ozone on the makeup water and do hit it hard with ORP > 500 mv. After storage to get decay of the ozone and some of the hypobromous, I then like a very massive multi-staged activated carbon filtration system to take care of some of the chemicals formed. I am a big supporter of the concept of keeping the bad bugs out of the system and not doing any significant disinfection within a system -- just do more water treatment and have higher quality water with the money saved. The primary thing system disinfection will achieve, if it is 100% effective, is to prevent tank to tank spread of a pathogen on a multi-tank recycle system. My experience indicates that if you have a nasty pathogen get in a system, the whole system should go down before it spreads to other systems via staff and other methods, with the water transfer via recycle only being one of the methods of transfer.

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COMMENTS 11:
I believe one of the main reasons for the success of recirculation in shrimp maturation is the stability of the system. I have worked with flow through for years (mainly because it was the cheapest way to operate) but broodstock really do not like wide fluctuations in temperature and hatch rates with eggs will be disastrous with even minimal variation.
Of course systems can be put in place to regulate temperature and heat the tanks but a well run recirculated system is inherently much more stable.

Christopher Denmark cbdenmark@hotmail.com

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COMMENTS 12:
How about using recirculation system for hatchery phase of shrimp? First problem that comes to mind is waste removal and small size of shrimp.

Jim Chew aeresources@yahoo.com

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COMMENTS 13:
I am in total agreement with Dallas also about the ozone issue. We use a side stream flow of 20 m3/hr through protein skimmer when the total flow is up to 200 m3 / hr around the system (marine fish). No monitoring of ORP though as I found it too unreliable so better without, just use far less ozone than is likely to cause a problem, but still keeps the water in the system nice and clear. Clarity will not be an

overnight phenomenon at low levels of ozonation, but will take a week or so to have a marked effect. On setting this system up we went from about 50 cm visibility to clearly seeing the bottom of the 1.5m tanks with fish at 100 Kg/m3. A good recirculation system should not be sterile at all - but very stable - remember the most stable ecosystems are the very diverse, that goes for biofilters too. Have used recirculation for fish hatcheries for many years and always had better results than flow through. At the flow rates acceptable for small shrimp / fish you are not going to remove hardly any solid waste as most of this will settle on the bottom of the tank. The smallest size you can achieve a self cleaning flow for fish is say 200 - 500 mg depending on species while the shrimp we have now (smaller than this) seem to clean their own tanks! Having not dealt with smaller than PL8 animals I'll leave someone else to comment on smaller sizes.

Mark Rigby
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COMMENTS 14:
With zoea or mysis in recirculation I have found that 300 plus animals per liter with continuous feeding gives good results. Good aeration takes care of settling as well as strainer blockages.

Anil Ghanekar anilghanekar@yahoo.com

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COMMENTS 15:
With Fenneropenaeus indicus, we found recirculation through a biofilter beneficial. The improvement may be due more to improved stability in water conditions than pheromone levels. From my reading on this topic, the balance is strongly in favour of recirculation. In fact, if not recirculated, the incoming water still needs to be treated to the same effect. Of course pH needs to be managed and ammonia much lower than for production ponds.

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EFFECT OF EXTENDER COMPOSITION AND FREEZING RATE ON POST-THAW MOTILITY AND FERTILITY OF ARCTIC CHAR, SALVELINUS ALPINUS (L.), SPERMATOZOA
Nabil Mansour, Gavin F. Richardson, Mary A McNiven-2006
Aquaculture Research 37 (9): 862-868
Abstract:
The effects of extender composition and freezing rate on motility and fertility of frozen-thawed Arctic char, Salvelinus alpinus, spermatozoa were investigated. Three freezing rates, two semen diluents and three cryoprotectants were tested. Semen frozen in 0.3 mol L1 glucose diluent with 10% methanol as a cryoprotectant or in a diluent described by Lahnsteiner with 10% N,N-dimethylacetamide (DMA) resulted in the highest sperm motility. Fertility was the highest for semen frozen in a glucose–methanol extender but was not significantly different than that for semen frozen in Lahnsteiner's diluent with 10% DMA. Dimethyl sulphoxide (DMSO) at 10% was a relatively ineffective cryoprotectant with either semen diluent. Semen frozen at 6 cm above the surface of liquid nitrogen resulted in a higher post-thaw sperm motility and fertility than semen frozen at 5 cm. The addition of 7% fresh egg yolk to glucose diluent containing methanol or DMSO did not improve the fertility of frozen-thawed spermatozoa. However, the addition of 7% fresh egg yolk to glucose–DMA extender significantly improved the fertilization percentages of frozen-thawed spermatozoa. In conclusion, dilution of semen 1:3 in 0.3 mol L1 glucose with 10% methanol and freezing 6 cm above the surface

of liquid nitrogen (freezing rate of 40±8°C min1, mean±SD from −5 to −55°C) is a promising protocol for cryopreservation of Arctic char semen.
(Department of Health Management, Atlantic Veterinary College, University of Prince Edward Island, Charlottetown, PEI, Canada; email of G. Richardson:

SEASONAL SHIFT IN SPAWNING OF ATLANTIC COD (GADUS MORHUA L.) BY PHOTOPERIOD MANIPULATION: EGG QUALITY IN RELATION TO TEMPERATURE AND INTENSIVE LARVAL REARING
Terje van der Meeren, Vladimir P Ivannikov-2006
Aquaculture Research 37 (9): 898-913
Abstract:
Commercial intensive fry production of Atlantic cod will be dependent on production of viable eggs independent of season. This can only be done by manipulation of maturation by photoperiod, but little is known about potential effects on egg characteristics and larval viability. In two cod broodstocks, maturation was successfully advanced or delayed 6 months compared with normal spawning season (March–April) by manipulation of photoperiod. The advanced broodstock spawned both in spring and autumn the same year. In two of the spawning tanks during autumn, ambient temperature was reduced after reaching 13.7°C during the first half of the spawning period. Egg quality and viability were monitored, and several egg batches were incubated, hatched and start-fed for examination of growth and survival. Temperatures above 9.6°C resulted in significant reductions in fertilization and normal egg development. Concurrently, fractions of dead and unfertilized eggs increased with elevated temperature. Actual relative fecundity was not affected by temperature. Egg characteristics improved when temperature was controlled and lowered below 9.6°C. Occurrence of irregular spawners suggests that handling of broodstock fish should be avoided during maturation and spawning. Cod larvae originating from eggs of the advanced or delayed broodstocks were successfully reared beyond metamorphosis. Survival was 9.0–46.6% and 29.3% in green and clear water respectively. Survival correlated with both initial and average feeding conditions, but growth rate did not correlate with either of survival and feeding conditions. Specific growth rates (8.3–13.6% day1) is comparable with other intensive rearing trials with cod, but were lower than reported from nature-like systems.
(Institute of Marine Research, Austevoll, N-5392 Storebø, Norway; email of T van der Meeren : Terje.van.der.Meeren@imr.no)

LIPID COMPOSITION OF RUDITAPES PHILIPPINARUM SPAT: EFFECT OF RATION AND DIET QUALITY
M.J. Fernández-Reiriz, U. Labarta, M. Albentosa, A. Pérez-Camacho-2006 Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology 144 (2): 229-237
Abstract:
This study investigates the influence of the lipid composition of microalgal and commercial flour diets on the lipid classes and fatty acids of Ruditapes philippinarum spat. Aspects of the nutritional role of the diets and the feeding ration are discussed with regard to previously published spat growth data. Our results demonstrated that clams showed the best growth rates when fed with diets that supplied a larger quantity of lipids, further characterised by a high content of phospholipids and triacylglycerols. We observed a significant correlation between the amount of triacylglycerols ($r = 0.929$, $p < 0.05$) and phospholipids ($r = 0.781$, $p < 0.05$) supplied and spat growth. In addition, R. phillipinarum spat reached the highest percentages of triacylglycerols (about 12%) and the lowest percentages of phospholipids (about 60%) and sterols (about 4%) with these growth-promoting diets. Spat fed with the other diets and/or rations showed lower growth rates and significantly lower quantities of triacylglycerols. In the present study, the alternative essentiality of 20:5n − 3 and/or 22:6n − 3 is confirmed. The diminishing supply of 22:6n − 3 without an increase of 20:5n − 3 has an effect on the growth of the spat. The dietary composition of fatty acids influenced the fatty acid profiles in bivalves. The results of our study would suggest that R. philippinarum is incapable of

transforming 18:3n − 3 to 20:5n − 3 and then to 22:6n − 3. Accordingly, although diets contained 18:3n − 3, the spat reflected the low content of 20:5n − 3 of the diets. With respect to 22:6n − 3, given that this fatty acid is present in high quantities in Isochrysis, the spat content of this fatty acid was relative to its content in the diet. This study showed that clams with the lowest growth rates presented an increase in 20:4n − 6. In the spat fed with the microalgal diets, 18:2n − 6 scarcely reached 2% whereas in spat fed with wheat germ 18:2n − 6 amounted to 18% of the total fatty acids. This fatty acid, by means of elongation, transforms to 20:2n − 6, which also appeared in important quantities in the lipids of the spat fed totally or partially by wheat germ. We note that 20:2n − 6 did not originate from the diet since it is absent in the microalgae and the flour. The desaturation of 20:2n − 6 to 20:3n − 6 has not been observed (low levels of 20:3n − 6 in all cases) and therefore it can be assumed that the observed levels of 20:4n − 6 were diet-related.
(Consejo Superior Investigaciones Cientificas, Instituto de Investigaciones Marinas, Vigo, Spain; email of M. J. Fernández-Reiriz: mjreiriz@iim.csic.es)

ARTEMIA AS A POSSIBLE VECTOR FOR MACROBRACHIUM ROSENBERGII NODAVIRUS (MRNV) AND EXTRA SMALL VIRUS TRANSMISSION (XSV) TO MACROBRACHIUM ROSENBERGII POST-LARVAE
R. Sudhakaran, K. Yoganandhan, V. P. Ishaq Ahmed, A. S. Sahul Hameed-2006
Diseases of Aquatic Organisms: 70(3): 161-166
Abstract:
Five developmental stages of Artemia were exposed to Macrobrachium rosenbergii nodavirus (MrNV) and extra small virus (XSV) by immersion and oral routes in order to investigate the possibility of Artemia acting as a reservoir or carrier of these viruses. The second objective was to determine if virus-exposed Artemia were capable of transmitting the disease to post-larvae (PL) of M. rosenbergii. There was no significant difference in percent mortality between Artemia control groups and groups challenged with these viruses. On the other hand, all the developmental stages of Artemia were positive for both viruses by nested RT-PCR, regardless of the challenge route. In horizontal transmission experiments, 100% mortality was observed in M. rosenbergii PL fed with Artemia nauplii exposed to MrNV and XSV by either challenge route. However, no mortality was observed in PL fed with virus-free Artemia. RT-PCR analysis of the M. rosenbergii PL confirmed the presence of MrNV and XSV in the challenge group and absence in the control group.
(Aquaculture Biotechnology Division, Department of Zoology, C. Abdul Hakeem College, Melvisharam-632 509, Vellore Dt., Tamil Nadu, India; email of A. S. Sahul Hameed: cah_sahul@hotmail.com)

SUCCESSFUL FERTILIZATION AND HATCHING OF FOUR EUROPEAN CYPRINID SPECIES USING CRYOPRESERVED SPERM
B. Urbányi, T. Szabó, E. Miskolczi, S. Mihálffy, K. Vranovics, Á. Horváth-2006
Journal of Applied Ichthyology 22(3): 201-204
Summary:
In this study we tried to develop a uniform method of sperm cryopreservation for four cyprinid fish species indigenous to Hungarian waters: the roach (Rutilus rutilus L.), the bream (Abramis brama L.), the silver bream (Blicca bjoerkna L.) and the barbel (Barbus barbus L.). The sperm was frozen in liquid nitrogen vapor in the presence of five extenders (350 mm fructose, 30 mm Tris, pH 8.0; 350 mm glucose, 30 mm Tris, pH 8.0; 300 mm sucrose, 30 mm Tris, pH 8.0; 200 mm KCl, 30 mm Tris, pH 8.0 and modified Kurokura's extender) and two cryoprotectants: 10% methanol (MeOH) and 10% dimethyl-sulfoxide. The highest post-thaw motility (roach: 77 ± 6%, bream: 77 ± 6%, silver bream: 67 ± 5%, barbel: 75 ± 6%), fertilization (roach: 84 ± 4%, bream: 83 ± 2%, silver bream: 63 ± 2%, barbel: 70 ± 4%) and hatching (roach: 74 ± 2%, bream: 67 ± 6%, silver bream: 54 ± 2%, barbel: 61 ± 4%) rates were found when either fructose or glucose extenders were used in combination with MeOH as cryoprotectant for all four investigated species. Strong correlations were found between

post-thaw motility of the sperm and fertilization or hatching rates, which indicates that motility can be used to predict fertilization success in these species.
(Department of Fish Culture, Szent István University, Páter K. u. 1., Gödöllõ, H-2103, Hungary; email of Á. Horváth: horvath.akos@mkk.szie.hu)

WILL PROVIDING A FILAMENTOUS SUBSTRATUM IN THE WATER COLUMN AND SHELL LITTER ON THE BOTTOM INCREASE SETTLEMENT AND POST-LARVAL SURVIVAL OF THE SCALLOP ARGOPECTEN PURPURATUS?
Aldo Pacheco, Wolfgang B. Stotz-2006
Journal of Experimental Marine Biology and Ecology 333(1): 27-39
Abstract:
The marked variability in the natural recruitment of Argopecten purpuratus, a common characteristic for many marine invertebrates with a pelagic larval stages, with important consequences for community functioning, is a problem for the fishery on this species. We ran experiments in the subtidal zone in Tongoy Bay, Chile, to test whether providing a filamentous settlement substratum in the water column and shell litter on the bottom would increase the settlement and post-larval survival of scallops. We placed collectors made of Netlon® 50 cm above the sand and mud bottoms, and three and a half months later there were significantly more scallop spat on the bottom under the collectors (38.5 ind m− 2), than in areas without collectors (0 ind m− 2), or in controls where collectors were installed but a bag around the collector prevented the juveniles from falling to the bottom (4.8 ind m− 2). Also, the addition of either entire or broken scallop shells to the bottom resulted in increased settlement of juveniles on the bottom (33.7 ind m− 2 with entire shells and 48.1 ind m− 2 with broken shells), compared to plots where no shell debris was added (0 ind m− 2). The 2 week survival rate of juveniles (< 3 mm shell height) added to plots covered with entire scallop shells (12.4%) and to plots covered with broken shells (15.1%) was greater than in plots where we did not add shells (3.5%). These results suggest that substrate availability explains spatial variability of recruitment for this species, while temporal variability (between years) is mainly the consequence of larval supply. The manipulation of substrates can locally increase settlement, but will not remove the temporal variability. Whereas our experiments provide useful insights into strategies for managing or establishing local scallop populations, experiments over a longer term and at a large scale are needed to further understand the community functioning in order to develop a strategy for managing this fishery resource.
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PHENOTYPIC AND GENETIC CONSEQUENCES OF SIZE SELECTION AT THE LARVAL STAGE IN THE PACIFIC OYSTER (CRASSOSTREA GIGAS)
Nicolas Taris, Bruno Ernande, Helen McCombie, Pierre Boudry-2006
Journal of Experimental Marine Biology and Ecology 333(1): 147-158
Abstract:
The life histories of oysters in the genus Crassostrea, like those of most marine bivalves, are typified by high fecundity and low survival in nature. Rearing conditions in hatcheries however ensure optimized density, diet, and temperature. Hatcheries are becoming increasingly important for the production of juveniles in aquaculture, and their culture practices often include culling of slow growing larvae to reduce and synchronize the time taken to reach settlement. Because previous studies have found substantial genetic variation for early life developmental traits in Crassostrea gigas, these culling practices are likely to cause highly different selective pressures in hatcheries from those in the natural environment. We studied the phenotypic and genetic impact of such culling practices in a factorial cross between 10 males and 3 females subjected to progressive culling of the smallest 50% of larvae, compared with a non-culled control. Measurements were made on larval growth, survival,

time taken to attain pediveliger stage and settlement success. Culling had a larger effect on the variance of these larval traits than on their means. The larvae in culled cultures were approximately 10% larger than those in controls, whereas the coefficient of variation was reduced by 30–40%. Culling also reduced the mean time to settlement by 12% and its variance by 55%. Using a multiplexed set of microsatellite markers to trace parentage, we also estimated the variance in reproductive success in a controlled experiment to quantify the consequences of intensive hatchery rearing practices. We also focused on changes in effective population size and genetic structure over time (and developmental stages). Our results show a loss of genetic diversity following removal of the smallest larvae by culling, as well as temporally varying genetic structure of the larval population. This supports the existence of genetic variability in early life developmental traits in C. gigas. Culling in hatcheries, like size-related selective pressures in the wild, are likely to have a significant genetic impact, through their effects on the timing of settlement.
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