SHRIMP LARVAE ALGAE CONSUMPTION RATES
From: ecotao@yahoo.com
To: shrimp@yahoogroups.com
Date: 20 July 2006

QUESTION:
Does anybody know or have a publication on how many cells of algae each larval stage would consume? How many algal cells would zoea 1 consume? And so on for each stage Z11, Z11 etc. Perhaps there is a feeding rate as cells per hour?

Laurence

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COMMENTS 1:
The best I can recommend is by Granville Treece and Joe Fox of Texas A&M, a description of their hatchery design at Yayan Dian Desa Hatchery in Jepara, Indonesia. I adhered to most of their recommendations, with great success in my hatcheries. There are a few items to take into consideration however, rather than ascertaining how much a single Zoea is going to eat, rather concentrate on volume of your tanks and maintaining a concentration of cells in that volume. Also, you might be aware that cells of different algae differ in size and you obviously want smaller cells such as isochrysis for your smaller animals. Sounds complicated but its not. Hereunder a suggested regime using the old standards of tetraselmis and chaetoceros (I am of course assuming you are still culturing P. monodon).

N6 - Z1: keep 50,000 cells per ml of Chaeto in your water column
Z1: keep 75,000 cells per ml of Chaeto
Z1 - Z2: keep 100,000 cells per ml of Chaeto and 20,000 cells of Tetra per ml in water column and so on.

You must also feed enriched artemia at Z3-M1 but this is your decision. I used to delay feeding Artemia for fear of disease transmission, I would delay up to M1 or M2.
If you maintain your algal cell level in your water column, you will have little problem in rearing healthy animals. There are of course great artificial feed supplements such as Frippak that I have used, together with egg yolk when we had an algal crash . etc
I think you will find a regular rule of thumb will come to you as you proceed with each new batch, and will become almost clock-work.

Alec Forbes aforbes@mfmr.gov.na

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COMMENTS 2:
There is a desired algae count on every larval stage but it depends on what kind of algae you wish to feed, then just monitor your larval cell count.
Anelyn Jabile anelynjabile@yahoo.com

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COMMENTS 3:
I could read by late 80's a book written by two Russian investigators about energy exchanges for crustaceans (Sorry, can't remember names). One of the chapters was about larvae consumption and

their results indicated a zoea larva could "eat" 50 cells per day. I could read too, that 80% of ingested cells would go out intact from the larvae. This would mean an ingestion of 250 cells/day.
At that time I made the calculation that, working at 100 larvae/l, this would mean a requirement of 25 cells/ml only! No idea anymore what was the larvae nor algae species, but I guess the range must not be that different...
Some time later we could produce starting with only 5000 cells/ml Tetraselmis, just promoting their growth with adequate light above the tank , gave 8000c/ml on next day (Z2) and 12000 at Z3 stage (1 stage a day, 1 day faster than starting with Isochrysis or Chaetoceros); even later we could produce without algae anymore...
Apparently there was be no feed rate per hour, zoea larvae should be "filtering" all the time (I guess they must reduce something when moulting; but just after moult they feed very fast).
Apart from growing in your larval rearing tanks (not too fast as the risk of crash would increase, or you would have to change water to monitor algae) algae species (Iso, Tetra, Chaeto...) or quantity is not that important when compared to growing ones, even more with the artificial feeds you can add. If your algae population grows slowly, there's no need to change the water even until PLs stages. Working with such small quantities of algae allow you, turning thr lamps out at late Z2, to feed the tanks live art, as soon as Z3 (if you wish... ask 2 aquaculturists, you will have 3 different opinions...).
For Artemia, we could not find ryhthms, but you can increase larvae daily consumption by increasing distribution frequency and number of Artemia in the tank.

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COMMENTS 4:
The reason I wanted to work on a consumption rate was to be able to quantify the daily algae requirement for a system such as the Continuous flow algae production unit with horizontal 10 x 2m bags fro Seasalter.

Laurence ecotao@yahoo.com

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COMMENTS 5:
As Alec pointed out in an earlier response, you should be looking at this from the point of view of needing to keep a certain concentration of algae (and other feeds) in the water at all times. The early larval stages (Z1 thru Z3) are filter feeders and they eat continuously. It's basically in one end and out the other, entering as individual particles and coming out in the packaged form of fecal strands. Shrimp larvae are pretty inefficient at digesting and assimilating what passes through their guts, hence if you examine the fecal strands under a microscope, you will often be able to identify what they have been eating, because much of it will look pretty much the way it did going in. In fact, fecal strands are pretty good food, and it's always a remarkable site to see a Zoea doing loop-de-loops while consuming it's own fecal strand. So yes, they do have the ability to capture, hold onto, and consume particles larger than single cells of algae, but still, their primary means of feeding is by filtration.

So for these larvae to feed efficiently, there has to be a certain minimal concentration of particles in the water for them to encounter and consume enough to stay alive. That number hardly changes whether you are stocking at 25 per liter or 250 per liter, each individual larvae still needs to run into the same number of particles of feed in order to stay alive. As points of reference, I usually try to keep a density of about 75,000 cells per ml of Chaetoceros, along with about 5,000-7,500 cells per ml of Thalassiosira, both of which are diatoms. (I'm afraid I have to disagree with Alec about the use of Isochrysis and/or Tetraselmis. Both of these are phytoflagellates and have very little nutritional value to shrimp larvae in comparison to diatoms, though Tetraselmis does have some antibacterial properties.) I also like to keep algae in the tanks all the way up through Mysis-3, if I have algae to spare, but there certainly should still be some in the tanks up through Mysis-2.

Even with a recirculating system, you should be able to get away with minimal water exchange up until Z3, so you can probably avoid the issue of losing your algae as a result of constant flow through. However, if you do find that you want to work with a continuous flow through during the early stages, I would approach the problem based on how much water you are actually exchanging, and how much algae you are taking out of the system.
Then you would simply have to arrange a constant feed system to replace the algae on a continual basis. You could do this by setting up an elevated algae reservoir tank in your larval rearing area, so that you could gravity flow algae into the LRT's through a drip system.

Josh Wilkenfeld josh.wilkenfeld@gmail.com

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COMMENTS 6:
I agree that Tetra and Isoch have poor nutritional value but they are easy to maintain and the larvae do gobble them up. I particularly like them because they are small and easily ingested. As you are well aware from years gone by, my favorite of all is Skeletonema costatum and Chaeto, both of which are Bacillariophyeae, but the Haptophyceae which include Isochrysis sp are also highly recommended.

Josh, you are absolutely spot on, keep a concentration in the water column at all times and you will avoid problems.
Alec Forbes aforbes@mfmr.gov.na

EFFECT OF AERATION ON THE EFFICIENCY OF ARTEMIA ENRICHMENT WITH EFA-RICH EMULSION AND LIPOSOMES
Óscar Monroig, Juan Carlos Navarro, Francisco Amat, Pedro González, Francisco Hontoria-2006
Aquaculture 257(1-4) : 382-392
Abstract:
A commercial emulsion and EFA-rich liposomes have been used as Artemia nauplii enrichment products in a study designed to determine the effect of the aeration on the enrichment efficiency and its importance as a source of variability in the final naupliar fatty acid content. With this purpose, fatty acid profiles of nauplii enriched under uncontrolled aeration conditions were compared to nauplii enriched under different controlled aeration modes. Concretely, both emulsions and liposomes were tested in six enrichment series resulting from the combination of three different airflows and two air diffusion systems. Moreover, the naupliar survival after the enrichment process was estimated since some mortality was previously recorded in liposome enrichments. The results revealed a small effect of aeration on both the EFA incorporation and naupliar survival in the emulsion treatment. However, liposome treated nauplii underwent the influence of the different aeration modes both in terms of EFA incorporation and naupliar survival. In general, the liposome enrichments showed the highest EFA incorporation when the enrichment procedures were carried out at low airflows. Besides, the use of airstones improved the enrichment efficiency at the lowest airflow, whereas this diffusion system produced a decrease of the EFA content in liposome enriched nauplii at the highest airflow. In spite of the unquestionable effect of aeration on the EFA enrichment in liposome enrichments, other

concomitant factors must be acting in the process since variability still occurred even with the control of aeration.
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EFFECTS OF DIETARY OXIDIZED LIPID AND VITAMIN A ON THE EARLY DEVELOPMENT AND ANTIOXIDANT STATUS OF SIBERIAN STURGEON (ACIPENSER BAERI) LARVAE

Stéphanie Fontagné,Didier Bazin, Jeannine Brèque, Christiane Vachot, Cédric Bernarde, Thierry Rouault, Pierre Bergot-2006

Aquaculture 257 (1-4) : 400-411

Abstract:
A 4-week feeding trial was conducted to investigate the effects of dietary oxidized lipid and vitamin A on the early ontogenesis and the antioxidant status of Siberian sturgeon larvae. Auto-oxidized capelin oil (peroxide value = 245 meq/kg) was added at 3 levels: 0, 40 and 80 g/kg in semi-purified casein based diets containing either 22,500 or 772,500 IU/kg vitamin A as retinyl acetate.
Survival and growth were significantly reduced in larvae fed diets containing oxidized lipid with the lowest vitamin A level. A high percentage (25%) of deformed larvae was noted with diets containing 80 g/kg oxidized lipid. These effects were not observed in larvae fed diets with higher vitamin A level indicating an interaction between dietary oxidized lipid and vitamin A. The highest dietary vitamin A level had negative effects in larvae fed fresh lipid and positive effects in larvae fed oxidized lipid, compared to the lowest supply of vitamin A.
Retinyl palmitate was found to be the main storage form of vitamin A with 6.7 μg/g in larvae fed diets with the highest vitamin A level and only 0.05 μg/g in larvae fed diets with the lowest vitamin A level, irrespective of the dietary oxidized lipid level. Retinol contents in larvae were also significantly affected by dietary vitamin A level. Retinoid levels in larval bodies were not modified by dietary oxidized lipid level. Indicators of lipid peroxidation in larvae such as 8-isoprostanes were the highest in larvae fed 80 g oxidized lipid/kg diet as activities of antioxidant enzymes such as superoxide dismutase, catalase and glutathione peroxidase poorly respond to dietary oxidized lipid and vitamin A. An increased oxidative stress in Siberian sturgeon larvae fed oxidized lipid may account for their poor growth and survival and high occurrence of deformed fish. A high dietary supplementation with vitamin A allowed to counteract partially the negative effects of dietary oxidized lipid, suggesting antioxidant properties of dietary vitamin A. However the precise role of dietary vitamin A on negative effects due to oxidized lipid in Siberian sturgeon larvae remains unclear.
(UMR NuAGe, Station d'Hydrobiologie INRA, 64310 Saint Pée-sur-Nivelle, France ; email of Stéphanie Fontagné : fontagne@st-pee.inra.fr)

EFFECT OF DIETARY PROTEIN LEVEL ON SPAWNING AND EGG QUALITY OF REDCLAW CRAYFISH CHERAX QUADRICARINATUS

Hervey Rodríguez-González, Manuel García-Ulloa, Alfredo Hernández-Llamas, Humberto Villarreal-2006

Aquaculture 257 (1-4): 412-419

Abstract:
The effect of dietary protein level on spawning and egg quality was evaluated for female Cherax quadricarinatus. Diets containing four different levels of crude protein were evaluated (22, 27, 32, and 37%). After 100 days, no significant effects of protein level were found on survival (78.6–84.5%), final weight (41.0–43.1g), or fecundity (8.5–9.2 eggs/g female). The percentage of spawning females ranged from 19.7 to 27.3%, and a significant fit, using a quadratic equation estimated maximum spawning to occur at 30% crude protein. Significantly greater egg area (3.90 mm2), volume (39.3 mm3), weight (5.44 μg), and diameter (2.27 mm) were observed at 32% crude protein. There were no significant differences in mean egg protein (2227.1 ± 445.0 μg/egg), lipid (430.9 ± 85.2 μg/egg) and carbohydrate (73.9 ± 10.6 μg/egg) contents, and energy (13.3 ± 2.1 kcal/egg) in relation to dietary

protein level. High statistical power indicated that biochemical composition was not affected by dietary protein level. We conclude that a dietary crude protein content of 32% is recommended for reproduction of female redclaw crayfish.
(Programa de Acuacultura, Centro de Investigaciones Biológicas del Noroeste (CIBNOR), Mar Bermejo 195, Col. Playa Palo Santa Rita, La Paz, B.C.S. 23090, México; email of Humberto Villarreal: humberto04@cibnor.mx)

AN INTEGRATED ASSESSMENT OF GROSS MARINE PROTEIN SOURCES USED IN FORMULATED MICROBOUND DIETS FOR BARRAMUNDI (LATES CALCARIFER) LARVAE

Leo Nankervis, Paul C. Southgate-2006

Aquaculture 257(1-4) : 453-464

Abstract:
A series of three feeding trials was conducted to determine the influence of different marine protein sources on growth, survival and thyroid hormone (T3 and T4) levels in barramundi larvae. Experimental diets including various proportions of fish meal, squid powder, mussel meal and krill meal were assessed in 14-day feeding trials. The suitability and appropriate inclusion levels of these protein sources for microbound diet formulations were assessed in an integrated manner, relating protein quality indices (amino acid profile and digestibility) to larval performance indices (growth, survival and thyroid hormone level) to elucidate mechanisms underlying the nutritional regulation of growth promotion in Lates calcarifer. Larvae fed diets containing a combination of fish meal and squid powder showed greater growth than larvae fed diets containing either mussel meal or krill meal. Larvae fed diets containing a 9:1 ratio of fish meal to squid powder, on a gross protein basis, had a higher final mean dry weight than those fed all other diets except the diet containing an 80:20 ratio of fish meal to squid powder, which had an intermediate value. Fish meal and squid powder were found to have a high nutritional value as protein sources for L. calcarifer larvae, by virtue of a synergistically favourable amino acid profile, moderate to high digestibility and low water solubility. The digestibility of squid powder was found to be significantly higher than that of fish meal, indicating that further development of this diet may benefit from processing techniques to increase fish meal digestibility. Thyroxine (T4) levels were found to relate strongly to growth, but did not relate specifically to any particular dietary composition, indicating that T4 is an appropriate indicator of growth performance in L. calcarifer larvae, though may not directly and quantitatively mediate nutritional growth promotion.
(Hatchery Feeds Research Group, School of Marine Biology and Aquaculture, James Cook University, Townsville, Queensland 4811, Australia; email of Leo Nankervis: Leo.Nankervis@jcu.edu.au)

USE OF MICROBOUND DIETS FOR LARVAL CULTURE OF THE MUD CRAB, SCYLLA SERRATA

May-Helen Holme, Chaoshu Zeng, Paul C. Southgate-2006

Aquaculture 257(1-4) : 482-490

Abstract:
Routine commercial production of mud crab seed is currently restricted by our limited understanding of the nutritional requirements of Scylla spp. as well as problems commonly associated with the live foods used in mud crab hatcheries. This study investigated the use of microbound diet (MBD) particles as a food source for megalopa and zoea III stage larvae of Scylla serrata. In the first experiment, the nutritional value of four MBD containing dried rotifers, Artemia meal, fish meal or squid meal were evaluated for megalopa reared individually in 250-ml aquaria. Survival of MBD-fed megalopa to the first crab stage ranged from 46.7% to 60.0% with those fed MBD containing fish meal or squid meal showing higher survival than those fed MBD containing Artemia meal or dried rotifers. Larvae fed live Artemia showed the highest survival (80%), while unfed megalopa did not survive to the first crab stage. There were no significant differences ($P > 0.05$) in the average time

required for megalopa to reach the first crab stage when fed any of the four MBD. However, shortest development time was recorded for larvae fed live Artemia. In a second experiment, zoea III larvae were cultured communally at a density of 25 larvae l− 1 and were fed either 100% live Artemia nauplii, 100% MBD or a 50%:50% combination of MBD and Artemia. Highest survival (66%) and development rate to the zoea IV stage were recorded for larvae fed the 50%:50% combination of MBD and Artemia. Some successful molts were also found among larvae fed MBD exclusively, while total mortality was observed in unfed (control) replicates. The results indicate that the experimental MBD may contain certain beneficial nutrients lacking in Artemia and that co-feeding the MBD with Artemia may enhance larval survival and development. However, they also show that total replacement of live food with the experimental MBD will result in poor survival of zoea III larvae of S. serrata. The results indicate great potential for the use of MBD particles as dietary components for both zoea and megalopa stages of S. serrata. These findings have important implications for the eventual development of cost-effective and reliable hatchery techniques for mud crabs.
(Tropical Crustacean Aquaculture Research Group, School of Marine Biology and Aquaculture, James Cook University, Townsville, Queensland 4811, Australia ; email of May-Helen Holme: mayhelen.holme@jcu.edu.au)

THE NUTRITIONAL VALUE OF SEVEN SPECIES OF TROPICAL MICROALGAE FOR BLACK-LIP PEARL OYSTER (PINCTADA MARGARITIFERA, L.) LARVAE
Erika Martínez-Fernández, Héctor Acosta-Salmón, Paul C. Southgate-2006
Aquaculture 257(1-4) : 491-503
Abstract:
Recent years have seen major developments in the culture and availability of tropical microalgae as a food source for tropical bivalve species. The nutritional value of seven small (< 9 μm) tropical microalgae species: two diatoms (Chaetoceros muelleri and Chaetoceros sp.); three golden-brown flagellates (Isochrysis sp., Pavlova salina and Pavlova sp.) and two green-flagellates (Micromonas pusilla and an unidentified coccoid CS-126), were analysed for carbohydrate, lipid and protein contents as well as fatty acid composition. Each species of microalgae was fed singly to early (D-stage veliger) and later (umbo stage veliger) stage larvae of the black-lip pearl oyster, Pinctada margaritifera. Highest survival of D-stage larvae over the 10-day experiment was recorded for those fed Pavlova sp. (CS-50). Greatest shell growth was shown by D-stage larvae fed the golden-flagellates Pavlova sp. (CS-50) and Pav. salina. Based on growth of D-stage larvae, the microalgae could be divided into three groups: (1) larvae fed Pav. salina and Pavlova sp. showed significantly greater growth than those fed other microalgae; (2) those fed Isochrysis sp., C. muelleri and M. pusilla showed significantly greater growth than unfed larvae; and (3) larvae fed Chaetoceros sp. and CS-126 did not grow at a rate greater than unfed larvae. Growth of D-stage veliger larvae was significantly correlated with carbohydrate, lipid and protein content of microalgae and with levels of dietary polyunsaturated fatty acid, specifically DHA ($r = 0.829$, $P = 0.021$). In a second experiment survival of umbo-stage larvae (including the unfed control) did not differ significantly between treatments ($P < 0.05$) after 8 days of culture. Larvae fed Pavlova sp. and Pav. salina showed the greatest incremental growth increases, but these were not significantly greater than those of larvae fed TISO and C. muelleri ($P > 0.05$). Growth of umbo-stage larvae fed M. pusilla, Chaetoceros sp. and the Prasinophyta sp. (CS-126) did not differ significantly from that of unfed larvae ($P < 0.05$). This study is the first comprehensive assessment of the nutritional value of tropical microalgae species for pearl oyster larvae. The results provide a basis for development of more effective larval culture techniques by identifying microalgae supporting good growth of P. margaritifera larvae of different ages.
(Pearl Oyster Research Group, School of Marine Biology and Aquaculture, James Cook University, Townsville, Queensland 4811, Australia; email of Erika Martínez-Fernández: Erika.MartinezFernandez@jcu.edu.au)

INDUCTION OF SPAWNING OF CAPTIVE-REARED SENEGAL SOLE (SOLEA SENEGALENSIS) USING DIFFERENT ADMINISTRATION METHODS FOR GONADOTROPIN-RELEASING HORMONE AGONIST

Maria J. Agulleiro, Victoria Anguis, José Pedro Cañavate, Gonzalo Martínez-Rodríguez, Constantinos C. Mylonas, Joan Cerdà-2006

Aquaculture 257 (1-4) : 511-524

Abstract:

Captive-reared Senegal sole were treated with intramuscular injection or sustained-release implants of gonadotropin-releasing hormone agonist [D-Ala6, Pro9, NEt] GnRHa (GnRHa) to induce spermiation and spawning. Fish were treated with GnRHa during spring (April–May) or autumn (October), the natural spawning seasons known to occur in wild Senegal sole. During spring, females injected with a dose of 5 μg GnRHa kg− 1 three times a week, or treated with a single GnRHa-loaded implant (50 μg kg− 1) showed multiple ovulations and spawns within a period of approximately 30 days. Plasma levels of 17β-estradiol (E2) were elevated at 7 days post-treatment, preceding the spawns with the highest fecundity, concomitant with a decrease in the levels of plasma testosterone (T). During autumn, however, females changed their responsiveness to GnRHa treatment, a dose of 5 μg kg− 1 being ineffective in inducing spawning, while a dose of 1 μg kg− 1 induced a few spawns. Accordingly, plasma E2 levels showed a small increase after injection of 1 μg kg− 1 GnRHa. In contrast to females, GnRHa injection or implantation in males was ineffective in enhancing spermiation or milt production, regardless of the season when the treatments were applied. However, GnRHa treatment in males increased plasma levels of T and 11-ketotestosterone (11-KT) during spring, while in autumn the levels of plasma androgens decreased after GnRHa injection. These results show that administration of GnRHa during spring either by injection or sustained-release implants induces multiple spawns in captive Senegal sole, although these treatments were ineffective in inducing or enhancing sperm production in males.

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GROWTH RESPONSE AND HEAT SHOCK PROTEIN (HSP) EXPRESSION IN CHLORELLA VULGARIS EXPOSURE TO ELEVATED TEMPERATURES

S. Zargar, K. Krishnamurthi, S.S. Devi, T.K. Ghosh, T. Chakrabarti-2006

Asian Fisheries Science 19 (1): 69-74

Abstract:

The present paper deals with the impact of various sublethal levels of temperature (26, 31, 33, 36, 39, 42 and 45°C) on growth and heat shock protein (Hsp) expression in freshwater green alga Chlorella vulgaris. Impact of select levels of temperature on growth rate (based on optical density), population count, chlorophyll-a and biomass, of the alga was evaluated in artificial growth medium for a period of 15 days. To determine the induction of Hsp in the alga, it was exposed to select temperature levels for 3 hrs. and further kept for 6 hrs at culturing conditions at 26oC. Induction of Hsp was confirmed by immuno detection followed by SDS-Polyacrylamide gel electrophoresis. The select growth parameters of the alga were reduced drastically at 39, 42 & 45oC. Temperatures below 39°C may be considered as the limit of safe exposure for thermal stress of the alga. The Hsp 70 expression was also observed only at 39°C.

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EVALUATION OF FISH MEALS AS NATURAL FEED STIMULANTS ON THE FEED BEHAVIOR OF FRY AND JUVENILES OF LATES CALCARIFER (BLOCH)

R.K. Singh, A.K. Balange, P.A. Khandagale, S.L. Chavan-2006

Asian Fisheries Science 19 (2): 97-106

Abstract:

Six purified diets were prepared for this experiment. Five of these six diets contained fish meals of five different fishes namely Bombay duck, Anchovy, Lesser sardine, Ribbon fish and shrimp head as natural stimulants for sea bass fry and juveniles. These five diets were prepared by adding 10% of each stimulant by weight in the purified diet. The sixth diet (F) was without stimulant and considered as control. The experiment was conducted on sea bass fry, 20 (+0.02) mm total length and juvenile, 217 (+0.15) mm total length by using one fish and two fish per tank respectively. The results indicated that Bombay duck meal containing diet i.e. diet 'A' has significant stimulating effect on the feeding behaviour of fry and also in juveniles of sea bass although the positive responses were higher in the case of juveniles (30 in case of fry and 34 in case of juveniles). Further, there were 34 positive responses in the case of two juvenile sea bass per tank experiment where as it was 30 in the case of two fry per tank experiment. The feeding responses were significantly different with two fish per tank as compared to one fish per tank showing that the number of fish had an influence on the feeding behaviour of both fry and juveniles. However, no feeding response was observed in the control diet. The study also revealed that Bombay duck meal is better and superior as feeding stimulant over the other fish meals for the Sea bass fry and juveniles.

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PREVALENCE OF HEPATOPANCREATIC PARVOVIRUS (HPV) IN PENAEUS MONODON POSTLARVAE FROM COMMERCIAL SHRIMP HATCHERIES IN TAMILNADU, SOUTHEAST COAST OF INDIA

A. Uma, A. Koteeswaran, I. Karunasagar-2006

Asian Fisheries Science 19 (2): 113-116

Abstract:

The prevalence of hepatopancreatic parvovirus (HPV) in Penaeus monodon postlarvae produced from commercial shrimp hatcheries in Tamilnadu, located along the southeast coast of India was studied during the period July 2002 to July 2003. A total of 1020 hatchery tanks rearing postlarvae were screened by microscopic method and polymerase chain reaction (PCR). Microscopic observation of Giemsa stained smear by rapid method or wet mount observation of squash preparation of hepatopancreas from postlarvae samples from the different tanks revealed a prevalence of 7.74% for HPV and 2.75% for dual infection with HPV and monodon baculovirus (MBV). PCR analysis of samples during the period of study showed a prevalence of 9.3% for HPV and 4.5% for dual infection with HPV and MBV

(Shrimp Disease Diagnosis Laboratory, Vaccine Research Centre – Viral Vaccines, Centre for Animal Health Studies, Tamil Nadu Veterinary and Animal Sciences University, Madhavaram Milk Colony, Chennai – 600 051, India; email of Iddya Karunasagar: mircen@sancharnet.in)

MICROBIAL DIVERSITY WITHIN THE WATER COLUMN OF A LARVAL REARING SYSTEM FOR THE ORNATE ROCK LOBSTER (PANULIRUS ORNATUS)

Matthew S. Payne, Mike R. Hall, Raymond Bannister, Lindsay Sly, David G. Bourne-2006

Aquaculture 258(1-4): 80-90

Abstract:

The ornate tropical rock lobster, Panulirus ornatus has substantial potential as an aquaculture species though disease outbreaks during the animal's extended larval lifecycle are major constraints for success. In order to effectively address such disease-related issues, an improved understanding of the composition and dynamics of the microbial communities in the larval rearing tanks is required. This study used flow cytometry and molecular microbial techniques (clone libraries and denaturing gradient gel electrophoresis (DGGE)) to quantify and characterise the microbial community of the water column in the early stages (developmental stage I–II) of a P. ornatus larval rearing system. DGGE analysis of a 5000 L larval rearing trial demonstrated a dynamic microbial community with distinct changes in the community structure after initial stocking (day 1 to day 2) and from day 4 to

day 5, after which the structure was relatively stable. Flow cytometry analysis of water samples taken over the duration of the trial demonstrated a major increase in bacterial load leading up to and peaking on the first day of the initial larval moult (day 7), before markedly decreasing prior to when > 50% of larvae moulted (day 9). A clone library of a day 10 water sample taken following a mass larval mortality event reflected high microbial diversity confirmed by statistical analysis indices. Sequences retrieved from both clone library and DGGE analyses were dominated by γ- and α-Proteobacteria affiliated organisms with additional sequences affiliated with β- and ε-Proteobacteria, Bacteroidetes, Cytophagales and Chlamydiales groups. Vibrio affiliated species were commonly retrieved in the clone library, though absent from DGGE analysis.
(Australian Institute of Marine Science, Tropical Aquaculture, PMB No 3, Townsville Mail Centre, QLD 4810, Australia; email of M. Payne: m.payne@aims.gov.au)

PATHOGENICITY AND COLONIZATION OF LITOPENAEUS VANNAMEI LARVAE BY LUMINESCENT VIBRIOS
Sonia A. Soto-Rodríguez, Nuno Simoes, Ana Roque, Bruno Gómez Gil-2006
Aquaculture 258(1-4): 109-115
Abstract;
The virulence of the bacterial strains CAIM 333 and CAIM 372 identified as Vibrio campbellii and strain CAIM 79, identified as V. harveyi, were evaluated using bioassays with Litopenaeus vannamei larvae at bacterial densities of 105 CFU ml− 1. There was no difference in virulence observed between the two strains of V. campbellii. The shrimp zoea stages were more susceptible to the CAIM 333 strain. L. vannamei larvae did not show any susceptibility to the bacterial strain CAIM 79. No statistical correlation (P > 0.05) was found between the number of CAIM 333 and CAIM 79 bacteria inoculated and ingested (inside the digestive tract), and no statistical correlation (P > 0.05) was found between number of CAIM 333 bacteria ingested and shrimp larval mortality. The colonization process begins in the oral region, followed by the cephalotorax and then the inside the MGT. A 2 h exposure experiment (Exp-2 h) proved to be better to evaluate the colonization process when compared to a 24 h exposure method.
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USE OF MICROALGAE AND BACTERIA TO ENHANCE PROTECTION OF GNOTOBIOTIC ARTEMIA AGAINST DIFFERENT PATHOGENS
Antonio Marques, Toi Huynh Thanh, Patrick Sorgeloos, Peter Bossier-2006
Aquaculture 258(1-4) : 116-126
Abstract:
The present study investigates the use of microalgae, probiotic and dead bacteria in gnotobiotic Artemia to overcome the virulence of two pathogenic bacterial strains: Vibrio campbellii and Vibrio proteolyticus. For that purpose, two strains of the microalga Dunaliella tertiolecta (a medium- and a good-quality microalga) and two beneficial bacteria, selected from previous well-performing Artemia cultures, were provided to the brine shrimp cultured under gnotobiotic conditions. The daily supplementation with D. tertiolecta conferred full protection to Artemia towards both vibrios and was apparently more efficient and stable than the use of probiotics and dead bacteria. Only when Artemia were cultured in sub-optimal conditions with microalgae (but not when fed ad libitum), the addition of probiotic bacteria was able to partially protect the animals against both pathogens. The contribution of dead bacteria to the protection of Artemia against both pathogens was more pronounced in animals cultured with poor-quality feeds.
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SETTLING ABALONE VELIGER LARVAE IN A FREE-SWIMMING MICROALGAL CULTURE

S.J. Pang, Z.H. Zhang, Y. Bao, S.Q. Gao-2006

Aquaculture 258(1-4): 327-336

Abstract:

In the current abalone hatchery in China, insufficient diatoms on vertically placed corrugated pvc plates at later stage often could not support the growth of postlarvae up to the stage that they can feed on live macroalgae. As a result, stripping the spats (3–5 mm) off by anaesthetization and switching the diet from live diatoms to artificial powdered diet in combination has to be performed in most of the abalone farms. This manipulation normally leads to more than 50% mortality. Here we report the direct use of the unicellular green alga Platymonas helgolandica Kylin var. tsingtaoensis as a potential alga to be used to settle the veliger larvae of the Pacific abalone Haliotis discus hannai and to feed the postlarvae. Settlement rate of 2-day-old veliger larvae in mono culture of P. helgolandica could be as high as 92% (± 4.2%) on day 10 in small scale trials, higher than that in the selected benthic diatom strain (53.6% ± 12.7%) when settled in the water in which bacteria propagation was controlled by treatment of 2 ppm of benzylpenicillinum calcium and streptomycin sulfate. Postlarvae fed solely on P. helgolandica or the selected benthic diatom Navicula-2005-A grew at rates of 40.1 (± 1.9) and 45.8 (± 3.4) μm day− 1, respectively, when raised at 22 °C until day 50 postfertilization. P. helgolandica was shown to have distinct diurnal settling rhythm characterized with a peak of settled cells in the middle of the night for cell division and a peak of free-swimming cells in the middle of the day. High density of attached P. helgolandica cells on the inner surface of the culture facility in the night fits the nocturnal feeding behavior of the abalone spats. Judged by the promising larvae settling rate, growth and survival rates of the postlarvae fed with this alga, the free-swimming micro-green alga P. helgolandica constitutes a potential species for settling the veliger larvae and for supporting the growth of postlarvae as well.

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NECROTIZING HEPATOPANCREATITIS (NHP) INFECTED PENAEUS VANNAMEI FEMALE BROODSTOCK: EFFECT ON REPRODUCTIVE PARAMETERS, NAUPLII AND LARVAE QUALITY

Luis Fernando Aranguren, Boris Briñez, Lácides Aragón, Camilo Platz, Xenia Caraballo, Andres Suarez, Marcela Salazar-2006

Aquaculture 258 (1-4): 337-343

Abstract:

Necrotizing hepatopancreatitis (NHP) is a disease of cultured Penaeus vannamei caused by a gram-negative intracellular bacterium rickettsia-like organism. NHP was first reported in Texas in 1985, as being responsible for mortalities in shrimp ponds in Central and South America. The growth and proliferation of NHP within the hepatopancreatic epithelial cells is associated with anorexia, lethargy, abdominal muscle atrophy, softened exoskeleton, growth retardation and mortalities ranging from 20% to 95%.

Although NHP can cause high mortalities in commercial ponds, it has been considered a problem only in broodstock ponds and maturation laboratories due to an increase in broodstock mortalities in Colombia. In order to evaluate additional negative effects at this level, we investigated the effect of NHP infection upon the reproductive behavior of females and the effect of maternal infection on nauplii and larval quality.

Broodstock from NHP affected ponds were transferred to a maturation laboratory. After copula, females were transferred to individual spawning tanks. After spawning, females were sacrificed for histopathology and PCR analysis, while the eggs were placed in individual tanks for hatching. Females were classified into three groups according to their histopathological findings: NHP negative (n = 23) had no NHP lesions, positive for NHP with lesions grade 1 (n = 20) and NHP positive females with lesions grade 2 (n = 12). For each group, we analyzed the number of eggs, hatching percentage and number of nauplii per female. Our results show that females with NHP lesions grade 2 presented a significant reduction in the number of eggs and nauplii ($P < 0.05$) as compared with NHP

negative females and females grade 1 NHP disease. No significant differences were found in hatching percentage among the three groups.
Triglyceride levels in nauplii II were significantly higher in NHP negative females than in females with grade 2 NHP ($P < 0.05$), whereas there was no difference between NHP negative and grade 1 females. No significant differences were found for glucose and cholesterol levels in nauplii among the three groups.
No differences were found in survival at zoea I, mysis I, PL-1 and PL-10 for the three groups. However, after a salinity stress test, the PL-10 survival decreased significantly in larvae from NHP positive females. Also a significant decrease in PL-10 length was also observed in the progeny of these females (grades 1 and 2).
This study demonstrated that NHP disease in female shrimp spawners affects both maturation and larviculture causing a decrease in the number of eggs and nauplii per female, a reduction in the levels of triglyceride in nauplii II and decreasing larvae growth and resistance to osmotic stress test at PL-10 stage.
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EFFECT OF STOCKING DENSITY ON GROWTH, SETTLEMENT AND SURVIVAL OF CLAM LARVAE, MERETRIX MERETRIX
Baozhong Liu, Bo Dong, Baojun Tang, Tao Zhang, Jianhai Xiang-2006
Aquaculture 258 (1-4): 344-349
Abstract:
To determine the optimal larval density for hatchery culture of the clam Meretrix meretrix, experiments with stocking densities of 5, 10, 20, 40 and 60 larvae ml− 1 were designed, which included the developmental stages from D-veliger to 8 days post-settlement. Shell length, settlement time and survival rate of the larvae were recorded. Results showed that, at each sampling time, larvae reared at the highest density had the smallest mean size, whereas larvae reared at the lowest density had the largest mean size. Statistical differences in mean shell length at different stocking densities appeared from day 2, and greater differences occurred with increased culture time. Specific growth rate (SGR) in the rapid growing stage (day 0–3) was negatively correlated with density; however, no correlation was found between SGR and density in the slow growing stage (days 3–7). Settlement time was prolonged and shell length of settled larvae decreased as density increased. However, larval survival rate (74.8–79.1%) was independent of stocking density. Results showed that a high stocking density, in the designated range, is feasible for larval culture of the clam M. meretrix. However, for large-scale culture, in the interest of costs and safety, a stocking density of 10–20 larvae ml− 1 is recommended.
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FEEDING AND DEVELOPMENT OF SENEGAL SOLE (SOLEA SENEGALENSIS) LARVAE REARED IN DIFFERENT PHOTOPERIODS
J. Pedro Cañavate, Ricardo Zerolo, Catalina Fernández-Díaz-2006
Aquaculture 258 (1-4): 368-377
Abstract:
The effects of 14L:10D and 24L:0D photoperiods on feeding activity and the development of cultured Senegal sole larvae were studied. Pre-metamorphic larvae up to an age of 8 days after hatching (DAH) depended on light to capture rotifers. Nearly 0% and less than 30% of the population had no stomach content after 10 h and 7 h in darkness, respectively. Under the permanent light regime, maximum larval feeding incidence varied with age from 67% ± 4 (3–4 DAH) to 93% ± 4 (7–8 DAH). However, a reduced feeding activity, with less than 24 ± 5% of the larvae between 3 and 8 DAH capturing preys, occurred at morning hours, in spite of lights had been on overnight. Ceasing of feeding during the light phase did not occur in larvae subject to 14L:10D or 10D:14L, photoperiods

that corresponded to opposite times of the day when the dark phase was artificially applied. These results suggest the existence of a circadian feeding rhythm that can also be modified by manipulating light conditions. From 10 DAH onwards, all Solea senegalensis stages, including those metamorphosing from 12 to 20 DAH, were feeding both during light and dark phases.
Food ingestion was not affected by photoperiod ($P > 0.05$) at any age. It increased from first feeding till the commencement of metamorphosis, reaching a stable average ingestion rate of 176 ± 18 μg dry food larva− 1 d− 1 for 11 to 16 DAH larvae. By the end of metamorphosis, ingestion increased to 271 ± 21 μg dry food larvae− 1 d− 1. The daily ration was also unaffected by photoperiod ($P > 0.05$). It was highest between 5 and 12 DAH, when 715 ± 58 μg per mg larval dry biomass was ingested by Senegal sole larvae every day. Daily rations were lower both for 3–4 DAH larvae (515 ± 74 μg mg− 1) and at the initial stages of metamorphosis on days 13–14 (459 ± 31 μg mg− 1), and decreased thereafter to 215 ± 16 μg mg− 1 throughout metamorphosis. Food conversion was similar under all photoperiods ($P > 0.05$), with average ratios of 3.2 for 3 to 10 DAH larvae, and 1.66 for 11 to 20 DAH individuals, respectively. Growth did not change ($P > 0.05$) as a consequence of photoperiod, and an average specific growth rate of 0.118 was found for pelagic stages, whereas it decreased to 0.081 for metamorphic stages. Survival was high in all instances, achieving 74.5% ± 2.9, 81.1% ± 7.8 and 80.0% ± 5.2 for 14L:10D, 10D:14L and 24L:0D photoperiods, respectively. No abnormalities of development were detected in fish exposed to 14L:10D photoperiods. However, 1.8% of the total population reared in permanent illumination exhibited an incomplete eye migration after metamorphosis.
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FEEDING OF EARLY LARVAL PIKE ESOX LUCIUS L. REARED IN ILLUMINATED CAGES
Vida Žiliukienė, Valdemaras Žiliukas-2006
Aquaculture 258(1-4) 378-387
Abstract:
The paper presents the results of investigations on the feeding of pike larvae reared in illuminated cages in a mesotrophic lake over a period of 19 days. The same zooplankton species were found both in the lake and illuminated cages. At night, the biomass of all zooplankton groups was higher in illuminated cages than in the lake (with Copepoda prevailing). The first exogenous food of pike larvae (with 13.1 mm average standard length) was cladocerans (Bosmina, Chydorus) and small copepods (Cyclops). Pike larvae were feeding throughout the whole period of 24 h, with the greatest intensity at night when illumination was switched on. The most popular zooplankton groups among pike larvae were Copepoda (up to 94.7%) with less numerous Cladocera (up to 28.8%) and other organisms (up to 0.9%). The indices of alimentary tracts filling (I) of larvae feeding on zooplankton reached up to 1220.5. With the age of pike larvae, Ivlev's selectivity indices (E) with respect to different food components changed—for Chydorus sphaericus and Bosmina sp. they were decreasing, and for Copepoda increasing. Rotifers usually made an insignificant part of the diet. Pike larvae willingly fed on Chironomus plumosus and roach larvae incidentally found in the cages. Cannibalism among pike larvae started when their standard length (SL) was 16.0–22.3 mm (18.7 mm on average). The size of a prey item constituted up to 90.9% of the predator's standard length. After passing over to predatory feeding, gut-filling indices in pike larvae reached up to 2859.6. Cannibalism occurred even in case of very low (230 ind. m− 3) concentration of pike larvae in cages, which on the 12th day of rearing made 3%; and on the 19th day, 42%. Pike larvae could be reared without additional feeding in illuminated cages up to 2 weeks. Over this period, their mean standard length increased from 13.1 to 20.0 mm. Further rearing of pike larvae does not make any point because their output started to decrease considerably as a result of cannibalism.
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THE INFLUENCE OF ANIMAL DENSITY AND WATER TURBULENCE ON GROWTH AND SURVIVAL OF CULTURED SPINY LOBSTER (JASUS EDWARDSII) LARVAE

Greg G. Smith, Arthur J. Ritar-2006

Aquaculture 258 (1-4): 404-411

Abstract:
The survival and growth of early stage phyllosoma larvae are dependent on establishing suitable larval stocking densities, and controlling the velocity and type of water turbulence within a culture vessel. This study examined the effects of larval density and flow-induced turbulence on growth and survival of Jasus edwardsii phyllosoma in culture. In the first experiment, newly-hatched phyllosoma were stocked at six densities (5–160 larvae l− 1) into 1.6 l plastic beakers with water flow introduced at the container floor (0.5 cm above the beaker bottom and parallel to it) facilitating 2.5 exchanges h− 1 and fed 2.5 mm long Artemia supplied at 1.5 ml− 1. Culture to Stage IV demonstrated that growth and survival were compromised at phyllosoma densities > 40 l− 1. The second experiment examined the influence of flow-induced turbulence, with a combination of two water exchange rates (2.5 or 5 times h− 1), two inlet positions (2 cm above the water surface or 0.5 cm above the beaker bottom and parallel to it), and at two phyllosoma densities (10 and 40 l− 1). Larvae were significantly larger at the low density but only at the slower flow rate, while survival was highest at the low density with water introduced 2 cm from the water surface. These conditions allowed larvae to capture sufficient Artemia prey without the stresses associated with uncontrolled swimming. We recommend that larvae be cultured up to Stage IV at densities no higher than 40 l− 1, under conditions of low turbulence, thus preventing excessive clumping of larvae, while maximising predator–prey ratios.

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ENHANCEMENT OF LARVAL SETTLEMENT AND METAMORPHOSIS THROUGH BIOLOGICAL AND CHEMICAL CUES IN THE ABALONE HALIOTIS DIVERSICOLOR SUPERTEXTA

Haifang Li, Wei Lin, Guang Zhang, Zhonghua Cai, Guopin Cai, Yaqing Chang, Kezhi Xing-2006

Aquaculture 258 (1-4): 416-423

Abstract:
Chemical and biological cues associated with substrata in the environment were considered to be the primary stimuli initiating larval settlement and metamorphosis in many marine mollusks. In present study, various settlement and metamorphosis inducers at both the laboratory and scale-up experiments were investigated to determine their effects in inducing settlement and metamorphosis on the abalone Haliotis diversicolor supertexta. In lab experiment, results showed that both bacteria and diatoms colonized on the substrata could greatly enhance the larval settlement and metamorphosis, and larval settlement and metamorphosis could be induced by exposure to natural seawater supplemented with potassium chloride (KCl), γ-aminobutyric acid (GABA) or KCl combined with GABA. Treatments supplemented with 5 mM KCl, 10 mM KCl, 10− 6 M GABA or some combinations can significantly enhance both the settlement and metamorphosis rates. And lower settlement and metamorphosis were induced by higher concentration up to 20 mM KCl or 5 × 10− 6 M GABA, which indicated that high concentrations of KCl or GABA were toxic to abalone larvae. The combination of KCl and GABA did not appear positive synergy effects than that of single supplementation. Time course experiment demonstrated that supplementing time was critical to the stimulatory effects on larval settlement and metamorphosis. In scale-up experiment, larval metamorphosis rates at 10 days after fertilization were significantly promoted by exposure to KCl or GABA at low concentration level. The inducement effects were similar to the results at laboratory scale experiment. The results imply that these inducers could be applied on the production of abalone hatchery industry.

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SPAT COLLECTION, GROWTH AND MEAT YIELD OF PINNA BICOLOR (GMELIN) IN SUSPENDED CULTURE IN NORTHERN AUSTRALIA

Andrew C. Beer, Paul C. Southgate-2006

Aquaculture 258(1-4): 424-429

Abstract:
Five species within the Family Pinnidae were collected on spat collectors at Pioneer Bay, Orpheus Island, north Queensland, Australia. Pinna bicolor represented > 99% of recruits. Approximately 950 P. bicolor spat recruited to collectors during 12 months of study beginning in late summer (March) with recruitment showing a distinct pulse during March/April with mean (± S.E.) recruitment of 72 ± 7 spat per collector. There was no significant difference between the intensity of recruitment at depths of 2 and 6 m ($P < 0.05$). P. bicolor spat grew rapidly following removal from spat collectors and had a mean hinge length (HL) of over 150 mm after 1 year in suspended culture. Gonad development was evident within 12 months and a reduced growth rate at this time may be attributable to reproductive activity. After 80 weeks, mean (± S.E.) HL was 176.5 ± 3.9 mm with a mean (± S.E.) whole wet weight of 114.3 ± 17.5 g. Tissue wet weight was 27.5 ± 0.5% of whole wet weight and the wet weight of the posterior adductor muscle was 3.5 ± 0.1% of whole wet weight and 12.8 ± 0.3% of tissue wet weight.

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Aquaculture
Volume 258, Issues 1-4 , 31 August 2006, Pages 470-478

Cross effects of the strain of dietary Saccharomyces cerevisiae and rearing conditions on the onset of intestinal microbiota and digestive enzymes in rainbow trout, Onchorhynchus mykiss, fry

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Abstract
Two strains of Saccharomyces cerevisiae were tested as probiotics for rainbow trout fry, during the first month of feeding. Each strain was introduced into separate diets, at the rate of 106 CFU g− 1 and their effects were compared with those of a control diet. Two rearing conditions were simultaneously compared, to test the adaptability of the probiotic treatment. From start feeding onwards, the water supply came from either spring or river, resulting in two different temperature ranges, 11–11.5 and 7–8 °C respectively. Growth and development were optimal in spring water, while some delay was observed with colder river water. A slight but significant increase in mortality was also observed in the river group. In all groups, the counts of bacteria associated with trout intestine were maximum 10 days post start feeding (dpsf; 107 CFU g− 1). The counts of probiotic yeast were also maximum at 10 dpsf (104–105 CFU g− 1), but the decrease was slower in river than in spring water. An autochthonous yeast, Debaryomyces hansenii, was also retrieved associated to the intestine of the control group in high numbers after 240 degree days of experiment (104–105 CFU g− 1), while the

colonization level was significantly less in trout fed the probiotic diets. The effect of the dietary yeast was observed by assaying the activity of three enzymes in the brush border membrane of the enterocytes: alkaline phosphatase (AP), γ-glutamyl-transpeptidase (GGT), and leucine-amino-peptidase N (LAP). At 10 and 20 dpsf, the trout reared in spring water had higher activities of the three enzymes when they were fed the strain S. cerevisiae var. boulardii, suggesting an earlier maturation of the digestive system in this group, compared with trout fed either the other strain of S. cerevisiae or the control diet. The effect was not observed in trout reared in river water with slower growth. Both S. boulardii and D. hansenii seemed to stimulate digestive maturation in fish, but the natural colonization by D. hansenii was likely too late for trout reared at optimal temperature. The supplementation of trout starter diet with S. boulardii may be particularly useful in fast growing conditions.

Keywords: Start feeding; Larval development; Gut maturation; Brush border membrane; Yeast; Debaryomyces hansenii
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Aquaculture
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Effects of photoperiod and feeding frequency on performance of newly weaned Australian snapper Pagrus auratus

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Abstract
An experiment was done to investigate the interactive effects of photoperiod (12L:12D or 18L:6D) and feeding frequency on the growth of newly weaned Australian snapper (mean weight = 0.14 g fish− 1). Feeding frequency was investigated over 4 levels with 2 feeds delivered during the first half of the daylight period (2FE), 2 feeds during the latter half of the daylight period (2FL), 4 (4F) or 8 (8F) evenly spaced feeds per daylight period. Each treatment combination was replicated in 6 tanks and each tank was stocked with a biomass of 15 g tank− 1 (i.e. approximately 108 fish tank− 1). Snapper were fed a constant ration of 10% BW day− 1 for 32 days, which was adjusted during the experiment according to frequent weight check procedures. Fish that died were counted but not replaced.

Photoperiod, feeding frequency and the interaction of these factors significantly affected the individual harvest weight and thermal growth coefficient (TGC) of snapper. Interactions were driven by an increase in the magnitude of individual weight and TGC in snapper fed the 4F and 8F treatments and reared under the 18L:6D photoperiod, compared to snapper fed at the same frequencies but reared under the 12L:12D regime. Weight gain and TGC were best in snapper reared under a 18L:6D photoperiod regime and fed 8 feeds day− 1, however, weight gain did not plateau, suggesting further increases in weight gain may be possible if feeding frequencies greater then 8F are employed. Survival and apparent feed conversion ratio (AFCR) were significantly affected by feeding frequency

alone, with significant improvements in snapper fed more frequently and in snapper fed twice daily but later in the same photoperiod (2FE < 2FL < 4F < 8F). Size heterogeneity (measured by the coefficient of variation for individual harvest weight, CVhw) was affected by photoperiod, and decreased significantly in snapper reared under the 18L:6D regime. Size heterogeneity was also affected by feeding frequency, however, only the CVhw for snapper reared under the 8F feeding frequency was significantly lower than snapper fed at other rates (i.e. 2FE = 2FL = 4F < 8F).

Snapper fed later in a photoperiod regime generally performed better than snapper fed earlier. Results from this study indicate that in order to maximize weight gain, survival and AFCR and to reduce size heterogeneity, newly weaned snapper should be reared under a 18L:6D photoperiod and, for fish fed 10% BW day− 1, fed 8 times day− 1.

Keywords: Weight gain; Survival; Feeding frequency; Photoperiod; Size heterogeneity
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INDUCTION OF POPULATION GROWTH, MICTIC FEMALE PRODUCTION AND BODY SIZE BY TREATMENT OF A SYNTHETIC GNRH ANALOGUE IN THE FRESHWATER ROTIFER, BRACHIONUS CALYCIFLORUS PALLAS

V. Sugumar, N. Munuswamy-2006,
Aquaculture 258(1-4): 529-534
Abstract:
Enriched commercial and artificial diets are unsuitable for the post larval stages of various commercially important crustacea and fish, which require live foods (such as rotifers, brine shrimp or fairy shrimp). The larger size of the brine shrimp and fairy shrimp make them unsuitable for larval fish and shrimp requiring small zooplanktons such as rotifers, as their initial diet. This study was designed to develop a reliable technique for inducing population growth, mictic female production and body size in the freshwater rotifer, Brachionus calyciflorus by treatment with the synthetic hormone Ovaprim. Ovaprim is a synthetic GnRH analogue with domperidone. Concentrations of Ovaprim from 0.05, 0.5, 5 and 50 μl ml− 1 were added to Chlorella vulgaris suspension (2 × 106 cells ml− 1).
Population growth significantly increased in treatments exposed to 0.05 and 0.5 μl ml− 1 while higher mortality was observed at the concentrations of 50 and 5 μl ml− 1. Ovaprim had no effect on mictic female production and hence also on the resting egg production. Lorica length increased to 19.47 and 19.16 μm in rotifers treated with 0.5 and 0.05 μl ml− 1 hormone concentrations and decrease in lorica length was observed at 50 and 5 μl ml− 1 concentrations (13.44 and 15.17 μm). Increase in the lorica width (13.41 μm) was observed on treatment with 0.5 μl ml− 1 concentration of Ovaprim when compared to the control. The results of the experiment suggest that Ovaprim treatment at 0.5 μl ml− 1 concentration have significant modulatory effects on the population growth, mictic female production and body size of B. calyciflorus.
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EFFECT OF SALINITY ON REPRODUCTION AND SURVIVAL OF THE COPEPOD PSEUDODIAPTOMUS ANNANDALEI SEWELL, 1919

Qingxiang Chen, Junqing Sheng, Qiang Lin, Yongli Gao, Junyi Lv-2006
Aquaculture 258(1-4): 575-582
Abstract:
The effect of salinity on reproduction, lifespan and survival rate, and the tolerance range on salinity shock of Pseudodiaptomus annandalei Sewell, was studied under controlled laboratory conditions. All individuals were fed with Platymonas subcordiformis. The total number of offspring was the most at 15 ppt, secondly was at 10 ppt among seven salinity levels during 10 days. The naupliar survival rate was the highest (98.33%) at 15 ppt when the nauplii were reared until some became adults at four

salinity levels (5, 10, 15, 20 ppt respectively). The highest total reproduction (334 ± 171.6 nauplii female− 1 (mean ± S.D.)) and mean daily offspring (22 ± 6.4 nauplii female− 1 day− 1 (mean ± S.D.)) were achieved at 15 ppt over a period of life. The optimum salinity was 15 ppt for the fecundity and the naupliar survival rate, and the appropriate salinity range was 5–20 ppt. The salinity tolerance of female P. annandalei was better than the male through comparison of their survival rate at several salinity shocks and the tolerance range of female and male were 4.5–40.5 ppt and 12.9–38.7 ppt respectively during 48 h.

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SHORT COMMUNICATION

PROTEIN SPARING EFFECT OF CARBOHYDRATES IN THE DIET OF CIRRHINUS MRIGALA (HAMILTON, 1822) FRY

Ravendra Kumar Singh, Amjad K. Balange, Manoj M. Ghughuskar-2006

Aquaculture 258 (1-4): 680-684

Abstract:

A series of experiments were conducted to ascertain the protein sparing effect of dietary carbohydrate in diets of Cirrhinus mrigala fry by using nine iso-energetic test diets. C. mrigala fry (0.751 ± 0.01 g) were fed with the diets containing three levels of crude protein (40%, 35%, 30%) and three levels (30%, 35%, 40%) of different carbohydrate sources (glucose, sucrose, dextrin) for 60 days. Highest weight gain was recorded in the fry fed with 40% dextrin as a source of dietary carbohydrate and 30% crude protein level. FCR (1.28 ± 0.45), specific growth rate (2.20 ± 0.1) and protein efficiency ratio (2.60 ± 0.25) were significantly ($P < 0.05$) improved with the decrease in protein content from 40% to 30% and with the increase in dextrin from 30% to 40%. Poor growth was recorded in the fry fed with glucose-containing diets as a source of carbohydrate while intermediate growth was observed when fed with sucrose-containing diet. The analysis of body composition of C. mrigala fry indicated significant differences ($P < 0.05$) in various test diets. It can be concluded that the diet containing 40% dextrin with 30% protein level achieved the highest growth by sparing of protein in C. mrigala fry.

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