

## INFORMATION OF INTEREST

- EU aquaculture production [statistics](#) 2007
- [PROMICROBE](#) *Microbes as positive actors for more sustainable aquaculture*
- FitFish - Workshop on the Swimming Physiology of Fish, Barcelona-Spain, July 2-3, 2010. The objective is to gain integral knowledge on swimming of fish for farming a fitter fish and setting direction for policy and future studies. Website <http://www.ub.edu/fitfish2010>
- Streptococcus symposium [proceedings](#) (presented at the WAS Veracruz meeting) are now available at the Aqua-Intervet website
- [www.fishnewseu.com](http://www.fishnewseu.com) is providing an impartial daily news service for the fisheries, aquaculture and fish processing sectors in Scotland, UK and beyond.
- Integrating cage fish farming system in reservoirs, ponds and temporary water bodies in Eastern Africa: [Book of Abstracts](#) of conference in September 2009 in Machakos, Kenya
- New book: Fisheries, Sustainability and Development: 52 authors on coexistence and development of fisheries and aquaculture in developing and developed countries Anonymous – 2009. Fisheries, Sustainability and Development. Royal Swedish Academy of Agriculture and Forestry, Stockholm, 478 pp.  
[Table of contents](#). To order or download see [website](#) – info in English.
- [Content Tables](#) Vol 8, n°4, 2009 – Journal of Ocean University of China
- Egypt has the largest aquaculture industry in Africa, producing 650,000 tons of finfish last year, accounting for four out of every five fish farmed on the continent: see [article](#) in InterPress Service News Agency.
- Clever whales: see [article](#) “Eco-physiological repercussions of dietary arachidonic acid in cell membranes of active tissues of the Gray whale”
- [Book](#): Biology & Artificial Cultivation of Mud Crab *Scylla serrata* (Forskål 1775). Li Shaojing and Wang Guizhong (Editors). College of Oceanography and Environmental Science, Xiamen University, China, 806 pp. (2007) [List of papers](#). Most articles in Chinese with English abstract.

## VLIZ Library Acquisitions no

- [452 November 13, 2009](#)
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TRIACYLGLYCEROL ACCUMULATION AND PROFILING IN THE MODEL DIATOMS THALASSIOSIRA PSEUDONANA AND PHAEODACTYLUM TRICORNUTUM (BACCILARIOPHYCEAE) DURING STARVATION

Eizadora T. Yu, Frank J. Zendejas, Pamela D. Lane, Sara Gaucher, Blake A. Simmons, Todd W. Lane-2009

Journal of Applied Phycology 21(6): 669-681

Abstract:

Although substantial economic barriers exist, marine diatoms such as *Thalassiosira pseudonana* and *Phaeodactylum tricornutum* hold promise as feedstock for biodiesel because of their ability to manufacture and store triacylglycerols (TAGs). The recent sequencing of these two marine diatom genomes by the United States Department of Energy Joint Genome Institute and the development of improved systems for genetic manipulation should allow a more systematic approach to understanding and maximizing TAG production. However, in order to best utilize these genomes and genetic tools, we must first gain a deeper understanding of the nutrient-mediated regulation of TAG anabolism. By determining both the yield and molecular species distribution of TAGs we will, in the future, be able to

fully characterize the effects of genetic manipulation. Here, we lay the groundwork for understanding TAG production in *T. pseudonana* and *P. tricornutum*, as a function of nitrate and silicate depletion. Diatoms were starved of either nitrate or silicate, and TAGs were extracted with hexane from lyophilized samples taken at various time intervals following starvation. The timing of TAG production and the relative abundance of TAGs were estimated by fluorescence spectroscopy using Nile red and the total yield per biomass determined by gravimetric assay. TAGs were analyzed using thin layer chromatography, gas chromatography–mass spectrometry, and electrospray ionization mass spectrometry to identify the major TAG species produced during the growth curve. Under our conditions, the TAG yield from *T. pseudonana* is about 14–18% of total dry weight. The TAG yield from *P. tricornutum* is about 14% of total dry weight. Silicate-starved *T. pseudonana* accumulated an average of 24% more TAGs than those starved for nitrate; however, the chemotypes of the TAGs produced were generally similar regardless of the starvation condition employed.

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#### A NOVEL METHOD USING CFD TO OPTIMIZE THE INNER STRUCTURE PARAMETERS OF FLAT PHOTOBIOREACTORS

Gang Yu, Yuanguang Li, Guomin Shen, Weiliang Wang, Chen Lin, Hongxi Wu, Zhisheng Chen-2009  
*Journal of Applied Phycology* 21(6): 719-727

##### Abstract:

The relationship between growth rates of algae and structure parameters of closed flat-panel photobioreactors was investigated. Ad/Ar (cross-section area of the downcomer/cross-section area of the riser), h0 (clearance from the upper edge of the baffles to the water level), and h1 (clearance from the lower edge of the baffles to the bottom of the reactor) were selected as the inner structure parameters. CFD (Computational Fluid Dynamics) was used to simulate the hydrodynamic parameter (TKE)<sub>d</sub> (turbulence kinetic energy of the downcomers) and the secondary parameters  $\epsilon$  (ratio between  $t_d$  and  $t_c$ ),  $t_c$  (cycle time), and DZ (dead zones), which were deduced from the hydrodynamic parameters mentioned above. The effects of (TKE)<sub>d</sub>,  $\epsilon$ ,  $t_c$ , DZ, and the inner structure parameters on cell growth of *Isochrysis galbana* 3011 were analyzed using data collected in 15-L airlift flat-panel photobioreactors. A model was developed to predict algae cell growth based on these inner structure parameters, thereby providing a new method for photobioreactor optimization. Validity of the model was confirmed by experimental data of *I. galbana* 3011 cultured in 15-L and 300-L photobioreactors, respectively. Finally, the prospect of applying CFD to photobioreactor optimization was discussed.

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#### EVALUATION OF DAIRY–YEAST PREBIOTIC SUPPLEMENTATION IN THE DIET OF JUVENILE GOLDFISH IN THE PRESENCE OR ABSENCE OF PHYTOPLANKTON AND ZOOPLANKTON

L. C. Savolainen, D. M. Gatlin III-2009

*Journal of Aquatic Animal Health* 21: 156-163

##### Abstract:

Prebiotics recently have been shown to increase immune responses and disease resistance in certain fish species; therefore, the current study was conducted to evaluate the commercially available dairy–yeast prebiotic, GroBiotic-A, for use with juvenile goldfish *Carassius auratus*. The study consisted of two 10-week feeding trials in which juvenile goldfish were fed practical diets that were either unsupplemented or supplemented with the dairy–yeast prebiotic at 2% by dry weight. Juvenile fish were sorted by size and stocked into 12 units within each of two culture systems: one indoor system supplied with recirculated well water and one system located outdoors with a continuous flow of pond water to provide a source of phytoplankton and zooplankton. Both diets were fed to fish in six units within each system at the same fixed percentage of body weight twice daily. Culture system (i.e., presence or absence of phytoplankton and zooplankton) was the primary factor influencing ( $P < 0.0001$ ) percent weight gain, feed efficiency, and survival of goldfish during the feeding trials. No dietary effect was

detected, although there was a significant ( $P < 0.05$ ) interaction between culture system and diet, with supplementation of the dairy–yeast prebiotic tending to improve weight gain and feed efficiency of fish in the presence of phytoplankton/zooplankton. During a controlled disease challenge with an intraperitoneally administered dose of *Aeromonas hydrophila* that was equivalent to a predetermined LD50 (dose lethal to 50% of test fish), average survival values ranged between 67% and 83% for fish that previously had access to phytoplankton/zooplankton compared with 17–33% for fish that had no access to phytoplankton/zooplankton. The dairy–yeast prebiotic, however, did not enhance resistance of goldfish to the bacterial pathogen and did not greatly alter microbiota of the anterior or posterior gastrointestinal tract based on denaturing gradient gel electrophoresis analysis. In conclusion, the dairy–yeast prebiotic did not improve feed efficiency in goldfish or resistance to a bacterial pathogen as previously observed in golden shiners *Notemigonus crysoleucas* and hybrid bass (white bass *Morone chrysops* × striped bass *M. saxatilis*).

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#### THE EFFECT OF DIFFERENT KINDS OF ELECTROLYTE AND NON-ELECTROLYTE SOLUTIONS ON THE SURVIVAL RATE AND MORPHOLOGY OF ZEBRAFISH DANIO RERIO EMBRYOS

F. Lahnsteiner-2009

Journal of Fish Biology 75(7): 1542 – 1559

Abstract:

The effect of electrolyte and non-electrolyte solutions on the survival and on the morphology of zebrafish *Danio rerio* embryos was investigated. Embryos in different ontogenetic stages were incubated in electrolyte (NaCl, KCl, MgCl<sub>2</sub> and CaCl<sub>2</sub>) and non-electrolyte solutions [sucrose and polyvinylalcohol (PVA)] of different concentrations for 5 – 15 min. The embryos were hatched to the long-pec stage and the effective concentrations which caused a 50% decrease in embryo development (EC50) were determined. The morphometric changes, which were caused by the test solutions, were measured. Ion channel blockers were used to see if active ion transport played a role for embryo survival. Finally, dechorionated embryos were exposed to the test solutions to get indications about the importance of chorion and perivitelline space. For 12 hours post fertilization (hpf) embryos and a 15 min exposure period, EC50 was highest for MgCl<sub>2</sub> (1.60 mol l<sup>-1</sup>), followed by sucrose (0.73 mol l<sup>-1</sup>), NaCl (0.49 mol l<sup>-1</sup>), KCl (0.44 mol l<sup>-1</sup>), CaCl<sub>2</sub> (0.43 mol l<sup>-1</sup>) and PVA [0.0005 mol l<sup>-1</sup> (2.2%)]. EC50 were lower for early embryonic stages than for advanced stages for all solutions with exception of MgCl<sub>2</sub> and sucrose. At the EC50, MgCl<sub>2</sub> and CaCl<sub>2</sub> solutions did not induce morphometric changes. NaCl and sucrose solutions induced reversible morphometric changes, which were compensated within 10 min. Only the EC50 of KCl and PVA solutions induced permanent morphometric changes, which could not be compensated. Incubation of embryos in electrolyte and non-electrolyte solutions together with ouabain (blocker of Na<sup>+</sup>– K<sup>+</sup> ATPase), HgCl<sub>3</sub> (dose-dependent inhibition of aquaporine channels), verapamil (inhibition of calcium and magnesium uptake) and amiloride (inhibition of sodium uptake) significantly decreased the per cent of embryos developing to the long-pec stage in comparison to the same solutions without blockers. Ouabain and HgCl<sub>3</sub> also induced morphometric changes. For dechorionated embryos the survival rates in water and in the different test solutions were similar to untreated embryos.

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#### EFFECT OF TURBULENCE ON FEEDING INTENSITY AND SURVIVAL OF JAPANESE FLOUNDER PARALICHTHYS OLIVACEUS PELAGIC LARVAE

M. Oshima, Y. Kato, R. Masuda, S. Kimura, Y. Yamashita-2009

Journal of Fish Biology 75(7): 1639 – 1647

Abstract:

Three-day rearing experiments were conducted to study the effect of turbulence on the feeding intensity and survival of pelagic larvae of Japanese flounder *Paralichthys olivaceus*. Four levels of turbulence as

control ( $10-7.2 \text{ m}^2 \text{ s}^{-3}$ ), low ( $10-6.2 \text{ m}^2 \text{ s}^{-3}$ ), mid ( $10-5.6 \text{ m}^2 \text{ s}^{-3}$ ) and high ( $10-5.0 \text{ m}^2 \text{ s}^{-3}$ ) were set by changing the flow rate of water pumped through pipes set on the bottom of the tanks. In B-stage larvae, defined as having buds of elongated dorsal fin rays, the feeding intensity and growth were higher in the low and mid turbulence levels, while survival was highest in the control level. Most of the larvae surviving in the control level, however, were judged to be in a seriously starved condition leading to subsequent high mortality. Because the three-day span of the rearing experiments was thought to be a little shorter than the periods before starvation-induced, high mortality occurs. In contrast, for D-stage larvae, their feeding and growth were optimal in the control and low levels. Feeding was more adversely affected in the high level for D-stage larvae compared with B-stage larvae. This is probably due to the compressed body shape and elongated dorsal fin rays of D-stage larvae, which may be more strongly affected by turbulence and, as a consequence, the larval feeding behaviour such as pursuit and capture of prey organisms becomes less efficient than in lower turbulence. Considering the vertical distribution of B and D-stage larvae in the oceanic water column, the optimum turbulence level range found in the present study corresponded to a wind speed of  $7-10 \text{ m s}^{-1}$ . Therefore, moderate weather conditions of this wind speed range are considered to potentially enhance survival of early larval stages of *P. olivaceus*.

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#### EFFECTS OF WATER FLOW AND DENSITY ON EARLY SURVIVORSHIP AND GROWTH OF THE NORTHERN QUAHOG *MERCENARIA MERCENARIA* L.

Sean P. Powers-2009

Journal of Shellfish Research 28(4):777-783

Abstract:

Clam aquaculturists have suspected low water flow over clam grow-out areas as a principal explanation for decreased growth and yield of bivalves; however, empirical data from field studies to support these observations are rare and in some cases contradictory. I conducted two experiments in Back Sound, NC, to examine the effects of water flow and juvenile density on hard clam survivorship and growth. The first experiment assessed differences in early growth and survivorship of juvenile seed clams under three manipulated water flows (enhanced [ $0-32 \text{ cm sec}^{-1}$ ], reduced [ $0-12 \text{ cm sec}^{-1}$ ], and ambient tidal flows [ $0-22 \text{ cm sec}^{-1}$ ]) and three initial stocking density (250, 500, or 1000  $\text{m}^{-2}$ ) of juvenile clams (shell length [SL] = 9 mm). The second set experiment examined the effects of two different water flow regimes (ambient [ $0-22 \text{ cm sec}^{-1}$ ] and low [ $0-11 \text{ cm sec}^{-1}$ ]), and three stocking densities (250, 500, or 1000  $\text{m}^{-2}$ ) on growth of seed clams (SL = 12 mm) to market size. Unlike the first experiment, in which no effort was made to exclude predators to examine survivorship, the second experiment mimicked aquaculture operations and used bottom netting to cover seed clams. Neither planting density nor flow regime affected growth or survivorship of juvenile seed clams in the first experiment. Overall survivorship was high ( $> 75\%$ ) and clams grew to an average SL of 24 mm during the 4 months of grow-out. In the second experiment, clam growth and, consequently, time to marketable size was affected by water flow; however, differences in clam growth were relatively small ( $< 4 \text{ mm SL}$ ). After 12 mo, 69% of clams were of harvestable size in the ambient flow ( $0-22 \text{ cm sec}^{-1}$ ) compared with 42% in the low flow ( $0-12 \text{ cm sec}^{-1}$ ). Planting density did not affect this relationship; no interaction between planting density and flow regime was evident in either experiment. This result suggests the positive effect of water flow on clam growth increases with individual clam size, but is not density dependent on the square meter scale of our experiments.

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#### UPDATING GEOGRAPHIC DISTRIBUTION OF ARTEMIA URMIANA GÜNTHER, 1890 (BRANCHIOPODA: ANOSTRACA) IN EUROPE: AN INTEGRATED AND INTERDISCIPLINARY APPROACH

Theodore J. Abatzopoulos, Francisco Amat, Athanasios D. Baxevanis, Genuario Belmonte, Francisco Hontoria, Stefania Maniatsi, Salvatore Moscatello, Graziella Mura, Nickolaj V. Shadrin-2009

International Review of Hydrobiology 94(5): 560 – 579

Abstract:

*Artemia urmiana* (a species previously considered endemic of Lake Urmia, NW Iran) has been found in Lake Koyashskoe, a hypersaline lake on the Black Sea coast of the Crimean peninsula (Ukraine). Therefore, this is the first record of *A. urmiana* in Europe which updates its distribution. The species identification was based on an integrated and interdisciplinary approach using discriminant analysis of the morphometric characters, scanning electron microscopy, and molecular profile analysis. The data derived from the above mentioned approaches converge to significant similarity of the population under investigation with *A. urmiana*. The updated geographic distribution of the species, deriving from the present report, asks for additional contribution of other disciplines (e.g., avian dispersal of cysts, history of salt trade) to be finally clarified. At present we suggest that the punctuated geographic distribution of *A. urmiana* is probably linked to its low dispersal capability, and we suppose that its presence in two distant sites could be explained by historical human salt trade between Lake Urmia and the ancient port of Kimmerik, whose remains have been found in the present Lake Koyashskoe.

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EFFECT OF FOOD QUANTITY AND QUALITY ON POPULATION GROWTH RATE AND DIGESTIVE ACTIVITY IN THE EURYHALINE ROTIFER BRACHIONUS PLICATILIS MÜLLER

Martina Strojsová, Koushirou Suga, Atsushi Hagiwara, Jaroslav Vrba-2009

International Review of Hydrobiology 94(6): 706 – 719

Abstract :

We investigated the nutritional effects of both food quantity and quality on *Brachionus plicatilis*. Decomposition of particulate and dissolved organic matter by rotifer digestive enzymes play a crucial role in rotifer nutrition. Among other enzymes, rotifers produce phosphatases, non-specific enzymes that allow for the release of orthophosphate from a variety of organic phosphorus compounds. Phosphatase saturation was measured in *B. plicatilis* homogenates using the spectrofluorimetric method. We examined population growth rate, reproduction and phosphatase activity in the homogenate of rotifers (PARH) fed by nutrient-replete algal food supplied at different quantities. Population growth rate, number of eggs per individual and PARH were affected by food quantity. Growth rate and number of eggs per individual significantly increased in rotifers fed by food supplied at the highest quantity. The highest population growth rate was reached by rotifers fed by nutrient-replete food, while it did not significantly differ between rotifers fed on nitrogen (N)-depleted and phosphorus (P)-depleted food. The number of eggs per individual was more affected by N than P supply. PARH and rotifer RNA content were not influenced by different food quality. The results indicate that *B. plicatilis* is not able to regulate its digestive apparatus in terms of efficiently getting access to essential nutrients when scarce, but do this when nutrient-replete food is available in different quantity.

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THE AMPHIPOD ISCHYROCERUS COMMENSALIS ON THE EGGS OF THE RED KING CRAB PARALITHODES CAMTSCHATICUS: EGG PREDATOR OR SCAVENGER?

Alexander G. Dvoretzky, Vladimir G. Dvoretzky-2010

Aquaculture 298(3-4): 185-189

Abstract:

Several symbionts occur on crab eggs. In most cases these symbionts have been described to be egg predators. One of the most important problems is detecting potential pathogens, diseases and negative associates of species harvested in artificial conditions. In the Barents Sea, the amphipod *Ischyrocerus commensalis* can be found on eggs of its host, the commercially important crab *Paralithodes camtschaticus*. Using a multifactorial experimental design, we studied whether or not the amphipod ingested the eggs of crabs and evaluated factors affecting this process. We found that in laboratory conditions, the amphipods ate  $0.29 \pm 0.04$  (SE) eggs per day (up to 10 eggs during a 10 d period). The

amphipods with body length < 6.9 mm ate no eggs while the feeding rates of the amphipods > 7 mm were similar to each other. There were no differences in the feeding rate of amphipods held at temperatures 2, 4, and 6 °C, but feeding significantly increased at 8 °C, the mean summertime temperature in coastal waters of the Barents Sea. Feeding rates were similar in male and female amphipods. Amphipods preferentially ate dead eggs over intact eggs. Feeding rates did not differ significantly between eggs in early developmental stages (violet and brown eyed eggs) but were lower on eggs in the latter stage (light-brown eyed eggs), which may be due to the differences in the egg diameters. Our experiments indicate that the amphipod *I. commensalis* is primarily a scavenger that attacks dead eggs, supporting other reports in the literature. The differences in egg feeding behavior of amphipods *Ischyrocerus* between the Barents Sea and Pacific Ocean are discussed.

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#### MORPHOLOGICAL FACTORS BEHIND THE EARLY MORTALITY OF CULTURED LARVAE OF THE ASIAN CATFISH, PANGASIANODON HYPOPHthalmus

E. Baras, J. Slembrouck, C. Cochet, D. Caruso, M. Legendre-2010

Aquaculture 298(3-4): 211-219

Abstract:

Cultured larvae of *P. hypophthalmus* often undergo high mortality that is generally attributed to intense but temporary cannibalism. Here, evidence is provided that mortality is largely independent from feeding or aggressiveness, but is a consequence of the developmental pattern of this species. Embryos grow oral teeth but also long (100 µm) sharp oral spines, which overhang from the mouth and prevent its closure at the start of exogenous feeding (60 haf, hours after fertilization). At the start of exogenous feeding, gape height exceeds body depth (18 versus 14% of the fish total length), so larvae can grasp siblings on any body location. The manoeuvrability and possibility of moving backwards are restricted in the absence of pectoral fins, which develop exceptionally late in this species. Hence, encounters between larvae can be deadly, irrespectively of the propensity of fish to feed or show aggressive behaviours, as was verified during experiments with anaesthetised specimens. The temporary nature of the phenomenon is accounted for by the negative allometric growth of jaw length, the positive allometric growth of body depth, and to the fact that oral spines stop growing after the yolk is fully absorbed (95 haf). Altogether, these traits largely account for why deadly clashes occur among young larvae of *P. hypophthalmus*, but are restricted to a few hours (clashes) or days (wounds). Implications for improving the larviculture of this species are discussed.

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#### EFFECTS OF DELAYED METAMORPHOSIS AND DELAYED POST-SETTLEMENT FEEDING ON POST-LARVAL SURVIVAL AND GROWTH OF THE ABALONE HALIOTIS DIVERSICOLOR

Toshihiro Onitsuka, Tomohiko Kawamura, Satoshi Ohashi, Shunsuke Iwanaga, Toyomitsu Horii, Yoshiro Watanabe-2010

Aquaculture 298(3-4): 239-244

Abstract:

To elucidate the effects of delayed metamorphosis and delayed post-settlement feeding on larval competence and post-larval survival and growth in the small abalone *Haliotis diversicolor*, we examined three sets of experiments. First, a pebble coated with crustose coralline algae (CCA) was used to induce competent *H. diversicolor* larvae to metamorphose at 2, 5, 8, 12, or 17 days (Group A) or 2, 6, 10, or 12 days (Group B) after fertilization. To observe spontaneous attachment and metamorphosis, some larvae from Group B were maintained without the addition of a CCA-coated pebble. Rapid metamorphosis was observed in older larvae of both CCA-induced groups; 2 days after the addition of the CCA-coated pebble, 50–75% of the 2-day-old larvae and more than 85% of the 5–12-day-old larvae had metamorphosed. The percentage of spontaneously metamorphosed individuals increased 14 days after fertilization, reaching  $50.6 \pm 16.7\%$  (mean  $\pm$  S.E.) at 18 days. Second, metamorphosed post-larvae that

had experienced larval periods of 5, 8, 11, or 15 days (Group A) or 4, 7, or 10 days (Group B) were reared at 26 °C with or without the benthic diatom *Nitzschia ovalis* as the sole food source. The survival and growth rates of the fed post-larvae in both groups decreased with the length of the larval swimming period; of the post-larvae from larvae of more than 7–11 days old, fewer than 70% still survived 16 days after metamorphosis. Mean growth rates during the 6 days after metamorphosis were lowest for the post-larvae from the larvae with the longest period of swimming. Third, newly settled post-larvae from 2-day-old larvae were reared at 26 °C with delays of 0, 3, 6, 9, or 12 days before first feeding (*N. ovalis*). Feeding delays of longer than 6 days dramatically depressed post-larval survival rates; approximately 1 week after the onset of feeding, more than 65% and fewer than 20% of the larvae subjected to feeding delays of 0–3 days or 6–12 days, respectively, still survived. These results indicate that *H. diversicolor* is more susceptible to the detrimental effects of delayed metamorphosis and delayed post-settlement feeding than are the larger abalone species *Haliotis discus hannai* and *Haliotis iris*. (Ocean Research Institute, The University of Tokyo, 1-15-1 Minamidai, Nakano-ku, Tokyo, 164-8639, Japan; email of Toshihiro Onitsuka: [onitsuka@affrc.go.jp](mailto:onitsuka@affrc.go.jp))

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#### EFFECTS OF DIETARY PROTEIN SOURCE AND PROTEIN-LIPID SOURCE INTERACTION ON CHANNEL CATFISH (*ICTALURUS PUNCTATUS*) EGG BIOCHEMICAL COMPOSITION, EGG PRODUCTION AND QUALITY, AND FRY HATCHING PERCENTAGE AND PERFORMANCE

Todd D. Sink, Rebecca T. Lochmann, Camilo Pohlenz, Alejandro Buentello, Delbert Gatlin III-2010  
*Aquaculture* 298(3-4): 251-259

##### Abstract:

The relative importance of proteins (amino acids) and protein-lipid interactions for reproduction of channel catfish can be assessed qualitatively. We conducted a feeding/spawning trial to determine the effects of protein source and protein-lipid interactions of channel catfish broodstock diets on egg biochemical composition and egg and fry production. A general linear mixed model was used to examine statistical significance ( $\alpha = 0.05$ ) among the diets and to compare the main effects using adjusted marginal means (Bonferroni) in order to examine the significance of the lipid source  $\times$  protein source interaction (contrast statements). All diets contained 36% crude protein and the broodfish were fed on 69 d of the 141-d trial based upon a water temperature dependent schedule. Broodfish fed an all plant protein (PP) diet with 10% fish oil (FO) had lower spawning success (33.3%) than fish fed three diets containing animal protein (58.3%). Fecundity of broodfish fed a control diet containing fish meal (FM), poultry byproduct meal (PBM) and 10% FO ( $6432 \pm 1915$  eggs kg female<sup>-1</sup>), or a diet containing FM-PBM-5% FO and 5% poultry fat (PF); ( $6420 \pm 1930$  eggs kg female<sup>-1</sup>) was greater than fecundity of fish fed the PP-FO diet ( $1072 \pm 371$  eggs kg female<sup>-1</sup>), while fecundity of females fed a diet containing PBM and 10% FO was intermediate ( $4060 \pm 1261$  eggs kg female<sup>-1</sup>). Total egg production was greater for fish fed the FM-PBM-FO-PF diet ( $38\,174.6 \pm 11\,031.8$  eggs-tank<sup>-1</sup>) than fish fed the PP-FO diet ( $6571.0 \pm 2212.1$  eggs-tank<sup>-1</sup>), while fish fed the FM-PBM-FO ( $32\,114.9 \pm 7034.4$  eggs-tank<sup>-1</sup>) or PBM-FO ( $20\,619.3 \pm 6084.1$  eggs-tank<sup>-1</sup>) diets had intermediate total egg production. Broodstock fed the FM-PBM-FO-PF diet produced heavier egg masses than broodstock fed the PBM-FO or PP-FO diets. The number of eggs per spawn was greater from fish fed the control and FM-PBM-FO-PF diets than from fish fed the PP-FO diet. No differences in protein-bound amino acid (AA) or free amino acid (FAA) composition were found among eggs when only dietary protein source (FM-PBM, PBM, or PP) was examined. A significant ( $P < 0.05$ ) dietary protein by lipid source interaction was found among diets when protein and lipid sources (diet) were used to examine FAA composition among eggs. Eggs produced by fish fed the FM-PBM-FO diet contained greater amounts of total FAA, essential isoleucine and leucine, and non-essential glycine, than eggs from fish fed the other diets. Eggs from broodfish fed the control or FM-PBM-FO-PF diets exhibited greater hatching success and total fry production than eggs from broodstock fed the PP-FO diet. A diet can be formulated to improve reproductive efficiency of channel catfish compared to current production diets. Results from the present experiment indicate that such a diet should contain 10% supplemental lipid as menhaden FO or a 1:1 or greater mixture of FO and PF. Also, the diet should contain 35% crude protein from a variety of plant and animal protein sources. Broodstock performance was enhanced when animal

protein sources (two or more preferable) comprised at least 15% of the total diet and menhaden FM comprised at least one third of the animal protein sources.

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DIETARY VITAMIN D3 AFFECTS DIGESTIVE SYSTEM ONTOGENESIS AND OSSIFICATION IN EUROPEAN SEA BASS (*DICENTRARCHUS LABRAX*, LINNAEUS, 1758)

Maria J. Darias, David Mazurais, Giorgos Koumoundouros, Nomiki Glynatsi, Stavroula Christodouloupoulou, Christine Huelvan, Elisabeth Desbruyeres, Marie M. Le Gall, Patrick Quazuguela, Chantal L. Cahu, Jose L. Zambonino-Infante-2010

Aquaculture 298(3-4): 300-307

Abstract:

The influence of dietary vitamin D3 (VD3) on survival, growth and morphogenesis during the larval development of European sea bass (*Dicentrarchus labrax*) was evaluated until 45 days post hatching. Diets contained 4% of the standard vitamin mix (VM) recommended by the National Research Council (NRC) and incorporated 0, 19.2, 38.4, or 140 IU of VD3 per gram of diet to give VD-0, VD-1, VD-2 and VD-3 dietary treatments, respectively. The present study revealed for the first time an impact of dietary VD3 on the sea bass digestive system ontogenesis that consequently conditioned the ossification process and morphogenesis. All dietary VD3 levels were in the “adequate range” based on larval survival. Nevertheless, growth, intestinal maturation and ossification at the end of the larval stage were harmed by the minimum dose of VD3 tested and resulted in the appearance of malformations. VD-2 and VD-3 groups showed satisfactory growth and ossification levels at the end of the larval period. However, results of enzymatic activity and expression of genes involved in the VD3 pathway (bone morphogenetic protein 4, osteocalcin, vitamin D receptors and transient receptor potential cation channel-subfamily V, member 6-) gave evidence of complications during the ossification process as revealed by the high percentage of deformed larvae. A VD3 level of 19.2 IU/g diet appeared necessary to obtain harmonious larval morphogenesis.

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YOLK PROTEIN EXPRESSION IN THE GREEN CRAB, *CARCINUS MAENAS*

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Abstract:

Mature oocytes from adult female green crabs (*Carcinus maenas*) were homogenized and an abundant protein peak (315 kDa) was purified by gel filtration chromatography. The protein peak was resolved into two bands (74 and 106 kDa) on SDS-PAGE. The bands were digested with trypsin and the tryptic peptides were sequenced by liquid chromatography-mass spectroscopy. Two peptides from the 74 kDa band were homologous to regions in other crustacean yolk proteins. Degenerate primers based on these sequences amplified a 545-bp cDNA fragment. The conceptual translation of this fragment showed a close relationship (60% identity and 75% similarity) to vitellogenins (Vgs) found in other crustaceans. Gene-specific primers for Vg showed that its mRNA was present in the ovary and hepatopancreas (HP). Northern blots detected a single 8.6 kb transcript in both tissues. Quantitative real-time PCR indicated that ovarian levels of Vg-mRNA were highest at stage II vitellogenesis, rising 2.4-fold from previtellogenic animals and then dropping over 10-fold in stage III animals. Vg-mRNA levels in the HP rose 60-fold between previtellogenesis and stage I vitellogenesis, remaining elevated through stages II and III. These results indicate that the ovary and the HP are both sites of Vg synthesis in the green crab but the HP appears to be a much more important synthetic site.

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