

**SUMMER MORTALITY OF HATCHERY-PRODUCED PACIFIC OYSTER SPAT (CRASSOSTREA GIGAS). II. RESPONSE TO SELECTION FOR SURVIVAL AND ITS INFLUENCE ON GROWTH AND YIELD**

Lionel Dégremont, Edouard Bédier, Pierre Boudry-2010

Aquaculture 299(1-4): 21-29

**Abstract:**

Response to divergent selection for “high” and “low” survival during the summer period, from July to October, was investigated in juvenile (six-month-old) Pacific oysters, *Crassostrea gigas*, by producing two sets of progenies in 2002 (Generation 2) and three sets of progenies in 2003 (Generation 3). A strict between-family approach was used and resistance of these selected progenies to summer mortality was assessed in three sites along French coasts, to determine their response to selection and estimate realized heritability of the trait. A significant difference in survival was observed between the “high” and “low” selected groups at all sites for all sets of progenies, indicating a significant genetic component. High realized heritabilities for survival obtained from Generation 2 oysters, ranging from  $0.61 \pm 0.08$  to  $0.98 \pm 0.15$ , were in line with previous results from the first generation. Finally, Generation 3 realized heritability, ranging from  $0.55 \pm 0.18$  to  $0.81 \pm 0.13$ , supported results from Generation 2. Our results demonstrate that selective breeding to improve survival during the first summer can be successfully implemented and should lead to rapid gains. Overall, selection on survival did not have any impact on growth, although it did have one on yield.

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**EFFECTS OF STOCKING DENSITY, ALGAL DENSITY, AND TEMPERATURE ON GROWTH AND SURVIVAL OF LARVAE OF THE BASKET COCKLE, CLINOCARDIUM NUTTALLII W.**

Wenshan Liu, H. Gurney-Smith, A. Beerens, C.M. Pearce-2010

Aquaculture 299(1-4): 99-105

**Abstract:**

This study determined optimal rearing conditions – stocking density, algal density, and temperature – for hatchery production of the basket cockle, *Clinocardium nuttallii*, from newly-hatched D-larvae to pediveligers using static rearing systems and discontinuous feeding. The combined effect of initial stocking density (2, 4, and 8 larvae ml<sup>-1</sup>) and algal density (10, 25, and 50 × 10<sup>3</sup> cells ml<sup>-1</sup>) on larval growth and survival was examined using a bi-algal diet of *Chaetoceros muelleri* (CM) and *Isochrysis* sp. (Tahitian strain, TISO). The effect of algal density (0, 2.5, 5, 10, 20, 40, 60, and 80 × 10<sup>3</sup> cells ml<sup>-1</sup>) as a single factor was assessed using a single-algal diet of TISO and a fixed stocking density (2 larvae ml<sup>-1</sup>) held constant throughout the experiment. The effect of temperature (5.9, 10.2, 14.2, 18.2, 21.9, and 26.3 °C) on larval growth and survival was also evaluated. The results showed that, when feeding the bi-algal diet of CM and TISO, an initial stocking density of 2 larvae ml<sup>-1</sup> combined with an algal density of 25 or 50 × 10<sup>3</sup> cells ml<sup>-1</sup> or an initial stocking density of 4 larvae ml<sup>-1</sup> combined with an algal density of 50 × 10<sup>3</sup> cells ml<sup>-1</sup> were optimal conditions for larval growth, and survival rate was significantly better in the treatment with 4 larvae ml<sup>-1</sup>. When feeding the single-algal diet of TISO, optimal larval growth was observed at algal densities of ≥ 40 × 10<sup>3</sup> cells ml<sup>-1</sup>. These optimal rearing conditions translated into minimum food rations of 18.4 and 20 × 10<sup>3</sup> algal cells larva<sup>-1</sup> day<sup>-1</sup> using the bi-algal and single-algal diets, respectively, to support maximum larval growth from newly-hatched D-larvae to pediveligers. Within the tested temperature range of 5.9 to 21.9 °C, larval growth was greater with increasing temperature but survival to settlement stage was not affected by temperature. The larvae failed to survive at the highest tested temperature of 26.3 °C.

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## EFFECTS OF DIETARY LIPID LEVELS ON GROWTH, SURVIVAL AND LIPID METABOLISM DURING EARLY ONTOGENY OF PELTEOBAGRUS VACHELLI LARVAE

Keke Zheng, Xiaoming Zhu, Dong Han, Yunxia Yang, Wu Lei, Shouqi Xie-2010

Aquaculture 299(1-4): 121-127

### Abstract:

A feeding trial was conducted to investigate the effect of dietary lipid level on darkbarbel catfish (*Pelteobagrus vachelli*) larvae during ontogeny with regard to growth, survival and lipid utilization. Larvae were fed, from mouth opening to 20 days after hatching (DAH), with five isonitrogenous microdiets containing different lipid levels (58, 74, 111, 151 and 199 g kg<sup>-1</sup> diet). Live prey (newly hatched *Artemia*, unenriched) was used as the control diet. The activities of lipoprotein lipase (LPL), hepatic lipase (HL), pancreatic lipase (PL) and LPL gene expression at 3 DAH (mouth opening), 6 DAH, 11 DAH and 20 DAH were examined. The results showed that dietary lipid significantly affected survival and growth of darkbarbel catfish larvae. At the end of the feeding trial, larvae fed diets containing 111 to 151 g lipid kg<sup>-1</sup> had significantly higher survival. Specific growth rate (SGR) of larvae fed the diet containing the highest dietary lipid (199 g kg<sup>-1</sup>) was significantly ( $P < 0.05$ ) lower while no significant differences were observed among other groups fed formulated diets. LPL mRNA level generally increased first with increasing dietary lipid levels and then reached a plateau at different sampling ages. A similar pattern was observed for LPL activity only at 6 DAH and 20 DAH. High dietary lipid increased HL activity at 20 DAH. At 6 DAH, highest PL activity was observed at 199 g lipid kg<sup>-1</sup> diet. Higher dietary lipid resulted in earlier elevated activities of LPL, PL and HL. The specific activities of the above three enzymes and LPL mRNA expression were detected at mouth opening and were significantly influenced by age. The activities of these enzymes increased first and then decreased or reached a plateau during development. The results suggest that dietary lipid could modify lipid utilization during ontogeny of darkbarbel catfish larvae.

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## LONG TERM/LOW DOSE FORMALIN EXPOSURE TO SMALL-SCALE RECIRCULATION AQUACULTURE SYSTEMS

Lars-Flemming Pedersen, Per B. Pedersen, Jeppe L. Nielsen, Per H. Nielsen-2010

Aquacultural Engineering 42(1): 1-7

### Abstract:

Repetitive long term formalin application at low dose was investigated to determine the effect on formaldehyde removal rate, biofilter nitrification and the microbial composition in small-scale recirculation aquaculture biofilters. Six pilot-scale recirculation aquaculture systems holding rainbow trout (*Oncorhynchus mykiss*) were designated to formalin treatments (C0 at 10 and 20 mg/L formaldehyde) on a daily or weekly basis. Formaldehyde removal rates were measured over 10 weeks, during which biofilter nitrification rates were measured in terms of standardized NH<sub>4</sub>Cl spiking events. The rates were positively correlated to the amount and frequency of formalin treatment. In systems with regularly low formalin dosage, the formaldehyde removal rate increased up to tenfold from  $0.19 \pm 0.05$  to  $1.81 \pm 0.13$  mg/(L h). Biofilter nitrification was not impaired in systems treated with formalin on a daily basis as compared to untreated systems. In systems intermittently treated with formalin, increased variation and minor reductions of ammonium and nitrite oxidation rates were observed. Nitrifying bacteria were screened by specific gene probes using fluorescence in situ hybridization and quantified by digital image analysis. The relative abundance of ammonia-oxidizing bacteria (AOB) was up to 5.4% of all Bacteria (EUB) positive cells, predominantly *Nitrosomonas oligotropha*. Nitrite-oxidizing bacteria (NOB), mainly consisting of *Nitrospira* sp. were found in all biofilm samples up to 2.9%, whereas *Nitrobacter* sp. was not detected. The relative abundances of AOB and NOB in the untreated system were generally higher compared to the system exposed to formalin. Low dose formalin in recirculated aquaculture systems proved to be a possible treatment strategy, as the effect on nitrification was minimal. Since formaldehyde was steadily removed by microorganisms, available biofilter surface area, hydraulic retention time and temperature can be used to predict removal and hence estimate e.g. effluent concentration.

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## AN EVALUATION OF COMMERCIALY AVAILABLE BIOLOGICAL FILTERS FOR RECIRCULATING AQUACULTURE SYSTEMS

Todd C. Guerdat, Thomas M. Losordo, John J. Classen, Jason A. Osborne, Dennis P. DeLong-2010  
Aquacultural Engineering 42(1): 38-49

### Abstract:

Three different commercially available biological filters were evaluated in triplicate on a 60 m<sup>3</sup> tank-based Tilapia system under commercial warmwater growout conditions. The study was performed at the North Carolina State University Fish Barn—a commercial scale research and demonstration recirculating aquaculture facility operated by the department of Biological and Agricultural Engineering. Total ammoniacal nitrogen (TAN) removal rates were determined for the three types of biofilters for a range of concentrations ranging from 0.13 to 1.20 g TAN m<sup>-3</sup>. TAN concentrations were varied by feed rates and ammonium chloride additions, and limited by fish feeding response. Maximum feed rates were 65 kg feed d<sup>-1</sup> using a 40% protein diet at a maximum biomass of 5500 kg. Average observed TAN removal rates (in g TAN m<sup>-3</sup> of unexpanded media d<sup>-1</sup> ± standard deviation) for the three filters were 267 ± 123, 586 ± 284, and 667 ± 344 for the moving bed bioreactor, floating bead filter, and fluidized sand filter, respectively. These results are considerably lower than results previously published at the laboratory scale using artificial waste nutrients. This study highlights the need for future biofilter evaluations at the commercial scale using real aquaculture waste nutrients.

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## EDITORIAL

### INTRODUCING THE NEW MULTIDISCIPLINARY JOURNAL AQUACULTURE ENVIRONMENT INTERACTIONS

Tim Dempster, Marianne Holmer-2009

Aquaculture production is expected to overtake wild fisheries as the major source of fish protein for humans in the course of this century. This enormous expansion of aquaculture will multiply its interactions with the environment. The journal Aquaculture Environment Interactions (AEI; [www.int-res.com/journals/aei/](http://www.int-res.com/journals/aei/)) will provide an international and interdisciplinary forum for primary research on the ecology of aquaculture. AEI will publish scientific results obtained in this increasingly vital field, foster the sharing of information among scientists, the aquaculture industry and environmental managers, and contribute to improving the long-term sustainability of aquaculture activities. Concept and scope of AEI were defined by an independent group of interested researchers: Tim Dempster, Marianne Holmer, Ioannis Karakassis, Ian Fleming, Pablo Sánchez-Jérez, Bengt Finstad and Kenneth Black, in collaboration with Inter-Research (IR). AEI will publish Research Articles, Notes, Reviews, As I See It articles (opinion pieces), and Comments and Reply Comments (critiques of articles published in the journal), Theme Sections (collections of articles that provide a synthesis of research on key areas; proposals for a Theme Section should be submitted to the Editors-in-Chief). Peer review for manuscripts submitted to AEI is managed using an online system, and 3 to 4 reviews will be solicited for each manuscript. We strive to limit the duration of initial review to 2 months. AEI volumes are 'built' online: articles will appear as soon as their content has been approved by the author(s), usually within 1 month after acceptance. Articles that the Contributing Editors and reviewers identify as groundbreaking will be published as Feature Articles. Initially, all AEI issues are published with Open Access. We are confident that AEI will quickly become a global leader for the publication of primary research on the interactions between aquaculture and the environment.

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DELAY OF THE EGG ACTIVATION PROCESS IN THE BLACK TIGER SHRIMP *PENAEUS MONODON* BY MANIPULATION OF MAGNESIUM LEVELS IN SPAWNING WATER

Pattira Pongtippatee, Roengsak Luppakane, Pinij Thaweethamsewee, Pornpimol Kirirat, Wattana Weerachayanukul, Boonsirm Withyachumnarnkul-2010

Aquaculture Research 41(2): 227 – 232

Abstract:

The aim of this study was to determine whether magnesium ( $Mg^{2+}$ ) in seawater is required for egg activation of the black tiger shrimp *Penaeus monodon* and whether manipulation of  $Mg^{2+}$  levels can be used to delay the process and thereby synchronize egg activation. Female *P. monodon* broodstock were allowed to spawn in artificial seawater containing  $Mg^{2+}$  at varying levels with respect to the normal (100%) level: 100%, 50%, 20% and 0%. Egg activation occurred normally at 100%  $Mg^{2+}$ , incompletely at 50% and 20%  $Mg^{2+}$  levels and did not occur at all with 0%  $Mg^{2+}$ . The fertilization rate with 100%  $Mg^{2+}$  was observed to be 83%, but fertilization failed to take place in all the other groups. The fertilization rate was restored from 0% to 76% following the 20%  $Mg^{2+}$  level treatment when  $Mg^{2+}$  levels returned to normal (100%) as soon as spawning was completed. This study suggests that the level of  $Mg^{2+}$  in seawater plays a vital role in *P. monodon* egg activation, and that commencement of this process could be delayed by manipulation of the  $Mg^{2+}$  level during and immediately after spawning.

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EFFECTS OF TRANSPLANTS AND EXTRACTS OF THORACIC NERVE CORD–GANGLIA ON GONAD MATURATION OF PENAEOID SHRIMP

Jorge Alfaro, Luís Vega-2010

Aquaculture Research 41(2): 182 – 188

Abstract:

It has been established recently that interspecific and intraspecific thoracic ganglia transplants from Penaeidae are gradually absorbed by the host without activating an encapsulation mechanism. Therefore, this research was designed to evaluate the thoracic ganglia extracts and implants from maturing *Trachypenaeus byrdi* (Burkenroad), *Xiphopenaeus riveti* (Bouvier) and *Penaeus* (*Litopenaeus*) *occidentalis* (Streets) females as potential inducers of sexual maturation in *Penaeus* (*Litopenaeus*) *stylirostris* (Stimpson), *Penaeus* (*Litopenaeus*) *vannamei* (Boone) and *T. byrdi*, from the Gulf of Nicoya, Costa Rica. Our findings suggest that interspecific and intraspecific thoracic ganglia extracts or implants from maturing penaeoid females are not capable of inducing a clear response in sexual maturation in males or females. Tissues were tested at increasing doses from 137, 386, 525 and 1500  $\mu\text{g g}^{-1}$  body weight, without any positive response. It is proposed that a hypothetical hormone, vitellogenesis-stimulating hormone, from the thoracic ganglia, is under the strong negative control of eyestalks, by the gonad-inhibiting hormone in the subgenus *Litopenaeus*. Therefore, the use of thoracic ganglia extracts or implants would be ineffective when compared with injecting serotonin alone, as the present results seem to support.

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PRECOCIOUS SEX CHANGE AND SPERMATOGENESIS IN THE UNDERYEARLING MALABAR GROUPER *EPINEPHELUS MALABARICUS* BY ANDROGEN TREATMENT

Ryosuke Murata, Hirofumi Karimata, Mohammad Ashraful Alam, Masaru Nakamura-2010

Aquaculture Research 41(2): 303 – 308

Abstract:

The Malabar grouper *Epinephelus malabaricus* is an important candidate species for commercial aquaculture in tropical and subtropical areas. In nature, this species requires more than 10 years to change sex from female to male and have active spermatogenic tissues in the testis. Thus, it is essential to find a means of producing sperm for seed production. This is the first report of artificial sex change in underyearling *E. malabaricus*. Female *E. malabaricus* with immature ovaries at 144 days post-hatch

(DPH) were fed a diet with 17 $\alpha$ -methyltestosterone (MT) at 50  $\mu\text{g g}^{-1}$  diet for 6 months. Sex change occurred in most of the treated fish, which had testis with all stages of spermatogenic germ cells including spermatozoa. In contrast, most of the control fish had immature ovaries. These results, which reveal that germ cells in the underyearling grouper have the ability to produce spermatozoa in response to exogenous androgen, demonstrate that sex change can be artificially induced during ovarian development.

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#### SHORT COMMUNICATION

#### APPLICATION OF A MICRODIET IN COBIA RACHYCENTRON CANADUM (LINNAEUS, 1766) LARVAE REARING

Bao G. Tang, Gang Chen, Zao H. Wu-2010

Aquaculture Research 41(2): 315 - 320

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#### EFFECTS OF SELECTED LEVELS OF WATER PH ON THE GROWTH AND SURVIVAL OF SWORDTAIL (XIPHOPHORUS HELLERI) LARVAE

P.H. Sapkale, R.K. Singh, A.S. Desai-2010

The Israeli Journal of Aquaculture - Bamidgeh 62(1): 38-42

Abstract:

Larvae of swordtail (*Xiphophorus helleri*) were exposed to pH levels of 5.5, 6.0, 7.0, 8.0, and 8.5 to study growth and survival under laboratory conditions for 42 days. The larvae were fed formulated dry pellets at 7% of their body weight. The growth and survival rates were highest at pH 8.0 and 8.5, while mortality was complete at pH 5.5. In all treatments, the specific growth rate was higher in the first week and decreased in subsequent weeks. Thus, for swordtail larvae, the pH of the water should be between 8.0 and 8.5.

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#### GROWTH AND SURVIVAL OF AFRICAN CATFISH (CLARIAS GARIEPINUS) LARVAE FED DECAPSULATED ARTEMIA, LIVE DAPHNIA, OR COMMERCIAL STARTER DIET

K.B. Olurin, A.B. Oluwo-2010

The Israeli Journal of Aquaculture - Bamidgeh 62(1): 50-55

Abstract:

The effects of three diets (decapsulated *Artemia*, live *Daphnia* spp., and commercial starter diet) on the growth and survival of *Clarias gariepinus* larvae were investigated in the laboratory for seven days using a completely randomized block design. Larvae were hatched by the hypophysation technique and, immediately after resorption of the yolk sac, randomly distributed into nine tanks at a stocking rate of 180 larvae per experimental plastic tank. Triplicate groups were fed treatment diets ad libitum twice daily, in the morning and in the evening. The highest growth values were obtained in larvae fed decapsulated *Artemia* ( $p < 0.05$ ), while the survival rate was similar in fish fed decapsulated *Artemia* and live *daphnia*. It is concluded that feeds of animal origin are more suitable for first feeding of *C. gariepinus* larvae than inert diets.

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#### NO EVIDENCE FOR LARGE DIFFERENCES IN GENOMIC METHYLATION BETWEEN WILD AND HATCHERY STEELHEAD (ONCORHYNCHUS MYKISS)

Michael S. Blouin, Virginie Thuillier, Becky Cooper, Vindhya Amarasinghe, Laura Cluzel, Hitoshi Araki, Christoph Grunau-2010

Can. J. Fish. Aquat. Sci. 67(2): 217–224

Abstract:

When salmonid fish that have been raised in hatcheries spawn in the wild, they often produce fewer surviving adult offspring than wild fish. Recent data from steelhead (*Oncorhynchus mykiss*) in the Hood River (Oregon, USA) show that even one or two generations of hatchery culture can result in dramatic declines in fitness. Although intense domestication selection could cause such declines, it is worth considering alternative explanations. One possibility is heritable epigenetic changes induced by the hatchery environment. Here, we show, using methylation-sensitive amplified fragment length polymorphism, that hatchery and wild adult steelhead from the Hood River do not appear to differ substantially in overall levels of genomic methylation. Thus, although altered methylation of specific DNA sites or other epigenetic processes could still be important, the hatchery environment does not appear to cause a global hypo- or hypermethylation of the genome or create a large number of sites that are differentially methylated.

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REDUCED HATCHERY REARING DENSITY INCREASES SOCIAL DOMINANCE, POSTRELEASE GROWTH, AND SURVIVAL IN BROWN TROUT (*SALMO TRUTTA*)

Sofia Brockmark, Jörgen I. Johnsson-2010

Can. J. Fish. Aquat. Sci. 67(2): 288–295

Abstract:

Hatchery fish reared for conservation or supplementation often have difficulties adapting to natural conditions, resulting in poor performance in the wild. In a standard hatchery, fish are confined at high densities, which creates a social environment different from that experienced after release. Here we investigated how rearing density influences social dominance, postrelease growth, and survival in brown trout (*Salmo trutta*). Fish were reared at three density treatments: conventional hatchery density, half of conventional hatchery density, and natural density. Four months after hatching, dominance status was determined, and 36 fish from each treatment were released into an enclosed stream and recaptured after 36 days. Trout reared at natural density had higher dominance status and grew faster, both in the hatchery and in the natural stream, than trout from higher densities. Moreover, trout reared at natural density were twice as likely to survive in the stream as trout from higher densities. These novel results suggest that more natural rearing densities would facilitate the development of adaptive behaviour in hatchery salmonids and, thereby, their contribution to natural production.

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SIZE AT HATCHING DETERMINES POPULATION DYNAMICS AND RESPONSE TO HARVESTING IN CANNIBALISTIC FISH

Tobias van Kooten, Jens Andersson, Pär Byström, Lennart Persson, André M. de Roos-2010

Can. J. Fish. Aquat. Sci. 67(2): 401–416

Abstract:

We hypothesize that size at hatching strongly affects population dynamics of cannibalistic fish species and is a crucial determinant of how populations respond to selective removal of large individuals (harvesting). We use a mechanistic mathematical model to study the relation between hatching size and response to harvesting mortality, using Eurasian perch (*Perca fluviatilis*) as a model organism. We show how hatching size determines dynamics through its effect on the relative strength of cannibalistic mortality and resource competition as mechanisms of population regulation. In populations with intermediate and large hatching size, cannibalistic mortality is an important determinant of population dynamics, and harvesting destabilizes population dynamics. When hatching size is small, population stability is less sensitive to this type of harvesting. Populations hatching at small size are regulated by competition, and harvesting large individuals affects such populations less. Harvesting can also induce the growth of very large individuals, absent in unharvested populations. Our results show that harvesting in cannibalistic lake fish populations can strongly alter population dynamics in ways that can only be anticipated on the basis of mechanistic knowledge about how populations are regulated.

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CDNA CLONING AND EXPRESSION OF UBC9 IN THE DEVELOPING EMBRYO AND OVARY OF ORIENTAL RIVER PRAWN, MACROBRACHIUM NIPPONENSE

Fengying Zhang, Liqiao Chen, Ping Wu, Weihong Zhao, Erchao Li, Jianguang Qin-2010

Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology 155(3): 288-293

Abstract:

The small ubiquitin-like modifier (SUMO) pathway in eukaryotes is an essential biological process involving cellular processes, development and organelle biogenesis. In a sequential enzymatic action, Ubc9 is an important conjugation enzyme in the SUMO pathway. Although the Ubc9 has been found in vertebrates, its expression in crustaceans is little known. In this study, the Ubc9 was identified in the embryo and ovary of a freshwater prawn *Macrobrachium nipponense* for the first time and it was denoted as MnUbc9. Bioinformatics analyses showed that this gene encodes a protein of 161 amino acids with predicted molecular mass of 18.32 kDa. Real-time quantitative PCR analyses demonstrated that the expression levels varied significantly in the developing embryo and ovary. In the embryo, the expression level of MnUbc9 was higher at the cleavage stage (CS) than at the blastula stage (BS), and reached even higher levels at the protozoa stage (PS) and the zoea stage (ZS). In the ovary, the MnUbc9 expression was low at the early stage, but reached the highest at the yolk granule stage (YG), and then abruptly declined at the maturation stage (MA). The differential expressions of MnUbc9 in the embryo and ovary suggest that MnUbc9 may play an important role in embryogenesis and oogenesis of *M. nipponense*.

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CHARACTERIZATION OF AN OVARY-SPECIFIC GLUTATHIONE PEROXIDASE FROM THE SHRIMP METAPENAEUS ENSIS AND ITS ROLE IN CRUSTACEAN REPRODUCTION

Long Tao Wu, Ka Hou Chu-2010

Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology 155(1): 26-33

Abstract:

In vertebrates, both reactive oxygen species (ROS) and the corresponding scavenging system components especially glutathione peroxidase (GPx) are indispensable for normal development of the gonads. To investigate the function of GPx in crustaceans, we cloned and characterized a full length GPx (MeGPx) transcript in the penaeid shrimp *Metapenaeus ensis*. Phylogenetic analysis showed that MeGPx clustered with the GPx from mollusks and nematodes and shared much higher similarity with vertebrate GPx3 and GPx5 than with GPx1 or GPx2. Multiple sequence alignment further demonstrated that MeGPx is evolutionarily conserved among invertebrates, with common functionally important motifs. MeGPx was specifically expressed in shrimp ovaries, but not in other tissues studied, including testis. In situ hybridization showed that MeGPx was highly expressed in pre-vitellogenic and mid-vitellogenic oocytes, while no expression was detected in late-vitellogenic oocytes. Moreover, real time PCR showed high level expression of MeGPx in the early ovaries. Since active protein synthesis and deposition occurred in mid-vitellogenic oocytes, MeGPx might play a pivotal role in preventing oocytes from oxidative damage and balancing ROS production. The present findings on shrimp GPx provide insights on the regulation of ROS in the ovarian maturation process and the role of GPx in crustacean reproductive biology.

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SURVIVAL, OSMOREGULATION AND AMMONIA-N EXCRETION OF BLUE SWIMMER CRAB, PORTUNUS PELAGICUS, JUVENILES EXPOSED TO DIFFERENT AMMONIA-N AND SALINITY COMBINATIONS

Nicholas Romano, Chaoshu Zeng-2010

Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology 151(2): 222-228

Abstract:

Ammonia-N toxicity to early *Portunus pelagicus* juveniles at different salinities was investigated along with changes to haemolymph osmolality, Na<sup>+</sup>, K<sup>+</sup>, Ca<sup>2+</sup> and ammonia-N levels, ammonia-N excretion and gill Na<sup>+</sup>/K<sup>+</sup>-ATPase activity. Experimental crabs were acclimated to salinities 15, 30 and 45‰ for one week and 25 replicate crabs were subsequently exposed to 0, 20, 40, 60, 80, 100 and 120 mg L<sup>-1</sup> ammonia-N for 96-h, respectively. High ammonia-N concentrations were used to determine LC50 values while physiological measurements were conducted at lower concentrations. When crabs were exposed to ammonia-N, anterior gill Na<sup>+</sup>/K<sup>+</sup>-ATPase activity significantly increased ( $p < 0.05$ ) at all salinities, while this only occurred on the posterior gills at 30‰. For crabs exposed to 20 and 40 mg L<sup>-1</sup> ammonia-N, both posterior gill Na<sup>+</sup>/K<sup>+</sup>-ATPase activity and ammonia-N excretion were significantly higher at 15‰ than those at 45‰. Despite this trend, the 96-h LC50 value at 15‰ (43.4 mg L<sup>-1</sup>) was significantly lower ( $p < 0.05$ ) than at both 30‰ and 45‰ (65.8 and 75.2 mg L<sup>-1</sup>, respectively). This may be due to significantly higher ( $p < 0.05$ ) haemolymph ammonia-N levels of crabs at low salinities and may similarly explain the general ammonia-N toxicity pattern to other crustacean species. (School of Marine and Tropical Biology, James Cook University, Townsville, Qld 4811, Australia)

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#### RIBOSOMAL RNA GENE SEQUENCES CONFIRM THAT PROTISTAN ENDOPARASITE OF LARVAL COD GADUS MORHUA IS ICHTHYODINIUM SP.

Alf Skovgaard, Stefan Meyer, Julia Lynne Overton, Josianne Støttrup, Kurt Buchmann-2010  
*Diseases of Aquatic Organisms* 88:161-167

##### Abstract:

An enigmatic protistan endoparasite found in eggs and larvae of cod *Gadus morhua* and turbot *Psetta maxima* was isolated from Baltic cod larvae, and DNA was extracted for sequencing of the parasite's small subunit ribosomal RNA (SSU rRNA) gene. The endoparasite has previously been suggested to be related to *Ichthyodinium chabelardi*, a dinoflagellate-like protist that parasitizes yolk sacs of embryos and larvae of a variety of fish species. Comparison of a 1535 bp long fragment of the SSU rRNA gene of the cod endoparasite showed absolute identity with *I. chabelardi*, demonstrating that the 2 parasites are very closely related, if not identical. This finding is discussed in relation to some morphological differences that appear to exist between *I. chabelardi* and the cod endoparasite.

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#### MULTIPLE B-DEFENSIN ISOFORMS IDENTIFIED IN EARLY DEVELOPMENTAL STAGES OF THE TELEOST PARALICHTHYS OLIVACEUS

Bo-Hye Nam, Ji-Young Moon, Young-Ok Kim, Hee Jeong Kong, Woo-Jin Kim, Sang-Jun Lee, Kyong-Kil Kim-2010  
*Fish & Shellfish Immunology* 28(2): 267-274

##### Abstract:

The  $\beta$ -defensin-like gene and its cloned isoforms (fBDI-1 to -5) were identified in an expressed sequence tag (EST) library from the early developmental stages of the olive flounder, *Paralichthys olivaceus*. The fBDI cDNA clones show identical amino acid sequences in 24 residues of the signal peptide and 38 residues of the mature peptide; however, the propeptide region varies in sequence and length, from 5 to 15 amino acid residues. The predicted molecular weight of the mature peptide is 3.83 kDa, and its predicted isoelectric point is 4.1, showing anionic properties. The genomic organisation of the isoforms was analysed using bacterial artificial chromosome (BAC) DNA containing the fBDI gene. Southern blotting and sequence analyses of fBDI BAC DNA confirmed that the fBDI isoforms cluster at the same locus and exhibit the conserved gene organisation reported for other fish defensin genes. The fBDI mRNA was expressed constitutively in early developmental stages after hatching, and pathogen challenge induced fBDI expression in the head kidney of juvenile fish. We also produced a recombinant fBDI peptide (smfBD) using the expression plasmid pET32 and examined its bioactivity toward *Escherichia coli*.

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HUMIC ACID STIMULATION OF GROWTH AND OPTIMIZATION OF BIOCHEMICAL PROFILES ON TWO MICROALGAL SPECIES PROPOSED AS LIVE FEEDS IN AQUACULTURE

N. Gamal-Eldin Mohammady-2008

International Journal of Recirculating Aquaculture 9: 1-21

Abstract:

IA series of batch culture experiments on two marine microalgae species, *Dunaliella salina* Teodoresco and *Nannochloropsis salina* Hibberd, was conducted at various humic acid (HA) concentrations (0.0, 0.1, 0.2, 0.3, 0.4, 0.5 mgL<sup>-1</sup>), in order to evaluate the stimulatory potential of HA on microalgae growth (expressed as a biomass concentration), pigment production (chlorophyll a and carotenoids) and carbon to nitrogen (C:N) ratio. The impact of HA on the proximate composition (moisture, ash, dietary fiber, crude lipid, available carbohydrates, crude protein, and energy content) was also considered. Results demonstrated a highly significant positive effect of HA on growth, pigment production, and proximate analysis ( $P \leq 0.01$ ). The excellent response of the two investigated microalgae to HA recommends it as a low-cost, high-yield investment, despite the finding that the C:N ratio in *D. salina* showed a gradual decrease upon addition of HA. A slight increase in the C:N ratio was observed upon addition of HA in *N. salina*.

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STIMULATING DENITRIFICATION IN A MARINE RECIRCULATING AQUACULTURE SYSTEM BIOFILTER USING GRANULAR STARCH AS A CARBON SOURCE

Megan M. Morrison, Yossi Ta, Harold J. Schreier-2008

International Journal of Recirculating Aquaculture 9: 23-41

Abstract:

Maintaining superior water quality in intensive recirculating aquaculture systems (RAS) by controlling levels of inorganic nitrogenous waste—ammonia, nitrate and nitrite—derived from uneaten food and fecal excretion is often a challenge. In most systems, solids are removed mechanically and ammonia is oxidized to nitrate by nitrifying biological filtration; nitrate is subsequently eliminated through numerous water exchanges. Alternatively, nitrate removal is achieved using a bacterial-mediated denitrification component that reduces nitrate to nitrogen gas under anoxic conditions, a process that depends on the application of external or endogenous electron and carbon donors, e.g. carbohydrates or organic alcohols. In this study, we compared the capacity of acetate, glucose, soluble starch, and granular starches to promote the denitrifying activity of heterotrophic bacteria in biofilm-coated polyethylene beads from a marine RAS moving bed bioreactor (MBB) under anaerobic conditions. Granular starches (corn, wheat, and rice) were as effective as glucose in supporting denitrification, and were 7.6 and 9.8 times more effective in removing nitrate when compared to soluble starch and acetate, respectively. Furthermore, granular starches retained their denitrification potential for longer time periods than soluble starch or acetate. The low cost, ease of use, and non-toxic nature of granular starches make them an ideal exogenous carbon source for promoting denitrification in RAS bioreactors. (Center of Marine Biotechnology University of Maryland Biotechnology Institute 701 E. Pratt Street, Baltimore, MD 21202; email of Harold Schreier: Schreier@umbi.umd.edu)

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VIBRIO ANGUILLARUM AND V. ORDALII DISINFECTION FOR AQUACULTURE FACILITIES

John W. Machen, Stephen A. Smith, George J. Flick, Jr.-2008

International Journal of Recirculating Aquaculture 9: 43-51

Abstract:

One of the major limitations to intensive aquaculture is disease. Diseases spread rapidly in an aquatic environment and pose a major threat to development and utilization of all species in aquaculture. Bacteria of the genus *Vibrio* play a major role in the diseases of cultured species of marine fish. The goal of reducing the incidence of disease in a population is either to eliminate potential pathogens or to increase the resistance of the host. To reach that goal, a disinfection assay to test the effectiveness of

nine common aquaculture chemical compounds was evaluated against two marine bacterial pathogens (*Vibrio anguillarum* and *V. ordalii*). Both bacterial species were susceptible to a variety of common disinfecting compounds including Chloramine-T®, chlorine, ethanol, iodine, Lysol®, Roccal®, and Virkon-S®.

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## EMERGING AQUACULTURE SPECIES FOR RECIRCULATING SYSTEMS IN THE NORTHEAST U.S.

F. Wheaton-2008

International Journal of Recirculating Aquaculture 9: 53-73

Abstract:

Emerging species are organisms for which we have enough information, regarding biology, nutrition, morbidity, etc., to allow individuals to attempt to culture them with some difficulty. With emerging species, there will be information a culturist would like to know that is still lacking; for example, market and economic information. Only highly knowledgeable fish culturists will be successful in culturing these species. Which aquatic organisms can be considered as emerging species for recirculating aquaculture will vary with the individual's knowledge and interest. This paper is an attempt to disseminate information on several freshwater, brackish and saltwater species that appear to meet the 'emerging' definition. Their inclusion as emerging species does not imply they are profitable to produce and market. Freshwater species include: barramundi, walleye, carp, white sucker, and grass carp. Brackish or saltwater species include: bay scallops, blue crab, mummichog, ornamental fish and invertebrates for the pet industry, rainbow smelt, cobia, European oysters, American oysters, bloodworms and sand worms, green sea urchins, black sea bass, and several species of aquatic plants.

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## THE RELATIONSHIPS BETWEEN GONAD DEVELOPMENT AND SEX STEROID LEVELS AT DIFFERENT AGES IN ACIPENSER SCHRENCKII

By Q.-Z. Qu, D.-J. Sun, B.-Q. Wan, G.-J. Ma-2010

Journal of Applied Ichthyology 26(1): 1 – 5

Abstract:

The histological developments of the gonad and the associated sex steroid levels were determined in the breeding stocks of *Acipenser schrenckii* (age classes 1 to 5) maintained under natural temperature regimes (December 4°C; August 26°C). Early sex differentiation was observed in 1-year-old fish, while testosterone (T) and 17β-estradiol (E2) levels ranged from T 1.1 to 3.4 nmol l<sup>-1</sup> (average 1.8 nmol l<sup>-1</sup>), and E2 varied from 24 to 85 pmol l<sup>-1</sup> (av. 50.3 pmol l<sup>-1</sup>). Gonadal status of 2-year-old males was in stage II while ovaries were at stage I, exhibiting T levels from 1.2 to 4.4 nmol l<sup>-1</sup> (av. 2.2 nmol l<sup>-1</sup>), and E2 concentrations from 10 to 97 pmol l<sup>-1</sup> (av. 38.9 pmol l<sup>-1</sup>). At the age of 3 years, the testes in males were at developmental stage III while the ovaries remained in stage I, with T levels ranging from 1.3 to 21.7 nmol l<sup>-1</sup> (av. 9.6 nmol l<sup>-1</sup>), and E2 concentrations ranging from 17 to 108 pmol l<sup>-1</sup> (av. 44.8 pmol l<sup>-1</sup>). At the age of 4 years, testes in males were at developmental stage III while ovaries in females had reached stage II, with T concentrations ranging from 7.3 to 52.6 nmol l<sup>-1</sup> (av. 26.3 nmol l<sup>-1</sup>), and E2 levels between 13 and 86 pmol l<sup>-1</sup> (average 55.3 pmol l<sup>-1</sup>). In 5-year-old fish, the testes reached maturity stage while the ovaries were mostly in stage III, with T values from 5.7 to 44.2 nmol l<sup>-1</sup> (av. 13.9 nmol l<sup>-1</sup>), and E2 concentrations from 21 to 453 pmol l<sup>-1</sup> (av. 137.7 pmol l<sup>-1</sup>). Data demonstrated large differences in sex steroid levels among immature Amur sturgeon, and testicular maturation occurred earlier than ovarian maturation.

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GROWTH PERFORMANCE, MORTALITY AND CAROTENOID PIGMENTATION OF FRY OFFSPRING AS AFFECTED BY DIETARY SUPPLEMENTATION OF ASTAXANTHIN TO FEMALE RAINBOW TROUT (*ONCORHYNCHUS MYKISS*) BROODSTOCK

A. A. Bazyar Lakeh, M. R. Ahmadi, S. Safi, T. Ytrestøyl, B. Bjerkeng-2010

Journal of Applied Ichthyology 26(1): 35 – 39

Abstract:

Growth performance, mortality and carotenoid pigmentation were studied in triplicate groups each with 1000 swim-up larvae of rainbow trout (*Oncorhynchus mykiss*), derived from five groups of female broodstock fed diets with 0.07, 12.5, 33.3, 65.1 or 92.9 mg astaxanthin kg<sup>-1</sup>, respectively. The first feeding fry (initial weight range from 113 to 148 mg) were fed a diet not supplemented with carotenoids in an experiment lasting 45 days. Fry were initially sampled for astaxanthin content and initial weight, and in subsequent 15-day intervals to determine weights, condition factors (CF), specific growth rates (SGR) and thermal growth coefficients (TGC). Total carotenoid concentration of the larvae was highly linearly correlated to that of the eggs ( $r^2 = 0.97$ ,  $P = 0.002$ ). About 59–67% of fry carotenoids consisted of esterified astaxanthin, and on average 39.7% of the egg carotenoids were recovered in the fry. Overall (0–45 days) SGRs and TGCs were significantly higher ( $P < 0.05$ ) in the offspring of the four groups of females fed supplemented diets (12.5–92.9 mg astaxanthin kg<sup>-1</sup>) than in offspring of females fed the non-supplemented diet. TGCs (0–45 days) within groups derived from broodstock supplemented with astaxanthin were similar ( $P > 0.05$ ), but higher than in the group derived from females fed the diet not supplemented with astaxanthin ( $P < 0.05$ ). Mortality (average 0.76%) was not significantly affected by treatment. The study indicates that dietary supplement of astaxanthin (>12.5 mg kg<sup>-1</sup>) to maternal broodstock diets improves offspring SGR and TGC with up to 33 and 38%, respectively.

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