

INFORMATION OF INTEREST

- Finfish Aquaculture Diversification: new book edited by N. Le François, M. Jobling, C. Carter, P. Blier and A. Savoie and published by Cabi International 2010; see [contents](#)
- 2010 CNPq-TWAS fellowships programmes for young scientists from developing countries (other than Brazil): see [website](#)

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AN EVALUATION OF DVAqua®, A FULLY-FERMENTED YEAST CULTURE, DURING LONG-TERM HATCHERY REARING OF MCCONAUGHY STRAIN RAINBOW TROUT

M.E. Barnes, D.J. Durben-2010

Aquaculture Nutrition 16(3): 299 – 304

Abstract:

The addition of a proprietary, fully-fermented yeast *Saccharomyces cerevisiae* culture supplement (DVAqua®, Diamond V Mills, Cedar Rapids, IA, USA) was evaluated during long-term feeding of McConaughy strain rainbow trout *Oncorhynchus mykiss*. Beginning at initial feeding and continuing for 408 days of hatchery rearing, the trout received either a commercially-manufactured feed or the same feed containing 0.125 g kg⁻¹ DVAqua. This study was conducted at a production level as part of normal (real-world) hatchery operations, with the fish periodically inventoried and moved into different rearing units. Although no rearing-tank replication occurred during the first 54 days of feeding, multiple tanks and raceways were used thereafter. Fish in rearing units receiving DVAqua supplementation exhibited less mortality, particularly during the earlier rearing stages. During the final 177 days of rearing in six raceways, DVAqua-fed McConaughy strain trout were significantly larger and had a significantly improved feed conversion ratio. The overall feed conversion ratio for the entire duration of the study was 1.17 in the fish receiving DVAqua supplementation compared to 1.21 in the control group. Despite the limitations of this study, the use of DVAqua is recommended for McConaughy strain rainbow trout and other less-domesticated, more difficult-to-rear salmonids.

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EXPRESSION AND CHARACTERIZATION OF THE JAK KINASE AND STAT PROTEIN FROM BRINE SHRIMP, ARTEMIA FRANCISCANA

Chia-Hsiung Cheng, Gen-Der Chen, Maw-Sheng Yeh, Cheng-Ying Chu, Ya-Li Hsu, Pung-Pung Hwang, Fore-Lien Huang, Chang-Jen Huang-2010

Fish & Shellfish Immunology 28(5-6): 774-782

Abstract:

In this study, we isolated and characterized both JAK and STAT genes from *Artemia franciscana*. Although AfJAK showed only 19% identity (33% similarity) to the *Drosophila* Hop protein, AfJAK contained the characteristic JAK homology domain (JH domain) from JH1 to JH7. On the other hand, AfSTAT showed higher identity (30%) to *Drosophila* STAT (STAT92E). The low identities of AfJAK and AfSTAT to *Drosophila* Hop and STAT92E suggest that JAK and STAT proteins are unique in each different species of invertebrate. RT-PCR analysis showed that both AfJAK and AfSTAT transcripts were ubiquitously expressed in the embryo, which is similar to the expression patterns of *Drosophila* Hop and STAT92E mRNAs during development. In addition, we generated a constitutively active form of AfSTAT by fusing the JH1 domain of AfJAK to the C-terminal end of AfSTAT. This fusion protein, AfSTAT-HA-JH1, autophosphorylated on its tyrosine residue and was able to bind to specific DNA motifs including the STAT-binding motifs in the *Drosophila* Raf

promoter. Both AfJAK and AfSTAT proteins elicited the transactivation potential toward the fly Raf promoter in Sf9 cells. However, tyrosine phosphorylation of AfSTAT was not detected, which is consistent with the cellular localization analysis that most AfSTAT proteins were in the cytoplasm. Our results demonstrate that both JAK and STAT are present in the genome of Artemia, which can serve as the basis for further investigations to explore the role of the JAK/STAT signal pathway in the development and immune response of brine shrimp.

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EFFECTS OF THE PROBIOTIC, BACILLUS SUBTILIS E20, ON THE SURVIVAL, DEVELOPMENT, STRESS TOLERANCE, AND IMMUNE STATUS OF WHITE SHRIMP, LITOPENAEUS VANNAMEI LARVAE

Kuan-Fu Liu, Chiu-Hsia Chiu, Ya-Li Shiu, Winton Cheng, Chun-Hung Liu-2010

Fish & Shellfish Immunology 28(5-6): 837-844

Abstract:

In this study, the probiotic, *Bacillus subtilis* E20, isolated from the human health food, natto, was used for white shrimp, *Litopenaeus vannamei*, larvae breeding to improve the larval survival rate and development by adding probiotic to the rearing water at (control), 108, and 109 cfu L⁻¹ salt water once every 3 days during the 14 days of breeding experiment. Thereafter, stress tolerance and immune status of postlarvae were evaluated. Shrimp larval development was significantly accelerated after adding the probiotic to the larval rearing water at a level of 109 cfu L⁻¹. The survival rate of larvae was significantly higher in the treatment with 109 cfu L⁻¹ compared to the control and the treatment with 108 cfu L⁻¹ after all larvae had metamorphosed to postlarvae. Adding the probiotic to the shrimp larvae rearing water produced a weak inhibition of bacterial growth by an analysis of the total bacterial count and presumptive *Vibrio* count. For stress tests, no postlarvae died when they were reared in water in which the temperature was decreased from 30 to 2 °C at a rate of 0.1 °C h⁻¹. Postlarvae had significantly lower cumulative mortality in the treatments with 108 and 109 cfu L⁻¹ compared to the control when they were suddenly exposed to fresh water and 60‰ salt water. A significant decrease in the cumulative mortality of postlarvae treated with the probiotic at a level of 109 cfu L⁻¹ was recorded after the sudden transfer to 300 mg L⁻¹ nitrite -N compared to the control and treatment with 108 cfu L⁻¹. The analysis of immune-related gene expressions showed that the gene expression of prophenoloxidase I, prophenoloxidase II, and lysozyme of larvae were significantly increased after being reared in probiotic-containing water at the levels of 108 and 109 cfu L⁻¹. However, no significant difference in serine proteinase or glutathione peroxidase gene expressions was recorded in this study. It is therefore suggested that 109 cfu L⁻¹ of probiotic, *B. subtilis* E20 adding to rearing water for shrimp larva breeding.

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EFFECT OF ENDOCRINE DISRUPTING CHEMICALS ON THE TRANSCRIPTION OF GENES RELATED TO THE INNATE IMMUNE SYSTEM IN THE EARLY DEVELOPMENTAL STAGE OF ZEBRAFISH (DANIO RERIO)

Yuanxiang Jin, Rujia Chen, Weiping Liu, Zhengwei Fu-2010

Fish & Shellfish Immunology 28(5-6): 854-861

Abstract:

Health concerns regarding the potential interference of endocrine disrupting chemicals (EDCs) in the immune system of wildlife and humans have increased in recent years. However, the effects of EDCs in aquatic systems on the immune system of fish species has only received limited attention. In the present study, we found that the mRNA levels of TNF α , IFN, IL-1 β , IL-8, CXCL-Clc, and CC-chemokine, which are closely related to the innate immune system, were affected in newly hatched zebrafish when exposed to EDCs, such as 17 β -estradiol, 17 α -ethynyestradiol, permethrin, atrazine and nonylphenol at various concentrations (0.1, 0.5, 2.5 and 12.5 μ g/l) for three days during the embryo stage. However, the different EDCs displayed different potentials to change innate immune-related gene transcription.

Among the selected chemicals, permethrin (PM) and 17 β -estradiol (E2) (12.5 μ g/l) significantly increased the mRNA levels of many cytokines, exhibiting their most prominent impacts on the innate immune system of zebrafish. In addition, it was found that the mixture of the above five chemicals (2.5 μ g/l each) had a greater effect on innate immune system-related gene transcription in zebrafish than equal amounts of the single compound. Moreover, the genes (such as Bcl2, Ucp2 and iNOS) relating to reactive oxygen species (ROS) and nitrogen reactive free radical production were also influenced by some EDCs and their mixture. We suggest that heavy oxidative stress and the balance of nitric oxide (NO) production lead to death of immune cells. These results may provide an explanation of the possible mode how EDCs influence the innate immune system in zebrafish. Taken together, the results obtained in the present study clearly demonstrate that EDCs and their mixtures in aquatic systems will greatly influence the immune system in fish, suggesting that the effects of EDCs on fish should be associated with immune toxicity.

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FEEDING RATES AND GROSS GROWTH EFFICIENCIES OF LARVAL DEVELOPMENTAL STAGES OF OITHONA DAVISAE (COPEPODA, CYCLOPOIDA)

Rodrigo Almeda, Christina B. Augustin, Miquel Alcaraz, Albert Calbet, Enric Saiz-2010

Journal of Experimental Marine Biology and Ecology 387(1-2): 24-35

Abstract:

Among marine planktonic copepods, the genus *Oithona* is probably the most abundant and ubiquitous copepod in the world's oceans. However, knowledge about the ecophysiology of Oithonids is very scarce compared to calanoid copepods, particularly for their larval stages. We determined feeding rates and gross growth efficiencies of different developmental stages of the cyclopoid copepod *Oithona davisae* as related to food concentration, body weight and temperature in the laboratory.

The feeding rates of nauplii and copepodites of *Oithona davisae* in relation to food concentration followed a type III functional response, with feeding threshold concentrations ranging from 50 to 75 μ g C L⁻¹, depending on the developmental stage. All feeding parameters varied according to body weight/age. The food concentration required to achieve the maximum ingestion rates increased from 200 μ g C E L⁻¹ in early nauplii to 320 μ g C L⁻¹ in copepodites. Specific ingestion rates (d⁻¹) increased with increasing temperature, with a Q₁₀ = 2.45. Growth rates were negatively related to larval size and positively related to food concentration and temperature. Gross growth efficiency ranged from 0.16 to 0.60 depending on the developmental stage, food availability and temperature.

Oithona davisae developmental stages exhibited much lower maximum specific ingestion rates than calanoid nauplii but exhibited quite similar gross growth efficiencies. This indicates that *Oithona* nauplii should display lower metabolic losses and consequently lower food requirements than calanoid nauplii. Together with other factors, this feeding/energetic strategy may contribute to the success of the *Oithona* species in marine ecosystems of contrasting trophic characteristics.

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EFFECTS OF THE MICROCYSTIN PROFILE OF A CYANOBACTERIAL BLOOM ON GROWTH AND TOXIN ACCUMULATION IN COMMON CARP CYPRINUS CARPIO LARVAE

I. El Ghazali, S. Saqrane, A. P. Carvalho, Y. Ouahid, F. F. Del Campo, V. Vasconcelos, B. Oudra-2010

Journal of Fish Biology 76(6): 1415 – 1430

Abstract:

A 12 day growth trial was conducted to compare the effect of the variation in microcystins (MC) composition of two bloom samples of *Microcystis aeruginosa* on the growth performance and microcystin accumulation in common carp *Cyprinus carpio* larvae. Two *M. aeruginosa* natural bloom samples with different MC profiles were collected and larvae were exposed to cyanobacterial cells through their diet. Three diets, a basal control diet and two diets prepared from the basal diet plus the

same toxins content (60 ng MC g⁻¹ diet) of each cyanobacterial bloom, were given at the same ration level to three groups of larvae during the experimental period. Larval mass and standard length from day 9 were significantly different between cyanobacterial treatments and in both cases lower than that of the control. The MC accumulation by larvae, inversely correlated with the growth performance, was also significantly different between cyanobacterial treatments (26.96 v. 17.32 ng g⁻¹ at the end of the experimental period). These results indicate that MC variants profile may have effects on the toxin uptake and toxicity. To date, this is the first laboratory study to show that fish accumulate MC depending on the toxin profile of the cyanobacterial bloom.

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ONTOGENETIC CHANGES IN SCHOOLING BEHAVIOUR DURING LARVAL AND EARLY JUVENILE STAGES OF PACIFIC BLUEFIN TUNA THUNNUS ORIENTALIS

H. Fukuda, S. Torisawa, Y. Sawada, T. Takagi-2010

Journal of Fish Biology 76(7): 1841 – 1847

Abstract:

Schooling was first observed at 25–27 days after hatching (26–2–33· 8 mm, total length) in the Pacific bluefin tuna *Thunnus orientalis*. At this time, the mode of swimming changed from intermittent sprinting to continuous cruising, and this allowed the fish to adjust to an inertial hydrodynamic environment.

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ASSESSMENT OF SPERM CONCENTRATION AND DETERMINATION OF OPTIMUM SPERM TO EGG RATIO IN HETEROPNEUSTES FOSSILIS (BLOCH)

J.G. Christopher, A.G. Murugesan, N. Sukuma-2010

Asian Fisheries Science 22 (4): 1071-1255

Abstract:

Determination of optimum sperm requirements in artificial breeding helps to improve the fertilization efficiency, avoids wastage of sperm and thus minimizes the sacrificing of males for milt. Quantification of sperm cells was done using a spectrophotometer at 420 nm followed by haemocytometer counting. Best correlation ($r^2 = 0.97$) was recorded. The minimum number of sperm cells required for optimal fertilization success in *Heteropneustes fossilis* was determined. Fertilization success of 78 to 93% was recorded at 8×10^3 to 8×10^7 per egg. The highest fertilization success of 98.18% was recorded at 8×10^7 spermatozoa per egg.

EFFECTS OF 3,4-DICHLOROANILINE ON EXPRESSION OF AHR2 AND CYP1A1 IN ZEBRAFISH ADULTS AND EMBRYOS

Yoshie Ito, Youhei Matsuda, Tohru Suzuki-2010

Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology: 152(2): 189-194

Abstract:

Arylhydrocarbon receptor (Ahr) and cytochrome P4501a1 (Cyp1a1) are members of the Ahr/Cyp1a1 pathway that oxygenates various toxic chemicals including aryl hydrocarbons. To elucidate Ahr/Cyp1a1 pathway responses in teleost fish tissues, we examined the effects of 3,4-dichloroaniline (3,4-DCA), a reference toxic compound known to activate the Ahr/Cyp1a1 pathway, on the expression of arh and cyp1a1 in zebrafish tissues and embryos by means of in situ hybridization (ISH). Our ISH analysis showed that cyp1a1 expression was markedly activated by 3,4-DCA in the gill and intestinal epithelia, skin epidermis, and liver parenchymal cells of adult zebrafish. Before differentiation of the gill, intestine, and liver, skin was the site of cyp1a1 activation in embryos. Unlike the cyp1a1 response, 3,4-DCA-mediated ahr activation was not marked in either adults or embryos, indicating a possibility that stable ahr transcripts persist in the cytoplasm of these cells to induce cyp1a1. Young oocytes

(previtellogenic to early vitellogenic stage) express *ahr*; however activation of *cyp1a1* by 3,4-DCA was negligible in these oocytes, suggesting that *ahr* expression in oocytes is not directly linked to *cyp1a1* activation. Based on our finding that skin epidermis up-regulates *cyp1a1* in response to 3,4-DCA, we demonstrated that fin explants, which can be harvested without sacrificing fish, can be used as a standard for assaying *cyp1a1* activation in addition to embryos that are now used.

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VISUALIZATION OF SKELETONS AND INTERVERTEBRAL DISKS IN LIVE FISH LARVAE BY FLUORESCENT CALCEIN STAINING AND DISK SPECIFIC GFP EXPRESSION

Y. Haga, S. J. Du, S. Masui, Y. Fujinami, M. Aritaki, S. Satoh-2010

Journal of Applied Ichthyology 26(2): 268 – 273

Abstract:

Zebrafish and medaka have become popular models for studying skeletal development because of high fecundity, shorter generation period, and transparency of fish embryo. The first step to study skeletal development is visualizing bone and cartilage. Live animal staining with fluorescent calcein have several advantages over the standard skeletal staining protocol by using alizarin red and alcian blue for bone and cartilage. However, there is no detailed study examining skeletal development of live marine fish larvae by calcein staining. Here we applied calcein staining to examine skeletal development in red sea bream larvae. In addition, green fluorescent protein (GFP) reporter zebrafish was employed to trace lineage analysis of intervertebral disk cells in live fish larvae. Calcein staining of red sea bream larvae successfully visualized development of craniofacial skeletons as well as urinary calculus. Histochemical detection of alkaline phosphatase (ALP) activity revealed that abnormal segmentation of notochord induced by RA during vertebral development in zebrafish. Immunohistochemistry clearly revealed that GFP-positive cells in intervertebral space was nucleus pulposus like cell in *twhh*-GFP transgenic zebrafish. It was demonstrated usefulness of calcein and ALP staining and *twhh*-GFP transgenic zebrafish for studying skeletal development in live fish larvae.

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SHORT COMMUNICATION

VISUALIZING MINERALIZATION IN DEFORMED OPERCULAR BONES OF LARVAL GILTHEAD SEA BREEM (SPARUS AURATA)

C. Morel, D. Adriaens, M. Boone, T. De Wolf, L. Van Hoorebeke, P. Sorgeloos-2010

Journal of Applied Ichthyology 26(2): 278 – 279

Abstract:

During the rearing process of gilthead sea bream (*Sparus aurata*), abnormal development of the opercular bone is particularly common (Aquaculture 156, 1997, 165). In order to alleviate its occurrence in rearing facilities, it's crucial to identify the very first physical signs of deviation in normal skeletal development. Nano-CT-scanning was tested for its applicability to quantify deviations in bone mineralization levels. Seven opercles were dissected from larvi of 65 days post hatching, randomly sampled at the commercial sea bream hatchery Maricoltura di Rosignano Solvay (Livorno, Italy). The samples were nano-CT-scanned and computationally reconstructed. Mineralization intensity was colorcoded using Amira software, resulting in a detailed visualization of opercular morphology and mineralization patterns. In conclusion, nano-CT-scanning promises to be a good tool to both describe morphology and detect mineralization levels in the early onset of deformities.

(Evolutionary Morphology of Vertebrates, Ghent University, K.L. Ledeganckstraat 35, B-9000 Gent, Belgium; email of Dominique Adriaens: dominique.adriaens@ugent.be)

SHORT COMMUNICATION

DOUBLE STAINING PROTOCOL FOR DEVELOPING EUROPEAN SEA BASS (DICENTRARCHUS LABRAX) LARVAE

M. J. Darias, O. Lan Chow Wing, C. Cahu, J. L. Zambonino-Infante, D. Mazurais-2010
Journal of Applied Ichthyology 26(2): 280 – 285

Abstract:

The alcian blue-alizarin red technique was successfully adjusted to stain developing European sea bass (*Dicentrarchus labrax*) larvae. For an optimal staining protocol design both larval size and their morphological characteristics at each developmental stage were considered, since such parameters notably influence the staining of tissues. The incubation times of the different solutions were adjusted to allow the stain penetration for revealing the integrity of cartilaginous and bony tissues without significant tissue degradation. Three developmental windows were determined for an optimal staining procedure: (i) 4.5–6.4 mm, (ii) 6.7–8.7 mm, and (iii) 12.8–15.5 mm total length (TL). In order to validate the continuity of staining along the larval development, quantification of bone mineralization and osteocalcin gene expression were also monitored. Quantitative analysis revealed that ossification followed an exponential kinetic that was positively correlated with the osteocalcin gene expression pattern ($R_s = 0.9762$, $P < 0.05$). The mineralized tissue increased from 6.4 mm TL onwards, corresponding with the detection of the first ossified structures. The quantity of bony tissue increased gradually until 7.6 mm TL, since mineralization remained limited to the skull. From 8.3 to 15.5 mm TL, the mineralized bone was notable and nearly concerned the whole larval skeleton (skull, vertebral column and caudal complex). Since it was possible to detect the first cartilaginous and mineralized structures in specimens as small as 4.5 and 6.4 mm TL, respectively, this procedure is a useful tool to study the European sea bass skeletal ontogenesis, to precociously diagnose skeletal malformations in small larvae and eventually to better characterize the effect of different environmental and/or nutritional factors on the ossification status of specific skeletal components.

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EFFECT OF HATCHERY ENVIRONMENT ON CRANIAL MORPHOLOGY AND DEVELOPMENTAL STABILITY OF ATLANTIC SALMON (*SALMO SALAR* L.) FROM NORTH-WEST RUSSIA

By A. Yurtseva, D. Lajus, V. Artamonova, A. Makhrov-2010

Journal of Applied Ichthyology 26(2): 307 – 314

Abstract:

The study addresses the effect of hatchery rearing on morphological variation and developmental stability of Atlantic salmon parr from North-West Russia. Totally, we collected nine samples. Four wild samples were collected from each of the rivers Kola, Umba, Keret' and Shuia. Five samples of hatchery-reared parr were the first-generation progeny of wild adults from these rivers reared separately at the four hatcheries (one hatchery was represented by two samples). Ten meristic and 48 morphometric cranial characters were analysed. We studied the morphological divergence between wild and hatchery fishes of the same river of origin. To analyze developmental stability we used fluctuating asymmetry (random deviations from perfect bilateral symmetry). It was found that hatchery-reared parr significantly differ from wild parr in both meristic characters and the shape of cranial bones. Different hatcheries caused similar effect on morphological variation in all populations. Fluctuating asymmetry in morphometric characters was significantly higher in hatchery fish than in wild from the Shuia River, indicating a higher level of developmental instability. However, wild parr from the Keret' River had significantly higher fluctuating asymmetry than cultivated parr of the same origin, possible due to a high infection pressure of the parasite *Gyrodactylus salaris* Malmberg which has led to significant decline of the wild salmon population in this river, or from genetic changes caused by cultivation. The obtained results indicate a notable effect of hatchery environment on Atlantic salmon's phenotype.

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REVIEW

STUDIES ON THE APPEARANCE OF SKELETAL ANOMALIES IN RED PORGY: EFFECT OF CULTURE INTENSIVENESS, FEEDING HABITS AND NUTRITIONAL QUALITY OF LIVE PREYS

M. S. Izquierdo, J. Socorro, J. Roo-2010

Journal of Applied Ichthyology 26(2): 320 – 326

Abstract:

Despite the great interest of red porgy as a new species for Mediterranean aquaculture, its commercial production is constrained by the high incidence of skeletal deformities occurring in this species under culture conditions. Several studies have been conducted to better understand the origin of these anomalies in this species, using different system intensiveness, rotifers enrichment products or rotifers docosahexaenoic acid content. The first study showed that culture intensification increased the number of fish with an extra vertebrae, what was probably related to the different nutritional quality of live preys employed in each treatment, since water temperature, salinity and genetic background were identical for the different batches of fish studied. Total incidence of skeletal abnormalities was higher in the intensive system, particularly cranial abnormalities and kyphosis in the cephalic vertebrae. In both rearing systems the most common skeletal anomalies were vertebral column disorders, lordosis and fused vertebrae, their localization along the column being affected by the culture intensiveness. Rotifer enrichment, predominantly its docosahexaenoic acid content significantly affected deformities occurrence. A marked positive effect of rotifer docosahexaenoic acid content was found on larval survival. X-ray studies denoted elevated levels of bone abnormalities associated, in both trials, to low docosahexaenoic acid content in live preys. Among different anomalies, the presence of fused vertebrae was the most frequent deformity for both rearing trials. A 50% reduction in the number of deformed fish for each type of deformity was obtained when the larvae were fed higher docosahexaenoic acid levels, denoting the important role of this fatty acid in bone development. Further studies are needed to elucidate the importance of essential fatty acids on the development of bone deformities in fish, since the functions of these fatty acids differ among them and can lead to very different effects in fish metabolism, including bone formation.

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EFFECTS OF PHOSPHORUS AND VITAMIN C DEFICIENCY, VITAMIN A TOXICITY, AND LIPID PEROXIDATION ON SKELETAL ABNORMALITIES IN ATLANTIC HALIBUT (HIPPOGLOSSUS HIPPOGLOSSUS)

L. M. Lewis-McCrea, S. P. Lall-2010

Journal of Applied Ichthyology 26(2): 334 – 343

Abstract:

Dietary nutrients play an important role in skeletal tissue metabolism of fish. Deficiency and toxicity of certain nutrients have been linked to bone deformities in larval and juvenile fish. The pathogenesis of skeletal disorders in larval and juvenile fish from the same genetic stock, cultured under similar environment conditions is often difficult to distinguish when marginal deficiencies of multiple nutrients are involved. A study was conducted to characterize the skeletal deformities linked to the deficiency of phosphorus and ascorbic acid, vitamin A toxicity and lipid peroxidation in juvenile halibut. Five experimental diets containing a low level of phosphorus (0.5% dry matter basis), no vitamin C supplement, high level of vitamin A (80 000 IU kg⁻¹) and oxidized marine fish oil (peroxide value, 7.53 meq kg⁻¹) and a control diet based on cod fillet and vitamin free casein were fed to juvenile Atlantic halibut for 14 weeks in an attempt to characterize the skeletal deformities. Phosphorus, ascorbic acid, retinol, and α -tocopherol concentrations of liver and kidney were measured at 0 and 14 weeks. Reduced vertebral ash and phosphorus content were observed in fish fed the low phosphorus diet. Skeletal abnormalities included abnormal hemal and neural spines in the hemal region and scoliosis in the cephalic and hemal regions of the vertebral column. Hepatic and kidney ascorbic acid concentrations were significantly lower in the group fed no ascorbic acid supplement. Skeletal abnormalities were scoliosis and lordosis primarily in the hemal region of the vertebral column. High levels of vitamin A in the diet caused increased hepatic retinol content and scoliosis spanning the cephalic/prehemal and anterior hemal regions of the vertebral column. Fish fed the oxidized oil diet

showed increased thiobarbituric acid (TBA) value in the liver and muscle tissue with no significant decrease in hepatic vitamin E concentration. The most frequent skeletal deformity observed was scoliosis, spanning the cephalic/prehemal regions as well as the anterior hemal region of the vertebral column. The pattern and type of abnormalities observed in fish fed these experimental diets were similar to those observed in a commercial halibut hatchery.

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SENEGALESE SOLE BONE TISSUE ORIGINATED FROM CHONDRAL OSSIFICATION IS MORE SENSITIVE THAN DERMAL BONE TO HIGH VITAMIN A CONTENT IN ENRICHED ARTEMIA

I. Fernández and E. Gisbert-2010

Journal of Applied Ichthyology 26(2): 344 – 349

Abstract:

Several studies have evaluated the effects of dietary vitamin A (VA) on the incidence of skeletal deformities during early ontogeny of fish, but little is known about its effects on bones depending on their process of ossification (dermal or chondral). We examined the incidence of skeletal deformities along development (30 and 48 dph) by double staining technique, in dermal (haemal and caudal vertebral bodies) and chondral (neural and haemal spines, epural, parahypural and hypurals) bones in Senegal sole post metamorphosed larvae fed with different dietary VA levels (37 000, 44 666, 82 666 and 203 000 UI total VA kg⁻¹ DW) during Artemia feeding phase (6 –37 dph, at 18°C). Results obtained in this study showed that dietary VA disrupted the skeletogenesis in Senegalese sole post metamorphosed larvae by increasing the incidence of skeletal deformities in the axial skeleton and caudal fin complex, which were dependent on both bone morphogenesis and ossification processes. Fish fed with the highest dietary VA content showed the highest incidence of skeletal deformities and its value increased along ontogeny. However, when we compared the incidence of deformities in skeletal structures considering their ossification process, most skeletal structures derived from chondral ossification showed a significant higher increase in deformity incidences in fish fed an excess of VA (44 666, 82 666 and 203 000 UI kg⁻¹ DW), however within chondral bones, hypurals deformity incidence only increased in sole larvae fed Artemia highest VA content. In contrast, this dietary dose-response effect was only noted in dermal bones from fish fed the highest dose of VA (203 000 UI kg⁻¹ DW). In addition, the incidence of deformities in chondral bones increased even when the dietary imbalance of VA was corrected, whereas dermal bones were not affected at later ages. These results indicated that depending on the ossification process from which different skeletal structures are derived, bones might be differentially affected by high dietary VA content. Those directly originated from the connective tissue with a preliminary cartilage stage were more sensitive to dietary VA excess than those formed by intramembranous ossification.

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PROGRESS IN MODELING QUALITY IN AQUACULTURE: AN APPLICATION OF THE SELF-ORGANIZING MAP TO THE STUDY OF SKELETAL ANOMALIES AND MERISTIC COUNTS IN GILTHEAD SEABREAM (SPARUS AURATA, L. 1758)

T. Russo, L. Prestinicola, M. Scardi, E. Palamara, S. Cataudella, C. Boglione-2010

Journal of Applied Ichthyology 26(2): 360 – 365

Abstract:

One of the most common drawbacks of artificial life conditions imposed by aquaculture is the quite high presence of skeletal anomalies (SAs) in reared fish, which reduce both functional performances and marketing image/commercial value of the reared lots. Thus, skeletal malformations and their incidence are one of the most important factors affecting fish farmer's production costs, and several efforts have been due to develop appropriate tools in detecting patterns of co-variation among rearing parameters and fish quality. In this paper we explore the advantages of using Self-Organized Maps (SOMs) when dealing with the analysis of correlations between the pattern of SA presence and rearing

parameters in gilthead seabream (*Sparus aurata* L.), that is a largely reared fish of high commercial value. SOM, which is one of the best known neural networks with unsupervised learning rules, were applied to develop a model of the occurrence of SAs, both in terms of type and quantity, in seabream lots from different rearing approaches (extensive, semi-intensive and intensive). The trained SOMs classified lots according to the variation observed in the different weights of SAs, but also allows the detection of a series of correspondences, namely between: (i) the pattern of SAs occurrence and the different rearing approach currently used in seabream aquaculture; and (ii) the total SAs incidence and the variability of meristic counts, represent a completely independent dataset. Mesocosms resulted the best rearing approach to produce wild-like fish, whereas intensive rearing is characterized by the large presence of SA. Globally, results suggested that this approach is reliable to be used for estimate the distance between aquaculture products and the wild-like phenotype used as quality reference.

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EFFECT OF REARING TECHNIQUES ON SKELETAL DEFORMITIES AND OSTEOLOGICAL DEVELOPMENT IN RED PORGY *PAGRUS PAGRUS* (LINNAEUS, 1758) LARVAE

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Journal of Applied Ichthyology 26(2): 372 – 376

Abstract:

Red porgy is a candidate species for marine aquaculture diversification. The objective of the present study was to describe the osteological development in this species and the occurrence of skeletal deformities in relation to the intensification of the rearing system. Fish samples were periodically collected along the development from hatching to juveniles (95 days after hatching). Osteological development and the presence of skeleton abnormalities were evaluated. Larvae reared under S-IS showed a better growth in terms of total length in comparison with IS reared ones. Regarding to osteological development for red porgy, this was similar between fish from both culture systems, but differing in timing of apparition and ossification of skeletal elements. X-ray studies revealed a high number of fish with skeletal deformities (Semi-intensive: 38.8%; Intensive: 46.5%), but no significant effect of the rearing technique on the incidence of deformities such as lordosis or fused vertebrae was found. However, cranial abnormalities and kyphosis incidences were significantly higher in intensive system cultured red porgy. These results, suggest a relationship among rearing technique, osteological development and the apparition of certain deformities.

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SHORT COMMUNICATION

EFFECTS OF SALINITY ON SURVIVAL AND Na^+/K^+ ATPASE ACTIVITY OF OBSCURE PUFFER *TAKIFUGU OBSCURUS* EMBRYOS

Z. Yang, J. J. Li, W. Gu, Y. Liu, W. Wang, R. X. Guo, G. X. Qin, Y. F. Chen-2010

Journal of Applied Ichthyology 26(3): 449 – 452

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SHORT COMMUNICATION

EFFECT OF SALT ADDITION AND FEEDING FREQUENCY ON *CASCUDO PRETO* RHINELEPIS ASPERA (PISCES: LORICARIIDAE) LARVICULTURE

By R. K. Luz, J. C. E. dos Santos-2010

Journal of Applied Ichthyology 26(3): 453 – 455

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HARVESTING CHLORELLA MINUTISSIMA USING CELL COAGULANTS

Aikaterini Papazi, Pavlos Makridis, Pascal Divanach-2010

Journal Journal of Applied Phycology 22(3): 349-355

Abstract :

Twelve salts were tested for their ability to coagulate microalgae cells in cultures of *Chlorella minutissima*. The final aim was to develop an easy and efficient approach for harvesting microalgae biomass in dense cultures. Aluminum, ferric, and zinc salts coagulated *C. minutissima* cultures, while optimum concentration was 0.75 and 0.5 g L⁻¹ for sulfate and chloride salts, respectively. Aluminum salts were most efficient, but caused some cell lysis, which may render this approach inappropriate in some cases. Ferric and zinc salts were ranked second and third, respectively, according to their culture cell-coagulation efficiency. Ferric salts caused a change in the color of the cells, mainly at concentrations higher than 1 g L⁻¹. Zinc salts were less harmful for the microalgal cells, but an additional problem was observed with cell aggregates adhering to the walls of the glass test tubes. Selection of the appropriate coagulant is related to the purpose of the coagulation process.

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POTENTIAL USE OF THE ASTAXANTHIN-PRODUCING MICROALGA, MONORAPHIDIUM SP. GK12, AS A FUNCTIONAL AQUAFEED FOR PRAWNS

Katsuhiko Fujii, Hisatoshi Nakashima, Yumiko Hashidzume, Terumasa Uchiyama, Kenzo Mishiro, Youji Kadota-2010

Journal Journal of Applied Phycology 22(3): 363-369

Abstract :

We determined the nutritional profile of *Monoraphidium* sp. GK12, a newly isolated astaxanthin (AXA)-producing microalga, and investigated its potential use as a functional aquafeed by evaluating its effect on prawn pigmentation. GK12 contained high levels of pantothenic acid. The β -carotene content of GK12 was higher than that of *Haematococcus*, a well-studied AXA producer, and was similar to that of *Spirulina*. GK12 also had a high content of unsaturated fatty acids, of which linolenic acid (C18:3 n-3) was the most plentiful. A GK12-containing feed resulted in significant pigmentation of the prawns, comparable to that of prawns fed on synthetic AXA or *Haematococcus*. A GK12-containing feed also increased the survival rate of the prawns. Therefore, in addition to improving cultivation methods for *Haematococcus*, further research is needed into the use of GK12 as an alternative AXA source and as an ingredient of functional aquafeed for farmed fish.

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UV PROTECTIVE COMPOUNDS TRANSFERRED FROM A MARINE DINOFLAGELLATE TO ITS COPEPOD PREDATOR

Samuel Hylander, Therese Jephson-2010

Journal of Experimental Marine Biology and Ecology 389(1-2): 38-44

Abstract:

Planktonic organisms living in surface waters can be exposed to harmful levels of ultraviolet radiation (UVR), but few studies have examined accumulation of UV protective compounds in marine zooplankton. Zooplankters are suggested to lack the ability to synthesize these substances and hence must accumulate them from their algal food. Here, we show that both phytoplankton (dinoflagellates) and their zooplankton grazers (copepods) respond strongly to UVR exposure by, respectively, synthesizing and accumulating the natural sunscreens mycosporine-like amino acids (MAAs). In our experiment, the MAAs content increased approximately four times in dinoflagellates exposed to UVR and PAR, as compared to non-UVR controls only receiving PAR (PAR = photosynthetically active radiation). The elevated MAAs level in the dinoflagellates was mirrored in the copepods, which accumulated more MAAs when exposed to UVR as compared to a non-UVR treatment. Overall,

copepods accumulated approximately 2–5% of the total MAAs pool. Other UV protective compounds, like carotenoids, were however not accumulated by the copepods. The ability of some species to produce or accumulate photoprotective compounds may lead to increased fitness, and thus these taxa may become more dominant in plankton communities.

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USING EXPERIMENTAL ECOLOGY TO UNDERSTAND STOCK ENHANCEMENT: COMPARISONS OF HABITAT-RELATED PREDATION ON WILD AND HATCHERY-REARED *PENAEUS PLEBEJUS* HESS

Faith Ochwada-Doyle, Charles A. Gray, Neil R. Loneragan, Matthew D. Taylor-2010

Journal of Experimental Marine Biology and Ecology 390(1): 65-71

Abstract:

Marine stock enhancement is often characterized by poor survival of hatchery-reared individuals due to deficiencies in their fitness, such as a diminished capacity to avoid predators. Field experiments were used to examine predation on *Penaeus plebejus*, a current candidate for stock enhancement in Australia. We compared overall survival of, and rates of predation on, wild *P. plebejus* juveniles, naïve hatchery-reared juveniles (which represented the state of individuals intended for stock enhancement) and experienced hatchery-reared juveniles (which had been exposed to natural predatory stimuli). Predation was examined in the presence of an ambush predator (*Centropogon australis* White, 1790) and an active-pursuit predator (*Metapenaeus macleayi* Haswell) within both complex (artificial macrophyte) and simple (bare sand and mud) habitats. Overall survival was lower and rates of predation were higher in simple habitats compared to complex habitats in the presence of *C. australis*. However, the three categories of juveniles survived at similar proportions and suffered similar rates of predation within each individual habitat. No differences in survival and rates of predation were detected among habitats or the categories of juveniles when *M. macleayi* was used as a predator. These results indicate that wild and hatchery-reared *P. plebejus* juveniles are equally capable of avoiding predators. Furthermore, exposure of hatchery-reared juveniles to wild conditions does not increase their ability to avoid predators, suggesting an innate rather than learned anti-predator response. The lower predation by *C. australis* in complex habitats was attributed to a reduction in this ambush predator's foraging efficiency due to the presence of structure. Ecological experiments comparing wild and hatchery-reared individuals should precede all stock enhancement programs because they may identify deficits in hatchery-reared animals that could be mitigated to optimize survival. Such studies can also identify weaknesses in wild animals, relative to hatchery-reared individuals, that may lead to the loss of resident populations.

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