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STRAIN-SPECIFIC VITAL RATES IN FOUR ACARTIA TONSA CULTURES II: LIFE HISTORY TRAITS AND BIOCHEMICAL CONTENTS OF EGGS AND ADULTS

Guillaume Drillet, Per M. Jepsen, Jonas K. Højgaard, Niels O.G. Jørgensen, Benni W. Hansen-2008
Aquaculture 279(1-4): 47-54

Abstract:

The need of copepods as live feed is increasing in aquaculture because of the limitations of traditionally used preys, and this increases the demand for an easy and sustainable large-scale production of copepods. In this study, 4 strains of the copepod *Acartia tonsa* Dana, 1849 were compared in a common garden experiment to identify a strain with life history traits essential for sustainable mass cultivation of copepods and to identify a strain which produces preys with a highly valuable chemical composition. The strains originated from 4 coastal sites in Øresund, Denmark (DIFRES), Kiel, Germany (KIEL), Turkey Point, Florida, USA, and Mobile Bay, Alabama, USA. Stage development and mortality were analysed at 17 °C, 34 ppt. When the copepods reached adulthood, individual females were isolated to determine the egg production and hatching success. The biochemical contents of both eggs and adults were evaluated for all strains. The DIFRES and Alabama strains had both shorter generation time (13.7 and 14.6 d⁻¹, respectively) and lower mortality (4.0 and 5.7% d⁻¹, respectively) than other strains, making them attractive for mass cultivation. Strain-specific patterns were observed in egg production, with highest productivity observed in the DIFRES strain. Hatching success of the eggs ranged from 47.3 to 83.6% in the DIFRES, Kiel and Alabama strains, but showed reduced hatching in the Florida strain (1.6 to 7.2%). The strains had similar total free amino acids (FAA) content in the eggs in comparison to their dry weight (6–8%). In general, the FAA pattern of the eggs was dominated by Proline, while the females had a more diffuse FAA pattern. The fatty acid ratio between DHA and EPA in the eggs was lowest for the Florida strain (0.82) and highest in the Alabama strain (1.48), and adults had even higher ratios (2.1 to 2.45). Apart from the low DHA/EPA ratio in the Florida eggs, we find that all the strains met nutritional values needed for the first feeding of marine finfish larvae. However, essential criteria for mass cultivation such as fast development, low mortality and high egg production led us to recommend the use of the DIFRES strain of *A. tonsa* under the present growth conditions. A study to

optimize the copepod cultivation to meet industry's criteria should include deliberate selection pressure on copepod to promote the needed traits for first feeding of finfish larvae. (Technical University of Denmark, Danish Institute for Fisheries Research, Dept. of Marine Ecology and Aquaculture, Kavalergården 6-2920 Charlottenlund, Denmark;; email of Guillaume Drillet: gdr@difres.dk)

INFLUENCE OF LIGHT INTENSITY ON FEEDING, GROWTH, AND EARLY SURVIVAL OF LEOPARD CORAL GROUPER (PLECTROPOMUS LEOPARDUS) LARVAE UNDER MASS-SCALE REARING CONDITIONS

Kenzo Yoseda, Kazuhisa Yamamoto, Kimio Asami, Masayuki Chimura, Koji Hashimoto, Shinichi Kosaka-2008

Aquaculture 279(1-4): 55-62

Abstract:

This study investigated the effect of different light intensities on feeding, growth and survival of early stage leopard coral grouper *Plectropomus leopardus* larvae. Four different light intensities (0, 500, 1000 and 3000 lx) were used and larvae were kept under constant light conditions from 0 day after hatching (DAH) to 5 DAH. The larvae were fed a small S-type of Thai strain rotifers at a density of 20 individuals/mL from 2 DAH. The number of rotifers in larval digestive organ and total length of larvae were examined at 3 h intervals between 04:00 and 22:00 h on 3 DAH, and thereafter at 6 h intervals until the end of the experiment (5 DAH). Four experimental trials of the larval rearing were repeated using by 60 kL mass-scale rearing tanks. The results indicate that coral grouper larvae are visual feeders and their food intake increases with increasing light intensity. Food intake of larvae reared at 3000 lx was significantly higher than those reared at 0–1000 lx on 3 DAH despite being the first-feeding day ($P < 0.01$). On 4 DAH, total length of larvae reared at 3000 lx was significantly larger than those reared at the lower light intensities (0, 500 and 1000 lx), and thereafter light intensity significantly influenced larval feeding and growth until the end of the experiment. Survival on 5 DAH did not show a significant difference between light intensities, but survival rate at 3000 lx and 1000 lx had a tendency to be higher than those reared at the lower light intensities (0 and 500 lx). In contrast, larvae reared at 0 lx exhibited stagnant and/or negative growth. These results indicate that light intensity is significantly the factor affecting larval feeding, growth, and survival in coral grouper larvae under the rearing conditions.

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BIOCHEMICAL COMPOSITION AND QUALITY OF CAPTIVE-SPAWNED COBIA RACHYCENTRON CANADUM EGGS

Cynthia K. Faulk, G. Joan Holt-2008

Aquaculture 279(1-4): 70-76

Abstract:

Interest in the commercial production of cobia *Rachycentron canadum* continues to rise as additional insight is gained into the hardy and fast growing nature of this species. However, research regarding the biochemical composition of captive-spawned eggs and egg and larval quality remains scarce. Such data is essential as a common bottleneck to production is a steady supply of fingerlings for grow-out. This study quantified the biochemical composition and quality of cobia eggs produced over 2 spawning seasons by broodstock on a traditional 'trash fish' diet which is commonly fed to tank spawning cobia. Throughout the study, batch fecundity, proportion of floating eggs and percent hatch averaged > 1 million eggs, 0.8 and 70%, respectively. Batch fecundity was significantly higher during the second spawning season as a result of the increased size of the females which weighed 18/22 kg and 22/26 kg at the beginning of each season. A positive correlation was found between the proportion of floating eggs and hatch rate for both spawning seasons. No correlations were found between egg composition (total lipid ($30.0 \pm 1.1\%$ dry wt), protein ($25.4 \pm 2.2\%$ dry wt), carbohydrate ($2.4 \pm 0.3\%$ dry wt), vitamin E ($10.2 \pm 0.6 \mu\text{g/g}$ wet wt) or dry weight ($119.1 \pm 5.5 \mu\text{g/egg}$)) and egg quality (proportion of floating eggs, hatch rate, larval growth and larval survival). Further, no

differences in egg composition were noted between seasons or over the course of each season. The fatty acid composition of cobia eggs varied between seasons possibly due to changes in the quality of frozen feed (fish, shrimp, squid) given to the broodstock. The only correlation between the fatty acid profile and egg quality was a decrease in the proportion of floating eggs as the total amount of n-3 highly unsaturated fatty acids increased. No relationship between egg quality and amino acid content was noted with the most prominent amino acids being glutamate, leucine, alanine, proline, lysine and aspartate nor were any differences detected between spawning seasons.

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FIELD AND LABORATORY PILOT REARING EXPERIMENTS WITH EARLY ONTOGENIC STAGES OF *CONCHOLEPAS CONCHOLEPAS* (GASTROPODA: MURICIDAE)

Patricio H. Manríquez, Alejandro P. Delgado, Maria Elisa Jara, Juan Carlos Castilla-2008

Aquaculture 279(1-4): 99-107

Abstract:

The carnivorous gastropod *Concholepas concholepas*, known in Chile as “loco”, is a species present only along the Chilean coast line and in central-southern Perú showing high economic and ecological importance. Its fishery, which in the past decades has ranged between 828 (2001) and 24,828 (1980) metric tons per year [SERNAP, 2005. Servicio Nacional de Pesca: Anuarios estadísticos. (http://www.sernap.cl/paginas/publicaciones/anuarios/index_anuario.php)], is based exclusively on the exploitation of wild stocks. So far, there has been limited interest in tackling the biological and technical feasibility of cultivation of *C. concholepas*. Hence, the knowledge about its early ontogenetic stages (i.e., larval, early postmetamorphic and small juvenile) cultivation is still deficient. In this study we investigated, under laboratory and field conditions, *C. concholepas* survivorship, growth rates, feeding rates and the onset of sexual reproduction. Competent loco's larvae were collected in the field and metamorphosed in the laboratory to assess growth rates and survivorship during the first six months of postmetamorphic life. Moreover, using small juvenile *C. concholepas* of ca. 20 mm of peristomal length, collected in the field, we monitored for the body size and live weight traits in laboratory and field rearing conditions. The feeding of the early postmetamorphics and small juveniles was exclusively based in mono diets of the mussel *Semimytilus algosus*. The rearing of small juveniles was conducted in two consecutive phases, using two specially designed rearing apparatus. The biochemical content of our laboratory cultivated specimens was compared with values obtained from specimens collected in natural habitats. Their rapid growth and good survivorship makes this species suitable for rearing of cocktail-size specimens (50–60 mm) in less than a year. According to the growing rates reported in this study the legal commercial size of *C. concholepas*: 100 mm of PL would be reached under field and laboratory conditions in 1.65 and 2.64 years respectively. Moreover, it was found that in our rearing conditions *C. concholepas* reach sexual maturity in less than a year of benthic life. In summary, considering the findings about *C. concholepas* high growth rates, and low mortalities, we suggest that our rearing methodologies may be scaled up and implemented for the commercial aquaculture of this unique and valuable muricid.

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ENRICHING ROTIFERS WITH “PREMIUM” MICROALGAE. *ISOCHRYSIS* AFF. *GALBANA* CLONE T-ISO

Martiña Ferreira, Ana Maseda, Jaime Fábregas, Ana Otero-2008

Aquaculture 279(1-4): 126-130

Abstract:

The effect of semi-continuous culture on the nutritional value of microalgae was tested in the rotifer *Brachionus plicatilis* in short-term enrichment experiments. *Isochrysis* aff. *galbana* clone T-ISO was cultured semi-continuously with renewal rates from 10 to 50% of the volume of the culture per day

and used to feed the rotifers. After 24 h, dramatic differences in dry weight and protein, lipid and carbohydrate contents were observed in the rotifers depending on the renewal rate applied to the microalgal culture. Rotifers fed T-ISO cultured with low renewal rates showed low dry weight and organic content, whereas rotifers fed microalgae from nutrient-sufficient, high renewal rate cultures showed higher dry weight and increases up to 60% in protein, 35% in lipid and 100% in carbohydrate contents. Feed conversion rate (FCR) and organic FCR decreased with increasing renewal rates, indicating a more efficient assimilation of the microalgal biomass obtained at high growth rates. The fatty acid profile of rotifers reflected that of T-ISO, with maximum content of polyunsaturated fatty acids (PUFAs), n-3 fatty acids and docosahexaenoic acid (DHA) being found in the rotifers fed microalgae from the renewal rate of 40%. Results demonstrate that the biochemical composition of *B. plicatilis* is strongly modified through the use of semi-continuous cultures of microalgae in short-term enrichment processes. This technique provides an excellent tool to improve the nutritional value of the live feed used in fish larvae cultures.

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ASPECTS OF GAMETOGENESIS, OOCYTE MORPHOLOGY AND MATURATION OF THE LUGWORM *ARENICOLA MARINA* (ANNELIDA: POLYCHAETA) IN RELATION TO COMMERCIALISED PROCEDURES TO EXTEND THE BREEDING SEASON

K.A. Betteley, G.J. Watson, L. Hannah, M.G. Bentley-2008

Aquaculture 279(1-4): 131-141

Abstract:

Environmental manipulation is a common method of extending the spawning season of aquaculture species including the polychaete worm *Arenicola marina*. Temperature synchronises autumn spawning populations and so its manipulation was used to advance and delay spawning. Females were exposed to a minimum period of 3 weeks at 5 °C in conjunction with the injection of prostomial homogenate to induce spawning up to 4 weeks prior to the natural spawning date. We also maintained individuals at 15–17 °C starting 4 weeks prior to, and then continuing after the natural spawning date, delaying spawning for up to 4 months. Both sexes can be manipulated, but males suffered higher mortalities and a greater rate of spontaneous spawning within the tanks. In ‘advanced’ females, mean oocyte diameters (measured in September, one month prior to spawning) were significantly larger and more homogenous compared to ambient individuals, whilst ‘delayed’ females produced a second cohort of oocytes approximately 8 weeks into the treatment. Delaying and advancing spawning induced significant changes in the ultrastructural morphology of prophase and metaphase oocytes, and delayed prophase oocytes showed a significant increase in the number with cracks on the surface of the vitelline membrane. Although, SDS-PAGE and Western blots confirmed that Maturation Promoting Factor (MPF) activity was not different from ambient controls, there were significant changes in MPF activity levels (measured by histone kinase activity) in manipulated oocytes. *A. marina* has the plasticity for spawning to be delayed and advanced by a number of months; this is essential for the continued development of aquaculture of this species. However, the maturational ability of the oocytes is compromised and this may have significant implications for production and quality of the offspring from manipulated individuals.

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ONTOGENY OF THE DIGESTIVE TRACT OF THICK LIPPED GREY MULLET (*CHELON LABROSUS*) LARVAE REARED IN “MESOCOSMS”

Dora Zouiten, Ines Ben Khemis, Raouf Besbes, Chantal Cahu-2008

Aquaculture 279(1-4): 66-172

Abstract:

This work describes the ontogeny of the digestive tract in thick lipped grey mullet (*Chelon labrosus*) larvae reared until day 36 post-hatching with the semi-extensive technology in mesocosms. Diet was constituted by live preys, rotifers, *Artemia* and wild zooplankton, then compound diet was added from

day 20 (p. h.). Linear growth, weight growth and digestive enzymes specific activities were studied during larval ontogeny. Pancreatic enzymes (trypsin and amylase) and intestinal enzymes (leucine-alanine peptidase “Leu-ala”, aminopeptidase N “AN” and alkaline phosphatase “AP”) were assayed in larvae sampled throughout the rearing trial to evaluate gastrointestinal maturation along the development.

The trypsin specific activities were very high during the first two weeks and then declined as observed in marine fish species. A following increase in trypsin specific activity from day 20 was attributed notably to ingestion of particle compound diet. In contrast to the pattern generally described in fish larvae, amylase specific activity showed a continuous increase. This could be attributed to the fact that *C. labrosus* is an omnivorous species and suggests that the fish might be able to use efficiently diets containing higher levels of starch or other carbohydrates since the end of larval development.

Relative expression of intestinal brush border membrane enzymes (AP and AN) and cytosolic enzyme (Leu-ala), showed an abrupt increase of both AP/leu-ala and AN/leu-ala ratios at day 8 (p. h.), indicating that maturation of intestinal tract in *C. labrosus* larvae is particularly precocious. It is assumed that larvae of *C. labrosus* might support early co-feeding and weaning strategies, which could reasonably be initiated since mouth opening.

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DEVELOPMENT OF CRYOPRESERVATION FOR MAINTAINING YELLOW CATFISH PELTEOBAGRUS FULVIDRACO SPERM

Jianlin Pan, Shuyan Ding, Jiachun Ge, Weihui Yan, Chen Hao, Jianxiu Chen, Yahong Huang-2008
Aquaculture 279(1-4): 173-176

Abstract:

Yellow catfish (*Pelteobagrus fulvidraco*) is a candidate freshwater fish for aquaculture in China with its high consumer demand. The aim of this study was to examine the possibility of storage of the sperm of yellow catfish by cryopreservation in liquid nitrogen. Experiments were designed to investigate the effects of the different combinations of three extenders (Ringer extender, Kurokura-1 extender and D-15 extender) and three cryoprotectants (DMSO, Glycerol and Methanol) on the cryopreservation of yellow catfish sperm. Post-thaw sperm motility, fertilization and hatching rate were detected to evaluate the reliability of sperm cryopreservation. The results demonstrated that Ringer extender and 10% methanol was the best combination for protecting the sperm during freezing in liquid nitrogen by a three-step method and thawing in a water bath at 37 °C for 60 s. In this combination for cryopreservation, sperm maintained the highest post-thaw motility ($65 \pm 5\%$), fertilization ($90.47 \pm 3.67\%$) and hatching rate ($88 \pm 4\%$). And more interestingly, the fertilization and hatching rate were similar to those of fresh sperm ($97.55 \pm 2.74\%$ and $92 \pm 5\%$). Successful sperm cryopreservation techniques for yellow catfish have been developed for hatchery purpose.

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IDENTIFICATION OF SINGLE NUCLEOTIDE POLYMORPHISM CYTOCHROME P450-C19A AND ITS RELATION TO REPRODUCTIVE TRAITS IN JAPANESE FLOUNDER (PARALICHTHYS OLIVACEUS)

Feng He, Hai S. Wen, Shuang L. Dong, Bao Shi, Cai F. Chen, Lian S. Wang, Jun Yao, Xing J. Mu, Yu G. Zhou-2008

Aquaculture 279(1-4): 177-181

Abstract:

CYP19 is considered as an important factor affecting reproductive endocrinology in many fishes, and plays an important role in ovarian development, reproductive function and sexual differentiation. In this study, three single nucleotide polymorphisms (SNPs) within CDS of the CYP19a gene were tested and the associations between their genotypes and four reproductive traits were analyzed in 65 Japanese flounder individuals with Polymerase chain reaction and Single-stranded conformational polymorphism (PCR-SSCP). Results indicated that a SNP in the exon7 of CYP19a gene, SNP2, was

significantly associated with 17 β -estradiol (E2) ($P < 0.05$) and gonadosomatic index (GSI) ($P < 0.05$). Individuals with genotype AB of SNP2 had significantly higher serum E2 levels ($P < 0.05$) and GSI ($P < 0.05$) than those of genotype AA or BB. In addition, there was significant association between one diplotype based on three SNPs and reproductive trait. The genetic effects for both serum E2 of diplotype D9 and GSI of diplotype D1 were respectively much higher than those of other diplotypes ($P < 0.05$). The evidence of the associations between genetic variants with serum E2 and GSI may help explain effects of CYP19a gene in reproductive endocrinology of Japanese flounder.

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THE EXISTENCE OF GONADOTROPIN-RELEASING HORMONE (GNRH) IMMUNOREACTIVITY IN THE OVARY AND THE EFFECTS OF GNRHS ON THE OVARIAN MATURATION IN THE BLACK TIGER SHRIMP *PENAEUS MONODON*

Apichart Ngernsoungnern, Piyada Ngernsoungnern, Wattana Weerachatanukul, Jittipan Chavadej, Prasert Sobhon, Prapee Sretarugsa-2008

Aquaculture 279(1-4): 197-203

Abstract:

Immunocytochemical localization using antibodies against five isoforms of gonadotropin-releasing hormone (GnRH), namely, luteinizing hormone-releasing hormone (LHRH), salmon (s)GnRH, octopus (oct)GnRH, lamprey (l)GnRH-I, and lGnRH-III, showed that only lGnRH-I immunoreactivity (ir-lGnRH-I) was localized in follicular cells of proliferative, vitellogenic, and mature ovaries. The effects of exogenous GnRHs on the ovarian maturation cycle of *Penaeus monodon* were compared by treating female broodstocks with LHRH, sGnRH, and lGnRH-I. The cycle of ovarian maturation in both eyestalk-ablated and eyestalk-intact shrimp administered with the three isoforms of GnRH was significantly shorter than that of the control animals. Moreover, administrations of all GnRH isoforms showed similar numbers of spawned eggs and the percentage of successful fertilization as in the control animals. These findings suggest that GnRHs may be highly conserved peptides that play an important role in inducing the ovarian maturation in the shrimp.

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MORPHOLOGICAL CHARACTERIZATION OF ARCTIC CHAR, *SALVELINUS ALPINUS*, EGGS SUBJECTED TO RAPID POST-OVULATORY AGING AT 7 °C

Nabil Mansour, Franz Lahnsteiner, Mary A. McNiven, Gavin F. Richardson-2008

Aquaculture 279(1-4): 204-208

Abstract:

Egg quality in Arctic char, *Salvelinus alpinus*, kept indoors at 7 °C during spawning season was morphologically classified. Four egg categories based on lipid droplet distributions and egg diameter were characterized. Eggs with homogenous lipid vesicle distributions and a uniform size were classified as Good. Eggs with some yolk lipid droplets coalesced toward one pole but were homogeneous in size were classified as Fair. Eggs with lipid vesicles that were usually coalesced at one or two poles with were classified as Poor. The fourth egg category was Heterogeneous, in which lipid vesicle distribution and egg size were inhomogeneous. This distribution pattern of the lipid vesicle had a strong relationship with the percentage of fertilized and eyed eggs. Percentages of fertilized and eyed eggs in Good and Fair eggs were 85.5 and 83.4; 30.2 and 28.2, respectively. With Poor and Heterogeneous eggs, the percentages of fertilized and eyed eggs were zero. Egg diameter and absolute weight was increased in Poor eggs than in other egg categories. Relative weight increase during hardening after 30, 45 and 60 min were higher in Good and Fair eggs than in Poor and Heterogeneous eggs. Ovarian fluid collected from egg batches with low rates of fertilized and eyed eggs (Heterogeneous and Poor) had a lower pH and higher protein and aspartate amino-transferase enzyme than ovarian fluid from eggs batches classified as Good or Fair, while the ovarian fluid osmolality did not significantly differ. ATP contents of Poor and Heterogeneous eggs were lower than

for Good and Fair eggs. In Heterogeneous eggs, both ATP and acid phosphatase contents were very variable.

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EFFECTS OF SILVERING STATE ON INDUCED MATURATION AND SPAWNING IN WILD FEMALE JAPANESE EEL *ANGUILLA JAPONICA*

Akihiro Okamura, Yoshiaki Yamada, Noriyuki Horie, Tomoko Utoh, Naomi Mikawa, Satoru Tanaka, Katsumi Tsukamoto-2008

Fisheries Science 74(3): 642-648

Abstract:

The effects of silvering state of wild female Japanese eels *Anguilla japonica* on the success of induced maturation and the following spawning were examined. Thirty-eight females, collected in Mikawa Bay, were divided into four stages based on their silvering state: yellow (Y1), late-yellow (Y2), silver (S1) and late silver eels (S2). Despite injections of salmon pituitary extract (SPE) through the standard technique, Y1 and Y2 eels did not respond to the treatment with undeveloped gonad (gonad-somatic index [GSI]: 0.3–0.9), and all these females died by 5 weeks, probably due to an abnormal physiological condition. Most S1 (81%) and S2 eels (100%) matured completely (GSI: 17.8–51.4), and finally spawned successfully (69% for S1, 89% for S2). S2 eels fully matured with oocytes of over 750 μm in diameter by significantly smaller number of injections of SPE (5–6 times) than the case of S1 eels (6–8 times). The amount of eggs released by S2 eels (0.65 ± 0.11 g/fish per body weight [BW]) was significantly larger than those by S1 eels (0.54 ± 0.09 g/fish per BW). There was no difference in fertilization and hatching rates between eggs released by S1 eels and those of S2 eels. These results indicate that the success of induced maturation and spawning in wild female Japanese eels depends on their silvering state, and matured eggs can be obtained efficiently through the use of S2 eels rather than other stages.

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EFFECT OF COMBINATION FEEDING OF NANNOCHLOROPSIS AND FRESHWATER CHLORELLA ON THE FATTY ACID COMPOSITION OF ROTIFER BRACHIONUS PLICATILIS IN A CONTINUOUS CULTURE

Takayuki Kobayashi, Toshiya Nagase, Akinori Hino, Toshio Takeuchi-2008

Fisheries Science 74(3): 649–656

Abstract:

A continuous culture of rotifer was conducted to investigate the effect of combination feeding of both a high density of *Nannochloropsis oculata* (N) and condensed freshwater *Chlorella* (FC) on the fatty acid composition of L-type rotifer *Brachionus plicatilis* in a continuous culture system. The algal feeding of the rotifers was carried out in three successive steps: N-feeding \rightarrow N+FC-feeding \rightarrow FC-feeding. The culture was conducted at 24°C and 25–27 psu in a 2000 mL bottle with 50% of water exchanged daily. The combination N+FC-feeding was effective in increasing rotifer density. The rotifers fed on N+FC (N+FC-R) had more non-polar lipids than polar ones, similar to those on N (N-R), opposite to the rotifers fed on FC (FC-R). N+FC-R contained higher levels of 16:2, 18:2n-6 (linoleic acid [LA]) and 20:2n-6, but lower levels of 18:1, 20:4n-6 (arachidonic acid), 20:5n-3 (eicosapentaenoic acid [EPA]) and 22:5n-3 (docosapentaenoic acid [DPA]) compared with N-R. Whereas N+FC-R contained higher levels of 16:1n-7, EPA and DPA, but lower levels of 16:2 and LA compared with FC-R. N+FC-R had more DPA in polar lipids than in non-polar ones. The $\Sigma\text{n-6}/\Sigma\text{n-3}$ ratio in N+FC-R was 0.9–1.0, significantly different from those in N-R (0.4) and FC-R (6.6–8.4). Therefore, it is inferred that the fatty acid profile of the N+FC-R cultured in a continuous culture system was affected by both N and FC. Also, the combination N+FC-feeding may be effective in manipulating the $\Sigma\text{n-6}/\Sigma\text{n-3}$ ratio in continuously cultured rotifers.

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SURVIVING ABILITY IN ALBINO NEWLY HATCHED LARVAE OF JAPANESE FLOUNDER DETERMINED BY HIGH SALINITY TOLERANCE

Yukinori Shimada, Tadahisa Seikai-2008

Fisheries Science 74(3): 687–689

The salinity tolerance test has been used to explain the osmotic control of euryhaline fish such as coho salmon *Oncorhynchus kisutch*,^{1,2} ayu *Plecoglossus altivelis*³ and guppy *Poecilia reticulata*.⁴ Conversely, stenohaline marine fishes such as Japanese flounder *Paralichthys olivaceus* and red sea bream *Pagrus major* have been used to investigate the change of salinity tolerance corresponding to the ecologic change during metamorphosis,⁵ and to evaluate the comprehensive healthiness under environmental stress.^{6,7}

The appearance of the albino flounder was reported by Shikano,⁸ and they were found from the seedling production for restocking. Although we believe that albinos, showing brighter body colors than wild type (including hetero and normal genotypes) with red eyes, have not been released, because albinos are easily distinguished from wild type pigmentation by their body color, but caused by recessive heredity (Shimada and Seikai, unpubl. data, 2004-2006), there is a strong possibility that individuals with genotype of hetero were released with those of normal genotype. To explore the surviving ability of albino flounder in the wild, this study compared the surviving ability according to high salinity tolerance among albino, hetero and normal genotypes.

Since November 2002, albinos were reared as parental fish in the Research Center of Marine Bioresources, Fukui Prefectural University (Obama, Fukui), and their males and females matured in 2003 and 2004, respectively. Normal type parental fish, reared in captivity for at least two or three generations (approx. 20 years) at Fukui Prefectural Sea Farming Center (Obama, Fukui), were used as brood fish with completely normal genotype. I performed the 2×2 diallel mating experiment in 2004 as follows: albino♀/ albino♂ (AAF1 family), albino♀/normal♂ (ANF2), normal♀/albino♂ (NAF3) and normal♀/normal♂ (NNF4), and created a total of four families. These families were maintained separately under common environmental conditions ($20 \pm 1^\circ\text{C}$ and 33.4 ± 0.1 psu) until 1 day after hatching (DAH), with continuous water flow and gentle aeration in 5 L tanks with a mesh bottom in a water bath (1000 L tank). Sixty to 90 individuals from each family were randomly extracted and used for the high salinity tolerance tests. The salinity of examined sea water was adjusted to 35 (control), 40, 45, 50 and 55 psu with artificial seawater salt, and tolerance ability of 1 DAH larvae in each salinity was examined in 6-well micropalate (20–30 individuals/well) as in a previous report.⁶ In the present study, the authors measured the surviving duration (day) in each salinity, and calculated mean surviving duration, and 50% lethal concentration (LC50) after 24, 48, 72 and 96 h. Each measurement was performed in triplicate.

The two-way ANOVA was used to compare the surviving ability for high salinity tolerance among families. Mean surviving duration was significantly different among salinity concentrations ($P < 0.0001$) and families ($P = 0.0026$), although salinity–family interaction was not significantly different ($P = 0.0735$) (Table 1). Therefore, Tukey-Kramer's post-hoc test was used to compare differences among salinity concentration and family in mean survival duration. Differences among salinity concentrations in mean surviving duration were significant in all combinations, except the combination between 50 and 55 psu, and differences among families were significant in combinations between NAF3 (hetero), and AAF1 (albino) and NNF4 (normal) ($P < 0.05$, Fig. 1). In addition, differences among families in higher salinity than 45 psu were not observed although trends of lower mean surviving duration of AAF1 (albino) than other families were observed in 35 and 40 psu (Fig. 1). Although LC50 was also significantly different among hours ($P < 0.0001$) and families ($P = 0.0182$), respectively, hour–family interaction was not significantly different ($P = 0.0722$). Differences among hours in LC50 were significant in all combinations except the combination between 72 and 96 h, and difference among families was significant between NAF3 (hetero), and AAF1 (albino) and NNF4 (normal) ($P < 0.05$, Fig. 2). In addition, LC50 after 24 and 48 h were not different among families, although those of normal family after 72 and 96 h showed the intermediate values between albino and hetero families (Fig. 2). This would mean that the surviving ability of albino was inferior to wild type pigmentation. However, in the guppy, salinity tolerance ability was increased by hybridization among strains according to the heterosis.⁹ Examined parental fish of

normal type in this study was used from inbred population for at least three generations. Therefore, normal family (NNF4) might show lower salinity tolerance than hetero families (ANF3 and NAF4) according to the inbreeding effect.

This study suggested a dangerousness that the albino gene is spreading through the releasing juveniles as genotype of hetero into the nature. The presence of albino gene as hetero individuals of wild stock should be investigated.

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SPONTANEOUS SPAWNING OF CAPTIVE RED SNAPPER, *LUTJANUS CAMPECHANUS*, AND DIETARY LIPID EFFECT ON REPRODUCTIVE PERFORMANCE

Nikolaos Papanikos, Ronald P. Phelps, D. Allen Davis, Amy Ferry, David Maus-2008

Journal of the World Aquaculture Society 39(3): 324-338

Abstract:

Two experiments addressed the spontaneous spawning of red snapper, *Lutjanus campechanus*, under controlled temperatures and photoperiods and the effect of broodstock diets supplemented with oils rich in polyunsaturated fatty acids. In Experiment 1, broodfish were fed a standard diet (ST1) and one enriched with menhaden oil (ER1) over a 355-d period. ER1-influenced egg fatty acid profile, however, did not positively influence egg production. Both diets produced highly viable eggs and larvae but results varied within treatments. In Experiment 2, broodfish were fed either a standard diet (ST2) or one supplemented with oils (ER2) rich in docosahexaenoic and arachidonic acid using a 203-d cycle. Both treatments produced eggs but fertilization rates ranged 0–10%. There was no clear influence of the diets on egg fatty acid profiles. These results indicate that red snapper can spawn spontaneously in tanks under controlled environmental conditions and produce viable eggs and larvae when fed diets based on squid, shrimp, and fish. The fatty acid composition of the diets was reflected in the eggs to some degree, but the oil enrichments did not further enhance the reproductive performance and egg quality under the conditions of this study.

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COMPARISON OF TWO ENVIRONMENTAL REGIMES FOR CULTURE OF AUSTRALIAN SNAPPER, *PAGRUS AURATUS*, LARVAE IN COMMERCIAL-SCALE TANKS

D. Stewart Fielder, Geoff L. Allan, Patricia M. Pankhurst-2008

Journal of the World Aquaculture Society 39(3): 364-374

Abstract:

The performance of Australian snapper, *Pagrus auratus*, larvae from 4 to 33 days posthatch (dph) under two environmental rearing regimes was evaluated in 2000-L commercial-scale larval rearing tanks (N = 3 tanks/treatment). The treatments were the following: (1) a varying regime of salinity (20–35 ppt), temperature (24 C), and photoperiod (12 light [L] : 12 dark [D] to swim bladder inflation and then 18L : 06D) and (2) a constant regime of salinity (35 ppt), temperature (21 C), and photoperiod (14L : 10D). The final total length (TL) and wet and dry weights (mean \pm SEM) of larvae grown in the varying regime were greater (15.6 \pm 0.5 mm; 42.4 \pm 3.4 mg wet weight; and 7.3 \pm 0.6 mg dry weight) than those of larvae grown in the constant regime (11.1 \pm 0.2 mm; 12.9 \pm 0.8 mg wet weight; and 2.1 \pm 0.2 mg dry weight). By 33 dph, larvae in the varying regime were fully weaned from live feeds to a formulated pellet diet and were suitable for transfer from the hatchery to a nursery facility. In contrast, larvae in the constant regime were not weaned onto a pellet diet and still required live feeds. Neither survival (Treatment 1, 14.2 \pm 3.0% and Treatment 2, 13.3 \pm 1.9%) nor swim bladder inflation (Treatment 1, 70.0 \pm 17.3% and Treatment 2, 70.0 \pm 11.5%, by 13 dph) was affected by rearing regime. The incidence of urinary calculi at 7 dph was greatest initially in the varying regime; however, by 19 dph, when larvae were 8.0 \pm 0.28 mm TL, very few larvae in this treatment had urinary calculi. In contrast, many larvae in the constant regime had developed urinary calculi and this continued until the end of the experiment. The incidence of urinary calculi was not associated with larval mortality. Extrapolation of the snapper larval growth curves for the constant larval rearing

regime predicts that a further 15–18 d, or approximately 1.5 times longer, will be required until these larvae attain the same size and development of larvae reared in the varying regime.
(Department of Primary Industries, Port Stephens Fisheries Centre, Taylors Beach Road, Taylors Beach, NSW 2316 Australia)

EFFECT OF ULTRAVIOLET IRRADIATION ON SPERM OF THE LEFT-EYED FLOUNDER, *PARALICHTHYS OLIVACEUS*

Feng You, Jianhe Xu, Xiangping Zhu, Yongli Xu, Peijun Zhang-2008

Journal of the World Aquaculture Society 39(3): 414-422

Abstract:

In this study, at proper dosage of ultraviolet (UV) irradiation (180 sec: 36,000 erg/mm²), sperm chromosomes of left-eyed flounder, *Paralichthys olivaceus*, were inactivated, while spermatozoa maintained ability to move and inseminate eggs. Gynogenetic haploids were detected by morphological observation, chromosome counting, and flow cytometer analysis. The ultrastructure of treated sperm was observed under scanning electronic microscope (SEM) and transmission electronic microscope (TEM). The results showed that after being irradiated at lower dosage of irradiation (0–180 sec: 0–36,000 erg/mm²), the surface structure of spermatozoa was not affected by UV irradiation, while the inner structures including membrane system and karyoplasm denseness of treated spermatozoa were little changed. However, obvious changes were observed in their membrane system, mitochondria, and nucleus if the dosage of irradiation increased to 240 sec: 48,000 erg/mm² or 300 sec: 60,000 erg/mm². The sperm survival rates did not change at the lower dosages of the UV irradiation (0–180 sec: 0–36,000 erg/mm²) but decreased as the irradiation dosage increased. The motility of treated sperm was lower than that of control group in general but did not change with UV irradiation dosage increasing at the certain range of 0–300 sec: 0–60,000 erg/mm².

(Key Laboratory of Experimental Marine Biology, Institute of Oceanology, Chinese Academy of Sciences, Qingdao 266071, China)

TIMING OF APPEARANCE OF LYMPHOID CELLS DURING EARLY DEVELOPMENT OF SENEGALESE SOLE, *SOLEA SENEGALENSIS* KAUP

Manuela Castro Cunha, Pavlos Makridis, Florbela Soares, Pedro Rodrigues, Maria T. Dinis-2008

Journal of the World Aquaculture Society 39(3): 436-439

Abstract:

The development of lymphoid tissues has been poorly studied in the early life stages of marine fish species (Chantanachookhin et al. 1991; Nakanishi 1991; Jósefson and Tatner 1993; Padrós and Crespo 1996). No reports can be found in the literature about the ontogenetic development of lymphoid tissues in Senegalese sole, which is a new fish species for aquaculture. Senegalese sole has a high potential for the industry because of its high growth rate in captivity, its high market price, and the low mortalities during the first feeding period (Dinis et al. 1999). The low rates of mortality during first feeding period and increased resilience of sole larvae to environmental stress compared with larvae of other marine fish species in culture, such as sea bream (*Sparus aurata*) and sea bass (*Dicentrarchus labrax*), could be attributed to an earlier development of the immune system. During the first stages of development, the fish immune system depends mainly on the nonspecific immune defenses (Ellis 1988). A first step for the evaluation of immunocompetence in fish larvae at early life stages is the determination of the appearance of the lymphoid tissues (Ellis 1988). The aims of this study were to examine the timing of appearance of the lymphoid organs in Senegalese sole during the early life stages and to follow the development of the lymphoid tissues during the first 4 mo under rearing conditions.

(Centre of Marine Sciences, University of Algarve, Campus of Gambelas, 8000-810 Faro, Portugal)

“GOOD” AND “BAD” DIATOMS: DEVELOPMENT, GROWTH AND JUVENILE MORTALITY OF THE COPEPOD *TEMORA LONGICORNIS* ON DIATOM DIETS

Marja Koski, Thomas Wichard, Sigrun H. Jónasdóttir-2008

Marine Biology 154(4): 719-734

Abstract:

We measured development, growth and juvenile mortality of the common copepod *Temora longicornis* on 11 different monospecific diatom diets in order to estimate (1) how common the negative effects of diatoms are on the development of this copepod and (2) whether the arrested development is connected to deleterious polyunsaturated aldehydes (PUA) or food nutritional quality. Four diatom species (*Thalassiosira weissflogii*, *Thalassiosira rotula* CCMP1647, *Leptocylindricus danicus* CCPM469 and *Skeletonema costatum* CCMP1281) supported complete development, whereas development failed in or before metamorphosis on seven diatom species/strains (*Chaetoceros affinis* CCMP158, *C. decipiens* CCMP173, *C. socialis*, *T. rotula* CCMP1018, *Thalassiosira pseudonana* CCMP1010 and CCMP1335). However, four out of these seven species were not ingested by nauplii, either due to morphology (*Chaetoceros* spp.) or large size (*T. pseudonana* CCMP1010). The growth rate did not correlate with the ingestion rate of PUA, neither with ingestion of food mineral (nitrogen) nor with biochemical (polyunsaturated fatty acids, sterols) components. We show that, although some diatoms are of inferior food quality, this is unlikely to be connected to toxicity or due to a direct limitation by a single food nutritional compound.

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A MORPHOLOGICAL AND STRUCTURAL STUDY OF THE LARVAL SHELL FROM THE ABALONE *HALIOTIS TUBERCULATA*

E. Jardillier, M. Rousseau, A. Gendron-Badou, F. Fröhlich, D. C. Smith, M. Martin, M.-N. Helléouet, S. Huchette, D. Doumenc, S. Auzoux-Bordenave-2008

Marine Biology 154(4): 735-744

Abstract: The larval shell of the marine gastropod *Haliotis tuberculata* was investigated by polarised light microscopy, scanning electron microscopy, Raman microspectroscopy and infra-red spectroscopy. Trochophore and veliger larval sections were used for histological examination of the growing shell and each larval stage was related to the shell development and the appearance of calcified formations. We determined the stage of initial calcification by specific staining combined with polarised light examination. The shell of 30-h-old pre-veliger larvae was found to be mineralized, confirming that calcification occurred before larval torsion. Using both infra-red and Raman spectroscopy, we showed that CaCO₃ deposition occurred at the pre-veliger stage and that the mineral phase initially deposited was essentially composed of aragonite.

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LIPID AND PROTEIN UTILISATION DURING EARLY DEVELOPMENT OF YELLOWTAIL KINGFISH (*SERIOLA LALANDI*)

Zoë Hilton, Carolyn W. Poortenaar, Mary A. Sewell-2008

Marine Biology 154(5): 855-865

Abstract:

The pelagic yellowtail kingfish *Seriola lalandi* has become a target species for aquaculture in Asia and Australasia. Australasian production is reliant on larviculture from eggs of captive brood stock; however, knowledge regarding the nutritional requirements of larvae of this species is still scarce, particularly in relation to lipids. As a first step in establishing these requirements, eggs and larvae from captive *S. lalandi* brood stock were examined for differences in total protein, total lipid and lipid classes between individual spawning events, over the spawning season, and during larval development from fertilisation to 15 days post hatch. Results indicate that total protein egg⁻¹ varied significantly between individual spawning events within a season, but neither total lipid nor total protein egg⁻¹ varied significantly across the spawning season. Brood stock egg lipids were made up of approximately 60% phospholipid, 25% wax and/or sterol esters (WE), 15% triacylglycerol (TAG), and small amounts of sterols and free fatty acids. During the early larval period, both WE and TAG were utilised concurrently for energy. The larvae experienced very high mortality around 5–7 days

post hatch, which coincided with very low levels of all neutral lipid classes. Although many other factors may also influence larval mortality, these results indicate that lipid provisioning may be an important factor in larval survival during the critical period around first-feeding in this species. Examination of ratios of TAG:ST, often used as a condition index in fish larvae, suggested that some of the larvae were suffering from starvation. However, as egg-derived WE appears to provide a significant source of energy during the early larval period in *S. lalandi*, it is suggested that WE should be included in any index of larval nutritional state.

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GENE EXPRESSION PATTERNS DURING THE LARVAL DEVELOPMENT OF EUROPEAN SEA BASS (*DICENTRARCHUS LABRAX*) BY MICROARRAY ANALYSIS

M. J. Darias, J. L. Zambonino-Infante, K. Hugot, C. L. Cahu, D. Mazurais-2008

Marine Biotechnology 10(4): 416-428

Abstract:

During the larval period, marine teleosts undergo very fast growth and dramatic changes in morphology, metabolism, and behavior to accomplish their metamorphosis into juvenile fish. Regulation of gene expression is widely thought to be a key mechanism underlying the management of the biological processes required for harmonious development over this phase of life. To provide an overall analysis of gene expression in the whole body during sea bass larval development, we monitored the expression of 6,626 distinct genes at 10 different points in time between 7 and 43 days post-hatching (dph) by using heterologous hybridization of a rainbow trout cDNA microarray. The differentially expressed genes ($n = 485$) could be grouped into two categories: genes that were generally up-expressed early, between 7 and 23 dph, and genes up-expressed between 25 and 43 dph. Interestingly, among the genes regulated during the larval period, those related to organogenesis, energy pathways, biosynthesis, and digestion were over-represented compared with total set of analyzed genes. We discuss the quantitative regulation of whole-body contents of these specific transcripts with regard to the ontogenesis and maturation of essential functions that take place over larval development. Our study is the first utilization of a transcriptomic approach in sea bass and reveals dynamic changes in gene expression patterns in relation to marine finfish larval development. (Ifremer, Nutrition Aquaculture and Genomics Research Unit, UMR 1067, Ifremer, Technopole Brest-Iroise, BP 70, 29280 Plouzané, France; email of D. Mazurais dmazurai@ifremer.fr)

THE ENCYSTED DORMANT EMBRYO PROTEOME OF *ARTEMIA SINICA*

Qian Zhou, Changgong Wu¹, Bo Dong, Fengqi Liu, Jianhai Xiang-2008

Marine Biotechnology 10(4): 438-446

Abstract:

The possibility of the brine shrimp *Artemia* to produce dormant embryo (cysts) in diapause is a key feature in its life history. In the present study, we obtained a proteomic reference map for the diapause embryo of *Artemia sinica* using two-dimensional gel electrophoresis with a pH range of 4–7 and a molecular weight range of 10–100 kDa. Approximately 233 proteins were detected, and 60 of them were analyzed by capillary liquid chromatography tandem mass spectrometry (LC–MS/MS). Of these, 39 spots representing 33 unique proteins were identified, which are categorized into functional groups, including cell defense, cell structure, metabolism, protein synthesis, proteolysis, and other processes. This reference map will contribute toward understanding the state of the diapause embryo and lay the basis and serve as a useful tool for further profound studies in the proteomics of *Artemia* at different developmental stages and physiological conditions.

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EFFECT OF 1,3;1,6- β -D-GLUCANS ON DEVELOPING SEA URCHIN EMBRYOS

Marina I. Kiseleva, Larissa A. Balabanova, Valery A. Rasskazov, Tatiana N. Zvyagintseva-2008
Marine Biotechnology 10(4): 466-470

Abstract:

The effect of 1,3;1,6- β -D-glucooligo- and polysaccharides with different structures (from 1 to 10 kDa of molecular mass; from 10–25% of β -1,6-linked glucose residues content) on the developing embryos of sea urchin, *Strongylocentrotus intermedius*, was evaluated for the screening of potential positive stimulants. 1,3;1,6- β -D-glucans with a molecular mass of between 6–10 kDa and at concentrations of 0.05–0.25 mg/ml shown the best modulator effect on the sea urchin embryos. 1,3;1,6- β -D-glucans increased the survival of the sea urchin embryos up to 2.5-fold compared with the control animals.

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TRANSLATED ABSTRACTS FROM CHINESE JOURNALS

Journal of Shanghai Fisheries University 08-1-2

1 The construction of androgenic gland cDNA library of malaysian giant prawn *Macrobrachium rosenbergii* and the partial screening of expressed sequence tags

LIU Ping, Qiu Gaofeng, ZHENG Liang, ZHANG Yu-ke

2 Sequence analysis of mitochondrial putative control region gene fragments of wild *Portunus trituberculatus* in four sea regions in China

FENG Bing-bing, LI Jia-le, NIU Dong-hong, CHEN Lin, ZHOU Zhi-qiang,
ZHENG Yue-fu, ZHENG Kai-hong

3 Construction of PCR-DGGE gene fingerprint for the gastrointestinal bacterial community in *Ephippus orbis*

ZHOU Zhi-gang, SHI Peng-jun, YAO Bing, HE Su-xu

4 Genetic diversity in *Parabramis pekinensis* from the lower reaches of the Yangtze River from RAPD analysis and mitochondrial D-loop sequences

LI Jian-lin, TANG Yong-kai, YU Ju-hua

5 MtDNA control region sequence structure of the genus *Coilia* in Yangtze River estuary

ZHU Ting-jun, YANG Jin-quan, TANG Wen-qiao

6 Isolation and characterization of novel microsatellite markers from an enriched mud carp (*Cirrhina molitorella*) genomic library

YANG Cheng, ZHU Xin-ping, HAO Jun, SUN Xiao-wen

7 Effect of four diets on reproductive performance of broodstock *Onchidium struma*

WU Xu-gan, TANG Bo-ping, TENG Wei-ming, CHENG Yong-xu, WANG Jin-feng, ZHOU Bo, HU Bing, YANG Xiao-zhen

8 Comparisons of morphological characters in *Hemibarbus labeo* of 1-2 year old and their correlations

LV Yao-ping

9 Fish composition and species biodiversity of the Beijing section of Juma River

YANG Wen-bo, LI Ji-long, LI Xu-xing, LIU Bao-xiang, SHEN Gong-ming, ZHANG Xiao hui, LEI Yun-lei, LI Xiao-shu, JIA Jing

- 10 Comparison on nutrient composition and morphology between wild and cultured *Synechogobius hasta*
LUO Zhi, LI Xiao-dong, BAI Hai-juan, YUAN Yong-chao, GONG Shi-yuan
- 11 Folic acid requirement for grass carp fingerling, *Ctenopharyngodon idella*
ZHAO Zhi-yong, WEN Hua, WU Fan, LIU An-long, JIANG Ming, LIU Wei
- 12 Effects of plants extracts on growth, factors associated with immunity and antioxidation, and disease resistance of allogynogenetic crucian carp (*Carassius auratus gibelio* var *erqisi*, Bloch)
LIU Bo, Zhou Qunlan, HE Yijin, HE qingguo, XIE Jun, XU Pao, ZHOU Ling
- 13 Availability of phosphorus in various inorganic phosphorus sources in dietary of *Hemibarbus maculatus* Bleeker
ZHAO Chao-yang, ZHOU Hong-qi, XU Pao, CHEN Jian-ming, YE Jin-yun, LI Hong-xia
- 14 Morphological variations and discriminant analysis of *Scomber japonicas* and *Scomber australasicus* in the Yellow Sea and East China Sea
SHAO Feng , CHEN Xinjun , LI Gang, QIAN Weiguo
- 15 The effect of ultrasonic wave on the growth of *Pseudobagrus vachelli*
FANG Jin , QIAN Wei-guo , LI Wei-chun, ZHOU Ying-qi
- 16 A primary study on characteristics of Chinese midwater trawls of Chilean jack mackerel (*Trachurus murphyi*)
XU Yongjiu, ZHANG Min. ZOU Xiaorong, ZOU Lijin
- 17 Studies on microbiological quality and safety characteristics of bottled crab paste in cold storage
MA Chao, XU Zhong, YANG Xian-shi
- 18 A simple model to calculate the defrosting electrical energy input and the ways to optimize the air cooler's electro thermal defrosting system
WAN Jin-kang, ZHANG Qing, CAO Guang-rong, LI Jian-guo, GONG Hai-hui
- 19 Features and the comparative analysis of the Sino US aquatic products trade
GUO Miao (College of Economics and Management, Shanghai Fisheries University, Shanghai 200090, China)
- 20 Effects of dietary selenium supplementation on the activities of two antioxidant enzymes in *Caridina denticulata sinensis* exposed to ambient parathion
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LIU Xianmin, LI Xingxing, LENG Xiangjun, LI Xiaoqin¹, WANG Xichang
- 22 Study on the performance of a direct expansion solar assisted heat pump system
LIU Li-ping , YIN Peng
- 23 Realization of communication between simens PLC and the LED Chinese display control card
WU Yanxiang, QI Qijun, WU Pengjie

24 Effects of feeding broad bean on growth , muscle composition and intestine protease activity of different sizes of grass carp, *Ctenopharyngodon idella*
LI Baoshan. LENG Xiang-jun. LI Xiaoqin. LIU Xianmin. HU Bin. LI Jiale

25 Effects of feeding broad bean on growth , muscle composition and intestine protease activity of different sizes of grass carp, *Ctenopharyngodon idella*
LI Baoshan. LENG Xiang-jun. LI Xiaoqin. LIU Xianmin. HU Bin. LI Jiale

26 Identification and phylogenetic analysis of pathogen *Ewardsiella tarda* from cultured turbot (*Scophthalmus maximus*)
YANG Chunzhi, WANG Xiuhua, HUANG jie

27 Studies on efficient methods of algae DNA isolation
HAN Jing, YU Shunwu, LUO Lijun

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1 Genetic structure and evolution characters in three populations of *Coilia mystus* based on cytochrome *b* gene segment sequence of mitochondrial DNA
CHENG Qiqun(Key Laboratory of Marine and Estuarine Fisheries Certificated by the Ministry of Agriculture, East China Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, Shanghai 200090, China), MA C, ZHUANG P, et al//J F C, 2008, 32(1). 1—7.

2 Analysis of mtDNA COII sequence and phylogeny in three populations of Chinese mitten crab, *Eriocheir sinensis*
WANG Chenghui(Key Laboratory of Aquatic Genetic Resources and Aquacultural Ecosystem Certificated by the Ministry of Agriculture, Shanghai Fisheries University, Shanghai 200090, China), LI S F, LIU Z Z, et al//J F C, 2008, 32(1). 8—12.

3 The sequence and expression of the immunoglobulin M heavy chain cDNA of *Ctenopharyngodon idellus*
WANG Xinxin(State Key Laboratory of Freshwater Ecology and Biotechnology, Institute of Hydrobiology, Chinese Academy of Sciences, Wuhan 430072, China), SUN B, CHANG M X//J F C, 2008, 32(1). 13—20.

4 Comparison study on the spermary histological structure of triploidy and diploid *Carassius auratus gibelio*
YANG Jie(Department of Aquaculture, Northeast Agriculture University, Harbin 150030, China), CHEN W X, WU H D, et al//J F C, 2008, 32(1). 21—26.

5 Ultrastructure of the spermatozoon of *Hucho taimen*
YIN Hongbin(Heilongjiang River Fisheries Research Institute, Chinese Academy of Fisheries Sciences, Harbin 150070, China), YIN J S, SUN Z W, et al//J F C, 2008, 32(1). 27—31.

6 The relation between morphology, distribution and function of the oropharyngeal cavity gustatory organ of the tongue sole *Cynoglossus semilaevis*
WANG Xinan(Key Laboratory for Sustainable Utilization of Marine Fisheries Resources Certificated by Ministry of Agriculture, Yellow Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, Qingdao 266071, Shandong Province, China), MA A J//J F C, 2008, 32(1). 32—38.

7 Comparative study on quality evaluation of *Litopenaeus vannamei* cultured in different models
CEN Jianwei(South China Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, Guangzhou 510300, China), WANG J H, LI L H, et al//J F C, 2008, 32(1). 39—44.

8 Comparative study on the flesh quality of hybrid F₃ and its parents: Big-head carp, Amur carp and German mirror carp

LI Chitao (Heilongjiang River Fishery Research Institute, Chinese Academy of Fishery Sciences, Harbin 150070, China), GUAN H H, HU X S, et al//J F C, 2008, 32(1). 45—50.

9 Genetic analysis of the intergenus hybridization of *Pseudosciaena crocea* (♀) × *Miichthys miiuy* (♂)

WANG Xiaoqing (Key Laboratory of Science and Technology for Aquaculture and Food Safety of Fujian Province University, Xiamen 361021, Fujian Province, China), WANG Z Y, XIE Z G, et al//J F C, 2008, 32(1). 51—57.

10 Growth of the juvenile hybrids from different crossing combinations of the imported *Scophthalmus maximus* L

11 Studies on the dietary niacin requirement of juvenile *Ctenopharyngodon idellus*

WU F (Yangtze River Fisheries Research Institute, Chinese Academy of Fishery Sciences, Jingzhou 434000, Hubei Province, China), JIANG M, ZHAO Z Y, et al//J F C, 2008, 32(1). 65—70.

12 Effect of dietary cassava meal on growth, feed utilization and body composition of Jifu strain of Nile tilapia, *Oreochromis niloticus*

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