

EFFECTS OF DELAYED FIRST FEEDING ON GROWTH AND SURVIVAL OF ROCK BREAM *OPLEGNATHUS FASCIATUS* LARVAE

Xiujuan Shan, Hanfeng Quan, Shuozeng Dou-2008

Aquaculture 277(1-2): 14-23

Abstract:

The effects of the timing of first feeding (0, 1 and 2 days after yolk exhaustion) and starvation on the point-of-no-return (PNR), survival and growth of laboratory-reared rock bream larvae were studied under controlled conditions. Larvae began to feed exogenously at 3 days after hatching (dah) and reached PNR on 54 h after yolk exhaustion at 22 ± 1.5 °C. Larvae growth was significantly affected by the time of first exogenous feeding. The growth of 0 day delayed first feeding larvae was obviously faster than those of the other delayed first feeding larvae ($P < 0.05$) whether at 7 dah (SL = 3.40 mm, SGR = 5.7, CV = 4.0) or at 15 dah (SL = 4.85 mm, SGR = 6.1, CV = 8.2) with a more uniform size distribution. Survival of 0 day delayed first feeding larvae and 1 day delayed first feeding larvae was 13% and 8% at the end of experiment, respectively, while no larvae survived up to 7 dah for 2 days delayed first feeding larvae and unfed larvae. Food resulted in a progressive deterioration of the larval digestive system and atrophy of skeletal muscle fibre. The ratios of head length to SL (standard length), body height to SL and eye diameter to SL were the most sensitive morphometric indices to detect the effects of fasting on larval condition. Present results showed that the combination of morphological and morphometric variables could be used to evaluate the nutritional condition of rock bream larvae. In order to avoid the potential mortality and gain better development, survival and growth in industrial production, the rock bream larvae must establish successful first feeding within 2 days after yolk exhaustion.

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THE EFFECT OF CHEMICAL CUES ON SETTLEMENT OF PEARL OYSTER *PINCTADA FUCATA MARTENSII* (DUNKER) LARVAE

Xiujuan Yu, Weihong He, Ji-Dong Gu, Maoxian He, Yan Yan-2008

Aquaculture 277(1-2): 83-91

Abstract:

The pearl oyster *Pinctada fucata martensii* is an important aquaculture species in South China Sea and has great commercial value in the pearl culture industry. As difficulties in the commercial culturing of molluscs are mainly associated with larval settlement and metamorphosis, it is important to find a routine, inexpensive and effective technique for the induction of synchronous settlement and metamorphosis of larvae. In the present study, the effects of 11 chemicals on inducing larval settlement of the *P. fucata martensii* were investigated in the laboratory. The larvae were exposed to the chemicals for 96 h. Among the chemicals tested, K^+ (10 and 20 mM), Ca^{2+} (1 and 50 mM), γ -aminobutyric acid (10^{-4} M), 3-isobutyl-1-methylxanthine (10^{-4} M), choline (10^{-3} , 10^{-4} M), acetylcholine (10^{-4} M), and serotonin (10^{-3} , 10^{-4} , 10^{-5} M) induced high percentage of the larvae to settle without acute toxic effects, while Mg^{2+} , NH_4^+ , dopamine, and 3-(3,4-Dihydroxyphenyl)-L-alanine at all the tested concentrations were less effective. Serotonin of 10^{-4} M resulted in the highest settlement rate, but the chemical is expensive. K^+ was slightly less effective, but the chemical is much cheaper, therefore maybe more economical in the commercial production.

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CRITICAL LEVELS OF ESSENTIAL FATTY ACIDS FOR NORMAL PIGMENTATION IN ATLANTIC HALIBUT (*HIPPOGLOSSUS HIPPOGLOSSUS* L.) LARVAE

Kristin Hamre, Torstein Harboe-2008
Aquaculture 277(1-2): 101-108

Abstract:

High levels of n-3 polyunsaturated fatty acids and a low level of arachidonic acid (ARA, 20:4n-6) in larval diets seem to be necessary for normal pigmentation of Atlantic halibut juveniles, whereas energy status and fatty acid composition seem to modulate eye migration in flatfish in general. However, we do not know the limits or the critical combinations of essential fatty acids that will give normal development of the larvae. In the present study we fed Atlantic halibut larvae enriched Artemia with small differences in fatty acid composition. Artemia enriched with the high TAG (triacylglycerol) emulsion contained average eicosapentaenoic acid (EPA, 20:5n-3) and docosahexaenoic acid (DHA, 22:6n-3) of 13.9 and 12.5% of total fatty acids, respectively, while in Artemia enriched with the high MAG (monoacylglycerol) emulsion, the levels were 12.9 and 9.4%. The fatty acid composition of the larvae reflected the composition of Artemia, in addition ARA was slightly lower in the high TAG than in the high MAG enriched Artemia, i.e. 3.7–4.0 and 4.2–4.3% of total fatty acids, respectively. There were no differences in lipid level, measured as fatty acid methyl esters, neither between the Artemia types, nor between the larval groups. The percentages of normal pigmentation in Atlantic halibut juveniles that had been fed the high TAG and high MAG enriched Artemia were 77 ± 2 and $46 \pm 16\%$, respectively, the eye migration was also slightly better in the high TAG group, but the final weight was lowered from 1.98 ± 0.17 g in the high MAG group to 1.56 ± 0.13 g in the high TAG group. There was a correlation between pigmentation and eye migration, since fish where the left eye had passed the mid-dorsal ridge did not get pigmentation on the blind side. It is concluded that DHA in larval whole body should be higher than 13% of total fatty acids to obtain normal pigmentation in Atlantic halibut larvae when the EPA:ARA ratio is approximately 3.5. The differences in fatty acid composition in the present study had only minor effects on eye migration.

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SHORT COMMUNICATION

EXPERIMENTAL STUDIES ON THE EFFECT OF FOOD IN EARLY LARVAE OF THE CLEANER SHRIMP *LYSMATA AMBOINENSIS* (DE MANN, 1888) (DECAPODA: CARIDEA: HIPPOLYTIDAE)

Luís Cunha, Maite Mascaró, Xavier Chiapa, Ana Costa, Nuno Simões-2008

Aquaculture 277(1-2): 117-123

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BIO-ECONOMICAL AND ETHICAL IMPACTS OF ALIEN FINFISH CULTURE IN EUROPEAN INLAND WATERS

Giovanni M. Turchini¹ and Sena S. De Silva-2008

Aquaculture International 16(3) : 243-272

Abstract:

Since 1989, and in comparison to the global trend, inland aquaculture production of European finfish has declined. To date, the yearly European freshwater aquaculture production is 371,727 tons, valued at over US\$1 billion. Indigenous species accounted for less than one-third of the production, whereas alien species (a species that has been moved beyond its natural range of distribution) accounts for the remainder. However, in general, indigenous species command a higher market price. Currently, food quality and food safety are leading concerns of consumers, and European consumers are also becoming alert to environmentally detrimental practices. Therefore, to aim at economic sustainability, the sector needs to satisfy consumer expectations of environmentally friendly practices. It is believed that farming alien finfish species can threaten local biodiversity through escapes, and this represents a current

environmental concern relative to aquaculture. In this context, an attempt is made in this paper to understand and quantify the impacts of alien finfish cultivation in European inland waters, and to suggest remedial measures.

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EFFECTS OF MICROALGAL DIETS ON LARVAL GROWTH AND SURVIVAL OF PAPHIA MALABARICA CHEMNITZ

Raghavan Gireesh, Cherukara Purushothaman Gopinathan-2008

Aquaculture Research 39(5) : 552–556

Abstract:

The effects of food availability on the larval growth and survival of *Paphia malabarica* were studied in two experiments by feeding the larvae with six algal diets. Newly hatched larvae of *P. malabarica* were fed with six different marine microalgae species, singly and in a combination of two species. The best growth was with *Isochrysis galbana* and *Nannochloropsis salina* as a single species of diet. The nutritional value of single-species diets was in the order of *N. salina*, *I. galbana*, *Dicrateria inornata*, *Chaetoceros calcitrans*, *Tetraselmis gracilis* and *Dunaliella salina*. Of the mixtures tested, 50% *I. galbana*/50% *N. salina* supported growth and metamorphosis equivalent to those of the *I. galbana* control.

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EFFECT OF FEEDING SCHEME AND PREY DENSITY ON SURVIVAL AND DEVELOPMENT OF CHINESE MITTEN CRAB *ERIOCHEIR SINENSIS* ZOEAL LARVAE

Li-ying Sui, Mathieu Wille, Xu-gan Wu, Yong-xu Cheng, Patrick Sorgeloos-2008

Aquaculture Research 39(6): 568–576

Abstract:

The effect of feeding scheme and prey density on survival and development of *Eriocheir sinensis* zoeal larvae was studied in three experiments. Different combinations and densities of rotifers (*Brachionus rotundiformis*) and newly hatched *Artemia* nauplii were fed to zoeal larvae. Average survival at each stage, larval development (larval stage index, LSI), duration of zoeal stage and individual megalopa dry weight were compared among treatments. This study revealed that, under the experimental conditions, rotifers should be replaced with *Artemia* between the zoea 3 (Z3) and the zoea 4 (Z4) stage. The optimal rotifer feeding densities for zoea 1 (Z1) and zoea 2 (Z2) were 15 and 20 mL⁻¹ respectively, while the optimal *Artemia* feeding density for Z3, Z4 and zoea 5 (Z5) was 3, 5 and 8 mL⁻¹ respectively. Further trials in production scale are recommended.

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USE OF PROBIOTIC BACTERIA IN THE REARING OF SENEGALESE SOLE (*SOLEA SENEGALENSIS*) LARVAE

Pavlos Makridis, Sílvia Martins, João Reis, Maria Teresa Dinis-2008

Aquaculture Research 39(6): 627–634

Abstract:

Three candidate probiotics, which had shown antimicrobial activity *in vitro* against two fish pathogens, were used in the rearing of Senegalese sole larvae and postlarvae. These probiotics improved the survival of starved sole yolk-sac larvae. A feeding experiment of sole larvae and postlarvae comprised three treatments: A, B and C. Cultures of a *Vibrio* sp. (2J18) were added to treatment A, whereas a gram-positive (J84) and a *Shewanella* sp. strain (2J27), were added to treatment B, while in a control treatment C no bacteria were added. Addition of

bacteria in treatment B increased survival of larvae in the first phase of the experiment [0–20 days after hatching (DAH) ($P < 0.05$)] and decreased the numbers of colony-forming units (CFU) in larval gut 5 DAH compared with the control treatment ($P < 0.05$). No differences were observed in survival (25–47%) during the second phase of the experiment (20–60 DAH). Nevertheless, the total numbers of CFU in fish gut 40 DAH were significantly lower in treatment B ($P < 0.05$). The colonization rates of the added bacteria were the highest 5 and 11 DAH, and the highest average values reached were 65%, 82% and 17% of the total CFU count for the strains 2J18, 2J27 and J84 respectively.

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SURVIVAL OF BLUE KING CRAB PARALITHODES PLATYPUS BRANDT, 1850, LARVAE IN CULTIVATION: EFFECTS OF DIET, TEMPERATURE AND REARING DENSITY

Bradley G. Stevens, Sara Persselin, Julie Matweyou-2008

Aquaculture Research 39(4): 390–397

Abstract:

Blue king crab (*Paralithodes platypus*) larvae were cultivated to test the effects of diet, temperature and rearing density. Dietary treatments included no feeding (unfed), *Artemia nauplii* enriched with diatoms *Thalassiosira nordenskiöldii* (THAL), unenriched *Artemia* fed in addition to *Thalassiosira* (A+THAL) and a control diet of *Artemia* enriched with frozen *Isochrysis* paste (ISO 6). Trials were conducted at 6 °C, and a rearing density of 10 zoea L⁻¹, with six replicates per treatment. The ISO 6 diet was also tested at 3 °C (ISO 3) and 9 °C (ISO 9), and at densities of 20 (ISO 20) and 40 (ISO 40) zoea L⁻¹. Survival of zoea larvae fed the A+THAL diet (91.7%) was significantly higher than all others, whereas unfed zoea larvae died within 2 weeks. Temperature and rearing density had no significant effects on survival. Time required to reach stage C1 was significantly greater at 3 °C (109 days) than at 6 °C (70 days), but did not decrease further at 9 °C. After reaching the postlarval (glaucothoe) stage, half of the replicates in the ISO 20 and ISO 40 treatments were fed continuously, but survival did not differ significantly from unfed glaucothoe. We conclude that blue king crab larvae are not lecithotrophic and can be cultivated with high survival using the proper diet. These techniques can be used to produce large numbers of juvenile crab for laboratory research, or could be modified for use in stock-enhancement programmes.

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EFFECTS OF SPIRULINA AND PLANT OIL ON THE GROWTH AND LIPID TRAITS OF WHITE STURGEON (*ACIPENSER TRANSMONTANUS*) FINGERLINGS

Giovanni Battista Palmegiano, Francesco Gai, Franco Daprà, Laura Gasco, Mario Pazzaglia, Pier Giorgio Peiretti-2008

Aquaculture Research 39(6): 587–595

Abstract:

The aim of this research was to evaluate the efficiency of diets with *Spirulina* and plant oils (POs) inclusion for white sturgeon weaning and their effects on the fatty acid (FA) composition of fish flesh. Three isoproteic (45%) and isoenergetic (21 MJ kg⁻¹ DM) diets were formulated: one fish meal-based diet integrated with fish oil (FMO) and two 40% *Spirulina* meal-based diets integrated with corn (SPC) or soybean (SPS) oils respectively. One hundred and thirty-five white sturgeon fingerlings (mean weight 17.5 g) were stocked randomly in nine fibreglass tanks. At the end of the trial, which lasted 71 days, the growth performance traits and somatic indexes were determined. The chemical composition, gross energy and FA profile were determined on the fish fillets. No significant effects were observed for the growth performances or fillet chemical composition. The FA profile of the fillets reflected those of the diets. In particular, the fillets of the fish fed with the SPC and SPS diets were lower in n-3 FA, due to the substitution of fish oil (FO) with POs. It is possible to

replace FO and meal in sturgeon; therefore, Spirulina meal integrated with POs could be a good alternative to sturgeon diet.

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PROBIOTICS FOR SHRIMP LARVICULTURE: REVIEW OF FIELD DATA FROM ASIA AND LATIN AMERICA

Olivier Decamp, David J. W. Moriarty, Patrick Lavens-2008

Aquaculture Research 39(4): 334–338

Abstract:

Disease problems have emerged as major constraints in aquaculture production. The prophylactic application of antibiotics is expensive and detrimental, i.e. selection of bacteria that are drug-resistant or more virulent and the prevalence of drug residues in reared animals. Probiotics, which compete with bacterial pathogens for nutrients and/or inhibit the growth of pathogens, could be a valid alternative to the prophylactic application of chemicals. A mixture of specific *Bacillus* strains was designed following a research programme on the ability of numerous *Bacillus* strains to inhibit a range of pathogenic *Vibrio* strains, to grow under conditions prevailing in shrimp hatcheries and to degrade waste products. These strains were then included in bioassays and challenge tests in order to confirm the lack of toxin production and pathogenicity to humans, target organisms and the environment. Here, we report on the performance of a commercially available mixture of *Bacillus* strains (SANOLIFE® MIC), using data from Asian and Latin-American hatcheries, with *Penaeus monodon* (Fabricius 1798) and *Litopenaeus vannamei* (Boone 1931). These results show that probiotics may be a suitable alternative to the prophylactic use of antibiotics. Obviously, minimizing the risk of vibriosis demands a multi-disciplinary approach, including good hygiene and sanitation measures to reduce the input of potential pathogens, as well as a suitable farm management.

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MARKING LIVE FEEDS WITH INERT METAL OXIDES FOR FISH LARVAE FEEDING AND NUTRITION STUDIES

Matthew A. Cook, Ronald B. Johnson, Pete Nicklason, Harold Barnett, Michael B. Rust-2008

Aquaculture Research 39(4): 347–353

Abstract:

Yttrium oxide (Y₂O₃), ytterbium oxide (Yb₂O₃), lanthanum oxide (La₂O₃) and dysprosium oxide (Dy₂O₃) were evaluated as potential live feed markers for feeding and nutrition studies with fish larvae, by determining the uptake and depletion of markers over time in two trials, and quantifying ingestion of Y₂O₃-marked rotifers (*Branchionus plicatilis*) by Atlantic cod (*Gadus morhua*) in a third trial. In the first two trials, *Artemia* nauplii and rotifers quickly took up markers within 10 min to concentrations useful for nutrition studies (>2% dry weight). There was no significant difference ($P>0.05$) among temperatures in depletion of markers (10, 15, 20 °C) with *Artemia* or rotifers. Depletion from rotifers was not significantly different ($P>0.05$) between 5 and 20 min nor between 5 and 30 min for *Artemia* when marked at a concentration of 50 mg of marker per litre of seawater. In the second trial, rotifers and *Artemia* were marked with a higher concentration (250 mg L⁻¹) and allowed to deplete for a longer time (90 min). In the third trial, visual estimates of *Artemia* consumed by Atlantic cod larvae were similar to consumption estimates determined by analysis of Y₂O₃-marked *Artemia* using inductively coupled plasma optical emission spectroscopy ($r^2=0.77$).

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WEANING OF ALLIGATOR GAR (*TRACTOSTEUS SPATULA*) LARVAE TO ARTIFICIAL DIETS

R. Mendoza, C. Aguilera, L. Carreón, J. Montemayor, M. González-2008
Aquaculture Nutrition 14(3) : 223–231

Abstract:

Growth performance and survival of alligator gar (*Atractosteus spatula*) larvae fed *Artemia* nauplii, two artificial diets (with different protein content and buoyancy) and a control under starvation at first feeding [5 days after hatching (5 DAH)] were studied. All larvae under starvation (C) died at 10 DAH, while survival was near 60% for the rest of the treatments at the end of the experimental period. By the end of the experimental period morphological variables (total length, snout length, wet weight and dry weight) were better in larvae fed the artificial diets compared to live food. These results were confirmed by means of nucleic acid indexes and digestive enzymatic activity. The importance of the relationship between diet size and snout gape was evidenced from these results. Differences between artificial diets were attributed to different digestibility values. Alligator gar larvae are able to grow and survive satisfactorily when fed artificial diets from the start of exogenous feeding, provided that these have an adequate size, buoyancy and quality.

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EFFECTS OF DIETARY EICOSAPENTAENOIC ACID ON GROWTH, SURVIVAL, PIGMENTATION AND FATTY ACID COMPOSITION IN SENEGAL SOLE (*SOLEA SENEGALENSIS*) LARVAE DURING THE ARTEMIA FEEDING PERIOD

M. Villalta, A. Estévez, M.P. Bransden, J.G. Bell-2008
Aquaculture Nutrition 14 (3): 232–241

Abstract:

We examined the effect of dietary eicosapentaenoic acid (EPA, 20:5n-3) on growth, survival, pigmentation and fatty acid composition of Senegal sole larvae. From 3 to 40 days post-hatch (dph), larvae were fed live food that had been enriched using one of four experimental emulsions containing graduated concentrations of EPA and constant docosahexaenoic acid (DHA, 22:6n-3) and arachidonic acid (ARA, 20:4n-6). Final proportions of EPA in the enriched *Artemia* nauplii were described as ‘nil’ (EPA-N, 0.5% total fatty acids, TFA), ‘low’ (EPA-L, 10.7% TFA), ‘medium’ (EPA-M, 20.3% TFA) or ‘high’ (EPA-H, 29.5% TFA). Significant differences among dietary treatments in larval length were observed at 25, 30 and 40 dph, and in dry weight at 30 and 40 dph, although no significant correlation could be found between dietary EPA content and growth. Eye migration at 17 and 25 dph was affected by dietary levels of EPA. Significantly lower survival was observed in fish fed EPA-H diet. Lower percentage of fish fed EPA-N (82.7%) and EPA-L (82.9%) diets were normally pigmented compared with the fish fed EPA-M (98.1%) and EPA-H (99.4%) enriched nauplii. Tissue fatty acid concentrations reflected the corresponding dietary composition. ARA and DHA levels in all the tissues examined were inversely related to dietary EPA. This work concluded that Senegal sole larvae have a very low EPA requirement during the live feeding period.

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COUPLING CHANGES IN FATTY ACID AND PROTEIN COMPOSITION OF ARTEMIA SALINA WITH ENVIRONMENTAL FACTORS IN THE SFAX SOLAR SALTERN (TUNISIA)

Wassim Guerhazi, Jannet Elloumi, Habib Ayadi, Abderrahmen Bouain, Lotfi Aleya-2008
Aquat. Living Resour. 21: 63-73

Abstract:

The biochemical composition and biometry of different *Artemia salina* stages were determined in four ponds of increasing salinity (M1, M2, M3 and B1) in the Sfax solar saltern (Tunisia). Results showed the dominance of saturated fatty acids, which made up 48 to 57% of total fatty acids (FAs). Polyunsaturated fatty acids (PUFAs) 22:6(n-3) docosahexaenoic acid (DHA) and 20:5(n-3) eicosapentaenoic acid (EPA) represented on average only 3.1 and 4.0% of total FAs respectively. *A. salina* nauplii, cysts and metanauplii, in ponds M1, M2 and B1 respectively, were found to have optimal DHA/EPA ratios (>2) for use as live feed for invertebrate and fish larvae. Significant inter-pond variation in DHA/EPA levels was also recorded. The predominant FAs in *Artemia* were negatively correlated with both temperature and salinity. FA and protein contents were strongly affected by high temperatures (>30 °C) and probably by food sources (e.g., *Dunaliella salina*) ($r = 0.9$, $n = 27$). The density of *Artemia salina* was positively correlated with protein content in pond B1. The high DHA/EPA ratios (1 to 3.3) found in this study indicate that Sfax *Artemia* could be a valuable food source for larvae in large marine hatcheries and also for some aquarium species.

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