

INFORMATION OF INTEREST

8th International Symposium on Fish Nutrition & Feeding 2008: call for abstracts

FAO's Food Outlook: Fish & Fishery Products

Link to information of Interest for BibMail members

Aquaculture and Genetic Conservation – Literature website.

The purpose of this website is to point out some of the important, new papers which have been published in journals that are not primarily devoted to aquaculture or fisheries. The papers give useful insights on the management of broodstock, fry and fingerling production, strain improvement, disease susceptibility, and genetic conservation. However, the journals can be hard to find in many parts of the world.

Conference on European Aquaculture and its Opportunities for Development, Brussels, 15-16 November 2007: presentations and conclusions

EVIDENCE OF RESPONSE TO UNINTENTIONAL SELECTION FOR FASTER DEVELOPMENT AND INBREEDING DEPRESSION IN CRASSOSTREA GIGAS LARVAE

Nicolas Tarisa, Frederico M. Batista, Pierre Boudry-2007

Aquaculture 272, Supplement 1, S69-S79

Supplement: Genetics in Aquaculture IX

Abstract:

Underlying consequences of domestication and artificial selection still remain largely unexplored in most aquacultured species. For species with a two phase life cycle, including the Pacific oyster *Crassostrea gigas*, most genetic studies have focused on the post-metamorphosis juvenile and adult stages, but relatively few considered the larval stage. To assess the consequence of hatchery practices on larval characters, especially growth, we performed a phenotypic study on larval progenies derived from crosses between Pacific oysters from natural beds and farmed Pacific oysters selected for desirable production traits such as rapid growth, for over seven generations. A set of three microsatellite loci was used to compare the genetic variability between the two parental broodstocks and to establish the relatedness between pairs of individuals within each broodstock. The mean relatedness of the hatchery broodstock was significantly different from expectations under the hypothesis of random association (i.e. no relatedness). On one hand, our results show a lower survival performance in the hatchery broodstock, which is associated with a multimodal distribution of growth rates. On the other hand, the hatchery broodstock had a higher proportion of success at metamorphosis. The results suggest that these larvae suffered from inbreeding depression, but that this was offset by better metamorphosis success. The combined effects are likely the result of unintentional selection for faster development in the hatchery through the practice of culling slow growing larvae and a concomitant reduction in the effective population size leading to inbreeding depression.

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EQUALIZING SPERM CONCENTRATIONS IN A COMMON CARP (CYPRINUS CARPIO) SPERM POOL DOES NOT AFFECT VARIANCE IN PROPORTIONS OF LARVAE SIREED IN COMPETITION

Vojtech Kaspar, Klaus Kohlmann, Marc Vandeputte, Marek Rodina, David Gela, Martin Kocour, S.M. Hadi Alavi, Martin Hulak, Otomar Linhart-2007

Aquaculture 272, Supplement 1: S204-S209

Supplement: Genetics in Aquaculture IX

Abstract:

Proportions of offspring from five common carp contributing to a sperm pool composed of equalized sperm concentrations (N-progeny) or equal sperm volumes (V-progeny) were each compared to a uniform distribution. Four microsatellite markers (MFW1, MFW6, MFW7, MFW28) were used to determine the paternity of the progeny. The homogeneity of offspring numbers from each male for the two types of progeny, were tested using an exact test for the likelihood-ratio chi-square. Numbers of offspring in the progeny groups were highly variable (0.4–50% in V-progeny, 2.4–41.2% in N-progeny) and highly significantly different as shown by Pearson chi-square statistics ($\chi^2 = 189$, 4 df, $P < 0.0001$ in V-progeny and $\chi^2 = 139$, 4 df, $P < 0.0001$ in N-progeny). Significant heterogeneity between treatments ($P < 0.05$) together with reduction of χ^2 value from 189 to 139 showed that equalization of sperm concentration reduced heterogeneity in numbers of offspring. Number of sperm per male, sperm motility (71–98%), sperm velocity (97–155 $\mu\text{m s}^{-1}$) and control hatching rates (81–91%) all affected the observed number of offspring sired by each of the males, but the high variability in proportion of progeny among the 5 males remained unexplained.

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THE USE OF MICROSATELLITES FOR OPTIMIZING BROODSTOCKS IN A HATCHERY OF GILTHEAD SEABREAM (SPARUS AURATA L.)

G. Blanco, Y.J. Borrell, D. Bernardo, E. Vázquez, J.F. Asturiano, J.A. Sánchez, J.A. Sánchez-2007

Aquaculture 272, Supplement 1: S246

Supplement: Genetics in Aquaculture IX

The work is related to the use of molecular markers (loci microsatellites) in concrete workings of improvement and management of the operation in aquaculture of the most interesting Spanish Mediterranean's species: Sparus aurata. The main goal is the creation of a lot of reproducers that add the following characteristics: (a) present/display good morphologic conditions for standards of market, (b) with sufficient variability genetic to avoid “founding effect” that affects the maintenance of its productivity, (c) with relations of kinship well-known that allows to design scheme of crossovers productive that avoids inbreeding to the maximum. At the moment of the pre-selection, each unit was marked with a microchip. We have typed 206 seabreams (female) using 11 highly polymorphic microsatellites (mean $N_a = 16.91$; mean PIC = 0.778). This microsatellites set allows us to reach to a 99.98% of total exclusionary power in a simulated assignment procedures using the complete broodstock. Our criteria have been to select the less possible genetically related individuals to form 3 different lots of broodstocks. To do it we have used a stochastic search technique to solve this as a combinatorial optimization problem (annealing algorithm), and in the three new broodstocks the maximum relatedness coefficient between breeders pairs is limited to only $r + 0.1267$. The males had been selected 21 months later because they are a proterandric hermaphrodite species.

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GENETIC CHARACTERISATION OF COMMERCIALY IMPORTANT BRACHIONUS SP. STRAINS WITH 16S RDNA SEQUENCING AND DGGE (DENATURING GRADIENT GEL ELECTROPHORESIS) ANALYSIS

S. Dooms, S. Papakostas, S. Hoffman, K. Dierckens, A. Triantafyllidis, T.J. Abatzopoulos, P. Bossier, P. Sorgeloos-2007

Aquaculture 272, Supplement 1: S252

Supplement: Genetics in Aquaculture IX

Different molecular phylogenetic studies showed that many zooplanktonic organisms, like the cyclic parthenogenetic rotifer *Brachionus plicatilis* (Rotifera: Monogononta), are actually comprised of cryptic species with a high degree of morphological similarity. Recent phylogenetic studies with molecular markers (*ITS1*, ribosomal Internal Transcribed Spacer 1, and *COI*, Cytochrome Oxidase subunit I) on natural *Brachionus* populations described the presence of at least nine genetically divergent *B. plicatilis* biotypes within the *B. plicatilis* species complex (check: Gómez et al., 2002; Papakostas et al., 2005). Questions rise on the actual situation of rotifer strains used in aquaculture. Therefore, the challenge of this study consisted in the investigation of the genetic make-up of hatchery strains and strains used in aquaculture research institutes and laboratories. Nucleotide sequence variation from the mitochondrial 16S rDNA gene was used to detect genetic variance in a marker sequence. This 16S marker was combined with the PCR-DGGE (Polymerase Chain Reaction-Denaturing Gradient Gel Electrophoresis) fingerprinting technique, resulting in a powerful molecular characterisation method for aquaculture rotifer strains. Discrimination of distinct sympatric species lineages is important for the aquaculture industry because different *Brachionus* strains might have specific growing and rearing characteristics. In this way, cultivation of the in-house rotifer strain can be optimized.

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DEVELOPMENTS IN CONTROLLED GREEN-WATER LARVAL CULTURE TECHNOLOGIES FOR ESTUARINE FISHES IN QUEENSLAND, AUSTRALIA AND ELSEWHERE

Paul J. Palmer, Michael J. Burke, Claire J. Palmer, John B. Burke-2007

Aquaculture 272(1-4):1-21

Abstract:

Since 1989, researchers with the Department of Primary Industries and Fisheries (DPI&F) in Queensland, Australia, have successfully used controlled low-water exchange green-water cultures to rear the larvae of estuarine fishes and crustaceans through to metamorphosis. High survivals and excellent fry condition have been achieved for several commercially important endemic species produced for various projects. They include barramundi or sea bass, *Lates calcarifer*, Australian bass, *Macquaria novemaculeata*, dusky flathead, *Platycephalus fuscus*, sand whiting, *Sillago ciliata*, red sea bream or snapper, *Pagrus auratus*, banana prawn, *Fenneropenaeus merguensis*, and others. The consistent success of our standardised and relatively simple approach at different localities has led to it being incorporated into general fingerling production practices at several establishments in Australia. Although post-metamorphosis rearing methods have differed for each species investigated, due to various biological and behavioural traits and project requirements, these larval rearing methods have been successful with few species-specific modifications. Initially modelled on the Taiwanese approach to rearing Penaeids in aerated low-water exchange cultures, the approach similarly appears to rely on a beneficial assemblage of micro-organisms. Conceptually, these micro-organisms may include a mixture of the air-borne primary invaders of pure phytoplankton cultures when exposed to outdoor conditions. Whilst this would vary with different sites, our experiences with these methods have consistently been favourable. Mass microalgal cultures with eco-physiological youth are used to regularly augment larval fish cultures so that rearing conditions simulate an exponential growth-phase microalgal bloom. Moderate to heavy aeration prevents settlement of particulate matter and encourages aerobic bacterial

decomposition of wastes. The green-water larval rearing approach described herein has demonstrated high practical utility in research and commercial applications, and has greatly simplified marine finfish hatchery operations whilst generally lifting production capacities for metamorphosed fry in Australia. Its potential uses in areas of aquaculture other than larviculture are also discussed.

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CALCIUM CARBONATE SUPERSATURATION AND PRECIPITATION IN CHINESE MITTEN CRAB (*ERIOCHEIR JAPONICA SINENSIS*) LARVAL PONDS IN CHINA: MASS MORTALITY, CRYSTAL FORM ANALYSIS, AND SAFETY SATURATION INDEX

Xiaodong Li, Yanzhi Lei, Xiaodan Gao, Chiyuan Ma, Shuanglin Dong-2007

Aquaculture 272(1-4): 361-369

Abstract:

In recent years, mass mortalities of Chinese mitten crab (*Eriocheir japonica sinensis*) larvae have been reported in several crab culture regions in China and have resulted in great economic losses. The mass mortality usually occurs in seawater ponds in the afternoon of sunny days when water color suddenly changes from dark green or brown to cloudy white or light yellow, and mineral precipitate occurs. Moribund and dead larvae are typically covered with debris. A series of experiments was conducted to examine the cause of precipitation and mass mortality of crab larvae. Analysis of the precipitate from ponds with mass mortalities showed that CaCO_3 was the main component of the precipitate, accounting for 70.8% of the total weight. In an animal experiment, mortalities were observed within 48 h in all groups with CaCO_3 precipitate, and generally increased as pH and CaCO_3 saturation rates increased. Mortalities in groups with CaCO_3 precipitate were greater than those in groups without CaCO_3 precipitate ($P \leq 0.05$). All larvae in groups with CaCO_3 precipitate sank to the bottom of the beaker within 48 h. The animal experiment also showed that increased pH (up to 9.4) alone without CaCO_3 precipitate did not result in larval mortality within 48 h. Results from the present investigation indicate that mass mortalities of the crab larvae are caused by CaCO_3 supersaturation and rapid precipitation possibly triggered by increased pH as a result of intensive photosynthesis of phytoplankton in the seawater ponds. By comparing mean Ca^{2+} and CO_3^{2-} ionic product obtained at the equilibrium with solubility product constants for various CaCO_3 crystal forms, it appears that $\text{CaCO}_3 \cdot \text{H}_2\text{O}$ is the main CaCO_3 form. Based on the $\text{CaCO}_3 \cdot \text{H}_2\text{O}$ solubility product constant and our field investigations, we suggest that $\text{CaCO}_3 \cdot \text{H}_2\text{O}$ saturation indices of 2.5 and below be considered safe and 3.4 as warning signal for CaCO_3 precipitation. Since several factors may cause CaCO_3 supersaturation and precipitation in crab larval ponds, preventive measures should be implemented to stabilize pH and reduce the CaCO_3 saturation rate.

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EFFECTS OF FEEDING, STOCKING DENSITY AND WATER-FLOW RATE ON FECUNDITY, SPAWNING FREQUENCY AND EGG QUALITY OF NILE TILAPIA, *OREOCHROMIS NILOTICUS* (L.)

Getinet G. Tsadik, Amrit N. Bart-2007

Aquaculture 272(1-4): 380-388

Abstract:

This study investigated the effects of two levels of feeding (1 or 4% BW day⁻¹), two levels of stocking densities (3 or 10 female m⁻²) and two levels of water-flow rates (0.06 ± 0.00 or 0.35 ± 0.04 L s⁻¹) on the fecundity, relative fecundity, spawning frequency and egg quality

of Nile tilapia, *Oreochromis niloticus* (L.) with the goal of improving hatchery seed production. Males and females, 125 days of age, were stocked in recirculating concrete tanks. Eggs were collected every four days directly from the mouths of incubating females. Fecundity (eggs spawn⁻¹), body weight gain (g day⁻¹) and egg diameter (mm) and weight (mg), percent protein and lipid, fertilization and hatchability were measured over 120 days. Higher eggs kg female⁻¹ day⁻¹ (312 ± 36) was observed in treatments with lower levels of stocking density (3 female m⁻²) and water-flow rate (0.06 ± 0.00 L s⁻¹) under both feeding rates. The rate was 2 to 4 fold higher than the others. Overall, high feeding level (4% BW day⁻¹) increased growth (g day⁻¹) by 35% and eggs spawn⁻¹ by 18% and did not affect eggs kg female⁻¹ day⁻¹, spawn female⁻¹ and eggs m⁻² day⁻¹. Higher stocking density (10 female m⁻²) lowered eggs spawn⁻¹ by 19%, eggs kg female⁻¹ day⁻¹ by 52% and spawn female⁻¹ by 40%. Higher water-flow rate (0.35 ± 0.04 L s⁻¹) increased growth (g day⁻¹) by 33%, and lowered eggs kg female⁻¹ day⁻¹ by 51%. The variables also did not affect percent egg fertilization, hatchability, crude lipid and protein or egg diameter (mm). However, egg weight (mg) was higher in groups fed a lower ration (1% BW day⁻¹) with higher stocking density (10 female m⁻²) and higher water-flow rates (0.35 ± 0.04 L s⁻¹). Feeding levels interacted with water-flow rates in improving growth (g day⁻¹) while stocking density interacted with water-flow rates in lowering eggs kg female⁻¹ day⁻¹ and spawn female⁻¹. The eggs kg female⁻¹ day⁻¹ obtained in this study from the best treatments is comparable with the highest egg production rates reported by others for *O. niloticus*. This suggests that lower feeding level (1% BW day⁻¹), lower stocking density (3 female m⁻²) and lower water-flow rate (0.06 ± 0.00 L s⁻¹) could be adopted as a management strategy to improve current tilapia hatchery seed production, although, optimum water flow-related stocking density needs further investigation.

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EFFECT OF TEMPERATURE ON GROWTH AND SURVIVAL OF CRASSOSTREA CORTEZIENSIS SPAT DURING LATE-NURSERY CULTURING AT THE HATCHERY

Jorge I. Cáceres-Puig, Fernando Abasolo-Pacheco, José M. Mazón-Suastegui, Alfonso N. Maeda-Martínez, Pedro E. Saucedo-2007

Aquaculture 272(1-4): 417-422

Abstract:

Nine temperatures (16, 18, 20, 22, 24, 26, 28, 30, and 32 °C) within the natural range of distribution of the Cortez oyster *Crassostrea corteziensis* were tested in a first experiment to determine the optimal temperature for growth and survival. Based on these results, a second study assessed two temperatures above this range (34 and 36 °C) to determine upper median lethal temperature for the species. The species was thermo-tolerant between 16–32 °C, grew faster and larger at 24 to 30 °C, and had optimal growth at 28–30 °C. The lower tolerance of the species appears far from the lowest value tested (16 °C). In contrast, the upper tolerance temperature was near 32 °C, since 100% spat mortality occurred within 96 h at 34 and 36 °C. These results are being used to develop a protocol for large-scale hatchery culture of the species in Mexico.

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IMPROVING ARGOPECTEN PURPURATUS CULTURE IN NORTHERN CHILE: RESULTS FROM THE STUDY OF LARVAL AND POST-LARVAL STAGES IN RELATION TO ENVIRONMENTAL FORCING

Marcela Cantillán Silva, Gérard Thouzeau, Miguel Avendaño-2007

Aquaculture 272(1-4): 423-443

Abstract:

Scallop management studies including a spat collection program have been carried out within the marine reserve of La Rinconada Bay to protect genetic diversity of scallops, to restock natural populations and to provide wild spat to culture activities in Chile. Plankton sampling and spat collection were used to characterize larval and post-larval stages of the *Argopecten purpuratus* population within this reserve, between December 1995 and March 2000. Main goals were to determine optimal scallop spat collection area, temporal variations of spat settlement and the effect of collector distance off the bottom, and spat growth within the collectors. Larval sampling showed the almost continuous presence, although in variable abundances, of scallop larvae, except for late August–September. Greatest larval abundances were consistently observed from November–December to April–May of the following year. This pattern was altered during the La Niña event of 1998–2000 with unusual peaks of larvae in late July 1999 and November–December 1999. A significant positive relationship was found between the abundance of the large-sized larvae and Chl a concentration ca. 2 weeks before, between February 1999 and February 2000. Larval growth rates ranged from 3.5 to 7.3 $\mu\text{m day}^{-1}$. Shallow waters were not appropriate for spat collection; the best spat collection area was located in the northwestern part of the Reserve, in water depths ranging from 15 to 20–25 m. Spat settlement was significantly higher at 1 m and 2 m off the bottom, compared with 3 m off the seabed. There was no clear pattern of differential spat growth with collector distance from the bottom in a given site, but spatial variations were observed in the Bay at 1 m off the bottom depending on depth-related bottom-water temperature. Spat settlement occurred almost continuously between November 1997 and March 2000, but in variable proportions: spat abundance ranged from 12 to 6540 ind.coll. $^{-1}$. Mean spat growth rate was 175 $\mu\text{m day}^{-1}$ during the ENSO period, vs. 143 $\mu\text{m day}^{-1}$ during La Niña. Culture improvements are discussed from these new insights on the reproductive cycle and spat collection of *A. purpuratus*. The former would facilitate future management practices and would help to restore stocks in the Rinconada Bay.

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CHARACTERISATION OF BACTERIAL COMMUNITIES ASSOCIATED WITH EARLY STAGES OF INTENSIVELY REARED COD (*GADUS MORHUA*) USING DENATURING GRADIENT GEL ELECTROPHORESIS (DGGE)

Laila Brunvold, Ruth-Anne Sandaa, Helene Mikkelsen, Eirik Welde, Hogne Bleie, Øivind Bergh-2007

Aquaculture 272(1-4): 319-327

Abstract :

High mortality is often observed during the early life stages of intensively reared cod, and believed to be at least partly caused by opportunistic bacteria. The aim of the present study was to use Denaturing Gradient Gel Electrophoresis (DGGE) of PCR-amplified 16S rDNA to characterise the bacterial populations associated with early life stages of cod larvae in intensive hatcheries. At one hatchery the analysis was carried out during a period of approximately 4 weeks post hatch, and confirmed that cod larvae are associated with bacteria before and after the onset of exogenous feeding. A change in the number of bands and banding positions indicate that new bacteria or bacterial community were introduced between the samples taken at day 5 and 13, probably as a result of the onset of exogenous feeding. The post-feeding analyses were dominated by α -proteobacteria. An additional study from two other hatcheries of moribund fry, were dominated by *Vibrio* spp., including *V. xuii* and *V. logei*. It is concluded that DGGE is a suitable method for characterising bacterial communities in hatcheries. However, other genes than 16S rDNA might be more suitable for the discrimination of closely related taxa, particularly different *Vibrio* spp.

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BIOCHEMICAL COMPOSITION OF ZOOPLANKTON COMMUNITY GROWN IN FRESHWATER EARTHEN PONDS: NUTRITIONAL IMPLICATION IN NURSERY REARING OF FISH LARVAE AND EARLY JUVENILES

Gopa Mitra, P.K. Mukhopadhyay, S. Ayyappan-2007

Aquaculture 272(1-4): 346-360

Abstract:

This study was conducted to obtain a database describing the nutritional value of freshwater mixed zooplankton that are widely used for larval and grow-out rearing of freshwater fish. The macro and micronutrient composition of mixed zooplankton samples collected from 6 fertilized earthen ponds were analysed for protein, lipid, carbohydrate, ash and these ranged from 73–79%, 10.79–14.55%, 3–4.79% and 3.20–10.07%, respectively on a dry matter (DM) basis. Amino acid profile showed the presence of all the ten essential amino acids with low level of methionine. The content of saturated fatty acids (SAFA), mono unsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) ranged from 64–81%, 7–15% and 6–20% of total fatty acids, respectively. The predominant fatty acids were SAFA (16:0), MUFA (18:1n-9), PUFA viz. linoleic acid (LA 18:2 n-6) and linolenic acid (LNA 18:3 n-3). Among the vitamins, ascorbic acid (15–40.01 µg/gDM) was less than the requirement of fish especially for larvae, vitamin-A (13.61–63.95 µg/g DM) and vitamin-E (218–348µg/g DM) were more than the requirement of fish. Mineral and trace element content showed the presence of P, Ca, Fe, Cu, Zn and Mn. Seasonal variation of all biochemical components was evaluated in the study. Vitamin E had strong co-relation ($r_1 = 0.72$; $r_2 = 0.88$; $r_3 = 0.83$; $r_4 = 0.86$; $r_5 = 0.36$ and $r_6 = 0.88$) with seasonal variation in lipid content of zooplankton of different ponds and varied inversely with that of rising temperature. Enzyme content from the mixed zooplankton of different ponds showed availability of protease (6.21–7.92 µg leucine/mg protein/h), lipase (25.82–39.1 µg α-naphthol/mg protein/h) and amylase (100–226.1 µg maltose/mg protein/h), which could be used as an exogenous source of digestive enzymes for fish and shellfish during ontogenesis. Absence of l-gulonolactone γ-oxidase activity confirmed the incapability of these zooplankton to synthesize ascorbic acid (AA) de novo. The average dry weight in zooplankton in different ponds was 1.2–4.2 mg/l and different species present in these ponds were Moina (Moina dubia), Daphnia (Daphnia lumholtzi, Daphnia carinata); Cyclops (Mesocyclops hyalimus, Mesocyclops leuckarti); Diaptomus (Heliidiaptomus viddus, Neodiaptomus handeli); Rotifer (Brachionus). These results indicate that the biochemical composition and subsequently the nutritional value of these planktonic organisms are not only genetically determined but also influenced by its maturity stage and type of ingested food. These data may be helpful for reference purpose and for formulated feed preparation accessing the nutritional potentiality of these freshwater zooplankton in the nursery rearing of freshwater fish larvae and early juveniles.

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EFFECTS OF INCUBATION TEMPERATURE ON EMBRYONIC DEVELOPMENT RATE, SEX RATIO AND POST-HATCHING GROWTH IN THE CHINESE THREE-KEELED POND TURTLE, CHINEMYS REEVESII

Wei-Guo Du, Ling-Jun Hu, Jian-Lei Lu, Ling-Jun Zhu-2007

Aquaculture 272(1-4): 747-753

Abstract:

Understanding the effects of incubation temperature on embryos and hatchlings may have important implications for husbandry and conservation in turtles. Unfortunately, such knowledge is deficient for most Asian turtles. We incubated eggs of the Chinese three-keeled pond turtle (*Chinemys reevesii*) at 6 constant temperatures (24, 26, 28, 30, 32 and 34 °C) to test for the effects of embryonic thermal environment on incubation duration, hatching

success, hatchling size and mass, sex ratio and post-hatching growth. Incubation duration (ID) decreased nonlinearly as the temperature (T) increased, and could be estimated by the equation: $ID = 42.74 \exp(4.30 / (T - 17.28))$. Eggs incubated at 32 °C and 34 °C had lower hatching success than those at 24 °C, 26 °C and 28 °C. The turtle showed a Male–Female pattern of temperature-dependent sex determination (MF or TSDIa), with male bias at low temperatures (24 °C and 26 °C), and female bias at high temperatures (30 °C, 32 °C, and 34 °C). The relationship between sex ratio (SR) and temperature (T) could be estimated by a nonlinear equation, $SR = 0.025 + 0.923 / (1 + \exp(-(T - 30.03) / 0.009))^{0.006}$. Hatchlings from eggs incubated at 24, 26 and 28 °C were larger and heavier than their counterparts at 30 °C, 32 °C and 34 °C. However, the temperature influence on hatchling size disappeared when the turtles were 3 months old, while most hatchlings from eggs incubated at 34 °C did not survive. After 3 months, female turtles from 30 °C and 32 °C grew faster than did male turtles from 24 °C and 26 °C; females from 28 °C grew significantly faster than males from the same temperature. In contrast, there was no difference in growth rate either within females or within males from different temperatures. The dichotomy of growth rate between turtles from high vs low temperatures are thus largely attributed to between-sex difference rather than temperature effects. Taken together, our results indicate that the temperatures ranging from 28 to 30 °C are most suitable for egg incubation in *C. reevesii*, because of the high hatchability and post-hatching survival, and the fastest growth of hatchlings in these thermal regimes. Small hatchling turtles may catch up in the subsequent post-hatching growth if provided with a suitable husbandry environment, given that turtle size at hatching is not a determinant of growth in this species.

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SHORT COMMUNICATION

POTENTIAL FOR HATCHERY BROODSTOCK CONDITIONING OF THE CARIBBEAN SCALLOPS *ARGOPECTEN NUCLEUS* AND *NODIPECTEN NODOSUS*

L.A. Velasco, J. Barrosa-2007

Aquaculture 272(1-4): 767-773

Abstract:

Argopecten nucleus and *Nodipecten nodosus* are two commercially valuable scallop species found in the western Caribbean region. Field and laboratory experimentation was carried out to determine the feasibility of artificial induction of gonadal development in these species in order to have fully mature broodstock to provide gametes for massive culture trials. Scallops were either maintained as a control in the sea, or conditioned in the laboratory, 1) fed intensively with *Isochrysis galbana* and, 2) Fed with *I. galbana* (70%) and a lipid emulsion containing docosahexaenoic acid (EmDHA; 30%). Scallops with empty gonads were employed; these scallops were visually monitored periodically to determine percentage of specimens in each stage of sexual maturity. Complete gonadal development was obtained in all of the *A. nucleus* maintained in the laboratory after 16 days when fed at the highest concentrations of food having the highest organic content. In contrast, only 40% of *N. nodosus* individuals in the sea, and 20% of those in the laboratory fed with *I. galbana* became fully mature after 77 days. No progress in gonadal maturity was observed with this species in the laboratory on the diet supplemented with EmDHA.

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USING FACTORIAL MATING DESIGNS TO INCREASE THE EFFECTIVE NUMBER OF BREEDERS IN FISH HATCHERIES

Craig Busack, Curtis M. Knudsen-2007
Aquaculture 273(1): 24-32

Abstract:

We used Monte Carlo simulations to evaluate the potential of full- and partial-factorial mating designs to increase the effective number of breeders in fish hatchery operations, using two probability distributions (normal and uniform) to generate individual fitness values, two methods (multiplicative and additive) of combining fitness values in individual matings, four full-factorial designs (10×10 , 20×20 , 40×40 , 120×120), and three partial-factorial designs (2×2 , 5×5 , 10×10). Nb under full-factorial mating was nearly linearly related to, and quite predictable from Nb under single-pair mating. The higher the variance of family size under single-pair mating, the greater the Nb benefit of full-factorial mating; and the larger the population, the greater the full-factorial benefit. Under assumptions of additive combination of fitness values, full-factorial mating resulted in an average Nb increase of 33%. Partial-factorial designs as small as 2×2 achieved on average 45% of the Nb advantage attainable under full-factorial mating. The proportionate incremental Nb benefit from partial-factorial designs diminishes rapidly as the size of the design increases, but designs as small as 10×10 may attain such a large proportion of the full-factorial benefit as to render larger designs unnecessary.

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REPRODUCTIVE PERFORMANCE AND THE GROWTH OF PRE-STUNTED AND NORMAL NILE TILAPIA (OREOCHROMIS NILOTICUS) BROODFISH AT VARYING FEEDING RATES

Ram C. Bhujel, David C. Little, Amjad Hossain-2007
Aquaculture 273(1): 71-79

Abstract:

A 119-day experiment was conducted to investigate the effects of feeding rate and reproductive performance of stunted (S) and non-stunted or normal (N) Nile tilapia (*Oreochromis niloticus*). Both the groups were reared in tanks re-circulated with bio-filtered water and fed with floating pellets (30% crude protein) twice daily. Seed were harvested weekly from the mouths of incubating females. The study showed that early stunting with subsequent high feeding rate can improve both growth and reproductive output in female Nile tilapia. Broodfish type and feeding rate showed significant ($P < 0.05$) effects on both the frequency of spawning and the seed output. In general, seed output from normal broodfish increased linearly over the experimental period at all the feeding rates. However, seed output from stunted broodfish showed a linear increment for 3% feeding rate, exponential increment for 2% but quadratic for 1% showing decline after 10th week of the trial period. Results also showed that trends of seed output from stunted broodfish increased linearly with the increase in feeding rate showing that optimum rate could be higher than 3%. While from normal group the relationship was quadratic; increasing from 1%, peaked at 2% and declined at 3% feeding rate. Final GSI of the stunted females was significantly ($P < 0.05$) higher than that of normal females. The GSI of stunted fish showed a decreasing trend with the increased feeding rate. Both the broodstock groups fed at 1% biomass grew linearly whereas at 2 and 3%, they grew exponentially. As compared to the normal, stunted broodfish had significantly ($P < 0.05$) higher fat content in viscera although similar levels were in carcass and ovary. Carcass fat content was significantly ($P < 0.05$) lower in fish fed at 1% biomass but significantly ($P < 0.05$) higher in the ovary and viscera of fish fed at 3% biomass. This study shows that tilapia hatchery operators could manipulate the seed production according to the seasonal demand by using appropriate broodstock stunting and feeding strategies.

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EFFECTS OF TEMPERATURE ON THE INDUCED SPAWNING OF CHANNEL CATFISH AND THE PRODUCTION OF CHANNEL × BLUE CATFISH HYBRID FRY

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Aquaculture 273(1): 80-86

Abstract:

Hybrid catfish (channel catfish, *Ictalurus punctatus*, female × blue catfish, *I. furcatus*, male) can be obtained by induced spawning and artificial fertilization but with variable results. Temperature of the surrounding environment affects the rates of physiological processes in fish including time to ovulation following hormone injection and time post-ovulation when quality eggs can be obtained. Brood females were held at 24, 26, and 28 °C in 100 L aquaria and injected with LH-RHA at 20 µg/kg followed 12 h later with 100 µg/kg. Fish were monitored hourly recording the time of the first egg deposit. Some females were manually stripped soon after the first eggs were observed, and the remaining females were stripped 4–6 h after the first eggs were observed. Eggs were artificially fertilized with blue catfish sperm and incubated. The percent of females that ovulated were 52.9%, 82.4% and 95.5% at 24, 26, and 28 °C ($P = 0.001$) respectively. The majority of females that ovulated did so between 58 to 64 h at 24 °C, 48 to 52 h at 26 °C and 24 to 40 h at 28 °C for a degree hour response time of 1405 ± 117 , 1141 ± 238 and 951 ± 261 respectively ($P < 0.001$). Differences in eggs/kg female, eggs/g of eggs, percent viable eggs, percent hatch and survival of sac fry to swimup resulted in an average of 384.4 ± 316.97 fry/kg female at 24 °C, 370 ± 219.2 /kg at 26 °C and 1284 ± 1394.1 /kg at 28 °C ($P = 0.136$). Egg quality varied with how soon eggs were stripped after the first egg was observed. For fish held at 26 and 28 °C. the combined effects of egg quality and fry survival resulted in an average 1081 ± 1483.9 fry/kg female for fish stripped within 2 h after the first eggs were released and 500 fry/kg female when stripped after 4 or more hours once the first eggs were released.

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THE ROLE OF FATTY ACIDS ENRICHMENTS IN THE LARVICULTURE OF FALSE PERCULA CLOWNFISH AMPHIPRION OCELLARIS

M.A. Avella, I. Olivotto, G. Gioacchini, F. Maradonna, O. Carnevali-2007

Aquaculture 273(1): 87-95

Abstract:

At present, clownfishes are the best example of successfully captive bred ornamental specimens but little is known about the relationship between food enrichment and both larval growth and development. In fact, it is well known that a certain percentage of these fishes cultured in captive conditions show a miss-band pigmentation. In the present study, the effects of live prey enrichment on growth and pigmentation in false percula clownfish (*Amphiprion ocellaris*) larvae were tested.

Newly hatched *A. ocellaris* larvae were divided in three different groups and fed as follows: group A fed on enriched (Algamac 2000) *B. plicatilis* (10 ind./mL) from day 1 to day 5 post-hatch (ph); group B fed on enriched (Algamac 2000) *B. plicatilis* (10 ind./mL) followed by *Artemia nauplii* (5 ind./mL;) and group C fed on Algamac 2000 enriched *B. plicatilis* and Algamac 2000 enriched *Artemia nauplii*.

Samples of the larvae were collected on day 5 from group A and on day 11 ph in group B and C for morphometric and molecular analysis. On day 11 ph food enrichment resulted in a better growth of group C larvae respect to those of group B fed on not enriched *Artemia nauplii* (15.8 ± 0.2 mg and 8.78 ± 0.02 mm vs. 6.8 ± 0.2 mg and 6.93 ± 0.01 mm). Moreover, $36 \pm 2\%$ of the juveniles obtained from group B showed a miss-band pigmentation as compared to $29 \pm 1\%$ of the juveniles obtained from group C. At molecular level, the results

obtained by Real-Time PCR are in agreement with the morphometric ones: a positive induction of the Insulin-like Growth Factor II (IGFII) and Peroxisome Proliferator Activated Receptor α and β (PPAR α and PPAR β) gene expression and a reduction of Myostatin (MSTN) was observed in group C larvae fed on enriched live prey. IGFII gene expression was higher in group B.

The present study provides clear evidences of the positive role of Algamac 2000 on growth and pigmentation of captive cultured false percula clownfish.

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THE EFFECT OF DIETARY N-3 HUFA LEVELS AND DHA/EPA RATIOS ON GROWTH, SURVIVAL AND OSMOTIC STRESS TOLERANCE OF CHINESE MITTEN CRAB ERIOCHEIR SINENSIS LARVAE

Liyang Sui, Mathieu Wille, Yongxu Cheng, Patrick Sorgeloos-2007

Aquaculture 273(1): 139-150

Abstract:

The effect of varying levels of dietary n-3 highly unsaturated fatty acid (HUFA) and docosahexaenoic acid/eicosapentaenoic acid (DHA/EPA) ratios on growth, survival and osmotic stress tolerance of Eriocheir sinensis zoea larvae was studied in two separate experiments. In experiment I, larvae were fed rotifers and Artemia enriched with ICES emulsions with 0, 30 and 50% total n-3 HUFA levels but with the same DHA/EPA ratio of 0.6. In experiment II, larvae were fed different combinations of enriched rotifers and Artemia, in which, rotifers were enriched with emulsions containing 30% total n-3 HUFA, but different DHA/EPA ratio of 0.6, 2 and 4; while Artemia were enriched with the same emulsions, but DHA/EPA ratio of 0.6 and 4. In both experiments, un-enriched rotifers cultured on baker's yeast and newly-hatched Artemia nauplii were used as control diets. Larvae were fed rotifers at zoea 1 and zoea 2 stages; upon reaching zoea 3 stage, Artemia was introduced.

Experiment I revealed no significant effect of prey enrichment on the survival of megalopa among treatments, but higher total n-3 HUFA levels significantly enhanced larval development (larval stage index, LSI) and resulted in higher individual dry body weight of megalopa. Furthermore higher dietary n-3 HUFA levels also resulted in better tolerance to salinity stress. Experiment II indicated that at the same total n-3 HUFA level, larvae continuously receiving a low dietary DHA/EPA ratio had significantly lower survival at the megalopa stage and inferior individual body weight at the megalopa stage, but no negative effect was observed on larval development (LSI). The ability to endure salinity stress of zoea 3, zoea 5 and megalopa fed diets with higher DHA/EPA ratio was also improved.

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