

---

GROWTH PERFORMANCE, SURVIVAL, FEED UTILIZATION AND NUTRIENT UTILIZATION OF AFRICAN CATFISH (*CLARIAS GARIEPINUS*) LARVAE CO-FED ARTEMIA AND A MICRO-DIET CONTAINING FRESHWATER ATYID SHRIMP (*CARIDINA NILOTICA*) DURING WEANING

V. Chepkirui-Boit, C.C. Ngugi, J. Bowman, E. Oyoo-Okoth, J. Rasowo, J. Mugo-Bundi, L. Cherop-2011

Aquaculture Nutrition 17(2) : e82–e89

Abstract:

Problems of limited number of dry feeds as supplement or replacement of live feeds have led to poor larval nutrition in many species of fish. Therefore, the suitability of co-feeding 8-day-old African catfish (*Clarias gariepinus*) posthatch larvae using live feed (*Artemia salina*) and formulated dry diet containing freshwater atyid shrimp (*Caridina nilotica*) during weaning was investigated. The experiment ended after 21 days of culture and respective groups compared on the basis of growth performance, survival, feed utilization and nutrient utilization. Larvae co-fed using 50% *Artemia* and 50% formulated dry diet resulted in significantly ( $P < 0.05$ ) better growth performance, food gain ratio (FGR), protein efficiency ratio (PER) and productive protein values (PPV) than other treatments. The lowest growth performance occurred in larvae weaned using 100% formulated and commercial dry diets. Better survival of over 90% was obtained in larvae weaned using 50% *Artemia* and 50% dry diet, while abrupt weaning using 100% dry diets resulted in lower survival (<75%). These results support a recommendation of co-feeding *C. gariepinus* larvae using a formulated dry diet containing *C. nilotica* and 50% live feed when weaning is performed after 8 days posthatching period.

(Department of Fisheries and Aquatic Sciences, Moi University, P.O. Box 1125, Eldoret, Kenya; email of Victoria Chepkirui-Boit: [vcboit@yahoo.com](mailto:vcboit@yahoo.com))

---

BACTERIAL COLONIZATION OF WINTER FLOUNDER *PSEUDOPLEURONECTES AMERICANUS* FED LIVE FEED ENRICHED WITH THREE DIFFERENT COMMERCIAL DIETS

L.H. Seychelles, C. Audet, R. Tremblay, K. Lemarchand, F. Pernet-2011

Aquaculture Nutrition 17(2): e196–e206

Abstract :

The proliferation of bacteria in intensive aquaculture systems may be responsible for poor growth and mass mortality of marine fish larvae. Essential fatty acids provided in the diet could protect larvae by modulation of the immune response via arachidonic acid (AA) and eicosapentaenoic acid (EPA). Winter flounder *Pseudopleuronectes americanus* larvae were fed rotifers *Brachionus plicatilis* enriched with three commercial diets containing different fatty acid profiles. Bacterial colonization on the gills and skin and in the intestinal lumen was evaluated at the end of the rotifer feeding period (day 26), and growth was surveyed until metamorphosis. At 26 days post hatching, larvae fed rotifers containing the higher AA content and with a higher docosahexaenoic acid (DHA) to EPA ratio showed better growth and the lowest bacterial colonization of the intestinal lumen compared to larvae fed rotifers with the lowest AA and DHA : EPA levels. AA had been selectively incorporated into the polar lipids of larvae fed the rotifers enriched with the three diets. This is the first study in winter flounder larvae to report a link between different commercial rotifer enrichments and bacterial density in intestinal lumen.

(Institut des sciences de la mer de Rimouski, Université du Québec à Rimouski, 310 allée des Ursulines, Rimouski, Québec, Canada G5L 3A1 ; email Céline Audet : [celine\\_audet@uqar.qc.ca](mailto:celine_audet@uqar.qc.ca))

---

POTENTIAL USE OF ARTEMIA BIOMASS BY-PRODUCTS FROM ARTEMIA CYST PRODUCTION FOR THE NURSING OF GOBY *PSEUDAPOCRYPTES ELONGATUS* IN VIETNAM: EFFECTS ON GROWTH AND FEED UTILIZATION

N.T.N. Anh, M. Wille, N. Van Hoa, P. Sorgeloos-2011

Aquaculture Nutrition 17(2): e297–e305

Abstract :

The present study was performed to evaluate the effect of using Artemia biomass, by-product from Artemia cyst production on growth and feed utilization of goby *Pseudapocryptes elongatus* fingerlings. A control diet containing fishmeal as main protein source was compared with four experimental diets in which fishmeal protein was replaced by increasing dietary levels of Artemia protein, namely 25%, 50%, 75% and 100%. The five test diets were compared with a commercial diet and dried Artemia. All diets were formulated to be equivalent in crude protein (360–370 g kg<sup>-1</sup>) and lipid (58–65 g kg<sup>-1</sup>). The experiment was conducted in 80 L plastic tanks filled with water at a salinity of 15 g L<sup>-1</sup>. Goby fingerlings with 0.21 g initial weight were fed the test diets for 30 days. The results showed that weight gain and specific growth rate of goby were positively correlated with total feed intake. Moreover, growth performances and feed utilization in the fry receiving the commercial feed and fishmeal control diet were similar, both were inferior to the groups fed dried Artemia and the based formulated diets. These results illustrate that both dried Artemia and Artemia-based feeds can be used for feeding goby fingerlings, indicating the high potential of using locally produced Artemia biomass, which could contribute to reduce the reliance on fishmeal and improve profits for Artemia producers. (Faculty of Bioscience Engineering, Laboratory of Aquaculture & Artemia Reference Center, Ghent University, Ghent, Belgium; email of N.T.N. Anh: [ntnanh@ctu.edu.vn](mailto:ntnanh@ctu.edu.vn))

---

#### EFFECTS OF DIETARY CHITOSAN ON GROWTH, SURVIVAL AND STRESS TOLERANCE OF POSTLARVAL SHRIMP, *LITOPENAEUS VANNAMEI*

J. Niu, Y.-J. Liu, H.-Z. Lin, K.-S. Mai, H.-J. Yang, G.-Y. Liang, L.-X. Tian-2011  
Aquaculture Nutrition 17(2) : e406–e412

##### Abstract:

The effect of chitosan, a polymer of glucosamine obtained by the deacetylation of chitin, on growth, survival and stress tolerance was studied in postlarval *Litopenaeus vannamei*. An experiment was performed with postlarval shrimp (mean initial wet weight 1.2 mg) fed five isoenergetic and isonitrogenous diets containing five supplemented levels of chitosan (0, 0.5, 1, 2 and 4 g kg<sup>-1</sup> diet, respectively). The five compound diets (C0, C0.5, C1, C2 and C4) sustained shrimp growth throughout the experiment. Growth performance (final body weights; weight gain; SGR: specific growth rate) in shrimp fed diet C2 was significantly higher than that in shrimp fed diets C0, C0.5 and C1 ( $P < 0.05$ ), diet C4 treatment provided intermediate growth result. The survival in shrimp fed diet C1 was significantly higher than that in shrimp fed C0 diet ( $P < 0.05$ ), other diets treatments gave the intermediate survival results. No significant differences were found in growth and survival between diet C2 and C4 treatments. After 9 days of a stress tolerance test, survival in shrimp fed diets C1, C2 and C4 was significantly higher than that in shrimp fed diets C0 and C0.5. We concluded from this experiment that the incorporation of a moderate dietary chitosan was beneficial to the development of postlarval *L. vannamei*. Considering the effect of chitosan on both growth and survival of postlarval *L. vannamei*, second-degree polynomial regression of SGR and survival indicated optimum supplement of dietary chitosan at 2.67 and 2.13 g kg<sup>-1</sup>, respectively, so the level of chitosan supplemented in the diet should be between 2.13 and 2.67 g kg<sup>-1</sup>

(South China Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, Guangzhou, China)

---

#### EVALUATION OF WEANING PERFORMANCE OF CALIFORNIA HALIBUT (*PARALICHTHYS CALIFORNICUS*) LARVAE USING GROWTH, SURVIVAL AND DIGESTIVE PROTEOLYTIC ACTIVITY

J.-B. Muguet, J.P. Lazo, D.E. Conklin, R.H. Piedrahita-2011  
Aquaculture Nutrition 17(2): e486–e493

##### Abstract:

This study evaluated weaning success of California halibut, *Paralichthys californicus*, larvae onto a microdiet at various stages of development utilizing growth, survival and digestive enzyme activity. Weaning onto a microdiet was evaluated at 16, 26, 36 and 46 days posthatch (dph). Alkaline and acid proteases and leucine aminopeptidase activities were measured after weaning and compared between the weaned treatment and Artemia-fed controls. Survival was significantly lower in the microdiet-fed

treatments compared to the control groups. Growth was significantly reduced in all weaning treatments compared to the control, except for the 46 dph group. No differences in enzyme activities were detected between treatment and diet at 16 and 26 dph; however, activities were higher for the microdiet-fed larvae at 36 and 46 dph. This study demonstrates that California halibut larvae possess a differentiated and effective digestive system early in development and can be weaned with relative success (>40% survival) before completion of the metamorphosis (i.e., 36 dph). The lack of weaning success at an early date cannot be entirely because of the absence of a functional stomach but could be related to, among other factors, the low-microdiet ingestion rates observed and higher leaching of smaller microdiets. (Department of Animal Science, University of California Davis, One Shields Ave., Davis, California, USA; email of Juan P. Lazo: [jplazo@cicese.mx](mailto:jplazo@cicese.mx))

---

#### EFFECT OF DIFFERENT FORMS OF ARTEMIA BIOMASS AS A FOOD SOURCE ON SURVIVAL, MOLTING AND GROWTH RATE OF MUD CRAB (SCYLLA PARAMAMOSAIN)

N. T. N. Anh, V. N. Ut, M. Wille, N. V. Hoa, P. Sorgeloos-2011

Aquaculture Nutrition 17(2) : e549–e558

Abstract:

An experiment was conducted to evaluate the effect of different forms of Artemia biomass as a food source on survival, molting and growth rate of mud crab *Scylla paramamosain*. Instar 1 crablets with a mean weight of  $0.0082 \pm 0.0007$  g were reared both individually and communally and fed with different diets consisting of fresh shrimp meat (control feed), live Artemia biomass, frozen Artemia biomass and a dried Artemia-based formulated feed for 40 days. The highest survival was obtained for crablets receiving live Artemia (92.5% and 75.8%) followed by the groups fed with frozen biomass (90.0% and 47.5%), the control feed (72.5% and 24.2%) and the dried Artemia-based diet (60.0% and 21.7%) for individual and communal cultures, respectively. The intermolt period, the total number of moltings and the growth rate, which were determined on individually reared crabs, showed the same pattern as for survival. The results suggest that crab performance decreased in the following order: live Artemia > frozen Artemia > fresh shrimp meat > dried Artemia-based formulated feed. Live Artemia biomass proved an ideal feed for nursery of *Scylla paramamosain* crabs. Frozen Artemia biomass may be an alternative in times of shortage. Our findings illustrate the high potential for local utilization of Artemia biomass in Vietnam for reliable production of mud crab juveniles.

(Laboratory of Aquaculture & Artemia Reference Center, Faculty of Bioscience Engineering, Ghent University, Belgium; email of N.T.N. Anh: [ntnanh@ctu.edu.vn](mailto:ntnanh@ctu.edu.vn))

---

#### EFFECT OF PREY TYPE AND SIZE ON THE GROWTH, SURVIVAL AND PIGMENTATION OF COD (GADUS MORHUA L.) LARVAE

K.E.T. Busch, S. Peruzzi, F. Tønning, I-B. Falk-Petersen

Aquaculture Nutrition 17(2): e595–e603

Abstract:

The aim of this study was to investigate the effect of natural zooplankton versus rotifers and the effect of prey size on the growth and survival of cod larvae. At 20 days post hatch (DPH) myotome height, standard length and dry mass were significantly higher in larvae fed zooplankton compared to those fed rotifers. The dry mass at age 25 DPH was  $135 \mu\text{g}$  ( $\pm 45$ ),  $331 \mu\text{g}$  ( $\pm 114$ ),  $391 \mu\text{g}$  ( $\pm 121$ ) for larvae fed rotifers, small size and large size plankton, respectively. At 25 days post hatch, the survival rates were 41.8% ( $\pm 10.5$ ), 90.7% ( $\pm 2.3$ ) and 91.4% ( $\pm 1.7$ ) for larvae reared on rotifers, small size and large size plankton, respectively. The limited growth and survival of cod larvae reared on rotifers were not mainly caused by the small size of rotifers. Large differences in skin coloration between larvae in the rotifer group and the two zooplankton groups were observed, probably caused by the large difference in astaxanthin levels in rotifers and natural zooplankton. We suggest that the nutritional composition of rotifers is a limiting factor for cod larvae growth and survival.

(Faculty of Biosciences, Fisheries and Economics, University of Tromsø, N-9037 Tromsø, Norway; email of Kjersti Eline Tønnessen Busch: [Kjersti.Busch@uit.no](mailto:Kjersti.Busch@uit.no))

---

STAGING OF INITIAL PEPSINOGEN AND CHITINASE EXPRESSION AND COMPLETE GASTRIC GLAND DEVELOPMENT WITHIN THE LARVAL STOMACH OF JAPANESE FLOUNDER, SPOTTED HALIBUT, SEVEN-BAND GROUPEL AND GREATER AMBERJACK

Xiaoming Wu, Youhei Washio, Masato Aritaki, Yuichiro Fujinami, Daisuke Shimizu, Hiroshi Hashimoto, Takashi Iwasaki, Susumu Uji, Tohru Suzuki-2011

Aquaculture 314(1-4): 165-172

Abstract:

The gastric glands of marine aquaculture fish species are known to start secretion of pepsinogens (Pep) during larval development, far after first feeding. Although characterization of gastric gland development is considered useful for managing larval feeding, the timing of initial Pep synthesis by the gastric gland has only been reported for a few species. Consequently, this study employed *in situ* hybridization (ISH) to characterize the onset of expression of genes encoding the gastric enzymes Pep and Chitinase (Chi), as well as the complete development of gastric glands in the larval stomach of Japanese flounder (*Paralichthys olivaceus*), spotted halibut (*Verasper variegatus*), seven-band grouper (*Epinephelus septemfasciatus*) and greater amberjack (*Seriola dumerili*). The expression of both Chi and Pep was observed to begin in the cardiac region of the larval stomach at 25 days post-hatching (dph) in Japanese flounder, 36 dph in spotted halibut, 38 dph in seven-band grouper and 13 dph in greater amberjack. The gastric glands of these species were fully developed in the stomach approximately 5–12 days after the initiation of Pep expression. Development of gastric glands was observed to coincide with external manifestations of metamorphosis, such as the development of adult coloration in Japanese flounder and spotted halibut of the Pleuronectiformes, while it finished prior to adult-type coloration in seven-band grouper and greater amberjack of the Perciformes.

(Laboratory of Marine Life Science and Genetics, Graduate School of Agricultural Science, Tohoku University, Sendai 981-8555, Japan; email of Tohru Suzuki: suzukitr@bios.tohoku.ac.jp)

EFFECTS OF SALINITY AND TEMPERATURE ON THE GROWTH, SURVIVAL, WHOLE BODY OSMOLALITY, AND EXPRESSION OF Na<sup>+</sup>/K<sup>+</sup> ATPASE MRNA IN RED PORGY (PAGRUS PAGRUS) LARVAE

Andrew D. Ostrowski, Wade O. Watanabe, Frank P. Montgomery, Troy C. Rezek, Thomas H. Shafer, James A. Morris Jr-2011

Aquaculture 314(1-4): 193-201

Abstract:

Atlantic red porgy, *Pagrus pagrus*, is an important reef fish species in the Mediterranean and the snapper–grouper complex off the southeastern United States. Red porgy is a viable candidate for aquaculture with high market value and the ability to spawn freely in captivity. The objective of this study was to examine the combined effects of temperature and salinity on eggs, yolk-sac larvae, and early feeding-stage larvae of red porgy to day 16 post-hatching (d16ph). To determine the optimal temperature and salinity conditions for culture, embryos were reared under four temperatures (17, 19, 21, and 23 °C) and two salinities (24 and 34 g/L) in a 4 × 2 factorial design. Significant effects of temperature and salinity on growth (notochord length, wet and dry weight), survival, whole body osmolality, and expression of Na<sup>+</sup>/K<sup>+</sup> ATPase were observed with minimal interactive effects. Under both salinities, growth increased with increasing temperature. On d16ph, wet weights at 21 and 23 °C (2.03 and 2.91 mg, respectively) were significantly higher than at 17 and 19 °C (0.20 and 0.69 mg). Salinity had no effect on growth at any temperature, but had a significant effect on survival to d16ph, with greater survival at 24 g/L (18.4%) than at 34 g/L (6.77%). Salinity significantly affected whole body osmolality on d2ph and d11ph, with 24 g/L having lower whole body osmolality than 34 g/L on both days. Temperature significantly affected whole body osmolality on d6ph, with no clear trends and on d17ph, with 17 °C (534 mOsm/kg) higher than all the higher temperatures (396–411 mOsm/kg). After increasing each tank to 44 g/L to create a sublethal salinity challenge on d16ph, larvae from 34 g/L treatments did not show an increase in levels of Na<sup>+</sup>/K<sup>+</sup> ATPase mRNA after 24 or 48 h post transfer. However, fish in the 24 g/L treatments showed a significant increase in expression of Na<sup>+</sup>/K<sup>+</sup> ATPase mRNA after 24 h followed by a decrease after 48 h. Within the ranges tested, a temperature of

23 °C and a salinity of 24 g/L appear to be optimal for culture of red porgy embryos, yolk-sac, and first-feeding stage larvae to d16ph.

(University of North Carolina Wilmington, Center for Marine Science, 601 S. College Rd, Wilmington, NC 28403, USA; email of Wade O. Watanabe: watanabew@uncw.edu)

---

#### SPERMATOOZOA OF THE TELEOST FISH *PERCA FLUVIATILIS* (PERCH) HAVE THE ABILITY TO SWIM FOR MORE THAN TWO HOURS IN SALINE SOLUTIONS

Franz Lahnsteiner-2011

Aquaculture 314(1-4) : 221-224

Abstract:

Spermatozoa of the perch, a teleost fish with external fertilization are motile for < 90 s in water which is similar to other teleost fresh water fish species investigated so far. When motility was activated in a saline solution consisting of 75 mmol/l NaCl, 5 mmol/l KCl, 1 mmol/l MgSO<sub>4</sub>, and 1 mmol/l CaCl<sub>2</sub> it was prolonged to > 2 h at 4 °C. The initial motility rate 10 s after activation was 72.6 ± 17.6% and the swimming velocity 126.4 ± 14.2 µm/s. After 4 min motility dropped to 42.8 ± 14.0%. Thereafter, the motility rate and swimming velocity remained constant for > 2 h (41.6 ± 10.0% and 102.2 ± 14.3 µm/s). This is the first report demonstrating that teleost fish spermatozoa are able to swim in saline solutions and without exogenous energy supply with constant high velocities and unchanged motility parameters for several hours.

(Department of Organismic Biology, University of Salzburg, Hellbrunnerstr. 34, A-5020 Salzburg, Austria; [Franz.Lahnsteiner@sbg.ac.at](mailto:Franz.Lahnsteiner@sbg.ac.at))

---

#### INFLUENCE OF DIETARY PHOSPHOLIPIDS LEVEL ON GROWTH PERFORMANCE, BODY COMPOSITION AND LIPID CLASS OF EARLY POSTLARVAL *LITOPENAEUS VANNAMEI*

J. Niu, Y.-J. Liu, L.-X. Tian, K.-S. Mai, H.-Z. Lin, X. Chen, H.-J. Yang, G.-Y. Liang-2011

Aquaculture Nutrition 17(2) : e615–e621

Abstract:

One experiment was conducted to determine the nutritive value of phospholipids on growth performance of early postlarval shrimp, *Litopenaeus vannamei*. Five isoenergetic and isonitrogenous diets with five supplemented levels of phospholipids (P1, P2, P3, P4 and P5 with 0, 10, 20, 40 and 80 g kg<sup>-1</sup> diet, respectively) were fed to triplicate groups of *L. vannamei* (mean initial wet weight 0.8 mg) for 27 days. After the 27-day feeding trial, the lowest weight gain (WG, %) and specific growth rate (SGR, % day<sup>-1</sup>) was found in P1 treatment, the highest WG and SGR was found in P3, P4 and P5 treatments, P2 treatment provided intermediate result and showed significant difference compared to P1, P3, P4 and P5 treatments. Shrimp fed the P1 diet had significantly lower survival than shrimp fed other diets, while no significant difference was found in survival among P2, P3, P4 and P5 treatments. Broken-line analysis on WG indicated that the optimum dietary phospholipids for early postlarval shrimp, *L. vannamei*, is 45.96 g kg<sup>-1</sup> diet.

(South China Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, Guangzhou, China; email of Li-Xia Tian: edls@mail.sysu.edu.cn)

---

#### EFFECT OF THREE DIETS ON GROWTH AND SURVIVAL RATES OF AFRICAN CATFISH *HETEROBRANCHUS BIDORSALIS* LARVAE

Yao Laurent Alla, Ble Melecony Célestin, Atse Boua Célestin, Kone Tidiani-2011

The Israeli Journal of Aquaculture – Bamidgheh 63

Abstract:

Investigations are underway in the Centre de Recherches Océanologiques d'Abidjan (Côte d'Ivoire) to find whether the catfish (*Heterobranchus bidorsalis*) could be an interesting aquaculture species. Within this framework a 28-day aquarium culture feeding trial was conducted to investigate the effects of three diets (*Artemia salina* nauplii, beef brain enriched with vitamins, and a compound food) on the growth and survival rates in 2-day post hatch *H. bidorsalis*. The feeding experiments started after the yolk sac of the larvae was absorbed (initial mean weight = 2.03±0.38 mg). Larvae fed *Artemia* nauplii had a

higher growth rate (final mean weight = 708.60±411.61 mg] than those fed beef brain (381.81±118.88 mg) or compound food (102.72±48.09 mg). Conversely, the beef brain diet yielded a better survival rate (70.47±9.48%) than the *Artemia nauplii* (38.72±7.74%) or the compound diet (5.37±2.24%). Thus, beef brain can be used as a starter food for larval rearing of *H. bidorsalis*.

(Centre de Recherches Océanologiques, BPV 18 Abidjan, Côte d'Ivoire ; email of Yao Laurent Alla : laurentalla@yahoo.fr)

---

#### POPULATION GROWTH OF BOSMINA LONGIROSTRIS FED CHLORELLA VULGARIS AND SCENEDESMUS SUBSPICATUS IN DIFFERENT DENSITIES

Ömer Osman Ertan, Zekiye Güçlü, Ömer Erdoğan, Sevgi Savaş, İskender Gülle-2011

The Israeli Journal of Aquaculture – Bamidgeh 63

Abstract :

In this study, the effects of the different densities of *Chlorella vulgaris* (0.05 x 10<sup>6</sup>, 0.1 x 10<sup>6</sup>, 0.2 x 10<sup>6</sup>, 0.4 x 10<sup>6</sup>, or 0.8 x 10<sup>6</sup> cells/ml) and *Scenedesmus subspicatus* (0.05 x 10<sup>6</sup>, 0.1 x 10<sup>6</sup>, 0.2 x 10<sup>6</sup>, or 0.4 x 10<sup>6</sup> cells/ml) on culture of the water flea, *Bosmina longirostris*, were investigated. The experiment was carried out in a photoperiod of 16 h light:8 h dark at 25±1°C. At the beginning of the experiment, one *B. longirostris* individual (<24 h old) was put into each vessel, and the number of individuals and rate of population increase were determined for 30 days. Increasing the food density increased the number of individuals and the rate of population. The maximum number of *B. longirostris* individuals (7.1±2.08 ind/ml) and maximum rate of population increase (0.2±0.004/day) was in the group fed 0.2 x 10<sup>6</sup> cells/ml *S. subspicatus*. The effect on the number of the individuals was statistically significant (p<0.05).

(Faculty of Fisheries, Süleyman Demirel University, Eğirdir, Isparta, Türkiye; email of Ömer Osman Ertan: ooertan@sdu.edu.tr)

---

#### EARLY WEANING OF DISCUS SYMPHYSODON SPP. LARVAE: HISTOLOGICAL AND MORPHOLOGICAL OBSERVATIONS

İhsan Çelik, Umur Önal, Şükran Cirik, Canan Duman, Tuncay İngin, Pınar Çelik-2011

The Israeli Journal of Aquaculture – Bamidgeh 63

Abstract:

To determine the optimal timing for weaning discus (*Symphysodon* spp.), larvae were fed a control diet of 100% *Artemia*, or weaned onto a micro-ground diet on day 18, 23, or 28 after hatching, until 45 days after hatching. During the first 14 days, the development of the digestive tract was studied to determine key events in the early ontogeny of discus larvae. There were significant (p<0.05) differences among treatments in the growth of the larvae. The highest weight increase was observed in the control group but good growth was also obtained when the larvae were weaned to dry feed 28 days after hatching. The specific growth rate (SGR) was 6.0±0.19 in the control group and 0.4±0.239, 2.0±0.257, and 5.2±0.382 in the 18, 23, and 28 day groups, respectively. Mean survival in all treatments was 56.25% with no significant differences among treatments.

(Department of Aquaculture, Fisheries Faculty, Çanakkale Onsekiz Mart University, Terzioğlu Campus, 17100 Çanakkale, Turkey; email of İhsan Çelik: celik\_ihsan@yahoo.com)

---

#### SEMEN PROPERTIES AND SPERMATOZOAN STRUCTURE OF YELLOW CROAKER, LARIMICHTHYS POLYACTIS

Minh Hoang Le, Han Kyu Lim, Byung Hwa Min, Jung Uie Lee, Young Jin Chang-2011

The Israeli Journal of Aquaculture – Bamidgeh 63

Abstract :

The aim of this study was to determine the properties of semen and the structure of spermatozoa of cultivated yellow croaker, *Larimichthys polyactis*. The volume of semen was 1.1±0.3 ml/fish, the sperm density 2.5±0.2 x 10<sup>9</sup> cells/ml, the spermatocrit 97.1±1.8%, and the sperm count 2.7±1.0 x 10<sup>9</sup> cells/fish. The seminal plasma contained 148.3±4.7 mmol/l sodium, 17.1±1.8 mmol/l potassium, 115.5±4.8 mmol/l chloride, 2.9±0.1 mmol/l calcium, 1.8±0.4 mmol/l magnesium, 0.1 mmol/l glucose,

and 1.0 g/l total protein; osmolality was  $342.5 \pm 3.6$  mOsm/kg and pH was  $7.7 \pm 0.1$ . Regression analysis showed significant positive linear relationships between semen volume and fish weight, semen volume and fish length, sperm count and fish weight, and sperm density and spermatocrit. Thus, spermatocrit can be used as a rapid estimator of sperm density in yellow croaker. The spermatozoa consisted of three parts: a head without an acrosome, a mid-piece with three mitochondria, and a flagellum with a typical "9+2" arrangement. The longitudinal section of the head was kidney-shaped and  $0.6-0.8 \times 1.4-1.6 \mu\text{m}$ . This study provides information on yellow croaker sperm physiology that can be used to improve sperm management efficiency in yellow croaker. The values and correlations between semen and seminal plasma can be used to formulate a species-specific extender for cryopreservation of yellow croaker semen.

(Department of Aquaculture, Pukyong National University, Busan 608-737, Korea; email of Minh Hoang Le: mhle.vn@gmail.com)

---

#### EFFECTS OF CRYOPROTECTANT TOXICITY ON EMBRYOS OF THE CHINESE MITTEN CRAB, *ERIOCHEIR SINENSIS* (DECAPODA, BRACHYURA)

Huang, Xiaorong, Zhuang, Ping, Zhang, Longzhen, Yao, Zhifeng, Liu, Ting, Liu, Jianyi, Feng, Guangpeng-2011

Crustaceana 84(3): 281-291

Abstract:

The response of embryos of the Chinese mitten crab (*Eriocheir sinensis*) in terms of survival to cryoprotectants was investigated for basic knowledge to enhance cryopreservation success of *E. sinensis* embryos. Five stages of embryonic development (cleavage, blastula, gastrula, eyed stage, and heart-beating stage embryos corresponding to 7, 14, 20, 26, and 31 days post-spawning) were chosen and exposed to various cryoprotectants, namely methanol (MeOH), propylene glycol (PG), dimethyl sulfoxide (DMSO), and dimethylformamide (DMF), at three concentrations (10, 15, 20%) for an experimental period of 30 min. at culture temperature ( $16^\circ\text{C}$ ). The toxicity tolerance of *E. sinensis* embryos varied with developmental stage and cryoprotectant concentration. Cleavage and blastula embryos were very sensitive to cryoprotectant concentrations above 10%. Gastrula, eyed stage, and heart-beating stage embryos tolerated cryoprotectants to 20%, although a higher survival percentage was observed in heart beating stage embryos than in gastrula and eyed stage embryos. The survival percentage declined with an increase in cryoprotectant concentration. PG and DMF were relatively less toxic as compared to DMSO and MeOH. Based on the sensitivity to cryoprotectant exposure, heart beating stage embryos of *E. sinensis* are an appropriate stage for further cryopreservation.

---

#### DEVELOPMENT OF DIGESTIVE ENZYMES IN LARVAE OF MAYAN CICHLID *CICHLASOMA UROPHthalmus*

G. López-Ramírez, C. A. Cuenca-Soria, C. A. Alvarez-González, D. Tovar-Ramírez, J. L. Ortiz-Galindo, N. Perales-García, G. Márquez-Couturier, L. Arias-Rodríguez, J. R. Indy, W. M. Contreras-Sánchez-2011

Fish Physiology and Biochemistry 37(1): 197-208

Abstract:

The development of digestive enzymes during the early ontogeny of the Mayan cichlid (*Cichlasoma urophthalmus*) was studied using biochemical and electrophoretic techniques. From yolk absorption (6 days after hatching: dah), larvae were fed *Artemia* nauplii until 15 dah, afterward they were fed with commercial microparticulated trout food (45% protein and 16% lipids) from 16 to 60 dah. Several samples were collected including yolk-sac larvae (considered as day 1 after hatching) and specimens up to 60 dah. Most digestive enzymes were present from yolk absorption (5–6 dah), except for the specific acid proteases activity (pepsin-like), which increase rapidly from 8 dah up to 20 dah. Three alkaline proteases isoforms (24.0, 24.8, 84.5 kDa) were detected at 8 dah using SDS-PAGE zymogram, corresponding to trypsin, chymotrypsin and probably leucine aminopeptidase enzymes, and only one isoform was detected (relative electromobility,  $R_f = 0.54$ ) for acid proteases (pepsin-like) from 3 dah onwards using PAGE zymogram. We concluded that *C. urophthalmus* is a precocious fish with a great capacity to digest all kinds of food items, including artificial diets provided from 13 dah.

(Laboratorio de Acuicultura Tropical-DACBIOL, Universidad Juarez Autonoma de Tabasco, Carretera Villahermosa Cardenas km 0.5, 86139 Villahermosa, Tabasco, Mexico; email of A. Alvarez-González: alvarez\_alfonso@hotmail.com)

---

FEEDING *ACIPENSER PERSICUS* AND *HUSO HUSO* LARVAE WITH *ARTEMIA URMIANA* NAUPLII ENRICHED WITH HIGHLY UNSATURATED FATTY ACIDS AND VITAMIN C: EFFECT ON GROWTH, SURVIVAL AND FATTY ACID PROFILE

F. Noori, G. A. Takami, M. Van Speybroeck, G. Van Stappen, A.-R. Shiri-Harzevili, P. Sorgeloos-2011  
Journal of Applied Ichthyology 27(2): 781–786

Special Issue: Proceedings of the 6th International Symposium on Sturgeon Wuhan, China October 25-31, 2009

Summary:

This study aimed at evaluating the effects of enriching *Artemia* nauplii with the essential fatty acids docosahexanoic acid (DHA) and eicosapentaenoic acid (EPA), and vitamin C (ascorbyl-6 palmitate) on growth and survival of early life history stages of *Acipenser persicus* and *Huso huso*. The fish larvae were fed with *A. urmiana* either in the form of decapsulated cysts, newly-hatched nauplii, or nauplii enriched with saturated lipid or highly unsaturated fatty acid (HUFA) emulsions supplemented with vitamin C, (0, 10 and 20% w/w) during a 15-days culture period. The zootechnical parameters were measured every alternate day in order to determine larval survival and growth. Larvae fed on decapsulated cysts of *A. urmiana* had significantly lower growth and survival compared to other treatments. Survival of larvae fed on HUFA + 20% vitamin C was significantly better than the larvae fed only with vitamin C. Maximum increase in growth parameters was observed in larvae fed *Artemia* nauplii enriched with HUFA + 20% vitamin C.

(Laboratory of Aquaculture & Artemia Reference Center, Ghent University, Gent, Belgium; email of F. Noori: f.noori@urmia.ac.ir)

---

FEEDING *ACIPENSER PERSICUS* AND *HUSO HUSO* (*ACIPENSERIFORMES*) LARVAE WITH *ARTEMIA URMIANA* NAUPLII ENRICHED WITH HUFA AND VITAMIN C: II. EFFECT ON TOLERANCE TO SHOCK EXPOSURE OF ENVIRONMENTAL FACTORS

F. Noori, G. A. Takami, M. Van Speybroeck, G. Van Stappen, P. Sorgeloos-2011

Journal of Applied Ichthyology 27(2): 787–795

Special Issue: Proceedings of the 6th International Symposium on Sturgeon Wuhan, China October 25-31, 2009

Summary:

The effects of feeding *Acipenser persicus* and *Huso huso* larvae with *Artemia* nauplii enriched with ascorbyl palmitate (AP) and lipid emulsions on inducing tolerance against abrupt changes in environmental conditions (such as elevated levels of salinity, temperature, nitrite and total ammonia) were investigated. The 10 days post-hatch fish larvae were fed with decapsulated cysts (DC) or newly hatched *Artemia urmiana* nauplii enriched with saturated lipids and HUFA emulsions containing 0, 10, and 20% AP. The control groups received non-enriched nauplii as source of food. Each feeding experiment was carried out for 15 days in four replicates under controlled laboratory culture conditions. Ten randomly collected *A. persicus* and *H. huso* larvae from each replicate were subjected to different salinities, nitrite, total ammonia concentrations and temperatures. The results showed that feeding with *Artemia* nauplii enriched with HUFA and higher concentrations of vitamin C induces significantly higher tolerance to shocks in abiotic conditions in fish larvae of both species, as shown by higher survival. Nevertheless the two fish species did not exhibit a similar pattern of response: *A. persicus* showed higher tolerance compared to *H. huso*. Enrichment with HUFA alone did not result in a significantly improved tolerance, indicating the importance of dietary vitamin C to cope with abrupt physico-chemical changes.

(Laboratory of Aquaculture & Artemia Reference Center, Ghent University, Gent, Belgium; email of F. Noori: f.noori@urmia.ac.ir)

---



EFFECTS OF REPLACING LIVE FOOD WITH FORMULATED DIETS ON GROWTH AND SURVIVAL RATES IN PERSIAN STURGEON (*ACIPENSER PERSICUS*) LARVAE

M. Shakourian, M. Pourkazemi, M. A. Y. Sadati, M. H. S. Hassani, H. R. Pourali, U. Arshad

Journal of Applied Ichthyology 27(2): 771–774

Special Issue: Proceedings of the 6th International Symposium on Sturgeon Wuhan, China October 25-31, 2009

Summary:

This study was conducted to adapt Persian sturgeon larvae to commercially prepared diets over a period of 35 days. A total of 6000 *Acipenser persicus* larvae (mean weight:  $0.406 \pm 0.047$  g (Mean  $\pm$  SD; n = 180) were randomly stocked into 12 concrete tanks (diameter: 2.5 m, height: 30 cm). Each tank was stocked with 500 individuals. Three diets were used: (i) a formulated diets in the form of a paste; (ii) a formulated diet in pellet form, and (iii) a paste diet combined with chopped chironomid larvae. A control group fed live food (*Daphnia* + chironomid larvae + gammarids) was also used. Growth rates in the group 3 were significantly different ( $P < 0.05$ ) from the other two groups. Highest body weight (2.51 g) was gained in experimental group 3 and the lowest weight (1.17 g) was observed in the second group. Highest survival rate (91.5%) was recorded in the control group while the lowest rate (7.2%) was observed in experimental group 2. This study revealed that by a gradual replacement of live food during a period of 35 days Persian sturgeon larvae can be successfully weaned to formulated diets.

Sturgeon Research Institute, Rasht, Iran

(International Sturgeon Research Institute, PO Box 41635-3464, Rasht, Iran; email of Mahmoud Shakourian: puriatania@yahoo.com)

---