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**BIOLOGICAL DATA ON ARTEMIA SALINA (BRANCHIOPODA, ANOSTRACA) FROM CHOTT MAROUANE (NORTHEAST ALGERIA)**

Amarouyache, M., Derbal, F., Kara, M.H.-2009

Crustaceana, 82(8): 997-1005

**Abstract:**

Some biological and ecological aspects of *Artemia salina* from Chott Marouane (northeast Algeria) were studied during the wet period of 2001. The population develops between late winter and spring. It is adapted to the high salinity of the site, ranging between 230 and 360 psu. Sex-ratio is in favour of males. These are smaller in size than females: their respective average lengths are 6.02 and 7.01 mm. Oviparity is the main mode of reproduction (more than 86.6%). Females produce between 4.9 and 17 cysts/brood, according to the sampling period.

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**EFFECTS OF SEROTONIN, DOPAMINE, OCTOPAMINE, AND SPIPERONE ON OVARIAN MATURATION AND EMBRYONIC DEVELOPMENT IN THE GIANT FRESHWATER PRAWN, MACROBRACHIUM ROSENBERGII (DE MAN, 1879)**

Tinikul, Yotsawan, Soonthornsumrith, Boworn, Phoungpetchara, Ittipon, Meeratana, Prasert, Poljaroen, Jaruwan, Duangsuwan, Pornsawan, Soonklang, Nantawan, Mercier, A. Joffre, Sobhon, Prasert-2009

Crustaceana, 82(8): 1007-1022

**Abstract:**

Mature female *Macrobrachium rosenbergii* in stage I of their ovarian cycle were divided into 17 groups (14 experimental groups and 3 controls) of 28 animals each. Animals in each experimental group were injected intramuscularly with 2-3 doses of serotonin (5-HT), dopamine (DA), octopamine (OA), spiperone (SP), or 5-HT plus SP, at four-day intervals from day 1 to 49. Five animals each in every group were sacrificed, respectively, at day 14, 25, and 49 to evaluate the gonadosomatic index (GSI) and oocyte diameters. The experimental groups that received the doses of  $2.5 \times 10^{-5}$ ,  $2.5 \times 10^{-6}$  mol of 5-HT/prawn,  $2.5 \times 10^{-5}$ ,  $2.5 \times 10^{-6}$ ,  $2.5 \times 10^{-7}$  mol of 5-HT/prawn plus  $2.7 \times 10^{-7}$  mol of SP/prawn, as well as SP alone at the dose of  $5.4 \times 10^{-7}$  mol of SP/prawn, exhibited significantly shorter periods of ovarian maturation and embryonic development, as well as increased GSI values and oocyte diameters, when compared with vehicle-injected and untreated control groups. In contrast, groups injected with DA and OA at similar doses showed decreased ovarian maturation, oocyte diameters, and embryonic periods, but no differences in GSI, when compared with control groups. For the number of eggs per spawn, the groups of animals that received 5-HT at doses of  $2.5 \times 10^{-5}$  and  $2.5 \times 10^{-6}$  mol/prawn, 5-HT at doses of  $2.5 \times 10^{-5}$  mol plus SP at  $2.7 \times 10^{-7}$  mol/prawn, 5-HT at  $2.5 \times 10^{-6}$  mol plus SP at  $2.7 \times 10^{-7}$  mol/prawn, and SP at a dose of  $2.7 \times 10^{-7}$  mol/prawn, yielded higher numbers than the control groups, and with a significant difference ( $P < 0.05$ ). All DA and OA injected groups showed lower numbers of eggs when compared to the control groups. Eggs from all these experimental groups exhibited equally good quality both among each other and in comparison with control groups, as judged from the percentage of fertilized eggs.

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**DNA IDENTIFICATION OF CILIATES ASSOCIATED WITH DISEASE OUTBREAKS IN A NEW ZEALAND MARINE FISH HATCHERY**

P. J. Smith, S. M. McVeagh, D. Hulston, S. A. Anderson, Y. Gublin-2009

Diseases of Aquatic Organisms 86:163-167

**Abstract:**

Ciliates associated with fish mortalities in a New Zealand hatchery were identified by DNA sequencing of the small subunit ribosomal RNA gene (SSU rRNA). Tissue samples were taken from lesions and gill tissues on freshly dead juvenile groper, brain tissue from adult kingfish, and from ciliate cultures and rotifers derived from fish mortality events between January 2007 and March 2009. Different mortality events were characterized by either of 2 ciliate species, *Uronema marinum* and

Miamiensis avidus. A third ciliate, Mesanophrys carcini, was identified in rotifers used as food for fish larvae. Sequencing part of the SSU rRNA provided a rapid tool for the identification and monitoring of scuticociliates in the hatchery and allowed the first identification of these species in farmed fish in New Zealand.

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#### CHALLENGE OF NEW ZEALAND GREENSHELL™ MUSSEL PERNA CANALICULUS LARVAE USING TWO VIBRIO PATHOGENS: A HATCHERY STUDY

Aditya Kesarcodi-Watson, Heinrich Kaspar, M. Josie Lategan, Lewis F. Gibson-2009

Diseases of Aquatic Organisms 86:15-20

Abstract:

Bacterial diseases remain a large problem in aquaculture hatcheries. The successful design and implementation of protective measures in the hatchery depends on an understanding of the dynamics of the infection process. Developing an in situ experimental protocol for pathogen challenge is therefore of paramount importance. Here, we demonstrated the minimum effective pathogenic dose (MEPD) of *Vibrio splendidus* (105 CFU ml<sup>-1</sup>) and a *Vibrio coralliilyticus/neptunius*-like isolate, *Vibrio* sp. DO1 (106 CFU ml<sup>-1</sup>), for New Zealand Greenshell™ mussel (GSM, *Perna canaliculus*) larvae during hatchery production. In a flow-through water hatchery system, larvae given 1 to 2 h of static water exposure to these pathogen doses showed respective average cumulative mortalities of 58 and 69% on the fourth day following pathogen exposure. After the 1 to 2 h static exposure, larvae were returned to flow-through water. Larvae exposed to a dosage one order of magnitude greater than the MEPD had higher mortalities of 73 and 96% for *V. splendidus* and *Vibrio* sp. DO1 respectively. These 4 levels of mortality were significantly greater than those of the non-exposed control larvae which respectively averaged 23 and 35% in experiments involving *V. splendidus* and *Vibrio* sp. DO1. Experiments were repeated 4 times to confirm reproducibility. After pathogen exposure, pathogens were detected in the larvae and tank water of treatments with dosages of  $\geq 105$  CFU ml<sup>-1</sup> (*V. splendidus*) and 106 CFU ml<sup>-1</sup> (*Vibrio* sp. DO1), but not in treatments with lower pathogen dosages. The challenge protocols are reproducible and provide an opportunity to assess measures for the protection of GSM larvae against infection in the hatchery environment.

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#### GROWTH RATE DURING EARLY LIFE AFFECTS SEXUAL DIFFERENTIATION IN ROACH (RUTILUS RUTILUS)

Gregory C. Paull, Amy L. Filby, Charles R. Tyler-2009

Journal Environmental Biology of Fishes 85(4): 277-284

Abstract:

Many environmental factors have been shown to influence sex differentiation in fish, resulting in sex-biased populations, but the effects of growth rate have received limited attention. We conducted a controlled laboratory experiment in which growth rate and population density were manipulated in roach (*Rutilus rutilus*) during early development, and the subsequent effects on sex ratio determined. Significant differences in growth rate between fish populations were induced through provision of three different ration levels. In the slowest growing population there were fewer females compared within the fastest growing population (19% compared to 36% females), suggesting that in roach it may be more advantageous to become a small male than a small female when growth potential is limited. This may result from the fact that fecundity is limited by body size in female roach and that male roach are able to reproduce at a significantly smaller body size than females. In contrast, where roach were kept at different stocking densities, and there were no differences in growth rate, the subsequent proportion of females did not vary. Our data highlight the importance of controlling for growth rate in research on sexual differentiation in this species, notably when assessing for the effects of endocrine disrupting chemicals and other environmental factors, and have implications for fisheries

management and aquaculture. The underlying mechanism for the influence of growth rate on sex differentiation has yet to be determined but is likely to have a strong endocrinological basis. (Environmental and Molecular Fish Biology Group, School of Biosciences, Hatherly Laboratories, University of Exeter, Prince of Wales Road, Exeter, Devon, EX4 4PS, UK; email of Gregory C. Paull: g.c.paull@exeter.ac.uk)

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## REVIEW

### ANTIVIRAL IMMUNITY IN CRUSTACEANS

Haipeng Liu, Kenneth Söderhäll, Pikul Jiravanichpaisal-2009

Fish & Shellfish Immunology, 27(2): 79-88

#### Abstract:

Viral diseases of shrimp have caused negative effects on the economy in several countries in Asia, South America and America, where they have numerous shrimp culture industries. The studies on the immunity of shrimp and other crustaceans have mainly focused on general aspects of immunity and as a consequence little is known about the antiviral responses in crustaceans. The aim of this review is to update recent knowledge of innate immunity against viral infections in crustaceans. Several antiviral molecules have been isolated and characterized recently from decapods. Characterization and identification of these molecules might provide a promising strategy for protection and treatment of these viral diseases. In addition dsRNA-induced antiviral immunity is also included.

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## REVIEW

### ROLE OF MATERNALLY DERIVED IMMUNITY IN FISH

P. Swain, S.K. Nayak-2009

Fish & Shellfish Immunology 27(2): 89-99

#### Abstract:

Maternal immunity is of paramount importance for protection of young ones at early stage of life since the immune factors of an immunocompetent female are transferred transplacentally or through colostrum, milk or yolk to an immunologically naive neonate. Both innate and adaptive type of immunity are transferred from mother to offspring in fishes. These factors include immunoglobulin (Ig)/antibody, complement factors, lysozymes, protease inhibitors like  $\alpha$  macroglobulin, different types of lectins and serine proteases like molecules. Among different types of Ig viz. IgM, IgD, IgT/IgZ and IgM-IgZ chimera types, IgM is present in most of the teleostean fishes. In teleosts, IgM either as a reduced/breakdown product or monomeric form is usually transferred to the offsprings. The maternally derived IgM usually persists for a limited duration, exhausts within the completion of yolk absorption process, and completely disappears thereafter during larval stages. Maternal transfer of immunity which provides defense to embryo and larvae depends upon the health as well as the immune status of brood fish. The overall health status of brood fish can affect breeding performances, quality seed production and protection of offsprings. However, factors such as age, maturation, reproductive behaviour and nutrition (micro and macro-nutrients) may affect the immunity in brood fishes. Besides these, seasonal changes such as photoperiods, temperature, adverse environmental conditions, and stress conditions like handling, crowding, and water pollution/contamination can also affect the immunity of brood fishes. The maintenance of the brood stock immunity at high level during vitellogenesis and oogenesis, is utmost important for reducing mortalities at larval/post larval stages through maximum/optimum transfer of maternal immunity. Brood stock immunization prior to breeding as well as selective breeding among the disease resistant families might be the ideal criteria for producing quality seed.

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OTOLITH MICROSTRUCTURE OF JAPANESE SEA BASS LARVAE AND JUVENILES:  
INTERPRETATION AND UTILITY FOR AGEING

Md. S. Islam, M. Ueno, Y. Yamashita-2009

Journal of Applied Ichthyology 25(4): 23 – 427

Abstract:

This paper interprets and discusses the usefulness of otolith microstructure for ageing Japanese sea bass (*Lateolabrax japonicus*) larvae and juveniles. Samples were collected from the Tango Sea along the Japan Sea coast, January–March 2007. Known-age (0-day and 10-day-old) larvae were obtained from the Ibaragi Prefectural Hatchery, Japan. Sagittal and lapillar otolith were processed and read using an otolith reading system. Clearly discernible hatch- and first-feeding marks were evident on sagitta, and development of accessory premordia (AP) appeared to be associated with larva-juvenile transition; however, no other marks indicating metamorphosis or settlement were evident. In lapillus, no discernible check mark was found. Known-age larvae showed that deposition of the first daily increment (DI) corresponded to first-feeding, which occurred at day-4 post-hatch. However, mean increment counts were significantly lower in lapillus than in sagitta, caused by poorly expressed increments around the centrum as well as relatively unclear centrum of the lapillus. The authors suggest that the use of lapillus can cause significant underestimation of age. Therefore, the sagitta is recommended for age and growth estimations of larvae and juveniles, although the presence of numerous subdaily increments warrants careful preparation and interpretation of the microstructure. A test for asymmetry showed the right and left otoliths to be quite symmetrical and their DI counts not significantly different, suggesting that either otolith can be used for studying age and growth of Japanese sea bass larvae and juveniles.

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VALIDATION OF DAILY SAGITTAL INCREMENTS IN THE GOLDEN-SPOTTED  
RABBITFISH *SIGANUS GUTTATUS* (BLOCH) USING KNOWN-AGE LARVAE AND  
JUVENILES

V. Soliman, H. Yamada, K. Yamaoka-2009

Journal of Applied Ichthyology 25(4): 438 – 441

Abstract:

The study presents a first report on the validation of otolith increment in the golden-spotted rabbitfish *Siganus guttatus*. The formation of daily sagittal growth increments in *S. guttatus* was validated using hatchery-reared larvae and juveniles collected from day of hatching to day 35. Mean increments were 5.6, 13.1, 24.5 and 34.8 for the 7, 15, 25 and 35 day-old fish, respectively. The results demonstrated that sagittal increments were formed daily and thus can be used to determine the age in days of the species.

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USING PASSIVE SONIC TELEMETRY METHODS TO EVALUATE DISPERSAL AND  
SUBSEQUENT MOVEMENTS OF HATCHERY-REARED WHITE STURGEON IN THE  
KOOTENAY RIVER

M. D. Neufeld, P. J. Rust-2009

Journal of Applied Ichthyology 25(s2): 27 - 33

Special Issue: Proceedings of the Inaugural Meeting of the North American Chapter of the World Sturgeon Conservation Society, Ottawa, Canada, August 19-21, 2008

Abstract:

A total of 35, age 1 juvenile Kootenay River white sturgeon (*Acipenser transmontanus*), were fitted with sonic tags in 2005 and released as part of larger hatchery release groups at five sites to evaluate dispersal and subsequent movements (seven tags per site). Juvenile sturgeon released at three locations within the deep, low gradient reach (typical gradient of 0.02 m km<sup>-1</sup> and velocities of <0.4 m s<sup>-1</sup>) of the Kootenay River below Bonners Ferry, ID showed substantial dispersal both up and

downstream; however, downstream redistribution was more common. White sturgeon from all three release locations overlapped during dispersal, with 9% of tagged fish moving from river release sites into Kootenay Lake. The three hatchery release locations in this low gradient reach produced good dispersal of hatchery progeny into available habitats. Tagged fish released above Bonners Ferry in the shallow, higher gradient reach (typical gradient of 0.6 m km<sup>-1</sup>, and velocities >0.8 m s<sup>-1</sup>) at two additional sites all moved downstream of the gradient break at Bonners Ferry, ID into the lower gradient reach within 2 months of release. In total, 93% of these tagged fish relocated to the low gradient section within 25 days of release, with some fish undertaking this movement within 1 day. In general, age 1 hatchery release juveniles were mobile and capable of substantial movements. (British Columbia Ministry of Environment, Nelson, BC, Canada ; 2 Idaho Department of Fish and Game, Coeur d'Alene, ID, USA; email of M. Neufeld: matt.neufeld@gov.bc.ca)

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#### COMPARATIVE ANALYSIS OF COST FACTORS IN STURGEON FINGERLING PRODUCTION IN IRANIAN HATCHERIES (2000–2004)

H. Salehi-2009

Journal of Applied Ichthyology 25(5): 522 – 528

Abstract:

Production cost analysis in aquaculture is an essential exercise to assist farm managers. Economic assessment of a farm operation also provides the basis to formulate governmental aquaculture and enhancement policies in many regions. The present study employed questionnaires and interviewed managers while also using governmental statistics to gain insight into production cost variables in Iranian sturgeon hatcheries. Within a decade, production of sturgeon fingerlings for release and stock enhancement increased in Iran to more than 21 million fingerlings by 2004. Costs and contributions of various production factors were determined using data obtained from a questionnaire involving all hatcheries between 2000 and 2004. A team of experts completed the questionnaire data sets while conducting interviews at all sturgeon centres and other related departments. From 2000 to 2004 the contribution of *A. persicus* was 79% of the total number of sturgeon fingerlings produced followed by *A. nudiventris* with 7.5% and *Huso huso* with 6.6%. Among the various expenditures between 2000 and 2004, the costs for permanent and part-time employees contributed the greatest share of total costs, averaging 44%, with a noticeable declining trend from 51% in 2000 to 36% in 2004. Obtaining and incubating fertilized eggs averaged 22% of total costs, increasing during the same time period from 6 to 35%, respectively. On average, the 2000–2004 production cost for a single sturgeon fingerling was estimated at Rials 1667 (US\$ 0.20), increasing from Rials 992 (US\$ 0.12) to Rials 2623 (US\$ 0.29) over these 4 years. Permanent staff at a hatchery was determined as being the principal cost, followed by costs for obtaining fertilized eggs (including broodstock handling). Over the 5-year study period the results indicated that costs for part-time labour declined yearly and, conversely, the costs of obtaining broodstocks as well as fertilizing and incubating eggs increased. Considering the background of hatchery production and stock enhancement of sturgeon species and the results of fishing data, it is possible to arrive at a first estimate of the potential contribution of Persian sturgeon farming to the total catch in Iranian waters; it is assumed that these increases were most likely through stock enhancement.

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#### VERTICAL DISTRIBUTION OF LARVAL COD (GADUS MORHUA) IN EXPERIMENTAL TEMPERATURE GRADIENTS

K.W. Vollset, Ø. Fiksen, A. Folkvord-2009

Journal of Experimental Marine Biology and Ecology 379(1-2): 16-22

Abstract:

Behavioural responses to gradients of temperature and light in the pelagic can potentially regulate the distribution and survival of early life stages of fish. Vertical temperature gradients (strong, mild and no thermocline, range 4–8 °C) were established in transparent experimental plastic bags (15 cm diameter and 1 m depth) to investigate changes in vertical distribution of larval cod in response to

temperature and light conditions. The vertical position of the larvae (10 cm intervals) was recorded at three different developmental stages: after yolk absorption (10 days post hatch, dph), at established feeding (26 dph) and metamorphosing larvae (47 dph). Observations were first made after 2 h in light, and then after 2 h in darkness the upper and lower part of the bag was sampled by pursing the plastic bag at the level of the thermocline. Additional experiments with reverse light settings were done on consecutive days. At 10 dph larvae were all found in the upper few cm of the water column regardless of temperature or light settings. At 26 dph larvae were generally found deeper in the water column, but with a larger variation in response to light exposure. In darkness fewer larvae were found in the colder water, depending on the strength of the thermocline. At 47 dph the larvae actively avoided the coldest water in the light. However, these patterns disappeared in the dark. Larvae distribution did not change with reversed light settings at any of the developmental stages. Larvae in the upper part of the column were significantly heavier throughout the experiment. Our results indicate an ontogenetic change in the response to a thermal gradient through the first two months after hatching, as well as a complex response to different light settings at later stages.

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#### LUNAR AND DAILY SPAWNING RHYTHMS OF SENEGAL SOLE *SOLEA SENEGALENSIS*

C. Oliveira, M. T. Dinis, F. Soares, E. Cabrita, P. Pousão-Ferreira, F. J. Sánchez-Vázquez-2009

Journal of Fish Biology 75(1): 61 – 74

##### Abstract:

A periodicity of 29 days was observed in spawning rhythms in Senegal sole *Solea senegalensis*, with an acrophase around the last quarter and the new moon. In both spring and autumn, a very marked nocturnal spawning rhythm was registered, with spawning beginning after dusk and the acrophase occurring around 2300 hours. When the photoperiod was artificially extended (from 10L:14D to 14L:10D), *S. senegalensis* synchronized to the new photoperiod: spawning took place after the new 'dusk', the beginning gradually shifting from 2100 to 2300 hours and the acrophase from 2325 to 0032 hours. Under continuous light conditions, fish sustained rhythmicity for 2 days, with an acrophase at 2249 hours, which suggested the existence of an endogenous pacemaker controlling the daily spawning rhythm. These findings provided new insights for better understanding the reproductive physiology of this species and for optimizing the timing protocols of egg collection and larvae production in *S. senegalensis* aquaculture.

(Physiology Department, Faculty of Biology, Murcia University, 30100 Murcia, Spain, † CCMAR, Universidade do Algarve, Campus de Gambelas, 8005-139 Faro, Portugal; email of F. J. Sánchez-Vázquez: [javisan@um.es](mailto:javisan@um.es))

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#### MELATONIN CONCENTRATIONS DURING LARVAL AND POSTLARVAL DEVELOPMENT OF GILTHEAD SEA BREEM *SPARUS AURATUS*: MORE THAN A TIME-KEEPING MOLECULE?

H. Kalamarz, M. Nietrzeba, J. Fuentes, G. Martinez-Rodriguez, J.M. Mancera, E. Kulczykowska-2009

Journal of Fish Biology 75(1): 142 – 155

##### Abstract:

In this study, melatonin (MEL) and thyroxine (T4) concentrations were measured during larval and postlarval development of gilthead sea bream *Sparus auratus*. Hormones were measured in whole bodies of larvae or the head and trunk of postlarvae after 67 days of exposure to constant light, 24L:0D, constant darkness, 0L:24D or 12L:12D and in the plasma of 6 month juveniles kept under the 12L:12D, 0L:24D and 24L:0D regimes. High MEL concentrations in larvae suggested a distinct role of MEL in early organogenesis and development of *S. auratus*. In larvae, the gastro-intestinal tract seemed to be an important extrapineal and extraretinal source of MEL. No endogenous rhythm of MEL synthesis was demonstrated in 67 day larvae; however, in 6 month juveniles, it was evident. At early ontogenesis of *S. auratus*, the role of MEL is probably related mostly to the control of development and protection against free radicals, whereas its action as a time-keeping molecule

develops later. The increase in T4 concentration during the *S. auratus* larva–juvenile transition, i.e. between 50 and 70 days post-hatch, which was observed concurrently with the decrease of MEL concentration, may suggest an inverse relationship between T4 and MEL.

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#### EFFECTS OF EGG SIZE, PARENTAL ORIGIN AND FEEDING CONDITIONS ON GROWTH OF LARVAL AND JUVENILE COD *GADUS MORHUA*

H. Paulsen, O. S. Kjesbu, V. Buehler, R. A. J. Case, C. Clemmesen, G. Carvalho, L. Hauser, W. F. Hutchinson, E. Moksness, H. Otterå, A. Thorsen, T. Svåsand-2009

Journal of Fish Biology 75(3): 516 – 537

##### Abstract:

An experimental study was performed to disentangle parental and environmental effects on the growth of Atlantic cod *Gadus morhua* larvae and juveniles. Eggs were collected during the spawning season from spawning pairs (families) kept separately in specially designed spawning compartments. Newly hatched larvae were released simultaneously into two mesocosms of 2500 and 4400 m<sup>3</sup>. Larval growth was monitored by sampling over a 10 week period, after which juveniles were transferred to on-growing tanks, where they were tagged and kept for up to 2 years. Maternal origin was determined by individual microsatellite genotyping of the larvae (n = 3949, 24 families) and juveniles (n = 600). The results showed significant positive correlations between egg size and larval size during the whole mesocosm period. Correlations, however, weakened with time and were no longer significant at the first tank-rearing sampling at an age of 9 months. Significant family-specific differences in growth were observed. The coefficient of variation (c.v.) was calculated in order to examine variation in standard length of larvae during the mesocosm period. Inter-family c.v. was on average 69% of intra-family c.v. Differences in zooplankton densities between the two mesocosms were reflected in larval growth, condition factor and c.v. Low food abundance appeared to reduce c.v. and favour growth of larvae that showed relatively slow growth at high food abundance. It is suggested that genetically determined variation in growth potential is maintained by environmental variability

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#### DISTRIBUTION OF CHOLECYSTOKININ-IMMUNOREACTIVE CELLS IN THE GUT OF DEVELOPING ATLANTIC COD *GADUS MORHUA* L. LARVAE FED ZOOPLANKTON OR ROTIFERS

M. B. Hartviksen, Y. Kamisaka, A.-E. O. Jordal, R. M. Koedijk, I. Rønnestad-2009

Journal of Fish Biology 75(4): 834 – 844

##### Abstract:

One of the main gastrointestinal hormones, cholecystokinin (CCK), was studied in order to advance understanding of the control of the digestive process in Atlantic cod *Gadus morhua* larvae after onset of first feeding. Larvae were fed either natural zooplankton or enriched rotifers in similar rearing systems and sampled from hatching to 22 days post-hatch (dph). CCK was visualized by immunohistochemistry and the first CCK-immunoreactive (IR) cells were detected at 8 dph corresponding to 6 days after first feeding. The CCK-IR cells were mostly found in the anterior midgut, and the number of CCK-IR cells was lower in the posterior midgut. They were also present in the hindgut of some of the larvae, but not in the foregut. No clear differences were found in the ontogenetic appearance and the distribution pattern of CCK-IR cells between the two dietary treatments. This indicates that the onset of CCK production in the gut as well as the spatial distribution of the CCK-IR cells is not differentially affected by these diets. To what extent the hormone production itself is influenced by dietary factors needs to be studied by more sensitive methods.

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ASSESSMENT OF DIGESTIVE ENZYMES ACTIVITY DURING THE FRY DEVELOPMENT OF THE ENDANGERED CASPIAN BROWN TROUT *SALMO CASPIUS*

A.Zamani, A.Hajimoradloo, R.Madani, M.Farhangi-2009

Journal of Fish Biology 75(4): 932 – 937

Abstract:

The study of digestive enzymes activity at *Salmo caspius* fry showed that enzymes were available at the moment of mouth opening on the first day post hatching (dph) and the activity of enzymes showed no significant difference from the hatching day 28 dph. An increased activity was seen between 32 and 43 dph and this activity was significantly higher than the activity during the first 28 days. In the primary stages after yolk sac resorption (43–58 dph), enzymes activity showed an increased profile, however none of them showed a significant difference between 43 and 58 dph.

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FEEDING ARTEMIA FRANCISCANA (KELLOGG) LARVAE WITH BACTERIAL HEAT SHOCK PROTEIN, PROTECTS FROM VIBRIO CAMPBELLII INFECTION

Y. Y. Sung, M. F. Ashame, S. Chen, T. H. MacRae, P. Sorgeloos, P. Bossier-2009

Journal of Fish Diseases 32(8): 675 – 685

Abstract:

Among their numerous physiological effects, heat shock proteins (Hsps) are potent immunomodulators, a characteristic reflecting their potential as therapeutic agents and which led to their application in combating infection. As an example, the up-regulation of endogenous Hsp70 in the branchiopod crustacean *Artemia franciscana* (Kellogg) is concurrent with shielding against bacterial infection. To better understand this protective mechanism, gnotobiotic *Artemia* were fed with *Escherichia coli* treated to over-produce different prokaryotic Hsps. This was shown to increase larval resistance to experimental *Vibrio campbellii* exposure. Immunoprobings of Western blots showed that the enhanced resistance to *V. campbellii* correlated with DnaK production in *E. coli*. A definitive role for DnaK was then demonstrated by feeding *Artemia* larvae with transformed bacteria over-producing only this protein, although other Hsps such as DnaJ and *grpE* also provided tolerance against *Vibrio* infection. Feeding of bacteria synthesizing selected Hsps is therefore suggested as an alternative to antibiotic use as a means of enhancing resistance of *Artemia* larvae to bacterial infection, which may have potential applications in aquaculture.

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NATURAL VARIATION IN LARVAL SIZE AND DEVELOPMENTAL RATE OF THE NORTHERN QUAHOG *MERCENARIA MERCENARIA* AND ASSOCIATED EFFECTS ON LARVAL AND JUVENILE FITNESS

R. Przeslawski, A. R. Webb-2009

Journal of Shellfish Research 28(3): 505–510

Abstract:

Larval size and developmental rate can vary tremendously within and among cohorts because of genetics, environment, and maternal investment. This natural variation in larvae may have effects that span multiple life stages. Here we investigate the effects of larval size and developmental stage on the subsequent life stages of the commercially and ecologically important clam *Mercenaria mercenaria*. Fifteen days after fertilization, we divided larvae into two groups based on their developmental stage (umbonal or pediveliger) and recorded survival, size, and developmental stage of individuals over the next 4 months. Results revealed that after four months larvae that had only reached the umbonal stage by Day 15 were significantly smaller than those that had reached the pediveliger stage. These smaller and less developed larvae were less successful than the larger and more developed larvae across late larval and juvenile stages. In particular, smaller and less developed larvae were less likely to



metamorphose, required more time to metamorphosis, and had lower survival and growth rates. These results suggest that natural variation in larval size and developmental rate can affect recruitment in a variety of ways: (1) Increased time to metamorphosis may increase the cost to larvae via predation or exposure to environmental stress, (2) Decreased proportion of larvae able to metamorphose may directly reduce the number of settlers, and (3) Decreased growth and survival rates for juveniles may reduce the number of new recruits. We also discuss the persistence of natural variation in larval size and developmental rate in light of the observed negative effects associated with smaller and less-developed larvae.

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#### ECOBIOLOGICAL SURVEY OF THE BRINE SHRIMP ARTEMIA SALINA FROM SABKHET EL ADHIBET (SOUTH-EAST TUNISIA)

Hachem Ben Naceur, Amel Ben Rejeb Jenhani, Mohamed Salah Romdhane-2009

Journal of the Marine Biological Association of the United Kingdom 89:1109-1116

Abstract:

In order to provide a better characterization and understanding of the brine shrimp *Artemia salina* life-cycle, different ecological and biological parameters were taken out monthly during two periods from November 2005 to April 2006 and from November 2006 to April 2007 in Sabkhet El Adhibet (south-east Tunisia). Variation of water temperature, salinity, pH, dissolved oxygen, nutrients (orthophosphate, nitrites, nitrates and ammonium) and phytoplankton density were monitored. The *Artemia* population was also surveyed. *Artemia* were present in the site with salinity between 32.2 and 281.7 g l<sup>-1</sup> and water temperature between 12.1 and 25.4°C. The pH ranged from 7.6 to 9 and dissolved oxygen concentration from 3.4 to 17.5 mg l<sup>-1</sup>. Minimum and maximum values of phytoplankton density were 0.19 and 14.59 10<sup>6</sup> cell l<sup>-1</sup>. In addition, the nutrient analysis registered showed that nitrate and ammonium represent the major nutrient. The *Artemia* population density fluctuated between 0.22 and 38.57 individuals per litre. The male:female ratio was dominated by the males. *Artemia* from Sabkhet El Adhibet showed variability in fecundity (total offspring and brood size) as well as in the ratio encystment/oviviparity. The individual fecundity fluctuates between 29.4 and 70.2 cysts and 17.8 and 69.8 nauplii. Finally, the influence of physical and chemical parameters as well as phytoplankton density over the *Artemia* population was noticed.

(Research Unit Aquatics Ecosystems Resources, National Institute of Agricultural Sciences of Tunisia, University 7th November at Carthage, 43 Avenue Charles Nicolle 1082 Tunis Mahrajène, Tunisia)

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#### EFFECT OF DIET AND PARALARVAL DEVELOPMENT ON DIGESTIVE ENZYME ACTIVITY IN THE CEPHALOPOD ROBSONELLA FONTANIANA

Sandra V. Pereda, Iker Uriarte, Juan Carlos Cabrera-2009

Journal Marine Biology 156(10): 2121-2128

Abstract:

This study aims at establishing the maturation of the digestive system in *Robsonella fontaniana* by means of measuring the digestive enzyme activity in paralarvae after hatching. Different groups of newly hatched paralarvae were fed with *Artemia* sp. (FA), *Lithodes santolla* zoea (FL) or were starved to serve as negative control (ST), the experimental period lasted 27 days after hatching (DAH). The semi-quantitative assay api® ZYM (bioMérieux, France) was used to identify the pool of digestive enzymes present in paralarvae prior to selecting the specific enzymes acid phosphatase, total protease, trypsin and chymotrypsin for analysis. Mortality and larval protein content were also measured during the experiment. The survival of *R. fontaniana* hatchlings differed depending on the quality of the diet offered (ST < FA < FL), the same trend was observed with respect to paralarval protein content. Total protease and acid phosphatase activities were not related to either time of development or diet (P < 0.05). However, the activity of trypsin and chymotrypsin after DAH 10 was dependent on diet (P < 0.05). Paralarvae fed with *Lithodes* zoea (FL) performed better than paralarvae in the other two groups, exhibiting lower mortality, higher protein content and the highest proteolytic activity for

trypsin and chymotrypsin. The results indicate that *Lithodes*-larvae are a better diet for *R. fontaniana* paralarvae than *Artemia* sp.

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ENRICHING ROTIFERS WITH "PREMIUM" MICROALGAE NANNOCHLOROPSIS GADITANA

Martiña Ferreira, Paula Coutinh, Pedro Seixas, Jaime Fábregas, Ana Otero-2009

Journal Marine Biotechnology 11(5): 585-595

Abstract:

The nutritive quality of *Nannochloropsis gaditana* cultured semicontinuously with different daily renewal rates was tested as a diet for short-term enrichment of the rotifer *Brachionus plicatilis*. After 24 h, dramatic differences in the survival, dry weight, and biochemical composition of the rotifers depending on the renewal rate of microalgal cultures were observed. Survival after the feeding period increased with increasing renewal rates. Rotifers fed microalgae from low renewal rate, nutrient-deficient cultures showed low dry weight and organic contents very similar to those of the initial rotifers that were starved for 12 h before the start of the feeding period. On the contrary, rotifers fed nutrient-sufficient microalgal cells underwent up to twofold increases of dry weight and protein, lipid, and carbohydrate contents with regard to rotifers fed nutrient-depleted *N. gaditana*. Consequently, feed conversion rate decreased in these conditions, indicating a better assimilation of the microalgal biomass obtained at high renewal rates. No single microalgal biochemical parameter among those studied can explain the response of the filter feeder. Similarly to gross composition, EPA and n-3 contents in rotifers fed microalgae from nutrient-sufficient cultures were double than the contents found in rotifers fed nutrient-limited microalgae. In addition, very high positive correlations between the contents of EPA and n-3 in *N. gaditana* and *B. plicatilis* were observed. These results demonstrate that selecting the appropriate conditions of semicontinuous culture can strongly enhance the nutritional value of microalgae that is reflected in the growth and biochemical composition of the filter-feeder even in short exposure periods.

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ONTOGENETIC CHANGES OF BODY DENSITY OF LARVAE AND JUVENILES IN SEVEN-BAND GROUPER EPINEPHELUS SEPTEMFASCIATUS AND KELP GROUPER EPINEPHELUS BRUNEUS

Yoshiro Hirata, Katsuyuki Hamasaki, Kazuhisa Teruya, Keiichi Mushiake-2009

Nippon Suisan Gakkaishi 75 (4): 652-660

Abstract:

Sinking death syndrome has been considered as one of the causes of early larval mortality during the seed production of seven-band grouper and kelp grouper. To elucidate the rearing period when larvae show strong minus buoyancy, ontogenetic change of body density was examined for larvae and juveniles of two species. Larvae tended to show nearly neutral buoyancy from hatching to growing to 3.5-3.9 mm in total length (TL) when the buds of the second dorsal fin and pelvic-fin spines appeared. Then, body densities greatly increased with increasing the length of fin spines and reached a plateau at 1.060-1.070 g/cm<sup>3</sup> after the size of around 11 mm TL. Swim bladder inflation was not observed in the seven-band grouper; however, it was observed in the kelp grouper after 8.2 mm TL and the percentage of kelp grouper with inflated swim bladders largely increased after 18.6 mm TL. Body densities of kelp grouper with inflated swim bladders decreased to 1.024-1.035 g/cm<sup>3</sup>. It could be speculated that fin spines regulate the larval buoyancy by generating drag forces. It is therefore considered that larvae show strong minus buoyancy in rearing seawater at the initiation of great increase in body density when fin spines begin to elongate.

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TOXICITY AND ANTIBACTERIAL ACTIVITY OF SILVER IONS IN THE REARING WATER OF JAPANESE EEL EGGS AND LARVAE

Akihiro Okamura, Yoshiaki Yamada, Noriyuki Horie, Naomi Mikawa, Tomoko Utoh, Satoru Tanaka, Katsumi Tsukamoto-2009

Nippon Suisan Gakkaishi 75(5): 786-792

Abstract:

To apply the antibacterial activity of silver ions to the rearing of Japanese eel *Anguilla japonica* larvae, we tested the effects of exposure to silver ions on hatching, survival and growth in eel larvae. Hatching rate of eggs was significantly decreased at a silver nitrate concentration of higher than 0.1 mg/L in rearing water ( $p < 0.01$ ), whereas the survival rates of 0 or 5-day-old larvae were not influenced by exposure to the same condition for 120 hours. However, the survival rates of those larvae were decreased by exposure to 1 mg/L silver nitrate for more than 24 hours. During long-term rearing experiments, the number of bacteria on the wall of the rearing tank was significantly reduced by intermittently (four times a day) adding silver nitrate (max. 1 mg/L) to rearing water, and larval survival rate at the early stage (5 to 60-day-old) became significantly higher than that in the normal rearing method ( $p < 0.05$ ). Growth was not influenced by adding silver nitrate, and six larvae in the silver-added tank finally metamorphosed into glass eels without any morphological anomalies. These results suggest that the use of silver ions in rearing eel larvae can facilitate the efficient production of artificial glass eels.

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EFFECT OF MATERNAL DIET ON SURVIVAL AND LIFE HISTORY PARAMETERS OF NEXT GENERATIONS IN THE ROTIFER BRACHIONUS PLICATILIS SP. COMPLEX

Masahiko Koiso, Masayo Yoshikawa, Hiroshi Kuwada, Atsushi Hagiwara-2009

Nippon Suisan Gakkaishi 75 (5) : 828-833

Abstract:

The effect of maternal diet on the survival rate and life history parameters of next generations in the rotifer *Brachionus plicatilis* sp. complex was investigated. Maternal rotifers as well as their offspring were individually cultured successively to the 5th generation in three feeding patterns, including the feeding of *Nannochloropsis oculata* alone (N), baker's yeast alone (Y), and feeding of baker's yeast to the 1st generation and *N. oculata* to the next generations (YN). In the Y-rotifers, survival rate, development time and spawning interval of the 1st and 2nd generations were significantly inferior to those of the N-rotifers, and all individuals died in the 3rd generation. As for YN-rotifers in the 2nd generation, survival rate decreased by 20% compared with N-rotifers, and development time and spawning interval were 1.1-1.2 times longer. These results suggest that the effect of maternal diet influenced even next generations by affecting the quality of amictic eggs.

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