

## A REVIEW OF THE USE OF COPEPODS IN MARINE FISH LARVICULTURE

O. O. Ajiboye, A. F. Yakubu, T. E. Adams, E. D. Olaji, N. A. Nwogu

Reviews in Fish Biology and Fisheries 21(2): 225-246

## Abstract:

In spite of the growing interest and success obtained using cultured-copepods, their use in marine aquaculture remains sporadic. Besides, mass culture of several marine copepods has been well established by several authors. However, the upscale of copepod cultures to commercial levels is still a challenge. The practice of using wild copepods from natural ponds which thus increases the risk of parasitic infections of most species has limited their application in aquaculture. The present paper thus emphasizes on recent research efforts focused on the use of chemical treatments and freeze-thawing methods to eradicate procercoids from copepods. Research efforts focused on copepod culture systems which subsequently improved and refined their culture in marine fish larviculture are also well discussed. Advances in the use of copepod eggs as potential source of nauplii for marine fish larvae with special emphasis on the viability, storage conditions and biochemical compositions of the copepod eggs are underscored. Additionally, recent advances in the biochemical compositions (protein, amino acids, pigments, and vitamins) of copepods, which has received relatively little attention compared to researches on the lipid and fatty acid compositions are well emphasized. Specific recommended areas for further research are also proffered.

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## DISRUPTION OF BACTERIAL CELL-TO-CELL COMMUNICATION BY MARINE ORGANISMS AND ITS RELEVANCE TO AQUACULTURE

F. M. I. Natrah, Tom Defoirdt, Patrick Sorgeloos, Peter Bossier-2011

Marine Biotechnology 13(2): 109-126

## Abstract :

Bacterial disease is one of the most critical problems in commercial aquaculture. Although various methods and treatments have been developed to curb the problem, yet they still have significant drawbacks. A novel and environmental-friendly approach in solving this problem is through the disruption of bacterial communication or quorum sensing (QS). In this communication scheme, bacteria regulate their own gene expression by producing, releasing, and sensing chemical signals from the environment. There seems to be a link between QS and diseases through the regulation of certain phenotypes and the induction of virulence factors responsible for pathogen-host association. Several findings have reported that numerous aquatic organisms such as micro-algae, macro-algae, invertebrates, or even other bacteria have the potential to disrupt QS. The mechanism of action varies from degradation of signals through enzymatic or chemical inactivation to antagonistic as well as agonistic activities. This review focuses on the existing marine organisms that are able to interfere with QS with potential application for aquaculture as bacterial control.

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## INDUCTION OF OVARIAN MATURATION AND SPAWNING IN PENAEUS MONODON BROODSTOCK BY DOUBLE-STRANDED RNA

Supattra Treeratrakool, Sakol Panyim, Apinunt Udomkit-2011

Marine Biotechnology 13(2): 163-169

## Abstract:

Ovarian maturation in crustacean is under the control of gonad-inhibiting hormone (GIH); a neuropeptide secreted from X-organ sinus gland complex in eyestalks. Unilateral eyestalk ablation that partially destroys GIH source is therefore a general practice in *Penaeus monodon* hatchery to induce ovarian maturation and spawning. Our previous report showed that silencing of GIH expression by

GIH-specific double-stranded RNA (GIH-dsRNA) resulted in an increased expression level of vitellogenin in *P. monodon*, thus suggesting that GIH-dsRNA could be an alternative method to induce ovarian maturation in female *P. monodon* broodstock. In this study, we further demonstrated that a single injection of GIH-dsRNA into previtellogenic female *P. monodon* at the concentration of 3 µg GIH-dsRNA per gram body weight of shrimp was able to inhibit GIH expression for a minimum of 30 days. This dsRNA-mediated GIH silencing led to ovarian maturation and eventual spawning in both domesticated and wild female broodstock, particularly with a comparable effect to eyestalk ablation in wild shrimp. This is the first report that demonstrates a potential strategy to induce ovarian maturation in female *P. monodon* broodstock by GIH-dsRNA and thus provides a possible substitute for the cruel and detrimental eyestalk ablation practice.

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#### TRANSCRIPTOME PROFILING OF EMBRYONIC DEVELOPMENT RATE IN RAINBOW TROUT ADVANCED BACKCROSS INTROGRESSION LINES

Peng Xu, Lauren M. McIntyre, Julie Scardina, Paul A. Wheeler, Gary H. Thorgaard, Krista M. Nichols-2011

Marine Biotechnology 13(2): 215-231

Abstract:

In rainbow trout (*Oncorhynchus mykiss*) and other fishes, embryonic development rate is an ecologically and evolutionarily important trait that is closely associated with survival and physiological performance later in life. To identify genes differentially regulated in fast and slow-developing embryos of rainbow trout, we examined gene expression across developmental time points in rainbow trout embryos possessing alleles linked to a major quantitative trait loci (QTL) for fast versus slow embryonic development rate. Whole genome expression microarray analyses were conducted using embryos from a fourth generation backcross family, whereby each backcross generation involved the introgression of the fast-developing alleles for a major development rate QTL into a slow-developing clonal line of rainbow trout. Embryos were collected at 15, 19, and 28 days post-fertilization; sex and QTL genotype were determined using molecular markers, and cDNA from 48 embryos were used for microarray analysis. A total of 183 features were identified with significant differences between embryonic development rate genotypes. Genes associated with cell cycle growth, muscle contraction and protein synthesis were expressed significantly higher in embryos with the fast-developing allele (Clearwater) than those with the slow-developing allele (Oregon State University), which may associate with fast growth and early body mass construction in embryo development. Across time points, individuals with the fast-developing QTL allele appeared to have earlier onset of these developmental processes when compared to individuals with the slow development alleles, even as early as 15 days post-fertilization. Differentially expressed candidate genes chosen for linkage mapping were localized primarily to regions outside of the major embryonic development rate QTL, with the exception of a single gene (very low-density lipoprotein receptor precursor).

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#### INVESTIGATION ON NATURAL DIETS OF LARVAL MARINE ANIMALS USING PEPTIDE NUCLEIC ACID-DIRECTED POLYMERASE CHAIN REACTION CLAMPING

Seinen Chow, Sayaka Suzuki, Tadashi Matsunaga, Shane Lavery, Andrew Jeffs, Haruko Takeyama-2011

Marine Biotechnology 13(2): 305-313

Abstract:

The stomach contents of the larvae of marine animals are usually very small in quantity and amorphous, especially in invertebrates, making morphological methods of identification very difficult. Nucleotide sequence analysis using polymerase chain reaction (PCR) is a likely approach, but the large quantity of larval (host) DNA present may mask subtle signals from the prey genome. We have adopted peptide nucleic acid (PNA)-directed PCR clamping to selectively inhibit amplification of host DNA for this

purpose. The Japanese spiny lobster (*Panulirus japonicus*) and eel (*Anguilla japonica*) were used as model host and prey organisms, respectively. A lobster-specific PNA oligomer (20 bases) was designed to anneal to the sequence at the junction of the 18 S rDNA gene and the internal transcribed spacer 1 (ITS1) of the lobster. PCR using eukaryote universal primers for amplifying the ITS1 region used in conjunction with the lobster-specific PNA on a mixed DNA template of lobster and eel demonstrated successful inhibition of lobster ITS1 amplification while allowing efficient amplification of eel ITS1. This method was then applied to wild-caught lobster larvae of *P. japonicus* and *P. longipes bispinosus* collected around Ryukyu Archipelago, Japan. ITS1 sequences of a wide variety of animals (Ctenophora, Cnidaria, Crustacea, Teleostei, Mollusca, and Chaetognatha) were detected.  
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#### FORAGING BEHAVIOUR OF LARVAL COD (*GADUS MORHUA*) AT LOW LIGHT INTENSITIES

K. W. Vollset, A. Folkvord, H. I. Browman-2011  
Marine Biology 158(5)

Abstract:

The ability to forage at low light intensities can be of great importance for the survival of fish larvae in a pelagic environment. Three-dimensional silhouette imaging was used to observe larval cod foraging and swimming behaviour at three light intensities (dusk  $\sim 1.36 \times 10^{-3}$  W/m<sup>2</sup>, night  $\sim 1.38 \times 10^{-4}$  W/m<sup>2</sup> and darkness  $\sim 3.67 \times 10^{-6}$  W/m<sup>2</sup>) at 4 different ages from 6 to 53 days post-hatch (dph). At 6 dph, active pursuit of prey was only observed under dusk conditions. Attacks, and frequent orientations, were observed from 26 dph under night conditions. This was consistent with swimming behaviour which suggested that turn angles were the same under dusk and night conditions, but lower in darkness. Cod at 53 dph attacked prey in darkness and turn angles were not different from those under other light conditions. This suggests that larvae are still able to feed at light intensities of  $3.67 \times 10^{-6}$  W/m<sup>2</sup>. We conclude that larval cod can maintain foraging behaviour under light intensities that correspond to night-time at depths at which they are observed in the field, at least if they encounter high-density patches of prey such as those that they would encounter at thin layers or fronts.

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#### IMPROVING ESCAPE RESPONSES OF HATCHERY-REARED SCALLOPS *ARGOPECTEN PURPURATUS*

Katherina B. Brokordt, Gabriela A. Núñez, Carlos F. Gaymer-2011  
Marine Biology 158(6)

Abstract:

Hatchery rearing of the scallop *Argopecten purpuratus* has resulted in successive generations of scallops not exposed to predators that are less sensitive to and escape more slowly from predators than wild scallops. The present study examined whether conditioning hatchery-reared *A. purpuratus* to its natural predator, the sea star *Meyenaster gelatinosus*, improved its escape responses. Both juvenile and adult *A. purpuratus* from Tongoy Bay, Chile, were exposed for 7 days to different conditions: (1) continuous predator odor, (2) predator contact for 30 min three times a day, (3) a combination of the two previous conditions, and (4) no exposure to the predator (control). After conditioning, we evaluated scallop's escape responses: reaction time, total clap number, duration of the clapping response, clapping rate, and the time scallops spent closed when exhausted. Conditioning with contact and odor plus contact (i.e., high predation risk) resulted in 25 and 50% shorter reaction times of juveniles and adults, respectively. Further, these stimuli caused juveniles to increase the number of claps and clapping rate. For adults, the time spent closed after exhaustion decreased by 50 and 63% after conditioning with contact and odor plus contact, respectively. Therefore, it is shown for the first time that exposure of scallops to increasing predator stimuli enhances escape responses, evidence of threat-sensitive predator avoidance.

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EARLY ONTOGENY OF THE ATLANTIC HALIBUT *HIPPOGLOSSUS HIPPOGLOSSUS* HEAD

R. Cloutier, J. Lambrey de Souza, H. I. Browman, A. B. Skiftesvik-2011

Journal of Fish Biology 78(4): 1035–1053

Abstract:

An ontogenetic sequence of Atlantic halibut *Hippoglossus hippoglossus* larvae, reared in intensive culture conditions, was cleared and stained and histologically processed to determine normal cranial chondrification for specimens ranging from 0 to 41 days post-hatch (dph). Twenty-six cranial cartilaginous structures were described, at daily intervals post-hatch. The ontogenetic trajectory, composed of alternating steps and thresholds, was interpreted as saltatory. In comparison with other flatfishes, *H. hippoglossus* exhibits delayed onset of chondrification. From 9 dph onwards, the ontogenetic trajectory resembles more than that of the turbot *Psetta maxima* than that of the common sole *Solea solea* or the summer flounder *Paralichthys dentatus* and winter flounder *Pseudopleuronectes americanus*. *Hippoglossus hippoglossus* with the gaping-jaw malformation, common in intensively cultured individuals of this species, were examined histologically. The reason larvae cannot close their mouth, as their yolk-sac resorbs, seems to be related to the fusion of the interhyal to the hyosymplectic and ceratohyal with which it is normally articulated.

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ASSESSING THE CONDITION OF WALLEYE POLLOCK *THERAGRA CHALCOGRAMMA* (PALLAS) LARVAE USING MUSCLE-BASED FLOW CYTOMETRIC CELL CYCLE ANALYSIS

Steven M. Porter, Kevin M. Bailey-2011

Journal of Experimental Marine Biology and Ecology 399(2): 101-109

Abstract:

Flow cytometric cell cycle analysis was used to determine the fraction of muscle cells in the S and G2 phases of the cell cycle, which were used as covariates with temperature and standard length, in a laboratory-developed model to assess the physiological condition of wild walleye pollock, *Theragra chalcogramma*, larvae. The assay was calibrated to the range of temperatures larvae are likely to encounter in the eastern Bering Sea, and it was sensitive to changes in condition within 3 days of starvation. The S and G2 phases of the cell cycle gave an indication of larval walleye pollock condition. Healthy larvae had a larger fraction of cells in the S phase than G2 phase, and unhealthy larvae had a larger fraction of cells in the G2 phase than the S phase. Validation tests showed that the model classified 75% to 83% of the larvae correctly. The assessment of the condition of walleye pollock larvae collected from the southeastern Bering Sea in 2007 indicated that unhealthy larvae were located on the continental shelf (6%), and this may be due in part to the coldest temperatures occurring there and less abundant prey. In the continental slope/ocean basin waters, where prey levels were higher and temperatures warmest, no larvae in unhealthy condition were found.

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FIELD COMPARISON OF SURVIVAL AND GROWTH OF HATCHERY-REARED VERSUS WILD BLUE CRABS, *CALLINECTES SAPIDUS* RATHBUN

Eric G. Johnson, Alicia C. Young, Anson H. Hines, Margaret A. Kramer, Martha Bademan, Michael R. Goodison, Robert Aguilar-2011

Journal of Experimental Marine Biology and Ecology 402(1-2): 35-42

Abstract:

The efficacy of restocking as a fisheries management tool depends upon the ability of hatchery-reared juveniles to survive, grow and reproduce in the wild following release. However, hatchery-reared animals may be maladapted to the natural environment as a result of morphological, physiological, or behavioral deficiencies acquired during the hatchery phase. To assess the competency of hatchery-reared blue crabs *Callinectes sapidus* Rathbun, a species under consideration for restocking in Chesapeake Bay, we compared survival and growth of hatchery-reared and wild juveniles using

complementary field tethering experiments and small-scale field releases in shallow blue crab nursery habitats of the upper Chesapeake Bay. We observed no difference in the survival rates of hatchery-reared and wild crabs in either tethering experiments or paired field releases. Hatchery-reared and wild juveniles also exhibited similar growth rates and levels of growth variability. The results indicate that hatchery-reared juveniles are competent and likely not disadvantaged relative to wild conspecifics, and that poor performance of hatchery-reared individuals following release is not a significant barrier to restocking for this species in Chesapeake Bay. Further, our study highlights the potential utility of release experiments with hatchery-reared animals to provide key biological data for stock assessments and fishery management.

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#### SPIRULINA (ARTHROSPIRA) INDUSTRY IN INNER MONGOLIA OF CHINA: CURRENT STATUS AND PROSPECTS

Yun-Ming Lu, Wen-Zhou Xiang, Yong-Huang Wen-2011

Journal of Applied Phycology 23(2)

From the issue entitled "Special Issue: 7th International Conference on Algal Biotechnology – Delhi"

Abstract:

This paper outlines an investigation on current situation of Spirulina (Arthrospira) industry in Inner Mongolia, an internal region of China with temperate continental climate. More than 20 Spirulina plants have been established in Inner Mongolia since 2001, most of which are located at Wulan Town in the Ordos Plateau. By the end of 2009, the total annual production of Spirulina in the Ordos Plateau surpassed 700 t (dw), which account for ca. 80% of the total productivity of Inner Mongolia, and ca. 20% of China. Besides abundant solar radiation and enough freshwater favorable for Spirulina production, the three technical strategies contribute to the prosperity and success of Spirulina industry in the region: (1) reducing the cost or investment by overall advantages of rich local natural resources with low cost for Spirulina production, such as alkaline lakes, coal, electricity, and sandy land; (2) controlling the culture temperature and to avoid contamination by building plastic greenhouses on raceway ponds, (3) reducing investment by simplifying the construction of the ponds and the greenhouses. As the result, the growth period of Spirulina has been prolonged from about 120 to about 165 days, the cost of Spirulina has decreased by 25–30%, and the quality of products has been enhanced substantially. Inner Mongolia is expected to become the largest base for Spirulina production not only in China, but also in the world in the near future.

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#### ANISOTROPY AND SHIFT OF SEARCH BEHAVIOR IN MALABAR GROUPER (EPINEPHELUS MALABARICUS) LARVAE IN RESPONSE TO PREY AVAILABILITY

Mohamed-Sofiane Mahjoub, Sami Souissi, François G. Schmitt, Fan-Hua Nan, Jiang-Shiou Hwang-2011

Hydrobiologia 666(1): 215-222

From the issue entitled "Copepoda: Biology and Ecology / Guest Editors: L. Sanoamuang, J.-S. Hwang // Zooplankton Behavior and Ecology / Guest Editors: J.-S. Hwang, K. Martens"

Abstract:

In order to enhance encounters with prey, planktonic predators may display different swimming behavior with respect to food availability and distribution. In this study, we used 3D video techniques to record the swimming behavior of malabar grouper (*Epinephelus malabaricus*) larvae in both the absence and the presence of prey (*Artemia* sp. nauplii). Swimming properties were investigated in all of the 3D, the two vertical, and the horizontal projections using scale-dependent (mean speed and Net to Gross Displacement Ratio) and scale-independent (fractal dimension) metrics. When prey was added, larvae swam slower and in a less convoluted way as compared to what was observed in the absence of food. The results obtained with scale-dependant metrics were confirmed by those obtained with scale-independent analyses. Both unveiled the anisotropy of the swimming behavior of grouper larvae that

tend to swim toward the vertical axis in order to maximize encounters with prey patches. This study shows that malabar grouper larvae can optimize their search volume by switching their behavior and further draws attention to the need to consider both vertical- and horizontal-projections components while addressing the plankter's swimming trajectories.

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#### A NOVEL GROWTH-PROMOTING PROTEIN IN THE CONDITIONED MEDIA FROM THE ROTIFER BRACHIONUS PLICATILIS AT AN EARLY EXPONENTIAL GROWTH PHASE

Fumito Ohmori, Gen Kaneko, Toshio Saito, Shugo Watabe-2011

Hydrobiologia 667(1): 101-117

Abstract:

We confirmed the existence of growth-promoting substances in the conditioned media (CM) from the rotifer *Brachionus plicatilis* at an early exponential growth phase and isolated a novel protein with a growth-promoting activity from the crude extract (CE) of rotifer cells. CM was prepared from the culture media where rotifers had been cultured at an early exponential growth phase and filtered through a 0.22- $\mu$ m filter membrane. The growth-promoting activity was determined using rotifers in CM for 5 days. As a result, the increase of rotifers added with CM was significantly higher than that of the control in artificial seawater ( $P < 0.001$ ). Moreover, the growth-promoting activity of CM was dose-dependent and inactivated by heat treatment at 80°C for 60 min. Meanwhile, CM filtered through a <10 kDa ultrafiltration membrane showed a low activity, whereas proteinase K treatment resulted in a complete inactivation. These results suggest that the rotifer secretes growth-promoting proteins into CM. CE also contained a protein with the activity and properties similar to those found in CM. Then, CE was subjected to purification of a growth-promoting protein for convenience using various types of chromatography after fractionation with 30–80% saturated ammonium sulfate. Subsequently, a protein with an approximate molecular weight of 25000 was isolated, and its N-terminal amino acid sequence was determined to be PAVVDFTA VWFGLQMIKP. An orthologue was found in the EST database of *B. plicatilis*, the full sequence of which showed about 50% identity to the corresponding regions of thioredoxins from other organisms.

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#### EMBRYONIC EXPOSURE TO CYPERMETHRIN INDUCES APOPTOSIS AND IMMUNOTOXICITY IN ZEBRAFISH (*DANIO RERIO*)

Yuanxiang Jin, Shanshan Zheng, Zhengwei Fu-2011

Fish & Shellfish Immunology 30(4-5): 1049-1054

Abstract:

Cypermethrin (CYP) is widely used for control of indoor and field pests. As a result, CYP is one of the most common contaminants in freshwater aquatic systems. In the present study, we investigated the effects of CYP exposure on the induction of apoptosis and immunotoxicity in zebrafish during the embryo developmental stage. The mRNA levels of some key genes including P53, Puma, Bax, Apaf1, Cas9 and Cas3 on the mitochondrial pathway of cell apoptosis were significantly up-regulated at the concentration of 3 and 10  $\mu$ g/l CYP. Correspondingly, the activities of Cas3 and Cas9 increased significantly after exposure to 3 or 10  $\mu$ g/l CYP. In addition, the mRNA levels of iNOS and the total content of NO were also up-regulated significantly after CYP exposure. Moreover, it was also observed that the mRNA levels of IFN, CXCL-Clc, CC-chem and C3, which are closely related to the innate immune system, were affected in newly hatched zebrafish when exposed to 3 and 10  $\mu$ g/l CYP, exhibiting CYP's prominent impacts on the innate immune system of zebrafish. Taken together, our results suggest that CYP has the potential to induce cell apoptosis and cause innate immune system disruption in zebrafish during the embryo stage. The information presented in this study will help elucidate the mechanism of CYP-induced toxicity in fish.

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ONTOGENETIC EXPRESSION AND 17 $\beta$ -ESTRADIOL REGULATION OF IMMUNE-RELATED GENES IN EARLY LIFE STAGES OF JAPANESE MEDAKA (*ORYZIAS LATIPES*)

Liwei Sun, Xiaolu Shao, Yudan Wu, Jingming Li, Qinfang Zhou, Bo Lin, Shenyuan Bao, Zhengwei Fu-2011

Fish & Shellfish Immunology 30(4-5): 1131-1137

Abstract:

Accumulating evidence suggests that environmental endocrine disrupting chemicals (EDCs) may exert adverse effects on aquatic organisms via the modulation of immune competence in addition to the endocrine system. However, to date, most studies have been undertaken only on biochemical and histopathological endpoints, and few studies have addressed the role of immune response gene transcript abundance in response to estrogen. In the present study, the ontogenetic expression of immune-related genes, including three complement components (C3-1, C3-2 and Bf/C2), two cytokines (IL-21 and type I IFN [IFN]), lysozyme (LZM), novel immune-type receptor (NITR-18), Ikaros (IK) and ceruloplasmin (CP) were characterized during different developmental periods (from 0 to 28 d post-hatch [dph]) in Japanese medaka. Furthermore, the responses of these genes to natural estrogen (i.e., 17 $\beta$ -estradiol [E2]) were evaluated. E2 exposure at sublethal concentrations (0.1–10  $\mu$ g/L) down-regulated the gene expression of C3-1, C3-2, Bf/C2, LZM and CP, while up-regulating the expression of IL-21, IFN, NITR-18 and IK. The results demonstrate a very different trend in gene expression in fish larvae exposed to E2 when compared with the ontogenetic changes in control, suggesting that exposure to environmental chemicals with estrogenic activities may interfere with immune-related genes and thus potentially influence the susceptibility of fish to opportunistic infections. These findings confirm the ability of exogenous estrogens to elicit changes in immune-related gene expression, and broaden our understanding about the mechanisms underlying the actions of EDCs. In addition, the expression profiles of immune-related genes can be developed for use as biomarkers for future immunotoxicological studies.

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ONTOGENETIC DIETARY CHANGES OF WHITEFISH LARVAE: INSIGHTS FROM FIELD AND EXPERIMENTAL OBSERVATIONS

Orlane Anneville, Vincent Berthon, Olivier Glippa, Mohamed-Sofiane Mahjoub, Juan Carlos Molinero, Sami Souissi-2011

Environmental Biology of Fishes 91(1): 27-38

Abstract:

Ontogenetic changes in resource use are widespread in many fish species. This study investigated the feeding habits of whitefish (*C. lavaretus* L.) larvae in Lake Annecy (France) coupled with experimental behavioral studies in order to identify the underlying mechanisms of the ontogenetic shifts in the diet. The predatory behavior of wild larvae, and the escape responses of their zooplankton prey were both videorecorded in experimental tanks under controlled laboratory conditions. Ontogenetic diet patterns showed that young whitefish larvae have a preference for small cyclops, while older larvae selectively predate cladocerans. Our experimental observations showed that the capture success rate also varied in relation to ontogenetic development in fish. Young larvae were more successful in capturing small copepods, whereas old larvae were more successful in capturing *Daphnia*. In addition, the larvae were able to adjust their predatory behavior (speed, pursuit) according to the swimming pattern of the prey. These observations suggest that the selective predation on cladocerans observed in old larvae is the outcome of both active and passive choices depending on the escape swimming behavior of the prey, and handling time of the predator.

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REDUCED RECRUITMENT PERFORMANCE IN NATURAL POPULATIONS OF ANADROMOUS SALMONIDS ASSOCIATED WITH HATCHERY-REARED FISH

M. W. Chilcote, K. W. Goodson, M. R. Falcy-2011

Canadian Journal of Fisheries and Aquatic Sciences 68: 511-522

Abstract:

We found a negative relationship between the reproductive performance in natural, anadromous populations of steelhead trout (*Oncorhynchus mykiss*), coho salmon (*O. kisutch*), and Chinook salmon (*O. tshawytscha*), and the proportion of hatchery fish in the spawning population. We used intrinsic productivity as estimated from fitting a variety of recruitment models to abundance data for each population as our indicator of reproductive performance. The magnitude of this negative relationship is such that we predict the recruitment performance for a population composed entirely of hatchery fish would be 0.128 of that for a population composed entirely of wild fish. The effect of hatchery fish on reproductive performance was the same among all three species. Further, the impact of hatchery fish from “wild type” hatchery broodstocks was no less adverse than hatchery fish from traditional, domesticated broodstocks. We also found no support for the hypothesis that a population's reproductive performance was affected by the length of exposure to hatchery fish. In most cases, measures that minimize the interactions between wild and hatchery fish will be the best long-term conservation strategy for wild populations.

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