
PROBIOTICS IN AQUACULTURE OF CHINA — CURRENT STATE, PROBLEMS AND PROSPECT

Zizhong Qia, Xiao-Hua Zhang, Nico Boon, Peter Bossier-2009

Aquaculture 290(1-2): 15-21

Abstract:

The development of non-antibiotic and environmental friendly agents is one of the key factors for health management in aquaculture. The application of probiotics in aquaculture of China emerged in 1980s; subsequently, commercial probiotic products from USA, Japan and United Kingdom were introduced into China in the middle of 1990s and evaluation experiments were conducted in vivo. In the mean time, scientists in China started to screen for new probiotic strains from local aquaculture rearing unit in an attempt to suit the specific requirements in China. Also, different modes of action of probiotics were studied. As products containing probiotic bacteria are gaining popularity in aquaculture of China, the quality control of probiotics in aquaculture has become an important issue in China. At present, data about the efficacy of probiotics in commercial aquaculture of China are still lacking. This review discusses mainly the studies and applications about species, effects, mechanisms, problems and prospect of probiotics used in aquaculture of China, and highlighted several effective evaluation methods to control the quality of commercial probiotic products.

(Department of Marine Biology, Ocean University of China, Qingdao, China; email of Xiao-Hua Zhang: xhzhang@ouc.edu.cn)

BREEDING AND MASS-SCALE REARING OF THREE SPOTTED SEAHORSE, HIPPOCAMPUS TRIMACULATUS LEACH UNDER CAPTIVE CONDITIONS

A. Murugan, S. Dhanya, R.A. Sreepada, S. Rajagopal, T. Balasubramanian-2009

Aquaculture 290(1-2): 87-96

Abstract:

Recent establishment of techniques for captive breeding and closure of the life cycle of some seahorse species is expected to help in achieving the twin objectives of reducing pressure on wild stocks as well as providing alternative subsistence livelihoods to fisher-folk currently involved in seahorse fishing. The relatively higher fishing pressure on the three-spotted seahorse, *Hippocampus trimaculatus* Leach, one of the commercially important species sought in traditional Chinese medicine, necessitated the need to develop techniques for captive breeding and mass-scale rearing for conservation and aquaculture purposes. In this paper, we present data on the reproductive efficiency of captive broodstock and the effect of exogenous factors (light intensity, prey type, ingestion and salinity) on survival and growth of juveniles of *H. trimaculatus*. Significantly higher reproductive efficiency (number of juveniles released) was observed when parent seahorses were fed with amphipods (*Eriopisa* spp.) ($P < 0.05$). The survival of pelagic phase juveniles reared under three different light intensities (1000, 1500 and 2000 lx) differed significantly ($P < 0.05$) with 2000 lx resulting in the highest survival ($77.3 \pm 3.1\%$). An ontogenetic shift in feeding behaviour from rotifer to copepod nauplii was observed in > 2 DAB (days after birth) old juveniles. Estimated digestion period (DP) in 6 DAB old juveniles was 3 h 20 m and the DP reduced as the juveniles grew in size. Salinity tolerance experiments indicated that juveniles and adults of *H. trimaculatus* are able to tolerate salinities not extending below 26 and 17 ppt, respectively. The average growth rates peaked during 15–30 DAB (Ht, 1.64 mm day⁻¹). The first sign of maturity in male (pouch development) and female (dropping of egg clutch) was noticed at 95 DAB and 115 DAB, respectively. The sex ratio of cultured seahorses skewed towards female (1:1.2) and differed significantly from equality ($P < 0.05$). Mean number of newborn juveniles released by first mated males was 65 ± 20 juveniles seahorse⁻¹ ($n = 9$ pairs) and egg clutch droppings by newly matured females was 45 ± 17 eggs seahorse⁻¹ ($n = 21$) in F2 generation. Maximum height (Ht) attained at the end of the culture period of 26 weeks was 125 mm with no significant difference in growth between the sexes ($P > 0.05$). Mean growth attained (Ht, 119.9 ± 15.3 mm) and survival rate achieved (65%) at the end of 26 weeks of mass-scale rearing are comparable with reports on other seahorse species. It is expected that the results of this study

could guide future programmes in hatchery technology and aquaculture of this commercially important fast dwindling seahorse species.

(Aquaculture Laboratory, National Institute of Oceanography, Dona Paula-403 004, Goa, India; email of R.A. Sreepada: sreepada@nio.org)

ONSET AND DEVELOPMENT OF AGGRESSIVE BEHAVIOR IN THE EARLY LIFE STAGES OF THE SEVEN-BAND GROUPER EPINEPHELUS SEPTEMFASCIATUS

F. de la S. Sabate, Y. Sakakura, M. Shiozakia, A. Hagiwara-2009

Aquaculture 290(1-2): 97-103

Abstract:

Onset and development of aggressive behavior were observed in the early life stages of seven-band grouper *Epinephelus septemfasciatus*. Fish culture was divided into two terms: the first term, from hatch until 21 days after hatching (DAH); and the second term, from 21 DAH until settlement (65 DAH). During the second term the effect of different aeration rate on survival was investigated. Survival during the first term was $14.1 \pm 7.1\%$. In the second term, survival in control tanks (aeration rate 200 mL/min) was $14.7 \pm 10.2\%$ and $18.8 \pm 7.8\%$ in the increasing aeration tanks (aeration rate 200–800 mL/min). Behavioral observations were conducted at about 8-day intervals and aggressive behavior was quantified by the frequency of chase behavior. Aggressive behavior was first observed on 52 DAH when pigment appeared on the dorsal area of the metamorphosing larvae (standard length 16.6 ± 6.0 mm). Aggressive behavior significantly increased from 59 DAH coinciding with the beginning of settlement.

(Graduate School of Science and Technology, Nagasaki University, Bunkyo 1-14, Nagasaki 852-8521, Japan; email of Y. Sakakura: sakakura@nagasaki-u.ac.jp)

LARVAL RELEASE AND SETTLEMENT OF THE MARINE SPONGE HYMENIACIDON PERLEVIS (PORIFERA, DEMOSPONGIAE) UNDER CONTROLLED LABORATORY CONDITIONS

Lingyun Xue, Xichang Zhang, Wei Zhang-2009

Aquaculture 290(1-2): 132-139

Abstract:

The insufficient supply of wild sponge biomass, i.e., “the supply problem,” critically limits the development of sponge-derived bioactive natural products and other applications. Intensive aquaculture of sponges through artificial seed rearing may provide an alternative sustainable supply of sponge biomass. To develop the technology of sponge aquaculture, protocols for artificial seed production need to be established. To understand larval release and settlement under artificial controlled environments, a model marine sponge *Hymeniacidon perlevis* was investigated under controlled laboratory conditions. The larval release of *H. perlevis* is an asynchronous event in the laboratory-controlled environment. Sponge explants attached on substrata release 5 times more larvae than unattached sponge explants. Over the course of 12 days of release, the mean release rate was 7.2 larvae g⁻¹ wet sponge day⁻¹ for attached sponges. Over the course of 7 days of release for unattached sponges, the mean release rate was 2.6 larvae g⁻¹ wet sponge day⁻¹. Light (6000 lx) stimulated the sponges to release more larvae than did dark incubation. The highest number of sponge larvae (195.8 larvae g⁻¹ wet sponge) was released at 18 °C, while only 48 and 51.7 larvae g⁻¹ wet sponge were released at 14 °C and 25 °C, respectively. Larval settlement was favored in dark condition. The highest percentage of larvae settled at 22 °C, among all temperatures tested.

(Marine Bioproducts Engineering Group, Dalian Institute of Chemical Physics, Chinese Academy of Sciences, Dalian 116023, China; email of Wei Zhang: weizhang@dicp.ac.cn)

CAPTIVE BREEDING AND SEED PRODUCTION OF ETROPLUS SURATENSIS IN CONTROLLED SYSTEMS

K.G. Padmakumar, L. Bindu, P.S. Manu-2009

Asian Fisheries Science 22(1): 51-60

Abstract:

Pearlspot, *Eetroplus suratensis*, the largest indigenous cichlid, breeds in shallow, peripheral waters and are most critically exposed to human interferences in Vembanad lake, the home ground of this species. The species exhibit a complex courtship behaviour involving pairing and nesting. Captive breeding of *E. suratensis* was undertaken, in specially designed artificial raceway tank, with depth situations ranging from 30 to 80 cm. Paired fishes were stocked for breeding in raceways provided with artificial spawning surfaces and breeding pits to facilitate egg attachment and ipit caringi, characteristic of the species. A total of 50 trials were carried out and in over 75 % of the cases, nests were confined to shallow depths between 12 and 45 cm. The mean number of eggs within a nest was observed to be 32 cm⁻². Almost round the year breeding was possible in this controlled system and the breeding success was as high as 71 %, much higher than that in the traditional earthen pond system (60 %). The fertilization rate in the confined raceway system fluctuated between 82 to 100 %. When eggs were incubated allowing parental care, hatching rate varied from 63 to 99 %. Hatching of eggs occurred in 70-72 hrs at 25-27°C. The hatched out larvae, were heavily yolked and were observed to become free swimming on the 6th day. The fry yield under the devised system is perceptibly high (61 %), as compared to that in earthen ponds (28 %). The technique devised is a reliable system for large scale production of seeds of this species under controlled conditions.

DIETARY INFLUENCE ON THE EGG PRODUCTION AND LARVAL VIABILITY IN TRUE SEBAE CLOWNFISH AMPHIPRION SEBAE BLEEKER 1853

B. Varghese, R. Paulraj, G. Gopakumar, K. Chakraborty-2009

Asian Fisheries Science 22(1): 7-20

Abstract:

Broodstock nutrition is one of the most important research areas in aquaculture. In this study, sebae clownfish was used to find out the influence of diet on reproductive performance parameters like egg production, fertilization rate, hatchability, and larval quality. The feeds used were of marine origin such as squid, cuttlefish, deep sea prawn, immature and mature mussel. The diets were analyzed for their proximate composition, amino acids profile, fatty acids profile and astaxanthin. The sub-adult fishes were collected from wild and conditioned prior to experiment. Data were collected after initial three spawning to achieve stability in egg production and quality. The egg production was found to be significantly influenced by diet and those fed cuttlefish meat gave the highest number of eggs per clutch (1520±260 eggs). The fertilization rate and hatchability were found to be unaffected by the tested diets. The highest larval survival (62.3±7 %) after 12 days post hatching was obtained for fish groups fed deep sea prawn. The dietary carotenoid content was also found to influence the egg and larval pigmentation. The result also indicates the importance of dispensable amino acids in egg production. The role of protein, lipids, and essential fatty acids in the broodstock diets for sebae clownfish are also discussed.

USE OF COPEPODS AS LIVE FEED FOR LARVICULTURE OF DAMSELFISHES

G. Gopakumar, I. Santhosi-2009

G. GOPAKUMAR, I. SANTHOSI

Asian Fisheries Science 22(1): 1-6

Abstract:

It is well established that small-sized live feed with sufficient DHA, EPA and ARA as starter feed is the key factor for the success in larviculture of marine fishes with altricial larvae having limited yolk, which are in an undeveloped state at hatching. Copepods form a major component of the natural diet of many fish larvae and the wide range of body sizes of copepods both within and between species is extremely useful for employing the early stage nauplii and copepodites as starter feed for very small larvae with small mouth opening. Improved survival, growth and normal pigmentation have been documented in the larviculture of several marine finfishes reared with the early stage nauplii and copepodites. This is generally attributed to the levels of DHA, EPA and or arachidonic acid (ARA) in the diet and particularly to the DHA: EPA ratio in the diet. Two species of copepods viz. *Euterpina acutifrons*, a harpacticoid copepod and *Pseudodiaptomus serricaudatus*, a calanoid copepod were

selected and cultured. They were employed as starter feed for the larviculture of three species of damselfishes viz. the three spot damselfish, *Dascyllus trimaculatus*, the humbug damselfish, *Dascyllus aruanus* and the blue damselfish, *Pomacentrus caeruleus*. It was found that co-culturing of copepods in greenwater in the larviculture tank is the most effective method for initiating the exogenous feeding of the species studied. Initially greenwater was developed in the larval rearing tanks by adding sufficient quantity of the culture of microalgae *Nannochloropsis* sp. so as to get a cell count ranging from 1×10^5 cells•ml⁻¹ to 6×10^5 cells•ml⁻¹. Adults of copepods *E. acutifrons* and *P. serricaudatus* were introduced into the greenwater. When the copepods started their growth phase, newly hatched larvae were introduced into the tanks. The number of egg bearing copepods and nauplii per 50 ml in the larviculture tanks up to 20-25 days of post hatch is presented. The larval survival in relation to abundance of nauplii and egg bearing copepods is also given. The utility of copepods in the larviculture of damselfishes is discussed in the light of the results of the study.

REVIEW

POTENTIAL ROLE OF BONE MORPHOGENETIC PROTEIN-15 IN ZEBRAFISH FOLLICLE DEVELOPMENT AND OOCYTE MATURATION

Chun Peng, Eric Clellanda, Qian Tan-2009

Comparative Biochemistry and Physiology - Part A: Molecular & Integrative Physiology 153(1): 83-87

Abstract:

Bone morphogenetic protein (BMP)-15 is a member of the transforming growth factor β (TGF- β) superfamily and is closely related to growth and differentiation factor (GDF)-9, both structurally and functionally. In mammals, BMP-15 is predominantly produced by oocytes and exerts important regulatory functions within the ovary, such as promoting early folliculogenesis, preventing premature luteinization and enhancing cumulus cell expansion. The role of BMP-15 in mammalian ovary differs between monoovulatory and polyovulatory species. Recent studies in zebrafish have provided initial evidence that BMP-15 is also an important regulator of ovarian functions. BMP-15 is produced by the zebrafish ovary throughout follicle development and maturation. In vitro studies using zebrafish follicles have revealed that incubation with recombinant human BMP-15 or over-expression of BMP-15 in oocytes results in an inhibition of gonadotropin- and maturation inducing hormone (MIH)-induced oocyte maturation. Conversely, immunoneutralization with BMP-15 antiserum or silencing of BMP-15 expression using morpholino antisense oligonucleotides enhances oocyte maturation. A key step in BMP-15 action is the sensitivity of follicles to MIH. In vivo injection of BMP-15 antiserum causes a significant decrease in maturation-incompetent (insensitive to MIH) small early growth phase follicles and a concomitant increase in mature follicles. These findings support a role in BMP-15 in preventing precocious oocyte maturation in zebrafish. We propose that the suppression of premature oocyte maturation by BMP-15 may be important to maintain oocyte quality and subsequent ovulation and fertilization.

(Department of Biology, York University, Toronto, Canada; email of Chun Peng: cpeng@yorku.ca)

IS THE FISH EMBRYO TOXICITY TEST (FET) WITH THE ZEBRAFISH (DANIO RERIO) A POTENTIAL ALTERNATIVE FOR THE FISH ACUTE TOXICITY TEST?

E. Lammer, G.J. Carr, K. Wendler, J.M. Rawlings, S.E. Belanger, Th. Braunbeck-2009

Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology 149(2): 196-209

Abstract:

The fish acute toxicity test is a mandatory component in the base set of data requirements for ecotoxicity testing. The fish acute toxicity test is not compatible with most current animal welfare legislation because mortality is the primary endpoint and it is often hypothesized that fish suffer distress and perhaps pain. Animal alternative considerations have also been incorporated into new European REACH regulations through strong advocacy for the reduction of testing with live animals. One of the most promising alternative approaches to classical acute fish toxicity testing with live fish is the fish embryo toxicity (FET) test. The FET has been a mandatory component in routine whole effluent testing in Germany since 2005 and has already been standardized at the international level. In

order to analyze the applicability of the FET also in chemical testing, a comparative re-evaluation of both fish and fish embryo toxicity data was carried out for a total of 143 substances, and statistical approaches were developed to evaluate the correlation between fish and fish embryo toxicity data. Results confirm that fish embryo tests are neither better nor worse than acute fish toxicity tests and provide strong scientific support for the FET as a surrogate for the acute fish toxicity test.

(Aquatic Ecology and Toxicology Section, Department of Zoology, University of Heidelberg, Im Neuenheimer Feld 230, D-69120 Heidelberg, Germany; email of Th. Braunbeck: braunbeck@zoo.uni-heidelberg.de)

SEM STUDY OF THE EARLY DEVELOPMENT OF THE MANDIBLE OF ARTEMIA URMIANA AND A. PARTHENOGENETICA (BRANCHIOPODA, ANOSTRACA)

Davoodi, P., Rahimian, H., Agh, N.-2009

Crustaceana 82(3): 257-266

Abstract:

The development of the molar surface in post-embryonic stages of *Artemia urmiana* and *A. parthenogenetica* was studied using scanning electron microscopy (SEM). Cysts of both species have been collected from Urmia Lake, Iran, and its adjacent lagoons and were hatched and raised under laboratory conditions. The cuticular teeth on the molar surface appeared in stage L9 in *A. urmiana* but at L3 in *A. parthenogenetica*. While the appearance and development of the molar surface of those species were different during metanaupliar and post-metanaupliar stages, the morphology was similar in post-larval stages. Thus, these species can be distinguished based on the morphology of the molar surface and by the appearance of adult characteristics, all readily apparent in early phases of their respective life cycles.

(Faculty of Biology, College of Science, University of Teheran, Teheran, Iran; email of H. Rahimian: rahimian@khayam.ut.ac.ir)

CORRESPONDENCE OF THE SEASONAL PATTERNS OF THE BRINE SHRIMP, ARTEMIA SALINA (LEACH, 1819) (ANOSTRACA) WITH SEVERAL ENVIRONMENTAL FACTORS IN AN ARID SOLAR SALTERN (SFAX, SOUTHERN TUNISIA)

Crustaceana 82(3)

Guermazi Wassim, Ayadi Habib, Aleya Lotfi-2009

Abstract:

We investigated the correspondence of the seasonal patterns of *Artemia salina* with several environmental factors along a natural salinity gradient in four ponds (M1, M2, M3, and B1) located in the arid solar saltern of Sfax (southern Tunisia). The shape of the frontal knobs of males showed the dominance of the autochthonous species, *A. salina*. *Artemia* abundance and fecundity were assessed. Biometrics of *A. salina* stages were studied by comparing cyst size and body length. *A. salina* abundance displayed a clear seasonal and spatial variation. Abundance of live *Artemia* ranged between 0.25×10^3 and 1414×10^3 ind m⁻³. The highest numbers were recorded in pond M3, as nauplii (771.8×10^3 ind m⁻³ corresponding to 31.8 g m⁻³). This resulted from low male and female numbers (34 and 17×10^3 ind m⁻³, respectively). *Artemia* cysts were predominant (92.96% of total *Artemia*), and grouped in small (216 μ m) and large (243 μ m) sized cysts, which correlated negatively with temperature ($r = -0.4$, $N = 294$, $p < 0.01$) and salinity ($r = -0.39$, $N = 294$, $p < 0.01$), and positively with female fecundity ($r = 0.6$, $p < 0.05$). The large (270 μ m) and small (216 μ m) cysts suggested the presence of also the species *A. parthenogenetica* and *A. franciscana* in the saltern, respectively. Fecundity showed a summer-autumn distribution that correlated significantly (-0.6 and -0.9 , $N = 35$, $p < 0.01$) with both temperature and salinity. *A. salina* performed best in M2 (more than 80 cysts per brood), at about 200 g l⁻¹ and 26.8°C, with gravid females representing 20%. *A. salina* from the Sfax solar saltern was unable to withstand extreme temperatures (35°C), but tolerated extreme salinity (330 g l⁻¹). Abundance, biometrics, and reproductive descriptors of *A. salina* appeared to be governed chiefly by temperature and salinity, the physical structure of the saltern, and food availability, such as the unicellular green alga, *Dunaliella salina*. Nauplii (mean length: 401 μ m)

from small-sized cysts encountered in the saltern might be a valuable food source for hatcheries of some small-mouthed marine fish.

(Unité de Recherche LR/UR UR05ES05 Biodiversité et Ecosystème Aquatiques, Département des Sciences de la Vie, Faculté des Sciences de Sfax, Université de Sfax, Route Soukra Km 3.5, B.P. 1171, CP 3000 Sfax, Tunisia; email of Guerhazi Wassim : Wassim016@yahoo.fr)

STRUCTURAL COMPLEXITY IN RELATION TO THE HABITAT PREFERENCES, TERRITORIALITY, AND HATCHERY REARING OF JUVENILE CHINA ROCKFISH (SEBASTES NEBULOSUS)

Jonathan S. F. Lee, Barry A. Berejikian-2009

Journal Environmental Biology of Fishes 84(4): 411-419

Abstract:

Conservation efforts require an understanding of the basic behavior and ecology of target species. However, limited information exists for a wide range of taxa, including declining species of rockfish (genus *Sebastes*). First, we observed captive juvenile China rockfish (*S. nebulosus*) to determine how they interact with their environment and conspecifics. Juveniles exhibited site fidelity and territoriality. These aggressive interactions occurred within the context of size-biased dominance, centered on competition for structurally complex habitat. Given the apparent importance of structure and the absence of structure in typical hatchery environments, we then asked how the absence of structure affects future behavior. When barren-reared and structure-reared juveniles were combined into a structurally complex aquarium, barren-reared fish displayed less structure use and less site fidelity than structure-reared fish. However, after 1 to 2 weeks, barren-reared fish began to use structure and showed site fidelity that eventually equaled that of structure-reared juveniles, showing that those behavioral effects of the rearing environment were not permanent. Though these short-term effects may still impact survival after hatchery release, we were unable to detect significant effects on vulnerability to a predator (lingcod, *Ophiodon elongatus*) in laboratory trials.

(Resource Enhancement and Utilization Technologies Division, National Marine Fisheries Service, Northwest Fisheries Science Center, Manchester Research Station, P.O. Box 130, Manchester, WA, 98353, USA)

EARLY TREATMENT WITH LACTOBACILLUS DELBRUECKII STRAIN INDUCES AN INCREASE IN INTESTINAL T-CELLS AND GRANULOCYTES AND MODULATES IMMUNE-RELATED GENES OF LARVAL DICENTRARCHUS LABRAX (L.)

Simona Picchiatti, Anna Maria Fausto, Elisa Randelli, Olyana Carnevali, Anna Rita Taddei, Francesco Buonocore, Giuseppe Scapigliati, Luigi Abelli-2009

Fish & Shellfish Immunology 26(3): 368-376

Abstract:

Lactobacillus delbrueckii ssp. *delbrueckii* (AS13B), isolated from the gut of adult *Dicentrarchus labrax*, was administered live to developing sea bass using rotifers and *Artemia* as live carriers. Immune-related gene transcripts were quantified in post-larvae at day 70 post-hatch (ph) and histology, electron microscopy and immunocytochemistry of the intestinal tissue were performed at day 74 ph. Since the probiotic was orally administered the studies were focused on intestinal immunity.

In treated fish gut integrity was unaffected, while the density of T-cells and acidophilic granulocytes in the intestinal mucosa was significantly higher than in controls. Probiotic-induced increases in intestinal T-cells and total body TcR- β transcripts are first reported in fish. Significantly lower IL-1 β transcripts and a trend towards lower IL-10, Cox-2 and TGF- β transcription were found in the treated group.

Evidence is provided that early feeding with probiotic-supplemented diet stimulated the larval gut immune system and lowered transcription of key pro-inflammatory genes.

(Department of Environmental Sciences, Tuscia University, Viterbo, Italy; email of Luigi Abelli: abl@unife.it)

HIGH POTENTIAL OF ADHESION TO ABIOTIC AND BIOTIC MATERIALS IN FISH AQUACULTURE FACILITY BY VIBRIO ALGINOLYTICUS STRAINS

M. Snoussi, E. Noumi, H. Hajlaoui, D. Usai, L.A. Sechi, S. Zanetti, A. Bakhrouf-2009

Journal of Applied Microbiology 106(5): 1591 – 1599

Abstract:

Aims: The ability of *Vibrio alginolyticus* strains isolated from *Sparus aurata* and *Dicentrarchus labrax* nursery to adhere to epithelial cell lines (Hep-2 and Caco-2), fish mucus and their ability to form a biofilm on different surfaces (glass, polystyrene, polyethylene and polyvinyl-chloride) was investigated in this study.

Methods and Results: The extracellular products were rich in enzymes and the strains were haemolytic on Wagatsuma agar and possessed several hydrolytic exoenzymes such as proteases, DNase and lipases. Most strains tested were multiresistant to the 17 antibiotics tested including those used in the farm to treat vibriosis.

Conclusions: These bacteria were able to form a biofilm on all the surfaces tested and the cell density was the highest on the PVC surface followed by that on the glass slides, polystyrene and the polyethylene surface. More than 50% of the tested strains were adhesive to the epithelial cell lines (Hep-2 and Caco-2).

Significance and Impact of the Study: These properties allow these bacteria to survive, proliferate and persist in all stages of fish rearing nursery even after seawater treatment with UV light.

(Laboratoire d'Analyse, Traitement et Valorisation des Polluants de l'Environnement et des Produits, Department of Microbiology, Faculty of Pharmacy, Rue Avicenne, Monastir, Tunisia; email of M. Snoussi: snmejdi@yahoo.fr)

THERMALLY INDUCED PHENOTYPIC PLASTICITY OF SWIMMING PERFORMANCE IN EUROPEAN SEA BASS DICENTRARCHUS LABRAX JUVENILES

G. Koumoundouros, C. Ashton, D. G. Sfakianakis, P. Divanach, M. Kentouri, N. Anthwal, N. C. Stickland-2009

Journal of Fish Biology 74(6): 1309 – 1322

Abstract:

The vulnerability of embryonic and larval stages of European sea bass *Dicentrarchus labrax* to environmental temperature and the longer-term consequences for the early juveniles was demonstrated. This phenotypic plasticity was highlighted by subjecting *D. labrax* at 15.2 ± 0.3 or 20.0 ± 0.4 °C (mean \pm s.d.) up to metamorphosis and then at the same temperature (18.5 ± 0.7 °C). After 4–6 weeks at the same temperature, the measurement of critical swimming speed at four exercise temperatures (15, 20, 25 and 28° C) showed a significantly higher swimming capacity in the fish initially reared at 15° C than for fish initially reared at 20° C. This performance was correlated with significant differences in the phenotype of red muscle. Thermally induced phenotypic plasticity was clearly demonstrated as an important mechanism controlling swimming performance in early juveniles of *D. labrax*.

(Department of Biology, University of Patras, Rio 26500, Patras, Greece, email of G. Koumoundouros: koumound@upatras.gr)

DELIVERING OXYTETRACYCLINE TO FIRST-FEEDING ZEBRAFISH, DANIO RERIO (HAMILTON), AND GOBY, ASTERROPTERYX SEMIPUNCTATA RÜPPELL, LARVAE USING LIPID SPRAY BEADS

E. Temple, C. Langdon-2009

Abstract:

Lipid spray beads (LSB) were evaluated for delivery of the low-molecular weight, water-soluble antibiotic, oxytetracycline·HCl (OTC) to fish larvae. Various OTC core-to-lipid ratios and OTC core concentrations were evaluated to maximize OTC delivery efficiency by LSB. Acceptability and digestion of LSB containing OTC and riboflavin by larval zebrafish, *Danio rerio* (Hamilton), and larval gobies, *Asterropteryx semipunctata* Rüppell, were also evaluated. Increasing LSB core-to-lipid ratios from 1:3 to 1:1 v/v resulted in an increase in encapsulation efficiency (EE) from 2.33 to 3.68% w/w. Increasing OTC concentrations of core solutions from 0.1 to 0.5 g OTC mL⁻¹ increased EE from 3.95 to 18.77% w/w, respectively. Although retention efficiency (RE) was unaffected by this increase, delivery efficiency was increased to $7.9 \pm 0.7\%$ w/w, after correcting for leakage losses because of the suspension of beads in water for 60 min. Consumption of LSB containing OTC by first-feeding zebrafish and goby larvae was confirmed by analysis of feeding incidence and gut fullness. Visual observations of larvae fed on LSB containing riboflavin indicated that larvae of both species digested LSB. Zebrafish larvae fed on OTC LSB contained 39.3 ± 2.5 ng OTC after purging LSB from their guts. Use of LSB provides an effective means of delivering therapeutics to fish larvae and could greatly reduce required doses compared with current methods of immersing larvae in solutions of therapeutic agents.

(Coastal Oregon Marine Experiment Station, Fisheries and Wildlife, Oregon State University, 2030 SE Marine Science Drive, Newport, OR 97365, USA; email of E. Temple: ephraimtemple@gmail.com)
