

LARVAL REARING OF CALICO SCALLOPS, *ARGOPECTEN GIBBUS*, IN A FLOW-THROUGH SYSTEM

Samia Sarkis, Michael Helm, Claudia Hohn-2006

Aquaculture International 14(6): 527-538

## Abstract:

A flow-through (FT) culture system is described for calico scallop, *Argopecten gibbus*, larvae. Its performance was assessed by larval survival rate, shell growth, settlement rate and post-larval shell growth for the duration of larval life (13 days). Comparisons were made with larvae reared in standard static system (S). Effect of increased larval density on FT performance was also investigated. With comparable larval densities, survival rate of Day 2 larvae to pediveliger stage was similar in both larval rearing systems. Shell growth for FT-reared larvae was comparable or significantly higher than in the static system ( $P < 0.01$ ). Settlement rate of pediveligers was comparable for both systems, averaging 30.7%, and no significant difference was seen in shell growth of FT- and static-reared pediveligers. Increased initial larval density did not affect survival rate in FT, but did negatively affect larval shell growth, settlement rate and post-larval shell growth yielding lower growth and minimal settlement rate ( $10.9 \pm 2.8\%$ ) compared to the static system. This FT system was successful as larval rearing system, optimising space allocation in the hatchery, reducing labour, and eliminating the use of antibiotics. Optimising initial larval density within the system needs to be investigated in association with food ration.

(Department of Conservation Services, Ministry of the Environment, Flatt's, Bermuda; email of S. Sarkis: [scsarkis@gov.bm](mailto:scsarkis@gov.bm))

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EFFECTS OF WATER EXCHANGE REGIMES ON GROWTH, SURVIVAL AND SHELL NORMALITY OF THE HATCHERY REARED JUVENILE SPOTTED BABYLONIA (*BABYLONIA AREOLATA* LINK 1807) IN A RECIRCULATING SEAWATER SYSTEM

S. Kritsanapuntu, N. Chaitanawisuti, W. Santhaweesuk, S. Y. Natsukari-2006

Aquaculture International 14(6): 587-594

## Abstract:

Growth, survival and shell normality of hatchery reared juvenile *Babylonia areolata* were examined at four water exchange regimes of 0, 15, 30 and 60 day intervals in a recirculating seawater system over a 120 day experimental period. Higher body weight gains and shell length increments were observed in snails held at water exchange of 15 day intervals, especially when compared with those held at water exchange of 60 and 0 day intervals ( $P < 0.05$ ). Water exchange affected the final survival of *B. areolata*. At the end of the experiment, final survival rates were  $65.47 \pm 0.66\%$ ,  $87.48 \pm 0.67\%$ ,  $86.34 \pm 0.92\%$  and  $78.50 \pm 3.26\%$  for snails held in the water exchange treatments of 0, 15, 30, and 60 day intervals, respectively, and those of shell abnormality were  $97.65 \pm 1.04\%$ ,  $93.09 \pm 2.34\%$ ,  $97.08 \pm 1.18\%$  and  $96.71 \pm 1.84\%$ , respectively. The present study concluded that water exchange regimes of the recirculating system influenced growth, survival, shell normality and water quality of the recirculating culture system for this species.

(Faculty of Technology and Management, Prince of Songkla University (Surat Thani campus), Surat Thani, Thailand; email of N. Chaitanawisuti: [nilnajcl@hotmail.com](mailto:nilnajcl@hotmail.com))

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ONTOGENIC DEVELOPMENT OF THE DIGESTIVE ENZYMES IN COMMON PANDORA, *PAGELLUS ERYTHRINUS*, L. LARVAE

Cüneyt Suzer, Kürşat Fırat, Şahin Saka-2006

Aquaculture Research 37(15): 1565-1571

## Abstract :

Ontogenic development of some digestive enzymes (proteases, amylase and lipase) in common pandora *Pagellus erythrinus* larva was assayed during larval development. The green-water technique was employed for larval rearing, and whole-body homogenates were used for enzymatic assays in triplicate. Important alterations in specific activities of all digestive enzymes measured during the period of this study were mostly related to metamorphosis and weaning. Mouth opening was observed on day 3 at  $2.23 \pm 0.01$  mm total length synchronously with the first determination of trypsin and chymotrypsin activities. After this date, the specific activities of these slightly increased until 25 days after hatching (DAH), respectively, and then slightly decreased and changed. The pattern determined for pepsin was strongly related to stomach formation on day 25 at  $9.72 \pm 2.3$  mm total length and a sharp increase was found until 30 DAH and then a slight decrease was measured from this date until the end of the experiment. Both amylase and lipase were measured for the first time on days 2 and 4, respectively, and also the specific activities of these showed similar patterns during the first week of the study. Then, slight variations were observed until 30 DAH and while lipase-specific activity had declined, an increase in the specific activity of amylase was found until the end of the experiment. Finally, it is thought that the variations observed in the specific activity in the profile of digestive enzymes were related to either metamorphosis such as formation of stomach (25 DAH) or to changes in characteristics of food (30 DAH). The pattern of development of the main digestive enzymes found in *P. erythrinus* is similar to that described in other Sparid species.

(Aquaculture Department, Faculty of Fisheries, Ege University, Izmir, Turkey; email of C. Suzer: [cuneyt.suzer@ege.edu.tr](mailto:cuneyt.suzer@ege.edu.tr))

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#### SHORT COMMUNICATION

#### PARALARVAL REARING OF THE COMMON OCTOPUS, *OCTOPUS VULGARIS* (CUVIER)

José Francisco Carrasco, Juan Carlos Arronte, Carmen Rodríguez-2006

Aquaculture Research 37(15): 1601-1605

(Consejería de Medio Rural y Pesca, Dirección General de Pesca, Centro de Experimentación Pesquera, Avda. Príncipe de Asturias s/n, 33212, Gijón, Spain; email of José Francisco Carrasco: [josefcf@princast.es](mailto:josefcf@princast.es))

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#### DEVELOPMENT OF EMBRYOS IN *MASTACEMBELUS MASTACEMBELUS* (BANK & SOLENDER, 1794) (MESOPOTAMIAN SPINY EEL) (MASTACEMBELIDAE)

Erdinç Şahinöz, Zafer Doğu, Faruk Aral-2006

Aquaculture Research 37(16): 1611-1616

Abstract :

In this study, the embryonic development of the eggs in the *Mastacembelus mastacembelus* (Bank & Solender, 1794) was examined. At the same time, possibilities of artificial breeding through artificial insemination were investigated. Artificial insemination was achieved by mixing the eggs of the mature female and sperm of the mature male samples caught with gill nets ( $22 \times 22$ ) in Ataturk Dam Lake in Turkey. To this end, first in a Petri dish ( $100 \times 20$ ), the testes were cut into small pieces with a lancet and the mixture of sperm–testes–tissue was obtained. The fertilization rate of the eggs was found to be 80%. The diameter of the eggs ranged from 2.015 to 1.147 mm. The perivitelline space formed 0.5 h after insemination. The first cleavage occurred at the animal pole 4 h after insemination. The oil droplets had fused to a single droplet 19 h after insemination. The blastoderm became an embryonic shield 30 h after insemination. The blastoderm covered almost half the egg 40 h after insemination and embryonic body was formed. The blastoderm covered almost the whole egg 50 h after insemination. Some somites were discernible 59 h after insemination. The embryonic body reached two-third of the circumference of the egg 70 h after insemination. The tail bud began to separate from the yolk 77 h after insemination. A newly hatched larva was observed at 85 h after insemination.

(Department of Fisheries, Bozova Vocational School, Harran University, Bozova, Şanlıurfa, 63850 Turkey; email of Z. Dogu: [zaferdogu@harran.edu.tr](mailto:zaferdogu@harran.edu.tr))

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EFFECT OF ARTEMIA ENRICHMENT ON THE GROWTH AND SURVIVAL OF PACIFIC BLUEFIN TUNA THUNNUS ORIENTALIS (TEMMINCK & SCHLEGEL) LARVAE

Amal Kumar Biswas, Jun Nozaki, Michio Kurata, Kenji Takii, Hidemi Kumai, Manabu Seoka-2006  
Aquaculture Research 37(16): 1662-1670

Abstract :

This study was carried out to investigate the suitability of Artemia enriched with docosahexaenoic acid (DHA) and choline as live food on the growth and survival rate of the Pacific bluefin tuna (PBT; *Thunnus orientalis*) larvae. The PBT larvae were fed either Artemia enriched with oleic acid (Diet 1), DHA (Diet 2), DHA+choline 1.0 mg L1 (Diet 3) and DHA+choline 2.0 mg L1 (Diet 4) or striped knifejaw larvae (Diet 5, reference diet), in duplicate for 12 days. Enrichment of Artemia with DHA significantly increased the DHA levels to 13.9, 13.8 and 12.5 mg g<sup>-1</sup> on a dry matter basis in Diets 2, 3 and 4 respectively; however, the levels were significantly lower than the reference diet (26.9 mg g<sup>-1</sup> dry matter basis; Diet 5). Although growth and survival rate were significantly improved by the enrichment of Artemia with DHA and choline, the improvement was negligible compared with the enhanced growth and survival rate of the fish larvae-fed group (P<0.05). The results demonstrated that enriched Artemia does not seem to be the right choice to feed the PBT larvae perhaps because of the difficulties in achieving the correct balance of fatty acid with higher DHA/EPA from Artemia nauplii.

(Fisheries Laboratory, Kinki University, Uragami, Nachikatsuura, Wakayama 649-5145, Japan; email of A. Kumar Biswas: [ns\\_akb@nara.kindai.ac.jp](mailto:ns_akb@nara.kindai.ac.jp))

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VERIFICATION OF PLOIDY LEVEL IN STURGEON LARVAE

Dorota Fopp-Bayat, Pawel Woznicki-2006

Aquaculture Research 37(16): 1671-1675

Abstract :

Chromosome preparations and assay of the microsatellite locus Afu-68 were used to determine ploidy in Siberian sturgeon (*Acipenser baeri* Brandt) and F1 hybrids of Siberian sturgeon and Russian sturgeon (*Acipenser gueldenstaedti* Brandt). The chromosome number and microsatellite locus Afu-68 were compared and these analyses were used for identification of 'haploid', 'diploid' and 'triploid' progeny of the studied cross of *A. baeri* × (*A. baeri* × *A. gueldenstaedti*).

(Faculty of Environmental Sciences and Fisheries, Department of Ichthyology, University of Warmia and Mazury in Olsztyn, 10-718 Olsztyn-Kortowo, Poland; email of D. Fopp-Bayat: [foppik@uwm.edu.pl](mailto:foppik@uwm.edu.pl))

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SHORT COMMUNICATION

FERTILIZATION SUCCESS AND EARLY SURVIVAL IN PURE AND HYBRID LARVAE OF MYTILUS EDULIS (LINNAEUS, 1758) AND M. TROSSULUS (GOULD, 1850) FROM LABORATORY CROSSES

Jorge E. Toro, Raymond J. Thompson, David J. Innes-2006

Aquaculture Research 37(16): 1703-1708

(Instituto de Biología Marina 'Dr. Jürgen Winter', Universidad Austral de Chile, Casilla 567, Valdivia, Chile; email of J.E. Toro: [jtoro@uach.cl](mailto:jtoro@uach.cl))

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PIGMENT DEFICIENCY CORRECTION IN SHRIMP BROODSTOCK USING SPIRULINA AS A CAROTENOID SOURCE

C. Regunathan, S.G. Wesley-2006

Aquaculture Nutrition 12(6): 425-432

Abstract :

In this study, an effort was made to cure the pigment deficiency syndrome (PDS) exhibited by pond-reared *Fenneropenaeus indicus* (H.Milne Edwards) broodstock, using the blue-green algae *Spirulina* as a carotenoid source in diet. The PDS symptoms included bleaching of ovary and reduced early larval performance. Biochemical analysis indicated reduced quantity of total carotenoids in egg and nauplii from the females with PDS. When PDS females were fed 30 g kg<sup>-1</sup> *Spirulina*-supplemented diet immediately after the appearance of symptoms, the egg and nauplii carotenoid values improved gradually and attained the pre-PDS values after a minimum of 4 week period. *Spirulina* supplementation also improved significantly ( $P < 0.05$ ) the spawn quality (hatch per spawn, nauplii per spawn, nauplii viability) and larval quality indices ( $P < 0.05$ ). The egg and nauplii protein values exhibited a trend similar to carotenoids, confirming the influence of latter on protein stability previously reported by researchers. The study confirms the bioavailability of carotenoids from *Spirulina* to shrimp broodstock and recommends its regular inclusion in diet to preclude carotenoid deficiency-related problems in shrimp hatcheries.

(Al Murjan Marine Resources Co. Ltd, Mukalla, Yemen; email of C. Regunathan: [oceanbiocare@gmail.com](mailto:oceanbiocare@gmail.com))

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FURTHER CHARACTERIZATION OF THE CATHEPSIN L-ASSOCIATED PROTEIN AND ITS GENE IN TWO SPECIES OF THE BRINE SHRIMP, ARTEMIA

Liqian Liu, Alden H. Warner-2006

Comparative Biochemistry and Physiology - Part A: Molecular & Integrative Physiology 145(4)

Abstract:

The major cysteine protease in embryos and larvae of the brine shrimp *Artemia franciscana* is a heterodimer composed of a cathepsin L-like polypeptide of 28.5 kDa and a 31.5 kDa polypeptide called the cathepsin L-associated protein or CLAP. In a previous study, CLAP was shown to be a cell adhesion protein containing two Fas I domains and two GTP/ATP binding sites known as Walker A and B motifs. Here, we have characterized CLAP and its genes to better understand the role of this protein in *Artemia* development. The polymerase chain reaction was used to investigate the structure of the CLAP gene in two species of *Artemia*, the New World bisexual diploid *A. franciscana* and the Old World parthenogenetic tetraploid *Artemia parthenogenetica*. The protein coding region of the CLAP gene from each species was 99.5% identical for a protein of 332 amino acids, while the 3' non-coding region, representing nearly 45% of the gene, was only 86% identical between the two related species. However, while the CLAP gene is intronless in *A. franciscana*, in *A. parthenogenetica* the gene contained a mini-intron of 30 base pairs in the 3' non-coding region. The sequences representing the CLAP gene in *A. franciscana* and *A. parthenogenetica* have been entered into the NCBI database as AY757920 and DQ100385, respectively. Northern blot analysis showed that while the cathepsin L gene is expressed constitutively in *Artemia franciscana* embryos and young larvae, the CLAP gene is not expressed in late embryos and young larvae. In contrast, Western blots indicated that CLAP is present in developing embryos and young larvae, at least to the first larval molt, supporting results obtained previously showing CLAP's resistance to degradation by its dimeric partner, cathepsin L. At the protein level we showed that the GTP/ATP binding sites in CLAP are functional with rate constants of 0.024 and 0.022 for GTP and ATP hydrolase activity, respectively. GTP but not ATP also had a slight stimulatory effect on cathepsin L activity of the heterodimeric protease containing CLAP. Our results support the hypothesis that CLAP plays an important role in targeting and expression regulation of cathepsin L activity during early development of *Artemia*.

(Department of Biological Sciences, University of Windsor, Windsor, Ontario, Canada N9B 3P4; email of A. Warner: [warner1@uwindsor.ca](mailto:warner1@uwindsor.ca))

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OPTIMAL WATER CHARACTERISTICS FOR COMMERCIAL PRODUCTION OF CYSTS OF THE BRINE SHRIMP, ARTEMIA IN SALT PONDS

Singh, R.K., Khandagale, P.A.-2006  
Crustaceana 79(8): 913-923

Abstract:

Experiments were conducted to identify optimal water depth, pH, salinity, and temperature in salt ponds, for influencing cyst production of the brine shrimp, *Artemia*. The results show that a water depth of 40 cm gave the highest cyst production (63.7 kg/ha) followed by 30 cm depth (52.1 kg/ha), in 90 days. Cyst production decreased with an increase in water depth from 40 to 50 and further to 60 cm. Cyst production started at a salinity of 95 ppt and higher. The highest production of cysts was recorded on the 39th day after the introduction of the nauplii in the salt ponds. A pH above 7.5 was suitable, while a water temperature of 31°C gave the highest survival (43%) of *Artemia* nauplii on the 15th day in comparison to 55% on the first day. The lowest survival, 25%, was recorded on the 1st day at 35°C, which further reduced to 8% on the 15th day. Similarly, the hatching percentage of *Artemia* cysts was highest (63%) at 27°C and lowest (25%) at 35°C. Therefore, while undertaking *Artemia* cyst production in salt ponds, a water depth of 40 cm, a salinity of 95 ppt or higher, a pH of 7.5 or higher, and a water of temperature 33°C or lower are desirable for achieving optimal results.

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EMBRYONIC AND LARVAL DEVELOPMENT OF THE MALABAR GROUPE, EPINEPHELUS MALABARICUS (PISCES: SERRANIDAE)

Ming-Yih Leu, Chyng-Hwa Liou, Lee-Shing Fang-2006

Journal of the Marine Biological Association of the UK 85: 1249-1254

Abstract:

The embryonic and larval development of *Epinephelus malabaricus* are described and illustrated for the first time. Fertilized eggs, with a mean diameter of  $0.90 \pm 0.02$  mm and a range from 0.87 to 0.93 mm, were spherical, transparent, buoyant and unpigmented. Embryonic development lasted 26 h 30 min at 25.5°C. Newly hatched larvae were  $1.93 \pm 0.04$  mm in total length (TL) with 26 (11+15) myomeres and had an oil globule in the ventroposterior area of the yolk sac. Three days after hatching (2.76 mm TL), the mouth opened. Early larvae had two clusters of well-developed melanophores appearing on the alimentary canal and at the caudal region of the body, and the appearance of xanthophores on the dorsal finfold. Nine days after hatching (4.04 mm TL), the buds of the second dorsal and pelvic fin spines had appeared. At 5.41 mm TL, the notochord was slightly flexed, and the hypural bones and caudal fin rays had begun to develop. At 7.39 mm TL, the ratios of the second dorsal and pelvic-fin spine lengths to TL attained their maximums, 52.68% and 48.62%, respectively. At 20.19 mm TL, all fins had the adult complement of rays and spines. By 30.18 mm TL, the body had become red, with five irregular, oblique, dark brown bars visible on the body. The larval habitat shifted from the surface and middle layers to the tank bottom.

(Department of Aquaculture, National Taiwan Ocean University, Keelung 202, Taiwan; email of Ming-Yih Leu: [myl@nmmba.gov.tw](mailto:myl@nmmba.gov.tw))

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INLAND HYPERSALINE LAKES AND THE BRINE SHRIMP ARTEMIA AS SIMPLE MODELS FOR BIODIVERSITY ANALYSIS AT THE POPULATION LEVEL

Gonzalo Gajardo, Patrick Sorgeloos, John A Beardmore-2006

Saline Systems 2:14

Abstract (provisional):

Biodiversity can be measured at different hierarchical levels, from genetic diversity within species to diversity of ecosystems, though policy-makers tend to use species richness. The 2010 goal of reducing biodiversity loss, agreed by the subscribers to the Convention on Biological Diversity, requires simple and reliable protocols to evaluate biodiversity at any level in a given ecosystem. Stakeholders, particularly policy makers, need to understand how ecosystem components interact to produce social and economic benefits on the long run, whilst scientists are expected to fulfil this demand by testing and modelling ideally simple (low diversity) ecosystems, and by monitoring key species. This work emphasizes the unique opportunity offered by inland, isolated salt lakes and the brine shrimp *Artemia*, an example of biodiversity contained at the intra-specific level, as simple models to understand and

monitor biodiversity, as well as to assess its predicted positive association with ecosystem stability. In addition to having well identified species and strains and even clones, that allow to test reproductive effects (sexual versus asexual), *Artemia* benefits from the possibility to set up experimental testing at both laboratory scale and outdoor pond systems, for which a comprehensive cyst bank with sufficient amount of samples from all over the world is available.

(Department of Basic Sciences/Laboratory of Genetics & Aquaculture, Universidad de Los Lagos, P.O. Box 933, Osorno, Chile; email of G. Gajardo: [ggajardo@ulagos.cl](mailto:ggajardo@ulagos.cl))

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## REVIEW OF THE AFRICAN DISTRIBUTION OF THE BRINE SHRIMP GENUS ARTEMIA

H. Kaiser, A.K. Gordon, T.G. Paulet-2006

Water SA 32(4): 597-603

Abstract:

Brine shrimp (genus *Artemia*) are small (8 to 12 mm long) cosmopolitan crustaceans (Anostraca) found predominantly in hypersaline water bodies such as inland salt lakes and pans, coastal lagoons, and salt works at salinity levels above 40 g/l. They have been extensively studied due to their high monetary value as food for larval fish in aquaculture and their unique reproductive strategies. Brine shrimp occur as either bisexual species or as parthenogenetic populations. Despite published reviews of their world-wide distribution little is known about their occurrence in Africa. This review adds new information about 70 African *Artemia* sites and lists 26 potential sites and their coordinates. Sixteen sites in Southern Africa and Namibia were visited during a collecting trip, and new information on the reproductive mode of nine of these sites is given. Several South African populations exhibit bisexual reproduction. In Namibia there are two parthenogenetic populations (Walvis Bay and Swartkops) and an additional bisexual population (Hentie's Bay). A mixed population (bisexual and parthenogenetic reproduction at the same site) was found at Coega, South Africa.

(Department of Ichthyology and Fisheries Science, Rhodes University, PO Box 94, Grahamstown 6140, South Africa; email of Horst Kaiser: [h.kaiser@ru.ac.za](mailto:h.kaiser@ru.ac.za))

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## A BIOMETRIC AND ECOLOGICAL COMPARISON BETWEEN ARTEMIA FROM MEXICO AND CHILE

Thalia B. Castro, Gonzalo Gajardo, Jorge M. Castro, German M. Castro-2006

Saline Systems 2(13)

Abstract:

### Background

A preliminary biometric and ecologic database for the brine shrimp *Artemia* from Mexico and Chile is presented. The area abounds in small and seasonal ponds and large inland lakes, the latter mainly located in Mexico, although relatively large and isolated lakes are found in complex hydrological settings in pre-high plateau areas of Chile. This paper summarizes research efforts aimed at the localization, characterization, and evaluation of the aquaculture potential of *Artemia* populations in Mexico and Chile, which exhibit great habitat diversity (ponds, salterns, coastal lagoons, sea arms, coastal and inland lakes), contrasting weather conditions and different levels of isolation and human intervention.

### Results

This study covered locations between 29° north latitude (Baja California, Mexico) to 50° south latitude (Puerto Natales, Chile). Biological characteristics considered are species name, reproductive mode, cyst diameter, chorion thickness, and nauplius length, whereas ecological data include pond size, pH, salinity, temperature, and water ionic composition. *Artemia franciscana* is the only species found in Mexico, it exists together with *A. persimilis* in Chile, though separated geographically. Ecological differences in habitat exist between both regions but also within countries, a pattern particularly clear with regard to water composition. Surprisingly, a Mexican (Cuatro Ciénegas, *A. franciscana*) and a Chilean location (Torres del Paine, *A. persimilis*) share habitat characteristics, at

least for the period when data were collected. The discriminant analysis for cyst diameter and nauplius length shows that *Artemia* from only one location match in cyst diameter with those from San Francisco Bay (SFB) (Point Lobos), and one (Marquez) is far apart from SFB and all the others. The Chilean locations (Pampilla, Cejar, Cahuil, Llamara, Yape) share cyst diameter, but tend to differ from SFB. The remaining Mexican locations (Juchitan, Ohuira, Yavaros) are well separated from all the others. With regard to nauplii length, populations tend to distribute in a relatively random manner, being Marquez the location differing the most in cyst diameter from SFB.

#### Conclusions

This database will contribute to the knowledge of radiation centers and serves as a baseline for further biogeographic studies, population characterization, management, and monitoring of *Artemia* biodiversity. Likewise, the impact of colonization and translocations for aquaculture purposes can be better assessed with a baseline for reference. Mexico and Chile exemplify the need to increase and further integrate regional information to tackle fundamental problems underlying practical utilization of *Artemia*.

(Universidad Autónoma Metropolitana-Xochimilco, Depto. El Hombre y su Ambiente, Calz. Del Hueso No. 1100. Col. Villa Quietud. México, 04960, D.F, Mexico; email of Thalia B. Castro: [cbt7515@correo.xoc.uam.mx](mailto:cbt7515@correo.xoc.uam.mx))

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