OPEN ACCESS
International Journal of Aquatic Science
ISSN: 2008-8019
Vol. 7, No. 1, 50-55, 2016

- Note-

Chirostoma estor (Jordan, 1879) a species in vulnerability, with alternatives for its preservation

Diego Alberto O. Retana, Javier S. Velasco* and Ma. De los Angeles M. Peralta

Instituto Nacional de Pesca (INAPESCA), Dirección General Adjunta de Investigación en Acuacultura. Pitágoras 1320. Col. Santa Cruz Atoyac, Del. Benito Juárez. México D.F., C.P. 03310. México

Received: 30 August 2015 **Accepted:** 09 October 2015 **Published:** 01 January 2016

The white fish is the name given for the species *Chirostoma estor*. This organism belongs to the family of Atherinospidae (Dyer and Chernoff, 1996), so it has great similarities with some marine atherinidae fishes, because of their common ancestors (Barbour, 1973; Miller *et al*., 2005). Their distribution include all the central region of Mexico (State of Michoacan). It is a native and endemic specimen of the Lake Patzcuaro with a great ecologic, cultural and commercial value. Unfortunately, in the last decades the natural population had been decreased, by different factors such as fishery, overexploitation, volume decrease and dewatering for various uses, joined to the sewage pollution, pesticide and introduction of exotic species (*Oreochromis aureus, Cyprinus carpio*, *Cyprinus rubrofuscus*, *Ctenopharyngodon idella* y *Micropterus salmoides*), in its natural habitat this organism is "vulnerable" (Chacón and Rosas, 1995; Martínez *et al*., 2002; Rojas and Sasso, 2005; Santoyo, 2006; DOF, 2015). The above is reflected in the captures of live weight that were reported for the Lake Patzcuaro in the last years: 122 tonnes for 1982, 9 tonnes for 1996, 4.1 tonnes for 1999, 1.2 tonnes for 2000, 0.32 tonnes for 2001, 0.11 tonnes for 2002 and since 2003 there are no capture reports (DOF, 2010). At the same time it has been observed that these organisms achieve less weight and length, as a consequence of the great fishery effort which has been subjected (Santoyo, 2006). It is important to notice that in the market, this fish are among the most expensive species of freshwater, reaching from $200.00 to $400.00 pesos/kilo or in other cases, it reaches 80.00 dollars (DOF, 2012; Martínez-Palacios *et al*., 2002). It is worrying and alarming the fact that being a native and endemic specie of the region, occupies the last level of abundance in relation to the rest of the species of the gender (*Chirostoma*). Therefore and because of its importance, nowadays it have been established different areas of refuge to protect the reproduction, growth and recruitment in the Lake Patzcuaro (Yunuén, Ichupio-Tzintzuntzan-Tzucurio, San Jerónimo-Santa Fe, San Andrés-Zacuapio-Oponguio y Puacuaro) (DOF, 2015).

Castro-Aguirre and Espinosa-Pérez (2006) describes the white fish with a large, slim and compact body with a gray lateral strip, its mouth has small jaw and unicuspid teeth. It has two well-separated dorsal fins, the first consisting of 5-6 very flexible spines and the second by 1 spine and 10-12 rays. In the anal fin plus, additionally to the 10-21 radios, is has also a flexible single spine. Its mouth is terminal and almost always very protrusible. The pelvic fins are in abdominal and pectoral position situated on the midline of the body. Its eyes are relatively large in relation to the head size. An interesting observation of the specie is that both the second dorsal fin and the anal radios have small branches. The Figures 1-3 shows the different schemes of the organisms, where is observed the form of the body, the fins and morphometric characteristics.

With regard to the reproduction of *C. estor* is oviparous, this specie is synchronous, because it spawn all along the year in its natural habitat and in

(✉) **javier.velasco@inapesca.gob.mx**

Fig. 1: Breeder of *Chirostoma estor* in the Regional Fisheries Research Centre - Patzcuaro, Michoacan. Mexico. Biometrics 17.5 cm (L_T) and 50.7 (g). (Photos from Velasco. S. J.)

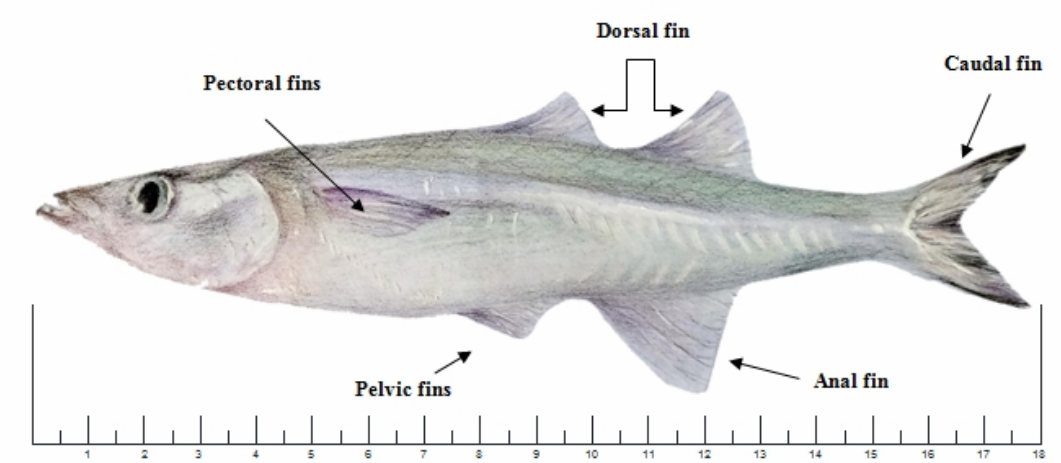

Fig. 2: Morphology squeme of a breeder of *Chirostoma estor* (white fish) where is shown the shape of the fins. (Picture from Retana. O. DA.)

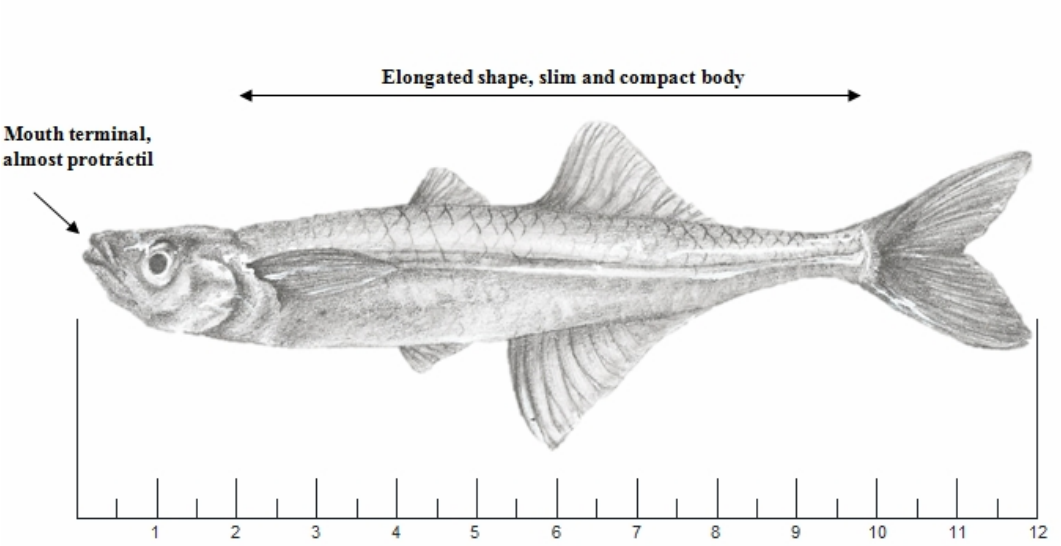

Fig. 3: Morphology squeme of white fish, where is denoted the shape of the body and mouth. Biometrics 12 cm (L_T) and 13.7 (g). (Picture from Retana. O. DA.)

captivity, however, two reproductive cycles are identified during the year, the most productive is from January to June increasing significantly in the period from March to June (Rosas, 1976; Alaye, 2006) and a second period from September to November (Alaye, 2006). The whitefish eggs are small (between 0.9 and 1.2 mm of diameter), translucent amber color, with 6-8 adherents threads and newly hatched larvae measure between 4.5 y 5 mm of total length. The fertilized eggs take from 7 to 8 days to hatch at (25°C) and the yolk sac disappeared by the third day after hatching (Campos, 2000; Martínez-Palacios *et al*., 2002). Moreover, unlike other types of eggs from other freshwater species, this specie has a limited amount of yolk, accompanied by a large globule of oil as an energy reserve which is consumed during larval development and that can be seen as a remnant until after 3-4 days last hatch (Fig. 4).

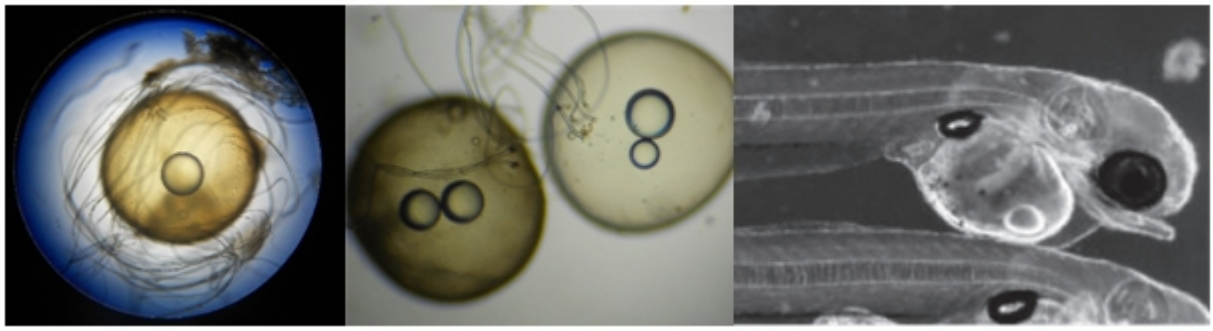

Fig. 4: Eggs and larvae of *Chirostoma estor* where the oil drop and the filaments are clearly shown. (Photos from Peralta-Martínez M.A. and Martínez-Palacios *et al*., 2006)

During the last decade different institutions like National Fishing Institution (acronym in spanish INAPESCA), National Polytechnic Institution (acronym in spanish IPN), Biology faculty and the Institute of Agricultural and Forestry Research -the last two belong to the Michoacan University of San Nicolás of Hidalgo- have achieve important advances for the crop of *C. estor*, closing the life cycle in captive. However, the researchers that have been done indicates results not favorable over the years.

Actually the works about the knowledge of the oropharyngeal structures (where it indicates that the fish is carnivorous, 1:0.7 (digestive tract: total length) ratio, but it seems that does not have a real anatomical and functional stomach as the whole digestive tract have shown a high pH along it and a very low activity of pepsine-like protease (so it is confirm that no has a true stomach)), its eating habits is of zooplankton, that occasionally feed small fishes and crustaceans when adult (Martínez-Palacios *et al*., 2006). The optimum conditions of salinity and temperature where it is properly developed is 25°C and 10 ppt for larvae and for adults reproductive 23°C and 12 ppt (Martínez-Palacios *et al*., 2002; Salgado-García *et al*., 2006; Ramírez-Sevilla, 2006). In addition, the studies that have been done about the feeding, have no successful results since the survival hardly have the 30-40%, due there is not specific balanced food for each stage of life (Estrada, 1991; Armijo y Sasso 1979; Mares *et al*., 1998; Mares *et al*., 2000; Mares *et al*., 2003). Also it has been implemented various live foods: rotifers (*Brachionus rubens* and *Brachionus plicatilis*), water flea (*Daphnia magna*), mosquito larvae (*Culex sp*) and nauplii and adult of *Artemia franciscana*, however these does not satisfy the needs of the specie (Ventura *et al*., 2006; Ventura, 2013; Navarrete *et al.,* 2006; Méndez, 2005). With regard to the reproduction, under the captive conditions it has been observed that there are reproductive problems because it reduced the seminal quality and quantity, resulting in a low fertilization, low hatching percentage and deformed fries (Mares *et al.,* 1999).

Spite of the several studies about the whitefish, it is missing a manual of good practices about its aquaculture production. Therefore, there is a need of developing investigations that contributes to new ideas to perfect the crop of whitefish, from the egg quality to the semen quality in adults. The first alternative is to generate an understanding of their

eggs and sperm quality, in the preservation of gametes (short, medium and long term) with the development of diluent to maintain the integrity of sperm and oocytes and the factors that affect the reproduction efficiency. With the knowledge about the gametes preservation and various indicators of sperm quality, will enable us to manage, manipulate, evaluate the sperm, fertilize efficiently and establish a reproductive status *C. estor*, optimizing a high percentage of fertilization in females and increase the seed production and improving fry.

The second alternative is to know the effect of biofloc systems of the specie (from larva to adult), since over the years it has been prove that these systems improve the survival, growth and immune system of aquatic organisms (Dibello-Rudolf, 2013; Emerenciano *et al*., 2012; Azim and Little, 2008).

Regarding to the nutrition, an alternative is the inclusion of a food made of biofloc meal (pellets) at the different stages of whitefish, since this replace a third part of conventional diet, because of the quality protein and other nutrients in the same food (Kuhn *et al*., 2015). Parallel it can be develop diets based on vegetable protein sources as seen with other fish species in particular have achieved satisfactory effects in sizes and survivals (Castro *et al.,* 2009).

Furthermore it can provide specific diets (i.e. HUFA-rich) in the pre-reproductive stage, since it has been observed that these diets have a positive effect on the egg quality, giving as a result a successful reproduction with low mortality (Watanabe and Vassallo-Agius 2003). Finally investigations of the growth and survival offering live food enriched with leaven (*Saccharomyces cerevisiae*) or probiotic strain isolated from the digestive tract, mucus gills and flakes of different aquatic organisms, hoping for better survivals and gains of height and weight, since the result of some authors show that the use of isolated strains of fish and amphibians –regardless they are or not from the same specie- this confer great benefits than the commercial probiotics isolated from humans or other mammals (Castro *et al.,* 2011a; Apún, 2007; Castro *et al.,* 2011b; Monroy *et al.,* 2013; Retana *et al.,* 2013).

It should be mentioned that all these alternatives are new for the crop of the whitefish, so we unknown the effect of each one. However the result that generates is a valuable contribution to the scientific community. It also can be used as a base to improve the crop in extensive, semi-intensive and intensive systems under controlled conditions. This would reduce the pressure on this resource in their natural habitat, to recover the natural populations in the Lake Patzcuaro.

Rererences

- ✓ Alaye R.N. (2006) Actualización de la información técnica para el manejo pesquero del lago de Pátzcuaro y actividades relativas a la ejecución del plan de manejo. Pátzcuaro: Instituto Nacional de la Pesca. Centro Regional de Investigación Pesquera Pátzcuaro.
- ✓ Apún M.J.P. (2007) Efecto de bacterias con potencial probiótico en el crecimiento y supervivencia de la tilapia *Oreochromis niloticus* (Linneaus 1758), cultivada en el laboratorio. Tesis de Maestría. Instituto Politécnico Nacional. Sinaloa. 58 pp.
- ✓ Armijo O.A. and Sasso L.F. (1979) Observaciones preliminares en acuarios sobre incubación y alevinaje de aterínidos (*Chirostoma sp.*) del Lago de Pátzcuaro, Michoacán. Conf. Tec. FAO sobre acuacultura. ONU. Fishing News Books. Ltd. 149-153 pp.
- ✓ Azim M.E. and Little D.C. (2008) The biofloc technology (BFT) in indoor tanks: Water quality, biofloc composition, and growth and welfare of Nile tilapia (*Oreochromis niloticus*). Aquaculture, 283: 29-35.
- ✓ Barbour C.D. (1973) The systematics and evolution of the genus *Chirostoma* Swainson (Pisces: Atherinidae). Tulane Studies in Zoology, 18 (3): 97-141.
- ✓ Campos A. (2000) Comparación del crecimiento de tres especies del género *Chirostoma* (Pisces: Atherinidae), en cultivo experimental dentro de sistemas parciales de recirculación de agua. Tesis de Maestría. Univeridad Michoacana San Nicolas de Hidalgo. Morelia, Michoacán. 70 pp.
- ✓ Castro J., Castro G., Alcántara N.F., Pacheco V. and Estrada E. (2011b) Comparación del incremento en peso de *Cambarellus montezumae* (de Saussure, 1857), alimentado con una dieta enriquecida con probiótico. Revista Digital E-bios, 1 (1): 20-26.
- ✓ Castro M.J., Espindola R.Y., Castro M.G. and Cremiux G. JC. (2009) Efecto de dos dietas proteicas en el crecimiento y sobrevivencia de prejuveniles de *Atractosteus tropicus* Gill, 1863 (Pejelagarto). Universidad Nacional Autónoma de México. Facultad de Estudios Superiores Iztacala. BIOCYT, 2 (8): 77-88.
- ✓ Castro T., Monroy M.C., Castro J., De Lara R. and Castro G. (2011a) Efecto de cuatro probióticos en el crecimiento y la sobrevivencia de *Carassius auratus*. Ciencia Pesquera, 19 (1): 21-28.
- ✓ Castro-Aguirre J.L. and Espinosa-Pérez H. (2006) Los peces de la familia Atherinopsidae (Teleostei:

Atheriniformes) de las lagunas costeras neutras e hipersalinas de México. Hidrobiológica, 16 (1): 89-101.
- ✓ Chacón T.A. and Rosas M. (1995) A restoration plan for pez blanco in lake Pátzcuaro, México. American Fisheries Society Symposium, 15: 122-126.
- ✓ Dibello-Rudolf J.C. (2013) Crecimiento y sobrevivencia de carpa común (*Cyprinus carpio*) y carassius (*Carassius auratus*) (osteichthys, cyprinidae) en un sistema súper intensivo con aplicación de biofloc, comparando con sistema de filtro biológico y sistema tradicional con aireación. Tesis de Doctorado. Universidad de la Republica, Facultad de Veterinaria. Montevideo Uruguay. 45 pp.
- ✓ DOF. (2010) Carta Nacional Pesquera. Ficha: Lago de Pátzcuaro, Michoacán. En: Diario Oficial de la Federación. 2 de diciembre de 2010. México. Tercera sección. 17 pp.
- ✓ DOF. (2012) Carta Nacional Acuícola. Ficha: Pescado blanco. En: Diario Oficial de la Federación. México. 6 de junio de 2012. México. Segunda sección. 91-94 pp.
- ✓ DOF. (2015) Norma Oficial Mexicana NOM-036-SAG-PESC-2015, Pesca responsable en el Lago de Pátzcuaro ubicado en el Estado de Michoacán. Especificaciones para el aprovechamiento de los recursos pesqueros. México. 11 de junio de 2015.
- ✓ Dyer B.S. and Chernoff B. (1996) Phylogenetic relationships among atheriniform fishes (Teleostei: Atherinomorpha). Journal of the Linnean Society, 117: 1-69.
- ✓ Emerenciano M., Cuzon G., Goguenhemi J., Gaxiola G. and AQUACOP. (2012) Floc contribution on spawning performance of blue shrimp *Litopenaeus stylirostris*. Aquaculture, 44 (1): 75-85.
- ✓ Estrada R.M.C. (1991) Verificación a nivel experimental de la existencia de hibridos entre las especies de *Chirostoma estor estor* y *Chirostoma grandocule* (Pisces: Atherinidae) del Lago de Pátzcuaro, Michoacán, México. Tesis de Licenciatura, Facultad de Biología, Universidad Michoacana de San Nicolás de Hidalgo. 113 pp.
- ✓ García de León F.J. (1984) Ecología pesquera, alimentación y ciclo gonádico de *Chirostoma estor* Jordan y *Micropterus salmoides* Lacépede, en el lago de Pátzcuaro, Michoacán, México. Tesis de licenciatura. Universidad Autónoma de Nuevo León, Monterrey. Facultad de Ciencias Biológicas. Monterrey. 172 pp.
- ✓ Kuhn D., Lawrence A. and Avnimelech Y. (2015) Ex-Situ Biofloc Technology. In: Avnimelech Y (ed.) Biofloc technology: a practical guidebook. Third Edition. The World aquaculture society, Baton Rouge. 258 pp.
- ✓ Mares B.L.G., Morales J.J., Hernández N.Z., Sabanero S.M. and León G.M. (1999) Comportamiento de reproductores de pez blanco en condiciones de cautiverio. Memorias de la IV Reunión Nacional de Redes de Investigación en Acuacultura. 129-134 pp.
- ✓ Mares B.L.G., Morales J.J., León F. and Hernández N. (1998) Desarrollo y crecimiento de larvas de pescado blanco *Chirostoma estor,* Jordán 1879. Informe Técnico, diciembre 1998. Instituto Nacional de Pesca. 15 pp.
- ✓ Mares B.L.G., Pedroza R., Morales J.J., Sabanero S., De Jesús S., León G. and Villagómez D.L. (2003) Evaluación de dos tipos de presentación de alimentos en crías de pescado blanco, *Chirostoma estor*, en laboratorio. Informe final de investigación. Instituto Nacional de Pesca. 42 pp.
- ✓ Mares B.L.G., Rojas M., Morales J.J., Hernández N. and Sabanero S. (2000) Efecto de tres fuentes proteicas en la sobrevivencia de larvas de Pescado Blanco *Chirostoma estor* Jordán (Pisces: Atherinidae). Informe final del proyecto "Desarrollo y crecimiento de larvas de pescado blanco *Chirostoma estor* Jordán". Proyecto CONACyT-INP, No. Ref.: 1185P-B9507. 20 pp.
- ✓ Martínez-Palacios C., Ríos-Durán M., Campos-Mendoza A., Toledo-Cuevas M. and Ross G. (2002). Avances en el cultivo del pescado blanco de Pátzcuaro Chirostoma estor estor. In: Cruz-Suárez, L. E., Ricque-Marine, D., Tapia-Salazar, M., Gaxiola-Cortés, M. and Simoes, N. (eds) Avances en Nutrición Acuícola VI. Memorias del VI Simposium International de Nutrición Acuícola. 3 al 6 de septiembre del 2002. Cancún, Quintana Roo, México.
- ✓ Martínez-Palacios C.A., Racotta I.S., Ríos-Durán M.G., Palacios E., Toledo-Cuevas M. and Ross L.G. (2006) Advances in applied research for the culture of Mexican silverdides (*Chirostoma*, Atherinopsidae). Biocell, 30 (1): 137-148.
- ✓ Méndez C.Z.T. (2005) Efecto del enriquecimiento del rotífero *Brachionus plicatilis* (Müller 1786) en el crecimiento y supervivencia de larvas del pez blanco *Chirostoma estor estor* (Jordán 1879), del lago de Pátzcuaro. Tesis de Licenciatura. Universidad Michoacana de San Nicolás de Hidalgo. Michoacán. 57 pp.
- ✓ Miller R.R., Minckley W.L. and Norris S.M. (2005) Freshwater fishes of México. The University of Chicago Press. 490 pp.
- ✓ Monroy M.D.C., Orozco D., Castro J., Ramírez J.A., De Lara R. and Castro G. (2013) Sobrevivencia y crecimiento de *Ambystoma mexicanum* alimentado con las cepas probióticas *Bacillus subtilis, Lactococcus lactis* y *Lactobacillus sp.* XII International Symposium on Aquaculture Nutrition. México.
- ✓ Navarrete P., Martínez C.A., Racotta I.S. and Palacios E. (2006) Determinación del punto de no retorno y efecto del enriquecimiento del rotífero *Brachionus plicatilis* en el crecimiento y supervivencia en larvas del pescado blanco de Pátzcuaro (*Chirostoma estor*). I Conferencia Latinoamericana sobre cultivo de peces nativos; III Conferencia Mexicana sobre el cultivo de peces nativos. Morelia, Michoacán, México. 18 al 20 de octubre de 2006.
- ✓ Ramírez-Sevilla R. (2006) Biología reproductiva y ontogenia de *Chirostoma humboldtianum* (Valenciennes, 1835) (Pisces: Atherinopsidae) en condiciones de laboratorio. Doctorado en Ecología, Secretaría de

Investigación y Posgrado, Escuela Nacional de Ciencias Biológicas, Instituto Politécnico Nacional. 155 pp.

- ✓ Retana D.A., Velasco J., Castro J. and Castro G. (2013) Effect on length and weight growth of *Pangasius hypophthalmus* (Sauvage 1878) fed with two probiotics. Revista Digital E-bios Vol. 1 (3): 1-5.
- ✓ Rojas C.P.M. and Sasso Y. L.F. (2005). El pescado Blanco. Instituto Nacional de la Pesca. Revista Digital Universitaria de la UNAM. 10 de agosto del 2005. México. Volumen 6 Número 8. ISSN: 1067-6079.
- ✓ Rosas M. M. (1976) Datos biológicos de la ictiofauna de lago de Pátzcuaro con especial énfasis en la alimentación de sus especies. Memorias del Simposio de pesquerías en aguas continentales. 3 al 5 de noviembre de 1976. Tuxtla Gutiérrez, Chiapas. Instituto Nacional de Pesca. Tomo II. 299-366 pp.
- ✓ Salgado-García R.L., Martínez-Palacios C.A., Racotta-Dimitrov I.S., Campos-Mendoza A. and Ross L.G. (2006) El efecto de la salinidad en huevos, larvas y juveniles de pez blanco *Chirostoma promelas*. I Latin American Conference on Aquaculture of Native Fishes. Morelia, 2006. & II Congreso Estatal de Ciencia y Tecnología. Zamora Michoacán, México.
- ✓ Santoyo Guzmán V. (2006) Crecimiento y reproducción del pez blanco *Chirostoma estor estor*, Jordan 1879 (Pisces: Atherinopsidae) en un sistema cerrado de recirculación de agua. Tesis de licenciatura, Facultad de Biología, Universidad Michoacana de San Nicolás de Hidalgo, Michoacán, México.
- ✓ Ventura M.J. (2013) Efecto de la alimentación con microdietas comerciales y alimento vivo en la supervivencia de las larvas del pescado blanco (*Chirostoma estor*). Memoria IV reunión nacional de innovación acuícola y pesquera. Veracruz, México. 10 al 13 de septiembre de 2013.
- ✓ Ventura M.J., Nandini S. and Sarma S.S.S. (2006) Selectividad en las larvas del pescado blanco (*Chirostoma estor*), alimentadas con los rotíferos *Anuraeopsis fissa*, *Brachionus rubens* y el cladócero *Moina macrocopa*. I Conferencia Latinoamericana sobre cultivo de peces nativos; III Conferencia Mexicana sobre el cultivo de peces nativos. Morelia, Michoacán, México. 18 al 20 de octubre de 2006.
- ✓ Watanabe T. and Vassallo-Agius R. (2003) Broodstock nutrition research on marine finfish in Japan. Aquaculture 227: 35-61.