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LIST OF THE ICHTHYOFAUNA IN THE SONTECOMAPAN LAGOON, VERACRUZ, MEXICO

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ABSTRACT

The aim of this study was to determine the ictic biodiversity in the lagoon Sontecomapan, Veracruz, Mexico and its space-temporal changes. Seventeen sampling points were selected using a stratified sampling for the dry and rainy seasons of 2005 and the dry season of 2006. Fishes in larval, juvenile and adult stage were obtained for each season. For the capture of larvae and juvenile, a dragging was carried out over the submerged vegetation using a Renfro net of 700 μ; the adult fish were obtained using a rowing-boat about 30 m long and 2 m high, with a mesh light of ¼ inch. Generally, the lagoon presented a mean depth of 166.57 cm, with a maximum of 650 cm and a minimum of 60 cm. Are present the physicochemical parameters for the dry season of 2005, the rainy season of 2005 and the dry season of 2006. It can be concluded that in the Sontecomapan lagoon live 52 species belonging to 24 families and 41 genus. The list of the ichthyofauna in the Sontecomapan Lagoon, Veracruz, Mexico is shown.

Key words: family, genus, ichthyofauna, list, Nortes, Sontecomapan, species.

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RESUMEN

El objetivo de éste estudio fue determinar la biodiversidad íctica de la laguna de Sontecomapan, Veracruz, México y los cambios espacio-temporales. Se seleccionaron diecisiete puntos de colecta empleando un muestreo estratificado para las estaciones seca y lluviosa de 2005 y la estación seca de 2006. Se obtuvieron peces en estadios larval, juvenil y adulto por cada estación. Para la colecta de larvas y juveniles se realizó un arrastre sobre la vegetación sumergida utilizando una red de tipo Renfro de 700 μ; los peces adultos fueron obtenidos empleando un chinchorro de 30 m de largo y 2 m de altura, con una luz de malla de ¼ de pulgada. De manera general, la laguna se caracterizó por presentar una profundidad promedio de 166.57 cm, con un máximo de 650 cm y un mínimo de 60 cm. Se presentan los parámetros fisicoquímicos para la temporada de secas 2005, temporada de lluvias 2005 y temporada de secas 2006. Se puede concluir que en la laguna de Sontecomapan, habitan 52 especies pertenecientes a 24 familias y 41 géneros. Se muestra el listado ictiofaunístico de la laguna de Sontecomapan, Veracruz, México.

Palabras clave: family, genus, ichthyofauna, list, Nortes, Sontecomapan, species.

INTRODUCTION

Among the geographic features that protrude from the national territory, we can emphasize its extensive coasts with nearly 11600 km and the varied and rich coastal ecosystems: bays, inlets, coastal lagoons and estuaries (Contreras *et al*., 2002).

The coastal lagoons are characterized by a complex ecological structure, due to their wide variety of habitats, high biodiversity and important primary productivity (Day *et al*., 1989). This productivity is due to the subsidies they receive through fluvial discharges and tidal movements, and also of the areas of surrounding coastal vegetation (swamps, swamp grasses) and submerged vegetation (marine grasses and macroalgae) that determine the magnitude of the secondary production This production in the fish community is of great importance in coastal ecosystems, since the species behave as energy regulators, due to their displacement capacity inside the ecosystem, and between ecosystems, which determines complexes biological interactions between the fish and the physical-environmental surroundings (Yáñez-Arancibia *et al*., 1993). These interactions reflect utilization patterns of the system through their life cycles, which modifies the diversity, distribution, abundance and frequency of the populations in a spatial and temporal way (Yáñez-Arancibia *et al*., 1993).

Coastal lagoons are migration routes for fish and also dwelling places both to marine and freshwater species, as well as suitable places for reproduction and feeding of other species such as crustaceans and mollusks (Sevilla and Guadarrama, 1977; Hammann and Rosales-Casián, 1990; Rosales-Casián, 1997 a).

The resident or visitor fish show tolerance to salinity changes and other parameters (Lagler *et al*., 1977). Apparently, the main effects of this salinity are to control the fish

distribution and to stimulate the attraction of larvae, post larvae, and juvenile to the estuaries (Corral *et al*., 2002).

In coastal lagoons, there is a substantial energy flow, and that is why these water bodies are ecologically important; they are places of hatchery, reproduction and shelter for many aquatic organisms species of commercial value (Contreras *et al*., 2002). The lagoon system of Sontecomapan, Veracruz, Mexico, despite being one of the smallest in the State regarding its area, houses a large number of registered fish species, with the second position after Tamiahua, Veracruz, Mexico (Kobelkowsky, 1993).

Despite this, a great ignorance exists about the resources provided by these ecosystems; therefore, they have been exploited in an irrational way. That is why it is important to understand the basic mechanisms that regulate these ecosystems and the reason to present a listing of the Ichthyofauna of the Sontecomapan lagoon in Veracruz, Mexico, in this work.

MATERIAL AND METHODS

Study area

The study was conducted in Sontecomapan Lagoon, Veracruz, México, that is part of the “Oyster Lagoon in the Tuxtlas Mountain Chain" (CONABIO, 1998), a high-priority region for the environmental preservation in Mexico. It is located in the San Martín Tuxtla region and Santa Marta Mountain Chain, in the southeast of the State of Veracruz, at a distance of 6 Km of the municipality of Catemaco in northwest direction, among parallels 18° 30´ and 18° 34´ of north latitude and meridians 95° 00´ and 95° 04´ of west longitude (Fig. 1). It has approximately 12 km long and 1.5 km wide and a surface of 89 hectares, its only connection with the sea is established through a deep channel of approximately 5.5 m which is denominated bar of Sontecomapan. The rest of the lagoon is shallow with a muddy bottom that turns sandy in the estuary channel. The mouth is located in the northwest part, in which edge there is a basaltic spill so-called Morro rock; toward the northwest, we can observe a sediment deposit and a valley that facilitates the accumulation of organic matter (Contreras, 1993).

The hydrology is influenced by several rivers and streams, mainly in the southern area. The system is surrounded mostly by *Rhizophora mangle* Linnaeus, 1753 and *Avicennia nitida* Linnaeus, 1958 (Stearn) and the aquatic vegetation is represented by *Ruppia maritima* Linnaeus, 1753 (Contreras, 1993).

The climate is hot and humid, with an annual rainfall of over 4500 mm. Even when it rains the whole year, there is a “rainy” season that lasts from June through February, and a "dry" season that extends from March to May. The driest month is May and the rainiest period is from August to November. There are variations in the total annual precipitation (EBTuxtlas, 2006).

From September to February the area is affected by the displacement of cold and humid air masses coming from the north. The resultant humid winds of this phenomenon are locally known as "Nortes". These winds contribute with near 15% of the yearly precipitation mean and move at a rate speed of up to 100 Km per hour, producing gradual environmental temperature decreases, reaching 10° C during some winter days (EBTuxtlas, 2006).

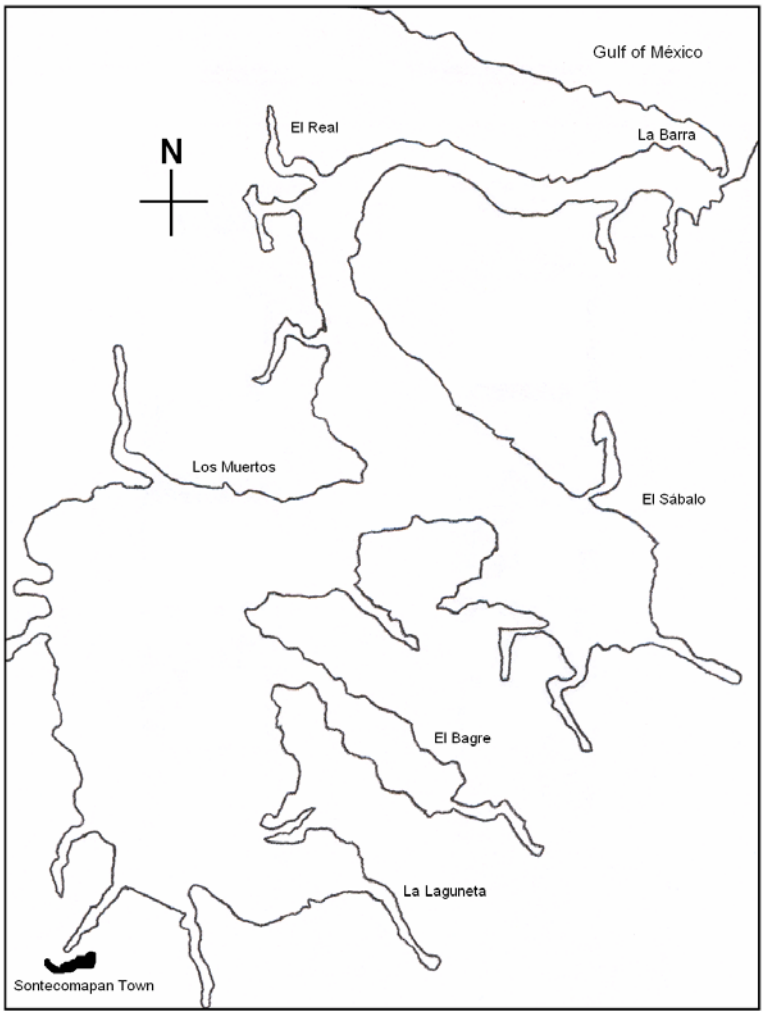

Figure 1. Sontecomapan Lagoon, Veracruz, México

Seventeen sampling points were selected using a stratified sampling for the dry and rainy seasons of 2005 and the dry season of 2006 in the Sontecomapan Lagoon, Veracruz, Mexico (Fig. 2). Each sampling point was georeferenced using a Magellan Map 410 GPS.

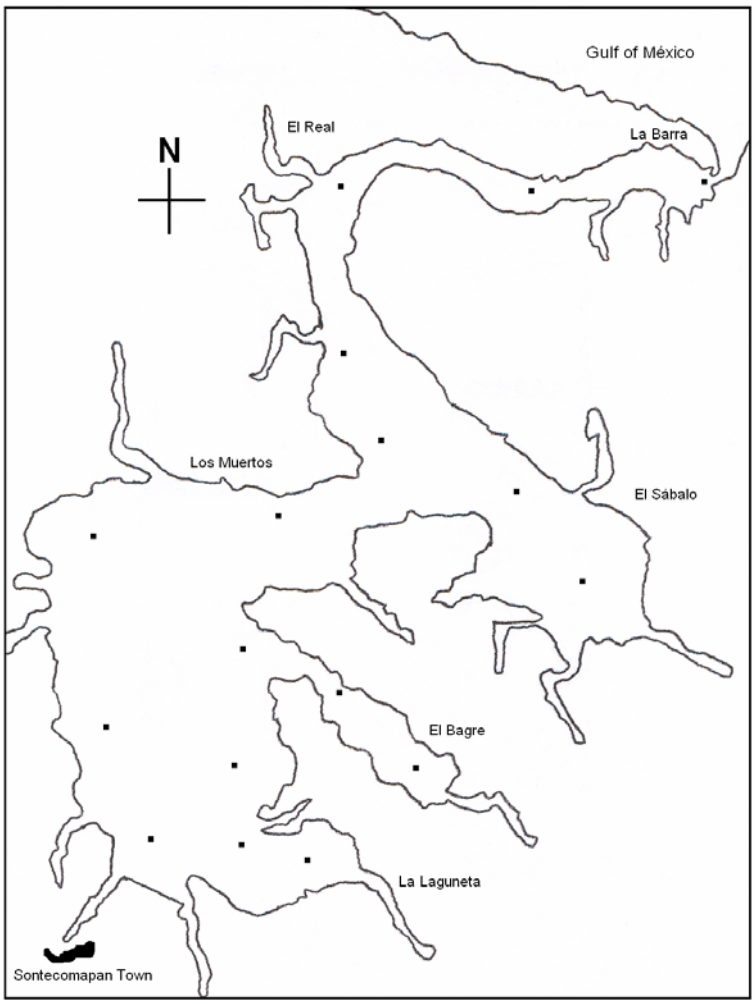

Figure 2. Map of sampling points in Sontecomapan Lagoon, México

Fishes in larval, juvenile and adult stage were obtained for each season. For the capture of larvae and juvenile, a dragging was carried out over the submerged vegetation using a Renfro net of 700 μ; the adult fish were obtained using a rowing-boat about 30 m long and 2 m high, with a mesh light of ¼ inch. The obtained material was fixed in 10% formol and placed in previously labeled polyethylene bags. The material was transported to the Laboratorio de Ecología de Peces of Facultad de Estudios Superiores Iztacala, Universidad Nacional Autónoma de México, México. The dragging areas of each sampling point were recorded (in m^2). In each sampling point the depth was registered, using a portable Dephmate SM-5 echo probe, dissolved oxygen with an Oakton DO 300 oximeter, and salinity and temperature were measured with a YSI 30 salinometer-conductimeter.

In the laboratory, the organisms were washed with current water, measured (with a 1/20 mm Vernier calliper Meter-Mex scale) and weighed (using an Acculab VI-1 mg scale

with a capacity of 120 g and a precision of 0.001 g). Later on, the fish were identified to species using the keys of Alvarez del Villar (1970), Lippson and Moran (1974), Hardy Jr. (1978), Johnson (1978), Jones *et al*. (1978), Douglas and Drewry (1978), Fritzsche (1978), Fahay (1983) Moser *et al*. (1984), Castro-Aguirre *et al*. (1999) and Miller *et al*. (2005).

Finally, the phylogenetic listing of the fish was elaborated according to Nelson's criteria (1994), (for Family) and Espinosa *et al.* (1993), *Castro-Aguirre et al. (1999*) and Miller *et al*. (2005) (for Genus and Species).

RESULTS

During the dry season of 2005, there was a depth mean of 149 cm with a maximum of 440 cm and a minimum of 60 cm. In the rainy season of 2005 there was a depth mean of 147.11 cm with a maximum of 380 cm and a minimum of 80 cm. In the dry season of 2006 there was a depth mean of 203.60 cm with a maximum of 650 cm and a minimum of 83 cm. In general, the lagoon presented a depth mean of 166.57 cm, with a maximum of 650 cm and a minimum of 60 cm. During the dry season of 2005, there was a mean temperature of 29.79° C with a maximum of 29° C and a minimum of 24° C. During the rainy season of 2005 there was a mean temperature of 29.72° C with a maximum of 31° C and a minimum of 28.10° C. During the dry season of 2005, there was a mean salinity of 8.80‰ with a maximum of 35‰ and a minimum of 2.40‰. In the rainy season of 2005 there was a mean salinity of 4.40‰ with a maximum of 19.6‰ and a minimum of 1.70‰. During the dry season of 2006 there was a mean salinity of 14.18‰ with a maximum of 28‰ and a minimum of 4.0‰.

In the dry season of 2005, there was a mean concentration of dissolved oxygen of 9.70 mg/l with a maximum of 11.21 mg/l and a minimum of 7.62 mg/l. In the rainy season of 2005 there was a mean concentration of dissolved oxygen of 7.93 mg/l with a maximum of 9.73 mg/l and a minimum of 4.70 mg/l. During the dry season of 2006 there was an oxygen mean concentration of 10.41 mg/l with a maximum of 12.11 mg/l and a minimum of 8.33 mg/l.

During the dry season of 2005, the collection consisted of 29 eurohaline species: *Diapterus auratus*, *Strongylura notata and Centropomus parallelus*; four permanent species of the lagoon-estuary pool: *Dormitator maculatus, Eleotris pisonis, Gobiomorus dormitor* and *Evorthodus lyricus* and four freshwater species: *Cichlasoma urophthalmus, Belonesox belizanus, Poecilia mexicana* and *Poecilia Sphenops*.

In the rainy season of 2005, the collection consisted of 17 eurohaline species: *Syngnathus scovelli, Lutjanus griseus* and *Centropomus undecimalis*, four permanent species of the lagoon-estuary pool: *Dormitator maculatus, Eleotris pisonis, Gobiomorus dormitor* and *Evorthodus lyricus*, two freshwater species: *Cichlasoma urophthalmus* and *Poecilia Sphenops* and one marine stenohaline species: *Sphyraena guachancho*.

In the dry season of 2006, the collection consisted of 26 eurohaline species: *Ulaema lefroyi, Pomadasys croco* and *Anchoa mitchilli*, four permanent species of the lagoon-estuary

pool: *Dormitator maculatus, Eleotris pisonis, Gobiomorus dormitory* and *Evorthodus lyricus*, two freshwater species: *Cichlasoma urophthalmus* and *Poecilia Sphenops* and two marine stenohaline species: *Sphyraena barracuda* and *Conodon nobilis*.

List of the Ichthyofauna

A total of 24 families, 41 genus and 52 species were determined.

Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
División: Teleostei
Subdivisión: Elopomorpha
Order: Elopiformes
Family: Elopidae
Genus: ***Elops***
Species: ***Elops saurus*** (Linnaeus, 1766)

Subdivisión: Clupeomorpha
Order: Clupeiformes
Family: Engraulidae
Genus: ***Anchoa***
Species: ***Anchoa hepsetus*** (Linnaeus, 1758)
Anchoa mitchilli (Valenciennes, 1848)

Subdivisión: Euteleostei
Order: Siluriformes
Family: Ariidae
Genus: ***Ariopsis***
Species: ***Ariopsis felis*** (Linnaeus, 1766)
Genus: ***Cathorops***
Species: ***Cathorops melanopus*** (Günther, 1864)

Order: Batrachoidiformes
Family: Batrachodidae
Genus: ***Opsanus***
Species: ***Opsanus beta*** (Goode y Bean, 1882)

Order: Mugiliformes
Family: Mugilidae
Genus: ***Mugil***
Species: ***Mugil curema*** (Valenciennes, 1876)

Order: Atheriniformes
Family: Atherinopsidae
Genus: ***Membras***
Species: ***Membras vagrans*** (Goode y Bean, 1950)
Membras martinica (Valenciennes, 1956)
Genus: ***Menidia***
Species: ***Menidia beryllina*** (Cope, 1867)

Order: Beloniformes
Family: Belonidae
Genus: ***Strongylura***
Species: ***Strongylura marina*** (Walbaum, 1792)
Strongylura notata (Poey, 1860)

Order: Cyprinodontiformes
Family: Poeciliidae
Genus: ***Poecilia***
Species: ***Poecilia sphenops*** (Valenciennes, 1846)
Poecilia mexicana (Steindachner, 1863)
Genus: *Belonesox*
Species: ***Belonesox belizanus*** (Kner, 1860)

Order: Gasterosteiforme
Family: Syngnathidae
Genus: ***Syngnathus***
Species: ***Syngnathus scovelli*** (Everman y Kendall, 1895)
Genus: ***Microphis***
Species: ***Microphis brachyurus lineatus*** (Kaup, 1856)

Order: Perciformes
Family: Carangidae
Genus: ***Caranx***
Species: ***Caranx latus*** (Agassiz, 1929)
Genus: ***Oligoplites***
Species: ***Oloigoplites saurus*** (Blonch y Schneider, 1801)
Genus: ***Chloroscombrus***
Species: ***Chloroscombrus chysurus*** (Linnaeus, 1766)
Genus: ***Selene***
Species: ***Selene setapinnis*** (Mitchill, 1815)

Family: Centropomidae
Genus: ***Centropomus***
Species: ***Centropomus undecimalis*** (Bloch, 1792)
Centropomus pectinatus (Poey, 1860)
Centropumus parallelus (Poey, 1860)

Family: Gerridae
Genus: ***Ulaema***
Species: ***Ulaema lefroyi*** (Goode, 1874)
Genus: ***Diapterus***
Species: ***Diapterus rombeus*** (Cuvier, 1829)
Diapterus auratus (Ranzani, 1840)
Genus: ***Eucinostomus***
Species: ***Eucinostomus melanopterus*** (Bleeker, 1863)
Genus: ***Eugerres***
Species: ***Eugerres plumieri*** (Cuvier, 1830)

Family: Haemulidae
Genus: ***Conodon***
Species: ***Conodon nobilis*** (Linnaeus, 1758)
Genus: ***Pomadasys***
Species: ***Pomadasys croco*** (Cuvier, 1830)

Family: Sparidae
Genus: ***Archosargus***
Species: ***Archosargus probatocephalus*** (Walbaum, 1792)
Genus: ***Lagodon***
Species: ***Lagodon romboides*** (Linnaeus, 1766)

Family: Scianidae
Genus: ***Bairdiella***
Species: ***Bairdiella chrysoura*** (Lacepède, 1802)
Bairdiella ronchus (Cuvier, 1830)

Family: Eleotridae
Genus: ***Gobiomorus***
Species: ***Gobiomorus dormitor*** (Lacepède, 1800)
Genus: ***Dormitator***
Species: ***Dormitator maculatus*** (Bloch, 1790)
Genus: ***Eleotris***
Species: ***Eleotris pisonis*** (Gmelin, 1788)

Family: Gobiidae
Genus: ***Bathygobius***
Species: ***Bathygobius soporator*** (Valenciennes, 1837)
Genus: ***Evorthodus***
Species: ***Evorthodus lyricus*** (Girard, 1858)
Genus: ***Gobionellus***
Species: ***Gobionellus hastatus*** (Girard, 1859)
Gobionellus boleosoma (Jordan y Gilbert, 1882)

Genus: ***Gobioides***
Species: ***Gobioides broussonneti*** (Lacepède, 1800)

Family: Lutjanidae
Genus: ***Lutjanus***
Species: ***Lutjanus griseus*** (Linnaeus, 1758)
Lutjanus jocu (Blonch y Schneider, 1801)

Family: Serranidae
Genus: ***Epinephelus***
Species: ***Epinephelus adscensionis*** (Osbeck, 1765)

Family: Sphyraenidae
Genus: ***Sphyraena***
Species: ***Sphyraena barracuda*** (Walbaum, 1792)
Sphyraena guachancho (Valenciennes, 1829)

Family: Cichlidae
Genus: ***Cichlasoma***
Species: ***Cichlasoma urophthalmus*** (Günther, 1862)

Order: Pleuronectiformes
Family: Paralichthyidae
Genus: ***Citharichthys***
Species: ***Citharichthys spilopterus*** (Günther, 1862)

Family: Achiridae
Genus: ***Achirus***
Species: ***Achirus lineatus*** (Linnaueus, 1758)

Order: Tetrodontoformes
Family: Tetraodontidae
Genus: ***Sphoeroides***
Species: ***Sphoeroides testudineus*** (Linnaeus, 1758)

DISCUSSION

During the dry season of 2006, the largest depth was registered with a mean of 203.60 cm, followed by the dry season of 2005, with a mean of 149 cm and, finally, the rainy season of 2005, with a mean of 147.11 cm. These depth variations could be originated by the tides which are related to the sea level rise (Sevilla and Guadarrama, 1977). In the three seasons, the greatest depth was registered in the channel and its communication mouth with the sea, gradually decreasing towards the lagoon body. This was also reported by Castellanos (2002) and Zamora (2002) in the same lagoon.

The highest temperature was registered in the rainy season of 2005, with a mean of 29.72º C, followed by the dry season. This occurred due to the amount of clouds and solar radiation. Cabral (2007), observed in the same lagoon that during the dry season of 2005 there was a mean number of clouds, mostly of the altostratus type and during the dry season of 2006, there was a large amount of clouds, mostly of the cumulus type, which reflect sun light, causing that a smaller amount of light penetrating the water column, contrary to what was observed in the rainy season of 2005, in which there were no clouds.

The highest salinity was registered during the dry seasons of 2005 and 2006, with a mean of 8.80 and 14.18 ‰, respectively; in the rainy season of 2005, a mean of 4.30 ‰ was registered. During the rainy season, the freshwater influence increases significantly, providing habitats predominantly oligohaline. The continuance of these characteristics is based on the quantity of freshwater inputs and the intensity of local rainfalls. The rainfall decrease is directly related to river inputs, leading to the gradual increase in marine influence through the tides (Contreras, 2001). The difference between both dry seasons was maybe because in the dry season of 2006 an event of Norte occurred; this triggered the entrance of great quantities of sea water, producing the saline increase in the lagoon body. The salinity in the superficial waters of the lagoons varies in a complex way determined not only by the direct action of the climatic season, but by the entrance pattern of sea water related with the different tide heights and also by the entrance pattern of fresh water and the incidence of strong winds (Elliott and Hemingway, 2002). The major salinities were registered in the channel and its communication mouth with the sea, gradually decreasing towards the lagoon body; this behavior has been described in other lagoon bodies (Martínez, 1987; Morán, 1994; Castellanos, 2002; Zamora, 2002; Vázquez-López *et al*., 2006).

The highest concentration of dissolved oxygen was registered in the dry season of 2006, with a mean of 10.41 mg/l, followed by the dry season of 2005, with a mean of 9.70 mg/l and, finally, the rainy season of 2005, with a mean of 7.93 mg/l, this was due maybe to the temperature, given that in the dry season of 2006, the temperature was lower; the event of the Norte could have increased the dissolved oxygen concentration generated by the swell. On the other hand, the differences in dissolved oxygen may also be affected by the photosynthetic activity of phytoplankton in the water column and in submerged vegetation, mainly sea grasses, which contribute significantly to the increase of dissolved oxygen concentration in the water column (Contreras, 2001).

In the three climatic seasons prevailed the eurohaline species of the marine component and they were able to endure abrupt salinity changes, manifesting a series of protection, endurance, osmoregulation and acclimatization mechanisms that allowed them to compete better for the resources (Castro-Aguirre, 1999). The presence of these species is due to the fact that the lagoon's salinity was mesohaline; this indicates that these organisms move toward the interior of the lagoon without any problems. The use of the estuary-lagoon environment by the marine or freshwater organisms is not casual; many species have selected this type of systems through the evolutionary behavior, so they have developed morphologic

and physiologic adaptations that optimize the use of this type of systems regarding, first of all, its high primary productivity (Sevilla and Guadarrama, 1977).

The fish that inhabit this environment at a given time can reproduce in the internal portion of the lagoon, the mouth, the platform, the reef zone or the continental slope. The larvae are attracted to continental waters; that is why they migrate towards the coast and penetrate these kinds of systems. Some of them stay in the lagoon body, where they feed, grow and reach the pre-adult stage, returning at this point to the marine environment; others penetrate more into continental waters, such as the mullets (*M. curema*) and basses (*C. undecimalis*, *C. parallelus* and *C. pectinatus*) where they grow, fatten and, in the pre-adult stage, return to the sea where they complete their cycle and reproduce (Sevilla and Guadarrama, 1977). Zamora (2002) observed that 75.76 % of the species collected in the Sontecomapan Lagoon, Veracruz, were eurohaline of the marine component. The presence or absence of certain species is due mainly to their feeding habits, their breeding season and the different types of habitats that exist in the lagoons (De la Lanza and Cáceres, 1994). Because of this, during the dry season of 2005 no estenohaline species of the marine component were collected.

It can be concluded that: A) in the Sontecomapan Lagoon, Veracruz, live 52 species belonging to 24 families and 41 genus, B) the lagoon is shallow, warm, mesohaline and well oxygenated, C) during the three seasons of the study, the predominant species were eurohaline of the marine component and D) in the Sontecomapan Lagoon in Veracruz live a wide variety of species, mainly of marine origin, whose frequency and abundance is related to the environmental variation of each climatic season, particularly the temperature and salinity that have a direct influence, though we must also consider the depth and extent of the mouth, since these allow the penetration of more species into the lagoon.

In dry season of 2005 was not present an event of “Norths”, as presented in dry season of 2006, which led to changes is the composition and distribution of ictic fauna; this differs from other similar studies. The catch of *S.guachancho* in 3.80 ‰, S. *barracuda* in 17 ‰ and *C. nobilis* in 17.04 ‰, is a first record, since these species usually are collected in environments above 30 and 40 ‰, or so their presence in this lagoon is occasional or incidental.

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REREFENCES

Alvarez del Villar, J. 1970. Peces mexicanos (claves). Instituto Nacional de Investigaciones Biológico Pesqueras Comisión Nacional Consultiva de Pesca. México. 166 p.

Cabral, T. R. A. 2007. Hidrología del sistema lagunar de Sontecomapan, Veracruz durante la temporada de secas y lluvias 2005 y secas 2006. Tesis de Licenciatura (Biología), Facultad de Estudios Superiores Iztacala, UNAM Tlalnepantla, Estado de México. 97 p.

Yáñez-Arancibia, A., A. L. Lara-Domínguez y Jr. J. W. Day. 1993. Interactions between mangrove and sea-grass habitats mediated by estuarine nekton assemblages: coupling of primary and secondary production. Hydrobiology. 264: 1-12. DOI10.1007/BF00014659. http://www.springerlink.com/content/7m0v4x4r42727136/fulltext.pdf

Castellanos, B. A. 2002. Caracterización hidrológica de la laguna de Sontecomapan, Veracruz. Tesis de Licenciatura (Biología), Facultad de Estudios Superiores Iztacala, UNAM, Tlalnepantla, Estado de México. 115 p.

Castro-Aguirre, J. L., P. H. Espinosa and J. Schmitter-Soto. 1999. Ictiofauna estuarino-lagunar y vicaria de México. Limusa. México. 711 p. ISBN 968-18-5774-7.

CONABIO, 1998. Comisión nacional para el conocimiento y uso de la biodiversidad. www.conabio.gob.mx

Contreras, E. F. 1993. Ecosistemas costeros mexicanos. Universidad Autónoma Metropolitana Unida Iztapalapa. México, pp. 167-168. ISBN 970-620-371-0

Contreras, E. F. 2001. Caracterización de lagunas costeras mexicanas a través de variables ecológicas seleccionadas. Tesis de Doctorado. División de Ciencias Biológicas y de la Salud, Unidad Iztapalapa, UAM, México. 95 p.

Contreras, E. F., O. Castañeda, L., E. Barba, M. y M. A. Pérez. 2002. Caracterización e importancia de las lagunas costeras. En: Guzmán, A. P., Quiroga, B. C., L. C Díaz, C. D. Fuentes, M. C. Contreras y S. G. López. La pesca en Veracruz. Secretaría de Agricultura Ganadería, Desarrollo Rural, Pesca y Alimentación. México D. F., pp. 31-35. ISBN 968-817-372-X.

Corral, M. Luisa, H. Grizel, J. Montes y E. Polanco. 2002. La Acuicultura: Biología, regulación, fomento, nuevas tendencias y estrategia comercial. Tomo I Análisis del desarrollo de los cultivos: medio, agua y especies. Grupo Mundi Prensa, España. ISBN 9788471148643.

Day, J. W., A. S. Hall, C., M. Kemp, W. y A. Yáñez-Arancibia. 1989. Estuarine Ecology. John Wiley & Sons. Nueva York. 576 p. ISBN 0-471-06263-0.

De La Lanza, E. G. y M. Cáceres. 1994. Lagunas costeras y el litoral mexicano. Universidad Autónoma de Baja California Sur, México. 525 p. ISBN 968-896-048-9.

Elliott, M. y K. L. Hemingway. 2002. Fishes in estuaries. Blackwell Science, London. 636 p. ISBN 0-632-05733-5.

Douglas, M. F. y G. Drewry, E. 1978. Development of fishes of the Mid-Atlantic Bight. An atlas of egg, larval and juvenile stage. Vol. VI, Stromateidae through Ogcocephalidae. U. S. Fish and Wildlife Services., Biological Services Program, FWS/OBS78/12, 416 p. Card number 77-86193, ASIN B000KJBF00.

EBTuxtlas (Estación de Biología los Tuxtlas, Instituto de Biología). 2006. Generalidades de la región.
http://www.ibiologia.unam.mx/tuxtlas/localizacion/generalidades/frame.htm

Espinosa, P. H., M. T. Gaspar, D. y P. Fuentes-Mata. 1993. Listados faunísticos de México, III. Los peces dulceacuícolas mexicanos. Instituto de Biología, UNAM. 98 p. ISBN 968-36-2780-3.

Fahay, M. P. 1983. Guide to the early stages of marine fishes occurring in the Western North Atlantic Ocean, Cape Fatteras to the Southern Shelf. Journal of Northwest Atlantic Fishery Science. Vol. 4 Northwest Atlantic Fisheries Organization. Dartmounth, Canada July 1983. 423 p. http://journal.nafo.int/J04/frontpag.pdf

Fritzsche, R. A. 1978. Developmental of fishes of the Mid-Atlantic Bight. An atlas of egg, larval and juvenile stage. Vol. V, Chaetodondidae through Ophidiidae. U. S. Fish and Wildlife Service, Biological Service Program, FWS/OBS78/12. Card number 77-86193.

Hardy, J. D. Jr. 1978. Developmental of fishes of the Mid-Atlantic Bight. An atlas of egg, larval and juvenile stage. Vol. III, Aphredoderidae through Rachycentridae. U. S. Fish and Wildlife Service, Biological Service Program, FWS/OBS78/12. 314 p. Card number 77-86193.

Johnson, G. D. 1978. Developmental of fishes of the Mid-Atlantic Bight. An atlas of egg, larval and juvenile stage. Vol. IV. Carangidae through Ephippidae. U. S. Fish and Wildlife Service, Biological Service Program, FWS/OBS78/12. 314 p. Card number 77-86193.

Jones, P. W., F. D. Martin y J. D. Hardy, Jr. 1978. Developmental of fishes of the Mid-Atlantic Bight. An atlas of egg, larval and juvenile stage. Vol. 1. Acipenseridae through Ictaluridae. U. S. Fish and Wildlife Service, Biological Service Program, FWS/OBS78/12. 366 p. Card number 77-86193.

Hammann, M. G. y J. A. Rosales-Casián. 1990. Taxonomía y estructura de la comunidad de peces del estero de punta Banda y bahía de Todos Santos, Baja California, México. Cap. 6. En: Rosa-Velez, J. y F. Gonzalez-Farias (eds). "Temas de Oceanografía Biológica en Mexico." UABC. 337 p. ISBN 9686260234.

Kobelkowsky, D. A. 1993. Ictiofauna de las lagunas costeras del estado de Veracruz. En: G. Figueroa, M., C. Álvarez, A. Esquivel y M. Ponce. Fisicoquímica y biología de las lagunas costeras mexicanas. México: Serie Grandes Temas de la Hidrobiología. (1): 74-93. 74-93. ISBN 10: 970620234X

Lagler, F. K., E. Bardach, J., R. R. Miller y D. R. May-Pasino. 1977. Ictiología. AGT editor. Mexico D. F. 488 p. ISBN 968-463-017-4.

Lippson, A. J. y R. L. Moran. 1974. Manual for identification of early developmental stages of fishes of the Potomac River estuary. Prepared for the Power Plant Siting Program of the Maryland Department of Natural Resources, PPSP-MP-13. 517 p.

Moser, H. G., E. H. Ahlstrom y J. R. Paxton. 1984. Myctophidae: Development. pp. 218-239. En: H. G. Moser; W. J. Richards; D. M. Cohen; M. P. Fahay; A. W. Kendall y S. L. Richardson (eds.). Ontogeny and systematics of fishes. La Jolla California, Ahlstrom Symposium. American. Society of Ichthyologists and Herpetology, Special Publication (1), 760 p.

Martínez, H. M. G. M. 1987. Distribución y abundancia estacional del ictioplancton de la laguna de Sontecomapan, Veracruz. Tesis de Licienciatura (Biología), ENEP Iztacala, UNAM, Tlalnepantla, Estado de México. 136 p.

Miller, R. R., W. L. Minckley y S. M. Norris. 2005. Freshwater fishes of Mexico. The University of Chicago Press, U. S. A. 490 p. ISBN 0-226-52604-6.

Morán, S. A. 1994. Caracterización hidrológica y espacio-temporal con base en los nutrientes y clorofila a, de la laguna de Sontecomapan, Veracruz. Tesis de licenciatura (Biología), Facultad de Estudios Superiores Iztacala, UNAM, Tlalnepantla, Estado de México. 66 p.

Nelson, J. S. 1994. Fishes of the world. John Wiley & Sons (ed), Inc. New York, USA. 600 p. ISBN 0-471-86475-7.

Rosales-Casián, J. A. 1997a. Estructura de la comunidad de peces y el uso de los hambientes de bahías, lagunas y costa abierta en el Pacífico norte de Baja California. Tesis de doctorado, CICESE, México, 201p.

Sevilla, M. L. y R. Guadarrama. 2005. Elementos de ecología marina. Instituto Politécnico Nacional. México. pp.174-179.

Vázquez-López, H., F. Alvarez-Noguera y J. Franco-López. 2006. First record on larval development of the cirripedian parasite *Loxothylacus texanus* (Cirripedia-Rhizocephala) under laboratory conditions in México. International Journal of Zoological Research. 2(1): 91-99.
http://scialert.net/qredirect.php?doi=ijzr.2006.91.99&linkid=pdf

Zamora, A. L. 2002. Hábitos alimentarios en larvas y juveniles de peces en la laguna de Sontecomapan Ver. durante las temporadas climáticas de 1996 a 1997. Tesis de Licenciatura (Biología), Escuela Nacional de Estudios Profesionales Iztacala, UNAM, México. 72 p.