

# Fish fishery resources of the Ostion lagoon, Mexico: An ecological approach.

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## Abstract

The Ostion lagoon is the southernmost coastal system in the State of Veracruz. Its fish community has been little studied in the last three decades, however, its species are the object of important artisanal fishing. The spatial and temporal variation of its community structure was analyzed considering the diversity, richness, evenness, density, biomass and average weight and its relationship with the physicochemical parameters of the system. Likewise, the fish associations and their correlation with the environmental factors of the system were defined. In this study, 34 species were collected and identified, 12 of which were new records for the lagoon. Four species were dominant in the system, *Citharichthys spilopterus*, *Opsanus beta*, *Diapterus rhombeus* and *Cathorops aguilula*. Community parameters showed a relationship with environmental gradients and climatic seasons. The diversity was highest in May ( $H' = 2.36$ ) and January ( $H' = 2.48$ ) and the density in July (0.018 ind./m<sup>2</sup>). The relationship of the composition and spatio-temporal distribution of the fish community was conditioned by salinity, temperature, dissolved oxygen, and depth. The knowledge of the community structure and biological functions of the fish and their interaction with the environmental factors of this lagoon is relevant since continuous studies have not been developed in this system and it has been affected by urban and industrial development due to the proximity of the Coatzacoalcos industrial city.

**Keywords:** Structure community, Diversity, Abundance, Dominance, Fish associations.

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## Introduction

The State of Veracruz in the Gulf of Mexico has the third place of importance for its lagoon-estuarine extension (1166 km<sup>2</sup>) and for its great diversity of fishing resources, mainly fish with wide distribution and abundance on a spatial-temporal scale in these systems [1-5]. The study of this lagoon fauna is of great ecological and economic interest, since many species that are subject to commercial exploitation; depend on these coastal ecosystems to complete some part of their biological cycles [5-8].

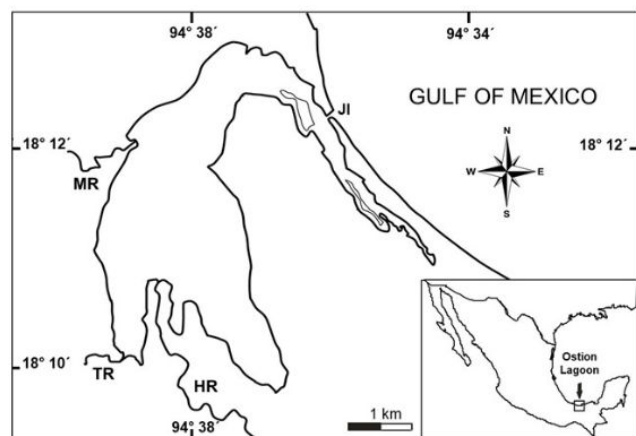
The Ostion lagoon located in the south of the State of Veracruz, has maintained a historical artisanal fishing directed mainly to the oyster (*Crassostrea virginica*) and shrimp (*Litopenaeus setiferus* and *Farfantepenaeus aztecus*) [9,10]. Likewise, towards coastal scale fishing for local consumption that includes the species *Eugerres plumieri*, *Lutjanus campechanus*, *Mugil curema*, *Caranx hippos*, *Lutjanus griseus*, *Scomberomorus cavalla*, *Centropomus parallelus*, *Orthopristis chrysoptera*, *Ocyurus chrysurus*, among others [11]. This lagoon, like others in the Gulf of Mexico, have been altered by climatic processes, affecting the regional season due to the increase in hurricanes of great intensity, the erosion of beaches and the change in sea level [12]. At the same time, industrial human activities have induced oil pollution and overfishing, which has disturbed the ecological structure of the ecosystem for several decades [4,13]. This has modified the organization

of the system and its fish communities, which is reflected in the constant reduction of diversity, decrease in the abundance of fishing resources, loss of habitats and environmental degradation [3,14]. The Ostion lagoon located near the Coatzacoalcos River is a coastal area with extensive urban, oil and fishing development since the sixties where the need for ecological research on the structure and function of the fish community in this lagoon is a priority, due to the scarce information on the current state of the system and its fishing resources [11,12,15]. In this context, the present study addresses the spatio-temporal analysis of the community structure of the ichthyofauna of this system in Veracruz.

## Ecological Characterization of the Ostion Lagoon

In Figure 1 this lagoon system is the southernmost of the coastal plain of Veracruz, just 20 km from the industrial city of Coatzacoalcos next to its mighty river of the same name. The coastal system of the Ostion is shallow with an area of 12.7 km<sup>2</sup> and represents 1.1% of the total surface of the coastal lagoons of the State. Its geomorphology includes a sandy barrier that separates it from the sea and presents permanent communication with it through a marine mouth (Jicacal inlet), which conditions the ebb and flow of saline water, as well as the exchange of marine fish fauna. It receives the discharge from the Metzapa, Huazuntlan and Temoloapan rivers [16]. Its climate is warm humid with rains in summer and annual

temperatures between 18°C and 22°C [17]. On an annual scale, the climate determines three well-defined climatic seasons, dry (February to May), rainy (June-September) and north season (October-February) [17,18]. There are different aquatic environments in the system with surrounding mangrove vegetation (*Rhizophora mangle*, *Laguncularia racemosa*, *Avicennia germinans*), emergent vegetation (*Thalia geniculata*, *Cyperus giganteus*, *Nymphaea ampla*), submerged vegetation (*Ruppia maritima*, *Syringodium filiforme*) and high sedimentation areas such as river mouths [11,18].



**Figure 1.** Ostion lagoon system. The geographic location in the state of Veracruz is indicated. The main physiographic features of this lagoon, and the rivers draining into the system are shown, Metzapa River (MR), Temoloapan River (TR), Huazuntlan River (RH), and Jicacal marine inlet (JI).

## State of Ecological Knowledge about the Fish Community

A fundamental focus on the knowledge of the ecological behavior of fish communities in the Mexican coastal systems of the Gulf of Mexico is the understanding of the relationship with the dynamics of the environment, especially with the physical and chemical conditions and with the biotic structural characteristics of the different habitats with aquatic or submerged vegetation, which conditions the temporal space variations of fish stocks. However, progress has been made in this context, not all studies on the structure and function of fish communities have been approached considering these factors in a homogeneous way in the State of Veracruz [5,16]. Recent studies have demonstrated more broadly the close correlation between the environmental framework and the ecology of fish communities, highlighting the need to adopt a homogeneous research strategy among the coastal systems studied, to make more complete ecological comparisons [16,19-21].

In the Ostion lagoon, the best known environmental and fish composition work for this lagoon dates to 1986, after which three decades have passed with few published works to date [22]. The most complete studies on the ecology of the fish community in this ecosystem are from 2008 to date, which have analyzed various ecological attributes such as the diversity, distribution, and abundance of fish associations in relation to their environmental dynamics [11,23]. These studies

have made it possible to evaluate the physicochemical variables that most influence the fish community and that determine its composition and functional structure in the ecosystem on spatio-temporal scales [20].

For the coastal zone of Veracruz, around 478 species of fish have been reported of which 68 (14.2%) are present in the Ostion lagoon [1]. The systematic list of this system was integrated from an extensive review of the literature of the last 30 years [22-25,11]. Likewise, from the field data record in the different climatic seasons of the year, from which 34 species were registered [16]. The best represented families in number of species were *Gerreidae* with 6: *Diapterus auratus*, *Diapterus rhombeus*, *Eucinostomus argenteus*, *Eucinostomus gula*, *Eucinostomus melanopterus* and *Eugerres plumieri*; *Lutjanidae* with 4: *Lutjanus analis*, *Lutjanus apodus*, *Lutjanus cyanopterus* and *Lutjanus griseus*; and *Centropomidae* with 3: *Centropomus parallelus*, *Centropomus pectinatus* and *Centropomus undecimalis*. Only the species belonging to the *Lutjanidae* and *Centropomidae* families have been important artisanal fishing resources in the lagoon for several decades and their abundance has now markedly decreased [26,27].

On the other hand, in this coastal system the fish community has been little studied in a systematic way, so there are still information gaps in the knowledge of the composition and spatial-temporal variations of species richness, so it is not possible to carry out a complete retrospective analysis on the variations in the number of ichthyofauna species in this lagoon. The results of this work showed that however, the limited knowledge of the fish composition of the Ostion lagoon system, this allowed to determine that 12 species were new records for the lagoon system: *Gymnura micrura*, *Anchovia clupeoides*, *Mugil curema*, *Centropomus pectinatus*, *Prionotus punctatus*, *Lutjanus analis*, *Lutjanus cyanopterus*, *Eucinostomus argenteus*, *Oreochromis niloticus*, *Gobiomorus dormitor*, *Citharichthys uhleri* and *Stephanolepis hispidus*, so it is reasonable to assume that the system may contain more species not recorded to date [16]. Likewise, the presence of invasive species such as *Oreochromis niloticus* captured in 2008 [11]. Recently the devilfish *Pterygoplichthys pardalis* of restricted distribution in the southwestern zone of the lagoon in areas of fluvial influence, which increases the stocktaking of the ichthyofauna in this system [28].

Likewise, the present study indicates that community structure parameters such as diversity, richness, evenness, abundance, and dominance of fish have been scarcely evaluated in the Ostion system. However, the results presented here also allow complementing the information with annual values of diversity ( $H'=2.7$ ,  $D=5.0$  and  $J'=0.77$ ), of abundance (density, ind./m<sup>2</sup>=0.010, biomass, g/m<sup>2</sup>=0.265 and average weight g/ind.=25.89) of the Ostion community. These community values were related to the spatio-temporal behavior of the species that presented dominance in the system such as *Citharichthys spilopterus*, *Opsanus beta*, *Diapterus rhombeus* and *Cathorops aguadulce*, with 52% in number and 45% in weight of the total catch. At the same time, these parameters are also related to the spatio-temporal variations of the physicochemical parameters, reflecting the ecological adaptations that the fish present to

optimize the environmental gradients from the marine mouth to the areas of fluvial influence. Thus, Table 1 shows the seasonal comparison of the community parameters for the Ostion lagoon, where it is observed that the richness, density, and average weight were the most contrasting, due to the spatio-temporal changes in the numerical abundance and the size of individuals of the dominant species throughout the year, for example *Citharichthys spilopterus* and *Diapterus rhombeus* during the dry season and *Cathorops aguadulce* and *Opsanus beta* in rainy and north seasons. Other species that contributed mainly to the variation of the average weight were those of greater size such as *Hypanus americana* in the dry season and *Centropomus parallelus* in the north season.

**Table 1.** Seasonal community ecological parameters in the Ostion lagoon system, Veracruz.

Parameters	Dry season	Rainy season	North season	Annual
Species number	21	22	24	34
Diversity (H')	2.52	2.06	2.61	2.70
Richness (D)	4.24	3.53	4.19	5.00
Evenness (J')	0.83	0.67	0.82	0.76
Density (ind./m <sup>2</sup> )	0.04	0.10	0.10	0.10
Biomass (g/m <sup>2</sup> )	2.15	2.06	2.15	2.12
Average weight (g/ind.)	57.6	16.1	26.79	25.89

A distinctive ecological property in coastal systems is the presence of associations or groups of fish that perform various biological functions and reflect their adaptations to environmental gradients, which determine the composition, distribution, and abundance of species in the community on a spatial-temporal scale [5,8,19,29-31]. In this study, the analysis of the relationship of the composition and abundance of the fish with their habitats allowed the identification of groups of fish related to the physicochemical gradients of the system, where the distribution of the species was conditioned by the ecological behavior of the different fish components identified. Thus, the presence of stenohaline and euryhaline species was recorded such as *Eucinostomus gula*, *Lutjanus analis*, *Lutjanus apodus*, *Gymnura micrura*, *Gobionellus oceanicus*, *Prionotus punctatus* and *Stephanolepis hispidus* associated with areas of greater marine influence near the mouth of connection with the sea and communication channel of the system (Figure 1), distributed in areas with submerged vegetation and mangroves where the values of dissolved oxygen, transparency and depth are greater. Likewise, a group of estuarine and euryhaline fish associated with lower values of salinity, transparency and depth was identified, characterized by species that tolerate wide variations of these parameters in areas of fluvial influence such as *Centropomus parallelus*, *Cathorops aguadulce* and *Gobiomorus dormitor*. This behavior of the composition and abundance of the species is also conditioned by the seasonal

migrations made by various species and by the dominant fish of the system, which are related to their strategies for feeding, protection, and maturation of various species, several of which have fishing importance in this coastal region. This behavior of fish associations has been analyzed in other similar coastal systems [29, 32-34].

## Conclusion

The ecological information presented establishes an advance in the knowledge of the ecological structure of the fish community in the Ostion lagoon, so it is necessary to obtain continuous scientific information and the development of a monitoring program to fully understand the spatial and temporal changes in the behavior of the lagoon ecosystem as well as fish community. The analysis carried out represents a reference framework for future evaluations of environmental and ecological comparison of the dynamics of the fish community. At the same time, due to the presence of non-evaluated invasive species related to an important artisanal fishing. In addition, this analysis provides information on the relationship of the environment with the structure of the Ostion fish community that allows increasing the necessary knowledge about the ecosystem and its fish populations, to propose management strategies for the conservation of fishing resources of this coastal system. Likewise, due to the proximity of the lagoon to the Coatzacoalcos Port, which today continues to be a focus of great urban and industrial development that demands several fishing resources of the system because it is easy to access and navigate.

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