Considerations on the Hydrography and Productivity of Alvarado Lagoon, Veracruz, Mexico

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Abstract

Based on more than 1500 observations on various biological and hydrological characteristics we have attempted to present an idea of the hydrography and productivity of the Alvarado Lagoon in central Veracruz, Mexico. The data were obtained through monthly observations at sixteen stations from January through August 1966.

In this article we report the hydrobiological contrast between the dry and rainy seasons at the same stations. To accomplish this we have presented a comparison of the months of March (dry season) and August (rainy season).

The following characteristics have been mapped: temperature, chlorinity, dissolved oxygen, productivity (as estimated by chlorophyl α), quantity of phytoplanktonic cells, planktonic biomass (as calculated volume of plankton in 1 cubic meter of water), and abundance of postlarval stages of the brown shrimp, *Penaeus aztecus* Ives.

We have distinguished five natural areas: (1) an area with a strong marine influence; (2) an area strongly influenced by fresh water; (3) an intergradient area; (4) a calm area; and (5) an adjacent but partially isolated area, the Camaronera Lagoon.

The hydrobiological characteristics of the Alvarado Lagoon were clearly regulated by the dry and rainy seasons. The productivity and the quantity of phytoplanktonic cells are inversely related to the amount of planktonic biomass and of postlarval *P. aztecus*. The latter, abundant during the dry season, were not found at all during August.

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INTRODUCTION

THE HIGH PRODUCTION OF SHRIMP in the economic fisheries of Campeche Bank in the Gulf of Mexico is well known, but no information has been available on the relationship between commercial capture of shrimp on the Campeche fishing grounds or productivity of estuaries around the Gulf of Campeche as shrimp nurseries.

OBJECTIVES

We have undertaken this research with the purpose of contributing to the knowledge of the coastal lagoons of Mexico and the relationship between the productivity of one of these lagoons and the yield of the shrimp fisheries in the Gulf of Campeche.

In the present research we report on the hydrology of Alvarado Lagoon, and compare the conditions of temperature, chlorinity and dissolved oxygen during the dry and rainy seasons. Productivity of the lagoon is shown from estimates of the chlorophyll, quantity of phytoplankters, planktonic biomass, and postlarval stages of economically valuable shrimp.

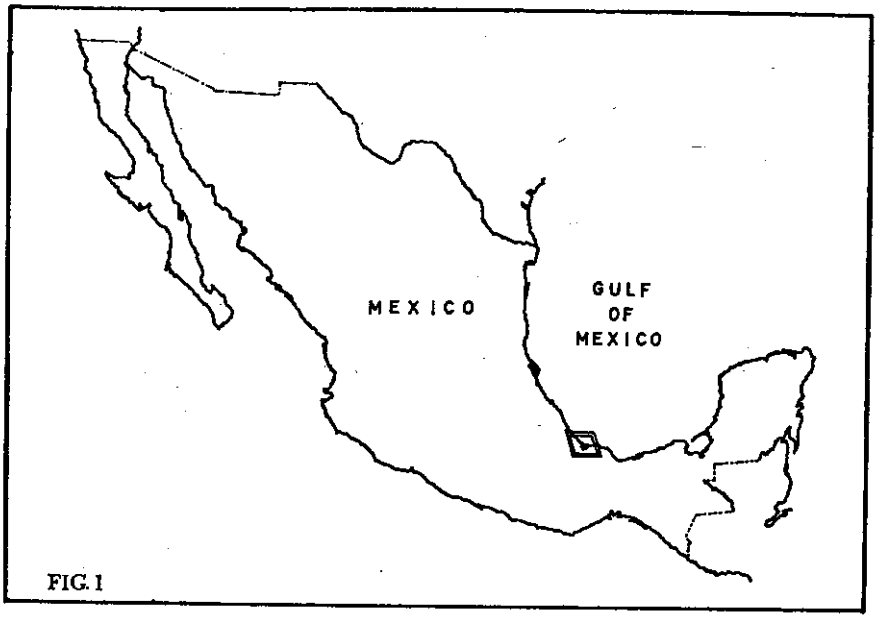


FIG. 1

Location And General Physiographic Characteristics

Alvarado Lagoon (Fig. 1) is located on the east coast of Mexico, southwest of the Gulf of Campeche. This lagoon is the vertex of the basin of Papaloapan River.

Its orientation is parallel to the coast line. There are three main rivers feeding into this lagoon: the Papaloapan, the Blanco, and the

Acula. This lagoon connects with the sea through a principal channel. There are two other channels, one connected with the Papaloapan River and the other at right angles to the principal channel (Fig. 2).

There are two secondary lagoons connected with the Alvarado Lagoon, the Camaronera and the Tlalixcoyan. Alvarado Lagoon is shallow, with a mean depth of two meters, and deeper areas are found in the channels.

In general terms the bottom is muddy in the middle of the lagoon, sandy on the beaches and sand with fragmented shells in the channels.

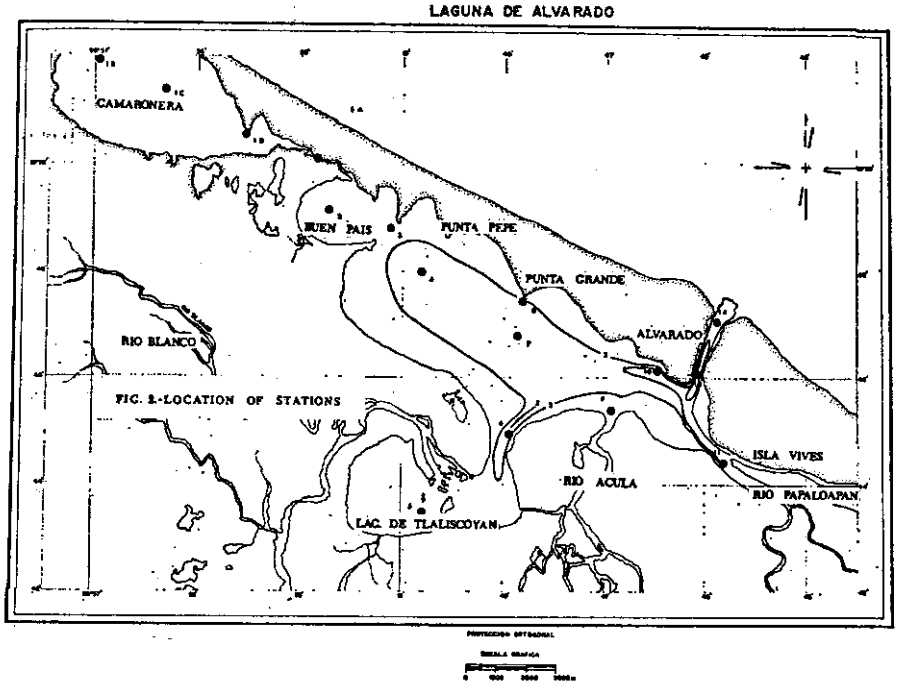


FIG. 2.-LOCATION OF STATIONS

METHODS

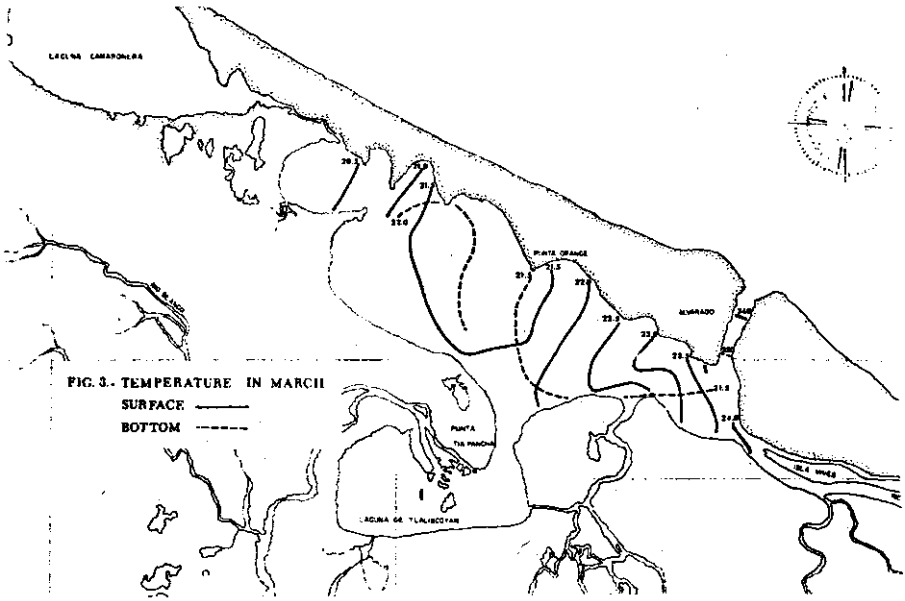
We have studied 16 stations during 6 cruises in the months of February, March, April, May, July, and August 1966 (Fig. 2).

Samples were taken with Van Dorn bottles. Temperatures were registered from either bucket thermometer or with a thermistor. Chlorinity was determined by using the Mohr-Knudsen method, and the dissolved oxygen by the Winkler method. Chlorophyll α values were measured spectrophotometrically. The number of phytoplanktonic cells was counted following the Utermohl method. The planktonic biomass and the number of postlarval shrimps were determined by a quantitative method.

RESULTS

We have distinguished five general areas according to their hydrological and biological characteristics: (1) Area with marine influence,

(2) Area with fresh water influence, (3) Area of gradient, (4) Area of calm, and (5) Adjacent area (Camaronera Lagoon). The limits of all of these areas change according to different factors.



Temperature

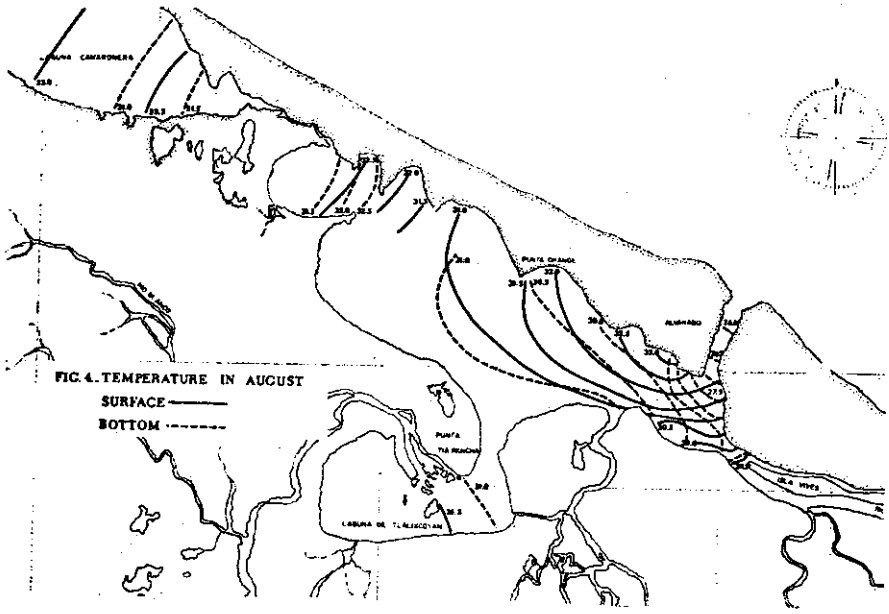
During the dry season in March we found a decreasing temperature gradient at the surface starting from the area of the channels to the interior of the lagoon up to Buen Pais. There was also a broad area situated between Punta Pepe and Punta Grande where the temperature was uniform (Fig. 3). On the bottom we found the temperature very stable. From the area of the channels up to Punta Grande we found a constant value of 21.50C. Off Punta Pepe we found an area with slightly higher temperature.

During the rainy season in August we found at the surface a temperature gradient which decreases with distance from station 10. From the station off Punta Pepe the temperature increased toward the Buen Pais Lagoon (Fig. 4).

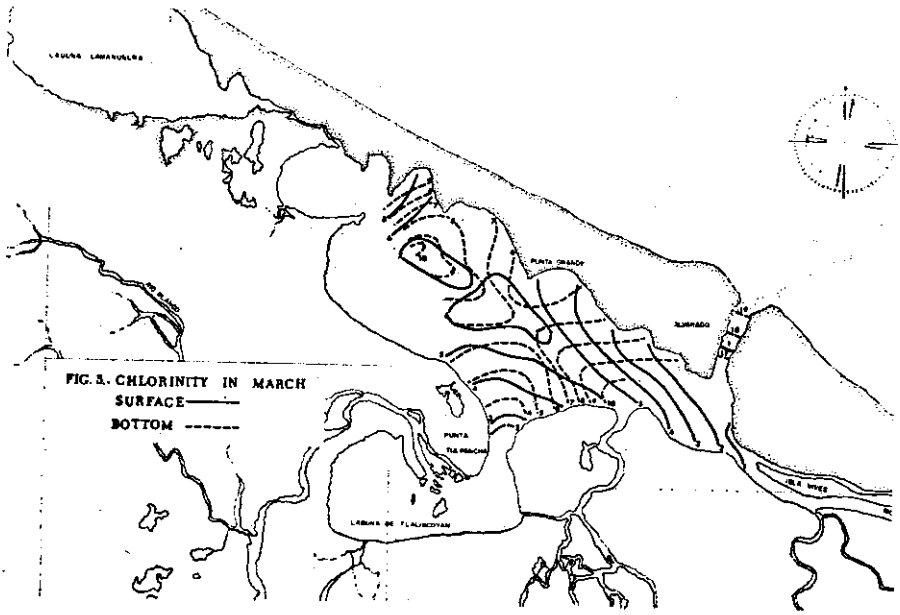
In the bottom waters there was an increased gradient which started in the main channel and progressed to the interior of the lagoon. At Buen Pais there was a decreasing gradient to the interior.

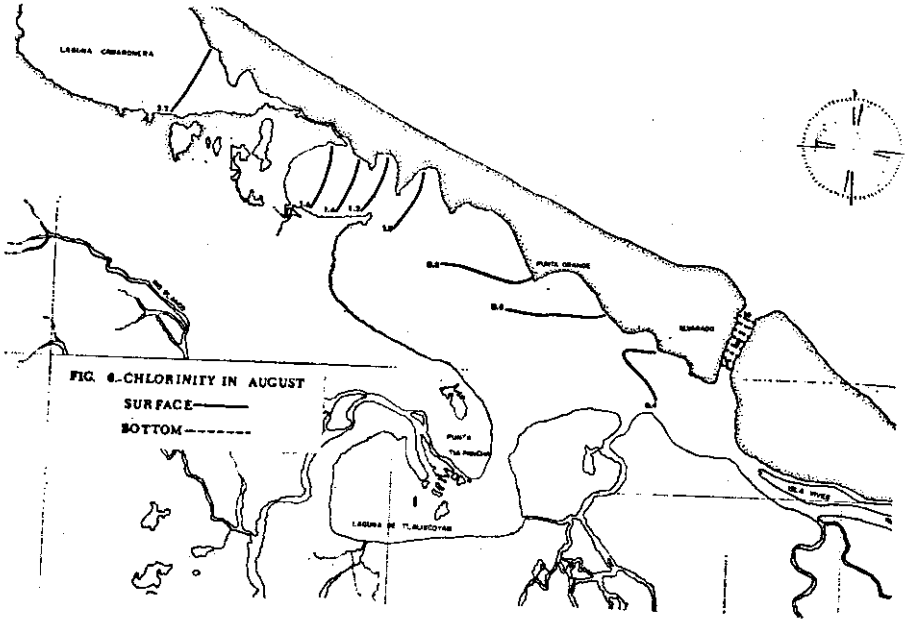
Chlorinity

In the dry season in March we found the highest values of chlorinity at the surface of the calm area. Starting from this area there were three decreasing gradients in the direction of the area of the channels, the Blanco River and the Buen Pais Lagoon (Fig. 5).



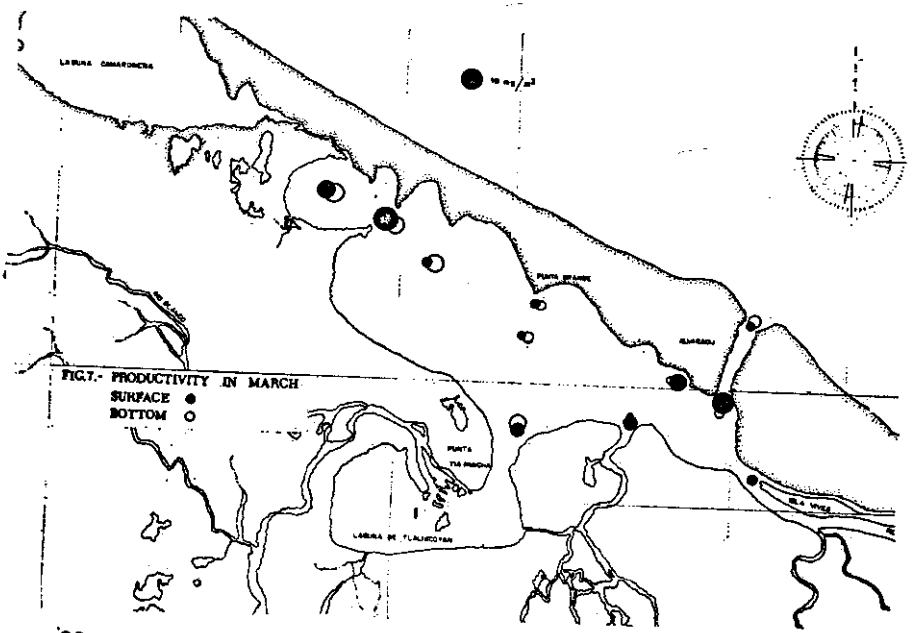
At the bottom we found a decreasing gradient starting in the area of the channels to the center of the lagoon. There were also two increasing gradients from Buen Pais Lagoon and Blanco River to the center of the main lagoon.





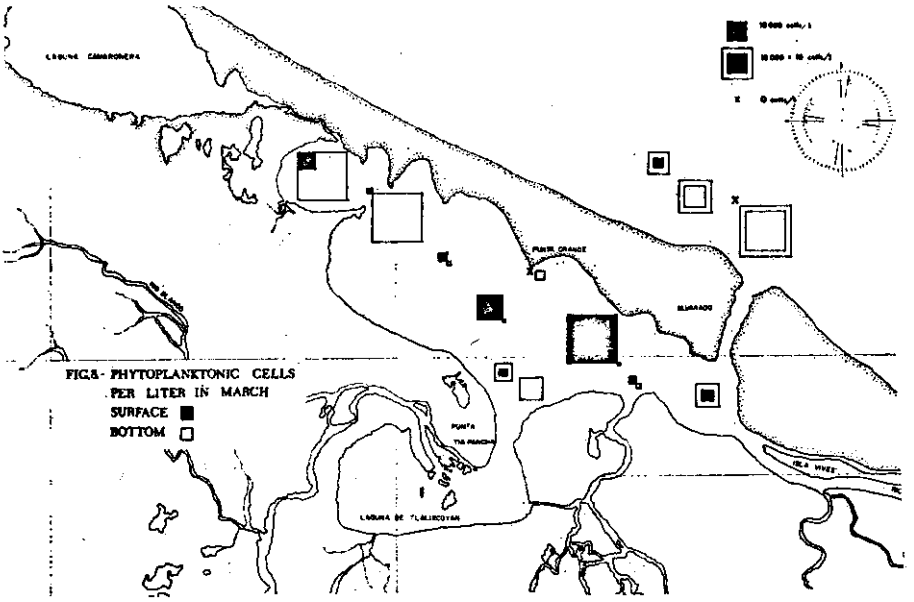
In contrast during the rainy season we found an increasing gradient of chlorinity from the channel areas to the interior of the lagoon, extending to Buen Pais (Fig. 6).

On the bottom in the main channel there was a very sharp gradient increasing toward the sea.



The differences between the dry season and the rainy season were as follows:

1) The extension of the gradient area was larger during the rainy season than during the dry season.
2) The extension and the stability of the calm area was remarkable during the dry season.
3) The difference between the chlorinity values of the dry season and those of the rainy season were very notable.
4) During the dry season the variability of the chlorinity was sharper than during the rainy season when it was almost homogeneous.



Productivity and Number of Phytoplanktonic Cells

During the dry season the primary productivity and the number of cells reached the highest values in the area of calm in the channels. The number of cells was exceptionally high in the mouth of the Blanco River (Figs. 7 and 8).

In the rainy season these values were considerably higher. The highest values were found in the calm area both during the rainy and the dry seasons (Figs. 9 and 10).

In the dry season the phytoplanktonic cells were predominantly neritic and estuarine forms. On the other hand the fresh water forms were predominant during the rainy season.

Dissolved Oxygen

During the dry season, we found in the surface an increasing gradient from station 11 to the interior of the lagoon in the direction of

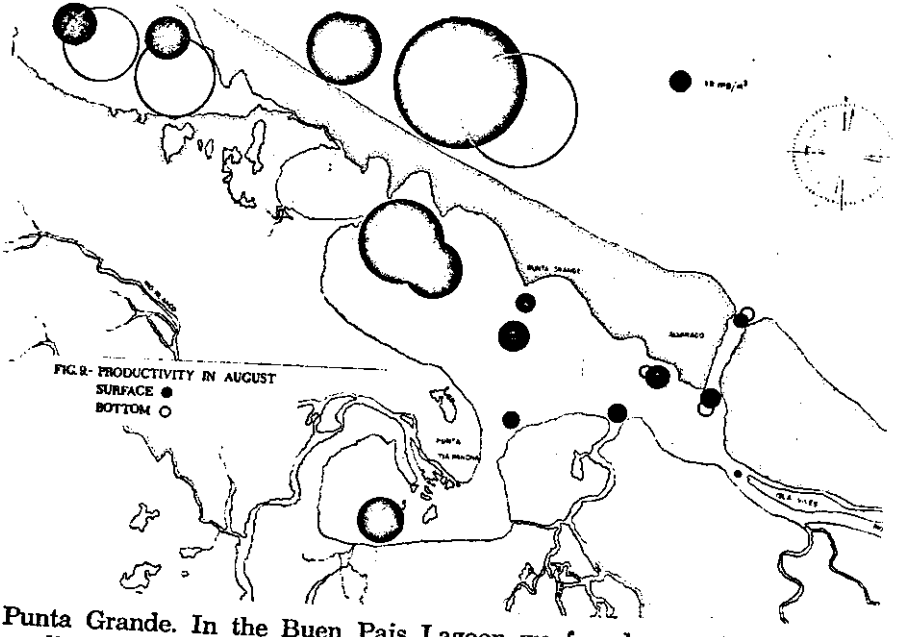


FIG. 9.- PRODUCTIVITY IN AUGUST
SURFACE ●
BOTTOM ○

Punta Grande. In the Buen Pais Lagoon we found a small decreasing gradient toward the interior (Fig. 11).

In the bottom of the main channel we found an increasing gradient toward the interior of the lagoon. There was also an increasing gradient from the Acula River toward the middle of the lagoon. In the area of calm the values were more or less uniform.

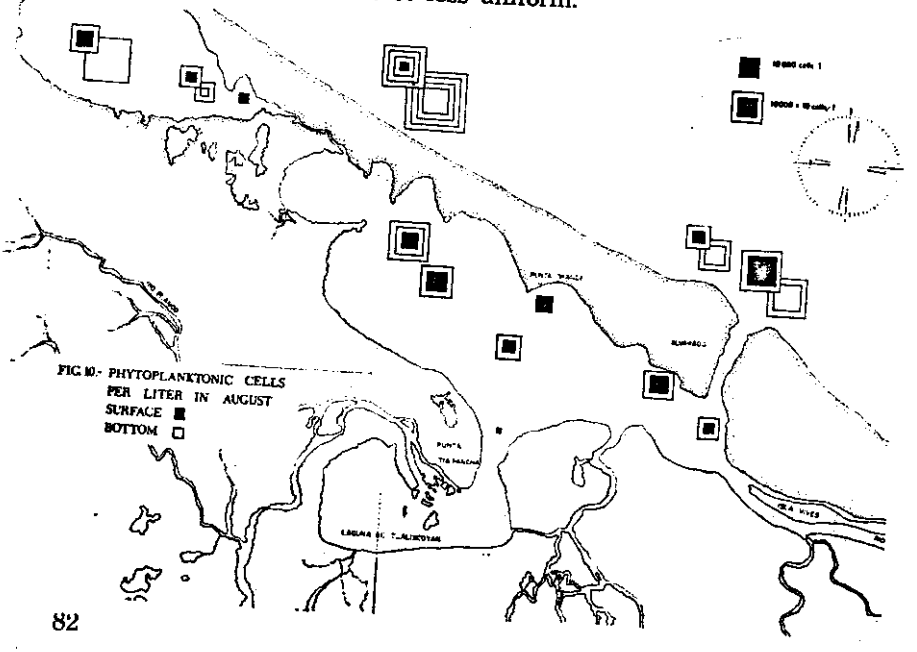


FIG. 10.- PHYTOPLANKTONIC CELLS PER LITER IN AUGUST
SURFACE ■
BOTTOM □

In the rainy season on the contrary we found in the surface a very sharp gradient in comparison with the conditions of the dry season.

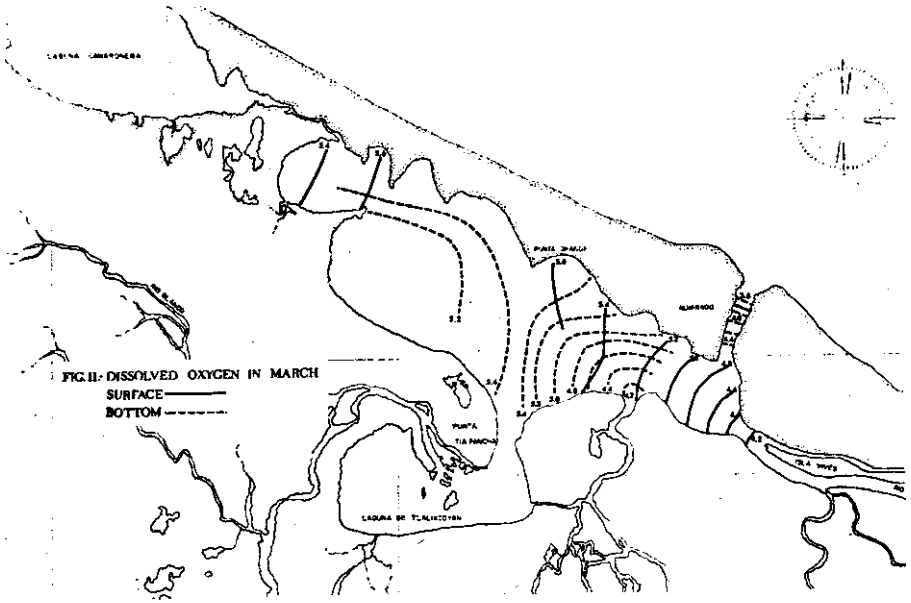


FIG.11- DISSOLVED OXYGEN IN MARCH
SURFACE———
BOTTOM - - - - - -

Furthermore, this gradient is distributed throughout the whole lagoon. The gradient increased from the mouth of the Blanco and Acula Rivers to the Buen Pais Lagoon. Besides in the Tlalixcoyan Lagoon we found

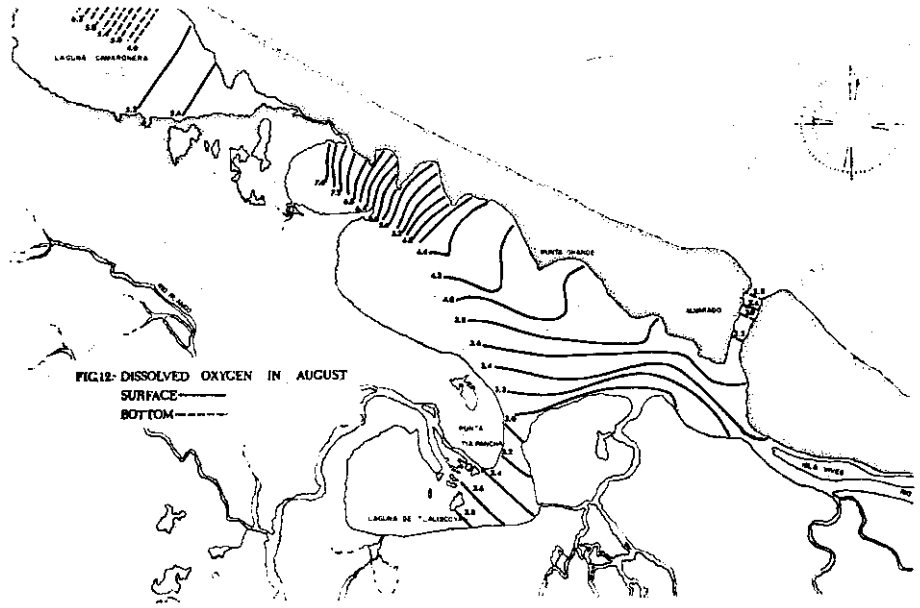


FIG.12- DISSOLVED OXYGEN IN AUGUST
SURFACE———
BOTTOM - - - - - -

a decreasing gradient in the direction of the Blanco River. In the bottom of the main channel we found an increasing gradient toward the interior of the lagoon (Fig. 12).

In both seasons the values of the primary productivity, number of

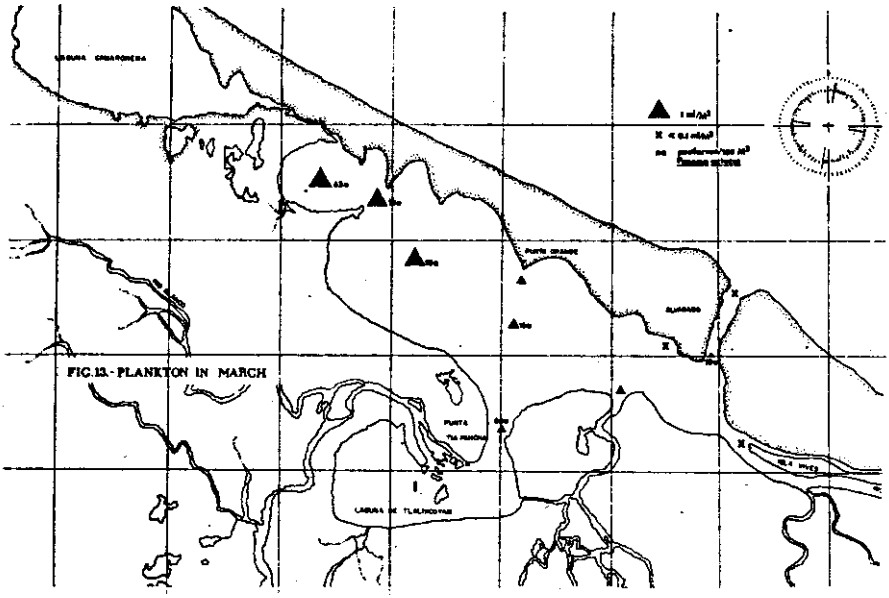


FIG.13.- PLANKTON IN MARCH

phytoplanktonic cells, and oxygen were found to be in direct proportion.

Particularly in the rainy season both values were considerably high.

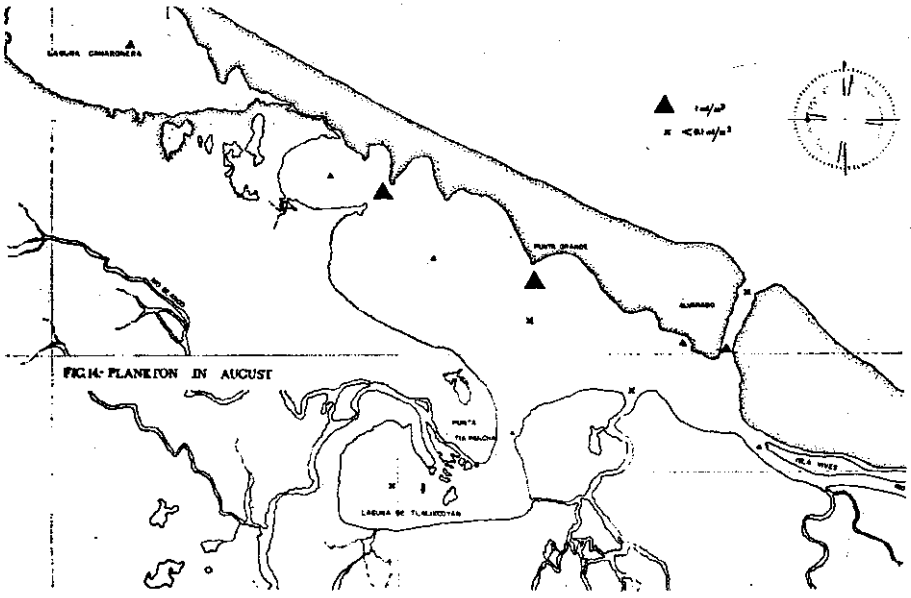


FIG.14.- PLANKTON IN AUGUST

In the dry season, we found the highest values of the planktonic biomass in the calm areas. In contrast we found the lowest values in the channel areas.

The density of the postlarval stages of shrimp (*Penaeus aztecus* Ives) was especially high in the calm areas and at station six (Fig. 13).

During the rainy season the planktonic biomass decreased considerably and no postlarval stages of shrimps were found (Fig. 14).

Generally, the values of the planktonic biomass were found in inverse proportion to the values of the primary productivity and number of phytoplanktonic cells.

CONCLUSIONS

1. We distinguished five natural areas in the Alvarado Lagoon according to their characteristics: (a) Area with marine influence, (b) Area with fresh water influence, (c) Area of gradient, (d) Area of calm, and (e) Adjacent area.
2. The hydrological and biological characteristics of Alvarado Lagoon were sharply defined by the dry and rainy seasons.
3. In the Alvarado Lagoon the biotic productivity was high, the primary productivity and the number of phytoplanktonic cells were in inverse relation with the values of planktonic biomass and postlarval stages of shrimp.
4. In the dry season the density of postlarval stages of shrimp was high. In contrast, during the rainy season no postlarval stages of shrimp were found.

ACKNOWLEDGMENTS

The authors wish to thank for their enthusiastic cooperation several institutions and persons which made possible the present paper: The Gulf and Caribbean Fisheries Institute; UNESCO; Banco de Fomento Cooperativo, México D. F.; Puerto Pesquero Piloto, Alvarado, Veracruz, México; Ing. Celis Arenal; Sr. Gerardo Green; Sr. Alberto Ramirez; Sr. Luis Soto.