Article

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Composition, abundance and diversity of larval and juvenile fish associated to the roots of the Mangrove trees, in the estuary of the Commune Palmar - Province of Santa Elena.

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Abstract

In the estuary of the Commune Palmar, the study of the composition and abundance of fish larvae and juveniles associated with the roots of the mangroves is done through systematic analysis in three seasons, during December 2014 - April 2015, using cast nets and trammel with mesh opening of 2.5 cm and 0.5 cm respectively for juveniles and larvae. Of the total of 2,414 fish collected, 3 orders and 5 families in 8 species were identified. The highest value of abundance is reflected in April with 900 ind., E3 station being population-average abundance of 39 individuals (44.81 ± stdev), and in February, with the lowest value of 109 ind. Monthly absolute abundance of each species recorded for statistical index (ANOVA) is considered, the significance of Kolmogorov-Smirnov (0.13> 0.05 α); indicating that the variances of the population means for sampling follow a normal distribution, the ANOVA analysis indicates that between population abundances significant differences. The values of diversity index Mg. (1.46 / 1.54 / 1.61) demonstrated homogeneity and low diversity of species in the three stations. According to environmental parameters high salinity correlation (0.004 <0.05) is recorded with respect to abundance (r = 0.87839), observed in February with the high value of 9.6 mg / L (± 2.15 desvt.), and April to 38.6 mg / L (± 0.95 desvt.); oxygen with a high correlation (0.04 <0.05) relative to the abundance (r = 0.71776), being March high value of 4.7 mg / L (± 0.86 desvt.) and February with a value below 3.1 mg / L (± 0.45 desvt.), considered these environmental parameters which determine the variation of fish communities in each of the research stations.

Diversity, abundance, correlation, fish communities, Commune Palmar

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Introduction

Mangrove ecosystems are some of the most productive, as they provide a large amount of nutrients to the east, provide environmental services and host a high diversity of life (CONABIO, 2008); within this ecosystem are estimated that host Parties of the youth populations and fish larvae, and of which we have identified some of the species of commercial importance (Gutierrez, O. and Chinchia, J., 2001), as part of fishing activity, exists in virtue of that certain species that take advantage, have in the roots of the mangrove a place of growth and aging since the early stages of life, since they protect and nourish the larvae and juvenile fish (Have et al 2003), these roots, At the same time serve as energy regulators through complex biological interactions among them and the different habitats of the ecosystem (Diaz-Ruiz et al., 2006).

At present it is to recognize the importance of mangrove ecosystems for the fish communities and their associations in the commune of Palmar, those that have become a place of interest of many investigations by having a great diversity of species.

Therefore, the present study aims to establish the composition, abundance and diversity of larval and juvenile fish associated with the roots of the mangrove and its relationship with the physical parameters in three different stations

Materials and methods

Area of study

The mangrove ecosystem is located to one side of the Ecuadorian coast, in the Commune Palmar del Santa Elena county, province of Santa Elena - Ecuador.

Limited by the following points: North Cerro Angahuel and shrimp farms (02° 00' 868" S and 80° 44' 240" W); to the south the neighborhoods, estuaries and Shell (02° 01' 232" S and 80° 44' 179" W); to the east the "Chila," shrimp (02° 01' 22" S and 80° 44' 46" W); to the west is the mouth of the Rio Grande (02° 00' 989" S and 80° 44' 451" W), (CIPS-IMSE, 2005). The topography is flat, taking this area a polygonal shape of 43.85 has of mangrove alive (IMSE - DGAM - 2005). Before the devastation of the ecosystem by the shrimp industry, mangrove forest was much more extensive, surpassing the 200 ha (C-CONDEM, 2006).

Monitoring Stations

The stations were selected considering the accessibility of the area, mainly in those areas with the highest number of species, due to a prior monitoring. Three stations were selected using a GPS (Garmin), for the identification of the reference points of observation. Photo 1 and Table 1.

Figure 1 mangroves of Palmar Province of Santa Elena. Source: Google Earth, 2015.

Stations	Coordinates	
	South Latitud	West Longitud
Station #1	02º 00˙ 998”	80º 43’ 762”
Station #2	02º 01’183”	80º 43’ 900”
Station #3	02° 01' 22	80° 44' 46´´

Table 1 Coordinates of the sampling stations.

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Systematic monitoring

After the bibliographic analysis and selection of the stations, it comes to the implementation of the systemic approach, the same that is directed to the study of the mangrove ecosystem, determining their components and the relationships between them, these relationships determine on the one hand the structure of the object and on the other hand its dynamics. To do this we rely on the analysis muestreal, in the three stations of study, this type of sampling to detect spatial variations in the community, proposed by Quintana in 2007. The sampling frequency bimonthly was conducted in sites with abundant mangrove roots during the months of study with a duration of 24 hours for each station, with intervals of collection of sample of 4 hours. The area on which it proceeded to place the trammel was 100m2, for each station, and also used the nets for species of smaller size.

Records of abundance

the collection of species is carried out every 4 hours, was to review the trammel nets and launch the, then proceeded to count each one of the agencies for their subsequent identification and classification. Photo 2 and 3.

Figure 2

Decision-parameters are made using special equipment such as the YSI (EXO 1 Multiparameter Areat) for temperature and dissolved oxygen, Refractometer (Brixco) to salinity, and a pH meter., for its application in situ.

For the identification of the species was used taxonomic keys of Massay, S. and J. Massay. 1999; marine fishes of Ecuador.

W. Fischer, F. Krupp, W Schneider, C. Somer, K.E. Carpenter and VH. Niem, 1995; FAO guide for the identification of species for the purposes of the fisheries; commercial fish of Peru Chirichigno, N. and J. Vélez. 1998; Urbina.I., and sources. H. 2002. Biodiversity Guide Vol. I macro-fauna. All these documents are considered to be of relevance for the detailed information that present on the classification of the fish.

For the ecological attributes: composition, abundance and distribution used the IBM SPSS statistical 19, for the analysis of ANOVA and the monthly absolute abundance was used first-E6 with ecological formulas; for the incorporated alpha diversity program was implemented Diverse, it should be mentioned that for the beta diversity of absolute abundance data had to be transformed to fourth root; in order to be able to perform the analysis of conglomerates cluster and for correlation of variables the program Basic Statistics (2 array variables) of the statistical package Statistics 8.

Analysis and interpretation of results.

Composition or biological variety.

The biological composition of fish associated to the roots of the mangrove forests on the Commune Palmar, was composed of 3 Orders (Perciformes, Cupleiformes and Mugiliformes), 5 families (Centropomidae, Elotridae, Gerridae, mullets (Mugilidae) and Engraulidae) and distributed in 8 species (Centropomus viridis, Centropomus robalito, Dormitator latifron, Diapterus peruvianus, Eucinostomus gracilis).

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Population abundance in December

The absolute abundance total, was of 291 individuals collected. Mugil cephalus (42 larv., and 31 juv.,) presented the highest value in absolute abundance population; follow him Anchovy nasus (29 larv., 15 juv.), Centropomus robalito (28 larv., 18 juv.), Mugil curema (20 larv., 21 juv.), Diapterus peruvianus (27 larv., 9 juv.); in lower population abundance of the species Dormitator latifrons (17 larv., 5 juv.), Centropomus viridis (9 larv., 8 juv.), and Eucinostomus gracilis (9 larv., 3 juv.). Graphic 1.

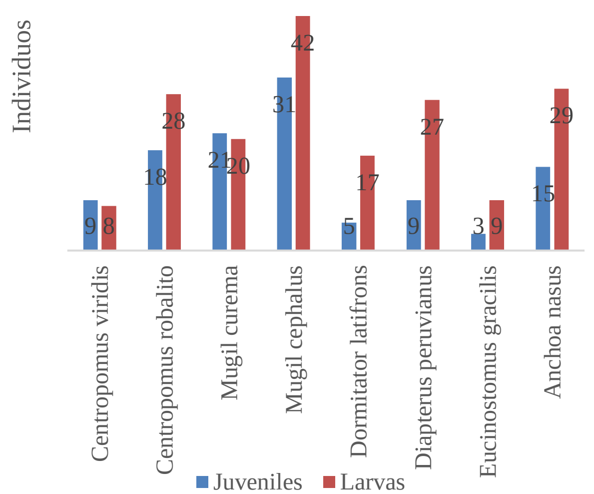

Table 1 Absolute abundance of fish in the roots of the mangrove of the Commune Palmar.

The station E1, was the area with the highest population average value in abundance of fish, with 15 individuals (± 7,90 STDEV.), the station E2 with 12 individuals (± 6.12 STDEV.), and the station E3 with 10 individuals (± 6.89 STDEV.). Chart 2.

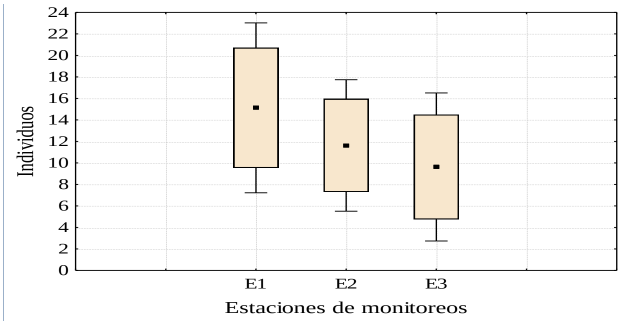

Table 2 Fish abundance by monitoring stations in the mangroves of Palmar.

In the three stations, records of population abundance of fish indicate that the stage with high levels in abundance is the larval phase, followed by the juvenile stage. Chart 3.

Table 3 Abundance of fish per stage in the monitoring stations in the mangroves of Palmar.

Population abundance in January

The total absolute abundance in the month, was of 738 individuals. The species Mugil cephalus was recorded with a value of 193 individuals (104 larvae and 89 juveniles), this being the highest log in absolute abundance population, followed the species Mugil curema with 146 individuals (83 larv., 63 juv.), anchovy nasus with 127 individuals (71 larv., 56 juv.), Centropomus robalito with 80 individuals (49 larv., 31 juv.), Diapterus peruvianus with 74 individuals (47 larv., 27 juv.).

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Dormitator latifrons with 73 individuals (44 larv., 29 juv.); in lower population abundance of the species Eucinostomus gracilis with 22 individuals (14 larv., 8 juv.) And Centropomus viridis with 23 individuals (11 larv., 12 juv.). Chart 4.

Table 4 Absolute abundance of fish per stage (youth-larva) in the mangroves of Palmar.

The station E1, with the highest population average value in abundance of fish, with 36 individuals (± 20.08 STDEV.), followed by the station E2 with 27 individuals (±16.51 STDEV.), and the station E3 with 29 individuals (± 23.55 STDEV.). Chart 5.

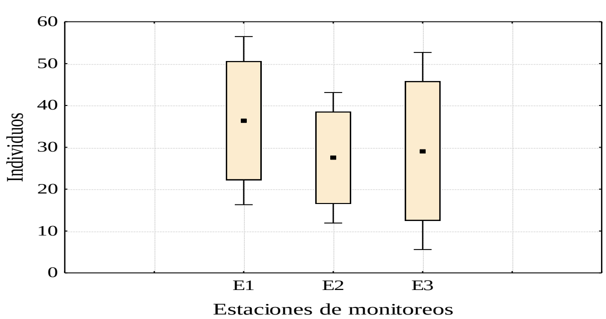

Table 5 Fish abundance by monitoring stations in the mangroves of Palmar.

In the three stations the records of population abundance of fish indicate that the stage with high levels in abundance is in the larval phase; followed by the juvenile stage. Chart 6.

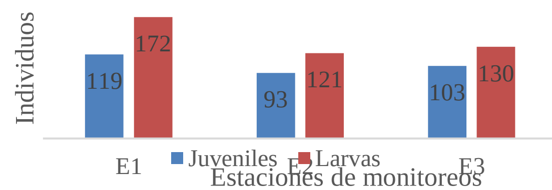

Table 6 Fish abundance by stage in the monitoring stations in the mangroves of Palmar population abundance in February.

The absolute abundance total was 109 individuals. The only species recorded in this month of monitoring was Dormitator latifrons with 109 individuals (62 larvae and 47 juveniles). Chart 7.

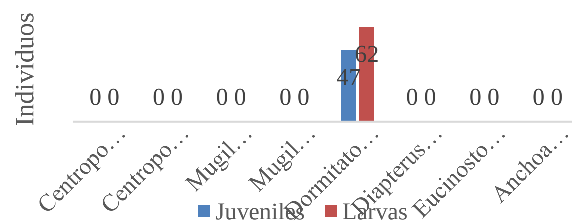

Table 7 Absolute abundance of fish per stage (youth-larva) in the mangroves of Palmar.

In the three stations the records of population abundance of Dormitator latifrons indicate that the stage with high levels in abundance, is the larval phase; followed by the juvenile stage. Chart 8.

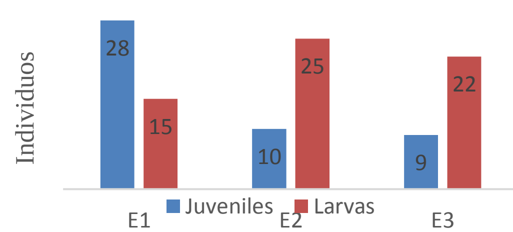

Table 8 Abundance of fish per stage in the monitoring stations in the mangroves of Palmar.

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Population abundance, in March

The absolute abundance total for this month was 721 individuals. The species Mugil cephalus (155 larvae and 104 juveniles), being the highest in absolute abundance population; follow him Dormitator latifrons (98 larv., 63 juv.), Mugil curema (96 larv., 52 juv.), Diapterus peruvianus (34 larv., 49 juv.), Centropomus robalito (25 larv., 27 juv.); Centropomus viridis (10 larv., 13 juv.), Eucinostomus gracilis (3 larv., 2 juv.) and was not recorded population abundance for the species Anchovy nasus. Chart 9.

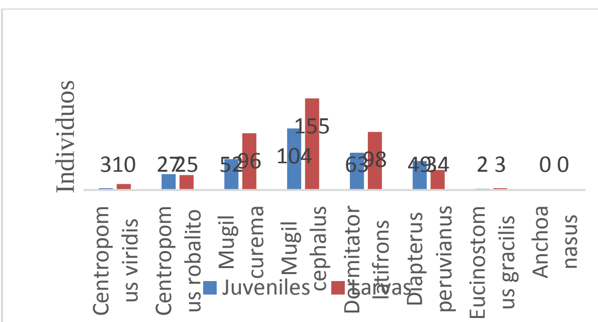

Table 9 Absolute abundance of fish per stage (youth-larva) in the mangroves of Palmar.

The station E1, was the area with the average value of population in abundance of fish, with 33 individuals (± 30.01 STDEV.), followed by the station E2 with 28 individuals (± 27,59 STDEV.) and the station E3 with 30 individuals (± 36.79 STDEV.). Figure 10.

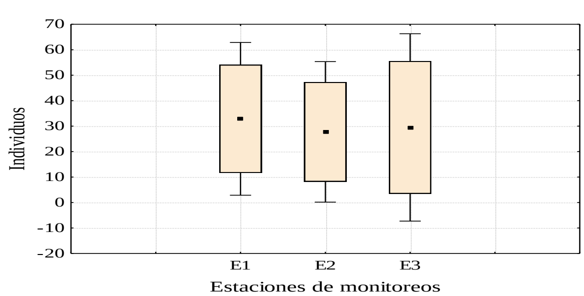

Figure 10 Abundance of fish by monitoring stations in the mangroves of Palmar.

The three stations, show that the stage with greater population abundance of fish is the larval phase; followed by the juvenile stage. Figure 11.

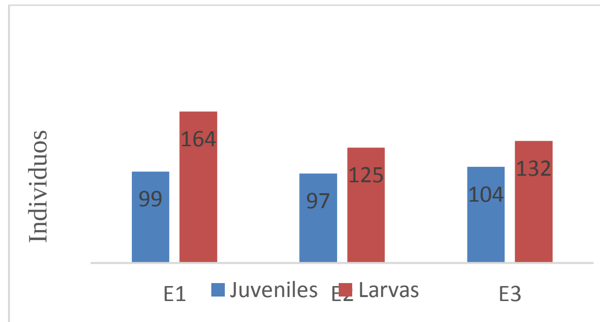

Figure 11 Abundance of fish per stage in the monitoring stations in the mangroves of Palmar.

Population abundance in April.

The total absolute abundance in the month, was 900 individuals. Mugil cephalus, registered with 280 individuals (226 larvae and 54 juveniles); followed by Anchovy nasus with 248 individuals (125 larv., 123 juv.), Mugil curema, with 158 individuals (122 larv., 36 juv.), Centropomus robalito with 84 individuals (55 larv., 29 juv.), Diapterus peruvianus 58 individuals (31 larv., 27 juv.), Centropomus viridis with 33 individuals (19 larv., 14 juv.), Dormitator latifrons with 25 individuals (17 larv., 8 juv.); in lower abundance Eucinostomus gracilis with 14 individuals (5 larv., 9 juv.). Figure 12.

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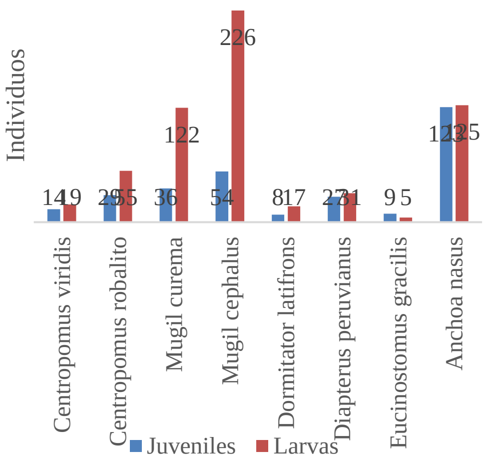

Figure 12 Absolute abundance of fish per stage (youth-larva) in the mangroves of Palmar.

The station E3 was the area with the highest population average value in abundance of fish with 39 individuals (± 44,81 STDEV.), followed by the station E1 with 38 individuals (± 33,10 STDEV.), and the station E2 with 36 individuals (± 33,10 STDEV.). Figure 13.

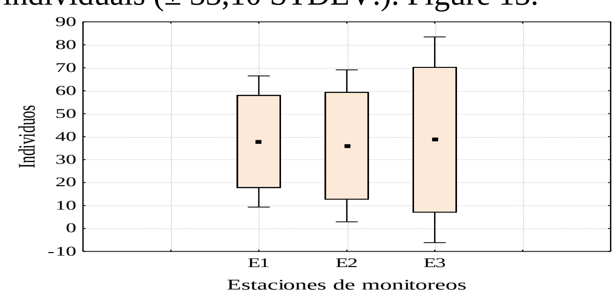

Figure 13 Abundance of fish by monitoring stations in the mangroves of Palmar.

In the three stations the records of population abundance of fish indicate that the stage with high levels in abundance is the larval phase; followed by the juvenile stage. Figure 14.

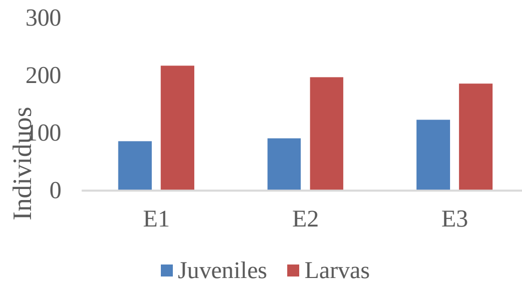

Figure 14 Fish abundance by stage in the monitoring stations in the mangroves of Palmar.

ANOVA analysis between population abundances.

It was considered the absolute abundance of each species monthly registered during the months of sampling in order to contrast the population variance and statistical significance (ANOVA). The significance of the Kolmogorov-Smirnov Test (0,132), is greater than the significance level of Î± (0.05); shows that the normality of the variances of the population means recorded during the study in the mangroves of the Commune of Palmar, follows a normal distribution.

ANOVA, indicates that the sample of 2,827 F value is greater than the F-critical 2,641; to compare the p-value being less than the value α, shows statistical significance (0.039 < 0.05); which indicates that among the population abundances registered in the study, presented significant differences. Table 1.

Origin of variations	Origin of variations	Origin of variations	Origin of variations	Origin of variations	Origin of variations	Origin of variations
Inter-grupos	56078,850	4	14019,713	**2,827**	**0,039**	**2,641**
Intra-grupos	173578,125	35	4959,375			
Total	**229656,975**	**39**				

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Post hoc Duncana, indicates that the abundance population mean more high, was recorded in the month of April; by deducting then that was the month where you found the largest number of individuals of fish in the roots of the mangrove of the Commune of Palmar; being statistically significant (0.054 > 0.05). Figure 15.

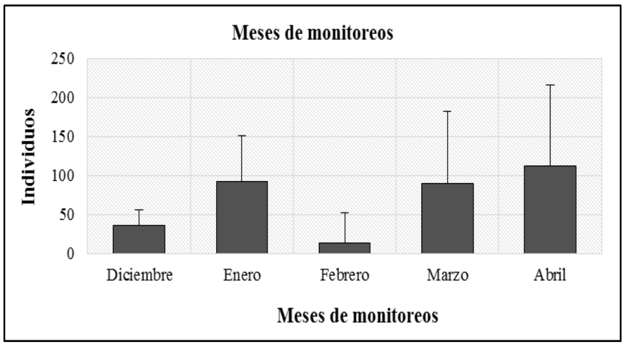
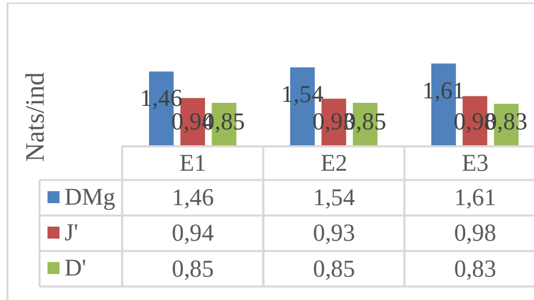


Figure 15 Fish population average registered in the roots of the mangrove of the Commune of Palmar.

Ecological Diversity alpha and beta in December

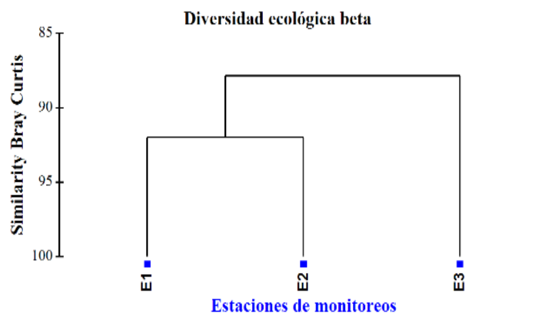
The Margalef diversity index indicates that all stations are low in species diversity; in the station E3 is attached a high level of homogeneity between the species with an index of equity of Pielou 0.98 NATS/ind and for seasons E1 and E2 an index of dominance of Simpson of 0.85 NATS/ind, which shows little dominance of species in this month. Figure 16.



	E1	E2	E3
DMg	1,46	1,54	1,61
J'	0,94	0,93	0,98
D'	0,85	0,85	0,83

Figure 16 Ecological Diversity alfa in the mangroves of the Commune of Palmar.

The hierarchical grouping of Bray Curtis, indicates that the station E1 - E2, presented a similarity of 92,01%. This association is determined by 6 species (Centropomus viridis, Mugil curema, Dormitator latifrons, Diapterus peruvianus, Eucinostomus gracilis, anchovy nasus), by its occurrence and similarity in population



abundance. Figure 17.

Figure 17 Ecological Diversity beta in the mangroves of Palmar.

Ecological Diversity alpha and beta in January

The Margalef diversity index, indicates that the diversity of species in the three stations is low. But pair the stations E1 and E2 are allocated a high level of homogeneity between their species, introducing the Pielou equity index of 0.93 NATS/ind and the index of dominance of Simpson 0.84 NATS/ind, which shows that there is little dominance of species in the study area. Figure 18.

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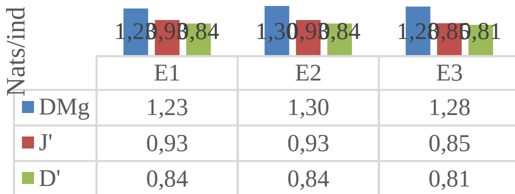


	E1	E2	E3
DMg	1,23	1,30	1,28
J'	0,93	0,93	0,85
D'	0,84	0,84	0,81

Figure 18 Ecological Diversity in the mangroves of the Commune of Palmar

The hierarchical grouping of Bray Curtis; indicates that the station E2 - E3, presents a similarity of 98,75%. The association is determined by 4 species by its occurrence and similarity in population abundance, of whom were; Centropomus viridis, Centropomus robalito, Mugil curema, Diapterus peruvianus. Figure 19.

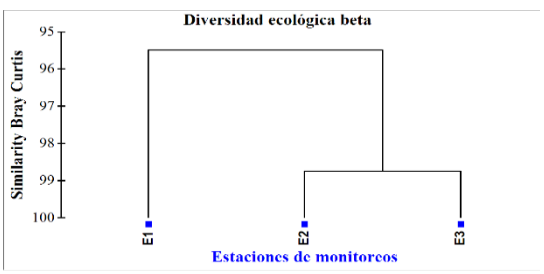


Figure 19. Ecological Diversity in mangrove roots of the Commune Palmar.

Ecological Diversity alpha and beta in February

The data obtained for the Margalef diversity, equity of Pielou and dominance of Simpson, determined that the values for each index are lower, because were only recorded a kind Dormitator latifrons; however the hierarchical grouping of Bray Curtis; indicates that in the station E2-E3 there is a similarity of 96,97%. Figure 20.

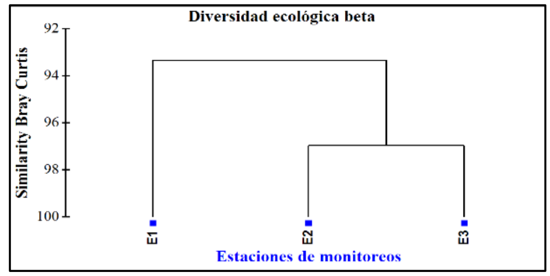
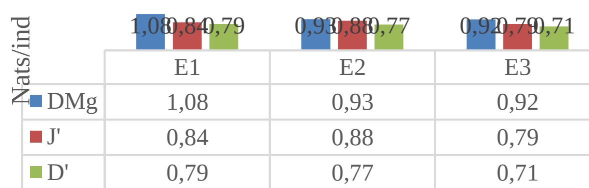


Figure 20 Ecological Diversity beta in mangrove roots of the Commune Palmar.

Ecological Diversity alpha and beta in March

The Margalef diversity index indicates that all stations are low in species diversity. The Stations E1 and E2, presented homogeneity between their heats with index of equity of Pielou 0.88 NATS/ind, index of dominance of Simpson 0.77 NATS/ind, which shows little dominance of species. Figure 21



	E1	E2	E3
DMg	1,08	0,93	0,92
J'	0,84	0,88	0,79
D'	0,79	0,77	0,71

Figure 21 Ecological Diversity alfa in mangrove roots of the Commune Palmar.

The hierarchical grouping of Bray Curtis, indicates that the station E2 - E3 presents similarities of 92,17%. The association is determined by 2 species Centropomus viridis, Centropomus robalito, by its occurrence and similarity in population abundance. Figure 22.

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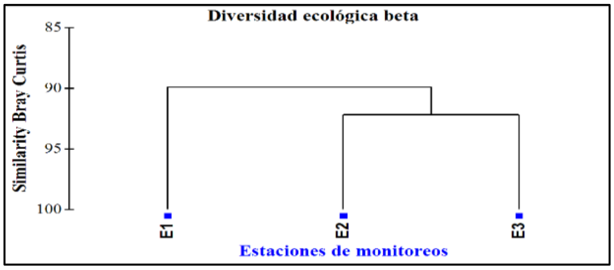
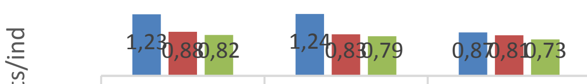


Figure 22 Ecological Diversity beta in the mangroves of Palmar

Ecological Diversity alpha and beta in April.

In this month the Margalef diversity index, indicates that all stations are low; the station E1 reflects high homogeneity between their species with Pielou equity index of 0.88 NATS/ind, and index of dominance of Simpson 0.82 NATS/ind, reflecting little dominance of species. Figure 23.



	E1	E2	E3
DMg	1,23	1,24	0,87
J'	0,88	0,83	0,81
D'	0,82	0,79	0,73

Figure 23 Ecological Diversity alfa in the mangroves of Palmar.

The hierarchical grouping of Bray Curtis, indicates that the stations E1 - E2 present similarity of 92,79%. The association is determined by 4 species Centropomus viridis, Centropomus robalito, Diapterus peruvianus, Eucinostomus gracilis, by its occurrence and similarity in population abundance. Figure 24.

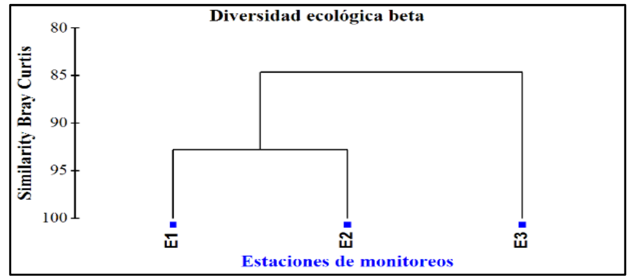


Figure 24 Ecological Diversity beta in the mangroves of Palmar

Correlation of variables

Temperature and population abundance

was recorded a linear correlation statistically non significant (0,786 > 0.05) low and direct (r = 0,11539); with a probability of 1.33%, which increased the water temperature of the mangroves in the commune Palmar, increases the abundance of fish. Figure 25.

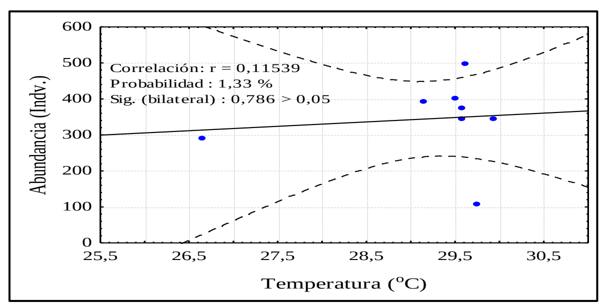


Figure 25 Salinity and population abundance.

Salinity and population abundance

There was a statistically significant linear correlation (0.004 < 0.05) high and direct (r = 0,87839); with a probability of 77,16%, that with increased salinity in the mangroves of the Commune Palmar increases the abundance of fish. Figure 26.

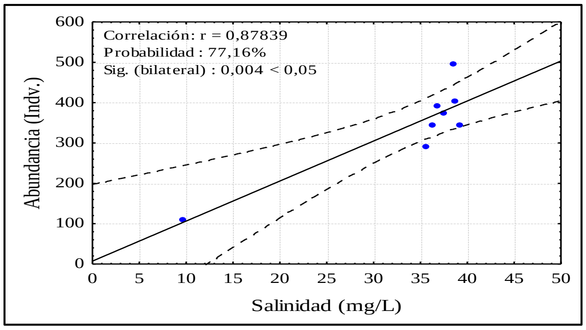


Figure 26 Salinity and population abundance.

Oxygen and population abundance

There was a statistically significant linear correlation (0.04 < 0.05), high and direct (r = 0,71776); with a probability of 51,52%, that by increasing the oxygen dissolved in the mangroves of the Commune Palmar increases the abundance of fish. Figure 27.

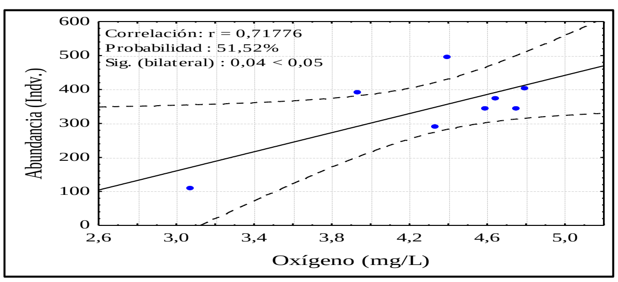


Figure 27 Oxygen and population abundance

PH and population abundance

was recorded a linear correlation statistically non significant (0.129 > 0.05) moderate and direct (r = 0,5861); with a probability of 34,06%, that to increase the pH in the mangroves of the commune Palmar increases the abundance of fish. Figure 28.

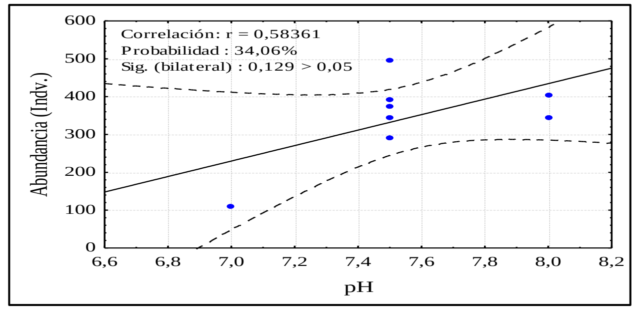


Figure 28 pH and population abundance

Conclusions

The results obtained in this research show that the composition of fish related to the roots of the mangrove is conformed by three orders, 5 families and 8 species present in the three stations, it should be noted that the month of February was presented only the species Dormitator latifron, the same that was conditioned by rainfall and water evacuation of the dam San Vicente, causing the low salinity, significantly.

Statistically the high population abundance was recorded during the months of March and April, presenting a greater concentration of individuals in the family mullets (Mugilidae) and the family Eleotridae; in the month of April the family Engraulidae, these occurrences are related to bibliographic references alluding to the periods of spawning of each family observed.

The diversity of the organisms of fish in the three stations, are conditioned by the physical parameters oxygen and salinity, this demonstrates that the mangrove ecosystem is no different in terms of fish fauna, it is worth mentioning that the results depend on the seasonality of the species mainly during the reproductive cycle.

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With the foregoing confirms the hypothesis in this study, since the environmental parameters if condition the variation of the fish communities, since marked significant differences, and variability in the community of individuals.

In addition rescues the importance of mangrove roots for fish species both larvae and juveniles, because that grant them protection, shelter and food during the life cycle of each species.

Recommendations

Should strengthen this study with research in other seasonality, to supplement the information and record other species that use these ecosystems, and at the same time be extended for up to a year to corroborate the patterns that impacted in the present investigation.

It is suggested that consideration be given to subsequent studies, an analysis of water to be able to relate the occurrence or absence of the ichthyofauna with possible polluting factors.

You must make comparisons the ichthyofauna present in the roots of the mangrove in natural environments and environments created by man (water reservoirs), I believe that in these reservoirs are present many species that are not normally found in natural environments and this is due to the fact that in these environments there is much variability in regard to physical factors.

You must consider future investigations that are oriented to the ecological and biological evaluation of the species of ecological importance and/or economic present in these systems, which will support the decision-making and raise alternatives to management and utilization of resources.

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