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Acuatic Insects at Southeast of Wetlands in the Tres Palos Lagoon, Acapulco, Guerrero, Mexico

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Abstract

Aquatic environment alteration is reflected in the biodiversity of the ecosystem, aquatic insects are used to evaluate the anthropogenic impact. In the dry season (May-June) the samples are taken in 13 collection sites in the area of wetlands. Low diversity (22 genera) is presented, the most abundant and widely distributed species corresponded to Notonecta undulata and Hetaerina americana (Hemiptera and Odonata, respectively). The Tipula sp (Diptera) recorded partial distribution and local distribution Potanamus rofous (Ephemeroptera). The 91 BMWP index corresponds to a moderate pollution degree with eutrophy.

Keywords: Diversity; BMWP; EPT; water quality; antropogenic impact; bioindicator.

1. Introduction

Tourist destinations are currently facing two main issues, a decrease in their natural habitats and water quality. On the other hand as indicated [1], the response to aquatic macroinvertebrate communities differ in abundance and diversity of sensitive taxa to stress factors. One of the latters, is the anthropic pressure in aquatic ecosystems.

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In this context it is needed to recognize the insects diversity that in aquatic macroinvertebrate, are an important component of such ecosystems [2] and, in order to evaluate water quality, they can be used as environmental bioindicators [3,4]. As a sample, methods sustained in physicochemical, biological, and, social-environmental have been developed, in order to assess the effect and magnitude of anthropic interventions [5]. Even though, natural causes are not ruled out [6] that is why, in order to keep the biodiversity, it is needed to preserve the ecosystems. The aim was to get to know the biodiversity of aquatic insects and water quality index like BMWP and EPT in the Tres Palos wetlands area in Mexico´s neotropic. The latter is a lentic environment with an anthropic impact and a high tourist potential.

2. Material and Methods

2.1 Study Area

Tres Palos lagoon is located in the municipality of Acapulco de Juarez, Southeast of Acapulco downtown, between the 16° 47’ y 16° 49’ North latitude and the 99° 39’ y 99° 47’ west longitude.

Annual average temperature goes from 16 to 28°C. It presents a shape from subcircle to elliptic (Figure 1). It has an aproximate surface of 55.5 km^2 (and a total of 5,500 Has.). Its maximum length is 15.85 km. Its maximum width covers 6 km length. The average deep is 3.5 m. [7]. The collecting locations were established in the mangrovers channel of 12 Km length approximately, located at the Southwest of the lagoon [8]. 10 collection sites were determined, including the different areas for touristic potential, as well as feeding and nesting sites for birds, these places located along the lagoon linking channel to sea environment. Other collected sites were included such as named: “manglito”, “carrizal”, *and*, “podrido”, thus, getting a total of 13 pick-up places (Figure 1).

Figure 1: Location of the study area and collection sites in the feeding of waterfowl and other tourist attractions; Southeast in the Tres Palos lagoon, municipality of Acapulco, Gro., Mex. (Prepared by the authors from information obtained from Google Earth, Image ©2013DigitalGlobe).

2.2 Field work

Sampling were carried out during the dry seasoned months of May-June, and for the insect collected, the rectangle shaped aquatic web with plastic mesh of 500 µm and pore edged was used [9, 10, 11,12].

Inside the Tres Palos lagoon the following vegetation types were found: deciduous and semi-deciduous tropical forest, halophytic marsh vegetation and, shore halofite plants, subaquatic plants with mangrove swamp, tular grove, reedbed and, gallery forest; aquatic plants with floating leaves and submerged hydrophytes, all of them with a varying degrees of alteration.

On each site of sampling, the web went from the surface deep into the water column bottom, obtaining both the insects from the sediment and insects from the same column as well. The collected organisms in each monitoring sites, were preserved in bottles with 80% alcohol [13].

2.3 Laboratory work and cabinet

With stereoscopic microscope the insect separation and quantification was made by hand. The taxonomic identification was made using specialized specific keys [14, 15, 16, 17, 18] and, being supported by experts for taxonomic confirmation purposes. The BMWP index (Biological Monitoring Working Party) was determined according to [19, 20] and, the EPT index (Ephemeroptera, Plecoptera y Trichoptera) following the Carrera and Fierro protocols [21].

2.4 Physico-chemical analysis

For the water physic-chemical characterization, several factor were determined such as temperature, dissolved oxygen, pH, electric conductivity, total dissolved solids, and, salinity.

The data were compared with two quality standards accepted by official Mexican regulations for several purposes: consumption usage, fish life, bath, and, life ecological criteria in both fresh water (NOM-127-SSA1-1994) and sea water (CE-CCA-01/89). Samples were taken all over the 13 collection stations (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, “manglito”, “carrizal”, *and,* “podrido”).

Sampling was carried out from 7:00 a 12:00 hr. A simple sampling was taken, by submerging plastic bottles 1L. After the water collected, bottles were placed in coolers to preserve them at 10°C , so that they would not lose their properties during transportation to the laboratory, before being processed with a multiparametric measurer Hash 156 (HA 54650-015).

2.5 Statistical analysis

In order to group the sampling collect points from the averages of the physicochemical values, as well as diversity and abundance, the one single factor analysis of variance was used, before obtaining Levene´s variances homogeinity. Likewise, the Scheffé and Tukey multiple arithmetical means were determined.

3. Results and Discussion

3.1 Puntual analysis

The physicochemical components analysis was carried out (Table 1) from the 13 sampling collect sites comparing them with the permissible limits (NOM-127-SSA1-1994).

As for temperature, variances resulted homogeneous and according to ANOVA, important significant differences between the collect sites were determined. Therefore, the collected sites outcome was considered homogeneous according to the multiple contrasts Scheffé tests (Table 2).

According to ANOVA, pH, dissolved oxygen and, conductivity variances resulted no homogenous; nevertheless, according to Scheffé and for pH, two average value groups were determined.

The first group was formed by sites 1, 2, 3, and, 10. The second, in turn, included 9, 7, 8, 4, 5, 6. On the other hand, for Tukey test and dissolved oxygen two groups were found. Inside those groups, the minimum value was shown for site 2, while the others showed values statistically similar. As for conductivity with Scheffé and Tukey, two groups were formed. The first group was formed by the smaller conductivity value, including sites 1, 2, and 10, for the rest, bigger average values were included (Table 2).

Table 1: Analysis of physico-chemical parameters in the 13 sampling stations at Tres Palos lagoon.

Chemica physical parameter	**Average**	**Permissible limits NOM-127-SSA1-1994**
Temperature	30.42°C	Does not apply
pH	7.30	6.5-8.5
Dissolved Oxigene	2.88 (mg/l)	1.0 (mg/l)
Electric conductivity	1524.88 µS/cm	Does not apply
Total dissolved solids (TDS)	111.90 (mg/l)	1000 (mg/l)
Salinity	1.06 % o ppm	Does not apply

Table 2: ANOVA results for one-way six physicochemical factors.

Parameter	**Homogeneity of de variances** **Levene´s - Significance**	**One-way ANOVA** **F-Fisher - Significance**
Temperature	0.86 – 0.56	0.18 – 0.99
pH	5.18 – 0.0	9.56 – 0.0
Dissolved Oxigene	4.20 – 0.00	2.70 – 0.007
Electric conductivity	1.34 – 0.22	22.0 – 0.0
Total dissolved solids (TDS)	2.27 – 0.02	22.56 – 0.0
Salinity	1.88 – 0.06	30.37 – 0.0

TDS, ANOVA variances, resulted no homogenous. Significatives differences were determined for at least one the average marks, as a result, with Scheffé test, it was determined that the minimum values showed in sites 1, 2 and 10.

For salinity, the behavior was similar, including site number 9 as well. In this context, temperature is marked as one of the most important environmental factors influencing survival and reproductions of organisms. As temperature arises, so their enzymatic reactions and reproductions rates do. Meanwhile, in most of natural aquatic ecosystems, pH goes from 5.0 - 9.0. And even though microorganisms are found in habitat inside broad pH boundaries, inside this habitat microorganisms are preserved at a neutral point. Certainly, pH fluctuates considerably, according to day time and water depth, given that the latter is heavily related to the carbon dioxide concentration. Waters with high conductivity represent an osmotic boundary for most species. By doing an analysis related to variable diversity, the homogeinity was observed and with ANOVA was determined that at least one of the groups is different. The multiple contrasts test Tukey, on the other hand, determined two groups where the minimum values were identified in sites 7, 8, 5. 6, 3,10, and, 4. While the bigger values were in sites 1, 9, and 2 (Table3). Furthermore, the smaller abundance was identified in sites 1, 8, 7, 10, 2, and 9, while the most abundance remained for sites 4, 3, 6, and 5 (Table 3).

Table 3: ANOVA one way for two biological variables

Parameter	**Homogeneity of variances** **Levene´s - Significance**	**ANOVA de una sola vía** **F-Fisher - Significance**
Diversity	1.19 – 0.30	3.20 – 0.002
Abundance	1.73 – 0.09	2.98 – 0.003

3.2 Biomonitoring

A total of 1,157 individuals were collected, distributed in 7 orders, out of which the most abundant one was Hemiptera (64.74%), followed by Odonata (22.91%) and Diptera (14.08%). In the meantime, the most minimun abundant order was Trichoptera (0.18%). The aquatic insects, in wetlands of "Tres Palos" lagoon are all a little diverse. The collect sites with bigger amount of collected groups were 8 and five respectively, while the smaller was 7 and additional sites such as "*manglito*", "*tamo*", "*Carrizo*", "*almuerzo*" and, "*campamento*" (Figure 1).

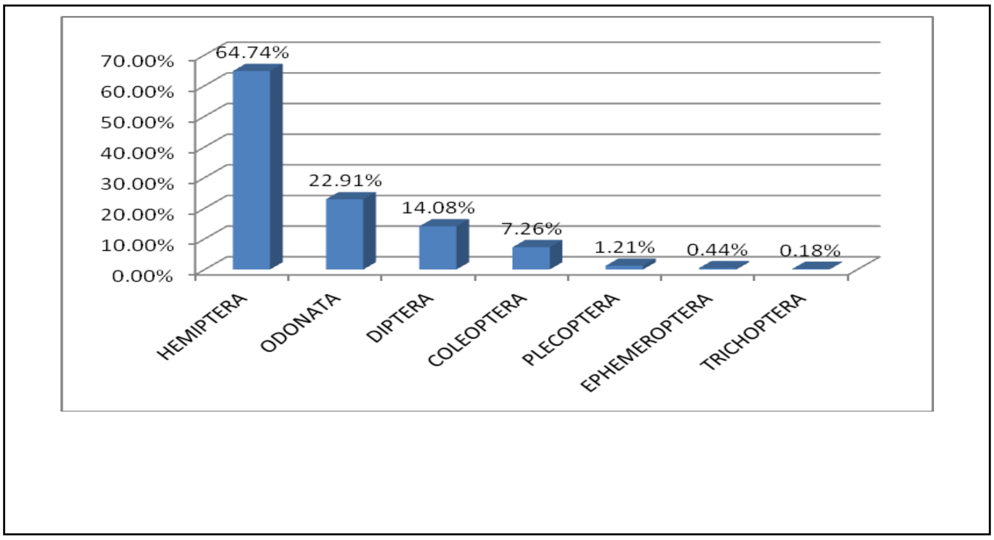

Figure 2: Diversity (X axis) and relative abundance (Y axis) of seven orders of aquatic insects larvae expressed as a percentage of 1,157 individuals total collected in the wetlands area of the Tres Palos lagoon.

The seven insects groups (Figure 2) were distributed in 21 families, 22 gender and 17 species; three species were not identified (Table 4).

The most important group concerning total collected and identified individuals was Hemiptera (749 individuals), followed by Odonata (265) and Diptera (163), while the less abundant was Trichoptera (two individuals).

BMWP index (Table 4) and EPT index (Table 5) were also calculated so as to determine water quality. The composition and abundance of aquatic insects in wetlands area is also influenced by the amount of organic material and water quality.

Those previously mentioned factors foster both, setting or absence in sampled sites. This situation also happens for aquatic lotic systems. The sea inlet at the opening of the flooding bar during the rainfall season may cause high degree of disturbance, as a consequence, only species able to resist an unstable habitat may live there, which explains the poor diversity there found (Table 4).

The BMWP index was 91, and located in parameter 61-100 which corresponds to a moderate pollution degree with eutrophy.

Regarding the group inside the index, according to Oxygen sensitivity degree of organisms, the result was class II, indicating water regular quality. By extracting EPT and BMWP indexes, the results also matched regular quality (Table 5).

As indicated [22], the insects groups composing the EPT (Ephemeroptera, Plecoptera and Trichoptera) are usually found in further abundance at the bottom of aquatic ecosystem, in this case, they were collected in the water column.

Pertaining, the species appearance during the low water at dry season, the Hemiptera and Odonata were both found in 8 samples sites (57%); nevertheless, the distributions for those groups resulted heteregoneous.

Groups such as Diptera, Coleoptera and Plecoptera, had partial distributions (regarding the sampling collect sites). Likewise Ephemeroptera and Trichoptera had local distribution.

The abundance can be influenced by factors such as habitat, vegetation type, temperature, electric conductivity, competence, tolerance, resistance and, ways to reproduce [23, 24].

Besides the strong anthropic impact generated by Sabana river, crossing the urban zone, ending in the lagoon, as well as tourist activity of boat-rides crossing the wetlands.

The impact of urbanization as pointed out [25] is a complex process linked to a broad parameter of selective pressure that Odonata group, for example, manifests according to specie and to the development stage in its life-cycle.

Thereby, species of this group can be severely damaged by the unloading of waste waters from the river of the Sabana; nevertheless, generalist species are expected to be tolerant to those conditions and increase their abundance.

After estimating the importance index for each one, the species *Notonecta undulate* (Hemiptera-Notonectidae), *Tipula* sp (Diptera-Tipulidae) and *Phyllogomphoides sp* (Odonata-Gomphidae), were determined the most frequent. Out of those, *Phyllogomphoides sp* presence given its abundance and frequency can be considered, (disregarding the need for using some other indexes) as the specie to assess the environment impact in the wetlands areas of Tres Palos lagoon.

Regarding another concern related to the Tres Palos lagoon, the aquatic bird species represent 92.46% of total birds registered for wetland. The register covers 7 orders, 16 families, 44 genders, and, 60 species [26]. Therefore, it was elucidate that in study areas, *N. undulata*, *Phyllogomphoides* sp y *Tipula* sp., are the main organisms that feed aquatic birds.

Table 4: Abundance and diversity of aquatic larva found in de dry season (1,157 individuals) in the wetlans of the Tres Palos lagoon, located in a indicator group of water quality and its value within the BMWP index.

Order	Family	Water quality Indicator group	Values BMWP Index	Specie	Frecuency
Odonata (265)	Gomphidae	II	7	*Phyllogomphoides* sp	136
				Archeogomphus sp	15
				Progomphus sp	9
	Libellulidae	II	6	*Libellula* sp	33
				Orthemis sp	25
	Lestidae	II	7	*Lestes* sp	47
Hemiptera (749)	Notonectidae	III	4	*Notonecta undulata*	597
	Veliidae	I	8	*Rhagovelia oriander*	22
	Gerridae	III	4	*Gerris remigis*	82
	Corixidae			*Sigora alternata*	3
	Hydrometridae	III	4	*Hydrometra martini*	1
	Naucoridae	III	4	*Pelocoris femoratus*	43
	Belostomatidae	III	4	*Lethocerus americans*	1
Ephemeroptera (5)	Leptohyphidae	II	5	*	5
Plecoptera (14)	Perlidae	I	10	*Acroneuria evolutan*	14
Trichoptera (2)	Hydropsychidae	II	5	*	1
	Hydribioscidae	II	5	*	1
Coleoptera (84)	Girinidae	I	8	*Dineutus assimilis*	55
	Dytiscidae	III	4	*Dytiscus* sp	29
Diptera (38)	Chironomidae	III	2	*Pseudodiamesa sp*	8

				Chironomus attenuatus	7
				Cricotopus sp	2
	Culicidae	III	2	*Culex pipiens*	7
	Tipulidae	III	2	Tipula sp	163

Table 5: Assessment of water quality by EPT index calculated from BMWP.

	BMWP index	**Frecuency**
TOTAL	91	1157
EPT absolute	25	
EPT	27	
WATER QUALITY	**Moderate**	

4. Conclusions

The aquatic insect community in the Tres Palos lagoon, in the wetlands area of the meander channel, was formed by around 22 species. The diversity was considered as low for each of the collecting sites. The spatial distribution of species resulted heterogenous. Through the generic components of the aquatic insects, the changes were analyzed in composition and abundance on the feeding areas for migratory birds at the end of the low water at dry-season.

The most representative orders, considering for their frequency and abundance were Hemiptera, Odonata, Diptera and Coleoptera and, the less representative were Trichoptera and Ephemeroptera. The collected sites with bigger amount of genders were the 8 and 5, the fewer amount was for the 7.

The frequency and abundance of Hemiptera, Odonata, Diptera and Coleoptera was obvious, as opposed to Trichoptera and Ephemeroptera. Out of 22 identified species *Notonecta undulata* and *Hetaerina americana* (Hemiptera and Odonata respectively), showed a broad distribution regarding sampling collect sites, besides corresponding to main organisms aquatic birds, present at the study areas, can feed from them. On the other hand, it also showed a partial local distribution of *Tipula* sp. (Diptera) and *Amphineura* sp. (Plecoptera) and *Potamanthus rufous* (Ephemeroptera).

The *Phyllogomphoides sp* (Odonata-Gomphidae) was considered the indicator species for assessing the ecosystem environmental impact. And given its abundance, it indicates that this has remained as low impact area.

The BMWP and EPT index corresponds to waters with moderate pollution, regular quality and early eutrophication.

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