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RESEARCH ARTICLE

IMPACT ASSESSMENT OF DRAGONFLY DIVERSITY IN DIFFERENT WETLAND ECOSYSTEMS IN COIMBATORE WITH SPECIAL REFERENCE TO ABIOTIC FACTORS

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Abstract

Coimbatore district possess many wetlands, amongst them Singanallur, Sulur, Kumarasamy and Narasampathy were selected for the present study. Physico-chemical parameters of the waters for four selected wetlands were carried out and it revealed that Singanallur and Sulur wetlands were highly polluted as it possessed the ranges beyond the permissible limits of WHO. Since dragonflies are the indicator and flagship species of the wetland ecosystem the diversity of dragonflies were analyzed with special reference to water quality parameters of the selected wetlands. According to the survey, totally 11 species of dragonfly, belonging to two families (Libellulidae and Aeshnidae) were identified. Among the selected four wetlands the diversity of dragonflies was high in Sulur and Singanallur where the pollution level was also high. The present study clearly indicated that the diversity of dragonflies was not dependent upon the water characters but vegetation (aquatic and marginal) could have influenced their abundance in these wetlands.

INTRODUCTION:

Dragonflies and damselflies are collectively called odonates and are one of the most common insects flying over forest, fields, meadows, ponds and rivers and are often termed as the bio-indicators of the aquatic ecosystem. They are the flagship insect communities which indirectly influence the tropic level balance of the lake ecosystem. Global about distributions of odonates indicated that 5,740 species are known, of this 470 species in 139 genera and 19 families exist in India (Subramanian, 2009). In Tamilnadu, Kandibane et al., (2005) recorded 12 species in irrigated rice fields of Madurai. Gunathilagaraj et al (1999) reported 16 species of Odonates in rice fields of Coimbatore, whereas, a recent study by Arulprakash and Gunathilagaraj et al., (2010) revealed twenty-one species of Odonata (14 species of Anisoptera and seven species of Zygoptera) belonging to 17 genera under four families were recorded from 13 temporary water bodies of Coimbatore and Salem districts in Tamil Nadu. Vincent et al., (2008) described that certain families of Anisopterans are dependent on the characters of the water habitat for instance the members of Coenagrionidae and Libellulidae are high in the stagnant water systems (Rehn, 2003).Perhaps there is a connecting link between the characters or the nature of the water systems that influences particular group of anisopterans to choose the specific environment for their survival. Several reports convey that the environmental and temperature conditions alter the species diversity of an area, and this is supported by the findings of Fraser (1933) and Subramanian (2005) which revealed that shade and aquatic vegetation could favour Zygoptera more than Anisoptera. Based on the above, the survey has been conducted to study impact of species diversity of dragonflies based on the biotic factors like water characteristics and aquatic vegetation in the selected wetlands of Coimbatore, Tamil Nadu.

MATERIALS AND METHODS

1. **Study area:**

The survey was conducted in four wetlands namely Kumarasamy, Narasampathy, Singanallur and Sulur which lies in the geographical extent of 11°00'N-77°00'E of Coimbatore region during December 2011 –May 2012.

2. **Collection and preservation:**

Dragonflies were collected by hand sweep net and random field sampling method was used to cover entire study area, the insects were pinned and photo documented by using Cannon power shot SX30 IS camera. Identification was done by observing wing venation, colour pattern and genetalia, described in available keys/identification guides by Fraser, 1957 and Subramanian, 2005 and Emiliyamma (2005). Information regarding date of collection, locality, etc., about each specimen was also recorded.

3. **Physico-chemical parameters:**

The physico-chemical parameters were determined according to the standard methods described in APHA, (1998).Parameters such as pH, Temperature, Salinity, Total Dissolved Solids (TDS) and Electrical Conductivity (EC) were recorded in the field using portable instrument (μ- Water and Soil Analysis kit model -1160). Dissolved Oxygen was analyzed by Winkler's method, while other parameters such as Alkalinity, Total Hardness, Chloride and Chemical Oxygen Demand (COD) were determined by standard titrimetric method.

4. **Diversity and Statistical analysis:**

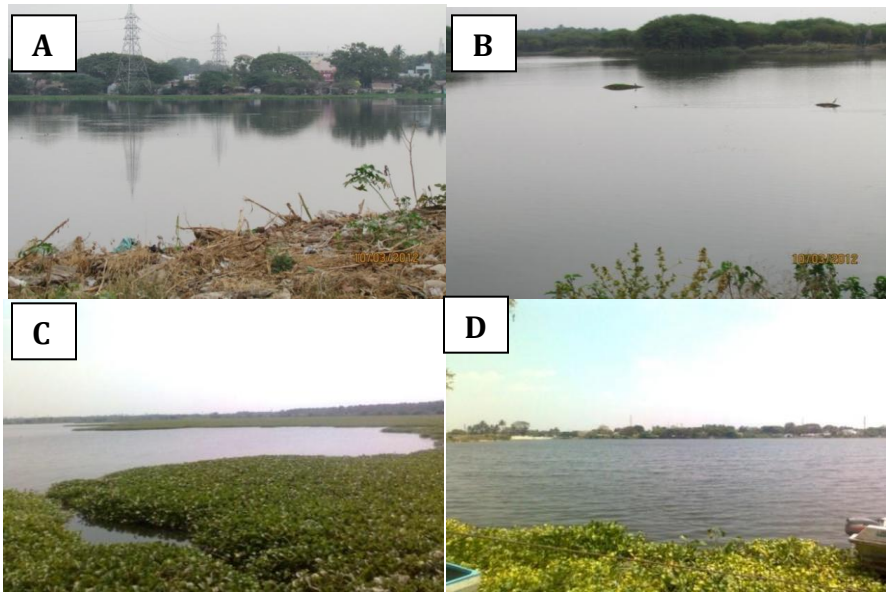
Quantitative estimation of species and individuals in different provenances was made using data from survey. All the statistical analyses were performed using PAST 3.01 software.

RESULTS:

A total of 181 individuals were recorded from the study area constituting of four wetlands (Kumarasamy lake, Narasampathy lake, Singanallur lake and Sulur lake) shown in (**fig-1)** during the period of December 2011-May 2012 (6 Months).About 11 species of Dragonflies belonging to 2 families, viz. Libellulidae and Aeshnidae were collected and identified (**fig-2**). The taxonomical composition of the species is represented (**fig-3)**, based on it the species belonging to Libellulidae dominated in all four wetlands. Aeshnidae was comparatively low to the Libellulidae family. The mean diversity range among the different habitats taken during the six months study period (December 2011- May 2012) revealed that the Sulur wetland possessed the high diversity range on comparison with the others and lowest mean diversity was recorded in the Kumarasamy wetland (**fig-4)**. In addition to it, the other two wetlands, Narasampathy and Singanallur recorded the moderate levels of the mean diversity range. The mean diversity range recorded during the study period (December 2011-May 2012) in the four habitats, resulted that the December month possessed highest diversity (**fig-5)** when compared to the other months. During the January month there was considerable decline in diversity range as compared to the diversity range of December. The mean diversity of January and February months were similar followed by considerable decline in the diversity during March, April and May months. SHE analysis was performed to know the diversity and evenness of the 11 species of dragonflies in the four wetlands (**fig-6**) and clustering analysis (**fig-7**) was performed based on the number and abundance of the different species of dragonflies in the four wetlands.

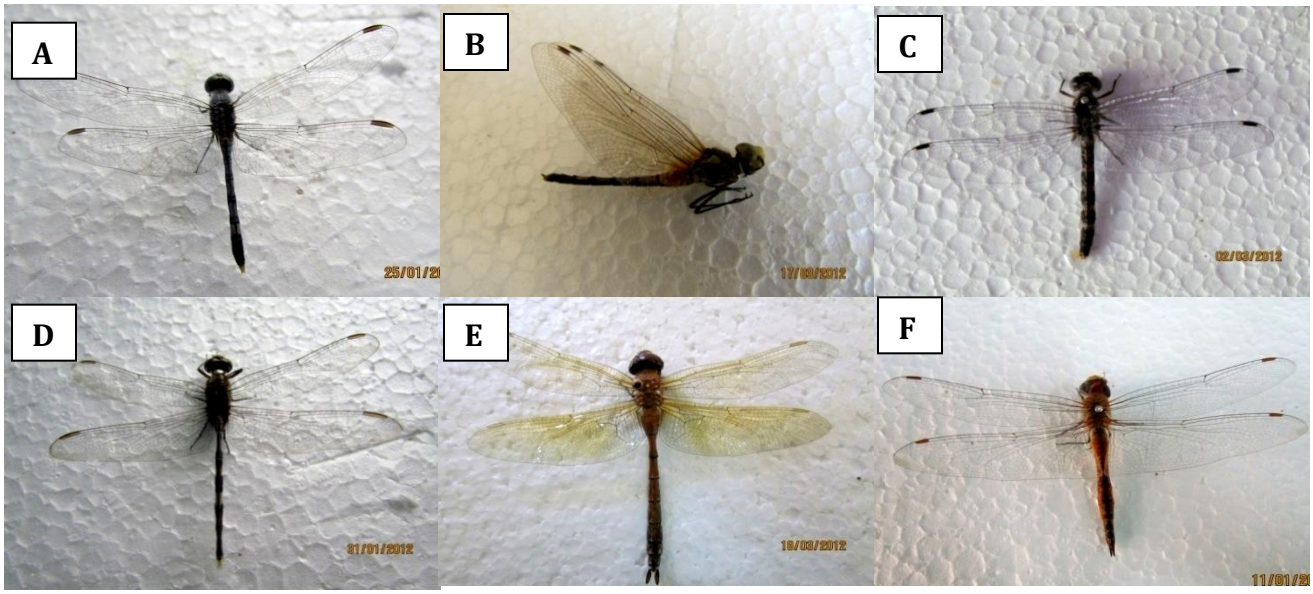
Coimbatore district possess many wetlands, amongst them four wetlands. Three of them are urban wetlands (Singanallur, Sulur and Kumarasamy) and one is the rural (Narasampathy).Physico-chemical analysis of the waters in four selected wetlands were carried out (**table-1)** and it revealed the parameters such as electrical conductivity, alkalinity, total hardness, chlorinity, and biological oxygen levels were beyond the permissible limits of WHO in the Singanallur wetland. Whereas, salinity, dissolved oxygen, total dissolved solids and chemical oxygen demand values were much beyond the permissible limits. Narasampathy and Kumarasamy wetlands possessed the values which were comparatively lower than that of Sulur and Singanallur.

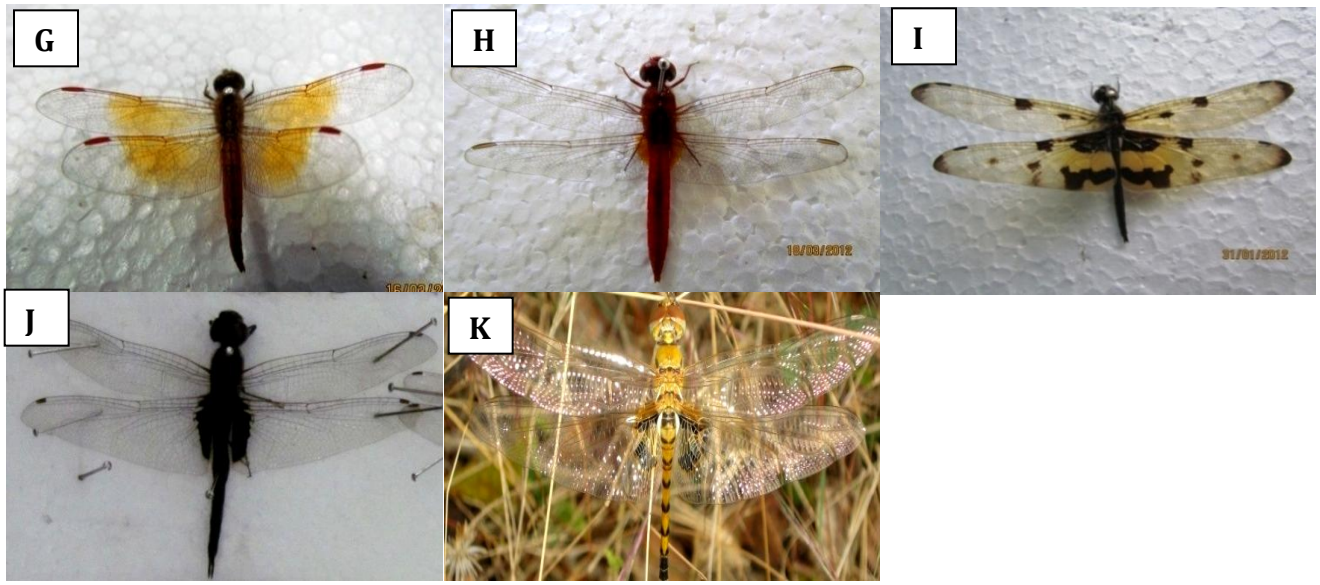
Figure 1
Location of the selected study areas with the presence of aquatic vegetation in (C) and (D) and garbage disposal in (A)



A-**Kumarasamy Lake**
B-**Narasampathy Lake**
C-**Singanallur Lake**
D-**Sulur Lake**

Figure 2
Eleven species of dragonflies belonging to Libellulidae (A, B, C, D, F, G, H, I, J and K) and Aeshnidae (E) family collected from the four wetlands





A-*Diplacodes trivialis* (Ground skimmer)
B-*Trithemis pallidinervis* (Long legged marsh glider)
C- *Bradinopyga geminata* (Granite Ghost)
D- *Orthetrum sabina* (Green Marsh Hawk)
E-*Anaciaeschna jaspidea* (Rusty darner)
F-*Pantala flavescens* (Common wandering glider)
G- *Brachythemis contaminata* (Ditch jewel)
H-*Crocothemis servilia* (Ruddy marsh skimmer)
I-*Rhyothemis variegata* (Common Picture wing)
J-*Tramea limbata* (Black Marsh Trotter)
K-*Tramea basilaris* (Red Marsh Trotter)

Figure 3

Box plot representation of the taxonomical composition of 11 species of dragonflies based on their abundance in the selected wetlands

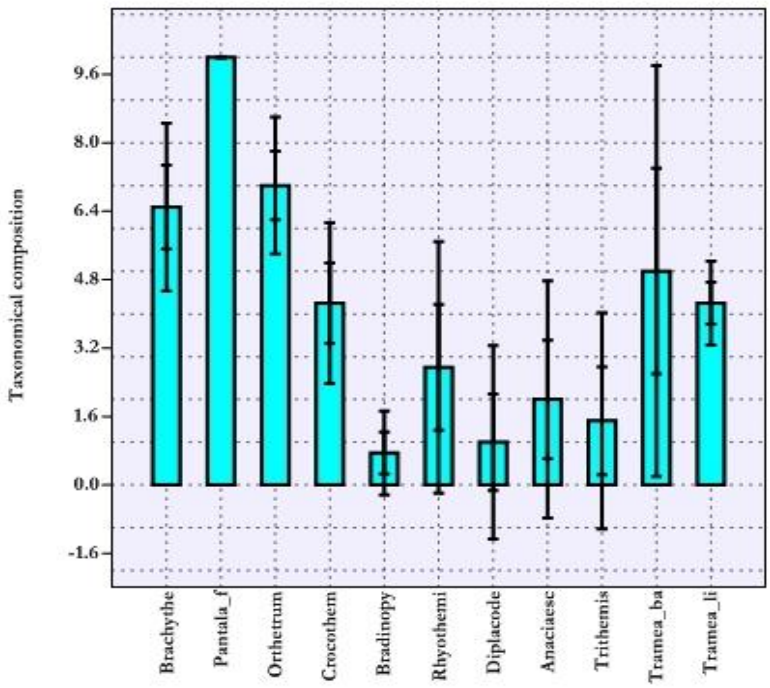


Figure 4

Mean Diversity range and Standard Deviation of 11 species of dragonflies between habitats

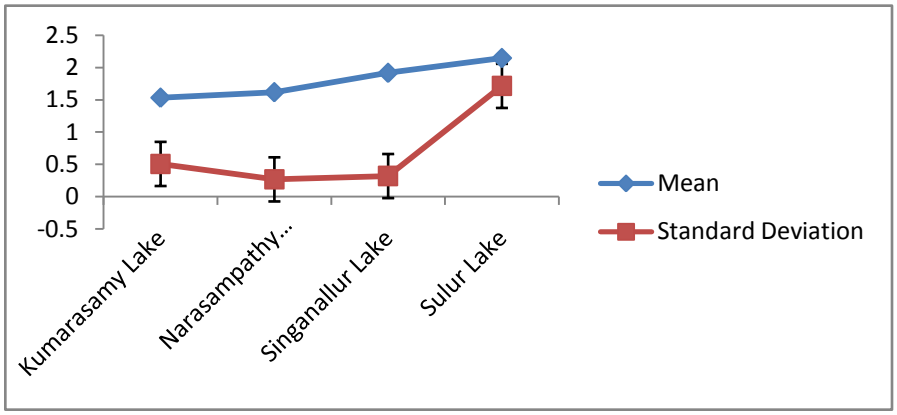


Figure 5

Mean diversity range and standard deviation of 11 species of dragonflies between months of the study period

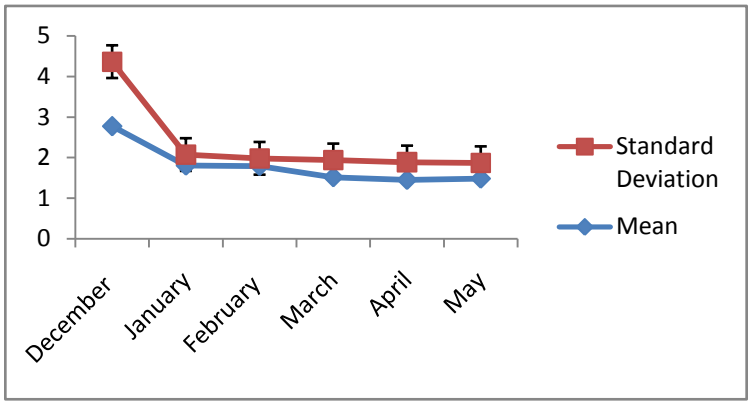


Figure 6

Graph representing the diversity indices Simpson, Shannon and Evenness (SHE) of the of 11 species of dragonflies

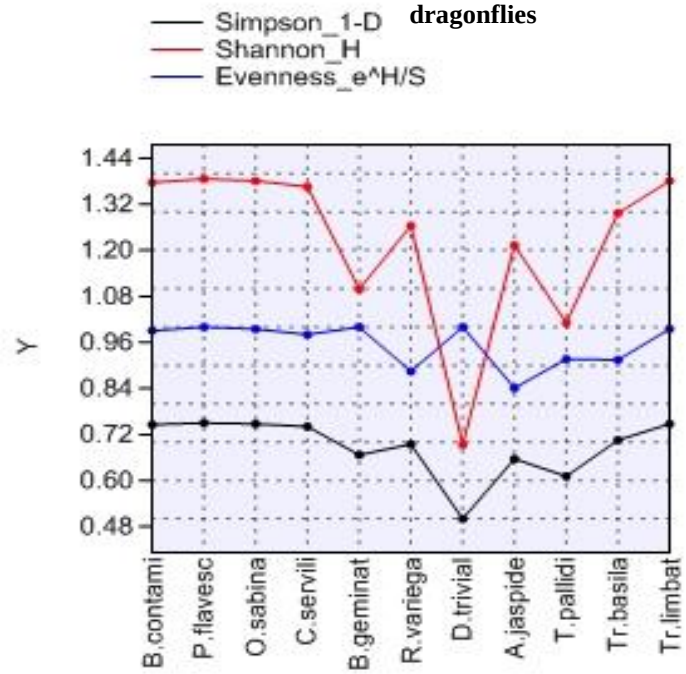


Figure 7

Cladogram representing the clustering analysis based on abundance of the of 11 species of dragonflies species

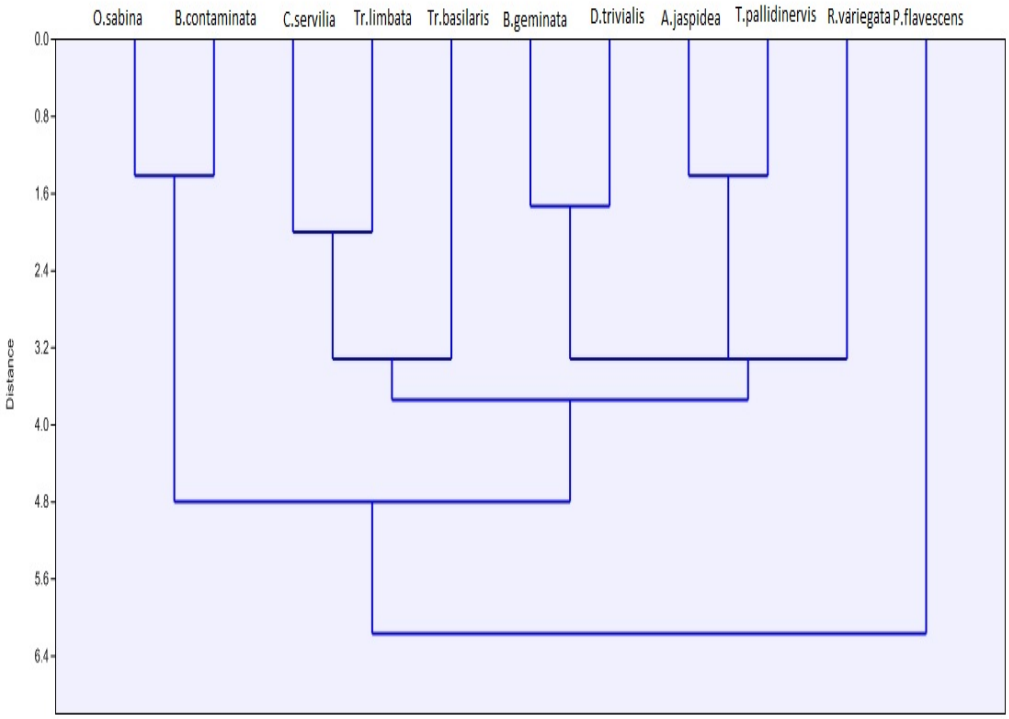


Table 1

Mean concentrations and S.D of the Physico-chemical parameters of the waters of selected wetlands

Parameters	NP	KS	SI	SU
p H	6.798± 0.40	6.516± 0.57	7.193± 0.39	6.628±0.51
Temperature (°C)	29.868± 3.00	30.046± 2.78	29.930± 2.41	30.057±3.18
EC (µs/cm)	284.351± 71.89	895.830± 189.33	1557.290±362.01	1132.680±121.97
Salinity(ppt)*	1.230± 0.715	1.327± 0.480	1.8625± 0.718	1.9306±0.552
Alkalinity(mg/L of $CaCO_3$)	114.060± 41.81	260.510± 46.28	386.661± 79.45	357.311±71.42
TDS (ppt)*	1.155± 0.5967	1.441± 0.6501	1.727± 1.0515	2.438±0.600
Total Hardness (mg/L)	84.068± 20.757	216.661± 42.729	458.915± 99.937	309.871±63.460
Chloride (mg/L)	46.531± 27.861	128.873± 27.378	267.846±76.68	169.55±50.789

DO (mg/L)	3.825± 0.203	1.738± 0.345	2.291±0.441	1.835±0.441
BOD (mg/L)	12.705± 4.570	33.158± 3.259	44.231±4.11	43.665±2.736
COD(mg/L)	12.273± 4.473	22.988±10.219	20.431±7.934	20.825±4.751

*µ- Water and Soil Analysis kit model -1160

DISCUSSION:

In the Coimbatore city, there are 28 major wetlands, mostly fed by the river Noyyal. The river and the river-fed lakes support a large number of plants (Chandrabose and Nair 1988) and animals including migratory species of birds. In an urban biodiversity, wetlands form an important area in supporting species diversity and to regulate the ecological web. Most of these wetlands get dried in summer and serves as a dumping yard for garbage and industrial waste. Several studies on the analysis of physicochemical parameters were carried out and the pollution from various industrial, municipal and domestic sources, and heavy metal contamination were studied and reported. According to Mohanraj et al., (2000), the pollution status of 8 lakes of the Coimbatore (Selvachinthamani Lake, Singanallur Lake, Ukkadam Lake, Perur Lake, Valankulam, Ammankulam, Selvampatti Lake and Kumarasamy Lake) was assessed and the reports of physicochemical characters of Kumarasamy wetland, the pH, COD and DO were considerably low. On contrary, our results indicated high levels of EC, Alkalinity, TDS, BOD and Chloride which indicated the maximum pollution. In the case of Singanallur wetland, The pH, EC, Alkalinity, Chloride, Total Hardness, DO and COD were high in the former studies by Mohanraj et al., (2000) in comparison with the present studies but TDS and BOD were low. This hike in the pH hints at its increased levels of pollution in the wetland.

The present study is comparable with that of Rachna et al., (2010), which was carried out to monitor the water quality of Ukkadam, Perur, Chinnakulam and Kuruchi lakes in the Coimbatore district. Vora et al., (1998) reported that the alkaline nature of the water could be due to solutes, which may show a buffering action i.e. H^+ ions are compensated with OH^- ions. The pH of the selected wetlands ranged from 6.5- 7.5, where all the values were in the permissible limit (6.5-8.5) as per the WHO standards. Conductivity of water depends upon the concentration of ions and its nutrient status and variation in dissolve solid content. Fluctuations in the conductivity were noted during the study period and it may be due to the increased concentration of salt because of evaporation. The electrical conductivity values were partly within the permissible limits (600µs/cm), that is Narasampathy wetland was within the permissible levels and all the other three wetlands EC values ranged from 895-1557 µs/cm. Certainly, a high level of conductivity reflects the pollution status as well as tropic levels of the aquatic body (Ahluwalia, 1999).Salinity values of the wetlands varied from 1.2-1.9ppt. In the case of the Alkalinity, the Narasampathy Lake was in the permissible limits of 120 mg/L whereas; the Singanallur Lake possessed the high alkalinity levels of 386.61mg/L. The addition of large amount of sewage waste and organic pollutant in the lake also effect photosynthesis rate, which also result in death of plants and living organism. The degradation of plants, living organism and organic waste might also be one of the reasons for increase in a carbonate and bicarbonate, resulting in the increase in alkalinity value (Chaurasia and Pandey, 2007).The TDS values of the four wetlands range from 1.15-2.43 ppt which is above the permissible limits. This may be due to the pollution caused by domestic waste water, garbage, fertilizer, etc. Certainly, high concentration of TDS enriches the nutrient status of water body which resulted into eutrophication of aquatic ecosystem (Verma et al., 2012). The values of total hardness was found within the permissible limits of WHO, Mohanta and Patra 2000 stated that addition of sewage, detergents and large scale human use might cause elevation of hardness of water, similarly the values of chloride content was also found within the WHO standards except Singanallur lake >250 mg/L. Sirsath et al., (2006) has indicated that, the greater source of chlorides in lake water was due to the disposal of sewage and industrial waste. In addition, Purohit and Saxena et al., (1990) reported that the high chloride concentration of the lake water may be due to high rate of evaporation or due to organic waste of animal origin. Measurement of dissolved oxygen is a primary parameter in all pollution studies. DO levels were very low below the permissible limits and range from 1.7- 3.8mg/L while the permissible limit is 5 mg/L. Dissolve oxygen value was comparatively higher in the Narasampathy Lake. According to Vijayan (1991), levels of high DO indicate good aquatic life. In addition elevated levels of temperature and accumulation of sewage and biological waste might be responsible for low value of DO. The BOD and COD values were tremendously high 12-44 mg/L and 12-20 mg/L respectively, which were comparably high with the WHO

standards 5 mg/L for BOD and 10 mg/L for COD. There is an inverse relationship between DO and BOD was noted. High values of total dissolved solids are responsible for higher BOD Karthikeyani et al., (2002).These studies also support our water sampling analysis and except Narasampathy all the other wetlands exhibited high levels of BOD. The COD levels were found to be high in Kumarasamy Lake due to the organic substances from the sewage and domestic garbage. It is obvious and clear from the results that Narasampathy was less polluted on comparing it with all the other three wetlands chosen for the study. But, interestingly, the diversity ranges of the dragonflies are found to be higher in the Sulur Lake that is likely to be highly polluted which is understood from the results of our study.

In the current study the diversity of the dragonflies were analyzed in the four wetlands. Odonates are the predominant aquatic insects and often referred as the bio indicators of the aquatic ecosystems and riparian vegetation. The period of study was done during the prevalence of north-east monsoon (January -April).Rainfall is the only source of water for the wetlands and it is the sole reason for the wetlands to receive water and get flooded during the monsoon seasons. Since dragonflies are aquatic insects the period of study was aptly chosen to analyse the diversity range of dragonflies in the four wetlands. Higher number of the individuals was recorded in the Sulur followed by Singanallur, Narasampathy and Kumarasamy wetlands. According to the studies of Maria et al., (2010) the dragonfly species collected from the urban sites tend to be commonly available species, those which are rare, often occur in the rural wetlands. This indirectly conveys the fact that rare species tend to choose less polluted habitats instead of the wetlands in the urban areas. Our studies were in perfect association with the above reports the species collected from our study areas belonged to the family of Aeshnidae and Libellulidae. In relation to the above interpretation Rehn, 2003 pointed out that almost all ubiquitous species belonging to Coenagrionidae and Libellulidae families dominate in unshaded habitats with stagnant water. The reasons for their occurrence in the wetlands may be due to their shorter life cycle and widespread in distribution Norma-Rashid et al., (2001) and tolerant to wide range of habitats (Gentry et al. 1975; Samways 1989).The diversity range of the dragonflies was high in the Sulur followed by the Singanallur, Narasampathy and Kumarasamy wetlands in terms of habitat preference. This may be due to the possible reasons due to the presence of marginal vegetation and less shade cover areas in the wetlands. The studies of Remsburg et al., (2008)proved that the physical habitat conditions influence adult dragonfly (Odonata: Anisoptera) riparian site selection and hypothesized that most breeding odonates select riparian areas are devoid of shade, and possessed with high density and variety of understory perch structures and the results revealed that there was less abundance of dragonflies in the areas where there were shade covers and these results indicated that shade alone directly reduces dragonfly habitat selection, isolating one aspect of habitat change that can alter insect behaviors.

Odonate species in the "percher" behavioral guild may require riparian understory vegetation because the adults guard breeding territories, thermoregulate, and watch for prey from plant perches (Corbet, 1999). Previous studies indicate greatest abundances of adult dragonflies in areas with tall lake plants (Foote and Hornung, 2005), perhaps because they serve as perch structures. In the present study all the wetlands possessed the riparian vegetation, in particular Sulur and Singanallur wetlands possessed the marginal vegetation that provided the distribution of the dragonflies encouraging their abundance and diversity. These favored the conditions such as perching, ovipositioning, territorial activity in case of male dragonflies and facilitating for the prey catching. Therefore these have been the basic reasons for the high diversity of the dragonflies in the Sulur and Singanallur wetlands.

Diversity of the dragonflies was high during the month of December because the water levels where considerably high and the temperature was quite low compared to the other months of the study period. The water levels were maintained from the previous monsoon rains although there was not much amount of rainfall received during the months of December and January. From the integrative reports of the physico-chemical parameters and the diversity of dragonflies in the selected wetlands of our study it is lucid that Sulur lake possessed the highest diversity range although the water of this particular lake possessed the parametric values above the permissible limits posed by WHO.

The Singanallur and Kumarasamy had a wide distribution of the floating aquatic plants, chiefly Eichornia crassipus during the study period. This distribution of the *Eichornia sp*. was also formerly reported by Mohan raj et al., (2000) from the Singanallur wetland. As per the studies of Steytler and Samways, 1995, nine physiognomic types of vegetation were recognized as the possible reasons for the presence of the dragonfly abundance: Tall emergent sedges, Bush, Grasses (Short grass, Broad-bladed grass), Water-surface plants, Water-lilies, and forest. Here from the present studies water surface plants for instance the above mentioned Eichornia species were widely spread along the margins of the two wetlands (Singanallur and Sulur).The presence of these water surface plants perhaps enhance the distribution of the dragonfly species by favoring in the ovipositional activity, prey catching and territorial behavior. Moreover, the marginal vegetation was found in the two wetlands which chiefly constituted the tall grasses and weeds. Reports of the studies carried out by Kandibane et al., (2005) conveyed that the species of

dragonflies preferred tillerring stage of the diversified ecosystem because the canopy of weed plants and rice crop covered the entire surface area to create a favorable microclimate for the abundance of dragonfly. Therefore the riparian vegetation found in those two wetlands provided facilitation for the perching and the ovipositioning behavior of the dragonflies which could be one of the possible reasons for their distribution in the wetlands. Whereas in the case of Narasampathy wetland, the aquatic vegetation was completely absent and the trees were mostly found on the bunks of the lake that provided shaded areas. Therefore the absence of vegetation would have been the reason for the less distribution of the dragonflies in this particular lake in spite of the less polluted status of it.

CONCLUSION

Dragonflies are bio indicators of the aquatic ecosystems. Hence, this study is only a preliminary assessment of examining whether the quality of the water samples have any influence on the diversity of the dragonfly communities and further warrants detailed research in this particular area to serve as a milestone for the conservation of the wetlands and their insect communities ultimately. In coherence to the above, the results acquired from the present study was compared with WHO and BIS standards and it was found that maximum number of water parameters in Sulur and Singanallur lake were above desirable limit during the selected study period. Obviously, it is clear that these wetlands receives very high amount of pollution from the surroundings and they are in a highly contaminated condition. But interestingly, the diversity was also high in the Sulur wetland. The life cycle of the dragonfly constitutes two life stages: the nymphal (aquatic) and the adult (aerial) phase. Mostly nymphal stage is predominant than the adult stage and much of the lifetime is spent in the water. Since the nymphal life stage is predominant in the life cycle of a dragonfly, it is directly associated with the aquatic ecosystem therefore the effects from polluted water system would have direct influence on the distribution of nymphs rather than the adult dragonflies. But in our study the nymphal assessment was not carried on, therefore in accordance with our studies, factors like vegetation, shade cover, presence of the aquatic plants and riparian vegetation perhaps could have highly influenced on the distribution of dragonflies in the particular wetlands.

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