AACL BIOFLUX
Aquaculture, Aquarium, Conservation & Legislation
International Journal of the Bioflux Society

Species richness of Odonata in selected wetland areas of Cagayan de Oro and Bukidnon, Philippines

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Abstract. Monitoring the environment through indicator species such as Odonata which has an aquatic larval stage and a terrestrial adult stage allows fast and easy means of evaluating habitat quality. This study aims to examine the species richness of Odonata in nine wetland areas of Bukidnon and Cagayan de Oro City. A survey using random sampling method was conducted from October to December 2012. Thirty-eight species were recorded under 28 genera and 12 families. Nineteen species are endemic. Species richness of the Odonata in relatively undisturbed areas ranges from 17-20 species. A lower species richness of 6-12 species was recorded in urbanized and disturbed areas. A relatively rare taxa, *Rhinagrion reinhardi* was recorded in one of the pristine areas. Further surveys in poorly studied and undisturbed areas may result in a higher species richness of Odonata.
Key Words: endemic, habitat, indicator, species, undisturbed.

Introduction. Odonata communities can be found in an extensive array of freshwater systems dependent on biotic and abiotic constraints. Several species are stenotopic and require specialized habitat conditions (Oertli 2008) and the assemblages are highly visible and sensitive indicators of long-term environmental conditions of the water environment (Stewart & Samways 1998).

There are at most 300 species of Odonata in the Philippines, with an estimated 350-400 species existing in the beginning of the 20th century, over 130 species are found in Mindanao (Hämäläinen & Muller 1997), which is the second largest island of the archipelago.

Recent works of Villanueva (2009) up to the present covered a number of expeditions to areas in the Philippine islands that are poorly or practically unexplored. These resulted to successive discoveries of new records of species distribution, as well as assessments of current threat status of species. In Mindanao, surveys include areas of Davao Oriental, Siargao and Bucas Grande islands on the eastern coast, one of the most interesting since species of Platycnemididae and Platystictidae are confined to this region, and recent surveys include Tawi-Tawi, Sanga-Sanga, and Jolo Islands (Villanueva & Mohagan 2010; Villanueva 2011a; 2011b; Villanueva & Cahilog 2012). Very recently, 36 species were documented by Cayasan et al (2013) in Zamboanga del Sur, Philippines. Quisil et al (2013) documented a higher number of species (49) in Surigao del Sur, Philippines of which two species are new records for the island.

The existing human-induced threats coupled with climate change, affect the abiotic and biotic conditions, putting detrimental pressures on the natural flora and fauna and increasing the risks of loss of biodiversity. Land-use change is recognized as the main threat to biological diversity of terrestrial biomes (Sala et al 2000). Native habitats are rapidly disappearing, as they give way to agronomic expansion and urbanization (Maala 2001). Oppel (2006) even showed that there is a difference in the Odonata diversity between disturbed and undisturbed sites as undisturbed sites mainly host

endemic species. Mapi-ot et al (2013) recorded low species diversity and endemicity of Odonata in areas of Misamis Occidental with high presence of on-site disturbances. Despite the many surveys in different areas in the Philippines, there is no available record on Odonata in Bukidnon and Cagayan de Oro City.

The objective of the present study was to assess the species richness and endemism of Odonata in five sampling areas in the province of Bukidnon which are relatively undisturbed sites and the four sampling sites in an urban area like Cagayan de Oro City.

Material and Method

Study areas. Four municipalities in Bukidnon, namely, Manolo Fortich, Sumilao, Impasug-ong and Damulog and two barangays, Bugo and Tablon in Cagayan de Oro City (Figure 1) were selected as study areas. Table 1 shows the nine sampling sites established in the study areas with the coordinates. Two sampling sites were established in the municipality of Manolo Fortich, one each in the municipalities of Sumilao, Impasug-ong and Damulog in the province of Bukidnon. Two sampling sites were established in Bugo and Tablon Cagayan de Oro City.

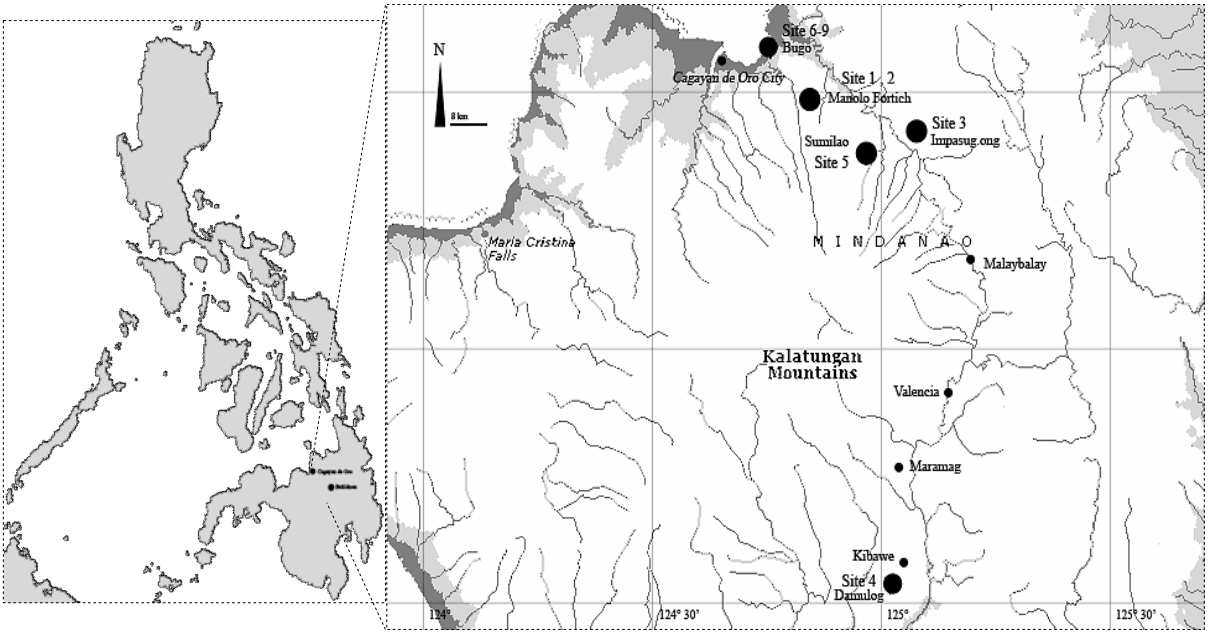


Figure 1. Study areas in Cagayan de Oro and Bukidnon (MSN Encarta 2009).

Table 1

Coordinates of the sampling sites in Cagayan de Oro and Bukidnon

Site no.	*Site name*	*Coordinates*	
1	Sankanan, Manolo Fortich, Bukidnon	8°31'78.2"N	124°857'043"E
2	Mangima, Manolo Fortich, Bukidnon	8°37'33.3"N	124°88'13.6"E
3	CEDAR, Impasug-ong, Bukidnon	8°24'94.6"N	125°03'49.2"E
4	Sampagar, Damulog, Bukidnon	7°52'4362"N	123°37'26.90"E
5	Poblacion, Sumilao, Bukidnon	8°31'50.6"N	124°96'85.7"E
6	Bantiles, Bugo, Cagayan de Oro City	8°30'7.1928"N	124°45'14.48"E
7	Villa Trinitas, Bugo, Cagayan de Oro City	8°30'31.09"N	124°46'10.50"E
8	Purok 1, Tablon, Cagayan de Oro City	8°29'0.1068"N	124°43'48.8"E
9	Nestle, Tablon, Cagayan de Oro City	8°28'34.974"N	124°43'46.9"E

Sampling site 1 - Brgy. Sankanan, Manolo Fortich, Bukidnon with an elevation of 704 meters above sea level (masl) is a long stretch of creek that traverses covered mixed secondary forest areas dominated by thickets of *Bambusa spinosa*, small grassland patches of *Paspalum conjugatum*, *Stachytarpheta jamaicensis*, and agro-ecosystem consisting of *Zea mays* and *Manihot esculenta* fields. An outlet of this river is utilized as irrigation for rice fields near the area. The nearest human settlement was 70-80 meters away.

Sampling site 2 - is located inside a tree park in Brgy. Mangima, Manolo Fortich, Bukidnon with an altitude of 520 masl. The site consists of a short stretch of stream running through a mixed secondary forest, small ponds, and ephemeral pools. It is also an established recreational area with a nature park and swimming pools located below the sampling area. Trees like *Gmelina arborea*, *Swietenia macrophylla*, *Artocarpus heterophyllus* and *Ficus* sp. were observed. Thickets of *B. spinosa*, *P. conjugatum* and *Imperata cylindrica* were the dominant grasses and weeds observed. The nearest human settlement was 50-80 meters away.

Sampling site 3 - Brgy. Impalutao, Impasug-ong, Bukidnon with an altitude of 792 masl constitutes a long stretch of river, creek and stream that traverses mixed primary-secondary forests. The site is located inside the Center for Ecological Development and Recreation, which is a 1,900 hectare reforestation project by the local government of Impasug-ong and the Department of Environment and Natural Resources (DENR). Trees in the area include *Shorea contorta*, *S. almon*, *Albizia acle*, and *Agathis philippinensis*. Shorelines were primarily dominated by thickets of Family Araceae, *B. spinosa*, Family Pandanaceae, and ferns of *Dicranopteris* species. Canopy epiphytes were present. The nearest human settlement was 150-200 meters away.

Sampling site 4 - Brgy. Sampagar, Damulog, Bukidnon with an altitude of 420 masl constitutes a spring that serves as headwater, primarily for irrigation purposes of large nearby rice fields. The area has a stretch of creek that runs through a short cover of secondary forest area dominated by thickets of *Colocasia esculenta*, *B. spinosa*, *Musa paradisiaca*, *Ipomoea aquatica*, and ferns. The water then divides into open fields of agro-ecosystem consisting of fields of corn *Z. mays* and cassava *M. esculenta*, and swamp areas. A large plantation of rubber trees *Hevea brasiliensis* was present about 120 meters away. Coconuts *Cocos nucifera* were also observed. The nearest human settlement was 150-200 meters away.

Sampling site 5 - Brgy. Poblacion, Sumilao, Bukidnon has an altitude of 540 masl. The spring in the area is a headwater, and serves as a water source of the town. The river is a long stretch that is about 5-10 meters wide, running through primary-secondary forests and a patch of crop area planted with *Solanum melongena* and corn *Z. mays*. Shorelines were primarily dominated by thickets of *B. spinosa*, Family Araceae , *I. cylindrica* and ferns. Dense vegetation of *Dendrocnide densiflora* was present along the slopes. The nearest human settlement was 300-350 meters away.

Sampling site 6 - Zone 1, Bantiles Bugo Cagayan de Oro City is an irrigated field with an elevation of 6 masl. There are no emergent trees in the sampling site but there are a number of canopy trees with an approximate height of 20 to 25 meters. Most of the plants found in the area were *C. nucifera*, and *Musa* sp. with a density of 80%. There were a lot of herbs and shrubs within the area, and the abundant vegetation found was *I. aquatica*. The water was stagnant, and was 10-20 meters away from human settlement.

Sampling site 7 - Villa Trinitas Phase 1, Bugo Cagayan de Oro City, has an elevation of 24 masl. Plant species noted were banana *Musa* sp. and Mango tree *Mangifera indica*. Common understory plants were *C. esculenta*, *Mimosa pudica*, *Corchorus capsularis*, *I. aquatica*, and *Ipomoea batatas*. The ground was covered by weeds. Grasses and sedges were also observed. The humus cover was 30-50 cm depth. The soil type was clay. The water was murky, and was 5 meters away from human settlement. The distance to anthropogenic clearing was about 2-5 meters.

Sampling site 8 - Purok 1 Tablon, Cagayan de Oro City is situated in an area which is densely populated and near a national road with an elevation of 5 masl. Most of the plant taxa found were *C. nucifera* and *Musa* sp. with 40% density. Common understory plants were *I. aquatica*, and *C. esculenta*. The ground was mostly covered

with weeds. The water was murky and stagnant with approximate distance of 3-5 meters from human settlement.

Sampling site 9 - Nestle Tablon, Cagayan de Oro City has an elevation of 7 masl. Common trees and plants found were *Terminalia catappa*, *Musa* sp. with 80% density, and coconut *C. nucifera*, *Ceiba pentandra*, *B. spinosa*, and *Gmelina arborea*. Ferns and canopy vines were present. Understory plants like *Celosia margaritacea*, *C. esculenta, M. pudica*, *C. capsularis*, and *Lantana camara* were found. The ground was covered mostly by shrubs and weeds. Plant density of Family Pandanaceae was 40%. The area was 75-100 meters away from human settlement. Illegal settlements and factories were some of the on-site disturbances observed.

Sampling methods and processing of samples. Opportunistic sampling was carried out between the months of October to December 2012 in five sampling sites in Bukidnon and four sites in Cagayan de Oro City. Odonata was sampled at 0900-1600 hours using sweep nets in every potential habitat, including creeks, ponds, and rivers within the nine sampling sites.

Voucher specimens were placed in small white envelopes with their wings folded over the back. Ethyl acetate was used to kill the specimens and halt metabolism. The specimens were then treated with acetone for 24 hours prior to drying. Photographs were taken in the field or right after the samples were caught. Identification of samples was done by the fourth author.

Biodiversity indices and Cluster Analysis of Odonata species were determined using Paleontological Statistics Software Package version 2.0.

Results and Discussion

Species composition, richness and endemism. Thirty-eight species belonging to 12 families and 26 genera with 19 species endemic to the country were documented. The record comprised 19 Zygoptera species belonging to nine families and 19 Anisoptera species belonging to three families (Table 2).

A relatively rare endemic species *Rhinagrion reinhardi*, which was recently described by Kalkman & Villanueva (2011) was found in Site 3 (Impalutao, Impasug-ong). This site is expected to hold much of the endemic species because of its forested creeks, streams, and semi-pristine characteristics.

Higher species richness was recorded in sampling sites that present semi-pristine characteristics such as the sampling sites of Bukidnon where a total of 36 species were recorded. Site 3 (Impalutao, Impasug-ong), had the highest richness with 21 species. Six Anisoptera species and 15 Zygoptera species were found in this site. The high number of damselfly species is probably because of the large canopy cover that provided shady areas in the site. Similar pattern was observed by Mabry & Dettman (2010) where dense and diverse vegetation provided a rich array of Odonata, particularly damselfly species. Site 3 is a reforestation project by the local government consisting of dipterocarp trees, natural vegetation, with lentic and lotic waters that are less disturbed. The forest dwelling *Drepanosticta flavomaculata* a member of family Platystictidae was recorded in the area. This species prefers seepage areas, trickles and small streams of virgin forests in Southeast Asia (van Tol 2005). Site 2 (Mangima, Manolo) was second in species richness with 17 species recorded. Equal number of Suborder Anisoptera and Zygoptera was present since the stream contains diverse vegetation and trees providing cover for damselflies, while dragonflies thrive in adjacent areas that were exposed.

Table 2

Species distribution and abundance of Odonata in Cagayan de Oro and Bukidnon

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Total	%
Zygoptera											
Amphipterygidae											
*Devadatta podolestoides basilanensis**	-	-	10	-	6	-	-	-	-	16	3.47
Calopterygidae											
*Neurobasis anumariae**	-	-	-	-	13	-	-	-	-	13	2.81
*Vestalis melania**	-	-	9	-	8	-	-	-	-	17	3.69
Chlorocyphidae											
*Cyrano angustior**	-	-	2	-	-	-	-	-	-	2	0.43
*Rhinocypha colorata**	3	4	4	17	-	-	-	-	-	28	6.07
*Rhinocypha turconii**	-	3	1	3	7	-	-	-	-	14	3.04
Coenagrionidae											
Agriocnemis femina femina	11	-	1	6	-	9	33	51	53	164	35.6
*Ceriagrion lieftincki**	-	2	-	-	-	-	1	-	-	3	0.65
Ischnura senegalensis	-	1	-	-	-	-	86	1	-	88	19.1
Pseudagrion pilidorsum pilidorsum	8	2	9	10	2	-	-	-	2	33	7.16
Euphaeidae											
*Euphaea amphicyana**	-	1	4	-	2	-	-	-	-	7	1.52
Megapodagrionidae											
*Rhinagrion reinhardi**	-	-	1	-	-	-	-	-	-	1	0.22
Platycnemididae											
*Risiocnemis appendiculata**	-	-	8	-	-	-	-	-	-	8	1.74
*Risiocnemis atripes**	-	-	14	-	-	-	-	-	-	14	3.04
*Risiocnemis flammea**	-	3	2	-	1	-	-	-	-	6	1.3
*Risiocnemis tendipes**	-	-	6	-	5	-	-	-	-	11	2.39
Platystictidae											
*Drepanosticta flavomaculata**	-	-	3	-	-	-	-	-	-	3	0.65
*Drepanosticta lestoides**	-	2	-	-	-	-	-	-	-	2	0.43
Protoneuridae											
*Prodasineura integra**	9	6	4	7	4	-	-	-	1	31	6.72
Anisoptera											
Aeshnidae											
Gynacantha subinterrupta	-	-	1	-	-	-	-	-	-	-	0.51
Corduliidae											
*Heteronaias heterodoxa**	-	-	5	-	-	-	-	-	-	5	2.53
*Idionyx philippa**	-	-	11	-	-	-	-	-	-	11	5.56
Libellulidae											
Acisoma panorpoides panorpoides	-	-	-	2	-	-	-	-	-	2	1.01
Brachydiplax chalybea chalybea	-	-	-	1	-	-	-	-	-	1	0.51
*Diplacina bolivari**	1	1	3	-	4	-	-	-	-	9	4.55
Crocothemis servilla	-	-	-	-	-	-	4	-	1	5	2.53
Diplacodes trivialis	3	-	-	12	-	1	-	-	8	24	7.58
Neurothemis ramburii ramburii	-	-	-	-	1	-	-	-	8	9	0.51
Neurothemis terminata terminata	2	8	-	42	1	2	5	1	3	64	26.8
Orthetrum pruinosum clelia	12	5	4	-	3	-	-	-	-	24	12.1
Orthetrum sabina sabina	3	1	-	21	-	2	-	1	2	30	12.6
Orthetrum testaceum testaceum	-	1	-	-	2	-	-	-	-	3	1.52
Pantala flavescens	3	-	1	2	-	5	3	1	1	16	3.03
Potamarcha congener	-	-	-	-	-	4	14	-	-	18	9.09
Tholymis tillarga	1	1	-	5	-	-	-	1	1	9	3.54
Trithemis festiva	2	-	-	-	-	-	-	-	3	5	1.01
Trithemis aurora	5	4	-	-	-	-	-	-	5	14	4.55
Zyxomma obtusum	-	1	-	-	-	-	-	-	-	1	0.51
Total number of individuals	63	46	103	128	59	23	146	56	88	712	
Total number of species	13	17	21	12	14	6	7	6	12		
Endemic species	3	8	16	3	9	-	-	-	-		

* Philippine endemic

Less number of species was observed in areas with existing anthropogenic disturbances such as in Site 5 (Poblacion, Sumilao) having only 14 species. The site has pristine characteristics similar to Sites 2 and 3, and is a water source for the town but landscape modification and patches of crop areas exposed the shoreline which may have caused the lower species richness. However, the Zygopteran *Neurobasis anumariae* was found only in Site 5. Orr & Hämäläinen (2007) reported that *Neurobasis* is one of the most conspicuous and well-known inhabitants of clear forest streams.

Large crop areas surrounded Sites 1 (Sankanan, Manolo) and 4 (Sampagar, Damulog) where lowest species richness for Bukidnon occurred, recording 13 and 12 species, respectively. Species composition varied between two sites, Site 1 had more Anisoptera species (9) while Site 4 had higher number of Zygoptera. This difference is probably due to the varying extent of disturbance as the stream in Site 1 is less vegetated compared to the stream in Site 4. The ample covering of the latter provided the occurrence of damselfly *Rhinocypha turconii* described as species sensitive to habitat disturbance and is primarily found in less disturbed lowland forest areas (Jumawan et al 2012; Villanueva et al 2012). Deforestation due to clearing for agricultural crops such as banana, cassava, and corn plantations appears to be the greatest factor that influences the distribution of species of Odonata in Bukidnon.

All four sampling sites located in Cagayan de Oro City had low species richness (15). The highest number of species (12) was in Site 9 (Nestle, Tablon) while only 7 species were found in Site 7 (Villa Trinitas, Bugo) and six species in Sites 6 (Bantiles, Bugo) and 8 (Purok 1, Tablon). This low number indicates the effect of habitat alteration. This finding is similar to the results of Mapi-ot et al (2013) where anthropogenic threats such as expansion to coconut and banana farms resulted to low number of Odonata species.

Willigalla & Fartmann (2012) reported that species richness increases along a gradient from the city center to areas outside the city, significantly highest in rural areas.

Factors like water temperature, percentage cover of macrophytes and shade are the most important environmental variables for Anisoptera and Zygoptera (Fulan et al 2008). The widespread damselfly, *Ischnura senegalensis* was the most abundant damselfly recorded in Site 7 (Villa Trinitas, Bugo). The Zygopteran *Agriocnemis femina femina* was observed to be the most abundant in Site 9. This species is common in areas with less canopy cover, associated with weedy habitats with shallow and open waters (Villanueva 2011b; Kandibane et al 2005).

Libellulidae, under suborder Anisoptera was the most represented family, with 16 species. Family Coenagrionidae and Platycnemididae had four species each. Species under Family Libellulidae are good fliers and characteristically occupy ephemeral ponds (May & Matthews 2008). *Neurothemis terminata terminata* was observed in almost all sampling sites except Site 3. Highest number was noted in Site 4 (Sampagar, Damulog) probably due to the large rice fields nearby. *Neurothemis* species is observed to have a close association with open areas and rice paddies, specifically at the tillering stage of the crops. The canopy of weed plants and rice crop cover create a favorable microclimate for the species (Kandibane et al 2005).

Clausnitzer et al (2009) reported that island endemic species of Odonata are the most threatened. Fifty percent of the recorded Odonata found in all sampling sites are endemic to the Philippines. Nineteen endemic species were present and only three endemic species, *Idionix philippa*, *Heteronaias heterodoxa* and *Diplacina bolivari* were under suborder Anisoptera while 16 endemic species belong to Zygoptera.

Figure 2 shows that the highest endemism (44%) was recorded in Site 3 (Impalutao, Impasug-ong, Bukidnon) which was most likely influenced by the large natural area it covers. This site housed endemic dragonflies *H. heterodoxa* and *I. philippa*, but endemic species of damselflies had the most number as the area retained a large part of remnant vegetation and forest cover, a common habitat preference of damselflies. Monitoring these endemic species is found to be important for detecting the initial decline of a habitat. In the country, Hämäläinen & Müller (1997) found that approximately, more than 50% of the 250 named species of dragonflies are endemic.

All four sites in Cagayan de Oro were observed to be open areas and disturbed habitats mainly due to conversion for agricultural and industrial uses. All sampling sites showed lower endemism, where only two of the 15 species recorded from all four sites are endemic (13%). The sites were also predominated by oriental species, primarily by Zygopterans *I. senegalensis* and *A. f. femina* and Anisopteran *Potamarcha congener* having tolerance to anthropogenic disturbance and higher dispersal abilities.

Related studies of endemism were recorded in 18 sites of Surigao del Sur by Quisil et al (2013) of which 23 species are Philippine endemic, higher than the record for areas of Cagayan de Oro and Bukidnon. Also, Cayasan et al (2013) recorded 17 endemic species for 12 areas in Zamboanga del Sur. Although lower endemism was recorded, the composition of species is different, having species that were not found in Cagayan and Bukidnon areas mainly Zygopterans such as *Teinobasis annamaijae*, *Coeliccia dinocerus, Risiocnemis fuligifrons, Drepanosticta krios* and Anisoptera *Gomphidia kirschii*. Mapi-ot et al (2013) recorded only seven endemic species in eight sites in Misamis Occidental because of high anthropogenic disturbance in the area.

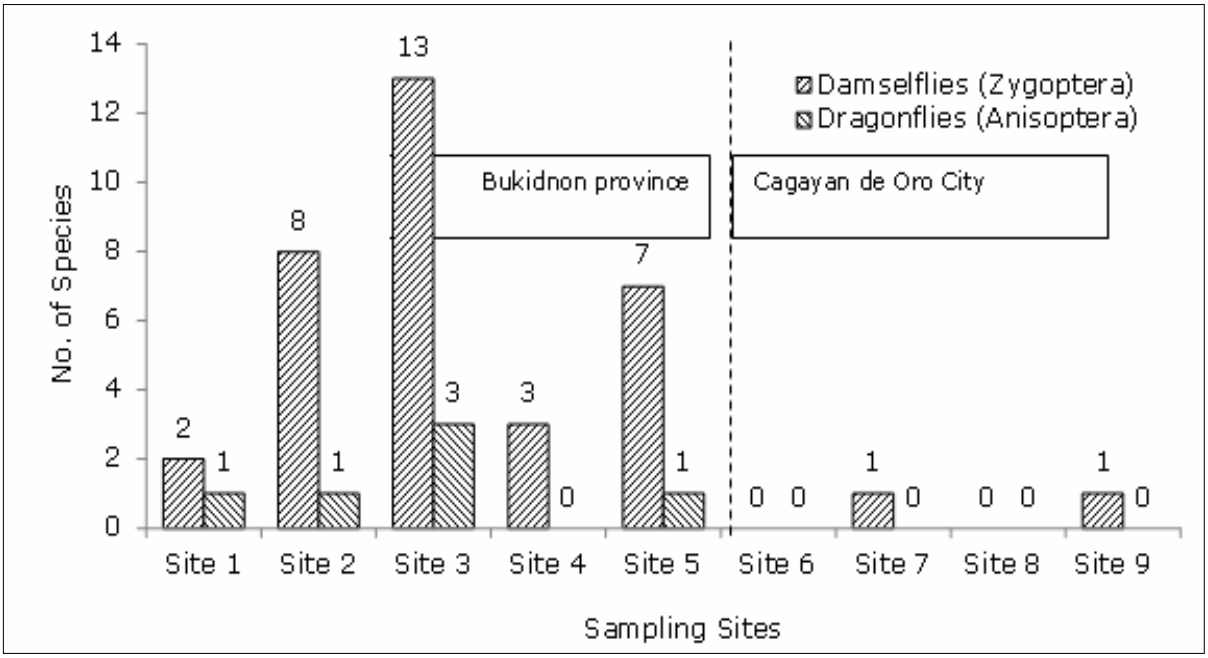


Figure 2. Endemism of the two suborders of Odonata in the different sampling sites.

Biodiversity indices. Table 3 shows higher species diversity in all sites in Bukidnon (Sites 1-5) while lower diversity was recorded in Cagayan de Oro (Sites 6-9). Species diversity varied across landuse types. High species diversity was observed in habitats associated with mixed primary-secondary forest. Urbanized and industrial areas had low diversity.

Balzan (2012) evaluated the association of Odonata to habitat variables in Maltese islands, and observed that diverse vegetation was found to be significantly correlated with Odonata diversity. Higher diversity may also be attributed to the number of microhabitats like sand, rocks, and leaf litter permitting the establishment of a greater number of species (Dalzochio et al 2011).

Even distribution was noted in Sites 1-6 which indicates that Odonata species are more or less evenly distributed. Site 4 (Sampagar, Damulog) had lower evenness value among the Bukidnon sites. It is in this site where a large number of *N. t. terminata* were found roosting along the shoreline. An uneven distribution was found in Sites 7-9 of Cagayan de Oro where Site 8 has least evenness due to the dominance of *A. f. femina*.

Table 3

Species richness, diversity, and evenness of Odonata in the 9 sampling sites

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Species richness	13	17	21	12	14	6	7	6	12
Shannon-Weiner (H')	2.29	2.59	2.76	2.04	2.40	1.57	1.16	0.48	1.48
Evenness (E')	0.90	0.91	0.91	0.82	0.91	0.87	0.59	0.27	0.59

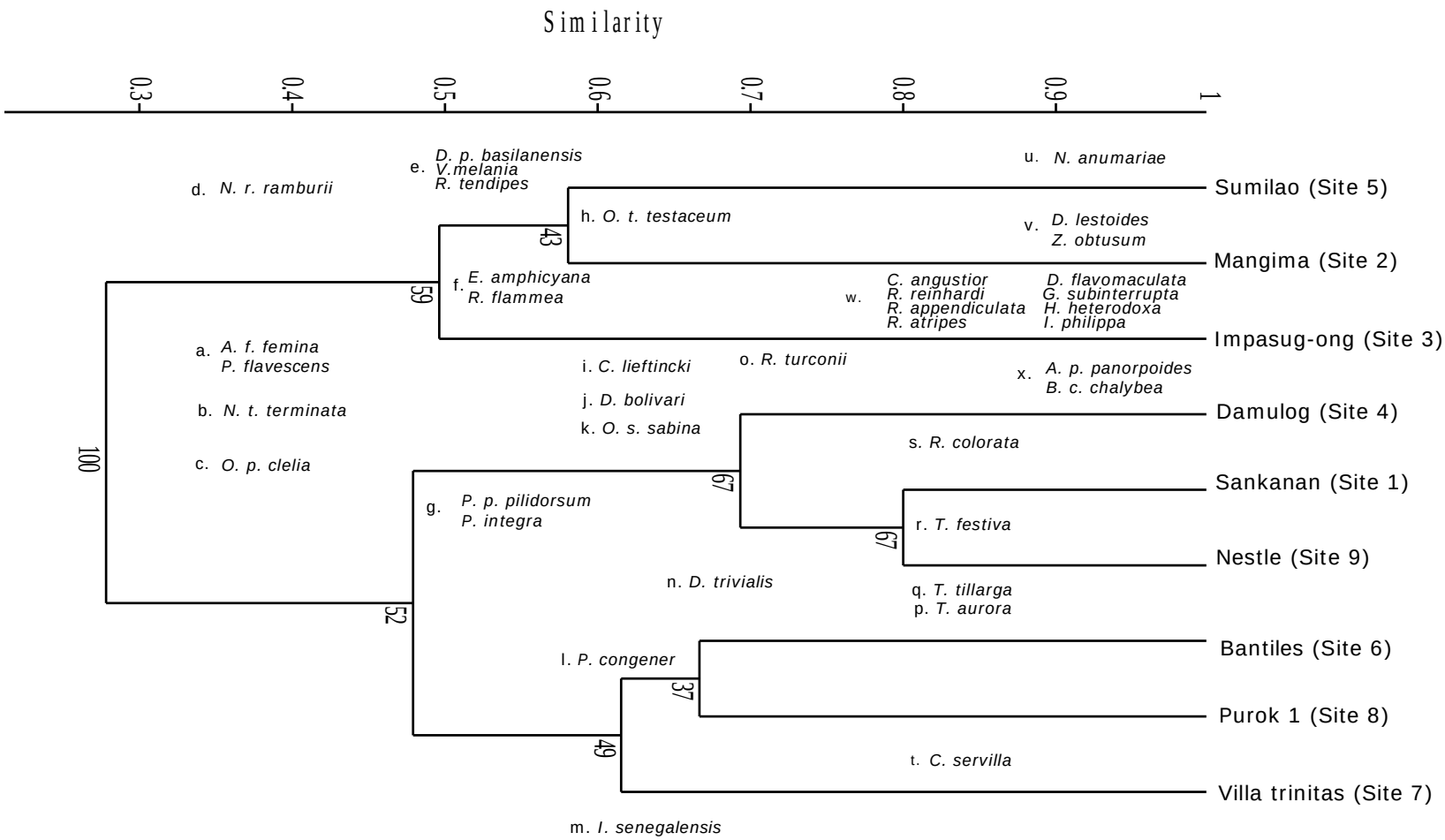
Figure 3 shows the dendrogram of cluster analysis using PAST: Paleontological Statistics Software Package (Hammer & Harper 2001) bootstrapped 1000 times for robustness. The similarity of the composition of Odonata species in secondary forests and in evident disturbed areas formed two substantially different groups. Results also show restricted species due to the distinguishing conditions of a site, particularly endemic species in mixed forest areas.

Areas in Cagayan de Oro City such as Site 7 (Villa Trinitas, Bugo), is clustered into Site 6 (Bantiles, Bugo) and Site 8 (Purok 1, Tablon) due to similarity of oriental species and having close distance to human settlement. Site 4 (Sampagar, Damulog) had restricted oriental species *Acisoma panorpoides panorpoides* described by Clausnitzer & Suhling (2009) to inhabit swampy and well-vegetated open habitats and *Brachydiplax chalybea chalybea* which is tolerant to disturbance (Dow 2010). It is further clustered into Site 1 (Sankanan, Manolo Fortich) and Site 9 (Nestle, Tablon). These three sites are largely associated with agroecosytem and clearing activities, but with less urbanization.

The high presence of endemic species formed the other group with <60% similarity and sharing two species *Euphaea amphicyana* and *Risiocnemis flammea*. Site 3 (Impalutao, Impasug-ong) had the highest number of restricted species. There were seven distinct species restricted to Site 3 such as the endemic species *Cyrano angustior, Rhinagrion reinhardi, Risiocnemis appendiculata, Risiocnemis atripes, Drepanosticta flavomaculata, H. heterodoxa* and *I. philippa*. Forest dwelling oriental species *Gynacantha subinterrupta* was also found in the area. Site 3 is further clustered into Site 5 (Poblacion, Sumilao) and Site 2 (Mangima, Manolo Fortich), which are in some way ecologically similar through dense and diverse vegetation. This may have formed diverse microhabitat suitable for the endemic species to thrive. Figure 4 shows a Philippine endemic Anisopteran while Figure 5 shows a Mindanao endemic Zygopteran.

Figure 4. *Idionyx philippa* ♂ Ris, 1912
Philippine endemic,
suborder Anisoptera.

Figure 5. *Risiocnemis atripes* ♂ Needham & Gyger, 1941 Mindanao endemic,
suborder Zygoptera.



a. Species distributed at Sites 1,3,4,6,7,8,9
b. Species distributed at Sites 1,2,4,5,6,7,8,9
c. Species distributed at Sites 1,3,4,6,7,8,9
d. Species distributed at Sites 5 & 9
e. Species distributed at Sites 3 & 5
f. Species distributed at Sites 2,3 &5
g. Species distributed at Sites 1,2,3,4,5 & 9
h. Species distributed at Sites 4 & 2
i. Species distributed at Sites 2 & 7
j. Species distributed at Sites 1,2,3,5
k. Species distributed at Sites 1,2,4,6,8,9
l. Species distributed at Sites 6 & 7
m. Species distributed at Sites 2,7,8
n. Species distributed at Sites 1,4,6,8,9
o. Species distributed at Sites 2,3,4,5
p. Species distributed at Sites 1,2,9
q. Species distributed at Sites 1,2,4,8,9
r. Species distributed at Sites 1 & 9
s. Species distributed at Sites 1,2,3,4
t. Species distributed at Sites 7 & 9
u. Species restricted at Site 5
v. Species restricted at Site 2
w. Species restricted at Site 3
x. Species restricted at Site 4

Figure 3. Dendrogram based on Sorensen-Dice's similarity for cluster analysis of Odonata species from the five sampling areas (Bootstrap N = 1000).

Conclusions and Recommendations. Higher species richness was recorded in sites that present semi-pristine characteristics such as dense and diverse vegetation with natural structures. Less number of species was recorded in areas with existing anthropogenic disturbances. The occurrence of a relatively high number of endemic Odonata species in an area suggests the urgent need for conservation measures to protect such vital ecosystem. It is recommended to conduct surveys in pristine habitats to assess diversity of Odonata and verify some characteristics that present potential use of Odonata in assessing the ecological health of an area, and to serve as basis for sound biological conservation decisions.

Acknowledgement. We are thankful to DENR-PAWD Region X for the issuance of Gratuitous Permit to collect samples in the study areas.

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Received: 28 September 2013. Accepted: 28 October 2013. Published online: 02 November 2013.
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How to cite this article:
Jomoc D. J. G., Flores R. R. C., Nuñeza O. M., Villanueva R. J. T., 2013 Species richness of Odonata in selected wetland areas of Cagayan de Oro and Bukidnon, Philippines. AACL Bioflux 6(6):560-570.