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Species diversity of the odonatofauna of Mts. Pinukis and Gimamaw, Zamboanga del Sur, Philippines

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Abstract

Odonatais highly sensitive to various changes in the environment which makes it an excellent bioindicatorof environmental health. This study was conducted to assess the species richness of Odonata in Mts. Pinukis and Gimamaw, Zamboanga del Sur, Philippines. Eleven sampling sites were surveyed comprising six sites in Mt. Pinukis and five sites in Mt. Gimamaw. Opportunistic sampling using sweep nets was conductedfor a total of 192 man-hours.Biodiversity indices, cluster analysis, and detrended correspondence analysis were determined using Paleontological Statistics Software Package (PAST) version 2.17b. Thirty-five species were recorded belonging to 25 genera and 10 families with relatively low endemism of 40%.There was a more or less even species distribution. High relative abundance of 18.83% was observed in site 1. Site11 was observed to have the most number ofendemic species. High species diversity was recorded in both Mts. Pinukis and Gimamaw. Detrendedcorrespondence analysis showed that vegetation structure greatly influences habitat preferences of odonata. It appears that human-induced disturbances limit the occurrence and abundance of the Odonata, especially the endemic species.

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Introduction

Odonata, comprising dragonflies and damselflies, is one of the most attractive and well-known orders of insects (Rathod*et al.,* 2012) that isdistributed worldwideexcept in Antarctica (Nelson *et al.,* 2011). Kalkman*et al.*(2008) reported that there are approximately5,680 known species of Odonata, 2,739 belonging to the suborder Zygoptera or the damselflies (19 families) and 2,941 to the suborder Anisoptera or the dragonflies (12 families).The presence of odonata is an important indicator ofecological balance(Acquah-Lamptey*et al.,* 2013). Odonata is an excellent bioindicator (Malawani*et al.,* 2014) as itis very sensitive to changes in the environment (Andrew *et al.,* 2008) and shows preference to specific habitats(Sheldon and Walker, 1998).

Distribution pattern of Odonata species is mainly determined by suitable habitat that maintains its population. Odonata utilizes a very wide range of freshwater habitat, from permanent running waters (Nelson *et al.,* 2011) and lakes to small temporary rain pools (Corbet, 1999).The tropics hold the highestdiversity and abundance since tropical temperature is favorable to its population (Wahizatul-Afzan*et al.,* 2006).

In the Philippines, Hämäläinen and Müller (1997) documented 309 species of which 203 (65.7%) are endemic species. High endemism is attributed to forested water bodies which is favorable for Odonata (Gapud, 2003). Recent studies in the southern island of the Philippines, Mindanao, contributed further to the odonatological data. Villanueva (2011) recorded 56 species in Diomabok Lake, Davao Oriental. Twenty-one species were documented by Dimapinto*et al.* (2015) in Lanaodel Sur which showed low species richness compared to a previous study conducted by Malawani*et al.* (2014) in the same province.

Although Philippine Odonata is well studied, some species are poorly identified leading to difficulty in assessing whether a species is really rare or just overlooked (Cayasan*et al.,*2013) particularly from poorly explored regions on the island of Mindanao (Villanueva, 2011).This study aims to provide additional record of Odonata in Zamboangadel Sur. This study would provide initial odonatologicalrecord for Mts. Pinukis and Gimamaw. This study also aims to document the species evenness, endemism, abundance,and to correlate vegetation type to the distribution of species.

Materials and methods

Study Area

The study was conducted in Mt. Pinukis (7˚57'13"N 123˚14'18"E) at 2, 347 meters above sea level (masl) and Mt. Gimamaw (7˚57'258"N 123˚14'359"E) at1, 765 masl located in Barangay Lison Valley (7.966°N 123.227°E; 520masl), one of the most secluded areas in Pagadian, Zamboanga del Sur (Fig. 1). The two mountains are two kilometers apart.Sampling sites were selected randomly at 789 masland below since no freshwater systems can be found above the said elevation.

Sampling Sites

Site 1 is at lower Labangan River in Mt. Pinukis (7˚57'16"N123˚14'22"E). This site has an elevation of 550 masl. This sampling site is at the foot of Mt. Pinukis. Communities and agricultural lands are found in this area. The indigenous people or the "Subanen" along with non-indigenous group live in this area and planted crops such as corn (*Zea mays*), rice (*Oryza sativa*) and coconuts (*Cocosnucifera*). Irrigation system is present in this area.

Site 2 is along the Middle Labangan River in Mt. Pinukis (7˚57'44"N123˚13'53"E). This area has an elevation of 672 masl. This site is composed of cultivated lands on the lower part and early secondary forest as well as grasslands. Most crops planted are cassava (*Manihotesculenta*), sugarcane (*Saccharum sp.*), and corn (*Z. mays*). The secondary forest part composed of Gmelina trees (*Gmelinaarborea*) is part of a government project for reforestation. "Hagonoy" (*Chromolaenaodorata*) and cogon grass

(*Imperatacylindrica*) are commonly seen along the river banks.

Site 3, Stream 1 is located in Mt. Pinukis (7˚57'35"N123˚13'41"E). This site is at 622 masl. It is composed of grassland and early secondary forest where Gmelina trees (*G. arborea*) as well as mahogany trees (*Swieteniamahogani*) are abundant. Ground plants such as wild daisies (*Tridax sp.*) and cogon grass (*I.cylindrica*) are present.

Fig. 1. Map showing the location of sampling sites in Zamboanga Del Sur; blue dot- Mt. Pinukis; yellow dot- Mt. Gimamaw(www.maphill.com, 2015).

Site 4, Stream 2 is located in Mt. Pinukis (7˚58'3"N123˚14'9"E). The elevation of this site is 764 masl. This site is composed of early secondary forest. Plants present in this site are mostly balete (*Ficus sp.*), spiny bamboo (*Bambusaspinosa*), and few lauan trees (*S.negrosensis*). Ground covering plants near the stream are mostly "gabi-gabi" (*Colocasiaesculenta*) and ferns (*Polystichum sp.*). Epiphytic plants are also present such as strap ferns (*Anarthropterislanceolata*), basket ferns (*Drynaria sp.*), and moss (*Bryophyta sp.*) growing on rocks.

Site 5, Upper Labangan River is located in Mt. Pinukis (7˚58'13"N 123˚14'28"E). This area is about 787 masl. This area is made up of advanced secondary forest, characterized by lesser canopy structure and few large trees. Thick and wide variety of trees and other plants are present alongside the river including "yakal" (Shorealeavis), "lauan" (*Shoreanegrosensis*), almaciga (*Agathisphilippinensis*), fern trees (*Cyathea spp.*), and "dapdap" trees (*Erythrinaorientalis*). Plants covering the ground were ferns (*Polystichum sp.*) and cogon grass (*Imperatacylindrica*).

Site 6, Stream 3 is located in Mt. Pinukis (7˚58'8"N123˚14'17"E). This site has an elevation of 795 masl. This site is composed of advanced secondary forest with large trees such as mahogany (*S.mahogani*), "dapdap" (*E.orientalis*), "ipil-ipil" (*Leucaenaleucocephala*), and "lauan" trees (*S.negrosensis*) which are abundant in the site. Tree ferns(*Cyathea spp.*)are also abundant in this area. Other kinds of ferns were also present such as swordferns (*Polystichum sp.*).

Site 7, Dalanganin stream is located in Mt. Gimamaw (7˚57'269"N 123˚14'367"E). The elevation of this site is at 596 masl. Few trees are present in this area since it is surrounded by rice fields. Mango trees (*Mangiferaindica*) and acacia trees (Acacia falcata) are common in the area with few coconuts (*C. nucifera*). Bamboo plants (*B.spinosa*) were also seen in the area. Shrubs such as "hagonoy" (*C. odorata*) and wild sage (*Lantana camara*) are abundant in this area.

Site 8, Magabal stream is located in Mt. Gimamaw (7˚57'5"N 123˚14'16"E) - at 648 masl.This area is composed of agricultural land and early secondary forest. Agricultural lands consist of vast rice fields. Gmelina trees (*G.arborea*) are present in the early secondary forest part of this area. Spiny bamboo (*B.spinosa*), hagonoy (*C. odorata*) and wild sage (*L. camara*) are also present. There are also few avocado trees (*Perseaamericana*) growing near the stream.

Site 9, Stream 4 is located in Mt. Gimamaw (7˚57'2"N123˚14'19"E). This site at 662 masl is composed of early secondary forest with a slightly open canopy. Mahogany trees (*S.mahogani*) and "kamansi" (*Artocarpusaltilis*) are very abundant in this area. Few bambooplants (*B.spinosa*) were also observed.

Site 10, Stream 5 is located in Mt. Gimamaw (7˚57'54"N123˚13'40"E) at 724 masl. This site is composed of advanced secondary forest. It is surrounded by vast variety of large trees, making the area shady and humid. Large trees such as mahogany (*S. mahogani*), "dapdap" (*E.orientalis*), and "lauan" trees (*S. negrosensis*) were observed. Fern trees (*Cyathea spp.*) are also common in the site.

Site 11, Aso stream is located in Mt. Gimamaw (7˚57'50"N123˚13'46"E). This site is composed of advanced secondary forest with an elevation of 789 masl. Trees such as "lauan" (*S.negrosensis*), and"dapdap" (*E.orientalis*) are among the dominant trees. Few fern trees (Cyathea spp.) and bamboo (*B.spinosa*) are also present. Mosses (*Bryophyta sp.*) are also growing on rocks. Since the area is humid, fungal growth such as turkey tail mushrooms (*Trametesversicolor*) sprout on trees and on fallen logs.

Collection, Processing of Samples, and Identification

Field sampling was conducted on July 30-31, 2014 and February 17-22, 2015at 0800-1600 hours for a total of 192 man-hours. Specimens were collected in the 11 freshwater systems in Mts. Pinukis and Gimamaw using opportunistic sampling method. Dragonflies and damselflies were collected through sweep nets. Each sampling site was surveyed twice. The collected Odonata species and their abundance were recorded. The collection of samples was mainly based on adult specimens. Photographs were taken. Vegetation structure was also documented at the sampling sites.

Acetone was used for the preservation of samples. Samples were completely submerged in acetone in an air-tight plastic container for 12 hours for damselflies, and 24 hours for dragonflies (Mapi-ot*et al.,* 2013). Samples were stored in new paper envelopes and kept in a sturdy plastic container without packing them tightly (Quisil*et al.,* 2013).

Naphthalene balls were added to the container to prevent entry of other insects that may damage the preserved samples (Cayasan*et al.,* 2013). The plastic containers containing the specimens were then placed in a cool and dry place. Collected specimens were transported to the Biodiversity laboratory of the Department of Biological Sciences, MSU-Iligan Institute of Technology, Iligan City. Samples collected were identified using pictorial keys and confirmed by the third author.

Data Analysis

Biodiversity indices, cluster analysis, anddetrended correspondenceanalysis were computed using Paleontological Statistics Software Package (PAST) version 2.17b. Relative abundance was computed manually. Detrended Correspondence Analysis (DCA) was doneto correlate vegetation type to the distribution of species.

Results and discussion

Species Richness and Endemism

Thirty- five species of Odonata were identified in both Mts. Pinukis and Gimamaw. Nineteen species of Anisoptera (dragonflies) and 16 species of Zygoptera (damselflies) under 25 genera were recorded (Table 1).

Table 1. Species richness and endemism of Odonata in Mt. Pinukis and Mt. Gimamaw, Pagadian, Zamboangadel Sur.

SPECIES NAME	Mt. Pinukis						Mt. Gimamaw					TOTAL
	Disturbed				Slightly disturbed		Disturbed			Slightly disturbed		
	Site 1 (LLR)	Site 2 (MLR)	Site 3 (Stream1)	Site 4 (Stream2)	Site 5 (ULR)	Site 6 (Stream3)	Site 7 (Dalanganin)	Site 8 (Magabal)	Site 9 (Stream4)	Site 10 (Stream5)	Site 11 (Asó)	
SUBORDER ZYGOPTERA												
Family Amphipterygidae												
*Devadattapodolestoidesbasilanensis**	-	-	-	-	-	2	-	-	-	-	10	12(1.53)
Family Calopterygidae												
*Vestalismelania**	-	-	-	-	35	12	-	-	-	7	4	58(5.57)
Family Chlorocyphidae												
*Rhinocyphaturconii**	-	-	-	-	-	5	-	-	-	4	2	11(1.06)
Family Coenagrionidae												
Agriocnemis f. femina	12	-	7	5	-	-	6	-	-	-	-	30(2.88)
Agriocnemispygmea	14	-	-	5	-	-	4	-	-	-	-	23(2.21)
Agriocnemisrubescens	9	-	-	-	-	-	-	-	-	-	-	9(0.86)
Agriocnemisrubescensintermedia	10	-	-	-	-	-	-	-	-	-	-	10(0.96)
*Ceriagrionlieftincki**	-	-	-	-	-	4	-	-	-	-	-	4(0.38)
Ischnurasenegalensis	-	-	-	-	-	-	-	-	-	5	-	5(0.48)
Pseudagrionmicrocephalum	14	-	-	-	-	-	-	-	-	-	-	14(1.34)
Pseudagrion p. pilidorsum	24	-	13	6	-	-	8	-	-	-	-	51(4.90)
Family Euphaeidae												
*Euphaeaamphicyana**	-	-	-	-	-	-	-	-	-	-	3	3(0.29)
Family Platycnemididae												
*Coelicciadinocerus**	-	-	-	-	-	-	-	-	-	-	2	2(0.19)
*Risiocnemisatripes**	-	-	-	-	-	-	-	-	-	-	1	1(0.09)
Family Plastystictidae												
*Drepanostictalestoides**	-	-	-	-	-	-	-	-	-	-	7	12(1.15)
Family Protoneuridae												
*Prodasineuraintegra**	-	-	-	-	-	4	-	-	-	5	-	9(0.86)
SUBORDER ANISOPTERA												
Family Corduliidae												
Epophthalmiavittigera	-	-	-	-	3	-	-	-	-	2	-	5(0.48)
*Hemicordulia m. mindana**	-	-	-	-	1		-	-	-	1	-	2(0.19)
*Heteronaiasheterodoxa**	-	-	-	-	9	3	-	-	-	4	1	17(1.63)
Family Libellulidae												
*Diplacinabolivari**	-	30	16	8	24	-	-	-	7	-	-	85(8.17)
*Diplacinabraueri**	-	19	-	5	13	-	-	-	6	-	-	43(4.13)
*Diplacina nana**	-	15	-	-	9	-	-	-	-	-	-	24(2.31)
Diplacodestrivialis	23	-	15	17	-	-	21	14	12	-	-	102(9.80)
Neurothemis r. ramburii	42	7	23	13	-	-	25	10	-	-	-	120(11.53)
Neurothemis t. terminata	14	19	8	8	-	-	14	9	-	-	-	72(6.92)
Orthetrumpruinosumclelia	-	-	20	13	-	-	8	-	-	-	-	41(3.94)
Orthetrum s. sabina	5	18	26	21	8	-	23	15	13	-	-	129(12.39)
Orthetrum t. testaceum	-	5	28	14	-	-	-	-	-	-	-	47(4.51)
Pantalaflavescens	24	30	-	-	6	-	7	-	-	-	-	67(6.44)
Potamarcha congener	3	-	-	-	-	-	-	-	-	-	-	3(0.29)
Rhyothemisphyllissubphylis	-	-	-	2	-	-	-	-	-	-	-	2(0.19)
Tholymistillarga	-	-	-	-	-	-	-	-	-	1	-	1(0.09)
Trithemis a. aurora	-	13	-	4	-	-	-	-	-	-	-	17(1.63)
Trithemisfestiva	-	-	-	-	8	-	-	-	-	-	-	8(0.77)
Zyxommaobtusum	2	-	-	-	-	-	-	-	-	-	-	2(0.19)
Total number of individuals	196(18.83)	156(14.99)	156(14.99)	121(11.62)	116(11.14)	35(3.36)	116(11.14)	48(4.61)	38(3.65)	29(2.79)	30(2.88)	1041
Total number of species	13	9	9	13	9	7	9	4	4	8	8	35
Total number of Endemic species	0	3	1	2	6	6	0	0	2	5	8	14

Legend: ( ) –relative Abundance in percentage, * –Philippine Endemic species, LLR –lower Labangan river, MLR –middle Labangan river, ULR –upper Labangan river.

This result isalmost similar to theOdonata survey conducted by Cayasan*et al.* (2013) with 36 species recorded in all 12 sites in Aurora, Lakewood, and Tukuran, Zamboanga del Sur, Philippines.However, the result is relatively low compared to the survey conducted by Loznik (2012) in Osa Peninsula, Costa Rica with 54 species belonging to 31 genera and 10 families. But compared to the survey conducted by Chandana*et al.* (2012) in Sri Lanka with 28 species, this result is relatively high.

Table 2. Species richness, diversity, and evenness of Odonata in Mt. Pinukis and Mt. Gimamaw.

	Mt. Pinukis	Mt. Gimamaw
Number of species (S)	30	25
Shannon-Wiener diversity index (H')	2.932	2.612
Evenness	0.625	0.568

Among the 10 familiesidentified in the area, Family Libellulidae had the highest number of species collected (Fig. 2).

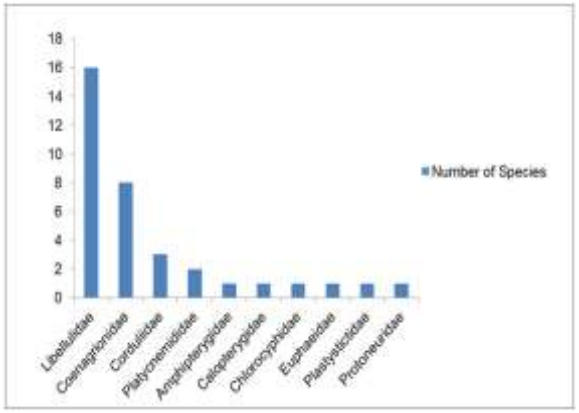

Fig. 2. Species distribution among families.

This cosmopolitan family is considered to be the largest among other familieswith 1,012 species identified worldwide and 190 species of this family are oriental species (Tennessen, 2003, Mamat*et al.*,2012).According to Mapi-ot*et al.* (2013), oriental species are most likely found in disturbed areas.Site 1 (Lower Labangan river) and site 4 (Stream 2) hadthe highest species richness. Identified species in site 1 were all oriental species, whereas in site 4, two of the species found are endemic. Species recorded in both sites 7 and 8 in Mt. Gimamaw areall oriental species. In addition, most species found in sites 2, 3, and 8 were also oriental species, with very few to no endemic species (site 2= 3; site 3 = 1; site 8= 0). The abundance of oriental species can be attributed tothe presence of agro-ecosystem and other human disturbances such as timber extraction for the local people's own use.The agro-ecosystemin lower Labanganriver (site 1) had the highest disturbance.The utilization of water resources for agricultural production implies that this habitat is disturbed or modified for human use (Villanueva and Mohagan, 2010). Sites 5, 6, 10, and 11 have relatively lower species richness compared to sites 1 and 4, although these sites still host most of the endemic species recorded. These sites are also of higher elevation (787masl, 795masl, 724masl, and 789masl) and less disturbed compared to the other sites hence, endemic species thrive in these areas. This indicates thatOdonata,particularly endemic species prefers forested and seemingly undisturbed areas (Malawani*et al.,* 2014).

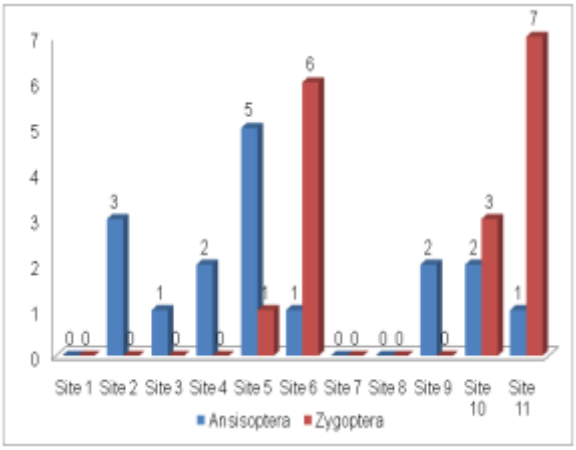

Fig. 3. Endemism of the two suborders of Odonata in the different sampling sites.

The Anisopteran species,*Orthetrum s. sabina* (12.39%) and *Neurothemis r. ramburii* (11.53%) were found to be most abundant in the area. These species

were abundant in disturbed areas such as sites 1, 2, 3, 4 in Mt. Pinukis and sites7, 8, and 9 in Mt. Gimamaw. These species are very common and widespread and are assessed as least concern by IUCN (2014).The least abundant species recorded in the area were*Risiocnemisatripes* and *Tholymistillarga*. *R. atripes* is an endemic species of Mindanao Island (Villanueva and Cahilog, 2012). It is often found in pristine areas with thick canopy cover like site 11 in Mt. Gimamaw. *T. tillarga* is widespread and a disturbance-tolerant species. The limited number of this species in the area may be due to its crepuscular behavior. Adults are active at dusk, night and dawn as well as during soft rainfall with low luminosity, so they are expected to be easily overlooked during the day (Clausnitzer, 2003).

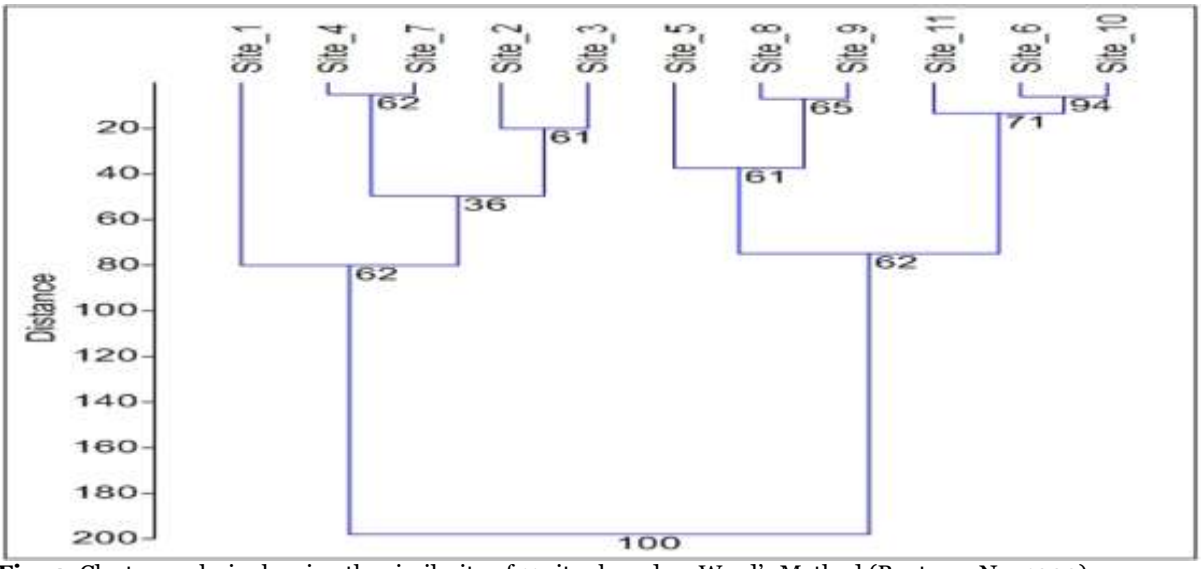

Fig. 4. Cluster analysis showing the similarity of 11 sites based on Ward's Method (Bootsrap N = 1000).

Hemicorduliamindanamindana is an endemic species found on the island of Mindanao in the Philippines and categorized as near threatened (IUCN, 2014). This species has a reasonably wide range and has been recorded on many of the islands within that range. The species is however dependent on areas with at least some forest cover and for that reason a continuing decline is inferred. Its distribution is likely to be partly dependent on forest habitats. This species is likely to be affected by human-induced degradation and loss of habitat (Kalkman*et al.,* 2010).

The overall endemism (40%) is relatively lower compared to the first record of Zamboangadel Sur (Cayasan*et al.*, 2013). The sites explored in this study are no longer pristine, which explains the lower endemism. However, the endemism is relatively higher than the study conducted byAspacio*et al.* (2013) in Iligan City and Lanaodel Norte which are more disturbed areas.Endemic species were mostly found in sites5 and 6 in Mt. Pinukis and sites 10 and 11 in Mt. Gimamawwhich are less disturbed compared to other sites. In site 11 (Aso stream),all species recorded are Philippine endemic, with only one (7.14%) endemic dragonfly and seven (50%) damselflies (Fig. 3). Site 5 (upper Labangan river) had five endemic Anisopteran and one Zygopteran species. Endemic species of six damselflies and one dragonfly were recorded in site 6 (stream 3), while site 10 (stream 5) had only two endemic species of dragonflies and three damselflies. Based on the result, site 11 has more favorable environmental condition to sustain endemic species.High endemism of damselflies (57.14%) and low endemism of dragonflies (35.71%) were significantly noted in sites 6 (stream 3) in Mt. Pinukis and sites 10 (stream 5) and 11 (Aso stream) in Mt. Gimamaw.Large trees surrounding these sites allowed less sunlight penetration.Remsburg*et al.* (2008) reportedthat

compared to sites with no shade, dragonfly abundance is lower at sites with high or moderate shade cover. The presence of shade cover and aquatic vegetation favors Zygopteran population more than Anisoptera (Arulprakash andGunathilagaraj, 2010).

Biodiversity indices

The higher the value of Shannon-Wienerdiversity index (H'),the higheris the diversity of an area. H' increases dramatically as the number of species increases (MacArthur and Wilson, 1967; Rosenzweig, 1995). High species diversity (Table 2) was recorded in both Mts. Pinukis and Gimamaw. A more or less even distribution was noted as the values are closer to one. As stated by Cerdá*et al.*(2011), evenness value closer to 1 indicates even distribution while a value closer to 0 means that there is a dominant species. The moderate species diversity is attributed to clean water systems and shady environments. Villanueva and Mohagan (2010) reported that the Odonata as a group has preference for dense forest, undisturbed vegetation, optimum temperature, and presence of aquatic habitat. Mt. Pinukis (H'=2.932) is slightly more diverse compared to Mt. Gimamaw (H'=2.612) as there are more species (S=30) found in the area and each species is abundant in population, although most of the species are oriental species since the sites are disturbed. The diversity of an area increases as both the richness and the evenness of the community increase(Magurran, 2004).

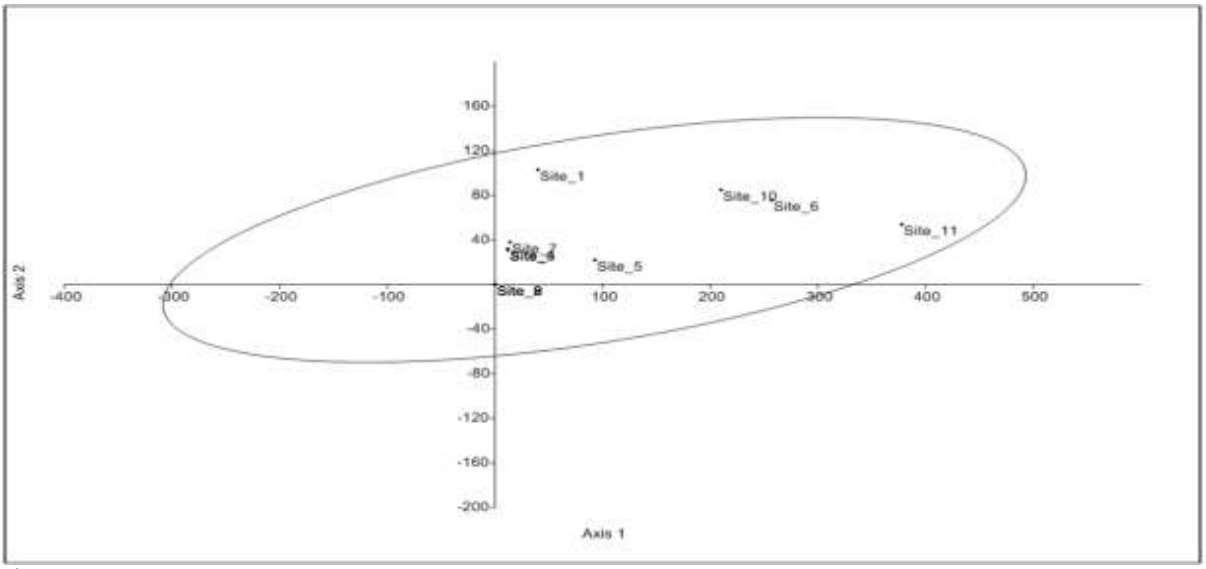

Fig. 5. Detrended Correspondence Analysis (DCA) plot of sampling sites.

Cluster Analysis

Fig. 4 shows the dendrogram of cluster analysis using Ward's Method in PAST v2.1b with 1000 times bootstrapped for robustness (Jomoc*et al.,* 2013). The results revealed that the Odonatofauna of sites 5 and 6 in Mt. Pinukiswas similar to that of sites 8, 9, 10 and 11 in Mt. Gimamawwhile site 1appears to be the outgroup community structure among disturbed sites. Compared to other disturbed sites such as sites 2, 3, 4 (Mt. Pinukis) and 7 (Mt. Gimamaw), site 1 (lower Labangan river) is the most disturbed as this area plainly consists of agricultural lands andhuman community. Human activities are responsible for shaping the community structure of Odonata. The two mountains are situated close to each other; however,sampling sites in Mt. Pinukis are more disturbed than in Mt. Gimamaw, as they are closer to human settlements. According to Harabiš and Dolný (2010), the habitat specificity of each species is classified according to its niche breadth. Sites 6 and 10 had the most similarities (94%). The result indicates that these areas share almost the same species which prefer shaded secondary forest. Hence, the nature of the microhabitat is a possible reason for this assemblage (Dimapinto*et al.,* 2015).

Detrended Correspondence Analysis

Detrended Correspondence Analysis (DCA) generated results which showed significant differences between sites according to vegetation type. Fig. 5 shows that lower Labanganriver (site 1) is an isolated sampling site in Mt. Pinukis. This site is located near agricultural lands (e.g., rice fields) and human settlements are mainly found in this area. Most collected species in this site are Orientals which can tolerate human disturbances. Human activities affect the natural drivers of structural complexity (Burger, 2000). Conversion of riparian areas into agricultural lands isexpanding rapidly leading to simplification of vegetation structure (Hansen *et al.*, 2005) by removal of the shrub layer (Elias and Meyer, 2003), floating macrophytes (Jennings *et al.*, 2003), and woods (Marburg *et al.*, 2006). The structural changes might have consequences for a variety of animals including Odonata communities. Sites 6 (Mt. Pinukis), 10, and 11 (Mt. Gimamaw) were also isolated from other sites. The three sites shared the same structure of vegetation (advanced secondary forest). These sites catered most of the endemic species recorded in this study. The diversity and abundance of Odonata often are correlated positively with local abundance of vegetation (Remsburg, 2007). Vegetation provides adult odonata with roosting structures for thermoregulation, foraging(Dmitriew and Rowe 2005), territory defense (De Marco andResende 2004), copulation (Buchwald, 1992), oviposition (Wildermuth, 1993) and protection from unfavorable weather which can affect their abundance and diversity (Rouquette and Thompson, 2007). Vegetation and other physical structures can interact with environmental controls on odonata to influence population sizes (Remsburg and Turner, 2009).

Conclusion

Sites 1 and 4 had the highest number of species collected (S=13) consisting of mostly widespread orientals. *Orthetrum s. sabina*and *Neurothemis r. ramburii*were the most abundant species found in disturbed sites. Both Mts.Pinukis and Gimamaw are diverse areas and species are moderately distributed, although endemism is low (40%). Species were found to be dependent on the type of vegetation (e.g., canopy structure) that surrounds the area.

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References

Acquah Lamptey D, Kyerematen R, Owusu EO. 2013. Using odonates as markers of the environmental health of water and its land related ecotone. International Journal of Biodiversity and Conservation **5(11),** 761-769.

Andrew RJ, Subramanian KA, Tiple AD. 2008. Common Odonates of Central India. In: The 18th International Symposium of Odonatology. Hislop College, Nagpur, India, 1-49 P.

Arulprakash R, Gunathilagaraj K. 2010 Abundance and diversity of Odonata in temporary water bodies of Coimbatore and Salem districts in Tamil Nadu. Journal of Threatened Taxa **2(8),** 1099-1102.

Aspacio KT, Yuto CM, Nuñeza OM, Villanueva RJT. 2013. Species diversity of Odonata in selected areas of Buru-un, Iligan City and Tubod, Lanao del Norte, Philippines. Animal Biology and Husbandry – International Journal of Bioflux Society **5(2),** 145-155.

Buchwald R. 1992. Vegetation and dragonfly fauna— characteristics and examples of biocenological field studies. Vegetation **101,** 99–107.

Burger J. 2000. Landscapes, tourism, and

conservation. Science of the Total Environment **249(1–3),**39–49.

Cayasan RD, Limitares DE, Gomid JVS, Nuñeza OM, Villanueva RJT. 2013. Species richness of Odonata in selected freshwater systems in Zamboanga del Sur, Philippines. Aquaculture, Aquarium, Conservation and Legislation-International Journal of the Bioflux Society **6(4),** 378-393.

Cerdá X, Angulo E, Caut S, Courchamp F. 2011. Ant community structure on a small Pacific Island: only one native species living with the invaders. Biological Invasions **14,** 323-339.

Chandana EPS, Rajapaksha ACD, Samarasekara WGKH. 2012. A survey of odonate assemblages associated with selected wetland localities in southern Sri Lanka. Asian Journal of Conservation Biology **1(2),** 67-73.

Clausnitzer V. 2003 Dragonfly communities in coastal habitats of Kenya: indication of biotope quality and the need of conservation measures. Biodiversity and Conservation **12,** 333–356.

Corbet PS. 1999. Dragonflies: Behav. Ecol. Odonata. Cornell University Press, Ithaca, New York, 829.

De Marco P, Resende DC. 2004. Cues for territory choice in two tropical dragonflies. Neotropical Entomology **33,** 397-401.

Dimapinto FA, Nuñeza OM, Villanueva, RJT. 2015. Species diversity of adult odonata in selected areas of Lanao Del Sur, Philippines. Journal of Biodiversity and Environmental Sciences **6(5),** 200-210.

Dmitriew C, Rowe L. 2005: Resource limitation, predation risk and compensatory growth in a damselfly. Oecologia **142,** 150-154.

Elias JE, Meyer MW. 2003. Comparisons of undeveloped and developed shorelands, northern Wisconsin, and recommendations for restoration. Wetlands **23,** 800–816.

Gapud VP. 2003 Biodiversity and biogeography of Philippine Odonata and waterbugs (Hemiptera). Department of Entomology. Univ. of the Philippines, Los Baños. Animal Taxonomy and Geography. Retrieved from http://agris.fao.org/agrissearch/search/display.do?f=2005%2FPH%2FPH0503.xml%3BPH2005000178

Hämäläinen M, Müller RA. 1997. Synopsis of the Philippine Odonata, with lists of species recorded from forty islands. Odonatologica**26(3),**249-315.

Hansen AJ, Knight RL, Marzluff JM, Powell S, Brown K, Gude PH, Jones A. 2005. Effects of exurban development on biodiversity: patterns, mechanisms, and research needs. Ecological Applications **15,** 1893–1905.

Harabiš F, Dolný A. 2010. Ecological factors determining the density-distribution of Central European dragonflies (Odonata). European Journal of Entomology **107,** 571–577.

IUCN. 2014. (on-line): IUCN Red List of Threatened Species. Date accessed: September 23, 2014. http://www.redlist.org.

Jennings MJ, Emmons EE, Hatzenbeler GR, Edwards C, Bozek MA. 2003. Is littoral habitat affected by residential development and land use in watersheds of Wisconsin lakes?.Lake and Reservoir Management **19(3),** 272–279.

Jomoc DJG, Flores RRC, Nuñeza OM, Villanueva RJT. 2013. Species Richness of Odonata in selected wetland areas of Cagayan de Oro and Bukidnon, Philippines. Aquaculture, Aquarium, Conservation and Legislation - International Journal of the Bioflux Society **6(6),** 560-570.

Kalkman VJ, Clausnitzer V, Dijkstra KDB, Orr AG, Paulson DR, Van Tol J. 2008. Global diversity of dragonflies (Odonata) in freshwater.Hydrobiologia **595,** 351-363.

Kalkman VJ, Boudot JP, Bernard R, Conze KJ, De Knijf G, Dyatlova E, Ferreira S, Jović M, Ott J, Riservato E, Sahlen G. 2010. European Red List of Dragonflies. Luxembourg: Publications Office of the European Union, 1-24.

Loznik B. 2012. Dragonflies and Damselflies: Odonata of the Monteverded, Costa, Rica.Retrieved from: http://efg.cs.umb.edu/monteverde/Ode/OdeIntro.html

MacArthur RH, Wilson EO. 1967. The Theory of Island Biogeography. Princeton, NJ: Princeton University Press, New Jersey.

Malawani AD, Ampang-Macabuat NM, Nuñeza OM, Villanueva RJT. 2014. Odonata of Lanaodel Sur, Mindanao, Philippines. International Research Journal of Biological Sciences **3(1),** 42-48.

Mamat N, Rashid N, Mohamed Z. 2012. Diversity and Habitat Preferences of Dragonflies (Order: Odonata) in Selangor, Peninsular Malaysia. Wulfenia Journal **19(11),** 1-20.

Mapi-ot EF, Taotao A, Nuñeza OM, Villanueva RJT. 2013. Species diversity of adult Odonata in selected areas fromMisamis Occidental Province, Philippines.Aquaculture, Aquarium, Conservation and Legislation - International Journal of the Bioflux Society **6(4),** 421-432.

Marburg AE, Turner MG, Kratz TK. 2006.Natural and anthropogenic variation in coarse wood among and within lakes. Journal of Ecology **94,** 558–568.

Magurran AE. 2004. MeausuringBiological Diversity. Ox- ford: Blackwell Publishing, 256 P.

Nelson B, Ronayne C, Thompson R. 2011. Ireland Red List No.6: Damselflies & Dragonflies (Odonata), National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, Dublin, Ireland, 1-26 P.

Quisil SJC, Arreza JDE, Nuñeza OM, Villanueva RJT. 2013. Species richness of Odonata in Lanuza and San Agustin, Surigao del Sur, Philippines. Advances in Environmental Sciences-International Journal of the Bioflux Society **5(3),** 245-260.

Rathod PP, Manwar NA, Pawar SS, Raja IA. 2012. Diversity and Abundance of Dragonflies and Damselflies (Order - Odonata) in Agro Ecosystems around the Amravati City (M.S.), India in Mansoon Season. International Journal of Agriculture Innovations and Research **3(1),** 2278-7844.

Remsburg AJ. 2007. Aquatic and terrestrial vegetation influence lacustrine dragonfly (order Odonata) assemblages at multiple life stages. PhD Thesis, University of Wisconsin, Madison, Wisconsin, 127 P.

Remsburg AJ, Olson AC, Samways MJ. 2008 Shade alone reduces adult dragonfly (Odonata: Libellulidae) abundance. Journal of Insect Behavior **21,** 460–468.

Remsburg AJ, Turner MG. 2009. Aquatic and terrestrial drivers of dragonfly (Odonata) assemblages within and among north-temperate lakes.Journal of the North American Benthological Society **28(1),** 44–56.

Rosenzweig ML. 1975. On continental steady states of species diversity.In: Cody M, Diamond J, Eds. The Ecology and Evolution of Communities. Cambridge, MA: Harvard University Press, 121 140 P.

Rouquette JR, Thompson DJ. 2007. Roosting site selection in the endangered damselfly, *Coenagrionmercuriale*, and implications for habitat design. Journal of Insect Conservation **11(2),** 187-193.

Sheldon G, Walker KA. 1998. Spatial distribution of littoral invertebrates in the lower Murray-Darling River System. Australia. Marine and Freshwater Research **49(2),** 171-182.

Tennessen KJ. 2003. Odonata (Dragonflies, Damselflies). In:Resh VH, Cardé RT, Eds. Encyclopedia of Insects. Academic Press, San Diego, California, USA, 814-823. p

Villanueva RJT, Mohagan AB. 2010. Diversity and Status of Odonata across Vegetation Types in Mt. Hamiguitan Wildlife Sanctuary, Davao Oriental, Asian Biojournal **1(1),** 25-35.

Villanueva RJT. 2011. Odonata fauna of Diomabok Lake and its surroundings, Davao Oriental, Mindanao Island, Philippines. International Dragonfly Fund-Report **38,** 1-29.

Villanueva RJ, Cahilog H. 2012 Notes on a small Odonata collection from Tawi-Tawi, Sanga-Sanga and Jolo islands, Philippines. International Dragonfly Fund-Report **55,** 1-32.

Wahizatul-Afzan A, Julia A, Amirrudin A. 2006. Diversity and Distribution of Dragonflies (Insecta: Odonata) In Sekayu Recreational Forest, Terengganu. Journal of Sustainability Science and Management **1(2),** 97-106.

Wildermuth H. 1993. Habitat selection and oviposition site recognition by the dragonfly *Aeshnajuncea* (L.): an experimental approach in natural habitats (Anisoptera: Aeshnidae). Odonatologica **22,** 27–44.

www.maphill.com. 2015. Map of the Philippines. Retrieved on May 14, 2015 from http://www.maphill.com/philippines/.