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Aquatic beetle assemblage in natural habitats of Agusan Marsh, Mindanao, Philippines

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Abstract

This paper describes the species composition of aquatic beetles in major habitats of Agusan Marsh and determines their distribution, abundance and diversity. Aquatic beetles are among the dominant insects in freshwater wetlands occupying the base of the food webs in the ecosystem. Several species of aquatic beetles are ubiquitous in the marsh. A total of 27 species of aquatic beetles was collected. Of this, 14 species belong to Family Hydrophilidae, 11 species belong to Family Dytiscidae, and 1 species each belonging to Family Noteridae and Hydraenidae. Of the habitat types, the sedge-dominated swamp has the highest diversity of aquatic beetles, while the sago forest has the lowest. Hydrophilids especially the *Berosus* sp., *Helochaeres* sp. and *Enochrus* sp. are the most common species collected in the various habitats. However, certain species are found unique in specific habitats in the Agusan Marsh. *Eretes sticticus* was only collected in the Sago forest, while *Sternolophus rufipes* was only found in the *Terminalia* forest. Two species, *Cercyon* sp. and *Platynectes* sp. were also unique to the sedge-dominated swamp. The sedge-dominated swamp and *Terminalia* forest appeared to be the most preferred habitats of some unique species of aquatic beetles. The existence of unique species indicates the presence of distinct habitat characteristics which is a crucial consideration for biodiversity management and conservation.

Keywords: Aquatic beetle, biodiversity; wetland; habitat; species distribution; ecological role

1. Introduction

1.1 Importance of biodiversity conservation

Biodiversity conservation has been among the themes of many environmental management programs since the signing of the Convention on Biological Diversity in 1992. This is because many natural habitats for flora and fauna have been converted into food production areas, energy production areas, human settlements, and other uses due to the rapidly growing human population. This, therefore, threatens the existence of many species, particularly those intolerant of habitat disturbances and those having special requirements for survival.

1.2 Status of biodiversity in Agusan Marsh

In Agusan Marsh, biodiversity has been extremely threatened as a consequence of the continued migration of humans into the area. It is declared as a Ramsar site being regarded as one of the repositories of important biodiversity. It is reported to have 7 diverse habitats that harbor a wide array of aquatic, semi-aquatic and terrestrial flora and fauna with a considerable number of endemic species ^[1,2]. However, the marsh aquatic fauna are not well studied and the majority of available information is patchy and intermittent ^[3]. Thus in 2008, an updated systematic list comprising aquatic faunal species collected from seven marsh localities based on a 2006 survey ^[4]. The inventory showed that a total of 64 species of aquatic fauna distributed in 45 genera and 37 families, wherein 59.3% are fishes, 17.2% are crustaceans, 14.1% are mollusks, and 9.4% are reptiles. Most of the aquatic fauna are native and migratory.

1.3 Aquatic insects and their role in biodiversity conservation management in wetlands

Aquatic insects are also ubiquitous species in Agusan Marsh. They are regarded to be at the base of the food webs in a wetland ^[5]. Generally, they are found associated with roots of plants in the various habitats, gliding on the water surface or swimming in the water. Among the most dominant groups are the water beetles. Many of the water beetle species are predaceous, which help in regulating other populations in the ecosystem. Certain species have multiple feeding habits which are important links in the food chains in the marsh. Hence, this study assessed the diversity of aquatic beetles in the natural habitats of Agusan Marsh to identify the

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species that can lead to understanding their contribution to basic wetland ecology. The information may likewise give insights on how can the wetland be managed adopting the ecosystem management for biodiversity conservation, and in turn, provide information for the conservation of natural resources in the wetland.

2. Methodology

2.1 Sampling

Sampling was conducted in the Agusan Marsh located in Agusan del Sur, Mindanao, Philippines in July 2010 to June 2011. The specific study sites include four (4) natural habitats representing the fern-dominated herbaceous swamp, sedge-dominated herbaceous swamp, Sago (*Metroxylon sagu*) forest and Terminalia (*Terminalia copelandii*) forest (Figure 1). Aquatic beetles were collected from the major natural aquatic habitats of Agusan Marsh. The sampled area

measured approximately 500 sq. meters in each study site, where three (3) 1 sq m quadrats were used as actual sampling points.

Insects in habitats with shallow water were collected using a dip net. The net was dipped and swept below the water surface to collect swimming insects. Aquatic insects that cling on debris found in water were washed off the debris and collected in plastic containers. For insects dwelling on the bottom of the water or in the sediment (eg. water scavenger beetles), the dip net was swept over the water bottom. The specimens were placed in labeled plastic jars containing tap water. These were sorted immediately in the laboratory to facilitate collection of insects from smaller debris, and transferred to small plastic jars with cap containing 80% ethyl alcohol. These were then classified based on morphological feature and placed in microvials containing 80% ethyl alcohol for later identification.



Fig 1: Sampling habitats in Agusan Marsh (clockwise: sedge-dominated swamp; disturbed sedge-dominated swamp; *Terminalia* Forest; Sago Forest).

2.2 Aquatic Beetle Identification

Aquatic insects were identified using taxonomic keys. The distinctive features of specimens were viewed under the stereomicroscope to key out following the taxonomic keys. For the common species, identification was done up to species level, while for those not commonly encountered, the insects were identified up to the lowest possible taxon. The aquatic beetles were identified using the taxonomic papers [6-8].

2.3 Data Analysis

The number of species and number of individuals per species were counted for each sampling site. The data were then analyzed using the diversity indices such as Shannon's index

of diversity, Jaccard's index of evenness and Simpson's index of dominance. To determine the similarity of species composition between natural habitats in the marsh, the cluster analysis of the Multi-Variate Statistical Package (MVSP) from Kovach Computing Services was used.

3. Results and Discussion

3.1 Aquatic Beetle Diversity and Abundance

The diversity of aquatic beetles in Agusan Marsh averages 3.55 based on the Shannon's index of diversity (Table 1). Of the habitats, the sedge-dominated swamp has the highest diversity while the fern-dominated swamp has the lowest. In terms of abundance, the sedge-dominated swamp has also the highest at 746; however, the individuals have relatively even

distribution per species as shown in Table 2. The most common species in this habitat with high number of individuals are the water scavenger beetles *Berosus* sp., *Helochaeres* sp. and *Enochrus* sp. under the Family Hydrophilidae. This results to the low evenness of population distribution as measured by Jaccard's index of evenness

resulting to lower diversity index. In habitats where some conditions are limiting, only the highly tolerant species control the limited resource. Hence, these tolerant species become dominant in terms of number or importance, forcing other less competitive species to migrate.

Table 1: Species diversity of aquatic beetles in the wetland natural habitats of Agusan Marsh¹.

Habitat	Diversity (using Shannon's Index of Diversity)	Relative Abundance
Fern-dominated swamp	3.43	700
Sedge-dominated swamp	3.71	746
Sago (<i>Metroxylon sagu</i>) Forest	3.47	622
Terminalia (<i>Terminalia</i> sp.) Forest	3.62	705

¹ Based on samples collected quarterly for 1 year

Table 2 presents the aquatic beetles in the Agusan Marsh distributed in the various vegetation-based natural habitats. In 2011, a total of 2773 individuals of aquatic beetles were collected from the different habitats of Agusan Marsh. These belong to 27 species, with the water scavenger beetles under Family Hydrophilidae predominating in number. The water scavenger beetles are generally associated with decaying

organic plant materials. In Agusan Marsh, decaying organic plant materials are very abundant particularly after the flood at the onset of the dry season. In ponds where water buffaloes cool off after the day's work, water scavenger beetles are likewise abundant. This is due largely to the animal manure that attracts the Hydrophilids especially the *Berosus* sp. and *Enochrus* sp.

Table 2: Species distribution of aquatic beetles in the vegetation-based natural habitats of Agusan Marsh.

Species	Fern-dominated swamp	Sedge-dominated swamp	Sago forest	Terminalia Forest
Dytiscidae				
<i>Copelatus</i> sp. 1	12	16	7	12
<i>Copelatus</i> sp. 2	10	4	2	11
<i>Eretes sticticus</i>	0	0	7	0
<i>Hydaticus</i> sp.	0	5	0	2
<i>Hyphydrus xanthomelas</i>	40	30	22	52
<i>Hyphydrus</i> sp.	14	0	6	17
<i>Hydroglyphus</i> sp.	72	66	69	55
<i>Laccophilus</i> sp. 1	15	22	26	23
<i>Laccophilus</i> sp. 2	6	9	14	20
<i>Platynectes</i> sp.	0	2	0	0
<i>Rhantus</i> sp.	0	0	0	13
Hydrophilidae				
<i>Anacaena</i> sp.	29	36	32	15
<i>Berosus</i> sp. 1	18	22	9	26
<i>Berosus</i> sp. 2	66	75	28	31
<i>Berosus</i> sp. 3	107	135	131	113
<i>Cercyon</i> sp.	0	3	0	0
<i>Enochrus</i> sp. 1	6	0	21	19
<i>Enochrus</i> sp. 2	86	85	82	62
<i>Enochrus</i> sp. 3	74	72	47	47
<i>Helochaeres</i> sp. 2	24	12	13	21
<i>Helochaeres</i> sp. 3	77	72	67	95
<i>Paracymus</i> sp.	5	30	0	25
<i>Sternolophus rufipes</i>	0	0	0	3
undet Berosinae	0	12	10	0
undet hydrophilid	10	4	0	13
Noteridae				
<i>Hydrocantus semperi</i>	3	2	0	11
Hydraenidae				
<i>Hydraena</i> sp.	26	32	29	22
Total No. of Species	20	22	19	23
Total No. of Individuals	700	746	622	705

The populations of different species of aquatic beetles are fairly distributed in the various habitats in the marsh. The highest abundance was recorded in the sedge-dominated swamp, at 746 individuals. The Sago forest has the least abundance, with 622 individuals. However, in terms of

evenness in the population distribution, those in the *Terminalia* forest have the highest index. The Sago forest has the lowest index of evenness due largely to the dominance of *Berosus* sp., *Enochrus* sp. and *Helochaeres* sp. In general, the index of evenness decreases resulting to lower diversity

index when 1 or 2 species predominate in a habitat. The predaceous diving beetles under Family Dytiscidae are quite diverse in the various habitats of the marsh. However, their abundance is lower compared to the water scavenger beetles. This can be attributed to their feeding behavior. As predators, their numbers are dependent on the available prey of the

Dytiscids, *Hydroglyphus* sp and *Hyphydrus xanthomelas* have the highest abundance at 262 and 144, respectively. In Fig 2, the abundance curve is shown to reflect species richness and species evenness of the various wetland natural habitats of Agusan Marsh. This trend is true to all the vegetation-based wetland habitats in the marsh.

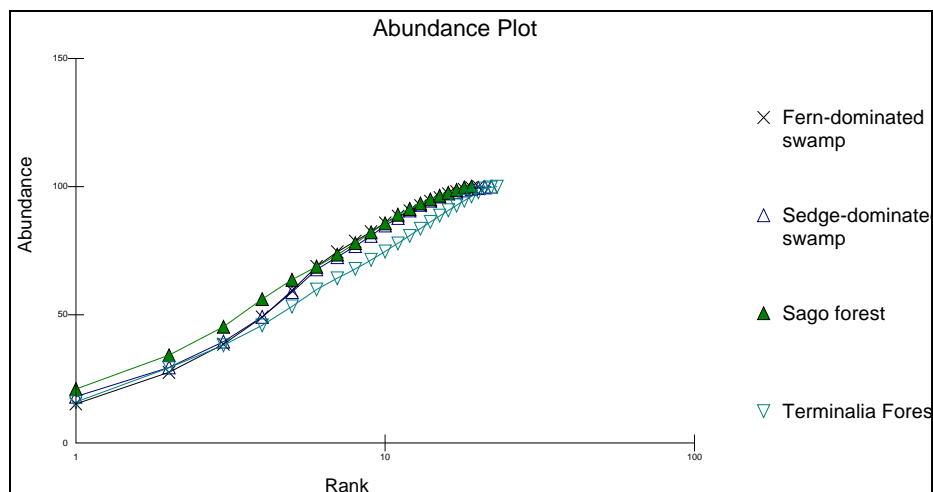


Fig 2: Relative species abundance of aquatic beetles sampled from the wetland natural habitats of Agusan Marsh

The aquatic beetles have similar species despite the differences in the species richness and abundance in the various wetland natural habitats. This can be due to the similarity of the characteristics among habitats resulting from the flooding that make the Agusan Marsh into one big lake. The similarities are evident between the *Terminalia* forest and the Fern-dominated swamp. More species of aquatic beetles are shared between them, while the Sago forest appears to be the outlier. This indicates that Sago forest has the least number of species shared with the other habitats.

Some species of water beetles appeared to be unique in one or two natural habitats. The existence of these unique species is an important consideration for biodiversity conservation because they serve as indicators in the quality of the habitat. In Agusan Marsh, the dytiscid beetle *Platynectes* sp. and the hydrophilidae beetle *Cercyon* sp. are unique to the sedge-dominated swamp. On the other hand, the dytiscid *Hydaticus* sp. and *Rhantus* sp. are also recorded in the sedge-dominated swamp and in the *Terminalia* forest only. The close proximity and the similarity in vegetation structure of these

habitats may explain these distributions. The unique microhabitat in the Sago forest may have supplied the survival requirements of the dytiscid beetle *Eretes sticticus* Linnaeus because it is found only in the Sago forest. Similarly, the hydrophilid beetles (*Sternolophus rufipes* Fabricius) were collected in ponds which are partially drying up in the *Terminalia* forest habitat. The presence of unique species of water beetles contributes to the higher diversity in the sedge-dominated swamp and the *Terminalia* forest. Thus the index of diversity is relatively higher in these habitats as shown in Fig. 3. However, the indices of diversity only differed slightly due to the seasonal flooding episodes that made the aquatic beetles to move from one habitat to another in the Agusan Marsh during flooding. The unique presence of some species in a particular habitat may indicate the provision of specific habitat requirements, such as the vegetation structure, amount of accumulated detritus, and the presence of food, which are important considerations in biodiversity conservation.

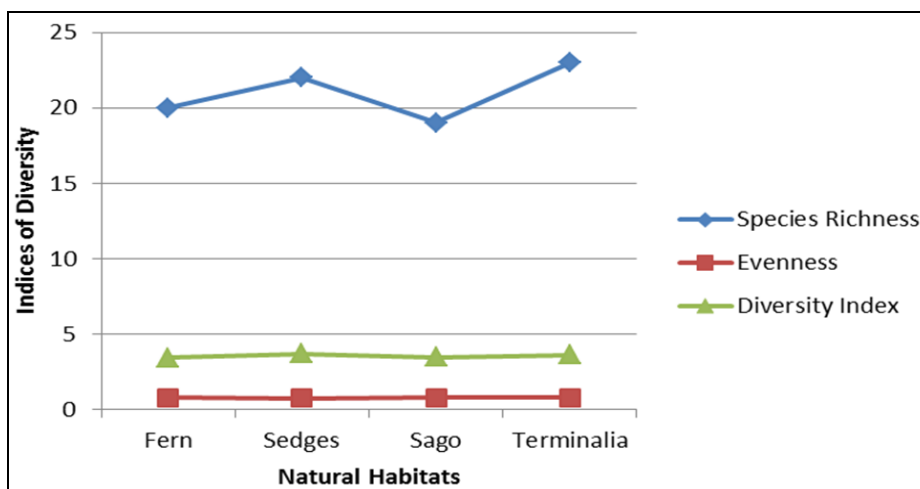


Fig 3: Diversity of aquatic beetles in the natural habitats of Agusan Marsh

In Agusan Marsh, the Hydrophilids predominate in terms of number and species richness due to the multiple roles they play in the wetland ecosystem [9]. At the adult stage, many hydrophilids are scavengers thus they probably made the habitat more favorable to other organisms by converting the organic debris into more readily available food. Moreover, they also are providing food as prey to other organisms in the system. By converting plant and animal debris into organic matter, these scavenger beetles likewise play an important role in the nutrient production system of the marsh. Some species of hydrophilids are predaceous during the larval stage. As such, they also help regulate the populations of their prey, thus helping minimize competition in the ecosystem.

4. Conclusion

The trend in the abundance and distribution of aquatic beetles in the different natural habitats of Agusan Marsh differed only slightly due to the periodic flooding events and probably to the group's nature as flyers during the adult stage. While the species composition of aquatic beetles in the natural habitats appeared to have similarity, some unique species are found in certain habitats which can be used as indicators of habitat quality. In addition, the sedge-dominated swamp and *Terminalia* forest appeared to harbor some unique species of aquatic beetles. The microhabitats in these ecosystems may be more conducive to the insects' survival. The existence of unique species of aquatic beetles points to distinct habitat characteristics. Thus a thorough study on the habitat requirements of the unique species is essential since this could be integrated in the planning for the biodiversity conservation of Agusan Marsh.

5. Acknowledgment

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