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Research Article

Local Community Perceptions of the Ecological and Socio-Economic Benefits of Spiders in Small-Scale Urban Green Spaces for Conservation Reinforcement

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ABSTRACT

Spiders are among the most ubiquitous arthropods that can dwell on diverse habitats, which include small-scale urban green spaces (UGS). To promote urban biodiversity, we assessed the awareness of a local community situated within UGS in Davao, Philippines about the ecological roles of spiders. Data were obtained by administering survey questionnaires to 80 households using convenience sampling. The survey revealed that the local community is knowledgeable on the occurrence of spiders in their area (97.5%), in which they are mostly acquainted with spiders of Pisauridae (25%) and Araneidae (20.3%). Also, the community has recognized the important ecological roles of spiders, in which they mostly acknowledged them as a significant source of food for other organisms (71.62%). However, a high proportion of respondents also recognized the socio-economic benefits of spiders through spider wrestling (60.81%). Henceforth, the ecological roles of spiders could be subjugated as spider wrestling is practiced in the local community, which could be a possible threat to the spider population. Thus, we highly suggest to involve concerned local communities in urban biodiversity management for the conservation of spiders in the Philippines, which is at risk due to its perceived socio-economic benefits.

Key words: Awareness, Arachnids, Arthropods, Local Knowledge, Biodiversity Management.

INTRODUCTION

Spiders are known for an array of important ecological functions that greatly influence the balance of the ecosystem. It is one of the oldest arthropod groups that act as primary invertebrate predators in various terrestrial ecosystems (Shirbhate & Vyas, 2012; Raiz Tabasum *et al*., 2018). Spiders are also known as significant natural enemy of different insect pests in agroecosystems (Lee & Kim, 2001; Maloney, Drummond & Alford, 2003), and have been potentially used as good biological control agents (Jeyaparvathi, Baskaran & Bakavathiappan, 2013). Moreover, spiders play a significant role as an important food source for other organisms like frogs, lizards, birds, and other animals (Sharma, Vyas & Sharma, 2010). They are also highly sensitive to changes in habitat structure, vegetation complexity, rapid response to disturbance, and microclimate characteristics (Schwerdt, de Villalobos & Miles, 2018), that made them highly appropriate as a good bioindicator (Maelfait & Hendrickx, 1997; Jansen *et al*., 2013; Schwerdt *et al*., 2018).

Spiders exhibit a ubiquitous way of living, as they can dwell on various aquatic and terrestrial habitats such as in plantations, gardens, bushes, caves, and even inside buildings and households (Turnbull, 1973). As they can be found in different types of ecosystem and elevational gradients, they have been considered as one of the most dominant macroinvertebrate groups, in which they can reach a maximum density of almost 1000 individuals per square meters depending on conditions (Duffey, 1962). To date, almost 49,000 species of spiders have been recorded worldwide, which were placed in more than 4000 genera and 128 families (World Spider Catalog, 2020). Henceforth, the incorporation of spiders in monitoring programs and conservation strategies is vital due to their diversity and functional roles.

Aside from undisturbed natural ecological systems, spiders can also thrive in disturbed habitat types and microhabitats such as in urban areas (Marc, Canard & Ysnel, 1999). Urban areas are vitally supported by urban green spaces (UGS) (Magura, Horváth & Tóthmérész, 2010; Moorhead & Philpott, 2013), which can be all-natural, semi-natural, and artificial ecosystems that support urban biodiversity (Aronson *et al*., 2017). These green spaces include public areas such as parks, sporting fields, riparian areas, community gardens, street trees, and trails (Roy, Byrne & Pickering, 2012). Private properties may also provide green spaces in urban areas such as gardens, private backyard trees, and small-scale agricultural farms (Wolch, Byrne & Newell, 2014). These green areas could be used as potential habitats of spiders which together provide a wide range of ecological services to the urban community.

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Figure 1. Map of the local community (Sitio 117) located within the UGS of UP Mindanao at Bago Oshiro, Tugbok District, Davao City, Philippines (Google Earth, 2020).

In the case of the Philippines, there is insufficient attention with regard to the utilization of urban green spaces in promoting urban biodiversity, although this has been incorporated recently in the country's framework in conserving biodiversity (BMB - DENR, 2016). Thus, urban green space management became one of the important concerns for biodiversity conservation in the country.

In past years, conservation efforts mainly focused on large pristine areas and protected landscapes to combat biodiversity threats. Urban areas, smaller reserves, and unprotected lands are generally overlooked due to the misconception that urban areas offer less abundant and diverse species. As the human population increases through time (Bloom, 2011), the potential damage to natural ecosystems and UGS may increase due to human actions (Kates, 1971; Palmer *et al*., 2004; Richards *et al*., 2017). Some of the key challenges for the conservation of UGS include balancing human perceptions, needs, and use of other ecological requirements for preserving and enhancing biodiversity (Aronson *et al*., 2017). A wider understanding of coordination in the neighborhood or smaller scales is one of the important keys to support biodiversity on larger scales. The perceptions from the human community towards biodiversity resources will influence their social and political will to conserve and support conservation efforts, as examined by previous studies (e.g. Vodouhê *et al*., 2010; Ouko *et al*., 2018; Abukari & Mwalyosi, 2020; Tarakini, Chemura & Musundir, 2020).

Hence, this paper presents an assessment of a local community's knowledge and perception of spiders situated within UGS of the University of the Philippines Mindanao. Spiders were tested as a target group because of their ubiquitous presence and their various ecological roles in different urban habitats. Furthermore, this study aims to determine the level of knowledge and awareness of the community on the ecological and socio-economic benefits of spiders to reinforce the conservation of this vital invertebrate group. The information generated here can be used by the university in engaging its community as a stakeholder in managing and promoting urban biodiversity as it gears towards becoming a green campus. The findings herein can also bring new insights to conservationists and managers in developing inclusive and effective conservation efforts relating to urban green spaces.

MATERIALS AND METHODS

Study area

The knowledge and perception of spiders were assessed from a local urban community at Sitio 117, Bago Oshiro, Tugbok District, Davao City, Philippines (Figure 1). This community is centrally situated within the University of the Philippines (UP) Mindanao campus, an institution that harbors small-scale urban green spaces composed of dense vegetation of secondary trees, bushes, and shrubs. The local council of Bago Oshiro reported more than 10, 000 people residing in the entire community. Hence, Sitio 117 can be considered an urban area following the criteria in the 2010 Census of Population and Housing (CPH) of the Philippine Statistics Authority (2020).

Data Collection

The collection of data was done through the administration of a survey questionnaire to 80 households using a convenience sampling method from September to November 2018. The target number of households was estimated using Slovin's formula (Yamane, 1967), which generated 139 households. However, 59 households withdrew from the study as they were not forced to answer the questionnaire even if they already agreed to participate in the first place. Each representative individual per household was asked to accomplish one survey questionnaire (Appendix 1) but they were not required to answer all questions. We used the questionnaire from the study of Pepito, Barrion-Dupo & Nuñeza (2016) with modifications. The survey was conducted using English and Cebuano, the local language used by the respondents, and with the help and assistance of the village leader. Consent forms were distributed at hand before the collection of data and all information from the respondents was treated with confidentiality throughout the study.

The first set of questions includes socio-demographic information (i.e. age, gender, occupation, and level of education), while the second set contains both open- and closed-ended questions that mainly focused on the community's knowledge of spider biology and its ecosystem services (ES). We also added a third set of questions that was only administered to those who recognized spider wrestling as a socio-economic

service, especially to those involved in such activities. Lastly, a separate set of photographs of spiders previously documented inside the study area was presented to the respondents to determine which species are familiar to them.

Statistical Analysis

Data were summarized using descriptive statistics. The Spearman's rank correlation coefficient was used to assess the association between socio-demographic factors and the community's knowledge and perception of spiders, especially the important ecosystem services. Chi-square test was also used to test the association of nominal socio-demographics (e.g. age) to binary categorical responses. The significance level was set at p-value ≤ 0.05. All the analyses were performed using the "cor" function, and the package "vcd" (Meyer, Zeileis & Hornik, 2020) in R software version 3.6.1.

RESULTS

Socio-Demographics

Of the 80 survey respondents, 75% were males while the rest were females (Appendix 2). The age was categorized into six ranks with 10 years interval, in which only 76 respondents declared their age with the mean of 27 years old. The occupation of the survey respondents was categorized into two: employed and not employed. Of the 52 respondents who revealed their occupation status, only 46.15% have occupation since some are still students. Moreover, only 54 respondents reported their highest educational attainment wherein the highest proportion achieved secondary education (57.41%), followed by those with primary school education (24.07%), and those who reached tertiary education (18.52%).

Knowledge and Perception of Local People Towards Spiders

Seventy-eight respondents (97.5%) indicated that they are aware of the occurrence of spiders within their vicinity. All of the socio-demographic factors recorded such as age, sex, occupation, and level of education were not found to have significant influence on their awareness (Table 1: $p > 0.05$; $r = -0.0027$; x^2=0.68376; $r = 0.1296407$; $r = -0.2180$, respectively).

Spiders were generally called as "*damang*", "*lawa-lawa*", and "*gagamba*" by the respondents (Table 2). Specific terms were also given to particular species based on spider size: a one-Philippine peso coin used as a point of reference (Appendix 3), color, pattern, and habitat. For example, a species of spider is called "*ituman*" from the Cebuano word "*itom*" which means black, since it is an obvious characteristic of the spider. Based on pattern, an example is the "*zerohan*" which is named after the black dot on the dorsum of the spider's abdomen resembling the number zero. For habitat, a species is named "*tambalayan*" from the Cebuano word "*balay*" which means a house because it is where the species can be usually found. Other bases of the local people for designating names to spiders included hair structures, movements, time of activity (nocturnal or diurnal), number of eyes and legs, and web patterns. Although spiders may belong to the same species, different local names may be given and vice versa.

Table 1. Correlation between socio-demographic factors and awareness on the occurrence of spiders in UP Mindanao.

Socio-Demographic Factors	Pearson Chi-Square (x^2)	Spearman rho (r)	p-value
Age	-	-0.002749164	0.9812
Sex	0.68376	-	0.40829
Occupation	-	**0.1296407**	**0.3597**
Level of Education	-	-0.2180366	0.1132

Table 2. Local names of spiders reported by the survey respondents.

	Local Names	Basis for Naming
A. General common names for spiders	*Damang*, *Lawa-lawa*, *Gagamba*	
B. Specific common names for different spider species	Black spider, White King, Ituman, *Baga-baga*, Black Molly	Color
	Wanan, *Intsikoy*, *Zerohan, Exan, Tickered, Aluman, Starran, Tigeran,* X-spider, *Tuldokan,*	Pattern
	Kapehan, Gagambahay, Lawa-lawa, Bagambahay, Tambalayan, Cacaohan, Balaybalayan	Habitat
C. Other common names	*Tamburong, Tarantikig, Buktotan, Tapay-tapay, Dalids, Iro-iroan, Iring-iringan, Bangkawan, Singot-singot, Kamel, Likon-likon,* Spiderman, *Tambayawan,* Fighter, *Labtikan,* Derby, *Insect-insect, Udto, Ikugan,* King spider, *Bukiwan, Hadla-hadlaan*	

Furthermore, we assessed the knowledge of survey respondents on the spider species occurring within their vicinity by using photographs from our quick spider inventory within the study area (unpublished data). The survey revealed that the respondents are most acquainted with spiders belonging to the following families: Pisauridae (25%), Araneidae (20.3%), Thomisidae (17.5%), and Sparassidae (14.5%) (Figure 2). The least recognized spider families were Ctenidae (3.80%), Corrinidae (8.80%), and Lycosidae (10.60%).

A total of 74 respondents (92.5%) have recognized the spider's ecosystem services (ES). A large proportion (71.62%) reported that spiders serve as a significant source of food for many organisms (Figure 3). This is followed by its potential as a biocontrol to regulate insect pest population (36.49%) and its ability to trap airborne particulates using its web (32.43%). All

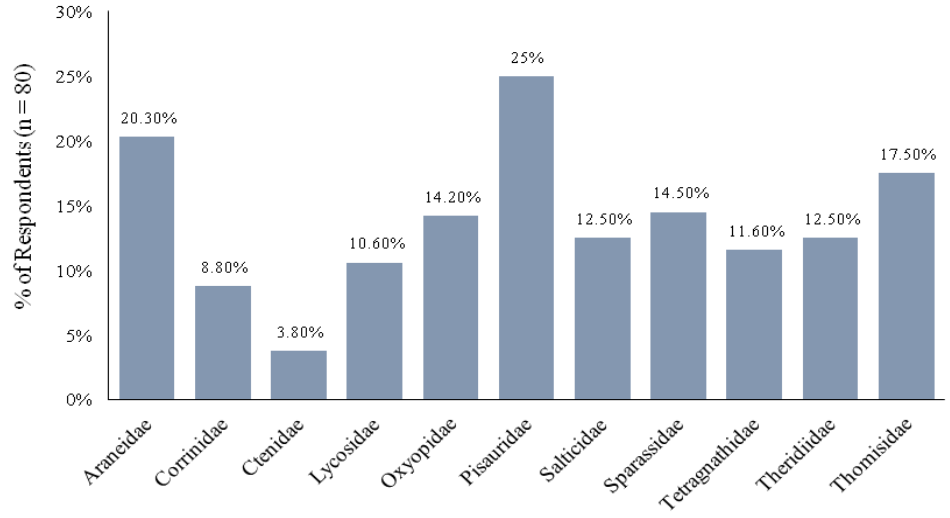

Figure 2. Percentage of respondents who can recognize spiders belonging to 11 families

Table 3. Correlation between socio-demographic factors and awareness of ecological services (S1-S4) and socio-economic benefits (E1).

Socio-Demographic Factors	Pearson Chi-Square (x^2)				Spearman rho (r)			
	S1	**S2**	**S3**	**E1**	**S1**	**S2**	**S3**	**E1**
Age	-	-	-		0.06199	0.1872855	-0.005352129	**- 0.4888195 ***
Sex	**67.125***	**68.365***	**66.795***	**82.603 ***		-	-	-
Occupation	-	-	-		0.1484644	0.1830771	0.141927	-0.2671122
Level of Education	-	-	-		0.1966321	**0.3130316***	-0.143668	**-0.3855727***

**p*-value < 0.05; S1 – Food for other organisms; S2 – Pest control; S3 – Trapping of particulates; E1 – Spider wrestling practice

the recognized ES by the respondents were significantly correlated with sex (Table 3). The level of education was also found to be correlated with their awareness of the spider's ES, in which secondary and tertiary education were more aware of the spider's ecological roles.

Spider Wrestling

Some of the respondents who have recognized the ES of spiders also reported its socio-economic benefits (Figure 3; 60.81%). These respondents practice spider wrestling for entertainment and gambling purposes. The socio-demographic factors that correlated with this benefit include age, sex, and level of education (Table 3; $p < 0.05$). Respondents belonging to the youngest age rank (8-18 years old; n=31), who are mostly males (n=36; 92.31%), and who have reached the secondary level of education (n=14; 60.89%) showed that they were more involved in spider entertainment activities. Of the 38 respondents who declared their motivation in playing with spiders, 15 played for recreation; 14 played for money; 9 played for both recreation and money-making. Age, occupation, and level of education of the respondents were not found to influence their participation in spider wrestling (Table 3: $p > 0.05$). However, sex and their motivation to participate in spider wrestling were significantly correlated, with males being more involved in recreation (Table 4: $x^2 = 4.6719$, $p < 0.05$).

The survey revealed that the species of spiders usually used as a game animal for spider wrestling belong to the genus *Neoscona,* which is commonly called as derby spiders (Figure 4A-C). As reported by the respondents, derby spiders are normally collected at night and are housed in small containers such as matchboxes before the fight. The spider individuals are forced to fast for two to five days to make them more aggressive. Only a little amount of food (e.g. shrimp and mosquitoes) and water are provided with time intervals. The provision of shrimp is believed to contribute to the stickiness of the spider's silk. Other aqueous substances are also given such as honey, dextrose, energy drink, and vitamins using cotton balls.

In the game, a stick held by one of the owners of the derby spiders is used as the stage. Regardless of species, the spiders are matched according to the size of its abdomen and the length of its legs. A referee of the game is also assigned. Before the two opposing derby spiders are placed at both ends of the stick, viewers and owners of the participating derby spiders place their

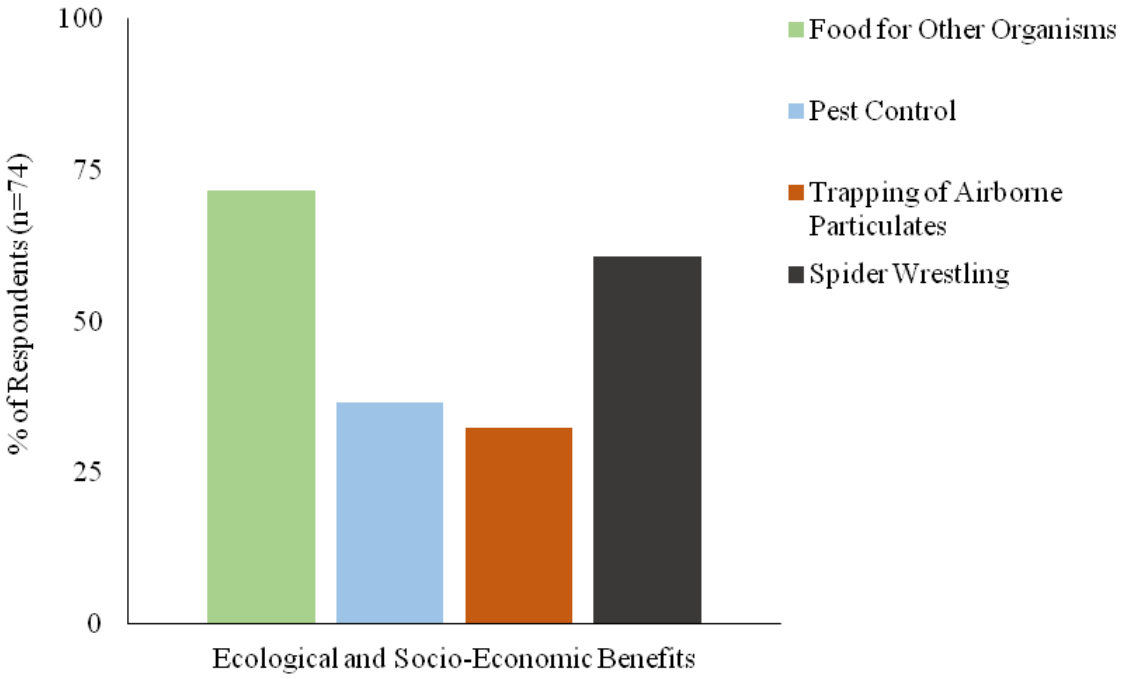

Figure 3. Percentage of the local people who reported about the ecosystem services of spiders as well as the socio-economic service, spider wrestling (black bar).

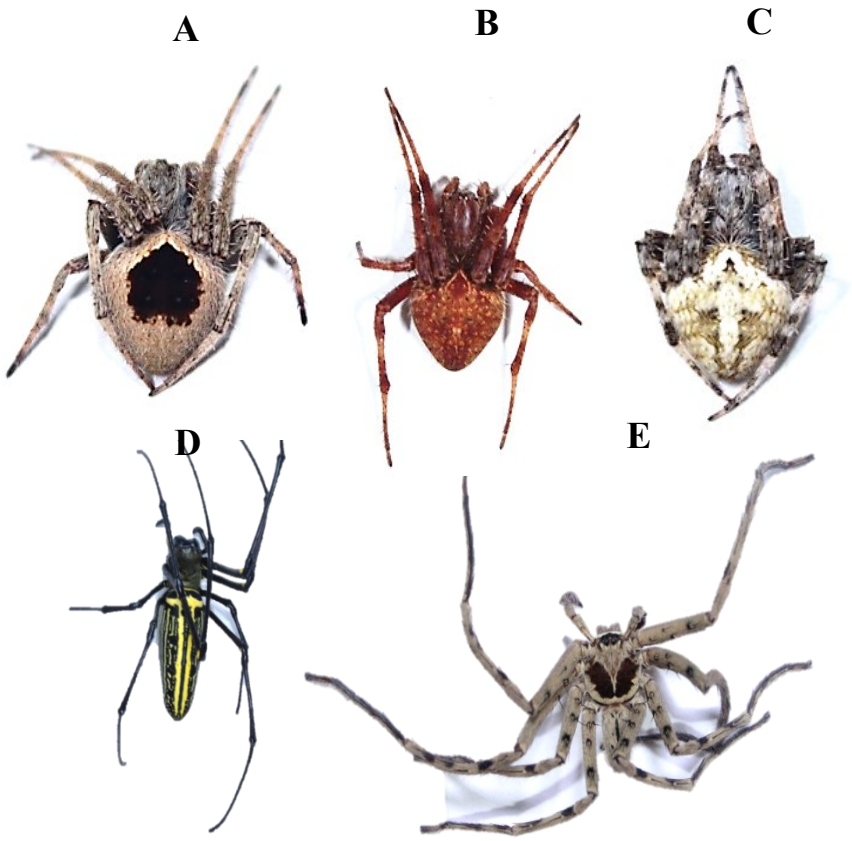

Figure 4. Derby spiders used in spider wrestling, *Neoscona* spp. (A-C); and spider species believed as harmful to humans, *Nephila pilipes* (D) and *Heteropoda venatoria* (E).

Table 4. Correlation between socio-demographic factors and motivations of spider wrestling participants.

Socio-Demographic Factors	Pearson Chi-Square (x^2)			Spearman rho (r)		
	Recreation	**Money**	**Both**	**Recreation**	**Money**	**Both**
Age	-	-	-	-0.1249762	0.06375767	0.07288109
Sex	**4.6719** *	1.82	0.9750	-	-	-
Occupation	-	-	-	-0.1240646	-0.1328469	0.2441202
Level of Education	-	-	-	-0.1489546	-0.01136083	0.1742672

*p-value < 0.05

bets. All the bets, which range from 0.10 to 16.45 US $, are pooled together and are only given to the winners of the match. The fight only ends when one of the spiders dies, falls from the stick two to three times, gets wrapped in spider silk, or runs constantly away from its opponent. Three strikes are given to each spider in case it only hangs itself from the stick and does not fight. If neither of the spiders battle against each other, the game is declared a draw by the referee.

In addition, more than half of the respondents (59.5%) believe that there are species of spiders that pose harm to humans. These spiders are not used in spider wrestling (Figure 4D-E). We found no significant association between the socio-demographic factors and this belief (Appendix 4). Besides, the respondents further reported that the potential harm brought by spiders through bites is not a serious threat to human health. The manifestations of the effects of spider bites were also reported in the survey, including mild allergic reaction, itchiness, and swelling of the bitten area. As a remedy, the respondents revealed various treatments. These "treatments" include liniment oil, herbal oil, alcohol, Moringa leaf extracts, pain reliever (i.e. Mefenamic acid), and antibiotics (i.e. Amoxicillin).

DISCUSSION

The survey revealed that the local community is knowledgeable about the occurrence of spiders in their area no matter their age, sex, occupation, or level of education. In addition, the community has recognized the important ecological roles of spiders, where they mostly acknowledged spiders as a significant food source for other organisms (Figure 3). Despite this, a high proportion of respondents has also recognized the socio-economic benefits of spiders through spider wrestling (Figure 3) which can become a threat to its population.

Participants assign local common names to particular spider species, which are based on size, color, pattern, and habitat (e. g. "*damang*", "*lawa-lawa*", and "*gagamba*") and are similar to the names reported in previous studies in Mindanao (Pepito *et al*., 2016; Aguhob, Dupo & Nuñeza, 2016). However, local names may be ambiguous and inconsistent because they vary from one community to another. For instance, the local name "*taga-mais*" refers to two different species of spiders: *Eriovixia laglaizei* (according to Pepito *et al*., 2016) and *Neoscona punctigera* (according to Aguhob *et al*., 2016). A similar observation was also recorded in this study, wherein a *Neoscona* spider is both called by the locals "*kapehan*" and "*cacaohan*" because it can be found in coffee and cacao trees, respectively.

In terms of the type of spider, results showed that the respondents were more familiar with species from Pisauridae, Araneidae, Thomisidae, and Sparassidae (Figure 2). Although Pisauridae is not among the largest spider families (World Spider Catalog, 2020), these reports may indicate that these families are widely distributed in the area and could be the most common spider families within the UGS where the local community nearly resides. Several studies had documented that the aforementioned families can be found from residential areas to highly vegetated sites in Mindanao (Garciano, Nuñeza & Barrion-Dupo, 2014; Achacoso, Walag & Saab, 2016; Juario, Nuñeza & Dupo, 2016a,b; Patiño, Barrion-Dupo & Nuñeza, 2016). These spiders are also more visible to people because of their time of activity (have both nocturnal and diurnal representatives), abundance, and guild classification (Uetz, Halaj & Cady, 1999). The high abundance and other ecological characteristics of these spider families also make them occupy more spaces which thereby increase their range of distribution, probably reaching human settlements. Due to this, an overlap in the guild structure of the families may occur because of their habitat variation, prey range, foraging strategy, and time of appearance (Cardoso *et al.,* 2011; Memah *et al*., 2014).

It was revealed that spiders are valued in terms of their ecosystem services, which include the following: significant source of food for many organisms (Sharma *et al*., 2010), keeping an insect pest population in check (Lee & Kim, 2001), and trapping of airborne particulates (Rybak *et al.,* 2015). On one hand, our findings showed that a high proportion of the respondents recognized the role of spiders as a significant source of food for other organisms (Figure 3), however, we cannot infer that this knowledge is sex-specific possibly due to the large difference between the number of male and female respondents. On the other hand, older respondents (>18 years) and those who have attained a higher education level (tertiary education) showed more understanding of a spider's ES. This suggests that it is the older respondents who have more awareness of the significant ecological roles of spiders supplemented by relevant teachings in higher education.

Unfortunately, the value of spiders was also viewed in economic terms through spider wrestling (Figure 3). Spider wrestling is a seasonal sport that has become a gambling activity in communities across the Philippines (Matejowsky, 2003). Our analyses concur

with the observation of Matejowsky (2003), Aguhob *et al*. (2016), and Pepito *et al*. (2016), in which we have determined that spider wrestling is mostly performed by young men, with an age of 8-18 years, and mostly reached secondary education. We found that these participants are motivated to practice spider wrestling for pastime or recreation and money-making. Our data also showed that sex is correlated with their motivation to practice spider wrestling. These results suggest that young males (8-18 years) have more free time to play spider wrestling than adults for recreation. Even though money is involved sometimes in this activity, our results showed that sex does not correlate with their response to motivation for money-making. The earnings of those participants involved in spider wrestling for money-making can reach up to more than 16 US $ per match. This report on earnings is lower than previous studies in Mindanao (Aguhob *et al*., 2016, and Pepito *et al*., 2016) but still can be of significant source for economic benefit. Although spider wrestling may considerably contribute to the economic well-being of the local people, this activity is considered as one of the serious threats to the population of spiders. One reason is that adult female spiders are mostly collected for this activity, which could exceptionally limit the population expansion of species. Also, removing spiders from their habitats can impact UGS, inhibiting their significant ecological roles in the ecosystem. Moreover, the collection of spiders is deemed illegal in the country according to the Republic Act No. 9147 also known as the Wildlife Resources Conservation and Protection Act. Thus, this arthropod group should not be collected without a permit from the wildlife conservation agencies.

On a lighter note, we observed that spider wrestling increases the interaction between humans and spiders. Human-spider interplay is a spectrum from positive to negative, where the experience of humans with spiders can affect how they perceive the species (Kretser *et al*. 2009). Attitudes of the people about their environment are determined by how they feel and what they believe about it (Pooley & o'Connor, 2000). In the context of the local people in this study, the local community encountered different spiders due to spider wrestling and other entertainment activities. With this, they believe that there are spiders that can be harmful to humans if they bite (n=46; 58.23%) (Figure 4D-E). They prefer to administer their own "treatments" such as liniment oil, herbal oil, alcohol, *Moringa* leaf extracts, antibiotics, and pain reliever if bitten by spiders. However, these reported "treatments" are not medically known and proven effective to treat spider bites (arachnidism). According to Isbister & Fan (2011), antivenoms are the primary remedy to treat patients bitten by medically harmful spider species. In the Philippines, only a few cases of arachnidism were documented, which are the cases from *Nephila pilipes* and *Neoscona minima* in the 1980s (Barrion *et al*., 1987). Spiders may show aggressive behavior when they are disturbed, threatened, injured, or provoked (Rahmani *et al*., 2014). In such cases, people may develop negative attitudes or perceptions towards spiders, which can become a human-wildlife conflict bringing considerable setbacks for its conservation.

CONCLUSION

One of the readily available habitats for ubiquitous animals, such as spiders, includes small-scale urban green spaces that still harbor diverse taxa especially for the highly adaptive animal groups like arthropods. With this, priority conservation is of utmost importance for UGS. Overall, we found that the local community in a small UGS has a positive perception of spiders as they have recognized and understood some of their significant roles in the ecosystem. However, these could be neglected since spider wrestling is also practiced in the area where the locals are motivated for recreation and money. It can become alarming because this might worsen the current threats to this important invertebrate group. We recommend reinforcement of the knowledge on the ecological services of spiders to the young members of the community. This may include promoting positive perceptions and addressing the factors that contribute to negative viewpoints. Biological and social perspectives must be also integrated to create an effective conservation plan for the benefit of both humans and wildlife. Therefore, we highly suggest to involve and capacitate concerned local communities as one of the stakeholders in urban biodiversity management for the conservation plan for this arthropod group, which is highly at risk due to its perceived socio-economic benefits.

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