

## A REVIEW OF BIODIVERSITY-RELATED REPORTS IN THE CORDILLERA HIGHLANDS, NORTHERN LUZON, PHILIPPINES

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**ABSTRACT** – The Cordillera Administrative Region (CAR) is not only considered as “Watershed Cradle” but likewise an “Ecological Zone” of Northern Luzon, Philippines having the Key Biodiversity Areas. Biological diversity is a precious asset for it provides supporting, regulating, provisioning, and cultural services unique to the Cordillera. However, is the richness of the Cordillera natural heritage adequately documented to reference the future generation? Therefore, this paper assesses the status of biodiversity-related studies in the region and how these data are being shared with the public. It highlights the strength of biology in biodiversity studies. We gathered biodiversity datasets from various sources such as libraries, research offices, universities, and internet search engines with open access. These materials were categorized to capture the three levels of organization: genetic, species, and ecosystem diversity. The distribution of studies was also assessed based on study sites, and the year these were reported. Results show that the accessibility of these biodiversity data is deficient and only concentrated in Benguet Province. The majority of the biodiversity-related studies in Cordillera are unpublished, with only 54 out of 226 reviews (24%) reaching the global audience through international publication. Available resources were mostly focused on utilizing plants, followed by species diversity assessment on limited taxa. An ecosystem approach to the study of flora and fauna found in different habitats is wanting. Some of the proposed explanations for this dearth of information from a supposedly rich biodiversity area are the lack of taxonomic experts and field-based researchers, funding opportunities, publishability of taxonomic work, computer databases, inventories, and information networks for the collection and collation of information. By data sharing, we know what exists, what we are losing, and what we need to conserve.

*Keywords: Biodiversity, Cordillera, data sharing, datasets, Taxonomy*

### INTRODUCTION

Biodiversity is a portmanteau for biological diversity, referring to the full range of variety and variability within and among living organisms and the ecological complexes in which they occur. It has

become a popular scientific concept after E.O. Wilson edited and published the book “Biodiversity” in 1988 (Lousley, 2012). The full range of biological diversity corresponds to the three fundamentally and hierarchically related biological organization levels: genes, species, and ecosystems (Catibog-Sinha and Heaney 2006).

A variety of genes representing the inherited characteristics found among individual representatives of a species reflects genetic diversity. These inherited characteristics are critical to the survival of species. A variety of genes provides for resilience (i.e. the ability to recover) under environmental stress, which allows a species to adapt to changing conditions. Species diversity is receiving much attention since it is the most convenient indicator of biodiversity. However, with very few taxonomists working in the field, there could be more species than we could imagine. Ecosystem diversity is related to the variety of habitats, biotic communities, and ecological processes in the biosphere. Species occupying a particular area of land or water interact with each other and their physical environment to form natural units called ecosystems (the basic unit of ecological studies). Mapping and conducting an inventory at a detailed scale can measure ecosystem diversity.

Based on these three levels of organization, Philippines undoubtedly qualifies as a megadiverse country, harboring enormous, diverse species per unit area (Catibog-Sinha and Heaney, 2006). Various laws were enacted to protect this rich diversity of the country. The National Integrated Protected Areas System Act of 1992 (RA 7586) led to establishing and managing protected areas comprising of proclaimed national parks, game refuge, wildlife sanctuaries, nature reserves, and wilderness areas, mangrove reserves, watershed reservations, and fish sanctuaries.

Out of the 101 terrestrial Key Biodiversity Areas (KBAs) in the Philippines, 27 are protected, and 3 of these are located in the Cordillera Administrative Region (CAR): the Balbalasang-Balbalan National Park in Kalinga, Mt. Pulag National Park that are covered by the provinces of Benguet, Ifugao, and Nueva Viscaya, and the Apayao Lowland Forest bordered by Apayao and Cagayan (BMB DENR, 2016).

About 80% of the Philippines’ land resources are considered uplands (Villanueva, 2005), and the Cordillera Administrative Region (CAR), with its upland areas, comprise diverse land uses and habitats (Villanueva, 2005) conducive for a wide array of endemic species. Cordillera Administrative Region (CAR), with 57% of the 672,320 ha of total forest, is a closed forest (DENR FMB, 2011) and serves as a haven for wild animals, plants, and other living forms.

The Cordillera Administrative Region, with its biodiversity sites, is also home to many indigenous peoples. The government recognized the rights of Indigenous Peoples to their ancestral land through the Indigenous Peoples Right Act of 1997 (RA 8371). Magcale-Macandong (2010) emphasized the role of indigenous people in biodiversity conservation and management. For example, upland biodiversity conservation is often linked to indigenous knowledge (IK) in agroecosystem management. *Muyong*, for instance, is a known tradition among Ifugaos that promotes sustainable forest management as expressed in their respect to customary laws about land rights, adoption of upland cultivation practices, and biodiversity protection (Jianchu and Ruscoe, 1993; Camacho et al., 2016).

Biodiversity is a precious asset to present and future generations in the Cordillera because indigenous people rely heavily on ecosystem services for daily sustenance and livelihood. The species’ survival and the integrity of habitats and ecosystems are threatened by this close link between ecosystem services and human well-being (Conservation International Philippines, 2007), making it more critical to do biodiversity-related research. The usual approach in studying any ecosystem is to obtain baseline information on the area’s biophysical conditions, including flora, fauna, landforms, soil types, hydrology,

and resource and land use. Social and communication scientists contribute to understanding the biodiversity concept by studying people's perception of their environment and how the knowledge is utilized and operationalized. This paper only highlights literature collections from the biology discipline in assessing the status and trends of biodiversity studies in Cordillera and how these data are being shared with the public.

## MATERIALS AND METHODS

Biodiversity datasets covering the upland landscapes in Cordillera Administrative Region were gathered from libraries and research offices of universities, non-government organizations, and local government agencies, which are enumerated in Table 1. Studies dealing with microbial and fungal diversities were not included.

**Table 1.** Summary of the sources of secondary literature used in the study.

Source	Name of Institutions
<i>Academic institution</i>	<ol style="list-style-type: none"> <li>1. Abra State Institute of Science and Technology, Abra</li> <li>2. Apayao State College, Calanasan, Apayao</li> <li>3. Divine Word College, Abra</li> <li>4. Benguet State University, La Trinidad, Benguet</li> <li>5. Ifugao State University, Ifugao</li> <li>6. Kalinga State University, Kalinga</li> <li>7. Mountain Province State Polytechnic College, Tadian, Mountain Province</li> <li>8. Nueva Vizcaya State University, Bayombong, Nueva Vizcaya</li> <li>9. Saint Louis University, Baguio City</li> <li>10. University of the Philippines- Baguio, Los Baños, Diliman Campus Libraries, University of the Philippines, Open University</li> <li>11. University of the Cordilleras, Baguio City</li> <li>12. University of Baguio, Baguio City</li> </ol>
<i>Government Agencies</i>	<ol style="list-style-type: none"> <li>1. Department of Environment and Natural Resources, Ecosystems Research and Development Service (ERDS), Baguio City and UP Los Baños</li> <li>2. City Environment and Natural Resource Office, Pinukpuk, Kalinga, and Lagangilang, Abra</li> <li>3. Provincial Environment and Natural Resources Office, Nueva Vizcaya</li> </ol>
<i>Non-government Organizations</i>	<ol style="list-style-type: none"> <li>1. Mabuwaya Foundation, Cabagan, Isabela</li> <li>2. Jaime V. Ongpin Foundation, Baguio City</li> </ol>

Some references were directly requested from authors. Materials available via the internet were accessed using search engines with open access, including Open Science Directory (<http://www.opensciencedirectory.net/>), Public Library Science (<http://www.plos.org/>), Google Scholar (<http://scholar.google.com.ph/>), and the Journal of Nature Studies

(<http://www.journalofnaturestudies.org/>). The access to JSTOR (jstor.org) was provided by the University of the Philippines Baguio library.

The collected materials were first classified into three themes, namely ecosystem, fauna, and flora. When diversity study is related to the type of habitats, the topic is categorized as ecosystem level. Both flora and fauna are assessed at this level, including the micro- and macrohabitats and the species present serving as an indicator of the type of environment. For studies concerning only fauna or flora, they were further classified into the following subtopics or subthemes:

- i. Genetic level – when studies are focused on variation within the species
- ii. Species level – when involves inventories and assessment of physicochemical parameters within the same habitat type
- iii. Taxonomy – when involves characterization of certain species leading to its identification; new records of species; spatial and temporal distribution of species
- iv. Management – involves efforts on how to conserve native species in the wild, thus excludes crops and the parasites/pests in agriculture
- v. Utilization – when studies involve a listing of species from the wild/forest and how local and indigenous peoples use them

After classifying the resource materials into themes and subthemes, they were further organized into topoi tables for easy referencing with the following information: annotations, year reported, area or zone of study, complete bibliographic entry, and classification as either unpublished or published reports. To assess which life forms are usually studied in Cordillera's landscapes, a species list was summarized for every reference used. Only materials that were available until 2019 were included. The topoi tables are available upon request to the corresponding author.

All of the topoi tables' information were eventually translated into figures to find trends and data gaps on the ecosystem types and specific taxa being studied. References with a broader scope, including checklists for the entire country, are not included. For comparative studies covering CAR and other provinces outside the region, only those species documented in CAR were included in the species count.

## **RESULTS**

### ***Classification and Accessibility of the Studies***

The 226 pieces of literature derived from various libraries and agencies, accessed via the internet, and shared directly by the authors, were categorized into themes and accessibility to the readers through publication (Table 2). Studies on flora rank first (130/226 or 57%), followed by fauna (66/226 or 30%), and the last on the ecosystem (30/226 or 13%). Of the total sources, 144 (64%) are unpublished project reports (e.g. Department of Environment and Natural Resources, Ecosystems Research and Development Service (ERDS) and terminal reports of funded projects), graduate, and undergraduate theses. The remaining 82 (36%) secondary sources are published in local (19/82 or 24%), national (9/82 or 11%), and international (54/82 or 65%) circulation.

**Table 2.** Classification and accessibility of the literature gathered from various sources.

Classification	Rank	No. of studies (N=226)	Unpublished (n= 144)				Published (n=82)	
			Project Report	Graduate Thesis	Undergrad Thesis	International	National	Local
<b>Ecosystem</b>	3	30	7	2	5	10	1	5
<b>Fauna</b>	2	66	2	6	40	13	2	3
<b>Flora</b>	1	130	8	15	59	31	6	11
<b>Subtotal</b>		226	17	23	104	54	9	19

**Studies on Ecosystem biodiversity**

The ecosystem category usually includes the study of flora and fauna concerning the habitat requirements or habitat types. These include published studies conducted at forests of Central Cordillera mountains (Peñafiel, 1995; Austria and Romero, 2001; Banwa, 2011); in more specific habitats in the municipalities of Benguet (Cuevas and Balangcod, 2014), Ifugao (Baguion and Miel, 2013), Apayao (Abaño et al., 2016); national parks such as Mt. Pulag (Lit et al., 1998; Buot, 2001 a,b, 2002, 2010; Buot and Okitsu, 1998), Mt. Data (Kowal, 1966) and Balbalasang-Balbalan, Kalinga (Malabrigo, 2013); and the land areas of Busol Watershed in Benguet (Balangcod and Gutierrez, 2001; Baoanan et al., 2001).

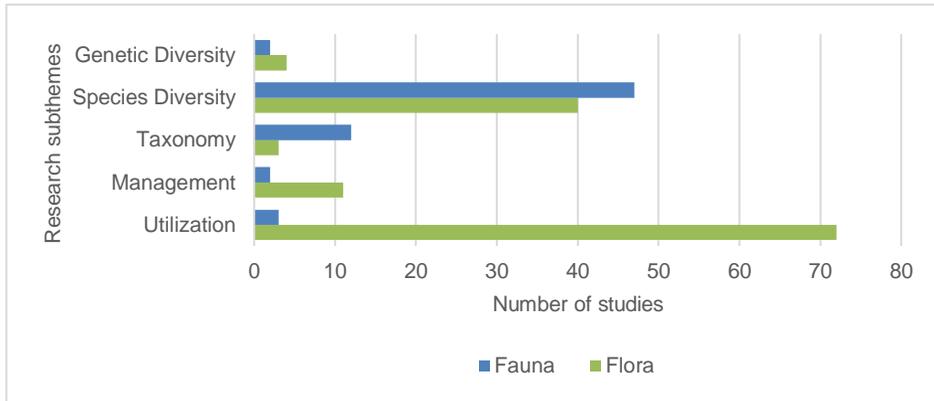
**Studies on Fauna and Flora**

With 130 studies on flora and 66 on fauna, it is pertinent to present the emerging subthemes typical for both kinds of biodiversity studies prevalent in the Cordillera. Studies in the Cordillera that are focused on flora and fauna tend to fall into the following subthemes: genetic diversity, species diversity, taxonomy, management, and utilization (Figure 1).

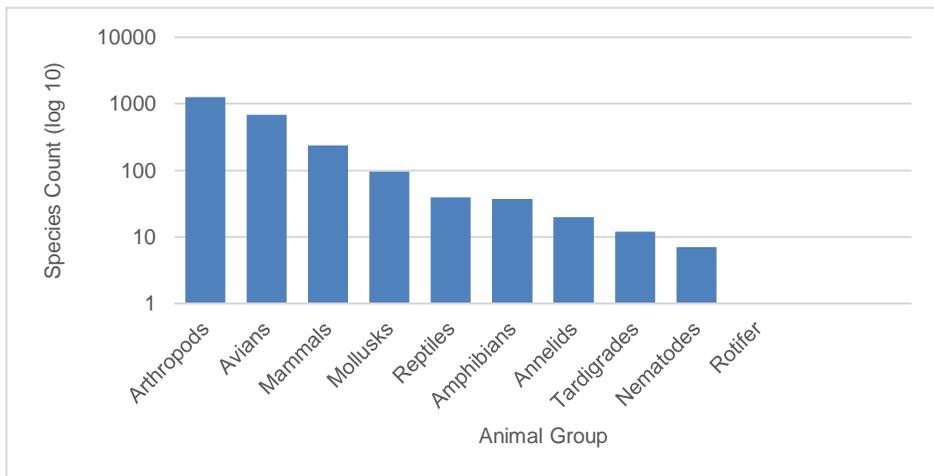
Genetic diversity research subthemes are studies that dealt with variations in the gene sequences of single species of animals or the variety of single species of plants. Species diversity as a subtheme pertains to inventories of different species within prescribed areas of studies. This subtheme may include the characterization of the physicochemical properties of a single habitat. Studies that only involved the identification/naming or new records of species were categorized under taxonomy. Indigenous practices and other efforts to preserve the species itself, its habitat, or the entire ecosystem fall under management. Reports dealing with the screening of organisms for potential human benefit features were categorized as utilization, which may include IKSP (Indigenous Knowledge Systems and Practices).

Figure 1 shows that most faunal studies deal with species diversity involving inventories (47/66 or 71%), followed by 12 studies focused on the taxonomic identification of a particular species. Reports on genetic diversity and management only had a fair share of two studies each with three on utilization. Although arthropods (i.e. insects, arachnids, crustaceans, and others) and avians (birds) are widely studied among the animal groups (Figure 2), most of these are unpublished or unvalidated reports. All studies that dealt mainly with annelids, tardigrades, nematodes, and rotifers were unpublished undergraduate theses. Floresca (2015) and Dinets (2001) contributed mostly to the number of bird records in the Benguet area. Published materials are mainly on mammalian diversity in Central Cordillera (Rickart, Balete, et al., 2011), Balbalasang-Balbalan National Park (Heaney et al., 2003; Rickart, Henaey, et al., 2011); Ifugao Rice Terraces (Stuart et al., 2007); Mt. Amuyao, Mt. Province (Rickart et al., 2016); Mt. Sto Tomas, Benguet (Reginaldo and de Guia, 2014), and Baguio City forest patches (Reginaldo et al., 2013). Examples of

taxonomic studies are the revision of the name of Luzon endemic rat from *Rattus latidens* to *Abditomys latidens* (Musser, 1982) and new species of shrew-mouse *Archboldomys* from Kalinga (Balete et al. 2006) and two others from larger Luzon area (Balete et al., 2007). There were also studies on amphibians and reptiles in Balbalasang-Balbalan National Park (Diesmos et al., 2005). Baoanan and Obanan (2011) studied land snail (mollusk) diversity in Mt. Polis, Mt. Province. The utilization of wild animals was mainly for food consumption and as pets (Aquino, 1997).



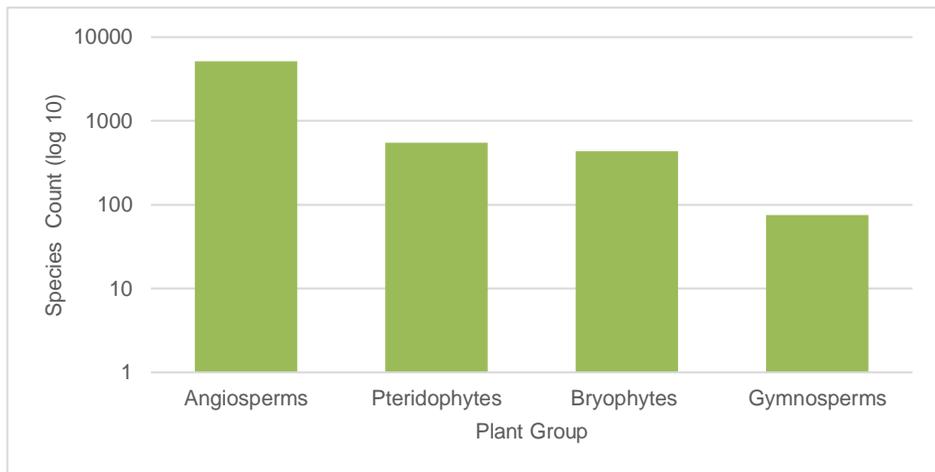
**Figure 1.** Research subthemes of collected faunal and floral studies.



**Figure 2.** Summary of the number of faunal species filtered from both published and unpublished reports from Cordillera classified into major animal groups.

For the floral studies, the research subtheme is mainly on utilization with 72 out of 130 or 55% of share (Figure 1). These researches are considered biodiversity-related studies because of the information on plants' validated scientific names and location. The majority of the plants are studied as an essential source of food and natural medicines (Conklin, 1967; Bodner and Gereau, 1988; Balangcod, 2001; De Luna, 2001; Lirio et al., 2007; Angagan, 2010; Lirio et al., 2010; Balangcod and Balangcod, 2009, 2011, 2015; Balangcod et al., 2012; Ammakiw and Odiem, 2013; Laruan et al., 2013; Patacsil et al., 2014; San Luis et al., 2014; Barcelo, 2014,2015; Tad-awan and Sagalla, 2015; Galvez, 2016). Floral species diversity constitutes about 31% (40/130), while 3% (4/130) are at the genetic level. A minimal 2% (3/130) was devoted to the taxonomic study and the remaining 9% (11/130) for management studies, which are still often linked to resource utilization.

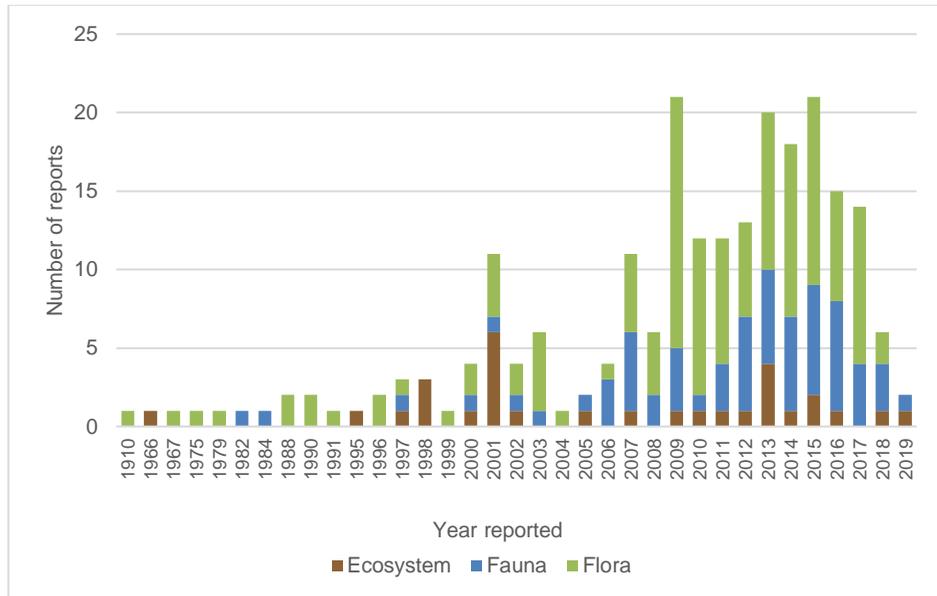
Floral species diversity studies are focused on angiosperms (Figure 3) recorded from Benguet (Merrill and Merritt, 1910; Aguilar et al., 2000; Subilla and Buot, 2012), Ifugao (Daniels et al., 2010; Taguiling, 2013; Lumbres et al., 2014; Rabena et al., 2015), Kalinga (Bawer, 2015), Abra (Segismundo et al., 2010), and Apayao (Begay and Gutierrez, 2009; Gutierrez et al., 2009). Next are the pteridophytes with reports of Barcelona (2003) from Mt. Bali-it, Balbalasang-Balbalan National Park in Kalinga and Angalan et al. (2014) from Bauko, Mt. Province. Hipol and colleagues (2007) contributed to bryophyte studies in Mt. Pulag National Park, Benguet. *Pinus kesiya* predominates the studies on gymnosperms in Cordillera pine forests (Taguiling, 2013; Lumbres et al., 2014).



**Figure 3.** Summary of the number of floral species filtered from both published and unpublished reports from Cordillera classified into major plant groups.

**Studies per Year**

The number of biodiversity-related studies reported through the years is summarized in Figure 4. The colors correspond to the themes or topics written in specific years: brown for the ecosystem, blue for fauna, and green for flora. The most frequently reported are on floral studies. The years with no reported data were omitted in the figure.



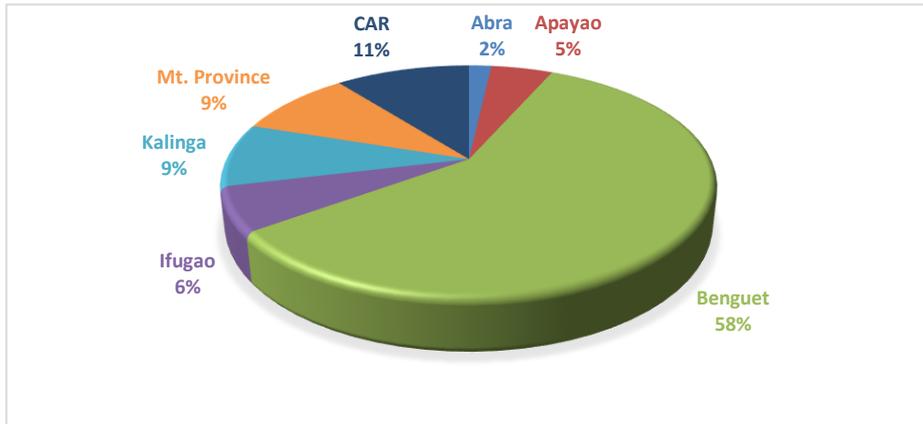
**Figure 4.** Summary of the biodiversity-related studies reported in Cordillera from 1910 to 2019.

The publication of Merrill and Merrit in 1910 on the flora of Mt. Pulog (more popularly known in the Philippines as Mt. Pulag) is the earliest biodiversity-related report from Cordillera. It took more than five decades before the next publication came out. In 1966, Kowal published an ecosystem approach to understanding the nature and interrelationships of the plant communities in Mt. Data National Park (Cordillera Central) and how these were affected by agricultural farming, soil erosion, and recurrence of fire at different slopes of the mountain. Unfortunately, only a small patch of the montane forest and its original vegetation remain (Subilla and Buot, 2012) hence the recommendation for its disestablishment as a protected area (Quitasol, 2016). In 1967, Conklin published the works of Beyer and Merrill (with permission) on the ethnobotany of Ifugao. The subsequent reports in 1975, 1979, and 1984 were unpublished graduate theses. The next publication came out in 1982 on a native Philippine rat originally named *Rattus latidens* Sanborn, 1952 that was revised by Musser into *Abditomys latidens* based on distinctive features (Musser, 1982). He re-examined a type specimen that was deposited at the Field Museum of Natural History, Chicago (FMNH 62347), an adult female collected on April 29, 1946 from Mt. Data, Mt. Province. Following in 1988, Bodner and Gereau published the plant uses and cultivation practices among the residents of Tukuran, Bontoc, Mt. Province. They included the scientific names and phytogeography of 325 species documented from the locality. The other floral study on that same year and successively in 1990 and 1991 were again unpublished graduate theses. In 1995, a Filipino author's valuable work was internationally published as a book chapter covering the mossy forests' ecosystem functions in the Central Cordillera (Peñafiel, 1995). However, only a preview of this publication can be freely accessed online. Mr. Peñafiel has retired from service and does not have a hard or electronic copy of the book (personal communication). From that year onwards, biodiversity-related research in Cordillera was conducted and reported regularly, reaching its peak in 2009 and 2015, each with 21 studies. However,

only three of the 21 reports were published in 2009 covering floral studies but eventually increased to 8 in 2015 (one on birds and seven on plants). The number of publications dropped again to four in 2016 (one on ecosystem study and three on plants). The rest of the reports from 2017 to 2019 are still unpublished.

#### ***Distribution of Biodiversity Studies in the Provinces of the Cordillera***

Looking at the distribution of the site's biodiversity data (Figure 5), most studies are concentrated in Benguet (58%). The rest were distributed in the provinces of Kalinga (9%), Mt Province (9%), Ifugao (6%), Apayao (5%), and Abra (2%). About 11% of the secondary sources cover several sites in Cordillera (CAR) in their studies.



**Figure 5.** Distribution of reported studies per province. The work is classified under CAR if it covers more than one site or as stated in the report.

## **DISCUSSION**

### ***Trends on Biodiversity Studies in Cordillera***

Biodiversity reports in Cordillera are generally classified under three themes, namely ecosystem, flora, and fauna. The ecosystem approach is the least studied, while the primary interest is on flora. Five subthemes emerged from faunal and floral studies including genetic diversity, species diversity, taxonomy, management, and utilization.

The plausible explanation of why only a few studies deal with ecosystem diversity is due to its complexity. Reports covering the ecosystem level would often require specialists' collaboration on every taxonomic group to be included in the inventory at a usually larger scale. Moreover, biodiversity as research tends to be dominated by some hard sciences fields, resulting in a mono-disciplinary approach. Given that ecosystem diversity types of research require inter and multi-disciplinary expertise, earlier biodiversity researchers may find the merging of disciplinary specializations challenging. It was only in 2016 when the Commission on Higher Education officially recognized the need for university researchers to shift to trans-, multi- and interdisciplinary engagements under CHED Memorandum Order (CMO) No. 52.

Although the three levels of organization in approaching biodiversity assessment (i.e. from genetic, to species, to ecosystem) are represented from the gathered literature search, there are still biases in studying biodiversity resources for utilization purposes, especially on plants that address the need of the society. It appears that the role of biodiversity studies, in the case of studies on flora, are examined to serve human needs. This trend indicates that biodiversity research focuses on the definition and function of flora as contained in a biodiversity site as a utility, a product, or resource that can be used and useful for man. This finding is consistent with the BMB DENR (2016) report that in the Philippines, over 3,000 plants (of the estimated 10,000-14,000 species of vascular and non-vascular plants including fungi (Ong et al. in 2002) are utilized for food, feed, shelter, fiber, fuel, medicine, ornamentals, and ornaments.

Furthermore, most of the earlier studies were confined to plants and are generally localized (i.e. specific to certain areas). This trend could be explained by the fact that plants are less mobile than the faunal counterpart; hence, they can be sampled in a more defined boundary. The high mobility of animals and the complexity of their life cycles constrain the spatial extent of information that the researcher can access at any point in time (Karban et al., 2016).

While biodiversity studies rely heavily on taxonomy, the number of taxonomists and better training for them fails to keep up with the need to identify the species before they are gone extinct due to various environmental and anthropogenic pressures (Drew, 2011). Young biologists may not learn taxonomy until they specialize, like those who conducted their theses. The few who choose taxonomy train on a very narrow focus, and that generalists or group experts are aging out of the field.

Taxonomists are apparently not valued in academia (Drew, 2011); hence applying for taxonomic initiatives is often declined by funding agencies. Scientific productivity of taxonomists and systematists includes specimen collecting; curation; digital objects such as data, video, and images; software applications; and other work that does not fit into the traditional peer-reviewed publication formula. Thus, their outputs are frequently not accepted for promotion purposes. Printing and postage costs also led to journals' reluctance to publish primary biodiversity data tables and appendices (Costello et al., 2013). Seniority and expert-mentality create a notion that a study should be noble and quantitative to be worthy of publication.

Acquiring the necessary permits to conduct biodiversity studies can also be very bureaucratic, causing considerable delays in implementing projects. Other than the security issues associated with exploration studies, there are also legal implications of collecting biodiversity information for the risk of overexploitation and biopiracy of some valuable resources (Corpuz, 1995; Costello, 2009). The current policies covering the release of funds, procurement, and disbursement of government-funded projects are most often not applicable to the nature of field-based researches, thereby imposing difficulties on the part of the lead proponent. These realities create an inhibiting environment for people in the academe who want to pursue taxonomic and biodiversity studies.

In terms of the number of biodiversity-related studies reported from 1910 to 2019 (Figure 4), we can see that foreign researchers mostly authored the earlier publications. Before 1995, there were years where there were no reports on biodiversity-related studies. Information published by local researchers on biodiversity studies only came out in the mid-1990s. It can only be inferred that mentoring on taxonomic works is at a slow pace. It did not increase significantly even after the country's involvement in the International Convention on Biological Diversity on the Earth Summit at Rio de Janeiro in 1992. It was only in 1995 onwards when reports became regular, which could indicate the availability of faculty

members mentoring students in biodiversity-related studies. Still, very few taxonomists are working on the rich biodiversity in the Cordillera. It follows that the taxa under investigation are dependent on the field of expertise of these taxonomists in the academe. Based on the DENR's Biodiversity Management Bureau website, only seven faculty members from the University of the Philippines Baguio are included in the Roster of Experts (DENR BMB, 2016). This limited number of experts also explains why very few studies are focused on the inventory of species richness in the region.

Concerning the distribution of biodiversity-related studies in the Cordillera, 58% are conducted at Benguet while the rest are thinly spread from the other provinces. The proximity and accessibility of major universities to Benguet's uplands may contribute to the increased interest in studying the area, but there could be other underlying factors. One factor may concern national security issues since statistics from 2017 have not changed in terms of rebel-infested sites with 18 villages in Abra, 16 in Kalinga, five in Mountain Province, and seven in Ifugao (NEDA, 2011; Catajan, 2018). The rugged terrains of the uplands make it even more risky to conduct biodiversity assessments in these areas.

### ***Challenges of Low Publications***

The results indicate that the accessibility of the biodiversity data from Cordillera's uplands is very deficient, with only 54 out of 226 peer-reviewed studies reaching the global audience through international publication. The majority of the unpublished materials were graduate (23/144) and undergraduate theses (104/144), indicating that many universities in the Cordillera do not require publication of research to earn a degree. For this reason, these papers did not pass through the rigor of review by the experts in the field. There is also impeding ethical concerns on publishing students' works and involving them in funded and collaborative projects (Olitsky and Weathers, 2005), which are deemed vital in increasing the universities' research productivity.

Few other unpublished biodiversity studies are project outputs (17/144). There are some funding agencies which are not requiring publication as part of project deliverables. As a result, these vital biodiversity pieces of information are confined in the archives and are not easily accessible.

From the authors' perspective, the publishability of biodiversity studies can be enhanced through the following:

#### *a. Mentoring role of the University and other related agencies*

It may not be necessary to impose publication of undergraduate thesis but requiring a publication to earn a graduate degree is more tenable. The CHED Memorandum Order No. 15, s. 2019 already requires students in the Master of Science/Master of Arts to publish in a refereed journal or juried creative work. Those in the Doctor of Philosophy programs need to publish in internationally/nationally indexed journals or juried creative work. Therefore, it is imperative that faculty members themselves, in the graduate programs, especially the doctoral level, must be doctoral degree holders themselves with a track record of scholarly work. To meet these standards, the universities need to develop research guidelines that promote a culture of cooperation among students, faculty, and various stakeholders and better mentoring practices for aspiring students.

The government and other support agencies should sustain fellowships and scholarships for faculty and students' capacity building. It will help if there will be a better way of easing researchers' requirements for biodiversity assessments in protected areas and those covered by ancestral domains. There must be appropriate policies governing the disbursement of funded projects to ease the burden of the researchers.

*b. Publication requirement for funded researches*

Out of 144 unpublished studies, 17 are project reports. Funded projects, especially those by the government, should be obliged to publish their work in scholarly journals to become accessible to the public who, in a way, financed the project through their tax payments. The Department of Science and Technology for example is requiring this for approved projects.

*c. Motivating online publication of biodiversity data*

We are now living in a digital world where information is easily accessible. Information that is not available online is easily overlooked. The availability of data from local to global scales through publication is critical for dealing with relevant issues affecting society, including biodiversity loss (Costello, 2009). Fortunately, there is a continuing effort to promote the custodianship of ecological and biodiversity data (Specht et al., 2018). Publication of biodiversity data becomes vital to improve data accuracy and increase data use (Costello et al., 2013).

Therefore, the dilemma of low publication of biodiversity studies can be addressed by encouraging online biodiversity data publication to be cited and abstracted as scientific print papers with corresponding impact factor (Costello et al., 2013). Currently, there are many open-access scholarly biodiversity databases, such as the Global Biodiversity Information Facility (GBIF) that provides Digital Object Identifier (DOI) to track the origin of data published online to give credit to taxonomists (Robertson et al., 2014). These online data publications should also be recognized for promotion purposes, just like any other scholarly article. Moreover, there is an ongoing effort to establish a resource databank of Northern Luzon biodiversity at the University of the Philippines Baguio through CHED-DARE TO (Commission on Higher Education-Discovery Applied Research and Extension for Transfer/Inter-disciplinary Opportunities (DARE TO) funded project to make the biodiversity data resources available to the broader community. This resource databank is something to look forward.

While most biodiversity-related studies are unpublished, all of these reports are in fact contributing to our understanding of the richness of biodiversity in the Cordilleras. Creating a repository of biodiversity resources is essential to make the data available for future generations.

## **CONCLUSION AND RECOMMENDATIONS**

Despite the presumed rich biodiversity in Cordillera due to its unique environmental and biotic conditions, there is a dearth of biodiversity data available to the public. Very few are published. The lack of expertise, funding opportunities, and taxonomic works' publishability are the main impediments to this gap in biodiversity information. It is high time to explore the digital world of data publication. Biodiversity is such a broad field necessitating the interplay between and among biodiversity, humanity, and society. Therefore, to enrich research literature on biodiversity, there is a need for more collaborative, inter, and multi-disciplinary researches. Such kinds of biodiversity studies will thicken discussions on nature and its relation to individuals and social groups. A network of biodiversity researchers from varied disciplines should also be established to enable sharing knowledge and developing biodiversity research further.

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## REFERENCES

- Abaño, T.R.C., Salvador, D.J.I. and Ibañez, J.C. (2016). First nesting record of Philippine Eagle *Pithecophaga jefferyi* from Luzon, Philippines, with notes on diet and breeding biology. *Forktail* 32: 86-88.
- Aguilar, N. O., Cardenas, L. B. and Cajano, M. A. (2000). Spore- and Seed-bearing Plants of Mount Pulag, Benguet, Philippines. Museum of Natural History, University of the Philippines Los Baños, Laguna, Philippines. 49p.
- Ammakiw, C.L. and Odiem, M.P. (2013). Availability, preparation and uses of herbal plants in Kalinga, Philippines. *European Scientific Journal* 4:483-489.
- Angagan, J.S., Buot, I.E., Jr., Relox, R.E., and Rebanco, C.M. (2010). Ethnobotany of the plant resources in Conner, Apayao, Northern Luzon, Philippines. *Journal of Nature Studies* 9(1): 31-38.
- Angalan, N.Q., Reyes, G.A. and Gomez, R.A., Jr. (2014). “True” measure of lithophytes diversity across microclimate. *Journal of Nature Studies* 13(1): 39-47.
- Aquino, C. P. (1997). The practice of ikik in Mt. Pulog National Park: implications to conservation. *Sylvatrop* 7(1&2):96-100.
- Austria, C. and Romero, R. (2001). Biodiversity reconnaissance survey of Baguio-Bontoc- Banaue road areas. In *Towards Understanding Peoples of the Cordillera: A Review of Research on History, Governance, Resources, Institutions and Living Traditions*. Volume 3 (pp. 30-51). Baguio City: Cordillera Studies Center.

- Baguinon, N.T. and Miel, J. (2013). Threat of potential bioinvasion in a natural forest in Poitan, Banaue, Ifugao, Cordillera Administrative Region. *Philippine Journal of Science* 142 (2):101-113.
- Balangcod, T. (2001). The useful flora of Tabaan Norte, Tuba, Benguet Province. In *Towards Understanding Peoples of the Cordillera: A Review of Research on History, Governance, Resources, Institutions and Living Traditions*. Volume 3 (pp. 82-83). Baguio City: Cordillera Studies Center.
- Balangcod, T. and Gutierrez, R. (2001). Biodiversity study of Busol Watershed: An initial inventory of its floristic composition and structure. In *Towards Understanding Peoples of the Cordillera: A Review of Research on History, Governance, Resources, Institutions and Living Traditions*. Volume 3 (pp. 74-76). Baguio City: Cordillera Studies Center.
- Balangcod, T.D. and Balangcod, A.K.D. (2009). Underutilized Plant Resources in Tinoc, Ifugao, Cordillera Administrative Region, Luzon Island, Philippines. *Acta Horticulturae*. DOI: 10.17660/ActaHortic.2009.806.80
- Balangcod, T.D. and Balangcod, A.K.D. (2011). Ethnomedical knowledge of plants and healthcare practices among the Kalanguya tribe in Tinoc, Ifugao, Luzon, Philippines. *Indian Journal of Traditional Knowledge* 10(2):227-238.
- Balangcod, T.D. and Balangcod, K.D. (2015). Ethnomedicinal plants in Bayabas, Sablan, Benguet Province, Luzon, Philippines. *Electronic Journal of Biology* 11(3):63-73.
- Balangcod, T.D., Vallejo, V.L., Apostol, O., Laruan, L.M.V.A., Manual, J., Cortez, S., and Gutierrez, R.M. (2012). Phytochemical screening and antibacterial activity of selected medicinal plants of Bayabas, Sablan, Benguet Province, Cordillera Administrative Region, Luzon, Philippines. *Indian Journal of Traditional Knowledge* 11(4):580-585.
- Balete, D S, Rickart E A. and Heaney, L R. (2006). A new species of the shrew-mouse *Archboldomys* (Rodentia: Muridae: Murinae), from the Philippines. *Systematics and Biodiversity* 4:489-501.
- Balete, D.S., Rickart, E.A., Rosell-Ambal, R.G.B., Jansa, S. and Heaney, L.R. (2007). Descriptions of two new species of *Rhynchomys* Thomas (Rodentia: Muridae: Murinae) from Luzon Island, Philippines. *Journal of Mammalogy* 88(2):287-301.
- Banwa, T.P. (2011). Diversity and endemism in mossy/montane forests of Central Cordillera Region, Northern Philippines. *Biodiversity* 12(4):212-222.
- Baoanan, Z., Rafanan, J., Balangcod, T., Gutierrez, R., Giron, O., Javier, D., Bomilla, L., Austria, C., and Cariño, J. (2001). Biodiversity of Busol Watershed: Fauna Composition and Structure. In *Towards Understanding Peoples of the Cordillera: A Review of Research on History, Governance, Resources, Institutions and Living Traditions*. Volume 3 (pp. 77-81). Baguio City: Cordillera Studies Center.
- Baoanan, Z. and Obanan S. (2011). Land Snail Diversity of Mt. Polis, Central Cordillera Range, Luzon Island, Philippines. In *ISNAR C2FS Book 1 Proceeding*. Faculty of Agriculture, Indonesia.
- Barcelo, R.C. (2014). Ethno-botanical survey of edible wild fruits in Benguet, Cordillera Administrative Region, the Philippines. *Asian Pacific Journal of Tropical Biomedicine* 4(Suppl 1): S525-S538.

- Barcelo, R.C.. (2015). Phytochemical Screening and Antioxidant Activity of Edible Wild Fruits in Benguet, Cordillera Administrative Region, Philippines. *Electronic Journal of Biology* 11(3): 80-89.
- Barcelona, J.F. (2003). Preliminary report on the ferns and fern allies (pteridophytes) of Mt. Bali-it, Balbalasang-Balbalan National Park, Kalinga, Northern Luzon, Philippines. *Sylvatrop* 13 (1&2): 81-92.
- Bawer, M.C.C. (2015). Diversity of Bamboo Species in Lubuagan, Kalinga, North Luzon, Philippines. *International Journal of Interdisciplinary Research and Innovations* 3(3):72-79. Retrieved from [www.researchpublish.com](http://www.researchpublish.com)
- Biodiversity Management Bureau (BMB) Department of Environment and Natural Resources (DENR). *Philippine Biodiversity and Strategy and Action Plan (2015-2028): Bringing Resilience to Filipino Communities*. C. Cabrido (Ed.). Quezon City, Philippines: BMB-DENR, United Nations Development Programme-Global Environment Facility, Foundation for Philippine Environment. 248p.
- Begay, B. and Gutierrez, A.B. (2009). Floral inventory in rice terraces and its environment at Tanglagan, Calanasan, Apayao. *Journal of International Society for Southeast Asian Agricultural Sciences* 15(2):168-178.
- Bodner, C.C. and Gereau, R.E. (1988). A contribution to Bontoc Ethnobotany. *Economic Botany* 42(3): 307-369. Retrieved from <https://www.jstor.org/stable/4255087>.
- Buot, I. (2001a). Vegetation Zones of Mount Pulag. In *Towards Understanding Peoples of the Cordillera: A Review of Research on History, Governance, Resources, Institutions and Living Traditions*. Volume 3 (pp. 17-29). Baguio City: Cordillera Studies Center.
- Buot, I. (2001b). Latitudinal comparison of the vertical vegetation zonation on Mount Pulag (Philippines) with other Southeast and East Asian Mountains: Its contribution towards a better understanding of the Cordillera Vegetation. In *Towards Understanding Peoples of the Cordillera: A Review of Research on History, Governance, Resources, Institutions and Living Traditions*. Volume 3 (pp. 58-73). Baguio City: Cordillera Studies Center.
- Buot, I.E. (2002). Vegetation types on Mount Akiki, Northern Luzon, Philippines. *Flora Malesiana Bulletin* 13(2):154-156.
- Buot, I. (2010). Conservation status of the commonly collected plant species in selected Philippine mountain ecosystems. *The Journal of Tropical Biology* 8:3-13.
- Buot, I.E. and Okitsu, S. (1998). Vertical distribution and structure of the tree vegetation in the montane forest of Mt. Pulog, Cordillera mountain range, the highest mountain in Luzon Is., Philippines. *Vegetation Science* 15:19-32.
- Camacho, L.D., Dixon T. Gevaña, D.T., †Carandang, A.P. & Camacho, S.C. (2016). Indigenous knowledge and practices for the sustainable management of Ifugao forests in Cordillera, Philippines, *International Journal of Biodiversity Science, Ecosystem Services & Management*, 12:1-2,5-13, doi: 10.1080/21513732.2015.1124453.

- Catajan, M.E. (2018, May 2). NPA still plagues Cordillera towns. *SunStar Baguio* Retrieved from <https://www.sunstar.com.ph/article/1741310>.
- Catibog-Sinha, C. and L.R. Heaney. (2006). *Philippine Biodiversity: Principles and Practice*. Quezon City: Haribon Foundation for the Conservation of Natural Resources, Inc.
- Conklin, H.C. (1967). Ifugao Ethnobotany 1905-1965: The 1911 Beyer-Merrill Report in Perspective. *Economic Botany* 21(3): 243-272. Retrieved from <https://www.jstor.org/stable/4252883>.
- Conservation International-Philippines (2007). *Human Wellbeing and Conservation Framework and Strategy*. Quezon City, Philippines. 91pp.
- Corpuz, V.T. (1995). *Biopiracy and Boimperialism*. IN: *Biopiracy The Cordillera Experience*. Baguio City, The Cordillera Resource Center. 1-17.
- Costello, M.J. (2009). Motivating online publication of data. *Bioscience*. 49(5): 418- 427. Retrieved from [www.ucpressjournals.com/reprintinfo.asp.doi:10.1525/bio.2009.59.5.9](http://www.ucpressjournals.com/reprintinfo.asp.doi:10.1525/bio.2009.59.5.9)
- Costello, M.J., W.K. Michener, M. Gahegan, Z-Q Zhang, and P.E. Bourne. (2013). Biodiversity data should be published, cited, and peer reviewed. *Trends in Ecology & Evolution* 1699:1-8. Retrieved from <http://dx.doi.org/10.1016/j.tree.2013.05.002>
- Cuevas, V.C. and Balangcod, T.D. (2014). *Ecological Succession in Areas Covered by Gold and Copper Mine Tailings in Benguet, Philippines*. Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), Agriculture & development Discussion Paper Series, No. 2014-3, 56 pp.
- Daniels, J.G. and Cabutte, J.G. (2010). Indigenous Watershed Management and Conservation Practices in Ifugao. *The Upland Farm Journal* 19(1):16-25.
- De Luna, E. (2001). Chemotaxonomic studies on essential oil-producing plants from the Cordillera. In *Towards Understanding Peoples of the Cordillera: A Review of Research on History, Governance, Resources, Institutions and Living Traditions*. Volume 3 (pp. 153-159). Baguio City: Cordillera Studies Center.
- DENR Forest Management Bureau. (2011). *Philippine Forestry Statistics*. Retrieved from <http://forestry.denr.gov.ph/images/contents/pdfs/PFS2011.pdf>
- DENR Biodiversity Management Bureau. (2016). *Roster of Experts*. Retrieved from <http://www.bmb.gov.ph/mainmenu-resources/roster-of-experts>
- Dinets, V. (2001). Ornithological records from Luzon during January-February 2001, including a description of the voice of Luzon Rail (*Lewinia mirificus*). *The Oriental Bird Club Bulletin* 34: 40-41.
- Diesmos, A.C., Brown, R.M. and Gee, G.V.A. (2005). Preliminary report on the amphibians and reptiles of Balbalasang-Balbalan National Park, Luzon Island, Philippines. *Sylvatrop* 13 (1&2), 63-80.
- Drew, L.W. (2011). Are we losing the Science of Taxonomy? *Bioscience* 61(12): 942- 946. Retrieved from [www.biosciencemag.org](http://www.biosciencemag.org) doi:10.1525/bio.2011.61.12.4

- Floresca, J.A. (2015). Bird Watching as a Recreation and Nature Activity in Baguio City and Nearby Municipalities of Benguet Province Philippines: A Conservation Effort. *Asian Journal of Applied Sciences* 3(3):388-396.
- Galvez, M.A.C. (2016). Antibacterial Activity and Phytochemical Screening of Selected Folkloric Medicinal Plants of Maggok, Hungduan, Ifugao, Cordillera Administrative Region, Philippines. *International Journal of Scientific and Research Publications* 6(1):460- 464 .
- Gutierrez, A.B., Bangyad, S. and Begay, B. (2009). Macrofloral resources in the Tanglagan Watershed, Calanasan, Apayao. *Journal of International Society for Southeast Asian Agricultural Sciences* 15(3):171-181.
- Heaney, L.R., Balete, D.S., Gee, G.A., Lepiten-Tabao, M.V., Rickart, E.A., and Tabaranza, B.R., Jr. (2003). Preliminary report on the mammals of Balbalasang, Kalinga Province, Luzon. *Sylvatrop* 13(1&2):51-62.
- Hipol, R. M., Tolentino, D. B., Fernando, E. S., and Cadiz, N. M. (2007). Life Strategies of Mosses in Mt. Pulag, Benguet Province, Philippines. *Philippine Journal of Science* 136 (1):11-18.
- Jianchu, X. and Ruscoe, M.T. (1993). The Use of Indigenous Knowledge in Agroecosystem Management for Conservation: A Case Study in Barangay Haliap, Kiangan, Ifugao Central Cordillera, Philippines. University of the Philippines Los Baños, Institute of Environmental Science and Management and Ford Foundation.
- Karban, R., Orrock, J.L., Preisser, E.L. and Andrew Sih, A. (2016). A comparison of plants and animals in their responses to risk of consumption. *Current Opinion in Plant Biology* 32:1–8. Retrieved from <http://dx.doi.org/10.1016/j.pbi.2016.05.002>
- Kowal, N.E. (1966). Shifting Cultivation, Fire, and Pine Forest in the Cordillera Central, Luzon, Philippines *Ecological Monographs* 36(4): 389-419. Retrieved from <https://www.jstor.org/stable/1942374>.
- Laruan, L.M.V., Balangcod, T.D., Balangcod, K.D., Patacsil, M., Apostol, O.G., Manuel, J., Cortez, S., and Vallejo, V. (2013). Phytochemical and antibacterial study of *Lagerstroemia speciosa* (L.) Pers. and its ethnomedicinal importance to indigenous communities of Benguet Province, Philippines. *Indian Journal of Traditional Knowledge* 12 (3):379-383.
- Lirio L.G., Ayyokad L.O., and Paing J.N. (2007). Indigenous semi-temperate vegetables of Cordillera, Philippines. *International Conference on Indigenous Vegetables & Legumes. Prospects for Fighting Poverty, Hunger and Malnutrition. ISHS Acta Horticulture* 752.
- Lirio, L. G., Balcita, M. A., Pladio, L. P., Ayyokad, L. O., and Paing, J. N. (2010). Towards a Sustainable Semi-Temperate Vegetable Production: Characterization and Propagation of Indigenous Vegetables of the Highland Cordilleras. *Semi Temperate Vegetable Research and Development Center - Benguet State University, La Trinidad, Benguet. PCAARRD Regional Consortia*.
- Lit, I.L., Jr., Cajano, M.A.O., Eusebio, O.L., Baldovino, M.M., Cosico, E.A., and Eres, E.G. (1998). Please don't fall: A brief pictorial account of biodiversity in Mount Pulag National Park, Benguet. *NATURE Philippines*, 1(1), 19-30. Los Baños, PH: University of the Philippines Los Baños (UPLB) Museum.

of Natural History

- Lousley, C. (2012). "E. O. Wilson's Biodiversity, Commodity Culture, and Sentimental Globalism," In G. Martin, D. Minyete & U. Münster (Eds.) *Why Do We Value Diversity? Biocultural Diversity in a Global Context*. RCC Perspectives (9):11–16.
- Lumbres, R.I.C., Palaganas, J.A., Micoso, S.C. Laruan, K.A., Besic, E.D., Yun, C.W., and Lee, Y.J. (2014). Floral diversity assessment in Alno communal mixed forest in Benguet, Philippines. *Landscape Ecol Eng* 10:361–368. <https://doi.org/10.1007/s11355-012-0204-5>
- Lumbres, R.I.C., Pyo, J.K. and Lee, Y.J. (2014). Development of stem taper equations for *Pinus kesiya* in Benguet province, Philippines. *Forest Science and Technology* 10(1):22-28 <https://doi.org/10.1080/21580103.2013.821094>
- Magcale-Macandog, D. (2010). Conserving Indigenous Knowledge: Information System towards Food Information System towards Food Security and Sustainable NRM in the Security and Sustainable NRM in the Cordilleras. SEARCA Agriculture and Development Seminar Series. University of the Philippines Los Baños, Laguna, Philippines.
- Malabrigo, P.I.J. (2013). Vascular Flora of the Tropical Montane Forests in Balbalasang-Balbalan National Park, Kalinga Province, Northern Luzon, Philippines. *Asian Journal of Biodiversity* 4:1-22, <http://dx.doi.org/10.7828/ajob.v4i1.294>
- Merrill, E. D. and Merritt, M. L. (1910). The Flora of Mt. Pulog. *Philippine Journal of Science* 5(4):287-570.
- Musser, G.G. (1982). Results of the Archbold Expeditions No. 107: A new genus of arboreal rat from Luzon Island in the Philippines. *Novitates*. New York, NY: American Museum of Natural History.
- National Economic and Development Authority (NEDA). (2011). Major CAR development issues and concerns and corresponding plan of action. Retrieved from <http://car.neda.gov.ph/major-car-development-issues-and-concerns-and-corresponding-plan-of-action/>
- Olitsky, S. and Weathers, J. (2005). Working with Students as Researchers: Ethical Issues of a Participatory Process [66 paragraphs]. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research* 6(1), Art. 38, Retrieved from <http://nbn-resolving.de/urn:nbn:de:0114-fqs0501383>.doi:<http://dx.doi.org/10.17169/fqs-6.1.532>.
- Ong, P.S., L.E. Afuang & R.G. Rosell-Ambal (Eds.) 2002. Philippine Biodiversity Conservation Priorities: A Second Iteration on the National Biodiversity Strategy and Action Plan. Department of Environment and Natural Resources – Protected Areas and Wildlife Bureau, Conservation International Philippines, Biodiversity Conservation Program – University of the Philippines Center for Integrative and Development Studies, Foundation for the Philippine Environment. Quezon City, Philippines. 113pp.
- Patacsil, M., Manuel, J., Laruan, L.M.V.A., Cortez, S.M., and Balangcod, T.D. (2014). Phytochemical and antimicrobial studies of selected of selected aromatic plants in the Philippines. *Acta Horticulturae* 1023, 143-148.

- Peñafiel S.R. (1995). The Biological and Hydrological Values of the Mossy Forests in the Central Cordillera Mountains, Philippines. In: Hamilton L.S., Juvik J.O., Scatena F.N. (eds) Tropical Montane Cloud Forests. Ecological Studies (Analysis and Synthesis), Vol 110. Springer, New York, NY.
- Quitasol, K. (2016, June 13). DENR rejects Mt. Data downgrade from protected park. *Inquirer.net*, p.1. Retrieved from <https://newsinfo.inquirer.net/790314/denr-rejects-mt-data-downgrade-from-protected-park#ixzz6PA6c60Nd>
- Rabena, M.A.F., Macandog, D.M., Cuevas, V.C. and Espaldon, M.V.O. (2015) A vegetation inventory of a traditional secondary forest (muyong) in Kinakin, Banaue, Ifugao, Northern Luzon, Philippines Philippine Journal of Systematic Biology 9:10-32.
- Reginaldo, A.A., Ballesteros, V.F., Gonzales, M.P.A.V., and Austria, C.M. (2013). Small non-volant mammals in forest patches of Baguio City, Luzon, Philippines. *Asia Life Sciences* 22(1):131-139.
- Reginaldo, A.A. and de Guia, A.P.O. (2014). Species richness and patterns of occurrence of small non-flying mammals of Mt. Sto Tomas, Luzon Island, Philippines. *Philippine Science Letters* 7(1):37-44.
- Rickart, E.A., Balete, D.S., Alviola, P.A., Veluz, M.J., and Heaney, L.R. (2016). The mammals of Mt. Amuyao: a richly endemic fauna in the Central Cordillera of northern Luzon Island, Philippines. *Mammalia* 1-14. <https://doi.org/10.1515/mammalia-2015-0312>.
- Rickart, E. A., Balete D S., Rowe, R. J. and Heaney, L. R. (2011). Mammals of the northern Philippines: Tolerance for habitat disturbance and resistance to invasive species in an endemic insular fauna. *Biodiversity Research* 17( 3):530-541.
- Rickart E A, Heaney L R, Balete D S. and Tabaranza B R. Jr. (2011). Small mammal diversity along an elevational gradient in northern Luzon, Philippines. *Mammalian Biology* 76:12-21.
- Robertson T, Do ring M, Guralnick R, Bloom D, Wiczorek J, K. Braak, J. Otegui, L. Russell, and Desmet P. (2014). The GBIF Integrated Publishing Toolkit: Facilitating the Efficient Publishing of Biodiversity Data on the Internet. *PLoS ONE* 9(8): e102623. doi:10.1371/journal.pone.0102623
- San Luis, G.D., Balangcod, T.D. Abucay Jr J.B., Wong, F.M., Balangcod, K.D. Afifi, N.I.G. and Apostol, O.G. (2014). Phytochemical and antimicrobial screening of indigenous species that have potential for revegetation of landslides in Atok, Benguet, Philippines. *Indian Journal of Traditional Knowledge*13(1): 56-62.
- Segismundo, A.B., Navarro, R.B. and Abaya, J.L. (2010). Indigenous edible flora and fauna in the province of Abra. *UNP Research Journal* 19:1-7.
- Specht A, M. Bolton, B. Kingsford, R. Specht, and L Belbin (2018) A story of data won, data lost and data re-found: the realities of ecological data preservation. *Biodiversity Data Journal* 6: e28073. <https://doi.org/10.3897/BDJ.6.e28073>
- Subilla, M.S. and Buot, I.E., Jr. (2012). Woody plant species composition of Mount Data National Park, Mountain Province, Philippines. *The Thailand Natural History Museum Journal* 6(2):129-143.

- Stuart, A. M., Prescott, C. V., Singleton, G.R., Joshi, R.C. and Sebastian, L. S. (2007). The rodent species of the Ifugao Rice Terraces, Philippines-target or non-target species for management. *International Journal of Pest Management* 53(2):139-146, doi: [10.1080/09670870701192433](https://doi.org/10.1080/09670870701192433)
- Tad-awan, BA. and Sagalla, E.J.D. (2015). Cultivation and Conservation of Traditional Food Crops and Perceptions of Farmers on Biodiversity Loss In The Cordillera Administrative Region. *College of Agriculture. Benguet State University Research Journal* 7:62-81.
- Taguiling, N.K. (2013). Macrofloral Biodiversity Conservation in Ifugao. *European Scientific Journal* 4: 469-482, <https://doi.org/10.19044/esj.2013.v9n10p%p>
- Villanueva, T.R. (2005). *Upland Ecosystem Management*. 2<sup>nd</sup> Edition. UP Open University.

