Vol. 9 January 2018
Print ISSN 2094-5019 • Online ISSN 2244-0461
doi: http://dx.doi.org/10.7828/ajob.v9i1.1233

Asian Journal of Biodiversity
This Journal is in the Science Master Journal
List of Clarivate Analytics
Zoological Record

Plant Diversity Assessment in the Ecotone Ecosystem of Sitio Bulac, Barangay General Luna, Carranglan, Nueva Ecija, Philippines

ANNIE MELINDA PAZ-ALBERTO
ORCID NO. 0000-0002-2828-432X
melindapaz@gmail.com
Central Luzon State University, Science City of Munoz,
Nueva Ecija, Philippines

MARY ANN P. CABUTAJE
ORCID NO. 0000-0002-8262-2692
macabutaje@yahoo.com
Central Luzon State University, Science City of Munoz,
Nueva Ecija, Philippines

ABSTRACT

The study aimed to assess the present condition of the ecotone ecosystem of Sitio Bulac, Barangay General Luna, Carranglan, Nueva Ecija. Specifically, the objectives were to identify the endemic plants and unique plants and to determine the dominance and diversity of plant species in the said ecotone ecosystem. The different plants in the ecotone ecosystem were surveyed, collected, identified, classified, described and photographed. The ecological parameters were determined, computed and analyzed. Determination of the possible sources and level of impacts of environmental degradation as well as the threats and problems of the ecotone ecosystem that could affect the plant's diversity were also conducted. A total of 36 species of plants were identified and classified, and these were grouped into 4 divisions, 6 classes, 20 orders, 27 families and 32 genera. There are 18 endemic plants and nine unique species that were observed in the ecotone ecosystem of Sitio Bulac, Barangay General Luna, Carranglan Nueva Ecija. Grewia philippinensis Perk. earned the lowest biomass of -0.0555 is considered to be the keystone species. The diversity of plants in the ecotone ecosystem of Sitio Bulac, Brgy. General Luna is still high however, different threats in to human activities such as kaingin farming, illegal logging,

fires, pollution, mining, charcoal making, wildlife hunting, firewood collection and land conversion were present in the area which could affect the ecotone ecosystem and its biodiversity. Hence, protection and conservation of ecotone ecosystem is very important to prevent biodiversity loss and economic loss.

Keywords: Ecotone ecosystem, biodiversity assessment, diversity index, keystone, environmental degradation

INTRODUCTION

Ecotone ecosystem is a transition zone between two adjacent ecological communities, such as a forest and grassland. It has some of the characteristics of each bordering community and often contains species not found in the overlapping communities. An ecotone may exist along a broad belt or in a small pocket, such as forest clearing, where two communities blend together. The influence of two bordering communities on each other is known as the edge effect. An ecotonal area often has a higher density of organisms and a greater number of species than are found in either flanking community (Senft, 2009).

According to the World Resources Institute (1992), General Luna, Carranglan is a mountainous area in the part of Nueva Ecija. Most residents depend in its forest/ecotone abounding with natural resources which is inhabited by a variety of plants and animals.

Plants are important environmentally for various reasons. To some animals, one plant species may be their only source of food, and if taken away, the animal depending on this species may not survive. Preserving the biodiversity of plant species allows us to also sustain a population of various animal species within their ecosystem. Plants provide aesthetic value to humans, especially the flowers that make our gardens so pleasant, provide wood and many other useful possessions especially it can help make and preserve soil (Fernando, 2012).

Biological diversity or diversity refers to the collective genes, species and ecosystems in a certain area. Biodiversity is the totality of genes, species, and ecosystem in a region. The wealth of life on earth today is product of evolutionary history. Over the course of time, human cultures have emerged and adapted to the local environment, discovering, using and altering local biotic resources. Many areas that now seem "natural" bear the marks of millennia of human habitation, crop cultivation and resources harvesting, the domestication and breeding of local varieties of crops and livestocks have affected biodiversity of

various ecosystems (De Guzman, 2009).

One reputed characteristic of ecotones is that they have higher biological diversity than adjoining areas and thus hold high conservation value. Yet, there is a lack of strong evidence either supporting or refuting this claim. Furthermore, it is unclear as to what mechanisms would underlie such a spike in diversity and what environmental factors might influence and if so how it might be sustained (Senf, 2009).

There are only a few studies that clearly show high diversity at ecotones (Shmida & Wilson, 1985; Wolf, 1993; Kernaghan & Harper, 2001). Results of these studies showed higher species richness between predetermined altitudinal zones. Kirkman et al., (1998) and Carter et al., (1994) found higher species richness in wetland/upland boundaries. Brothers, (1993) obtained higher species richness at anthropogenic forest edges. Other studies looking at grassland/forest ecotones revealed species diversity at ecotones to be intermediate between the two bounded communities (Meiners et al., 2000) and (Harper, 1995).

Many studies have found that species diversity is higher in adjacent vegetation at some ecotones but lower in others. Burk (1977) looked at a zonation from water, through wetland, to upland, with ecotones at the upland/wetland boundary, and at the wetland/water boundary and found out that the highest richness was within the upland/wetland ecotone and the lowest in the wet/water ecotone. Lloyd et al. (2000) study showed that the species composition and richness at three different types of ecotones was intermediate between that of the adjacent communities of interest and suggested that these ecotones are more of a transition zone between a low and high richness community than a blending zone mixing species from both.

OBJECTIVE OF THE STUDY

The general objective of this study was to assess the diversity of plants present in ecotone ecosystem. Specifically, it aimed to; (1) collect, describe, classify and identify the different plants in the ecotone ecosystem; (2) determine the endemic plants and unique plants present in the ecotone ecosystem; (3) determine the dominance and diversity of plants and economic importance of the collected plants; and (4) determine the environmental problems and threats that could affect the diversity and habitat of plants.

METHODOLOGY

The plants species were collected from the ecotone ecosystem in Sitio Bulac, Barangay General Luna, Carranglan, Nueva Ecija. Pertinent documents and permits were secured at the DENR's Biodiversity Management Bureau (BMB), Local Government Unit of Carranglan, Nueva Ecija, CENRO, Barangay and Tribal Council. The study was conducted from March 2017 to May 2017.

Different plants in the area were surveyed, collected, identified, classified, described and photographed. Collected plants were dried and preserved into herbarium specimens. Ecological parameters were determined, computed and analyzed.

Collection of Plants in the Study Area

An assessment of the species diversity of the existing plants in the ecotone ecosystem of Sitio Bulac, Barangay General Luna, Carranglan, Nueva Ecija was conducted.

A random sampling procedure was used where the total area was divided into 5 quadrats measuring 20 meters by 20 meters (Alberto, 2005).

The modified strip transect method was used in this study. For every 250 meters of the transect line, sampling plots were established. If the transect line is less than 1km, sampling plots were established in regular intervals. Survey of floral diversity was conducted. GPS coordinates of the transect line and each sampling plots were recorded. Flagging tapes were marked for easy identification in succeeding monitoring activities.

These different plants were surveyed, photographed and collected. Then all collected plants were identified and verified by taxonomis from Central Luzon State University, University of the Philippines, Los Baños and National Museum, Philippines.

Preservation

The collected plant samples were preserved using plant pressers. Air-drying and sun drying were employed in the preservation of plants. Collected plants were dried and preserved into herbarium specimens and recorded. Aside from the role and function of the plant, the data and information about the plant was determined and recorded based on the following: collectors name, date of collection, family name, scientific name, common name, habitat, locality, altitude, municipality, province, its habit weather it is a tree, shrub, herb and vine, its flower's color, odor, special features, the fruit's color, odor, and texture.

Lastly, the economic importance was also be noted and determined. Herbarium preparation was also done for each plant that was collected.

Identification, Classification and Nomenclature

Identification of plant species that were collected from the area of study was based from the books, "A Pictorial Cyclopedia of Philippine Ornamental Plants" (Madulid, 1995), Lexicon of Phillipine Trees (Rojo, 1999) and a Laboratory Manual in Plant Taxonomy (Galvez & Banaticla, 2003). The plants were also identified by the taxonomist from the National Museum, Philippines. Only plants which have already been identified were verified by the taxonomist of the National Museum. Those plants which have not been identified were identified by the taxonomist of the National Museum.

Ecological Parameters

The ecological parameters of the plants species were gathered which include the total number of individual species, frequency, relative frequency, density, relative density, dominance, relative dominance, importance value index, Simpson's index of dominance, Shannon diversity index and percentage occurrence (Alberto, 2005). Formulas for the various ecological parameters were used in order to compute and analyze the dominance and diversity of species in the ecotone ecosystem. (Smith & Smith, 1998).

Sources and Level of Impact on Environmental Degradation of the Ecotone Ecosystem

To assess the present condition of the ecotone ecosystem the Checklist 1 which was developed by Alberto (2005) which pertains to the sources and level of impacts on environmental degradation of ecotone ecosystems was utilized.

The Checklist was rated using the values 1-4 by a minimum number of ten evaluators from the CENRO, DENR, CLSU, and LGU's in order to determine the present condition of the ecotone ecosystem. Four levels of impacts in each source of environmental degradation was used. For each level a value is assigned. The level of impact was estimated based on the percentage of impact/damage in the study area.

To get the mean of the answers of the respondents, the sum of the answers for each level was divided by the total number of respondents and a scale was used to interpret the scores in the level of impacts on the environmental degradation of any ecosystem (Alberto, 2005).

RESULTS AND DISCUSSION

Classification, Identification and Description of Plants

Based on the results of the study, 36 species of plants were identified and classified in the ecotone ecosystem of Sitio Bulac, Brgy. General Luna, Carranglan, Nueva Ecija. Identified species of plants are grouped into 4 divisions, 6 classes, 20 orders, 27 families and 32 genera.

There were only nine (9) species that were identified as unique plants. *Grewia philippinensis* Perk. got the highest percentage of 43.69 %, followed by *Leea aculeate (Bl.)* Spreng which had 28.38%. *Trigonostemon filiforme* Quisumb. obtained a percentage of 7.21% while *Pavetta indica* L. got only 5.41%. *Acanthus ilicifolius* L. had 4.50% while *Suregada multiflorum* (A. Juss.) Baill. and *Symplocos* sp. had only 3.60%. *Citrus* sp. got 2.25%. and *Pterospermum diversifolium* Bl. got the lowest percentage at 1.35%.

Endemic Plants

There are 18 endemic plants that were observed in the ecotone ecosystem. Species which are native or restricted for a certain country or area which have specialized habitats are much more vulnerable to extinction, since once their particular habitat is degraded or converted for human activity, they will disappear (Lantican et al, 2002).

Grewia philippinensis Perk. obtained the highest percentage of 32.3% followed by *Leea aculeata* (Bl.) Spreng which got 21%. *Caryota mitis* Lour. obtained a percentage of 6% while *Macaranga grandifolia* (Blco.) Merr. got only 4.33%. *Pavetta indica* L., *Shorea guiso* (Blco.) Bl. and *Gnetum latifolium* Bl. had 4 % while *Buchanania arborescens* (Bl.) Bl., *Garcinia binucao* (Blco.) Choisy and *Acanthus ilicifolius* L. had only 3.33 %. *Lygodium circinnatum* (Burm.) Sw. earned 3% while *Ixora longistipula* Merr. earned only 2.33%. *Semecarpus cuneiformis* Blco. got 2%. *Artocarpus blancoi* (Elm.) Merr. and *Melastoma malabathricum* L. had 1.67%, while *Anisoptera thurifera* (Blco.) Bl. and *Syzigium glaucicalyx* (Merr.) Merr. had only 1.33%. obtained 1.53 %. *Anisoptera thurifera* (Blco.) Bl. and *Syzigium glaucicalyx* (Merr.) Merr. *Pterospermum diversifolium* Bl. got the lowest percentage at 1%. *Grewia philippinensis* Perk. is common and occur in a wide variety of habitats in the study area. According to DENR-DAO 2007-11 and IUCN Red List of Threatened Species 2017-3, *G. philippinensis* Perk. is endemic to the Philippines with least concerned conservation status.

Table 1 shows the endemic species that were observed and collected. These plants were categorized based on the IUCN Red List and DENR List of Threatened Species and Categories 2007-11.

Table 1. List of endemic plants that were surveyed in the ecotone ecosystem of Sitio Bulac Barangay General Luna, Carranglan, Nueva Ecija (IUCN Red List 2017-3, DENR List of Threatened species and categories 2007-11)

Species	No. of Individuals	Percentage
Grewia philippinensis Perk.	97	32.33%
Leea aculeate (Bl.) Spreng	63	21.00%
*Caryotamitis*Lour.	18	6.00%
Macaranga grandifolia(Blco.) Merr.	13	4.33%
Pavetta indica L.	12	4.00%
Shorea guiso(Blco.) Bl.	12	4.00%
*Gnetum latifolium*Bl.	12	4.00%
Buchanania arborescens (Bl.) Bl.	10	3.33%
Garcinia binucao(Blco.) Choisy	10	3.33%
Acanthus ilicifolius L.	10	3.33%
Lygodium circinnatum (Burm.) Sw.	9	3.00%
Ixoralong istipula Merr.	7	2.33%
*Semecarpus cuneiformis*Blco.	6	2.00%
Artocarpus blancoi (Elm.) Merr.	5	1.67%
*Melastoma malabathricum*L.	5	1.67%
Anisoptera thurifera (Blco.) Bl.	4	1.33%
Syzigium glaucicalyx (Merr.) Merr.	4	1.33%
*Pterospermum diversifolium*Bl.	3	1.00%
TOTAL	**300**	**100%**

Unique Plants

Table 2 shows the unique plants that were observed in the ecotone ecosystem of Sitio Bulac, Barangay General Luna, Carranglan Nueva Ecija. Unique plants are those plants that are present only in the ecotone ecosystem but do not occur in the forest and grassland ecosystem.

Grewia philippinensis Perk. got the highest percentage of 43.69 %, followed by *Leea aculeata* (Bl.) Spreng which had 28.38%. *Trigonostemon filiforme* Quisumb. obtained a percentage of 7.21% while *Pavetta indica* L. got only 5.41%. *Acanthus ilicifolius* L. had 4.50% while *Suregada multiflorum* (A. Juss.) Baill. and *Symplocos sp.* had only 3.60%. *Citrus sp*. got 2.25%. and *Pterospermum diversifolium* Bl. got the lowest percentage at 1.35%.

Table 2. Unique plants present in the ecotone ecosystem of SitioBulac, Barangay General Luna, Carranglan, NuevaEcija

Species	No. of Individuals	Percentage
*Grewia philippinensis*Perk.	97	43.69%
Leea aculeate (Bl.) Spreng	63	28.38%
Trigonostemon filiforme Quisumb.	16	7.21%
Pavetta indica L.	12	5.41%
Acanthus ilicifolius L.	10	4.50%
Suregada multiflorum (A. Juss.) Baill.	8	3.60%
*Symploco s*sp.	8	3.60%
Citrus sp.	5	2.25%
Pterospermum diversifolium Bl.	3	1.35%
TOTAL	**222**	**100%**

According to Ross (2016), ecotones support higher species richness and species variations than it's adjacent habitats such as forests and grasslands. Patterns of higher species richness in ecotones has been studied ranging from spatial mass effect, increased environmental heterogeneity, seed predation or introduction by animals or insects and to increased dispersal ability.

Dominance and Diversity of Plant Species

The dominant indices such as Frequency (F), Relative Frequency (RF), Density (D), Relative Density (RD), Dominance (Do), Relative Dominance (RDo) and Importance Value Index (IVI) of plants identified and observed in

the ecotone ecosystem of Sitio Bulac, Brgy. General Luna, Carranglan, Nueva Ecija are shown in Table 3.

Grewia philippinensis Perk. obtained the highest frequency of 0.8 and relative frequency of 6.78% and also earned the highest density of 0.097, relative density of 13.13% and highest number of individual species with 97 individuals. It is also considered as the keystone species, unique plant and endemic plant.

Results also show that *Grewia philippinensis* Perk. got the highest importance value index of 33.03% , which indicates that this plant is the most common and the most dominant species that was observed in the ecotone ecosystem. High IVI indicates that the species is well represented due to a large number of individuals observed compared with other species (Hodabalo et al., 2013).

The over- all computation for the Shannon's Diversity Index and Simpson Diversity Index of the surveyed area revealed that the ecotone ecosystem exhibited high diversity, with values of 3.08 and 0.99, respectively. The high diversity of the ecotone ecosystem implies that this ecosystem contain many species with more numbers of individuals. Community that contains more numbers of individual species is said to have high diversity (Guiang, 2001). Another possible reason could be due to their adaptation to the soil properties such as acidic soil, high rainfall and with temperature ranging from 24°C-32°C which allow plants to grow and reproduce in the area.

There are a few studies that clearly show high diversity at ecotones. Kirkman et al., (1998) and Carter et al., (1994) found higher species richness in wetland/upland boundaries. Brothers (1993) obtained higher species richness at forest edges. Other studies looking at grassland/forest ecotones revealed species diversity at ecotones to be intermediate between the two bounded communities (Meiners et al., 2000) and (Harper, 1995).

Furthermore, other studies have found that species diversity is higher in adjacent vegetation at some ecotones but lower in others. Burk (1977) looked at a zonation from water through wetland, to upland with ecotones at the upland/wetland boundary, and at the wetland/water boundary and found out that the highest richness was within the upland/wetland ecotone and the lowest in the wet/water ecotone. Lloyd et al. (2000) study showed that the species composition and richness at three different types of ecotones was intermediate between that of the adjacent communities of interest and suggested that these ecotones are more of a transition zone between a low and high richness community than a blending zone mixing species from both.

Table 3. Computed ecological parameters of all surveyed species of plants in the ecotone ecosytem of SitioBulac, Barangay General Luna, Carranglan, NuevaEcija

Scientific Name	# of Individuals	Frequency	Relative Frequency (%)	Density	Relative Density (%)	Dominance	Relative Dominance (%)	IVI(%)
Grewia philippinensis Perk.	97	0.8	6.78	0.097	13.13	0.131	13.1	33.03
Saccharum spontaneum L.	91	0.2	1.69	0.091	12.31	0.123	12.3	26.33
Chromolaena odorata (L.) R.M.	86	0.6	5.08	0.086	11.64	0.116	11.6	28.35
*Leea aculleata*l.) Spreng	63	0.6	5.08	0.063	8.53	0.085	8.5	22.13
Cyperus diffuses Vahl	43	0.6	5.08	0.043	5.81	0.058	5.8	16.72
Quercus subsericea A. Camus	43	0.2	1.70	0.043	5.81	0.058	5.8	13.33
Syzygium sp.	25	0.4	3.39	0.025	3.38	0.034	3.4	10.18
Caryota mitis Lour.	18	0.4	3.39	0.018	2.44	0.024	2.4	8.23
Symplocos sp.	18	0.4	3.39	0.018	2.44	0.024	2.4	8.23
Trigonostemon filiforme Quisumb.	16	0.4	3.39	0.016	2.17	0.021	2.1	7.66
Glochidiun luzonense Elm.	16	0.4	3.39	0.016	2.17	0.021	2.1	7.66
Canarium sp.	14	0.6	5.08	0.014	1.89	0.019	1.9	8.88
Piper sp.	14	0.2	1.69	0.014	1.89	0.019	1.9	13.33
Macaranga grandifolia (Blco.)	13	0.2	1.69	0.013	1.76	0.018	1.8	5.26
Pavetta indica L.	12	0.4	3.39	0.012	1.62	0.016	1.60	6.62
Gnetum latifolium Bl.	12	0.4	3.39	0.012	1.62	0.016	1.60	6.62
Calamus sp.	12	0.4	3.39	0.012	1.62	0.016	1.60	6.62
Shorea guiso (Blco.) Bl.	12	0.4	3.39	0.012	1.62	0.016	1.60	6.62
Shorea sp.	12	0.2	1.69	0.012	1.62	0.016	1.60	4.92
Albizia sp.	11	0.4	3.39	0.011	1.49	0.015	1.50	6.38
Pteris sp.	11	0.2	1.69	0.011	1.49	0.015	1.50	4.69
Buchanania arborescens (Bl.) Bl.	10	0.4	3.39	0.01	1.35	0.014	1.40	6.15
Garcinia binucao (Blco.) Choisy	10	0.2	1.69	0.01	1.35	0.014	1.40	4.45
Acanthus ilicifolius L.	10	0.2	1.69	0.01	1.35	0.014	1.40	4.45
Homalium sp.	10	0.2	1.69	0.01	1.35	0.014	1.40	4.45
Lygodium circinnatum (Burm.)	9	0.4	3.39	0.009	1.22	0.012	1.20	5.81
Suregada multiflorum (A. Juss.)	8	0.2	1.69	0.008	1.08	0.011	1.10	3.88
Ixora longistipula Merr.	7	0.2	1.69	0.007	0.95	0.009	0.91	3.54
Semecarpus cuneiformis Blco.	6	0.2	1.69	0.006	0.81	0.008	0.80	3.31
Citrus sp.	5	0.2	1.69	0.005	0.68	0.007	0.70	3.07
Melastoma malabathricum L.	5	0.2	1.69	0.005	0.68	0.007	0.70	3.07
Artocarpus blancoi (Elm.) Merr.	5	0.2	1.69	0.005	0.68	0.007	0.70	3.07
Leucosyke sp.	5	0.2	1.69	0.005	0.68	0.007	0.70	3.07
Anisoptera thurifera (Blco.) Bl.	4	0.2	1.69	0.004	0.54	0.005	0.50	2.74
Pterospermum diversifolium Bl.	3	0.2	1.69	0.003	0.41	0.004	0.40	2.50
Syzygium glaucicalyx (Merr.)	3	0.2	1.69	0.003	0.41	0.004	0.40	2.50
TOTAL	**739**							

Economic Importance and Function of the Surveyed Plants

The collected and surveyed plants existing in the said ecotone ecosystem have their own different roles in the ecosystem but most of them are medicinal plants and sources of food. Moreover, different functions of plants present in the ecotone ecosystem of Sitio Bulac, Barangay General Luna, Carranglan, Nueva Ecija, are subdivided into forest trees, economic plants, weeds and ornamental plants.

Among the economic plants that are classified and identified in the ecotone ecosystem, 26 plants are known to be medicinal plants, 19 as sources of food and 4 are sources of shelter. Seven have industrial values, 3 are ornamental plants, 10 are fruit trees, 4 are weeds and 17 are forest trees.

The plants have great economic values such as source of food, source of medicine, source of forage and shelter to the inhabitants of the study area. Aside

from all the mention functions and uses of these plants, they are also the primary producers in the food chain and they are very essential to balance the state of forest ecosystem (Alberto, 2005).

Sources and Levels of Impacts of Environmental Degradation in the Ecotone Ecosystem of Sitio Bulac, Barangay General Luna, Carranglan Nueva Ecija.

Table 4 shows the impact of environmental degradation in the ecotone ecosystem. Kaingin farming had major impact which can cause possible loss in overall regional welfare, biodiversity loss which could lead to degradation of the habitat of animals, and it is also a contributing factor in deforestation.

Illegal logging got moderate impact because this result to the loss of aesthetic value and wildlife extinction of organisms that lead to biodiversity loss while occurrence of fire could result to environmental degradation.

Table 4. Impact of environmental degradation in the ecotone ecosystem of Sitio Bulac, Barangay General Luna, Carranglan Nueva Ecija.

Sources of Environmental Degradation	Mean of Answer	Interpretataion
Kaingin farming	3.67	Major Impact
Illegal Logging	3.25	Moderate Impact
Fire	2.67	Moderate Impact
Pollution	2.09	Small Impact
Mining	2.09	Small Impact
Soil Erosion	1.92	Small Impact
Charcoal Making	1.92	Small Impact
Quarrying	1.83	Small Impact
Land Conversion	1.83	Small Impact
Wildlife Hunting	1.75	No Significant Impact
Encroachment	1.75	No Significant Impact
Construction of Power Transmission Lines	1.67	No Significant Impact
Road Construction	1.50	No Significant Impact
Firewood Collection	1.42	No Significant Impact

CONCLUSION

The diversity of plants in the ecotone ecosystem of Sitio Bulac, Barangay General Luna, Carranglan Nueva Ecija is still high with most of the plants that were identified are endemic plants. There are nine unique plants that were observed in the ecotone ecosystem. Most of the plants identified are plants which are sources of medicine and food as well as forest trees. However, the plant populations had greatly decreased due to human activities such as kaingin farming, illegal logging and fire. Hence, protection and conservation of ecotone ecosystem is very important to prevent biodiversity loss.

RECOMMENDATIONS

Based on the results of the study, the following recommendations are suggested:

1. Regular monitoring of the ecotone ecosystem is necessary to lessen the impacts or risk that could cause disturbance in the ecotone ecosystem;

2. Strict implementation of the laws and activities should be done to conserve the ecotone ecosystem and to maintain and protect the ecotone biodiversity; and

3. Further research in molecular study should be done to identify some unidentified species in order to know if these species are new species.

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