May 2001

Species richness and composition in understory moss communities in lower montane rain forest in Monteverde, Costa Rica

Erika Carls

Species richness and composition in understory moss communities in lower montane rain forest in Monteverde, Costa Rica

Erika Carls,

Department of Biology, Gustavus Adolphus College

_____

ABSTRACT

This study investigated the difference in species richness and composition of mosses in primary lower montane rain forests, forest gaps and forest-pasture edges, as well as among different substrates. Mosses in Monteverde, Costa Rica were collected for equal amounts of time from rotting logs, tree trunks and leaves in all habitat types, and separated morphologically. Overall morphological species richness is 39 for primary forests, 38 for gaps and 28 for edges. Species richness is 26 to 22 for logs, 22 to 20 for trees and seven to zero for leaves. Moss epiphyll communities are very dissimilar (Sorenson's qualitative index 0.1 - 0.2) from all other substrates. No epiphylls were observed in edges, probably because edge conditions are hotter, drier and windier. This suggests that moss epiphylls may make good bioindicators of forest health. The low species richness of epiphylls could be explained by a random walk to monodominance or by inferior growth conditions of leaves.

RESUMEN

Este estudio investigó la diferencia en el número y la composición de especies de musgos en bosques primarios montano bajo, claros en el bosque, orillas del bosque y los pastizales; así como su presencia en diferentes substratos. Recogí musgos en Monteverde, Costa Rica por el mismo espacio de tiempo en leños podridos, troncos de árboles y hojas en diferentes tipos de ambientes y los separé por sus características morfológicas. Se encontró un total de 39 especies en el bosque primario, 38 en los claros y 28 en las orillas. Se encontraron de 22 a 26 especies en los leños, 20 a 22 en los árboles y de cero a siete en las hojas. Las comunidades de los musgos en las hojas son diferentes. (Índice Similaridad de Sorenson 0.1 - 0.2) a todos los otros substratos. No se encontró musgos en las orillas, probablemente porque es más caliente, hay mas viento y es más seco. Lo anterior sugiere que los musgos en las hojas son buenos indicadores de la salud del bosque. Es posible que se encuentren pocas especies en las hojas porque se asocia con una monodominancia o porque las condiciones para crecer no fueron las óptimas en las hojas.

INTRODUCTION

Mosses, in the division Bryophtya, are non-vascular plants which are similar to the first plants that evolved (Raven 1999). They are an important component of tropical rainforests. Mosses are good pioneers and store a lot of carbon (Raven 1999). They also store a great quantity of rainwater, keep humidity in the forest high, help epiphytes grow and provide shade for invertebrates and microorganisms (Gradstein 1995; Gradstein 2000). Furthermore, they may help keep nutrients in the system since they accumulate a large amount of organic matter (Frangi and Lugo 1992). The Neotropics harbor an estimated 2700 species of mosses, with about 50% found in rainforests (Gradstein 1995).

Forests above 1000m in elevation harbor more mosses than those of lower altitudes and in montane rainforests, mosses are found both in the canopy and in the understory (Gradstein 1995). The lower temperatures, higher light levels and more abundant water supply of montane rainforests as compared to lower rainforests are more favorable conditions for moss growth (Frahm and Gradstein 1991; Gradstein 2000). Biotic factors including the quantity of lianas,

number of epiphytes or tree ferns, the height of the forest, tree trunk morphology and leaf sizes also help define the altitude zones where different mosses are found (Frahm and Gradstein 1991).

Cloud forests may harbor many endemic species of mosses, especially as epiphytes (Raven 1999). Frahm and Gradstein (1991) found there are less than 50 species per hectare in the understory of lower tropical montane rainforests. Gradstein (1995) did a non-exhaustive study of four hectares of the Monteverde Cloud Forest Preserve which yielded 56 moss species. Of these species, 36% were found only in the canopy, 38% in the understory and 25% were found both in the canopy and understory. In the understory, trunk bases, shrubs, lianas or saplings and living leaves had the greatest number of moss species, ranging from 35-45 species. The lowest number of species was found on rotting logs, with 16 species (Gradstein 1995). However, Morales (2000) found few epiphytic species in Monteverde.

Moss species richness is greatly affected by different microhabitats or substrates. Small differences in the amount of light, temperature and nutrients, the amount or type of water and the physical or chemical nature of a substrate can result in different moss communities (Pócs 1983). Terrestrial mosses are more common in areas with higher light levels such as light gaps and forest edges (Gradstein 1995). Also, shade-mosses are more likely to disappear from a disturbed forest than sun tolerant mosses because they are less adapted for the drier edge conditions (Gradstein 1992). Mosses that grow on leaves, a type of epiphyll, prefer leaves with long lives and smooth leaf surfaces (Pócs 1983).

The rapid deforestation of the tropical forests negatively affects moss communities. Moss species compositions differ between the middle and the edge of a forest and disruption of tropical forests causes reduction in their richness or change in their species composition (Gradstein 1992). Along edges, conditions are sunnier, hotter windier and drier (Meffe and Carol 1997; Wheelwright 2000).

This study focuses on the species richness and the similarity of composition of mosses in different habitats. Mosses can be important indicators of forest health due to their high habitat specificity (Salazar et al. 1996). They can be used as bioindicators of the temperature and humidity conditions in an area (Frahm and Gradstein 1991). Since different moss communities are associated with very small microhabitats (Pócs 1983), it is possible they could be used as bioindicators for conditions even more specific than temperature and humidity. They could also make useful bioindicators because there are only about 2700 mosses in the Neotropics compared to about 90, 000 flowering plants (Frahm and Gradstein 1991).

The purpose of this study is to indicate whether preservation of non-fragmented primary rainforest is important to protect moss communities. It is also to determine how mosses may be indicators of forest health.

I hypothesized that species richness would range from highest to lowest for primary tropical rainforest, forest gaps and forest-pasture edges respectively. I further hypothesized that the species of mosses found in these three habitats would differ. I also hypothesized that species richness would differ by substrate.

MATERIALS AND METHODS

The study was conducted in lower montane wet forest from 1510-1580m in Monteverde, Puntarenas, Costa Rica at the Estación Biológica Monteverde. Three habitat types were used as study sites: forest-pasture edge, primary forest and gaps in primary forest. Mosses were collected at each study site from three substrate types: rotting logs, tree trunks and leaves. At each site, one hour and 20 minutes were spent collecting all morphological species of mosses encountered in every substrate category by removing a sample large enough to identify in the laboratory.

Samples were collected from two different study sites for each habitat/substrate category. The gap sites were contained within the primary study sites and the edge sites were not linked to the first or second primary/gap sites.

Mosses were collected from between zero and one meters above ground. Each leaf, tree trunk or log which was encountered in a random walk in the study site was sampled. Tree trunks for trees above about three meters were sampled, and there was no minimum size for leaves or rotting logs. Logs were considered rotting if they had no epiphytes growing on them and if they were soft enough to easily cut past the bark and into the wood beneath. Areas with streams were always avoided since streams were not present in all study sites.

Species were separated in the laboratory on the basis of morphological differences. Photographs of each morphological species were taken with a digital camera, and specimens of each morphological species were dried and preserved. Voucher photographs were catalogued and left at the Estación Biológica Monteverde.

Morphological species richness was determined for each habitat/substrate combination in each study site. The Shannon-Weiner diversity index was not be used as it is very difficult to quantify the number of individual mosses present in one area. Similarity between all sites was calculated using Sorenson's qualitative index of similarity (Magurran, 1988). The index ranges from zero for no shared species to one for all species shared. Based on data patterns, index values were divided into four similarity categories. A Sorenson index of 0.7 to one is highly similar; from 0.5 to 0.6 is moderately similar, 0.3 to 0.4 dissimilar and 0.1 to 0.2 very dissimilar.

RESULTS

Species Richness

For all substrates combined, morphological species richness is 39 for primary forests, 38 for primary forest gaps and 28 for forest-pasture edges (Table 1). The same pattern appears when sites one and two are examined independently (Table 1). When the substrates within each habitat are examined independently, similar patterns are found. For mosses on logs, species richness for primary, gap and edge habitats is 26, 23 and 22 respectively (Table 2). For mosses on trees, species richness is 22, 21 and 20 respectively (Table 2). For moss epiphylls, richness in primary and gap habitats is 7 and 6 species respectively when sites one and two are combined. No species were found on leaves along forest-pasture edges (Table 2).

The species richness of mosses is different for different substrates. When sites one and two are combined, moss species richness is highest for rotting logs, lower for trees and lowest for leaves. Rotting logs in primary, gap and edge habitats have 26, 23 and 22 species respectively (Table 2). Trees in primary, gap and edge habitats have 22, 21 and 20 species respectively. Leaves in primary, gap and edge habitats have seven, six and zero species respectively (Table 2). Similar patterns are evident when sites one and two are considered independently (Table 2).

Species Composition

When the morphological species in all substrates are combined for each habitat, and habitats are compared by the Sorenson qualitative index of similarity, primary and gap habitats are highly similar, at 0.70. Gap and edge habitats are moderately similar, with a value of 0.67. Primary and edge habitats have the lowest similarity at 0.57 (Table 3).

The similarity between species is measured by Sorenson's qualitative index of similarity. The similarity between mosses found on logs in different habitats is moderately similar (0.5) to dissimilar (0.4; Table 4). Mosses on trees in different habitats are dissimilar (0.3) to very

dissimilar (0.2) from each other. When moss communities on logs and on trees in different habitats are compared, the similarity ranges from highly similar (0.7) to very dissimilar (0.1) (Table 4). Moss epiphyll communities are moderately similar to each other (0.5). However, epiphyll communities are always very dissimilar from log and tree substrates in all habitats (0.1 – 0.2; Table 4).

Sites one and two for mosses on logs of each habitat were dissimilar (0.3 – 0.4) when measured with Sorenson's quantitative index of similarity (Table 5). Sites one and two for mosses on trees of each habitat could be dissimilar (0.3 – 0.4) or highly similar (0.8). Sites one and two for epiphylls could be dissimilar (0.4) to completely dissimilar (0.0; Table 5).

DISCUSSION

My hypothesis that moss communities in primary tropical rainforest is the most species rich followed by forest gaps and then by the forest-pasture edges is supported. Ten to eleven fewer species were found in the forest edges than in the primary forest and the forest gaps (Table 1). One reason for the reduced species richness in forest edges is the complete absence of moss epiphylls compared to the six to seven epiphyll species found in primary forest and gaps (Table 2). This trend indicates that primary forest and forest gaps are superior habitats for moss growth. Mosses grow better in the higher altitude zones of montane rainforests, which have lower temperatures, higher light levels and a more abundant water supply (Frahm and Gradstein 1991; Gradstein, 2000). Although the high light levels of forest-pasture edges may favor the growth of some mosses, edges have higher temperatures and drier conditions. These two factors may be responsible for the reduced richness of mosses in forest-pasture edges.

My hypothesis that the species composition of mosses found in these three habitats would differ is not entirely supported. The similarity between the species found in the three different habitat ranges from 0.57 to 0.70, which is moderately similar to highly similar (Table 3). Primary forests and forest-pasture edges are the least similar from each other at 0.57. Because mosses are found in specific microhabitats or substrates, this indicates that of the three habitats studied, the microhabitats in forest-pasture edges are the most different from primary forests. Forest edges and forest gaps are more similar to each other, as indicated by Sorenson's index of similarity (Table 3). Their microhabitats would be expected to be similar. Gaps have higher soil and air temperatures, and also have higher light levels when compared to primary forests. Edges also have more light and higher temperatures. The high similarity between forest gaps and primary forest may be explained because the gap sites are contained within primary sites, so rainfall patterns should be similar.

My third hypothesis, that species richness would differ by substrate, was supported. Species richness was highest for mosses on logs, less for mosses on trees and much less for moss epiphylls (Table 2). This supports Morales (2000) who found few species of epiphylls in Monteverde. The low species richness in epiphylls could be explained as the result of stochastic processes. Very few species are shared between mosses on leaves and mosses on other substrates (Table 4). This may indicate that the moss epiphylls are a relatively isolated metacommunity. According to the Hubbell nonequilibrium model, community drift can lead to the monodominance of a species in a metacommunity by random processes. This process is expedited by small metacommunity sizes and by low levels of immigration (Hubbell 1995). Thus the small number of species on leaves may be the result of lower immigration rates of species to the relatively isolated epiphyll communities. Mosses on trees and on logs share more species, thus comprising a larger metacommunity and they may also experience a higher level of immigration. The higher level of immigration and the larger metacommunity means that these species are less likely to go extinct.

The similarity between sites also supports the Hubbell model. Similarity can be very high or weak for logs and trees but the similarity between sites for leaves is dissimilar to zero (Table 5). Thus, mosses on trees and logs may be able to immigrate to mosses on the trees and logs of other sites. But mosses on leaves are less likely to be able to move to different areas. According to the Hubbell model, this limited immigration may lead to the lower species diversity observed in epiphyll communities.

The low species richness of moss epiphylls could also be explained as the result of deterministic processes. Rotten logs and tree trunks may be superior substrates for moss growth when compared to leaves. Mosses need an ample supply of water to grow, and logs and trees can absorb more moisture than leaves. According to Pócos (1983) tree trunks are the shadiest and most humid environment for bryophytes. The nutrient content of these substrates may also explain the lower richness of mosses on leaves. According to Pócos (1983) dead logs are a good moss substrate due to the nutrients in the decomposed cellulose and lignin. Since high richness was also found in moss communities on trees, I hypothesize that trees are good microhabitats for moss growth. This contradicts the study by Pasquier (1997) which shows a relatively low fitness of moss on trees as compared to logs, rocks or soil. Epiphylls, however, do not seem to receive organic compounds from the host (Eze and Berrie 1977). Thus, the lack of nutrients and moisture on leaves, which are inferior conditions for moss growth, should be expected to limit the growth of some mosses.

With this study, these deterministic explanations for fewer moss epiphylls cannot be separated from the stochastic explanations. Denslow (1987) states that deterministic and stochastic explanations are two extremes of a continuum. Further study is needed to determine how much of the lack of epiphyll richness is due to deterministic processes and how much is do to stochastic processes.

The lack of moss epiphylls in edges could be due to stochastic, deterministic processes or both. However, there is no support of stochastic models as similarity could not be accurately determined due to the complete absence of edge epiphylls. The amount of water available to epiphylls is relatively low for primary forest substrates. So in the drier forest edges, there may be insufficient moisture to support epiphylls. The complete lack of moss epiphylls in the edges suggests that epiphylls can be used as an indicator of forest health. Where epiphylls are absent, this could indicate that conditions in the area are drier than normal for forest conditions.

In the future, abundance data could be collected so that diversity of mosses could be determined. This would give a better indication of differences in moss communities. Based on my results, I conclude that the primary forest is important for the preservation of mosses and especially for obligate moss epiphylls.

ACKNOWLEDGEMENTS

LITERATURE CITED

Denslow, J.S. 1987. Tropical rainforest gaps and tree species diversity. Ann. Rev. Ecol. Syst. 18: 431-451.

Eze. J.M.O. and G.K. Berrie. 1977. Further investigations into the physiological relationship between an epiphyllous liverwort and its host leaves. Annals of Botany 41: 351-358.

Frahm, J.P. and Gradstein, S.R. 1991. An altitudinal zonation of tropical rainforests using bryophytes. Journal of Biogeography 18: 669-678.

Frangi, J.L. and A.E. Lugo. 1992. Biomass and nutrient accumulation in ten year old bryophyte communities inside a flood plain in the Luquillo experimental forest, Puerto Rico. Biotropica 24: 106-112.

Gradstein, R.S. 2000. *Bryophytes*. In: Monteverde: Ecology and Conservation of a Tropical Cloud Forest. N.M. Nadkarni and N.T. Wheelwright, eds. Oxford University Press, New York, pp. 80.

Gradstein, R.S. and D. Griffin III. 1995. Bryophyte diversity in the cloud forest of Monteverde. The Bryologist 98: 251-260.

Gradstein, R.S. 1992. Threatened bryophytes of the Neotropical rain forest: a status report. Tropical Bryology 6: 83-93.

Hubbell S. 1995. Towards a theory of biodiversity and biogeography on continuous landscapes. In: Preparing for Global Change: A Midwestern Perspective. G.R. Carmichael, G.F. Folk & L. L. Schnoor, eds.

Maburran, A.E. 1988. Ecological Diversity and its Measurement. Princeton University Press, Princeton, New Jersey, p. 95.

Meffe, G.K. and C.R Carroll. 1997. Principles of Conservation Biology. Sinauer Associates, Inc. Sunderland, Massachusetts. Pp. 294-297.

Morales, María I. 2000. *Plants growing on living leaves*. In: Monteverde: Ecology and Conservation of a Tropical Cloud Forest. N.M. Nadkarni and N.T. Wheelwright, ed. Oxford University Press, New York, pp. 80.

Pasquier, Myra. 1997. Substrate impact on bryophyte fitness. CIEE Spring 1997.

Pócos, T. 1983. *Tropical Forest Bryophytes*. In: Bryophyte Ecology pp. 59-101.

Raven, P.H., R.F. Evert and S.E. Eichhorn. 1999. Biology of Plants. W.H. Freeman and Company, New York. Pp.400-423.

Salazar, A.N., S.R. Gradstein, AND S.P. Churchill. 1996. Bryophytes as non-woody biodiversity indicators: a guide to the bryophytes of tropical America. A report Anales Inst. Biol. Univ. Nac. Autón. 67(1): 59-65.

Wheelwright, N.T. 2000. *Conservation Biology*. In: Monteverde: Ecology and Conservation of a Tropical Cloud Forest. N.M. Nadkarni and N.T. Wheelwright, ed. Oxford University Press, New York, pp. 422-423.

_____
TABLE 1. Morphological species richness of mosses in primary, gap and edge habitats for study sites one and two and the cumulative species richness at two sites in Monteverde, Costa Rica, 2001.

_____

		Species Richness	
Habitat	Site 1	Site 2	Combined
Primary	28	29	39
Gap	27	28	38
Edge	20	26	28

_____
TABLE 2. Morphological species richness of mosses on different substrate and habitat types at study sites one and two and the cumulative species richness at two sites in Monteverde, Costa Rica, 2001.

_____

		Species Richness	
Habitat & Substrate	Site 1	Site 2	Combined
Primary Log	14	17	26
Gap Log	16	13	23
Edge Log	15	16	22
Primary Tree	12	14	22
Gap Tree	11	16	21
Edge Tree	13	19	20
Primary Leaf	5	4	7
Gap Leaf	4	2	6
Edge Leaf	0	0	0

_____
TABLE 3. Sorenson's qualitative index of similarity for combined morphological species richness of sites one and two similarity to one for no differences.

_____

Habitat	Sorenson's Index of similarity
Primary & Gap	0.70
Gap & Edge	0.67
Primary & Edge	0.57

_____

TABLE 4. Sorenson's qualitative index of similarity for all pairs of substrate/habitat combinations. Index values very from zero for no shared morphological species to one for all species shared. Study sites one and two are combined. Data are separated by level of similarity. Edge-leaf data are not included since no mosses were observed in this habitat.

_____

Sorenson Index of Similarity Categories			
Highly Similar (0.7 – 1)	Moderately Similar (0.5 – 0.6)	Dissimilar (0.3 – 0.4)	Very Dissimilar (0.1-0.2)
Edge Log & Edge Tree; (0.07)	Primary Log & Gap Log (0.5)	Primary Log & Edge Tree (0.4)	Gap Log & Gap Tree (0.1)
	Primary Log & Edge Log (0.5)	Gap Log & Primary Tree (0.4)	Gap Log & Edge Tree (0.2)
	Primary Log & Primary Tree (0.5)	Primary Tree & Gap Tree (0.3)	Edge Log & Primary Tree (0.2)
	Primary Log & Gap Tree (0.5)	Edge Tree & Gap Tree (0.3)	Primary Tree & Edge Tree (0.2)
	Edge Log & Gap Tree (0.5)		
			Primary Leaf & Primary Log (0.2)
	Primary Leaf & Gap Leaf (0.5)		Primary Leaf & Gap Log (0.1)
			Primary Leaf & Edge Log (0.1)
			Primary Leaf & Primary Tree (0.1)
			Primary Leaf & Gap Tree (0.2)
			Primary Leaf & Edge Tree (0.2)
			Gap Leaf & Primary Log (0.2)
			Gap Leaf & Gap Log (0.1)
			Gap Leaf & Edge Log (0.2)
			Gap Leaf & Primary Tree (0.1)
			Gap Leaf & Gap Tree (0.2)
			Gap Leaf & Edge Tree (0.2)

_____

TABLE 5. Sorenson's qualitative index of similarity between sites one and two for all habitat combinations. Index values very from zero for no similarity to one for no differences. Edge Leaf data are not included since no mosses were observed there.

_____

Habitat	Sorenson's Index of similarity
Primary Log	0.3
Gap Log	0.4
Edge Log	0.3
Primary Tree	0.3
Gap Tree	0.4
Edge Tree	0.8
Primary Leaf	0.4
Gap Leaf	0.0
Edge Leaf	-

APPENDIX A. Morphological species of mosses in primary, gap and edge habitats for two sites on different substrates. Photo-catalogue on file at Estación Biológica Monteverde, Costa Rica. Mosses were collected at the Estación in 2001.

Species Name (Corresponds to photo label)   Habitat, Substrate, and Site 1 or 2

Species Name	PL 1	PL 2	GL 1	GL 2	EL 1	EL 2	PT1	PT 2	GT1	GT2	ET 1	ET 2	PLe1	PLe2	GLe1	GLe2	ELe1	ELe2
Branch cut, semi-curl; 3-20.JPG				1	1	1												
Cat feather tall midr; 3-12. JPG		1			1		1	1		1	1	1						
Cat Tail; Seeds open; 4-7. JPG					1							1						
Cat/flat; wheat; 4-4.JPG					1	1					1	1						
Cat/frst; tiny, needle; 3-11.JPG				1			1			1	1	1						
Cat; feathery; 2-8.JPG		1	1	1		1												
Cat; like cedar; 4-6.JPG						1												
Cat; like cedar; furry; 4-8.JPG																		
Cat; loose hair 2-11.JPG		1	1		1	1	1		1									
cat; nofuzz;tall; 2-9.JPG			1					1		1		1						
Cat; normal 2-12.JPG		1	1		1	1						1						
cat; feathery; base white; 4-5.JPG						1												
cat; lt green; seedling 2-10.JPG		1	1	1		1			1									
Cat; tiny; norm; 3-5.JPG													1	1			1	
Cat; tiny; tall; midrib; 3-6.JPG							1		1									
cedar; no midrib; 3-24.JPG										1								
fern, large, seeds; 2-6.JPG	1					1	1					1						
fern, large; f1; 2-16.JPG		1	1	1	1		1	1	1	1	1	1						
fern; mde; f4; 2-3.JPG	1	1	1															
fern; small; f1; 2-15.JPG			1															
fern; cedarlike; 3-15.JPG		1				1				1	1	1						
fern; f0; 2-14;.JPG		1				1					1	1						
fern; large; cedar; mdrib; 3-10.JPG							1	1	1	1								
fern; large; cedarlike; 4-3.JPG					1						1	1						
fern; large; f1; 3-16.JPG		1			1			1		1	1	1						
fern; large; furry; 3-9.JPG								1	1	1								
fern; like cedar; 3-17.JPG								1										
fern; med; f5; 2-2.JPG	1																	
fern; rubber; 3-22.JPG				1														
fern; small; f2; 2-4.JPG	1																	

	PL1	PL2	GL1	GL2	EL1	EL2	PT1	PT2	GT1	GT2	ET1	ET2	PLe1	PLe2	GLe1	GLe2	ELe1	ELe2
flt unbranched; 1-12	1																	
flt, no branch nomidrib 1-13	1				1	1									1			
flt, small/smooth branch 1-16	1							1										
flt/Cat rag&longleaf; 3-1.JPG	1	1		1	1	1		1	1						1			
flt/Cat; wheat; 3-21.JPG				1							1							
flt; hands; 3-7.JPG								1										
flt; no midrib; shiney; 3-8.JPG		1		1	1		1		1	1	1	1		1			1	
flt; rubber; tiny leaf; 3-23.JPG										1								
flt; runner; midrib 1-17	1	1		1						1								
flt; small, med rag 1-15	1	1																
flt; small; rag 1-14	1	1	1									1						
flt; small; super-rag; 2-17.JPG		1	1				1											
Fluffy 3-3.JPG										1		1	1	1	1			
frost; very rag 2-13.JPG		1	1	1				1										
frost; very rag; 3-4.JPG		1			1	1			1	1	1	1	1					
frst tiny 1-8	1						1											
frst; vry rag; trail 1-20	1				1	1	1		1	1	1	1						
frst; supertiny; 2-18;.JPG			1															
Lanyard normal; 2-20.JPG			1	1									1					
Lanyard; shiney, hooked 2-19.JPG			1	1	1	1						1						
Pretty UNK; 3-13.JPG							1	1		1	1	1						
Scribble; 3-2.JPG																1		
Sky moss 1-9	1							1					1					
Sky Moss 2; 3-14.JPG																1		
Sky Moss cat tail; 3-19.JPG								1										
Sky Moss tiny fuzz; 3-18.JPG																		

Cat = cat tail; long stalks with leaves

f0-f5: little to very ragged

feather = feather like texture

flt = flat form

frst = shape appears like frost

lt = light color

midr = midrib on leaf

rag = ragged texture

rubber = rubbery texture/feel

Sky moss = very elongated; much space between branches

P = primary forest

G = Primary forest gap

E = Forest - pasture edge

L = rotting log

T = Tree trunk

Le = Leaf