The Lepidoptera Diversity of a Lower Montane Cloud Forest in Costa Rica

Sarah Rathbone
Cloudbridge Nature Reserve
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Introduction:

Today, ecosystems worldwide are threatened by an encroaching anthropogenic presence. Deforestation, habitat degradation, and climate change are the three most potent dangers destroying our world's vast biodiversity. Although these threats are present in all ecosystems, tropical forests are known to possess the highest concentration of species in the world, and, therefore, these equatorial ecotones require the most immediate conservation action (Didham *et al*. 1996).

Global climate change is having a dramatic effect on many abiotic environmental factors, including: temperature, humidity, wind patterns, and rainfall. Due to their high elevation and delicately balanced abiotic conditions, tropical cloud forests are perhaps the most threatened ecosystem today. Cloud forest species that require specific temperatures and humidity to survive are forced to migrate to higher elevations, thereby reducing their effective habitat range. Not only is the cloud forest ecosystem rapidly shrinking due to the effect of indirect climate change, but it is also continually threatened by direct anthropogenic disturbances, such as deforestation and contamination.

Butterflies (Family Lepidoptera) are essential pollinators of any ecosystem, and are therefore, crucial components of a long-term forest restoration project. The purpose of this study is to comprehensively document the species diversity of Lepidoptera present in the Cloudbridge Nature Reserve. The data will provide a baseline survey of the Lepidopteran species currently represented in the reserve, so that changes in butterfly demographics due to indirect and direct anthropogenic influences can be monitored over time.

Methods:

The study was conducted from early March to late July in 2007, spanning both the dry and rainy seasons in Costa Rica. A total of eleven collecting sites were selected based on their accessibility, differing elevation, and habitat type. The elevation extremes examined for the study ranged from 1480 meters to 1734 meters. Each study site covered an elevation range of approximately 10 meters and was separated from adjacent sites by at least 5 meters in elevation. For this study, three different habitat types were surveyed, including: inhabited areas, pasture/natural regrowth areas, and secondary forest. Data could not be collected in the primary forest habitat type due to a significantly decreased lepidopteran density and the ineffectiveness of the sweep net methodology employed at other sites.

At each site, butterfly specimens were collected in the morning hours using a sweep net. Each specimen was transferred to a collecting jar and data regarding the time

of capture, the location, the specific elevation within the study site, its approximate height off the ground, and the activity of the butterfly prior to capture was recorded. Later, this data was used to ensure the accuracy of species identification, as well as to thoroughly document new locations and behavior of rare lepidopteran species.

In order to accurately identify the species, every specimen collected was placed in the freezer for 3 to 5 minutes, depending on their size. The freezing process lowered their metabolism and induced them into a temporary sedative state. Once removed from the freezer, the specimens were placed on a white cardboard background and photographed against a millimeter ruler on both their dorsal and ventral sides. Later these photographs were used to identify each specimen based on their dorsal and ventral markings, venation, wing length, and the habitat and activity data noted at capture.

Materials:

- Sweep net
- Bamboo pole
- Holding containers
- Field notebook
- Field guide (DeVries)
- Pencil
- White cardboard
- Blunt tweezers (2)
- Camera
- Freezer
- Ruler (mm)

Results/Discussion:

Initially, this study was aimed at examining the lepidopteran diversity at varying elevations and habitat types throughout the Cloudbridge Nature Reserve. However, the difficulty of the terrain and the inaccessibility of certain locations for effective butterfly capture made this objective unattainable. Therefore, the results presented in this section are representative of a preliminary study on the overall lepidopteran diversity present in the reserve.

Over the course of this study, a total of 218 specimens were captured and processed. This total was comprised of 61 different species in 14 lepidopteran subfamilies (figure 1). This species richness was representative of 4 main lepidopteran families: Hesperidae, Nymphalidae, Pieridae, and Riodinidae (figure 2). For unknown reasons, no specimens from the fifth family (Papilionidae), which should be present in the cloudforest ecotone, were collected. In order to determine the effectiveness of the study and its duration, I looked at the number of species and subfamilies caught over time. The graph depicting the number of subfamilies over time clearly indicates that after 14 field days, we reached a distinct plateau (figure 3). However, the graph depicting the number of species over time doesn't seem to exhibit the same trend (figure 4). Although, the rate at which new species are caught dwindles with each consecutive field day, it never develops into a distinct plateau. This indicates that more field days invested

collecting butterfly specimens could yield even more species than those captured during this study, thereby revealing a more complete picture of the total lepidopteran biodiversity in the reserve.

Another result that supports the continuation of this study is the overall percentages of species caught. Based on species descriptions of their preferred elevation and habitat type in both volume 1 and 2 of the DeVries lepidopteran field guide, a total of 236 Nymphalidae species, 34 Pieridae species, and 137 Riodinidae species should be present in the reserve (table 1). As can be seen in the figure 2 and table 1, the number of species within each of these families caught for this study is a mere fraction of the above totals. This indicates that the study has barely scratched the surface of the lepidopteran biodiversity that Cloudbridge contains, and further efforts should be made to better determine the complete picture of species richness.

This study revealed some interesting findings pertaining to aberrant and rare lepidopteran species. Although an expert must still authenticate these identifications, I believe that a total of four extremely rare butterfly species were captured during this study. These rare species include: Memphis titan peralta, Anthanassa otanes sopolis, Tegosa nigrella, and Lieinix viridifascia. What makes the capture of these specimens so incredible is that they are all considered endemic to volcanic soils and have previously been known to occur only in very specific locations in Costa Rica, none of which are within close proximity to the reserve. Additionally, all four species are significantly above their normal elevation range and habitat type. These two facts combined make their presence in the reserve a very significant finding with the potential for future and more in depth study.

This study is a preliminary attempt to determine the lepidopteran biodiversity in the Cloudbridge Nature Reserve. Not only should more research on the adult butterfly species richness be conducted based on the findings of this study, but also, more work is required on the larval and dormant life stages of lepidopterans in the cloudforest. The cloudforest is one of the most threatened ecosystems in the natural world, both directly and indirectly affected by human encroachment. Research on this quickly disappearing ecosystem is crucial to its conservation and restoration.

Tables and Figures:

Table 1. Species Percentages Caught

Families	Number of Species Caught	Total Number of Species in the Area	Percentage Caught
Nymphalidae	41	236	17%
Pieridae	8	34	24%
Riodinidae	4	137	3%

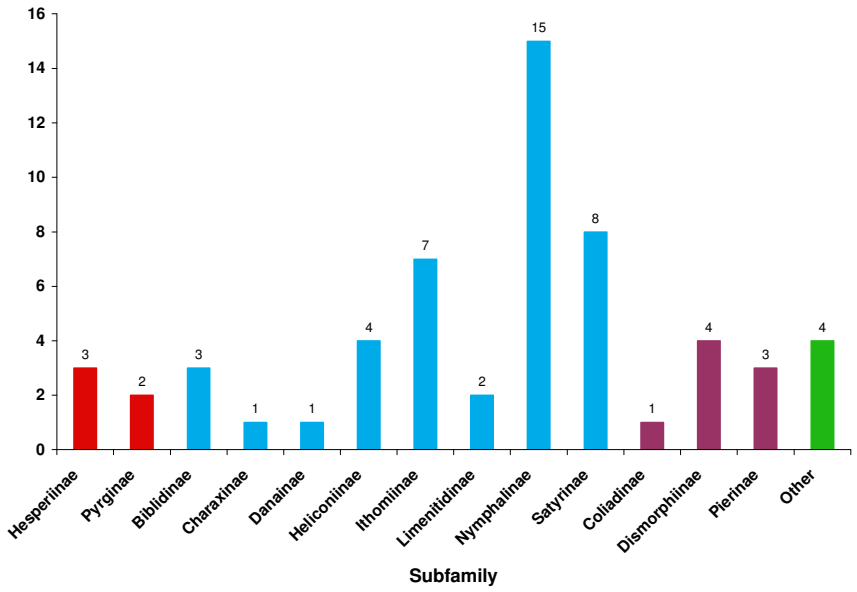

Figure 1. Species Richness by Subfamily. Color coded based on family groupings: red is Hesperidae, blue is Nymphalidae, purple is Pieridae, and green is Riodinidae.

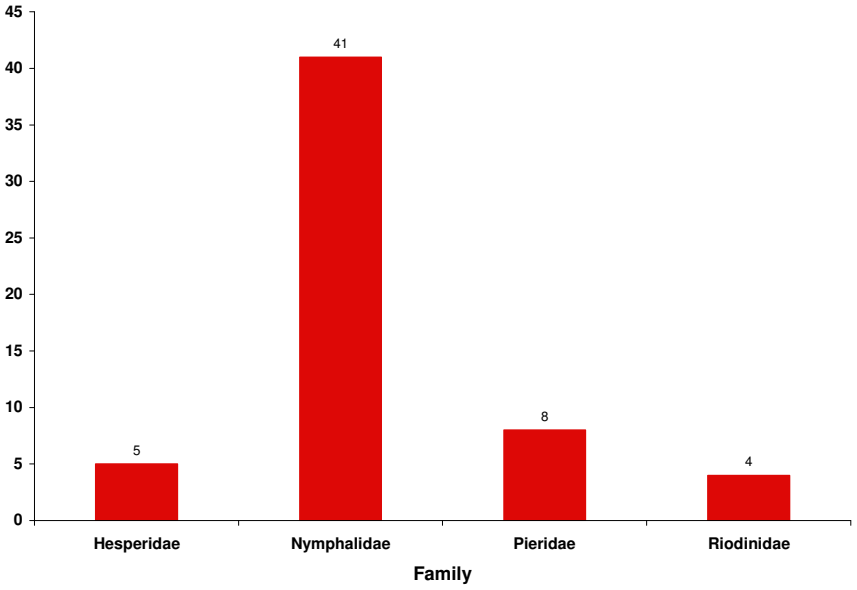

Figure 2. Species Richness by Family.

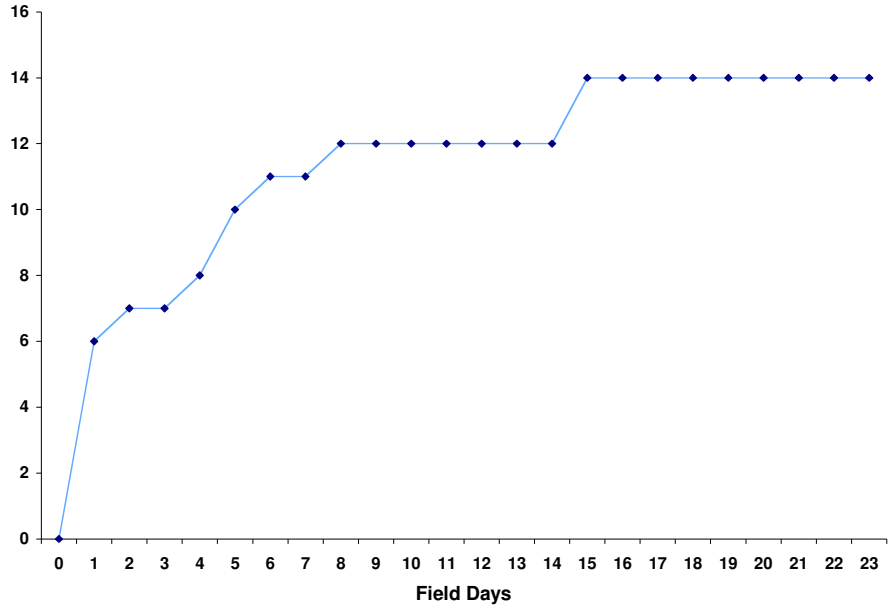

Figure 3. Cumulative Number of Subfamilies Collected Over Time.

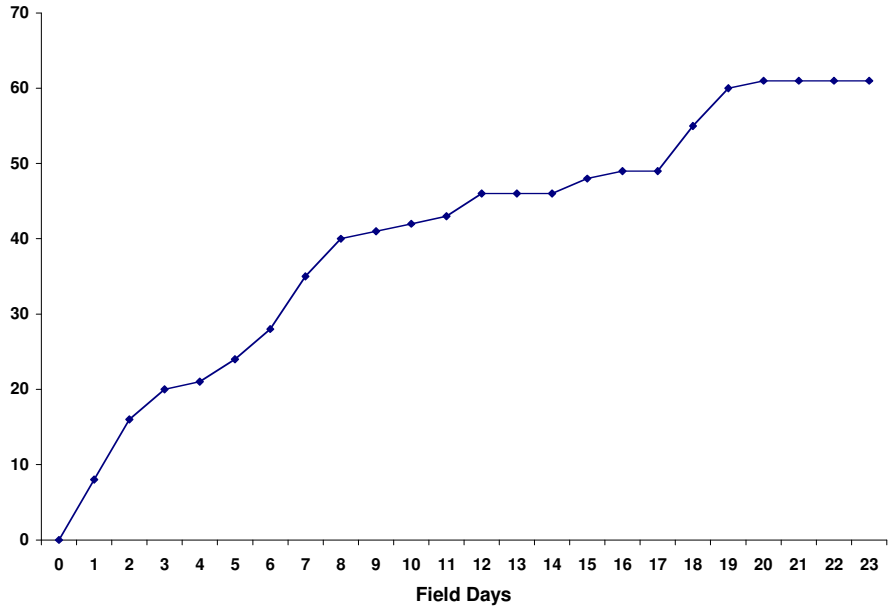

Figure 4. Cumulative Number of Species Caught Over Time.

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