Wild Cacao Survey and Mapping in Finca Las Piedras, Madre de Díos

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Abstract

Identifying wild cacao tree is important for domestication and gene preservation. The search was carried out at Finca las Piedras from July to August 2017. At the end of August, I found 18 individuals of T.cacao and 3 of T.bicolor. At first look, the 18 individuals of T.cacao seem to be distributed in three main clumps. However, more searches should be carried out before reaching a conclusion. In the near future, phenology and agronomy trait projects could be carry out with the found cacao trees.

Introduction

Biodiversity in the Madres de Díos region of Peru is suffering from gold mining and deforestation. Mining is deforesting Madre de Díos faster than any other activity. Twenty percent of Peru's bullion is mined illegally (Hill, 2016), using techniques that destroy forests and pollute local rivers. It has become so widespread that it threatens the Tambopata National Reserve and Manu National Park, which is the largest national park in Peru. Deforestation is also caused by agricultural activities, which occur mainly in form of papaya and banana monocultures in this region.

"Chuncho" is a native shade cacao tree of Madre de Díos which can be grown in a multi-canopy system. Investigating the natural habitat of wild cacao could help researchers understand more about this native cacao cultivar in order to recreate optimum conditions for domestication. It could be useful for promoting the growth of cacao in agroforestry systems, which will help to decrease the deforestation rate by providing people an economic alternative to papaya monocultures.

In addition, the majority of the material in cacao germplasm banks was collected prior to the 1940s (Dapeng & Motilal, 2016). While there are more than 5,000 different varieties of cacao currently in collections around the world, most of the breeding lines derived from a small number of types. There is still a large amount of genetic diversity that exists in the wild, especially in the center of origin of this species: the Western Amazon (Dapeng & Motilal, 2016). By inventorying wild cacao trees, a database for further research about the available gene pool could be established. This data would be helpful to set up a monitoring scheme with our cacao trees to identify desirable traits for yield or disease resistance which are native to this region.

Research objectives:

1. To identify and to locate the wild cacao trees in order to establish a monitoring record
2. To investigate the natural habitat of wild cacao

Research questions:

Objective 1:

1. Is there any special characteristic which can be used to more easily identify wild cocoa trees (shape of leaves and tree trunk, smell)?
2. Where can cacao trees likely can be found?
3. How are the wild cacao trees distributed?

Objective 2:
1. Does basal area have effect on cacao tree growth (tree height and DBH)?
2. Does light under tree canopies affect cacao tree growth?
3. Is there any correlation between basal area and light with tree growth?

Methods

Study site

The inventory was carried at Finca Las Piedras, a property of the Alliance for a Sustainable Amazon near Monterrey, Madre De Díos, Peru (-12.226, -69.111). The property is 54 hectares large and includes selectively logged terra firme forest and abandoned agricultural fields.

Data collection

This inventory was combined with a carbon estimation project in order to efficiently utilize resources such as the GPS and human effort. Modified Gentry plots are a standardized rapid inventory method. They have proven to be the most efficient method to estimate above-ground biomass and tree diversity (< 10% CV of Hill number) across all forest types (Baraloto, et al, 2012). Ten Gentry plots were established. Ten randomized points across the property were created using QGIS. From each random point, researchers walked south for 10 meters and expanded west and east 5 meters each to create a modified Gentry plot of 0.05 ha.

After searching six Gentry plots, only two cacao trees had been found. Therefore, I decided to expand the searching area to different trails in the property. The first search was along the main trail used for the Brazil nut inventory. The second search was along the northern border of the property which runs from East to West. The third search was along the southern border of the property, also running East-West. The last search was of the area between the main trail and the northern border. Based on research, the majority of wild cacao will form a "clump", i.e. several trunks at different development stages and overlapping generations at one growing site (Dapeng & Motilal, 2016). Therefore, at the location where one cacao tree was found, I thoroughly searched the area around every found tree to find other nearby.

Tree growth was quantified by measuring tree height and diameter at breast height (DBH). Due to lack of light, wild cacao trees can grow very high in the rainforest which makes it difficult to measure tree height with tape measures or range finders. Therefore, tree height was estimated by the researcher. DBH is a standard method of measuring the diameter of the trunk of a standing tree. Tree trunk is measured at the adult's breast height. In this study, the DBH was measured at 1.4 meters height using a tape measure.
To quantifying light, we took a photo of the tree's canopy and estimated the percentage of light in the photo relative to dark vegetation.

Results

Objective 1:

There were two different species of wild cacao found on the property, which are *Theobroma cacao* and *Theobroma bicolor.* We found 18 individuals of *T. cacao* and 3 of *T. bicolor* (Figure 1). There are more cacao trees shown in the map as we excluded trees found outside the property borders.

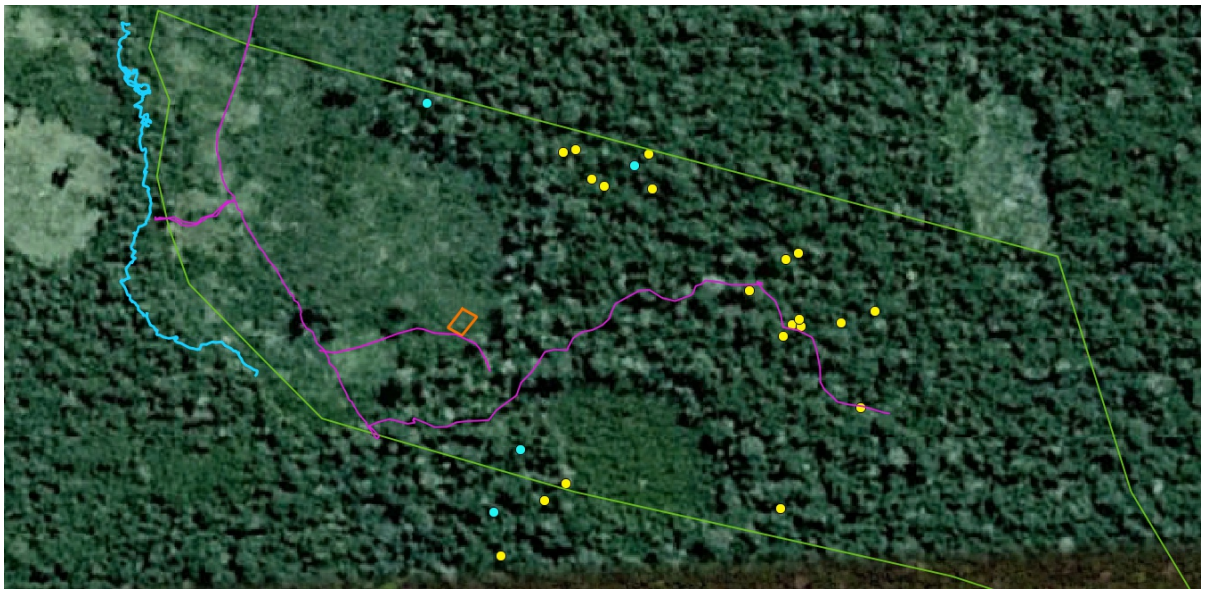

Figure 1: Location of *Theobroma cacao* (yellow) and *Thebroma bicolor* (blue) found in July and August 2017 at Finca las Piedras (map created using QGIS).

Identification of wild cacao

Identifying wild cacao in the dry season in Peru is difficult because there are no special characteristics to distinguish the cacao trees from other plants. In addition, it is time-consuming for one or two people to cover the whole property of 54 hectares. It would be more efficient if everyone in an organization knew how to identify cacao while they are doing their projects in different parts of the forest. Therefore, it is useful to have a comprehensive guide for identifying cacao.

Step 1: Look for pods and flowers on trunk and branches

Pods and flowers (even from the last season) are the easiest way to identify a cacao tree. In the dry season from June to the end of August, most of the pods found on cacao trees are dead pods of black color (Figure 2a). *T. cacao* ("chuncho") starts to bear fruit from December to January. The new pods will have a bright yellow color (Figure 2b)

T. cacao flowers right after the first rain in the forest. Their flowers a have white color and can be found on the trunk and branches (Figure 2c).

Figure 2: Characteristics of a cacao tree: (a) Measuring a dead cacao pod, (b) fresh cacao pods and (c) new white cacao flowers

Step 2: Look at the trunk

Most of the cacao trees found in dense shade have black or dark-colored bark. The bark will be lighter and whiter where there is less shade. When peeling off the outer bark, the first color that should be seen is red (Figure 3). The more the tree is shaded, the darker the red color is. After the red part, the inner tree wood is white. The wood of cacao trees does not have any smell.

Step 3: Look at the canopy

Wild cacao's canopy is not dense. It also does not form any specific shape or layers. The canopy is usually formed by two to three main branches (Figure 4a).

Cacao's leaves are alternative and not uniform in size (Figure 4b). Leaves are 10-30 cm in length. Most importantly, the Theobroma does not produce milky sap. If the plant has milky sap, it is definitely not cacao.

Objective 2:

Unfortunately, objective 2 could not be met for time constrains.

Discussion

At first look, all the *T. cacao* trees we have found are distributed in three main clumps (Figure 1). However, to confirm that the *T. cacao* in the property are distributed in clumps, we need to carry out more searches in the north-east and south-east of the property. By contrast, there were only three *T. bicolor* found. Therefore, the sample is not big enough to conclude how they are distributed.

Recommendations

With all the cacao trees we found, and the ones found in the future, a phenology project could be established to monitor the flowering and fruiting time.

These trees could also be monitored every year to examine their agronomy traits such

Figure 3: Trunk characteristics of a cacao tree: Examples of the bar and flesh of cacao trees

Figure 4: Canopy characteristics of a cacao tree: (a) Canopy of a cacao tree and (b) Alternative cacao leaves

as yield, fruit size and disease resistance. Trees with good traits then could be used for collaboration projects with other organizations working on cacao germplasm such as Sustainable Perennial Crops Laboratory in Maryland, USA and the International Cocoa Genebank in Trinidad.

Due to time constrains, stand density around found cacao trees could not be accurately quantified. The stand density was only estimated. However, this was not accurate enough to run statistics and test the effect of stand density on tree growth. This and other subobjectives of objective 2 could be done in the future. I recommend setting up transects around cacao trees or cacao clumps.

Furthermore, it will be easier to identify cacao tree in the rainy season, so further studies could be carried out in the rainy season. It is also important to find more cacao, so we have a bigger and more presentable sample.

Conclusion

In the end of the project, we were successful in being able to identify wild cacao trees in the dry season. There are 18 individuals *T. cacao* and 3 of *T. bicolor* in our property. There should be more search efforts to find more cacao trees in order to draw conclusions about how cacao is distributed. However, we could use the trees found and their recorded data to establish other research projects such as phenology and agronomy trait examination.

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