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Sustainable use of the endemic wild silkworm (*Borocera cajani)* in the tapia woodland of Madagascar

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Abstract

Wild silk or landibe is important for the Malagasy culture, nutritional value, and household income. Human activities in the tapia woodland of Ambatofinandrahana led to a decline of the endemic silkworm *Borocera cajani*. Threats affecting the density of silk and habitat destruction were known, but little remediation took place. We did project for mass-rearing silkworm, restored habitat, and promoted local tourism for two years. The landibe density increased nineteen times, from 91 kg to 1692 kg, on project completion. Mass rearing production was successful and gave a fillip to sericulture with add-on benefits to the landscape. Promoting ecotourism led to conserving tapia woodland and cultural heritage of the region.

Key words: silkworm, mass production, tapia, sericulture, ecotourism

1. Introduction

The Malagasy bury their dead in shrouds of thick wild silk secreted by the wild silkworm *Borocera cajani*. The worm and silk products are called *landibe* in the vernacular, and it has been traded since c.1800 (Callet 1958). The natural habitat of this worm is the tapia tree (*Uapaca bojeri*). Therefore, its life cycle, habitat conservation, and framing techniques are matters of cultural importance.

Tapia woodland is rare ecosystem in Madagascar resilient to fire. Burning may increase silk production by controlling the population of parasitic ants, reducing entomopathogen, and stimulating the growth of new leaves for the tapia tree (Kull 2002). Conservation of the woodland are part of the main goal of the ten Community Based COBA and the association AMAFI (Green Forest Development) for the tapia woodland in Ambatofinandrahana. However, human pressure from selective wood needs, over-harvesting, and bushfire are the main threats to the tapia woodland.

National statistics of silk production are a pointer to a significant variation from year to year, reaching 10t to 43t for the whole island in 1900 and 2009 respectively. (Corporation 2009). Our observations in the fields around Ambatofinandrahana inform a drastic drop in production during the past decade. The silk-weaving cooperative in the region is threatened and might close if the community and policy are unable to expeditiously make amends. So, we inquired into habitat restoration and wild silkworm rearing aspects of sericulture.

2. Methods

The Tapia woodland cover 7,610 ha of district Ambatofinandrahana, characterized by several patches of variable size starting from 15 ha to 400 Ha. The two-year study began in early 2020.

Two tapia sites were identified for the project implementation: Andrahalana (347 ha) and Ambatomenaloha (342 ha). Some parts of the woodland for both sites are burned annually. Ambatomenaloha was lastly burned in 2019 and 2017 for Andrahalana. Eight cages were randomly installed, with eighty larvae for each cage. The success of mass rearing is based on the high number of eggs laid by each female. It was estimated to be in the range of 250-845 (Razafimanantsoa, Rajoelison et al. 2013). The release step for adults was realized just before the emergence period.

Tapia tree is highly dependent on mycorrhize to grow (Ramanankierana, Ducousso et al. 2007). Habitat restoration is important for the success of mass rearing. Nurseries were laid out for each COBA, and the production of 120,000 seedlings was set as a goal. Ambatomenaloha has been a large, reforested area since 2005. To protect the woodland, 30 km of firebreak was assigned to the local communities as an additional activity.

3. Results and discussion

The density of silkworms before the mass rearing was too weak to explain why the sericulture weakened year after year. For generation F1, it ought to be higher than found in this study (**Figure 2**). This could be a COVID-19 lockdown impact. The period of absence led to diminished data collection by the project personnel.

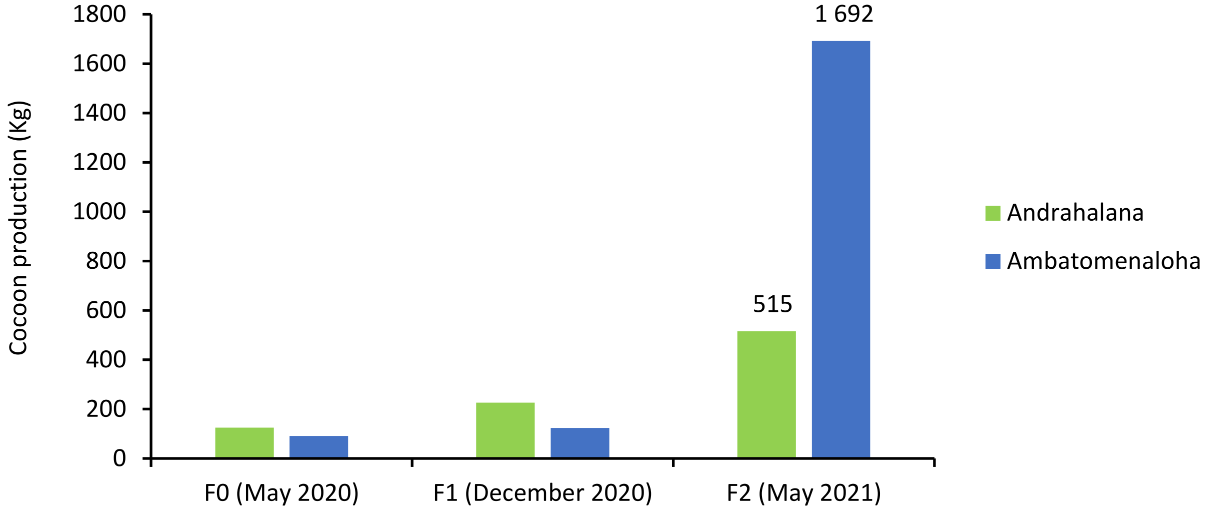

Figure 1. *Cocoon of the wild silkworm production Borocera cajani in the tapia woodland of Ambatofinandrahana*

The later yield was significantly increased from 91 kg to 1692 kg. The efficiency of these cages can be explained by three factors: fewer wild predators of the landibe viz., insects or birds, less disturbance from kids harvesting silk, and community awareness for habitat preservation.

Differences between the two sites can be explained by habitat quality and the fire history. With efforts from the COBA and AMAFI, these factors were controlled during the implementation of the cages. This method's success is well studied too by Mattoni, Longcore et al. (2003). These findings highlighted the importance of empirical experiments to respond to the community's needs and lack of education. Applied research must go beyond experimentation for knowledge generation (Abrami and Bernard 2006).

Figure 2. Weaver and students with local assistant near the breeding cage (Pic: A. Ravelomanana)

Eating insects is part of the Malagasy culture (Randrianandrasana and Berenbaum 2015). Chrysalides of the wild silkworm (*Borocera cajani)* were consumed for long as were the locust swarm (*Locusta migratoria)*. Consumption of wild cocoon remains competitive based on the rate of protein and availability compared to the locust (Table 1). This region has a 55% rate of children under five affected by chronic malnutrition (UNICEF 2021). The availability of this cocoon matches the lean season, so people should consume it. We estimated the entire tapia woodland could grow up to 37.6t. That production can ensure the minimum recommended protein needed for 506 602 women.

Table 1 Nutrition value of the leading edible insect in tapia woodland

Taxonomy Group	Edible species	Protein	Carbohydrate	Lipid	Calory (Kcal/100g)
Lepidoptera	*B. cajani*	60.50 ± 0.14	7.13 ± 0.30	25.55 ± 0.01	500.20
	Bombyx mori	48.93 ± 1.41	11.60 ± 1.64	30.02 ± 0.17	512.30
Coleoptera	*Encya sp.*	57.15 ± 0.29	17.51 ± 0.41	20.18 ± 0.07	480.18
Orthoptera	*Locusta migratoria*	69.66 ± 0.69	13.78 ± 0.84	6.85 ± 0.01	395.41
	Nomadacris septemfasciata	67.63 ± 0.41	12.45 ± 0.14	16.34 ± 0.24	467.38
Khi square test		Khi² = 279.455 P-value <0.001 ddl = 4	Khi² 56.388 P-value <0.001 ddl = 4	Khi²=317.329 P-value <0.001 ddl = 4	Khi²=839.511 P-value <0.001 ddl = 4

- Habitat restoration and ecotourism

The COBAs supported by AMAFI reached the replantation of 121525 tapia seedlings. These new trees cover up to 172 ha of the fragmented habitat. More than 66 km of firebreaks were built in and outside the Tapia woodland. These efforts emphasized the success of the mass-rearing approach and eenvironmental enrichment can improve the well-being of wild animals (Sheperd and Debinski 2005). At first sight, according to Hoffmann, Geiger et al. (2012), and Alvarado, Buisson et al. (2014), high fire frequency negatively impacts the Tapia tree, but silk production depends on the fire regime.

Cotton became a substitute to the expensive silk yarn. The current rate of silk production could incentivize sericulture. The cultural landscape of Malagasy highlands are shaped by "Lamba Landy" or silk fabrics (Green 2009). The silk production could be ten times higher if the woodland is well managed to produce up to 37.6t silk. This production is not far from the national production of 42t in 2009 (Corporation 2009). Obviously, the economic value is directly exploitable for the pesants and COBA as well. Besides, blending the natural and cultural environment is part of the strong value of ecotourism. Visiting Magnanerie is a tourist activity to develop regional ecotourism and save waivers activities. In northern Madagascar, the NGO SEPALI is good example of sustainable ecotourism. They produce 10,000 insect cocoons annually and earn an income of 125-275 USD (Craig, Weber et al. 2012). Saving the silkworm allows visitors to appreciate the unique natural landscape and preserve the age-old cultural heritage.

Figure 3. Cocoon produced by the VOI from Ambatomenaloha (Pic, A. Ravelomanana)

4. Acknowledgments

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