Ecology and conservation status of the endangered *Dracaena ombet* tree species in the degraded Arid Afromontane of Eastern Africa in Ethiopia

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1. Introduction

Dracaena ombet Kotschy and Peyr. is a globally Endangered tree species according to IUCN Red List, based on an assessment the criteria of v. 2.3 (IUCN, 1994), and it is known as a flagship species for north-east African arid Afromontane ecoregions. Its sparse populations now only occur in a very few mountains of Egypt, Sudan, Somaliland, Djibouti, Ethiopia and Eritrea (Ghazali et al., 2008). In Egypt and Sudan, it was reported that more than 65% populations of the species lost due to different combined factors including cutting, fodder, drought and climate change (Kamel et al., 2014).

In Ethiopia, the endangered D.ombet species is only sparsely found in the Desa'a protected forest in northern Ethiopia, bordering to Eretria (Zenebe, 1999; Ermias, 2011). The Desa'a forest (13^0 56' N and 39^0 51' E) is one of the dry Afromontane biodiversity hotspots of Eastern Africa. It is also one of globally registered biodiversity hotspot areas by Conservation International and now an effort to register it to UNESCO heritage list for its long contribution for conservation species and providing different ecosystem services **(Fig 1)** and ecosystem wellbeing (Ermias, 2011). The forest covers an area of 120,000 ha and a home for different plant and animal species, including many endemic species to Ethiopia. It is also the only habitat in Ethiopia for a globally endangered species such as *Dracaena ombet* tree and *Emberiza cineracea* bird. Despite its various ecological and conservational values, it is now under heavy pressure from human activity like illegal cutting, free grazing, settlement, agricultural expansion and climate change. As a consequence, it is one of the most degraded biodiversity hotspots of the world (Ermias, 2011; Tesfay et al., 2017).

The *D.ombet* found in the Desa'a degraded forest is highly exploited for different uses such as fodder, hive, utensil, farm equipment, chair, bed and different materials used at home. Hence, the species now seems heading to extinction due to over-exploitation, habitat degradation and fragmentation in Ethiopia. To data, no detail data or information about the tree species in the Desa'a forest, northern Ethiopia. Therefore, this project was developed to fill these gaps with following specific objectives:-

- To assess the current ecology, conservation threats and future interventions of *D.ombet* in Ethiopia by collecting data from local community and field survey
- Prepare a GIS-map for the *D.ombet* distribution within the study Desa'a forest using data from the local community and field survey
- To strength capacity of local community and other relevant stakeholders in conservation of *D.ombet* through different awareness training activities
- Prepare a short and long term conservation action plans for *D.ombet* tree species in Ethiopia
- To contribute for a regional (east-north African) development of *D.ombet* conservation actions; and to the Global Strategy for Plant Conservation (GSPC) for updating status of the tree in the IUCN Red List

Fig 1. Difference ecosystem services of the Desa'a forest for the local community including a) different fruits; b) conservation of endangered plants; c) conservation of wildlife; and d) source of fodder

2. Methodology

Our data collection methods followed robust scientific approaches. Before conducting a fieldwork, we met with the local community of the study area to arrange with them the appropriate community introduction and present our project. We then improved our methodologies of the project depending on the local communities' feedback and nature of the study area. Two key informants from the local community (who have a good knowledge about the tree species) were also selected with full participation of the locals to join the four team members of the project. The key informants helped us in determining geographical distribution of the tree in the study area; share their indigenous knowledge about the species; and to organize meetings, discussion and interviews with the local community. All the team members then participated in data collection from the local community and field survey **(Fig 2).**

Fig 2. Project team members

We collated data on the tree's conservation status from the local community of two nearby villages (Kelisha and Adi-Feham) of the Desa'a forest using focus group discussion and individual interview **(Fig 3 and 4)**. The local communities were asked to give their comments on the uses of the species**,** its conservation threats and future interventions using questionnaires **(Appendix 1)**. In addition, we collected data

related to the tree's density, diameter at breast height (DBH), height, regeneration, health status and conservation threats (have a look data collection formant in **Appendix 2**) from the randomly established 12 sample plots (20m x 20m) inside of the study forest (**Fig 5**). Each measured tree was also geographically linked using GPS for determining distribution ranges of the species. Besides, from each sample plot, all the woody species found in association with the study species were identified and counted. These collected were scientifically analysed for development of a document that includes the species current status, threats and future conservation interventions in Ethiopia by involving local community. The document was also used to raise awareness training for stakeholders including local community, students, experts and other stakeholders.

Fig 3. Data collection using focal group discussion of the local community on *Dracaena ombet* conservation status in the Desa'a forest, northern Ethiopia

Fig 4. Data collection using individual interview of the local community on *Dracaena ombet* conservation status in the Desa'a forest, northern Ethiopia

Fig 5. Collection of different data related to *Dracaena ombet* from the field survey

3. Key Results

3.1 Conservation status and threats of *D. ombet*

Our data analysis of the collected data showed that the endangered *D. ombet* has low density (225 trees per ha), and its prevailing populations are unstable with lack of regeneration and small diameter trees (DBH<12 cm)**.** For example, no newly regenerates of the species were counted per ha basis which implies that it is now suffering to continue its existence without conservation interventions. Its dominant populations (approximately 85%) have also a DBH ranges between of 15-30 cm with an average height in the ranges of 3-9.5 m. As a result, the species currently suffers in natural regeneration and the prevailing populations may vanish in near future (**Fig 6**).

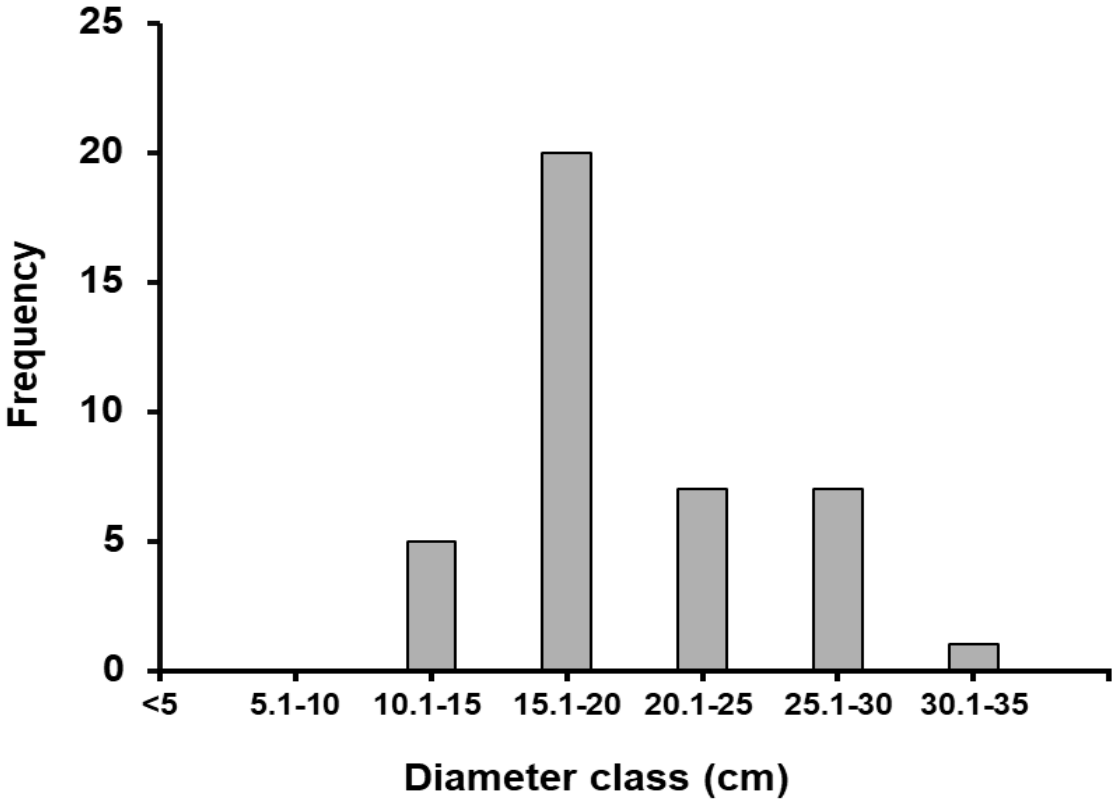

Fig 6. Diameter distribution of *Dracaena ombet* trees in the Desa'a forest, northern Ethiopia

According to the local community responses and field observations (**Fig 7**), the main conservation threats of the species were listed in **Table 1**. One of the participants of the focus group discussion said *"the species is selectively cut by locals for making their bee hives and sell it for the same purposes"* during our discussion. For example, in ha basis, we counted about 50 trees were totally cut down, 20 were defoliated and 18 were debarked**.** These are indicators that the species is under pressure of deforestation and degradation by the local community, and as the consequence it is in a rapid extinction.

Table 1. Key conservation threats for the endangered *Dracaena ombet* tree species in the Desa'a forest

S/no	Conservation threats
1	Illegal cutting
2	Defoliated leaves of the species for rope making
3	Invaded by aggressive shrubs such as Aloe berhana
4	Debarking
5	Lack of community awareness on the conservation of the species
6	Free grazing causing low regeneration
7	Climate change e.g drought
8	Disputes and conflicts between Afar and Tigray communities where the species is found
9	Lack of law enforcement
10	Settlement inside of the forest
11	Lack of sustainable management plan of the Desa'a forest
12	Lack of governmental follow-up
13	Fire in side of the forest

Fig 7. Key conservation threats of *Dracaena ombet* in the Desa'a forest, northern Ethiopia

During our discussion with the local community, we raised questions on what future conservation interventions will need to introduce for conservation of the endangered species in the Desa'a forest. According to the responses of the locals, the key conservation interventions for species were listed as:

- Stop/reduce illegal cutting
- Give continues awareness raising training for stakeholders on the species and its habitat
- Protecting the remaining populations of the tree using interventions such as exclosures, soil water conservation and others
- Reducing debarking of the truck of the species
- Reducing invasion of shrubs of species such as Aloe berhana
- Reducing over grazing of livestock using different interventions
- Solving the disputes and conflicts between the Afar and the Tigray communities

- Introduce a strong law enforcement and follow-up mechanisms
- Developing sustainable management plan for the forest
- Support the local community to improve their livelihoods using different interventions
- Introduce NGOs and other interested partners on conservation of the species and its habitat
- Increase number of guards with affordable salary to tight protection of the Desa'a forest where the species is found
- Relocate the settlement of the people inside of the forest

3.2 Distribution of *D. ombet* in the Desa'a forest

The endangered *D. ombet* was mapped to understand its distribution and associated woody species inside of the Desa'a forest. The species is not found throughout the Desa'a forest altitudinal ranges but it is mainly confined in altitudinal ranges of 1600-1900 m.a.s.l in small patch sites, having a stony and eroded soil types found both in Tigray and Afar regional states of northern Ethiopia **(Fig 8).** The main woody species found along with the tree species were *Cadia purpurea* (36%), *Shekoribae* (local name, 26%), *Acacia etbaica* (17%) and *Dodonea viscosa* (10%).

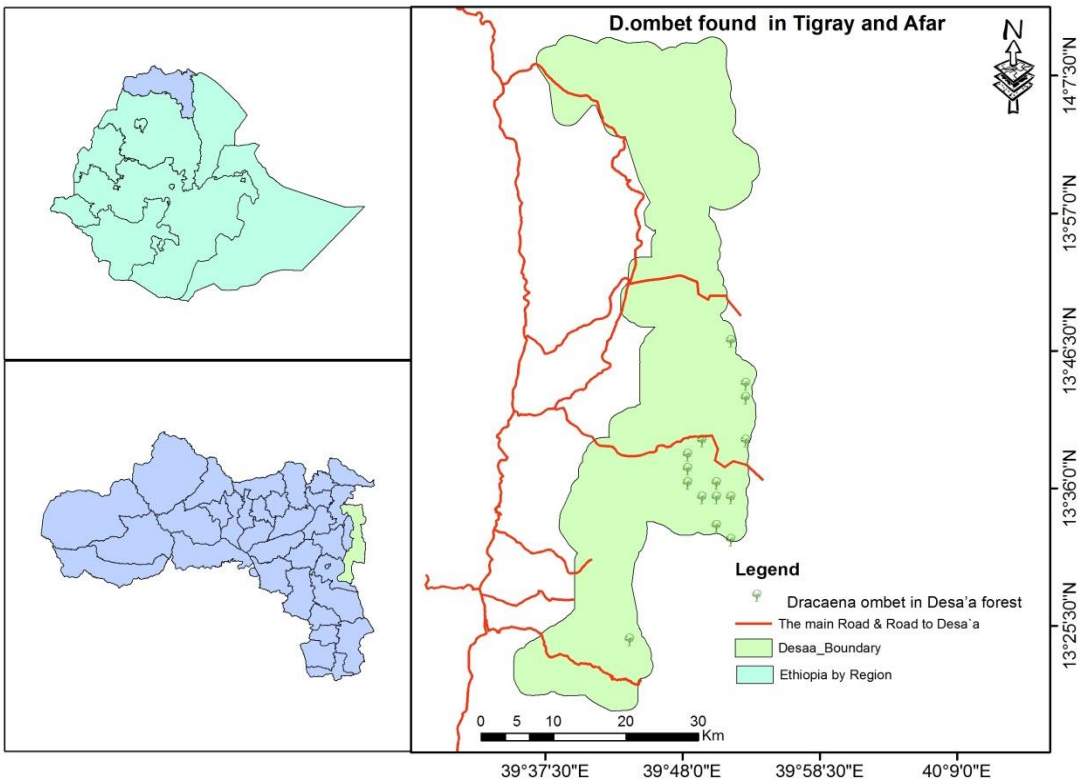

Fig 8. Distribution of the endangered *Dracaena ombet* tree species within the Desa'a forest

3.3 Awareness raising activities

We used different approaches to disseminate and communicate this project results for raising awareness activities on the endangered *D. ombet* tree species in Ethiopia. We provided training for the local community, experts, policy makers, colleagues and students on the species current conservation status, threats and future interventions (**Fig 9, 10 and 11**). Besides, results of the project were presented at national conference and were also disseminated by Medias such as Facebook, Research Gates and Academia.

Fig 9. Train local community on conservation status, threats and future interventions of *D. ombet* tree in Desa'a forest

Fig 10. Training for experts and policy makers on conservation status, threats and future interventions of *D. ombet* tree in Desa'a forest

Fig 11. Awareness raising training for colleagues and students on conservation status, threats and future interventions of *D. ombet* in Ethiopia

4. Conclusion

The following conclusions and recommendations have been given from the project:-

- Density of the endangered *Dracaena ombet* in Ethiopia is low
- The existing populations of *D. ombet* are unstable, and mainly are old-trees and unable to produce viable seed for its regeneration
- The prevailing mature populations of the species may vanish in near future due the local community interferences such as cutting, debarking and defoliation
- *D. ombet* is suffering in natural regeneration, no single regenerates and saplings (DBH<12 cm) found across the ranges of the species in the Desa'a forest
- *D. ombet* is confined in small patches within the Desa'a forest that have altitudinal ranges in between1600-1900 m.a.s.l
- The major conservation threats for *D. ombet* in the Desa'a forest are illegal cutting, debarking of trunk, defoliate of leaves, invaded by aggressive shrubs, grazing and lack of community awareness on its conservation
- For ensuring future conservation of *D. ombet* in Ethiopia, stakeholders (governmental, non-governmental and other partners) should jointly work on rising awareness trainings for stakeholders on conservation of the species to halt/reduce illegal cutting, debarking, defoliation
- Development of sustainable conservation interventions jointly with local community should be developed for conservation of *D. ombet* in Ethiopia
- The ecological and conservation status results of this project on *D. ombet* will add to the existing data of the east-north African region for updating the current status of the species on IUCN Red List

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Appendixes

Appendix 1. Data collection format for focus group discussion and individual interview of the local community

1. In the last five years populations of D.ombet

a. Increase b. decrease c. constant d. I don't know

2. List uses of D.ombet in your locality (list all the factors according their importance)

3. List currently threatening factors for D.ombet tree species (list all the factors according their importance)

4. What conservation activities have already been implemented in your area by you, NGO, community, government or others for D.ombet?

5. What do you suggest (including conservation activities) for future regeneration, conservation and to increases populations of D.ombet?

6. What type of research do you suggest in your area for better conservation of the D.ombet tree species?

Appendix 2. Data collection from Dracaena ombet sample plots (field survey) inside of the Desa'a forest, northern Ethiopia

1. General site and plot information

   Plot number _____

   Date _____

   Site name_____

   Village/tabia name _____

   woreda_____

   Plot center: Lat_____ Long_____ Elevation_____

2. Land use type 1. Forest 2. Enclosure 3. Grazing land 4. Settlement 5. Cultivated land 6. Open shrub land
3. Forest type 1. Dense (canopy cover >40%) 2. Open forest (canopy cover 10-40%) 3. Pasture land (canopy cover <10%) 4. Bare land (very little vegetation without trees)
4. Incidences in the plot
   I. Fire
   II. Grazing/browsing
   III. Illegal cutting
   IV. Presence of scar of tapping on the trees
   V. Erosion
   VI. Others, specify _____
5. Total dead trees in the plot
   I. Draceanea ombet _____
   II. Reasons for the dead of D.ombet
   III. Other trees (e.g

Data measurement of D. ombet tree in 20m x 20 m sample plot

s/n	D. ombet trees	DBH at 1.3m	DSH at 30 cm	Number of D. ombet regenerations	List the threats for the tree	Remark
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						

Data collection for other woody species found together with D.ombet in sample plots

S/n	**Species name**	**Total number**	**Life form**	**Remark**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

Regeneration status

	Species name	**Number of regenerations**	**Remarks**
1			
2			
3			