Chapter 4
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A Review of the Literature of African Blackwood-*Dalbergia melanoxylon,* Guill. and Perr

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ABSTRACT

The African Blackwood Conservation Project (ABCP) in Tanzania conducted a review of the literature on *D. melanoxylon* (African Blackwood) or Mpingo in the late 1990s (over twenty (20) years ago). Additionary, It is nineteen (19) years since the last population study and population density was conducted and seventeen (17) years since last inventory study was taken. Today studies on propagation, tissue culture, population and harvesting activities of the species have brought new information to be noted. Recent research on this species' propagation methods has piqued the interest of researchers, who are now looking forward to how they can save the species from becoming threatened or extinct, which can be caused by its low regenerative ability in natural environments. It was now a proper time to add new information to the literature of *D. melanoxylon* from various recent findings covering about thirteen (13) years from the last review of the literature of the species from 2000-2014 and now is (20) years ago from 2000. This literature review was written to provide useful information for researchers looking into advanced propagation strategies for this species, such as tissue culture and mycorrhiza association, as well as recent studies on the species. This review has also exposed the threats of the species, recent population status of the species in Tanzania, recently recommended research to be taken in consideration, ethnobotanical and ecological literatures as previous and early findings were not able to take botanists to the advanced propagation techniques which have been reported recently and finally Biology and silviculture of *Dalbergia melanoxylon.*

Keywords: African Blackwood; Dalbergia melanoxylon; propagation; Mpingo; Ethnobotanical.

1. INTRODUCTION

Increased harvesting of *Dalbergia melanoxylon* for commercial timber, forest clearance for new settlements and cultivation, regular bushfires, poor regenerative potential of the plant by natural methods, and a lack of national conservation efforts all pose a serious challenge to *Dalbergia melanoxylon's* future availability in Tanzania. This statement summarises the issues that *Dalbergia melanoxylon* faces today in Tanzania and around the world, as well as the need for quick strategies for multiple seedling development for *D. melanoxylon* propagation. In Tanzania, *Dalbergia melanoxylon* is classed as a Lower Risk / Near Threatened species, which means it is neither endangered nor of little concern. However it may be considered near threatened if propagation efforts are not instituted [1]. *Dalbergia melanoxylon* is also called African Blackwood (in English) or mpingo (in Swahili) as used by Tanzanians [2].

Little research which has been conducted so far on habitat, sivilculture, population status, germination, rooting, propagation, mycorrhizal association and callus induction have shown that onverharvesting is most threat of the species in Tanzania (Figs. 1-4). Findings have also reviled that, it is possible to establish a national large scale plantation of *D. melanoxylon* if a means of multiple productions of seedlings is obtained. Recent findings on mycorrhiza association and rooting indicated high ability of seedling production [3] but massive harvesting of cuttings for rooting practices is associated with deforestation practices. The remaining possible method for seedling multiple

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production without deforestation is tissue culture which recently have succeeded to induce callus in *D. melanoxylon.* This literature review therefore is also intended to ask for grants support from organizations, institutions and individuals to enable tissue culture research to be conducted at the University of Dar es Salaam Botany Department for multiple seedling production in *D. melanoxylon*. Success to this research will open a way to sustainable planting and propagation of the *Dalbergia melanoxylon*, mpingo in Tanzania.

2. HABITANT AND DISTRIBUTION OF *Dalbergia melanoxylon*

The interest of early researchers as Guillemin & Perrottet 1832 (Guill & Perr) and others in the mid-1960's were based on ethnobotanical research on *Dalbergia melanoxylon* including the habitat, ecology, distribution, economic uses, nomenclature and Synonyms of this species. *Dalbergia melanoxylon* Guill & Perr (Family Leguminosae and subfamily Papilionoidae) [4] grows under a wide range of conditions including semi-arid, sub-humid and tropical lowland areas. It is often found on dry, rocky sites but is most frequent in mixed deciduous forests and savannahs of the coastal region [2]. The mean minimum temperature in its native range is 18°C and the maximum is 35°C, with no frost. Annual rainfall averages 700 to 1200 mm, often distributed in a bimodal pattern of three to six months. Soils vary from loamy sands to clayey vertisols ("black cotton soils"). The species is water and light demanding; it is common near water and will not regenerate under heavy cover. Mature trees are fire tolerant. The species is wide spread in tropical Africa from

Senegal and Cote d'Ivore in the West, to Kenya and Ethiopia in the East, and extending south to South Africa**.**

It is found in 26 sub-Saharan countries [5].

Apart from Africa, *Dalbergia melanoxylon* is also found in India around Pune City [6]. In Tanzania, *Dalbergia melanoxylon* is abundantly found in T_4, T_5, T_6 and T_8 floristic regions and less abundant in T_1, T_2, T_3 and T_7 floristic regions [2]. *Dalbergia melanoxylon* inhabit rainforest and open miombo woodlands of Tanzania in which rainfall is often marginal with long drought periods.

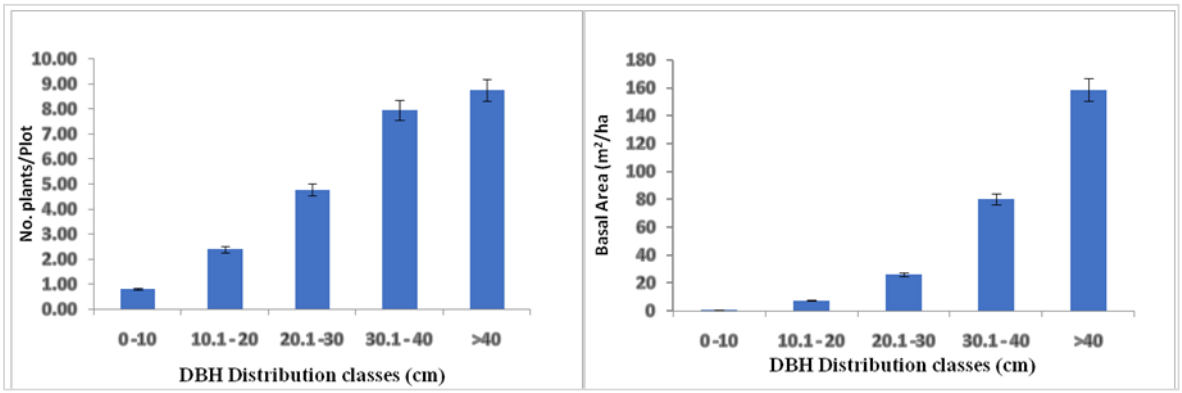


Fig. 1. Phenological Status of Mpingo in Nambawala Community Forest, Kilwa District

3. BIOLOGY AND SILVICULTURE OF *Dalbergia melanoxylon*

Researches which were conducted on *D. melanoxylon* from 1960's to early 2000's were based on biology and silviculture of the species rather than regenerative methods for propagation and conservation of the species. This is because overharvesting of mpingo from 1960's to early 1990's was not a threat issue. *Dalbergia melanoxylon* is a small, heavily branched tree, typically 4.5 to 7.5 m tall but occasionally reaching 15 m. The bole is fluted with high narrow ribs separated by deep indentations. Bole length occasionally reaches up to 3.6 m, but normally ranges from 1.2 to 1.8 m [7].

Average diameter at breast height (dbh) at maturity is less than 38 cm, although trees have been found with a dbh of more than 60 cm and recently a dbh of above 80 cm and basal area of above 80m^2 per ha was recorded as per unpublished document by Nyomora et al. [8] (Figs. 1-4) and Malimbwi et al. [9]. The bark is pale gray to grayish-brown, papery, fairly smooth, and flaking in long narrow strips [7]. The stems are often crooked. Branchlets are clustered at the nodes. Some grow out, while others are short and spine tipped. They are covered at first with short crisp hairs, and are usually glabrous. Leaves are pinnately and 6 to 22 cm long. The flowers are 6 to 9 cm long, occurring in dense clusters. Pods are elliptic oblong or irregularly oblong, bluntly pointed, flat and thin. They range from 3 to 7 cm long and 0.8 to 1.4 cm wide. They tend to be papery, glabrous, and laxly and rather diffusely veined.

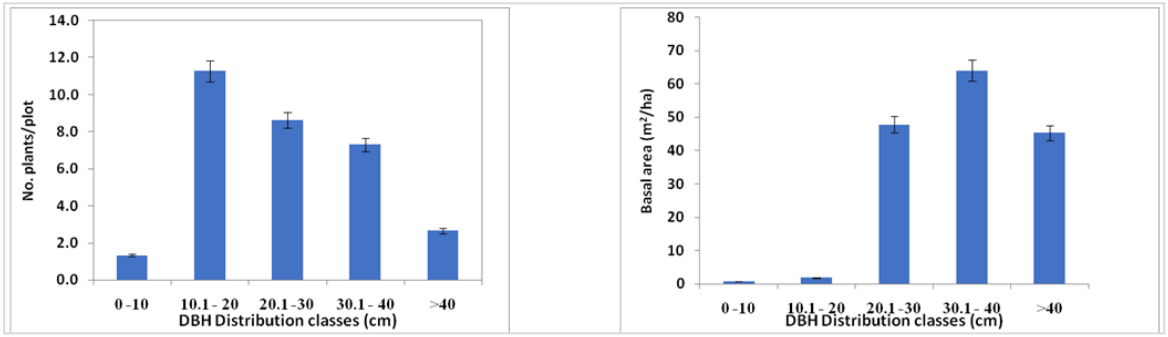


Fig. 2. Phenological Status of Mpingo in Ngea Community Forest, Kilwa District

As a member of Papilionoidea species *D. melanoxylon* seeds are usually hard and with a complex hilar valve and enclosed in pods (legumes), plants are shrubs or trees (habits)**,** leaves are usually compound and alternate, flowers are usually bilaterally symmetrical (Zygomorphic), Perfect or hermaphroditic (bisexual), entermophilous (insect pollinated) and white [10]). *Dalbergia melanoxylon* is a multi-stemmed plant, with irregularly shaped crowns. Its young branchlets are whitish grey with dense white lenticels and its old barks are pale grey. It has leaf like caducous stipules of about 5mm long with alternate leaves and alternate leaflets [11]. Flowering occurs in the second part of the dry season, particularly from October to December in Southern Africa. *D. melanoxylon* flowers are about 5mm long with 9 stamens [7].

Development of fruits from pollination to maturity takes about 6 to 8 months. In southern Africa, the fruits mature between January and March while in Tanzania they mature between July and September [12]. The fruits are flattened, indehiscent pods and green when unripe, pale green when mature and then turn grayish when dry. Each pod usually contains one to three seeds [7]. The seeds are papery kidney-shaped, laterally compressed, smooth, about 7.5 to 9.5mm long and 0.5 to 0.7mm wide giving an average fresh seed mass of between 0.06 and 0.17g. The seeds are very fragile and are difficult to separate from the pods when dry. Mature seeds are black and can easily be selected from immature white ones. The seeds have thin seed coats and the embryo is yellowish [13].

Seeds are about 42,000/kg of pods; generally remain viable for only a few months, although viability could probably be increased by storage in sealed containers. In about 16.000 seeds only 6000 seeds or 35% can germinate [13]. Seed extracted from pods germinates readily without treatment. However, few seedlings attain maturity under natural conditions due to fire and drought [14]. Seed storage behavior is orthodox; viability can be maintained for several years in hermetic storage at 3°C with 9-12% moisture content. Failure to maintain these recommended storage conditions viability can last for few months from the time of maturity [13]. Field trials are currently exploring suitable spacing for *D. melanoxylon* plantations. An initial spacing of 2 x 2 m results in good branching characteristics, while later thinning improves growth. Stem form is improved by raising the trees under medium shade provided by Pinus caribaea Morelet [10].

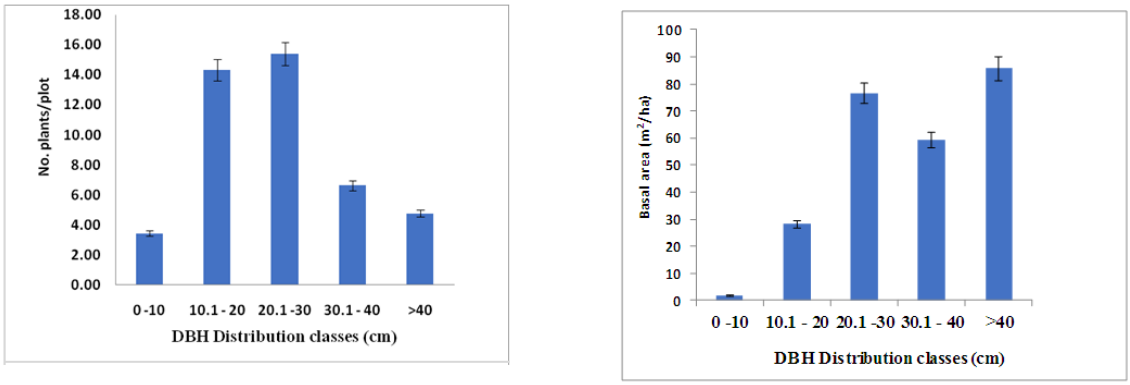


Fig. 3. Phenological Status of Mpingo in Mitature Forest Reserve, Kilwa District

4. PROPAGATION AND CONSERVATION EFFORTS OF *Dalbergia melanoxylon* IN TANZANIA

Propagation and conservation ideas and research started in Tanzania in mid-1980's when overharvesting, difficult to germinate and low seedling growth rate of *D. melanoxylon* were found to be big threats for the future availability of the species. These researches include that of Mbuya [15], Platt et al., [16], Beale [17], Fauna and Flora International [18], Sharman [19], TTSA [13] and ABCP or Chuwa Unpublished report [20].

Initially, Mbuya [15] wrote on propagation and management of agricultural and pastoral communities including *D. melanoxylon* when investigated useful and shrubs for Tanzania while Platt et al., [16] investigated the State of Knowledge about the Conservation and Cultivation Status of Mpingo (*Dalbergia melanoxylon)* in Tanzania but previously, UNEP, WWF and FFI brought the conservation ideas to Tanzania government in the late 1980's. This is a time when propagation and conservation ideas and research started to emerge among researchers and organizations.

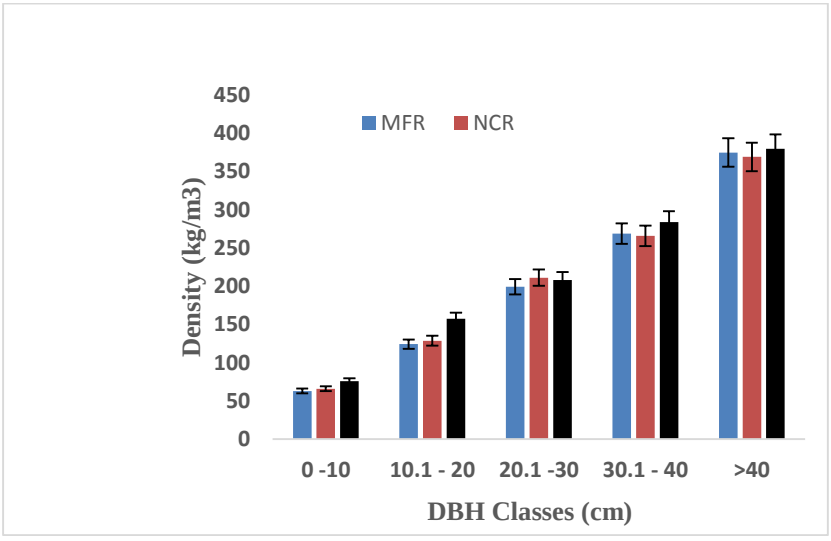


Fig. 4. Densities of the African Blackwood in Reserves and Community Forests in Kilwa (A)
MFR- MitatureForest Reserve, NCR-Ngea Community Forest, NACR- Nambalawa Community Forest

Beale [17] and Sharman [19] investigated the sustainable production and conservation of Mpingo where by Beale [17] investigation was on —An Ecological Economic Approach to Producing a Sustainable Mpingo Tradell while that of Sharman [19] was on —the Sustainable Management of a Tropical Timber Species Using *Dalbergia melanoxylon*ll.

Fauna and Flora International [18] reported on Conservation and Responsible Use of *Dalbergia melanoxylon* while the Tanzania Tree Seed Agency [13] reported on storage conditions for long period viability of *D. melanoxylon* seeds.

As an effort towards propagation of *D. melanoxylon* in Tanzania which emerged from ideas and researches by UNEP, WWF, FFI, Mbuya [15], Platt et al., [16], Beale [17], Sharman [19], FFI [18] and TTSA [13], the African Blackwood Conservation Project (ABCP) was established in 1996 by James Harris, a woodworker from Texas, USA, and Sebastian Chuwa, a botanist from Tanzania. Its purpose was to replenish the population of the mpingo tree, to sensitize the community on economic and ecological importance of the species, to involve the community in seedling production for propagation of the species, to conduct researches on Mpingo and keep records of results. This project used natural methods of soil seed germination which does not solve the problem of low germinability. However this project was abandoned due to lack of support from the government. In the late 1980's the Wildlife Conservation Society of Tanzania started an mpingo replanting effort but it has now ended. Several experimental plots were established in the early 1970's by research botanists but were abandoned in the early 1980's with no follow up. All these previous research as efforts to propagate and conserve Mpingo was not successful due to either lack of support, lack of follow-up and lack of advanced methods for multiple seedling production in *D. melanoxylon* rather than natural methods which are associated with low germination due to low seed viability.

Recently in the late 2000's to 2020 researchers have directed their research to alternative and advanced techniques and methods for *D. melanoxylon* seedling production and propagation. Finally the population stats study was carried in the southern Tanzania in Kilwa forests which comprise Mitatura Forest reserve and two community reserves (Ngea and Nambawala community reserves).

Amri [21] investigated ―the effect of Timing of Seed Collections and Provenances on seed viability and germination capacity of *Dalbergia melanoxylon*‖. In this study seed viability varied with different time of seed harvesting, for the seeds harvested between 8-12 weeks from their maturity viability was 57% and germination was 35% but for seeds harvested from 16 weeks and above viability was 37% and germination was 21% which correlate with germination reported by Washa and Nyomora [22] and not far from germination reported by TTSA [13] as 37%.

Washa [23] investigated ―The Dependence of *Dalbergia melanoxylon* Natural Population on Root Suckers Regeneration‖. In this study, more than 50% of *D. melanoxylon* seedlings and trees in the forest were found to originate from root suckers as a result of adaptation from low seed germinability and environmental harsh conditions. It was suggested that root suckers can be used for propagation of the species but initiating root suckers is also considered as destruction practices to the naturally occurring trees.

Amri [24] investigated ―The Effect of Age of the Donor plant, IBA treatment and Cutting position to the Rooting ability of Stem cuttings in *Dalbergia melanoxylon*‖. The juvenile stem cuttings or softwood rooted to 72% using IBA hormone compared to 20% rooting of the older stem cuttings under the same treatments. This rooting was defeated by rooting promoted by mycorrhiza inoculums into Washa et al., [3] in which softwood cuttings (juvenile) rooted to 100% while older stem cuttings did not root at all under the same treatments.

Washa and Nyomora [22] investigated ―The Effect of Moisture and Seed treatment on the *In-situ* and *E-situ* Regeneration of *Dalbergia melanoxylon* (African Blackwood) in Pugu Forest reserve‖. Available moisture to *D. melanoxylon* seeds was found to be main factor affecting germination in the natural environment, seeds of the species are vulnerable to high moisture level, they easily get rotten and loss viability at high moisture but also seeds are vulnerable to fungal and insect attach. This is why most seeds of the species produced yearly in the forest do not germinate and loss their viability few months from the time they mature.

Washa et al., [1] have three investigation studies on *D. melanoxylon***.** One is ―Identification of the mycorrhizal species associated with *D. melanoxylon*‖, second is ―Their effects to rooting ability of *D.*

melanoxylon stem and root cuttingsII and third is the unpublished part of the study which still in the process for publication, this succeeded to induce callus in *D. melanoxylon*.

The first investigation published three fungal species being associated with *D. melanoxylon* namely *Inocybe petignosa, Laccaria proxima and Glomus versifornes*. The second investigation tested the effect of these fungal species to rooting of *D. melanoxylon* cuttings. There was significant rooting in the fungal inoculated medium compared to rooting in sterilized medium. Harvesting of cuttings for rooting practices can simply be considered as deforestation practices.

Nyomora et al. [8] in her unpublished document conducted a population status study in Kilwa and found the species is overharvested and may extinct in few years to come if serious propagation and protection of the species will not be taken (Figs. 1-4).

5. CONCLUSION

When the Mpingo literature is surveyed from ethnobotanical studies in the mid-1960's by Tack (1962) and Bryce (1967) across the emerging of propagation ideas and research in the mid-1980's and establishment of the ABCP in 1996 to the recent studies on advanced propagation methods and population status of the species, still one step forward is required. This is a step which will take us into the multiple seedling production for propagation of *D. melanoxylon*. This is a tissue culture step which recently has succeeded to induce callus in *D. melanoxylon*. Another step is regular patrols by the authority responsible with the management of the forest reserve and community forest to stop illegal harvest but also replanting/restocking of *D. melanoxylon* in the reserve several times in order to balance the *D. melanoxylon* populations.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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Biography of author(s)



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He is a researcher in *Dalbergia melanoxylon* (African Blackwood), *Swartzia madagascariensis, Baphia kirrkii*, *Tetradenia raparia* and *Pleurotus ostreatus* (Oyster mushrooms), was born in 1965 in Tanzania, has three remarkable periods in his profession experience. One is a period of Teaching Biology and Chemistry in Secondary schools of Tanzania in which professionals and experts of various discipline were produced through his teaching. He taught about 7 secondary schools during this period from 1994-2007. Second is a Hardship period of BSc and MSc studies without a study leave through the Open University of Tanzania from 2000-2004 for BSc and 2005-2007 for MSc. His childhood life in forestry environments was a source for him to take an MSc in plant biology particularly the African Blackwood (*Dalbergia melanoxylon*). Third is his contribution to the science of Botany through investigations in *Dalbergia melanoxylon* from 2005 to date. He has been the first researcher in the world to test tissue culture in *Dalbergia melanoxylon* and the second researcher to write a Review of the Literature of this species in 2014. He has been a paper reviewer in various Journals including Tanzania Journal of Science (2012), International Journal of Plant and Soil sciences (2019), Recent Journal of Science and Technology (2020) and the Journal of Cell Biotechnology and molecular Biology (2020). He has also extended his research efforts into *Swartzia madagascariensis*, *Baphia kirrkii*, *Tetradenia raparia* and *Pleurotus ostreatus.* He is a Senior Lecturer in Botany at Mkwawa University College of Education, Biological sciences Department in Plant physiology, plant Anatomy, Mycorrhizae and plant Tissue culture from 2008 to present.

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