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Short Review

Phytotherapy and Polycyclic Logging: Implication on Genetic Multiplicity and Diversity of African Mahogany in Tropical Rainforest

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Abstract

There are over 8,000 globally threatened tree species. For each species, there is a different story behind why they are threatened and what values we stand to lose if we do not find the means to save them. Mahogany, a member of Meliaceae, is a small genus with six species. Its straight, fine and even grain, consistency in density and hardness makes it a high valued wood for construction purposes. The bitter bark is widely used in traditional medicine in Africa. The high demand for bark has also led to the total stripping of some trees, complete felling of larger trees to get the bark from the entire length of the tree and bark removal from juvenile trees. These species are now threatened with extinction due to selective and polycyclic logging, and also excessive bark removal. The natural regeneration of mahogany is poor, and mahogany shoot borer *Hypsipyla robusta* (Moore) attacks prevent the success of plantations within the native area in West Africa. In developing countries, most of the *Khaya* species exists in the wild state; therefore, the regeneration and long-term conservation are at the mercy of the vagaries of nature and the profit driven herb collectors and timber merchants. It becomes urgently necessary by government of developing countries to place ban on further harvesting of mahogany species to allow the remaining few trees of mahogany in the forest to recuperate and produce substantial seeds for regeneration.

Keywords: poor regeneration; species extinction; unsustainable harvesting

Introduction

Tropical rainforest, an ecosystem type that occurs roughly within the latitudes 28 degrees north or south of the equator was very rich in both plant and animal species (Groombirdge, 1992; Turner, 2001). This immense biodiversity generates a variety of natural resources which helps to sustain livelihoods of both local and urban communities (Kumar *et al*., 2006). Daily (1999) reported on the availability of several wood and non-wood products from this ecosystem and the contributions of the ecosystem to biodiversity conservation, environment sustainability and to rural and national development. In line with this, Ndah *et al.* (2013) highlighted some vital goods provided by the forests. Some of these goods include: medicinal plants, fodder, food, fruits, bush meat, construction materials, etc. Also, forest communities enjoyed the following services: the regulation of temperature, purification of air, detoxification of soil, thus producing a healthy environment for livelihoods support (Hadis *et al*., 2009; Tripathi *et al*., 2010). The recognition of forests role particularly in regulating the concentration of carbon dioxide (CO_2) as important greenhouse gas in the atmosphere only became noticeable after unprecedented deforestation and forest degradation.

Although rainforests have always been subjected to destructive natural forces such as storms, landslides, floods, volcanic eruptions, high winds, fire (mainly from lightning), drought and climate change, these factors have recently been overwhelmed by anthropogenic (human) forces. It was estimated that the original forest cover was approximately six billion hectares (Bryant *et al*., 1997) and about 45 percent of the earth's land area. Forests currently cover about 4 billion hectares, about 31 percent of the earth's land surface (FAO, 2010). According to Onyekwelu *et al.* (2005), an attempt to satisfy both local and international need for forest products and the continuous increase in rural population, forest resources exploitation in this ecosystem is carried out in an uncontrolled and unsustainable manner. The long-term effect is usually destruction of their quality and quantity. Several researchers

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had reported on the alarming rate at which this tropical rainforest is disappearing (Sarumi *et al*., 1996; FAO, 2005; Oyebo, 2006) and the consequences of this destruction has been widely recognized (Abubaka, 2010). There are over 8,000 globally threatened tree species. For each species, there is a different story behind why they are threatened and what values we stand to lose if we do not find the means to save them (IUCN, 2013).

Moreso, several successful efforts has been made to establish plantation of some tree species believed to be highly threatened with extinction due to over-exploitation. However, little or no success has been recorded on plantation establishment of mahogany species in many parts of the tropics owing to *Hypsiphila robusta*. Researchers tend to be discouraged as further biotechnological tools required to solve this problem are not readily available and where available, expensive. Hence, this review paper is prepared to awaking the consciousness of forest conservationists, policy maker, governmental and non-governmental organization about these species and the need to intensify research effort to avert the extinction of their natural diversity.

Man and Mahogany

Man had identified several species of mahogany distributed throughout the tropics for various uses ranging from construction and medicinal purposes. Mahogany, a member of Meliaceae, is a small genus with six species, four in tropical Africa and two in Madagascar and the Comores (Wiselius, 1998). The genus is easily recognized by its paripinnate leaves and round or mainly spherical 4-5 valved, dehiscent woody capsules. In Africa, Jemilat *et al.* (2006) reported the occurrence of five species of African mahogany. These are *Khaya anthoteca* (Welw.) C. Dc., *K. senegalensis* (Desv.) A. Juss, *K. ivoriensis* A. Chev. and *K. grandifoliola* C. Dc. One species, *K. nyasica*, was introduced from Central Africa. Khaya ivorensis A. Chev. (Family Meliaceae, sub-family Swieteniodeae) is among the most important economic hardwood timber tree species of Africa (Ofori *et al*., 2007). The species are distributed through coastal West Africa, Cote d'Ivoire through Ghana and Southern Nigeria to Cameroon, growing mostly in rainforest but extending into dry forests (Irvine, 1961). *Khaya grandifoliola* occurs in more or less the transitional zone between savanna and closed forests, *K grandfoIiola* (Kg) trees *are* predominant in the Ivory Coast, Ghana and Nigeria. *K senegalensis* has *a* very wide distribution and occurs in almost all areas of the savanna stretching from Senegal to Uganda. These areas cover Benin, Burkina Faso, Cameroon, Central *Afncan* Republic, Chad, Gabon, Gambia, Ghana, Guinea and Guinea Bissau. Others are Ivory Coast, Mali, Niger, Nigeria, Sierra Leone, Sudan, Togo and Democratic Republic of Congo. In South West Nigeria, *K. senegalemis* is prevalent in the savanna zone.

Uses of Mahogany

Mahogany has a straight, fine and even grain, and is relatively free of voids and pockets. Its reddish-brown colour darkens over time, and displays a reddish sheen when polished. Its consistency in density and hardness makes it an easy wood to work with. The wood is highly valued for furniture, cabinet work, decorative boxes and cases and veneer, and is also commonly used for window frames, paneling, doors and stair cases. It is suitable for light flooring, ship building, vehicle bodies, sporting goods, musical instruments, toys, novelties, carving, plywood and pulpwood (Maroyi, 2008). The bitter bark is widely used in traditional medicine in Africa. It is taken to treat cough, whereas bark decoctions or infusions are taken to treat fever, cold, pneumonia, abdominal pain, vomiting and gonorrhea, and applied externally to wounds, sores and ulcers. Pulverized bark is taken as aphrodisiac and to treat male impotence (Khairul *et al*., 2012). According to them, the root decoctions of *Khaya anthentica* are drunk to treat anemia, dysentery and rectal prolapsed in Tanzania. Also, in Bangladesh, the bark has been used by the *Shambaa* people for reddish brown dyeing.

This group of Meliaceae timbers under the trade name mahogany has long been regarded as premium quality woods for use in cabinetry and joinery applications. Mahoganies from South America (*Swietenia* spp.) and Africa (*Khaya* spp.) are well known in global timber markets and have been traded for centuries. African mahogany came into general use in Europe towards the end of the 19th century to supplement the diminishing supplies of 'true' mahogany from tropical America. Though distinct, the timber is closely related anatomically to the American wood, and is today universally accepted as mahogany (Matt *et al*., 2007). Currently, the international trade in mahogany from Africa is very limited. This is due in part to the increasing difficulty in sourcing natural-grown mahogany and over-exploitation.

Consequences of Unsustained Use of Mahogany

Mahogany species has long been exploited with little or no effort towards their conservation. This has not only resulted in the scarcity of these species but also impacted negatively on the economy of people and the government. International Union for Conservation of Nature (IUCN, 2006) red list of threatened species listed Khaya as one of the endangered valuable timber species. In South West Nigeria, the upsurge in ethno-botanical studies and scientific research into the use of plant species has further enhanced the pressure on populations of medicinal forest species as more people now use plants' parts for treating various body ailments. Iwu (1992) showed that more than 70% of the Nigerian population depends on folk medicine for their health. Okere and Adegeye (2011) pointed out that most of the *Khaya* species exists in the wild state; therefore, the regeneration and long-term conservation of these species are at the mercy of the vagaries of nature and the profit driven herb collectors and timber merchants. The natural regeneration of mahogany is poor, and mahogany shoot borer *Hypsipyla robusta* (Moore) attacks prevent the success of plantations within the native area in West Africa (Newton *et al*., 1993; Nikiema and Pasternak, 2008). Selective logging, polycyclic logging and excessive bark removal for medicinal purposes are also major contribution to the consequences we are witnessing today.

Effect of Polycyclic Logging on Mahogany Population

Polycyclic logging is the selective removal of only the largest individuals of desirable species at relative short interval (Bruijnzeel and Critchley, 1994). The objective is to wait for a sufficient number of trees to reach maturity, and then to remove these alone.

Mahogany has been selectively logged over the years and nobody planted any to replace those one naturally growing. Besides, it takes over hundred years for these species to grow to maturity and nobody wait for these donkey years before they harvest these species. In some countries like Nigeria, where there are laws guiding the diameter of timber to be harvested, this law has failed in its implementation as my timber contractors ended up cutting these species wherever they find them regardless of their size. This single act has gone a long way to reduce the population of mahogany in the tropical rainforest as many of these species have been seriously threatened by extinction (Alamu and Agbeja, 2011). According to them, the ratio of regeneration in general is, one cut to two replenishment but the replenishment is based on coppicing, which limits the power of the forest to replace lost volumes. Deforestation apart from its direct effect on endangered indigenous tree species impacts negatively on food supply, soil and landscape of South West Nigeria. They concluded that for improvement to be engendered in the Zone, more Education is needed for the entire citizenry on the need to conserve the endangered species as well as making sure that forest policies are well fashioned out and followed to the latter, to safeguard the tree species from extinction.

Excessive Bark Removal for Medicinal Purposes

In most African countries, the bark of Mahogany and several woody tree species are repeatedly collected by local healers as a source of products having medicinal properties (Diederichs, 2006). According to Malambo *et al*. (2005), the bark is often removed as a bulk product to be processed for subsequent use or as raw material from which flavourings or medicinal compounds are extracted to cure various ailments. Chungu *et al*. (2007) revealed that bark harvesting for medicinal purposes has become widespread in some countries in Africa mainly due to the high levels of poverty among the population. Their study which was aimed to ascertain the effects of different bark harvesting practices on the quality of wood of selected indigenous tree species often used as medicinal plants confirmed severe deterioration by displaying extensive tissue discolouration, increased insect infestation and profuse gum exudation, especially when the wound was not covered with mud.

Geldenhuys and Mitchell (2006) pointed out that most indigenous forest trees on the African continent are overexploited and many are now near extinction as a result of continuous and unsustainable harvesting, including medicinal bark harvesting practices. As a result of the proliferation of bark harvesters and traders, and thus increased competition, bark is harvested more regularly, often resulting in trees being ring-barked (Syampugani *et al*., 2005). Similarly, Malambo *et al*. (2005) observed that the high demand for bark has also led to the total stripping of some trees, complete felling of larger trees to get the bark from the entire length of the tree and bark removal from juvenile trees. In addition, upcalling indigenous knowledge of Mahogany trees for curative treatments of several ailments and the greater number of traditional healers have significantly contributed to the increased demand for medicinal plants, putting considerable pressure on forests, to the extent that the survival of this tree species is threatened.

Syampungani *et al*. (2005) reported that the current tree bark harvesting practices for medicinal purposes in the Southern African Development Community (SADC) region, including Zambia, have led to the death of many forest tree species, leading to considerable loss of biodiversity. According to Malambo *et al*. (2005), these practices have negatively affected the existence of the most valuable tree species for medicinal use and also for timber production. Consequently, the forest cover is depleted and its capability to provide other services such as medicine, timber and other products that could be derived from the tree is threatened. Unless sustainable practices of bark harvesting that have less impact on the wood quality are found, valuable forest biodiversity resources will continue to diminish or disappear.

Conservation and Sustainable Use of Mahogany

Mahogany is a special tree species that provides both timber and non-timber products. It is a high priced wood often used for carpentary, joinery, furniture, cabinetry and decorative veneer. It is also suitable for light construction such as staircase banisters, handrails and domestic flooring because the wood usually dries well and rapidly with a beautiful sheen when polished. The water-resistant nature of the timber makes it a very good material for ship-building.

Timber and non-timber forest products (NTFPs) are increasingly being studied due to their growing importance in enhancing livelihoods. According to Boateng *et al*. (2007), millions of people have a traditional knowledge on Non Timber Forest Products (NTFPs) and use them on a daily basis. Arnold and Ruiz-Perez (2001) opined that the increasing demand for NTFPs is reflected in a growing commercial trade which is becoming an important economic incentive for local collectors. Consequently, natural ecosystems may well suffer from over-exploitation of their plant genetic resources (McLain and Jones, 2005), especially in areas where people are economically dependent on NTFPs (Ticktin, 2004). In the context of the rapid growth of the human population and a NTFP production limited by ecosystem capacity, a sustainable harvest strategy reconciling plant genetic resources conservation and local people livelihood is utopia as pointed out by Rai and Uhl (2004).

Enrichment planting as recommended by Lawal and Adekunle (2013), could be adopted to prevent the extinction of mahogany in the tropical rainforest. Although, various ecological restoration methods involving planting of tree seedlings have been developed to reforest degraded lands (Lamb *et al*., 2005). Restoration can be achieved by some planting approaches that cover a range of

species and density of planting. These approaches include the dense planting of a large number of primary forest species (Miyawaki, 1999), staggered planting of primary forest species (Knowles and Parrotta, 1995), the framework species method (Goosem and Tucker, 1995; Shono *et al*., 2007) and the assisted natural regeneration (ANR). These methods have all been implemented with promising results. According to Lawal and Adekunle (2013), enrichment planting, which was introduced during the first phase of forest resources management in Nigeria, is a silvicultural practice that involves deliberate introduction of tree seeds or seedlings into a degraded forest.

Establishment of in situ conservation strategies, such as protected areas (PAs) particularly areas where mahogany and other trees species believed to be threatened by extinction are found should be protected. Although, some authors argue that many of the claimed positive conservation effects might be a function of a PA location i.e. low accessibility of protected land, but not the effect of actual protection measures (Ferraro *et al*., 2006; Andam *et al*., 2008). Therefore, government should place ban on harvesting of these species as it is necessary to allow the remaining few trees of mahogany in the forest to recuperate and produce substantial seeds for regeneration.

Conclusions

Genetic multiplicity and diversity of African mahogany, one of the world best timber species, is facing a serious threat both in the hands of timber contractors and traditional healers. Unfortunately, none of these users are making sincere effort towards domesticating or establishing a plantation of these species. Hence, the future of mahogany in Africa is at the mercy of natural regeneration. Research is crucial to understanding and addressing these threats and to developing effective strategies for conservation and sustainable use. An intensive research effort is therefore recommended to identify the existing genetic diversity of African mahogany and develop a sound strategy for their conservation and sustainable use. It is also recommended that government of developing countries particularly where mahogany is severely threatened by extinction should place barn on harvesting of mahogany to allow recuperation and production of seeds for future regeneration.

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