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Population dynamics of *Millettia stuhlmannii* Taub. in Ha-Makhuvha, Vhembe district of Limpopo Province, South Africa

Dinámica poblacional de *Millettia stuhlmannii* Taub. en Ha-Makhuvha, distrito de Vhembe de la Provincia Limpopo, Sudáfrica

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Abstract. The population dynamics of *Millettia stuhlmannii* Taub. was investigated to determine its current structure in Ha-Makhuvha. Plant populations are being utilized only for medicinal purposes under the close supervision of a local headman. It is used in treating stomach aches, as well as protecting homesteads and properties. Given the dependence of many rural communities on plants for medicine, timber, and various other non-timber resources, plant populations experience human pressures. These pressures demand great effort for *in situ* conservation and associated management needs of medicinal plants. Efforts also apply to sustainable usage and *ex situ* cultivation practices. The size-class distribution coupled with crown health and bark removal were used to determine the structure of the population as influenced by the medicinal use of *M. stuhlmannii*. Twenty four 5 m x 50 m transects were used to sample the area. Plant stem circumferences were measured at the basal area, and bark removal and crown health were estimated using the sliding scale. The number of plants with 0-50 cm stem circumference was lower than those with 51-100 cm, 101-150 cm and 151-200 cm. The majority of plants had their barks removed, and among them there were ring barked individuals. Some individuals had 100% crown mortality.

Keywords: *Millettia stuhlmannii*; Size-class distribution; Crown health; Stem circumference; Basal area; Mortality.

Resumen. La dinámica poblacional de *Millettia stuhlmannii* Taub. se investigó para determinar su estructura actual en Ha-Makhuvha. Las poblaciones vegetales solo son utilizadas para propósitos medicinales bajo la supervisión directa de un director local. Se utiliza para tratar dolores de estómago y para proteger propiedades y bienes del hogar. Dada la dependencia de plantas con fines medicinales, producción de madera y otros fines por parte de muchas comunidades rurales las poblaciones vegetales se hallan bajo la depredación por los humanos. Estas presiones demandan un gran esfuerzo para la conservación *in situ* y necesidades asociadas de manejo respecto a las plantas medicinales. Los esfuerzos también se aplican al uso sustentable y prácticas de cultivo *ex situ*. Para estudiar la estructura de la población influenciada por el uso medicinal de *M. stuhlmannii* se estudiaron la distribución de clases por edad asociada con la salud de la corona y la remoción de la corteza. Para muestrear el área, se utilizaron 24 transectas de 5 x 50 m. La circunferencia de los tallos fue medida a nivel del área basal, y la remoción de la corteza y salud de la corona se estimaron usando una escala. El número de plantas con una circunferencia de tallos de 0-50 cm fue menor que aquel con una circunferencia de 51-100 cm, 101-150 cm ó 151-200 cm. La mayoría de las plantas tuvieron removida su corteza, y entre ellas hubo individuos que tuvieron removida su corteza en forma de anillo. Algunos individuos tuvieron una mortalidad de corona del 100%.

Palabras clave: *Millettia stuhlmannii*; Distribución por clases de tamaño; Salud de la corona; Circunferencia del tallo; Área basal; Mortalidad.

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INTRODUCTION

The mountain top of Ha-Makhuvha village is characterized by the prominent stands of huge *Millettia stuhlmannii* trees, which can be seen from a distance. Hence, the tree is known locally as Muangaila wa Ha-Makhuvha. The trees form the canopy of the vegetation. Tree canopies influence the understory vegetation in several ways, for example, by litter accumulation, light conditions, and soil moisture (Naesset & Okland, 2002). The plant population is only utilized for medicinal purposes under the close supervision of a local headman. The traditional healers use the plant in treatment of stomach ache as well as protection of homesteads and properties.

As it is the only population in the region and in the whole Limpopo province, intense harvesting is highly experienced. The survival of the population can be attributed to several inadvertent or indirect controls and some intentional management practices by the headman as the custodian of the population. There are indigenous collection procedures that are followed during collection of medicinal materials. The fact that the population is still intact can be attributed to those indigenous practices around collection. Recently it has been discovered that there are many people who have been collecting the plant without permission of the chief. Use of natural resources will take place irrespective of whether it is permissible or not in many regions of South Africa (Dzerefos, 1999 in Grace et al., 2002). Such people are intensively and frequently harvesting the plant, putting it in danger of survival.

Bark is the major product harvested from trees for medicinal purposes in South Africa (Mander, 1998 in Grace et al., 2002). The same is applicable in this plant population: bark and roots are the parts which are being collected. The bark of many different forest and woodland tree species is used, although a relatively small number are in high demand and intensively used. Although bark may be harvested without killing the tree, plant death is usually the outcome due to the volume and frequency of bark removal: the result of using the traditional medicine for trading (Grace et al., 2002). Intense and frequent harvesting of bark from species with a high market demand often results in ring-barking of trees. Ring-barking has been recognized as the most destructive harvesting practice, as it often means that the debarked tree has no chance of survival, especially if the ring-barking is done by unskilled collectors (Zschocke et al., 2000). Plants are therefore either killed or limited to asexual reproduction due to harvesting (Grace et al., 2002). In South Africa, many people still use medicinal plants as an alternative or a supplement to western health care (Van Wyk et al., 1997 in Thring & Weitz, 2006). Hence, there is over-harvesting of the medicinal plants. Native plants are being destroyed almost daily: it means that many valuable, medicinally-important plants will be unavailable before scientists can even investigate them. Knowledge of these plants is of paramount importance because there is the potential to discover new alternatives for (1) illness treatment and (2) plant species conservation (Thring & Weitz, 2006). The disappearance of the *M. stuhlmannii* population from Ha-Makhuvha village may mean the loss of a plant species in the province. An optimal plant harvesting system should consider the regeneration potential of the study species (Mcregor, 1994; Hartshorn, 1995 in Obiri et al., 2002). Human activities, especially harvesting practices, can influence sustainable use of non-timber forest products by impacting forests at various levels. Harvesting intensity and technique may therefore determine the magnitude of these impacts (Sinha & Bawa, 2002).

The size-class distribution has been used to determine the dynamics of the *M. stuhlmannii* population. Population structure in forestry and ecological studies has been defined in terms of the size-class or stem diameter distribution of individuals (Knight, 1975; Peter, 1996 in Klimas et al., 2007). Frequency histograms have shown the number or percentage of individuals in the different size-classes. The sustainability of harvesting bark is also assessed according to the knowledge of tree distribution, abundance, and population structure, for example age/size distribution (Hall & Bawa, 1993 in Williams et al., 2007). The stem diameter frequency distribution can be used to indicate whether the density of smaller trees in forests is sufficient to replace the current population of larger trees (Rubin et al., 2006). Recently, Khan & Shaukat (1997) investigated population structure, intraspecific competition and physic development of *Urochondra setulosa* (Trin.) C.E. Hubb. Also, Shahid et al. (2009) studied intraspecific competition and aggregation in a population of *Solanum forskalii* dunal in a semiarid habitat. The present investigation was conducted to study the population dynamics of M*illettia stuhlmannii* around the Venda region at Ha-Makhuvha, in the Vhembe district, Limpopo Province, South Africa. The study area is on average at 750 m above sea level and about 25 km north of Thohoyandou town, South Africa. The vegetation of the study area can be described as a *Millettia stuhlmannii* woodland.

MATERIALS AND METHODS

Several visits were made to the headman and interviews were conducted to have a clearer understanding about the vegetation, and the method of conservation they were using. The site was visited together with the delegated person from the family. The line transect method was used to sample the area: twenty four 5 m x 50 m transects were sampled. They were placed across the population for all the individuals to be sampled. A tape was stretched for 50 m. All plants that were within 2.5 m at each side of the tape were measured. The parameters sampled were (i) stem circumference, (ii) crown health, and (iii) bark removal. Sony Mavica digital camera MVC-FD75 was used to take pictures during data collection.

Size class distribution. Stem circumference measurements were taken in centimeters on the basal area of the plants. Breast height was not used to measure stem circumference because most trees were multi-stemmed at breast height.

Crown Health. Crown health assessment was done on each individual using a sliding scale of 0 to 5. Classes of the sliding scale were interpreted as follows:

0 = 100% crown mortality,
1 = severe crown damage,
2 = moderate crown damage,
3 = light crown damage,
4 = traces of crown damage,
5 = healthy crown.

Bark removal. Bark harvesting intensity was also estimated with a sliding scale of 0 to 5. Classes of the sliding scale were interpreted as follows:

0 = no harvest at all,
1 = traces of bark removal,
2 = light bark removal,
3 = moderate bark removal,
4 = severe bark removal,
5 = 100% removal of bark around the stem.

RESULTS AND DISCUSSION

Indigenous Conservation Techniques – Some History. *Sacred sites*. The Chief performs rituals every time people go for medicinal material collection. According to the Chief, the rituals are a way of making sure that everything will be well during the collection of medicinal materials. The Chief also indicated that he feels it whenever there is an unauthorized person in the *M. stuhlmannii* population. Whenever he gets this feeling, he will send people up the mountains to seek for strangers; in most cases, unauthorized people are found collecting medicinal materials, and they are arrested. The Chief also indicated that people who entered the *M. stuhlmannii* population without permission, in the absence of the ritual performance, lose their way back to their departure point and end up at the Chief's kraal, were they are arrested. Heavy fines are imposed on the offenders of the collection protocol.

Collection procedures. Any collector of medicinal materials must pay a collection fee at the Chief's kraal. Collection of medicinal materials is done by a dedicated member of the Chief's kraal. Only roots are collected with care by the dedicated member of the royal family. Pieces of roots should be smeared with cold porridge before getting them into the house. The Chief indicated that if collection procedures are not followed, it may be difficult to obtain roots from the trees. According to the Chief, if roots are not smeared with cold porridge, they may change into snakes that might end up bothering family members.

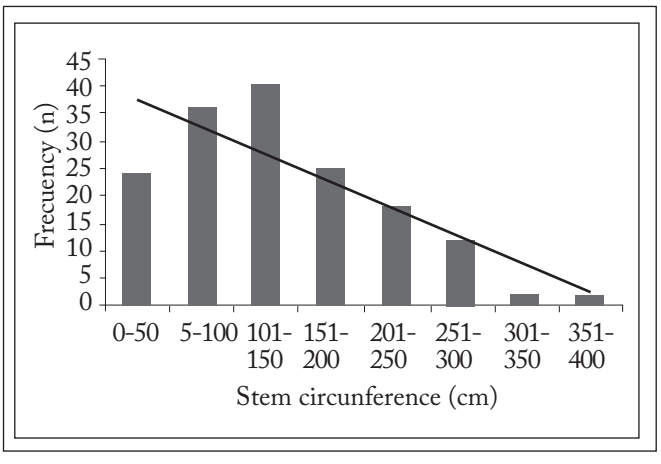
Size class distribution. Collected individuals were divided into eight size-classes based on their stem circumference as shown in Table 1. The majority of the stem circumferences are in the size-class of 101–150 cm. There were few seedlings established. This low seedling establishment is attributed to the fact that seedlings mainly develop from roots, and they are the target of medicinal collectors, who find it difficult to locate the roots from the parental plant. Locating seedlings automatically led collectors to the roots, the most sought after plant material. Therefore, the seedlings found within the population were those that were hidden within the dense forest.

Populations of *M. stuhlmannii* are threatened due to their low seedling establishment (Fig. 1).

Table1. Frequencies of individuals within the different size-classes.
Tabla 1. Frecuencia de individuos dentro de las diferentes clases de tamaño de la circunferencia del tallo.

Stem circumference in classes (cm)	Frequencies
0 - 50	24
51 - 100	36
101 – 150	40
151 – 200	25
201 – 250	18
251 – 300	12
301 – 350	2
351 - 400	2

Fig. 1. Size class distribution of *Millettia stuhlmannii* populations at Ha-Makhuvha from data collected in 2006.
Fig. 1. Distribución de clases por tamaño de poblaciones de *Millettia stuhlmannii* en Ha-Makhuvha. Datos recolectados en 2006.



Crown Health. The population of *M. stuhlmannii* is dominated by trees that possess healthy crown on average, and a number of individuals with mild traces of damage. Very few trees show unhealthy crowns, as shown in Fig. 2. The high

proportion of healthy crowns gives a healthy appearance to the population in the vegetation.

Fig. 2. Crown health status of *Millettia stuhlmannii* individuals (0 = 100% mortality, and 5 = healthy crown) as revealed by data collected in 2006.
Fig. 2. Estado saludable de las coronas de individuos de *Millettia stuhlmannii* (en una escala de 0 a 5, 0 = mortalidad de 100%, y 5 = coronas saludables) durante 2006.

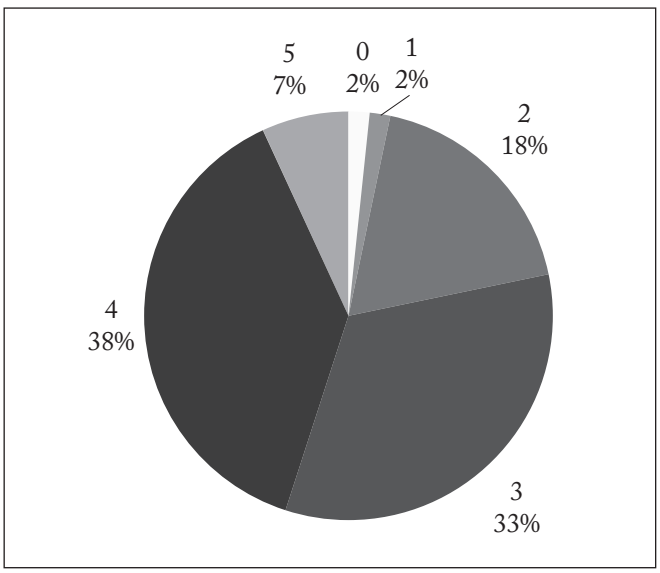
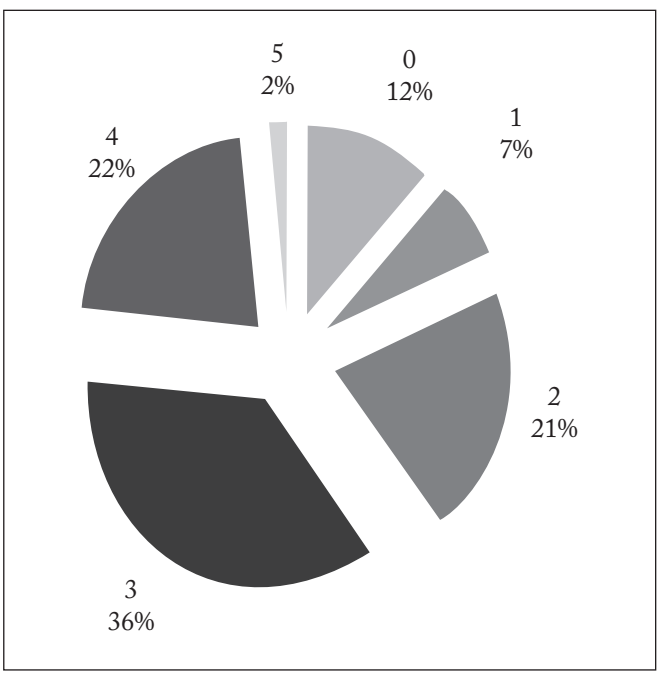


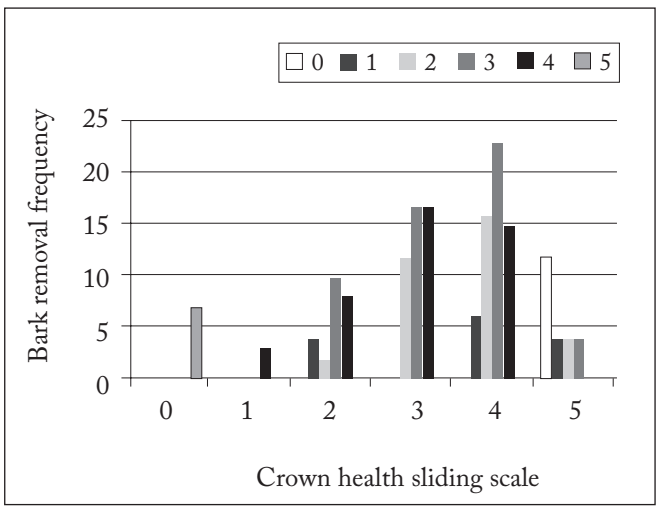
Fig. 3. Bark removal status of *Millettia stuhlmannii* individuals in percentages as per sliding scale (scale: 0 = no damage, and 5 = severe damage) as revealed by data collected in 2006.
Fig. 3. Grado de remoción de la corteza en individuos de *Millettia stuhlmannii* en una escala de 0 a 5 (en porcentaje) durante 2006.



Bark removal. Most of the adult individuals of the *M. stuhlmannii* population showed their barks removed. Very few individuals had not been harvested, and those were individuals with stem circumferences of less than 50 cm. Most of those individuals were seedlings. These seedlings were hidden in the dense bush, protected from medicinal material collectors. This practice of locating roots through seedlings performed by unauthorized medicinal material collectors, affects seedling establishment which will then have a negative effect on the population in the long term. The population will be left with mostly old individuals, which will not be replaced after dying. Nevertheless, the bark of *M. stuhlmannii* has the ability to regenerate from debarking. Some of the severely damaged plants are showing signs of regeneration. Figure 4 shows evidence of

Fig. 4. *Millettia stuhlmannii* stem showing bark regeneration ability as observed during data collection in 2006.
Fig. 4. Tallo de *Millettia stuhlmannii* que muestra la capacidad de regeneración de la corteza durante 2006.

Fig. 5. Correlation between crown health status and bark removal.
Fig. 5. Correlación entre el grado de salud de la corona y la remoción de la corteza.



the bark regeneration capacity from an old wound that was caused by unauthorized medicinal material collectors, since the dedicated members from the royal family only collected roots. It is believed that it is only the roots that are effective as a medicine. Therefore, there is no reason to collect bark.

Correlation between bark removal and crown health. All individuals with no crown were plants with 100% bark removal around the stem (Fig. 5). Plants with crown health of 5, according to the sliding scale, were individuals with no harvest of bark at all (Fig. 2).

CONCLUSIONS

The fact that *M. stuhlmannii* trees appear to be the dominant vegetation does not necessarily indicates that the population is doing well. The size-class distribution shown for *M. stuhlmannii* is indicating that some critical size-classes, essential for this species conservation, are exposed to threats of over-harvesting of the seedling developmental morphology stage. Some species (single-choice species) provide products which cannot be substituted by other species and their depletion may affect local people seriously (Kvist et al., 2001).

Management and control measures must be strengthened to conserve *M. stuhlmannii*, since medicinal collectors target the seedlings for easy location of the roots. Conservation of threatened and endangered medicinal species in wilderness is essential (Rahman et al., 2004). Fence establishment around the vegetation seems to be unavoidable as a measure to reduce over-harvesting and plant stealing as the demand for medicinal materials appears to increase. Environmental officers assisting the Chief in protecting this species from human predation should be in position to enforce laws against illegal collection of the study species. It appears that *M. stuhlmannii* of Ha-Makhuvha is the only plant population in South Africa upon wich the medicinal practicing depends. Thereafter, access to the trees could be allowed, but only under supervision of environmental officers and the tribal authority.

The environmental officers should also educate the community about the importance of conserving this species. It is important that local people know of the effects of harvesting *M. stuhlmannii*. Understanding the effects of harvesting on the composition and structure of the residual stand is essential for developing optimum harvesting systems (Cannon et al., 1994 in Boudreau et al., 2005). The success of conserving biological resources in any biosphere reserve or protected area depends on the extent of support, and positive attitudes and perceptions, of the local people towards such challenge (Rao et al., 2002). Ignoring the local people for preservation of renewable natural resources can lead to conflicts between resource managers and the local inhabitants. Indigenous conservation techniques are commended because of their role in conserving the plant population. However, they need to be coupled with scientific approaches as the result of the current, heavy demand on medicinal materials. Fire effects on the study plant species population have to be investigated further.

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REFERENCES

Boudreau, S., M.J. Laws, S.E. Piper & L.J. Phadima (2005). Subsistence harvesting of size understory species from Ongoye Forest Reserve, South Africa: Species preference, harvest intensity and social correlates. *Forest Ecology and Management* 216: 149-165.

Grace, O.M., H.D.V. Prendergast, J. Van Staden & A.K. Jager (2002). The status of bark in South African traditional health care. *South African Journal of Botany* 68: 21-30.

Khan, D. & S.S. Shaukat (1997). Population structure, intraspecific competition and phasic development of *Urochondra setulosa* (Trin.) C.E. Hubb, a coastal holophytic grass of Pakistan. *Pakistan Journal of Botany* 29: 271-288.

Klimas, C.A., K.A. Kainer & L.H.O. Wadt (2007). Population structure of *Carapa guianensis* in two forest types in the southwestern Brazil Amazon. *Forest Ecology and Management* 250: 256-265.

Kvist, L.P., M.K. Anderson, J. Stagegaard, M. Hesselsoe & C. Llapapasca (2001). Extraction from woody forest plants in food plain communities in Amazonian Peru: use, choice, evaluation and conservation status of resource. *Forest Ecology and Management* 150:147-174.

Naesset, E. & T. Okland (2002). Estimating tree height and tree crown properties using airborne Scanning laser in a boreal nature reserve. *Remote Sensing of Environment* 79: 105-115.

Obiri, J., M. Lawes & M. Mukolwe (2002). The dynamics and sustainable use of high-value tree species of the Coastal Pondoland forests of the Eastern Cape Province, South Africa. *Forest Ecology and Management* 166: 131-148.

Rahman, M.A., J.S. Mossa, M.S. Al Said & M.A. Al-Yahya (2004). Medicinal plant diversity in the flora of Saudi Arabia: A report on seven plant families. *Fitoterapia* 75: 149-161.

Rao, K.S., R.K. Maikhuri, S. Nautiyal & K.G. Saxena (2002). Crop damage and livestock depredation by wildlife: A case study from Nanda Devi Biophere Reserve, India. *Journal of Environmental Management* 66: 317-327.

Rubin, D.B., D.P. Manion & D. Faber-Langendoen (2006). Diameter distribution and structural sustainability in forests. *Forest Ecology and Management* 222: 427-438.

Shahid Shaukat, Waqar Ahmed, Moazzam A. Khan & Atif Shahzad (2009). Intraspecific competition and aggregation in a population of S*olanum forskalii* dunal in a semiarid habitat: impact on reproductive output, growth and phenolic contents. *Pakistan Journal of Botany* 41: 2751-2763.

Sinha, A. & K.S. Bawa (2002). Harvesting techniques, hemiparasites and fruit production in two non-timber forest tree species in south India. *Forest Ecology and Management* 168: 289-300.

Thring, T.S. & F.M. Weitz (2006). Medicinal plant use in the Bredeasdorp/ Elim region of the southern Overberg in the Western Cape Province of South Africa. *Journal of Ethnopharmacology* 103**:** 261-275.

Zschocke, S., T. Rabe, J.L.S. Taylor, A.K. Jager & J. Van Staden (2000). Plant part substitution–a way to conserve endangered medicinal plants. *Journal of Ethnopharmacology* 71: 281-292.

Williams, V.L., E.T.F. Witkowski & K. Balkwill (2007). Relationship between bark thickness and diameter at breast height for six tree species used medicinally in South Africa. *South African Journal of Botany* 73: 449-46.