

The population ecology of *Securidaca longepedunculata* Fresen. in the Nylsvley Nature Reserve, Limpopo Province, South Africa

Ecología poblacional de *Securidaca longepedunculata* Fresen. en la Reserva Natural Nylsvley, Provincia Limpopo, Sudáfrica

Tshisikhawe MP, O Baloyi, MH Ligavha-Mbelengwa, RB Bhat

Abstract. *Securidaca longepedunculata* Fresen., commonly known as the violet tree, belongs to the family Polygalaceae. It is widely distributed in tropical Africa, Mozambique, as well as in the North-West and Limpopo provinces of South Africa. The Vhavenda people use the roots of this species as an aphrodisiac. The species is co-dominant in the savanna vegetation of the Nylsvley Nature Reserve. This research looked at the ecology of the study species within the Nylsvley Nature Reserve because of its importance there. Understanding the population structure and environmental factors that impact on the species might help in assessing the population in urban areas. The population of the study species in the reserve displayed an adequate growth curve, when looking at its stem circumference and height-size classes. High intensity fires showed a negative effect on individuals of *S. longepedunculata*. Evidence of animals feeding on the roots at the study species was also recorded in the study.

Keywords: *Securidaca longepedunculata*; Aphrodisiac; Co-dominant species; Urban areas; Growth curve.

Resumen. *Securidaca longepedunculata* Fresen., comúnmente conocida como el árbol violeta, pertenece a la familia Polygalaceae. Está ampliamente distribuida en África tropical, Mozambique, y en las Provincias de North-West y Limpopo de Sudáfrica. La gente de Vhavenda usa las raíces de esta especie como un afrodisíaco. La especie es co-dominante en la sabana de la Reserva Natural Nylsvley. Se estudió la ecología de esta especie en dicha Reserva debido a su importancia allí. Entender la estructura de la población y los factores ambientales que impactan sobre la especie podría ayudar a evaluar su población en áreas urbanas. La población de la especie estudiada mostró una curva adecuada de crecimiento cuando se estudiaron su circunferencia de tallo y las clases de tamaño en altura. Fuegos de alta intensidad fueron perjudiciales para los individuos de la especie. También se registró evidencia en este estudio de animales que se alimentan de las raíces de *S. longepedunculata*.

Palabras clave: *Securidaca longepedunculata*; Afrodisíaco; Especie Co-dominante; Áreas urbanas; Curva de crecimiento.

INTRODUCTION

Plants are not evenly distributed in nature. There are a number of factors that influence the population dynamics and distribution pattern of plants. These factors include differences in environmental conditions, resources, neighbors and disturbance. Different environmental conditions not only can modify the distribution and abundance of individuals, but are likely to change other plant variables (e.g., growth rates, seed production, branching patterns, leaf area, root area and size of the individuals). Plant distribution, survival, and patterns of growth and reproduction reflect the plant's adaptations to a particular environment and are thus a critical part of plant ecology (Barbour et al., 1987).

Population structure in most forestry and ecological studies has been defined in terms of size-classes or the diameter distribution of individuals, with frequency histograms showing the number or percentage of individuals in each size-class (Knight, 1975; Peters, 1996). Determining the structure of a population is a first step that, combined with demographic data, such as size-specific growth rates (Condit et al., 1998), can be the basis for management (Bruna & Kress, 2002). Very little is known about the population structure of *S. longepedunculata*. Therefore, it is of great importance that we examine the population density, and distribution patterns of individuals, of this threatened species. This information will help us to develop sustainable management strategies for this species.

Securidaca longepedunculata commonly referred to as the violet tree, belongs to the family *Polygalaceae*. It is widely distributed in tropical Africa, Mozambique and the North-West and Limpopo provinces of South Africa (Van Wyk & Van Wyk, 1998). This species occurs in various types of woodlands and arid savannas over a wide range of altitudes and climates, and it is associated with sandy, acidic and rocky soils. It usually grows up to 12 m high. The leaves are alternate, simple, narrowly obovate to elliptic, thinly leathery, and the bark is pale-grey and smooth. It has white to cream flowers which attract birds, butterflies and insects. Its fruits are fleshy, spherical and orange-black when mature (Schmidt et al., 2002). It is also an ornamental species in parks and gardens because of its beautiful, attractive flowers. This plant species is facing threat of over-exploitation by people (Ndou, 2006). This is because the Vhavenda people use the roots of this species for several purposes: protection against children's illness during breastfeeding, mental disorders and sexual boost.

Securidaca longepedunculata is used as a general medicine for several other ailments such as coughs, colds, fever, back-ache, toothache, sleeping sickness, venereal diseases, malaria, inflammation, rheumatism, snakebites, tuberculosis, ulcers and pneumonia (Galeffi et al., 1990). According to Palgrave

(1977), *S. longepedunculata* is also used as a contraceptive. Neuwinger (1964) reported that in Nigeria and some other African countries like South Africa, the roots, stem, bark and leaves of *S. longepedunculata* are used as a medicine for treating crucial human and animal ailments. This earned the plant a popular vernacular name in the Hausa speaking north western part of Nigeria: "Uwar magnum guna", meaning "mother of medicines". Therefore, there is a need to introduce this useful, medicinal tree species into agroecosystems in order to prevent its extinction.

Securidaca longepedunculata is amongst the more prominent trees species of the *Burkea africana* savanna of the Nylsvley Nature Reserve. Other species in the area include *Burkea Africana*, *Terminalia sericea*, *Combretum zeyheri*, *Combretum molle*, *Ozoroa paniculosa*, *Strychnos cocculoides* and *Strychnos pungens* (Coetzee et al., 1976). It is therefore important to understand the population structure of *S. longepedunculata* since it is one of the species that characterizes the study area.

The main aim of this investigation was to study the population ecology of *S. longepedunculata* in the Nylsvley Nature Reserve, South Africa. The rationale of the study was to have an understanding of the population ecology of *S. longepedunculata*. If our study revealed that there is a healthy population in the Reserve, it could be a *S. longepedunculata* source in the event this species was depleted in urban areas as the result of over-exploitation. It would be comforting to know that there would always be a healthy population to rely on in the Nylsvley Nature Reserve. The objectives of this study were: (i) to identify threats on *S. longepedunculata* species, and (ii) to determine the population structure of *S. longepedunculata* in the Nylsvley Nature Reserve.

Study area. The research project was conducted at the Nylsvley Nature Reserve, Limpopo province, South Africa. Nylsvley Nature Reserve covers 3120 ha of mixed Bushveld (Acocks, 1953), and lies on a flat to gently undulating plain between 1080 and 1140 m.a.s.l. The mean annual rainfall is about 630 mm, and the mean annual temperature is 19.0 °C (Scholes & Walker, 1993).

The reserve comprises the farm Nylsvley 560 KR, located on the Springbok Flats, 10 km South from Mookgophong, Limpopo Province, South Africa (24° 36'– 24° 42' S, 28° 40'– 28° 44' E). Two hills feature prominently: Maroelakop (1140 m) in the south-west, and Stemmerskop (1090 m) slightly west of the former.

The area is bisected by the Nyl River which flows along a shallow valley from south-west to north-east. The soil to the south and east is essentially sandy, with the exception of Maroelakop and Stemmerskop which are formed by sandstones of the Waterberg System. The area to the west and north is underlain by loam or clay, particularly along the flat country flanking the Nyl River.

MATERIALS AND METHODS

Site selection. The *Burkea africana* savanna, where *S. longepedunculata* is located in the reserve (Coetzee et al., 1976 in Scholes & Walker, 1993), was selected and sampled using the line transect method.

Vegetation sampling. A line transect method was used to sample a population of *S. longepedunculata*. A 50 m tape was laid down and individuals, which included seedlings, juveniles and mature trees within 5 m on both sides of the 50 m tape, were sampled. A number of 50 x 10 m transects were therefore sampled. All plots in this study were marked by the Garmin Extrek GPS, and pictures during sampling were captured by a Sony Mavica MVC-FD75 digital camera. Plant heights were measured by using an 8 m high rod. The following parameters were recorded: (i) basal stem circumference (cm), (ii) plant height (m), (iii) damage estimates on a sliding scale of 0-5, and (iv) crown health estimates on a sliding scale of 0-5.

Population structure and status. Size-class distribution. Stem circumference measurements (cm) were taken on each basal area of the individuals. Basal area measurements were used instead of diameter at breast height (DBH) because most plants were multi-stemmed at breast height.

Plant height measurements. Plant height measurements were recorded in meters (m). Estimates were done where individuals were taller than the fully stretched 8 m rod.

Crown health. The assessment of crown health was made using a sliding scale of 0 to 5 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.

Disturbance damage. The damage intensity was also estimated using a sliding scale of 0 to 5 as follows:

- 0 - No damage,
- 1 - Traces of damage,
- 2 - Light damage,
- 3 - Moderate damage,
- 4 - Severe damage,
- 5 - 100% damage.

Population density. After sampling eighty 50 m x 10 m transects, the area sampled within the reserve was 40000 m² (50 m x 10 x 80 m). Two hundred and thirty two individuals were sampled within this area. Density of the *S. longepedunculata* population was then calculated as follows:

$$\text{Density} = \frac{\text{Number of individuals sampled}}{\text{Total area sample}}$$

Population structure. The population structure of *S. longepedunculata* was expressed through a stem circumference size-class distribution and a plant height size-class distribution.

RESULTS AND DISCUSSION

Population structure and status. Size-class distribution. Density of *S. longepedunculata* was 0.0058 individuals/m² (58 individuals/ha). Stem circumference size-class 0 cm - 20 cm showed high number of individuals (n = 117), and an extreme decrease in such number in the size-class of 20.1 cm - 40 cm (n = 24) (Table 1, Fig. 1). A healthy plant population is able to produce a large number of seedlings which proceed to become older individuals (Siaga, 2006). In the present study, it is evident that there were a high number of small circumference size-class individuals. There were difficulties in recruiting larger circumference size-classes, since there were a low number of mature trees. This might be due to certain growth limiting factors such as interspecific and intraspecific competition between seedlings for space and resources (e.g., sunlight, nutrients, moisture).

Table 1. Stem circumference size-class distribution of *S. longepedunculata* in the Nylsvley Nature Reserve. Frequency is taken as the number of individuals in any give size-class from the total population number. Data collected in July 2008.

Tabla 1. Distribución de las clases de tamaño de la circunferencia del tallo de *S. longepedunculata* en la Reserva Natural Nylsvley. En cualquier clase de tamaño, la frecuencia se refiere al número de individuos de dicha clase con respecto al número total de individuos de la población. Los datos se recolectaron en julio 2008.

Stem circumference size classes (cm)	Frequency (n)
0 - 20	117
20.1 - 40	24
40.1 - 60	12
60.1 - 80	18
80.1 - 100	27
100.1 - 120	15
120.1 - 140	10
140.1 - 160	2
160.1 - 180	5
180.1 - 200	0
200.1 - 220	1
220.1 - 240	0
240.1 - 260	0
260.1 - 280	1

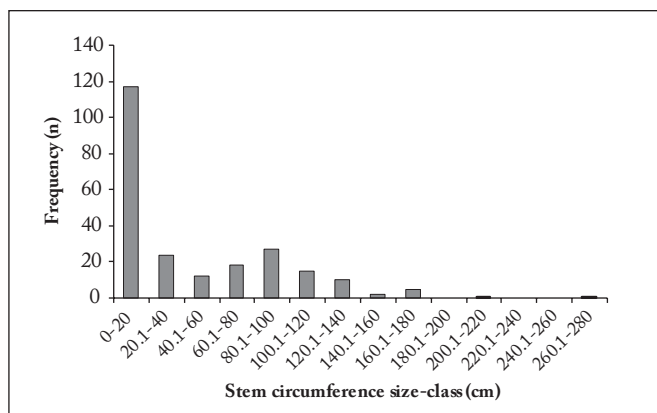


Fig. 1. Stem circumference size-class distribution of *S. longepedunculata* in the Nylsvley Nature Reserve. Frequency is taken as the number of individuals in any give size-class from the total population number. Data collected in July 2008.

Fig. 1. Distribución de las clases de tamaño de la circunferencia del tallo de *S. longepedunculata* en la Reserva Natural Nylsvley. En cualquier clase de tamaño, la frecuencia se refiere al número de individuos de dicha clase con respecto al número total de individuos de la población. Los datos se recolectaron en julio 2008.

Plant height measurements. Table 2 shows two hundred and thirty two individuals that were categorized into six plant height size-classes (see also Figure 2). Their percentages were also calculated.

Figure 2 shows an irregular shape, but from this pattern it is clear that the height class of 0 m - 2 m showed the highest number of individuals, and there was a decrease in the number of individuals from this to the remaining size-classes. Very few individuals were recruited into large-scale plant-height classes (Fig. 2). *Burkea Africana* is a dominant species in the area, thus occupying a large area, and might be inhibiting the establishment of other species.

Table 2: Plant height size-class distribution of *S. longepedunculata* in the Nylsvley Nature Reserve in July 2008. Frequency is expressed either as the number or percentage in any given class with respect to the total population.

Tabla 2. Distribución del tamaño de clases de altura de la planta de *S. longepedunculata* en la Reserva Natural Nylsvley en julio 2008. La frecuencia se expresa como el número o porcentaje en cualquier clase de tamaño con respecto al total de la población.

Plant height (m)	Frequency	
	Number	Percentage
0 - 2	100	43%
2.1 - 4	33	14%
4.1 - 6	18	8%
6.1 - 8	40	17%
8.1 - 10	31	13%
10.1 - 12	10	4%

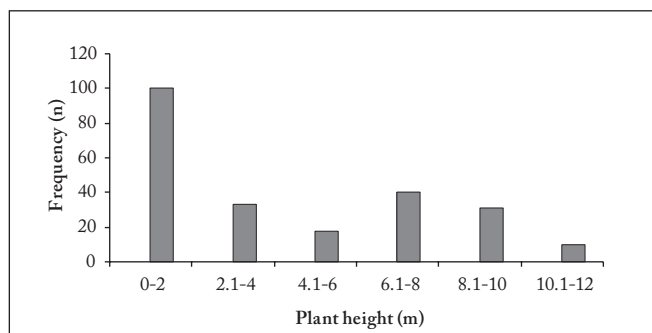


Fig. 2. Height size-class distribution of *S. longepedunculata* in the Nylsvley Nature Reserve. Frequency is taken as the number of individuals in any give size-class from the total population number. Data were collected in July 2008.

Fig. 2. Distribución de clases de tamaño de altura de *S. longepedunculata* en la Reserva Natural Nylsvley. En cualquier clase de tamaño, la frecuencia se refiere al número de individuos de dicha clase con respecto al número total de individuos de la población. Los datos se recolectaron en julio 2008.

Once again, there were a small number of individuals from the total population in the higher plant height size-classes (Fig. 2). If new seedlings are not recruited well into the adult population, it means that the population may become locally extinct (Ryniker et al., 2006). This can only be prevented by optimizing the Nature Reserve management strategies (i.e., by making sure that attention is given to juveniles in their management plans). Some other studies (Ryniker et al., 2006; Roder & Kiehl, 2006) suggest that the practice of fire has to be regular, and that an increase in browsers does play a role in opening space. This would allow plants the availability of resources which were not previously available to suppressed individuals, thus reducing intra – and interspecific competition.

Crown health. Most individuals (76%) of the population of *S. longepedunculata* have either healthy or just traces of crown damage (Fig. 3). Four percent (n = 9) of the population showed severely damaged crowns, and one percent (n = 3) was completely dead (Fig. 3). The low damage to crown health might have been due to the fire regime that is in practice in the Reserve.

Damage estimates. Most (45%) of the study individuals were not damaged at all (Fig. 4). Five percent of the sampled individuals were severely damaged, while one percent showed 100% mortality as a result of stem damages (Fig. 4).

The two main disturbances which seemed to have an effect on *S. longepedunculata* are fire and digging of roots by small animals in the Nature Reserve. Other than these two disturbances there were no large-scale incidences of population disturbances. Fires seemed to have a negative impact on mature trees by damaging their canopies and stems. However, seedlings seemed to have been regenerating well at the time of data collection after the fire events. Since the area is a protected Natural Reserve, there were no signs of human-impact through utilization of the species for any purpose.

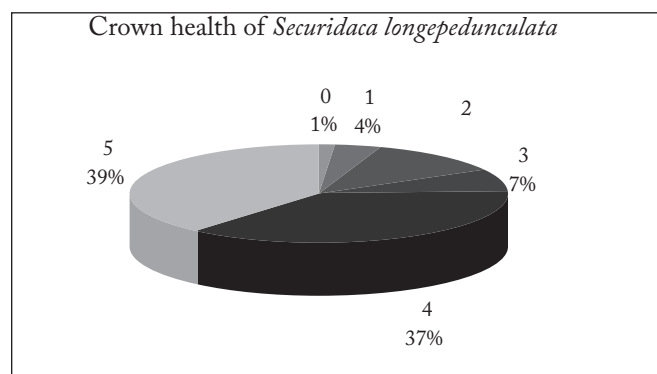


Fig. 3. Crown health class-size distribution (see the Methods Section for detail of classes from 0 to 5) of *S. longepedunculata* in the Nylsvley Nature Reserve in July 2008. Frequency is the percentage in any given size-class (0 to 5) with respect to the total population.

Fig. 3. Distribución del tamaño de clases de la salud de la corona (ver la Sección Métodos para detalles de las clases de 0 a 5) en *S. longepedunculata* en la Reserva Natural Nylsvley en julio 2008. La frecuencia es el porcentaje en cualquier clase de tamaño (0 a 5) con respecto al total de la población.

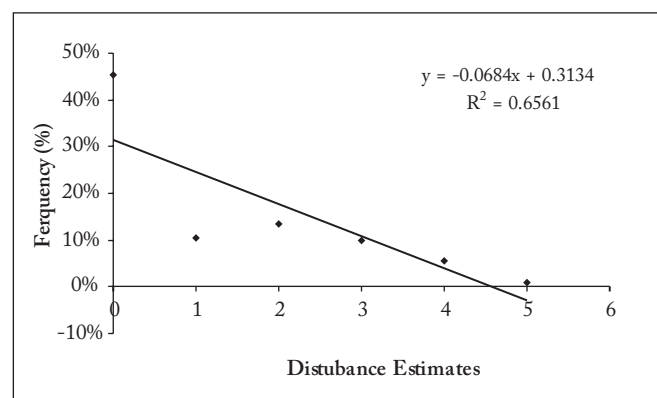


Fig. 4. Damage estimates of *S. longepedunculata* in percentages from the sliding scale of 0 to 5 on data collected from the Nylsvley Nature Reserve in July 2008. On the sliding scale, 0 indicated individuals with no damage and 5 indicated individuals with 100% damage. Each symbol is the percentage of individuals in that damage class from the total population (n=232). Data adjusted using simple linear progression.

Fig. 4. Estimaciones de daño de *S. longepedunculata* en porcentaje a partir de la escala de 0 a 5 (ver Métodos) en los datos recolectados en la Reserva Natural Nylsvley en julio 2008. En la escala, 0 indica individuos no dañados y 5 indica individuos con 100% de daño. Los datos se ajustaron usando regresión lineal.

CONCLUSIONS

The population of *S. longepedunculata* in the Nylsvley Nature Reserve is mostly healthy. It means that in the future there will be resources to use for scientific researchers or medicinal purposes. This is very comforting since the species is

getting depleted in urban lands. Lubke et al. (1983) found only thirteen individuals of *S. longepedunculata* in the Nature Reserve during their work in 1983. In the present study, two hundred and thirty two individuals were sampled in the same reserve. It therefore confirms that the population is expanding. Now that the study has revealed a healthy population of *S. longepedunculata* in the protected area, it is recommended that this kind of study should be undertaken in communal areas. This is to have a comparison and implement strategies in which the resources can be utilized in a sustainable manner by the local people.

Reserve managers are advised to burn the area when the fuel load is low so that the fire intensity does not have a negative impact on the growth of plants. Fire and digging by small animals were the only two main threats identified within the population of *S. longepedunculata*.

ACKNOWLEDGEMENTS

We thank the assistance received from the following people: Mr. K. Magwede, Ms. Legodi, Maeko T.L., Makubedu I.T., Tshautshau, and Rasekgala M. We also thank the management of the Nylsvley Nature Reserve for granting us the permission to conduct the study in their facility. The University of Venda is acknowledged for financial support.

REFERENCES

- Acocks, J.P.H. (1953). Veld Types of South Africa. *Botanical Survey South Africa* 28: 1-192.
- Barbour, M.G., J.H. Burk & W.D. Pitts (1987). *Terrestrial Plant Ecology*. 2nd edition. -The Benjamins/Cumings Publishing Company. Inc U.S.A.
- Bruna, E.M. & W.J. Kress (2002): Habitat fragmentation and the demographic structure of an Amazonian understory herb (*Heliconia acuminata*). *Conservation Biology* 16: 1256-1266.
- Coetzee, B.J., F. Van der Meulen, S. Zwanziger, P. Gonsalves & P. Weisser (1976). A phytosociological classification of the Nylsvley Nature Reserve. *Bothalia* 12: 137-160.
- Condit, R., R. Sukumar, S.P. Hubbell, & R. Foster (1998). Predicting population trends from size distribution: a direct test in a tropical tree community. *American Naturalist* 152: 495-509.
- Galeffi, G., E. Federici, J.D. Msonthi, G.B. Marini-Bettolo, & M. Nicolette (1990). New Xanthones from *Extiadiopsis oblongifolia* and *Securidaca longepedunculata*. *Fitoterapia* 61: 79-81.
- Knight, D.H. (1975). A phytosociological analysis of species-rich tropical forest on Barro Colorado Island, Panama. *Ecological Monographs* 45: 259-284.
- Lubke, R.A., J.W. Morris, G.K. Theron, & N. Van Rooyen (1983). Diversity, structure and pattern in Nylsvley vegetation. *South African Journal of Botany* 2: 26-41.
- Neuwinger, H.D. (1964). *Afrikanische Arzneipflanzen und Jaydgifte*. Wissenschaftliche Verlagsgesellschaft, Stuttgart.
- Ndou, A.P. (2006). *Securidaca longepedunculata* Fresen. Honours Thesis. Botany Department, University of Venda, South Africa. <http://www.plantzafrika.com/plantqrs/securilong.htm>.

- Palgrave, K.C. (1977). *Trees of South Africa*. Struik Publishers (pty) Ltd. Cape Town, South Africa. pp. 388-389.
- Peters, C.M. (1996). Chapter I-II: Introduction to ecology of tropical forest resources, pp5-91. In: *The ecology and management of non-Timber forest resources*. World Bank. Technical papers number 322. The World Bank.
- Roder, D. & K. Kiehl (2006) Population structure and population dynamics of *Pulsatilla patens* (L.) Mill. in relation to vegetation characteristics. *Flora* 201: 499-507.
- Ryniker, K.A., J.K. Bush & O.W. Van Auken (2006). Structure of *Quercus gambelii* communities in the Lincoln National forest, New Mexico, USA. *Journal of Forest Ecology and Management* 233: 69-77.
- Siaga, N.M. (2006). Population dynamics of *Millettia stuhlmannii* Taub. population of Ha-Makhuvha, Vhembe district in Limpopo province. Honours Thesis. University of Venda, South Africa.
- Schmidt, E., M. Lotter & W. Mcclelland, W. (2002). *Trees and Shrubs of Mpumalanga and Kruger National Park*. Jacaranda Publications. Johannesburg, South Africa.
- Scholes, R.J. & B.H. Walker (1993). *An African savanna: synthesis of the Nylsvley study*. Cambridge University Press. Cambridge, Great Britain.
- Van Wyk, A.E. & P. Van Wyk (1998). *Field guide to trees of Southern Africa*. Struik Publishers. Cape Town, South Africa.