Journal of Threatened Taxa

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ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

Short Communication

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26 August 2020 | Vol. 12 | No. 11 | Pages: 16614–16619
DOI: 10.11609/jott.5728.12.11.16614-16619

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 August 2020 | 12(11): 16614–16619
ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)
DOI: https://doi.org/10.11609/jott.5728.12.11.16614-16619
#5728 | Received 23 January 2020 | Final received 31 July 2020 | Finally accepted 06 August 2020
PLATINUM OPEN ACCESS

SHORT COMMUNICATION

Evaluating threats and conservation status of South African *Aloe*

Samuel O. Bamigboye

Botany Department, School of Mathematical and Natural Sciences, University of Venda, 0950, South Africa.
reachtoba@gmail.com

Abstract: South Africa is one of the biodiversity hotspots for *Aloe* in Africa. This makes it important to evaluate the conservation status and threats to this genus. The South African National Biodiversity Institute (SANBI) Red List was employed to evaluate these two factors. Results revealed that 44% of all species in this genus are of conservation concern with the majority of them facing threats. This study recommends that more attention such as strengthening the protection of these species and controlling the threats identified in this study should be given to species in this genus in terms of conservation management to reduce their risk of extinction.

Keywords: Asphodelaceae, biodiversity loss, extinction risk, hotspot, threatened species.

The genus *Aloe* belongs to the Asphodelaceae family (Cousins & Witkowski 2012). Biodiversity hotspots for this genus in Africa are located in Ethiopia, Madagascar and southern Africa (Grace 2009), which coincide with Africa's main biodiversity hotspots (Daru et al. 2013).

Aloes are important to any ecosystems where they are found (Cousins & Witkowski 2012). Their nectar is a source of food for many insects (Nicolson & Nepi 2005; Botes et al. 2009a,b) and avians (Symes et al. 2008; Forbes et al. 2009). They also modulate harsh environmental conditions, which facilitate colonization of the environment by other plant taxa (Wabuyele & Kyalo 2008). Their mat-like root that is dense assist in preventing soil erosion (Smith & Van Wyk 2009).

Some species of this genus are traded commercially as cosmetics (Grace et al. 2015) and medicine (Bjorå et al. 2015). This has led *Aloe* to become threatened, with the majority of species in this genus being included in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Grace 2011). This implies that conservation of the species in this genus should be given a high priority, especially in areas that are hotspots of this genus (Klopper & Smith 2013).

This study evaluated the conservation status and threats of *Aloe* in South Africa to determine which species in this genus are threatened, and to determine factors responsible for their risk of extinction. Unlike some previous studies that mentioned the overall conservation status of the genus *Aloe* (e.g., Grace et al. 2009; Cousins & Witkowski 2012), this study showed the conservation status and threats each species of *Aloe* is facing using the South African National Red List, and also quantified in percentages species in this genus under different Red List categories and threat categories.

Methods

This study used the SANBI Red List 2017 version to evaluate threats and conservation status of South

Editor: Martin Potgieter, University of Limpopo, Sovenga, South Africa. **Date of publication:** 26 August 2020 (online & print)

Citation: Bamigboye, S.O. (2020). Evaluating threats and conservation status of South African *Aloe*. *Journal of Threatened Taxa* 12(11): 16614–16619. https://doi.org/10.11609/jott.5728.12.11.16614-16619

Funding: None.

Competing interests: The author declares no competing interests.

African *Aloe*. The following percentages were calculated: the species that are highly threatened, threatened and of conservation concern (Critically Endangered, Endangered, Vulnerable, Near Threatened, Rare, and Data Deficient); *Aloe* species that fall under different categories of threats (Habitat destruction, individual's collection, invasive species occurrence, fire occurrence, overgrazing, and insect attack); species endemic and non-endemic to South Africa; threatened endemic species; and endemic species that are of conservation concern and different categories of threats (habitat destruction, individual's collection, invasive species occurrence, fire occurrence, overgrazing, and insect attack) to endemic species.

Results and Discussion

Endemic and non-endemic species of the genus *Aloe* in South Africa

A total of 125 taxa belonging to the genus *Aloe* were listed in the South African National Red List; 61.6% of species in the genus *Aloe* found in the South African National Red List are endemic, while 38.4% are non-endemic. Species endemism is an important factor to be considered in conservation because the loss of endemic species is of high significant impact in biodiversity loss in any geographic areas that they occur (Moraswi et al. 2019). A population survey of endemic taxa should be encouraged to determine their population size, density, and distribution in order to reveal their current population trend. This information will inform appropriate conservation measures, which are adaptive to local conditions.

Highly threatened, threatened, and species of conservation concern in South African *Aloe*

The various threat status categories of South African *Aloe* are: 52.8% (Least Concern), 10.4% (Rare), 2.4% (Data Deficient), 3.2% (Data Deficient, taxonomically problematic), 10.4% (Near Threatened), 11.2% (Vulnerable), 4% (Endangered), 5.6% (Critically Endangered), 44% are of conservation concern (Critically Endangered, Endangered, Vulnerable, Near Threatened, Rare, and Data Deficient). Species that are highly threatened are referred to as Critically Endangered (Williams et al. 2013) because they are at the brink of extinction. *Aloe* species in this study that falls into this category (Table 1) should be given quick conservation intervention such as preventing further collection by people, minimizing habitat loss, and improving on their regeneration potentials to prevent complete extirpation of their populations. Some plant species are not threatened, but can be flagged and given priority in terms of conservation, and thus be referred to as species of conservation concern (Victor & Keith 2004). Species of conservation concern in this study that are not threatened should be monitored to determine if they have become threatened (Table 1). For instance Data deficient taxa could possibly be threatened (Moraswi et al. 2019). This is why further efforts is required to obtain sufficient information about them in order to determine if they are threatened or not.

Threats to South African endemic and non-endemic *Aloe* species

Percentages of taxa in the genus *Aloe* in South Africa facing different types of threats are as follows: 41.6% are threatened by habitat destruction, 16.8% are threatened due to individual's collection, 14.4% threatened by occurrence of invasive species, 5.6% are threatened because of fire occurrences, 11.2% are threatened by overgrazing, 0.8% threatened due to insect attack, while there are no threats found for 42.4% of the taxa. *Aloe* species are generally threatened by habitat destruction and collection by people (Klooper et al. 2009), a situation also reflected in this study. The collection by people are majorly due to medicinal uses and horticultural uses which might be affecting the wild population of these taxa (Grace 2011). Enforcement of regulation restricting the collections of these taxa should be more encouraged. It must be noted that a thorough assessment of those species for which their threats are unknown can significantly change the results pattern in the threat categories as presented above.

Threats to endemic species of South African *Aloe*

The results of the percentages of endemic species of South African *Aloe* facing different kind of threats are as follows: 57% are affected by habitat destruction, 23.4% affected by Individual's collection, 17% are affected by invasive species, 9% by fire occurrence, 13% by overgrazing, while there are no threats found for 26% of the endemic species. Habitat destruction and collection by people still stood out among the threats to endemic South African *Aloe* species. It is recommended that species for whom their threats are not known (Table 1) be further assessed. Thus, it is possible that a reassessment of these species can alter the results presented above.

Conservation status of endemic species in South African *Aloe*

The results of the percentages of endemic *Aloe*

Table 1. List of *Aloe* species in South Africa, their SANBI Red List Status, their endemism status and their threats on SANBI Red List.

Species	SANBI Red List status	Endemism status	Threats
Aloe aculeata Pole-Evans	Least Concern	Not endemic	No threat
Aloe affinis A.Berger	Least Concern	Not endemic	Habitat destruction
Aloe africana Mill.	Least Concern	Endemic	Habitat destruction
Aloe albida (Stapf) Reynolds	Near Threatened	Not endemic	Habitat destruction
Aloe alooides (Bolus) Druten	Least Concern	Endemic	Habitat destruction
Aloe ammophila Reynolds	Least Concern	Endemic	No threat
Aloe angelica Pole-Evans	Least Concern	Endemic	Habitat destruction
Aloe arborescens Mill.	Least Concern	Not endemic	No threat
Aloe arenicola Reynolds	Near Threatened	Endemic	No threat
Aloe barbara-jeppeae T.A.McCoy & Lavranos	Near Threatened	Endemic	Habitat destruction
Aloe bergeriana (Dinter) Boatwr. & J.C.Manning	Data Deficient	Not endemic	Habitat destruction
Aloe bowiea Schult. & J.H.Schult.	Critically Endangered	Endemic	Habitat destruction
Aloe braamvanwykii Gideon F.Sm. & Figueiredo	Endangered	Endemic	Habitat destruction
Aloe branddraaiensis Groenew.	Least Concern	Endemic	Habitat destruction
Aloe brevifolia Mill. var. brevifolia	Vulnerable	Endemic	Habitat destruction, invasive presence, individual's collection
Aloe brevifolia Mill. var. depressa (Haw.) Baker	Data Deficient taxonomically problematic	Endemic	Habitat destruction
Aloe broomii Schönland var. *broomii*	Least Concern	Not Endemic	No threat
Aloe broomii Schönland var. *tarkaensis* Reynolds	Rare	Endemic	No threat
Aloe buhrii Lavranos	Vulnerable	Endemic	Individual's collection, habitat destruction
Aloe castanea Schönland	Least Concern	Endemic	No threat
Aloe chabaudii Schönland var. *chabaudii*	Least Concern	Not endemic	No threat
Aloe challisii Van Jaarsv. & A.E.van Wyk	Vulnerable	Endemic	Individual's collection, invasive presence
Aloe chlorantha Lavranos	Vulnerable	Endemic	Insect attack
Aloe chortoliriioides A.Berger var. chortolirioides	Vulnerable	Not endemic	Habitat destruction, invasive presence, fire occurrences,
Aloe chortoliriioides A.Berger var. *woolliana* (Pole-Evans) Glen & D.S.Hardy	Least Concern	Endemic	Habitat destruction, fire occurrences
Aloe claviflora Burch.	Least Concern	Not endemic	No threat
Aloe comosa Marloth & A.Berger	Least Concern	Endemic	Individuals collection, habitat destruction
Aloe condyae Van *Jaarsv*. & P.Nel	Vulnerable	Endemic	Invasive presence
Aloe cooperi Baker	Least Concern	Not endemic	Habitat destruction, overgrazing, invasive presence
Aloe craibii Gideon F.Sm.	Critically Endangered	Endemic	Individual's collection, fire occurrences, invasive presence, habitat destruction
Aloe cryptopoda Baker	Least Concern	Not endemic	No threat
Aloe dabenorisana Van *Jaarsv.*	Rare	Endemic	Individual's collection
Aloe dewetii Reynolds	Least Concern	Not endemic	No threat
Aloe dominella Reynolds	Near Threatened	Endemic	Habitat destruction, overgrazing, fire occurrences, invasive presence
Aloe dyeri Schönland	Least Concern	Not endemic	No threat
Aloe ecklonis Salm-Dyck	Least Concern	Not endemic	Habitat destruction, invasive presence
Aloe excelsa A.Berger var. *excelsa*	Least Concern	Not endemic	No threat
Aloe falcata Baker	Least Concern	Not endemic	Individual's collection, overgrazing
Aloe ferox Mill.	Least Concern	Not endemic	Individual's collection, habitat destruction, overgrazing
Aloe fosteri Pillans	Least Concern	Endemic	No threat

Species	SANBI Red List status	Endemism status	Threats
Aloe fouriei D.S.Hardy & Glen	Data Deficient taxonomically problematic	Endemic	Habitat destruction, overgrazing
Aloe framesii L.Bolus	Near Threatened	Endemic	Habitat destruction
Aloe gariepensis Pillans	Least Concern	Not endemic	No threat
Aloe gerstneri Reynolds	Vulnerable	Endemic	Habitat destruction, Overgrazing
Aloe glauca Mill.	Least Concern	Endemic	No threat
Aloe globuligemma Pole-Evans	Least Concern	Not endemic	No threat
Aloe graciliflora Groenew.	Least Concern	Endemic	No threat
Aloe grandidentata Salm-Dyck	Least Concern	Not endemic	No threat
Aloe greatheadii Schönland var. *davyana* (Schönland) Glen & D.S.Hardy	Least Concern	Not endemic	No threat
Aloe greatheadii Schönland var. *greatheadii*	Least Concern	Not endemic	No threat
Aloe greenii Baker	Least Concern	Not endemic	No threat
Aloe hahnii Gideon F.Sm. & R.R.Klopper	Near Threatened	Endemic	Habitat destruction
Aloe hardyi H.F.Glen	Rare	Endemic	No threat
Aloe hereroensis Engl. var. hereroensis	Least Concern	Not endemic	No threat
Aloe humilis (L.) Mill.	Least Concern	Endemic	Habitat destruction, individual's collection
Aloe inconspicua Plowes	Endangered	Endemic	Habitat destruction, overgrazing
Aloe integra Reynolds	Vulnerable	Not endemic	Habitat destruction, invasive presence, fire occurrences
Aloe jeppeae Klopper & Gideon F.Sm.	Least Concern	Endemic	No threat
Aloe kamnelii Van Jaarsv.	Rare	Endemic	No threat
Aloe karasbergensis Pillans	Least Concern	Not endemic	No threat
Aloe knersvlakensis S.J.Marais	Rare	Endemic	No threat
Aloe kniphofioides Baker	Vulnerable	Endemic	Habitat destruction, fire occurrences
Aloe komaggasensis Kritzinger & Van Jaarsv.	Vulnerable	Endemic	Individual's collection, habitat destruction, overgrazing
Aloe komatiensis Reynolds	Endangered	Not endemic	Habitat destruction, invasive presence
Aloe kouebokkeveldensis Van Jaarsv. & A.B.Low	Rare	Endemic	No threat
Aloe krapohliana Marloth	Data Deficient	Endemic	Individual's collection, habitat destruction, overgrazing
Aloe lettyae Reynolds	Endangered	Endemic	Habitat destruction, invasive occurrence, overgrazing, fire occurrences
Aloe linearifolia A.Berger	Near Threatened	Endemic	Habitat destruction, overgrazing
Aloe lineata (Aiton) Haw. var. *lineata*	Least Concern	Endemic	Habitat destruction
Aloe lineata (Aiton) Haw. var. *muirii* (Marloth) Reynolds	Least Concern	Endemic	No threat
Aloe littoralis Baker	Least Concern	Not endemic	No threat
Aloe longistyla Baker	Data Deficient	Endemic	Individual's collection, habitat destruction, overgrazing
Aloe lutescens Groenew.	Least Concern	Not endemic	No threat
Aloe maculata All.	Least Concern	Not endemic	No threat
Aloe marlothii A.Berger subsp. *marlothii*	Least Concern	Not endemic	No threat
Aloe marlothii A.Berger subsp. *orientalis* Glen & D.S.Hardy	Least Concern	Not endemic	No threat
Aloe melanacantha A.Berger	Least Concern	Not endemic	No threat
Aloe meyeri Van Jaarsv.	Rare	Not endemic	No threat
Aloe micracantha Haw.	Near Threatened	Endemic	Habitat destruction, invasive presence
Aloe microstigma Salm-Dyck	Least Concern	Not endemic	No threat
Aloe minima Baker	Least Concern	Not endemic	Habitat destruction
Aloe modesta Reynolds	Vulnerable	Endemic	Habitat destruction, Invasive presence

Species	SANBI Red List status	Endemism status	Threats
Aloe monotropa I.Verd.	Vulnerable	Endemic	Individual's collection
Aloe mudenensis Reynolds	Least Concern	Endemic	Habitat destruction
Aloe myriacantha (Haw.) Schult. & J.H.Schult.	Least Concern	Not endemic	Invasive occurrences
Aloe neilcrouchii R.R.Klopper & Gideon F.Sm.	Endangered	Endemic	Habitat destruction
Aloe neilcrouchii R.R.Klopper & Gideon F.Sm.	Critically Endangered	Endemic	Habitat destruction
Aloe nubigena Groenew.	Rare	Endemic	Habitat destruction
Aloe parvibracteata Schönland	Least Concern	Not endemic	No threat
Aloe pearsonii Schönland	Vulnerable	Not endemic	Overgrazing
Aloe peglerae Schönland	Critically Endangered	Endemic	Habitat destruction, individual's collection
Aloe perfoliata L.	Least Concern	Endemic	No threat
Aloe petricola Pole-Evans	Least Concern	Endemic	Habitat destruction
Aloe petrophila Pillans	Rare	Endemic	No threat
Aloe pictifolia D.S.Hardy	Rare	Endemic	No threat
Aloe pluridens Haw.	Least Concern	Endemic	No threat
Aloe pratensis Baker	Least Concern	Not endemic	Habitat destruction, individual's collection
Aloe pretoriensis Pole-Evans	Least Concern	Not endemic	Habitat destruction
Aloe prinslooi I.Verd. & D.S.Hardy	Near Threatened	Endemic	Individual's collection and invasive presence
Aloe pruinosa Reynolds	Vulnerable	Endemic	Habitat destruction, individual's collection, invasive occurrence
Aloe reitzii Reynolds var. *reitzii*	Near Threatened	Endemic	No threat
Aloe reitzii Reynolds var. *vernalis* D.S.Hardy	Critically Endangered	Endemic	Individual's collection
Aloe reynoldsii Letty	Rare	Endemic	Individual's collection
Aloe rupestris Baker	Least Concern	Not endemic	No threat
Aloe saundersiae (Reynolds) Reynolds	Critically Endangered	Endemic	Habitat destruction, overgrazing, fire occurrences
Aloe sharoniae N.R.Crouch & Gideon F.Sm.	Least Concern	Not endemic	Habitat destruction
Aloe simii Pole-Evans	Critically Endangered	Endemic	Habitat destruction, Invasive presence
Aloe soutpansbergensis I.Verd.	Rare	Endemic	Individual's collection
Aloe speciosa Baker	Least Concern	Endemic	No threat
Aloe spectabilis Reynolds	Least Concern	Endemic	No threat
Aloe spicata L.f.	Least Concern	Not endemic	No threat
Aloe striata Haw.	Least Concern	Endemic	No threat
Aloe succotrina Lam.	Least Concern	Endemic	No threat
Aloe suffulta Reynolds	Least Concern	Not Endemic	No threat
Aloe suprafoliata Pole-Evans	Least Concern	Not Endemic	No threat
Aloe thompsoniae Groenew.	Rare	Endemic	No threat
Aloe thorncroftii Pole-Evans	Near Threatened	Endemic	Habitat destruction, invasive presence
Aloe thraskii Baker	Near Threatened	Endemic	Habitat destruction, individual's collection
Aloe vanbalenii Pillans	Least Concern	Not endemic	No threat
Aloe vanrooyenii Gideon F.Sm. & N.R.Crouch	Least Concern	Endemic	No threat
Aloe verecunda Pole-Evans	Least Concern	Endemic	Habitat destruction
Aloe vogtsii Reynolds	Near Threatened	Endemic	Habitat destruction
Aloe vossii Reynolds	Data Deficient taxonomically problematic	Endemic	Habitat destruction, fire occurrences, Invasive presence
Aloe vryheidensis Groenew.	Data Deficient taxonomically problematic	Endemic	Habitat destruction
Aloe zebrina Baker	Least Concern	Not endemic	No threat

taxa in South Africa on SANBI Red List threat status categories are as follows: 32.4% (Least Concern), 5.2% (Data Deficient taxonomically problematic), 2.6% (Data Deficient), 15.6% (Rare), 15.5% (Near Threatened), 14.3% (Vulnerable), 5.2% (Endangered) and 9.1% (Critically Endangered); 28.6% of the endemic species in this genus are threatened (Critically Endangered, Endangered, Vulnerable); 62.3% of the endemic species are of conservation concern (Critically Endangered, Endangered, Vulnerable, Near Threatened, Rare, and Data Deficient). Endemic plant species are more vulnerable to extinction (Williams et al. 2013) because they are restricted to certain geographic regions and the total extirpation of their populations in that region automatically result in total extinction of the species (Bamigboye 2019). This is also being clearly revealed in this study as all the Critically Endangered *Aloe* species in this study are endemic species, which further supports the notion that a more proactive conservation intervention should be given to these species.

Conclusion

This study presents the current conservation status, endemic status and threats that each species of *Aloe* in South African Red List are facing. It also quantifies the percentages of species in this genus that fall into different SANBI Red List categories, threat categories, and endemism categories. This study provides information on the species of *Aloe* in South Africa that need more conservation attention. For instance the Critically Endangered species in this study that are all endemic species (Table 1) can be given higher priorities for conservation. Conservation status of species changes over time (Bamigboye et al. 2016). It is recommended that South African *Aloe* should be further evaluated to see if they have become more threatened in recent times or not. A recent evaluation will also reveal if the ones that are not threatened on SANBI Red List are now threatened.

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Journal of Threatened Taxa

www.threatenedtaxa.org

PLATINUM OPEN ACCESS

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

August 2020 | Vol. 12 | No. 11 | Pages: 16407–16646
Date of Publication: 26 August 2020 (Online & Print)
DOI: 10.11609/jott.2020.12.11.16407-16646

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