



Preliminary evaluation of the status of *Aloe castellorum* J.R.I. Wood (Asphodelaceae Juss.) in the Arabian Peninsula

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Abstract

Plant conservation planning requires assessing and monitoring the natural vegetation and the flora, particularly rare, endangered, and endemic species. A study aims to explain the status of an Arabian Peninsula endemic plant named *Aloe castellorum* J.R.I. Wood to aid conservation efforts. Around the world, this plant has only been recorded in Yemen and Saudi Arabia. This species' status and distribution range on the Arabian Peninsula has not been assessed. In order to assess and evaluate *A. castellorum* according to IUCN categories, the principles and criteria of the IUCN Red List were used and the EOO (Extent of Occurrence) and AOO (Area of Occupancy) of this species were measured using ArcMap 10.8. The geographical range of this endemic plant has been plotted. In addition, the species is described and illustrated.

Keywords: *Aloe castellorum*, Arabian Peninsula, Conservation, evaluation, IUCN

Introduction

IUCN is the International Union for Conservation of Nature's Red List and it is one of the most effective assessment systems for categorizing the status of threatened plants (Dublin, [14]). The importance of conservation and protection assessments for rare, endemic, and endangered plant species as a tool for conservation and preservation planning, management, and monitoring has grown and become increasingly essential tools (Rodrigues *et al.*, [26]; Sebsebe and Norda, [27]).

Aloe species are used for medicine, food, and ornamental plants, and they play an important role in sustaining national and individual incomes throughout their distribution areas [Grace *et al.*, [15]; Carter *et al.*, [10]. According to the APG IV system [7], the genus *Aloe* belongs to the Asphodelaceae, subfamily Asphodeloideae. The *Aloe* genus contains 600–650 taxa, including subspecies and varieties (Holland, [16]; Klopper & Smith, [19]; Amir *et al.*, [5]. The genus *Aloe* is thought to have originated in the SE African highlands (Holland, [16] and distributed throughout Africa, Madagascar, the Arabian Peninsula, India, and Ocean islands (Reynolds, [25]; Castillon & Castillon, [11]; Amir *et al.*, [5]; Mittermeier *et al.*, [23]).

Aloe species in Southwest Arabia show a high degree of endemism. Almost all *Aloe* species of the Arabian Peninsula are endemic, except *Aloe inermis*, *A. luntii*, and *Aloe vera* which have been found outside Arabia (Wood, [30]; Baker, [8]; Thulin, [29]. 35 species and 2 varieties of *Aloe* are endemic to the Arabian Peninsula (Collenette, [13]; Wood, [31]; Al-Khulaidi, [3]; Miller and Morris, [22]; Carter, *et al.*, [10]; McCoy, [21]. In Yemen, 33 species of *Aloe* were recorded, of which 27 were endemic to the Arabian Peninsula (Al-Khulaidi, [4]. There are 23 taxa of *Aloe* species in the flora of Saudi Arabia, of which 13 are endemic (Al-Hemaid, [1]; McCoy, [21]).

The goal of this research is to assess *Aloe castellorum* using IUCN categories. The findings of this study will be useful in future *Aloe* species and habitat planting and preservation projects.

Materials and Methods

Fieldwork was conducted in Yemen and Saudi Arabia between 2020 and 2022 to assess and record the presence of *A. castellorum* (Fig. 1). This plant's locations in Yemen and Saudi Arabia were also obtained from various sources [Collenette, [13]; McCoy, [21]; Wood, [31]; Al-Khulaidi, [3]. In order to assess it according to IUCN categories, The Extent of Occurrence (EOO) and Area of Occupancy (AOO) were created and measured using ArcMap 10.8. A taxon's area of occupancy is the area that it occupies within its range of occurrence. The area contained within the shortest continuous imaginary boundary that can be drawn to include all known sites of the present occurrence of a taxon is known as the extent of occurrence (IUCN, [18]). The AOO cell width is given in kilometers. The grid size of the area of occupancy was calculated using ArcMap to be four square kilometers and is applied to all selected taxon records (Fig.2). The following formula was used to calculate AOO (IUCN, [17], Al-Khulaidi, [4].

AOO = number of occupied cells * area of the individual cell.

AOO rating as for EOO, the AOO rating is based on the values listed under the IUCN Categories and Criteria Version 3.1 (IUCN, [17]. The area value for AOO is compared with the thresholds set in Criterion B2 and the relevant rating is returned. The threshold values are as follows (Moat, [24]:

AOO (km ²) Rating	Rating
<10	Critically endangered
<500	Endangered
<2,000	Vulnerable
<4,500	Near threatened

EOO rating The EOO rating is based on the values as listed under the IUCN Categories and Criteria Version 3.1 (IUCN, [17]. The area value for EOO calculated above is compared with the thresholds set in Criterion B1 and the relevant rating is returned. The threshold values are as follows (Moat, [24]:

EOO (km ²)	Rating
< 100	Critically endangered
<5000	Endangered
<20,000	Vulnerable
<45,000	near Threatened

AOO Density: AOO Density = 1 - (AOO Subpopulations/AOO Number of cells) is a measure to

Lat.	Long.	area	NO .individ	Wp	Altitude m.
19.880024	41.579014	Baljurashi	75	235	2034
19.885266	41.569556	Baljurashi	70	298	2019
19.785025	41.724909	Baljurashi	15	420	1925

Type specimen

Aloe castellorum grows in Southern Arabia, mist-covered slope mountains holotype Yemen (Manara, [20]. Wood, J.R.I. [2504], Yemen

Habitat and Ecology

Aloe castellorum is found on slopes of west-facing mountains between 1300 and 2200 m, in the Republic of Yemen (Wood, [31]; Al-Khulaidi, [3] and from Albaha to Jabal Fayfa, Saudi Arabia (Collenette, [13]; McCoy, [21]. In Albaha region the plant was found on rocky slopes and rock outcrops areas between 1925 and 2034 m. with an individual range between 15 and 75 species. The habit is severely degraded due to human activities, in particular, establishing houses, parks, and buildings (see plate 1)

Geographic Range

Yemen: West facing mountain slope of Northern region, between 1300 and 2200 m.

describe the density of the point distribution (IUCN, [18]; Thiers, [28].

Specimens Examined

The specimen was collected from Albaha, Saudi Arabia. Locality: rock outcrops, near settlements, Baljurash, Collector: Abdul Wali Al-Khulaidi.

Kuhlau to Hajjah road, Jebel Shahara, Kuhalan, Shahara, J. Razeh.

Saudi Arabia: 1300 and 2150, among rocks, rocky hillsides and rocky outcrops, between South Taif and Jabal Fayfa (Al-Sarat Mountain), such as Baljurashi, Off the Harajah-Ashraf-Khamris road. Above Farshih, 6 km north of Abha, Taif road, Near Jabal Ibrahim, the Taif- Abha road, Jabel Fayfa, about 100 km NE of Jizan

Phenology

February to September. June to July is generally the peak of the flowering season, however, irregular flowering can be seen throughout the year.

Uses

A.castellorum as other *Aloe* species can be one of useful medicinal and cosmetic plants, it is also used as food and as ornamental (Anis, *et al.*, [6]; Al Zandi, *et al.*, [2].

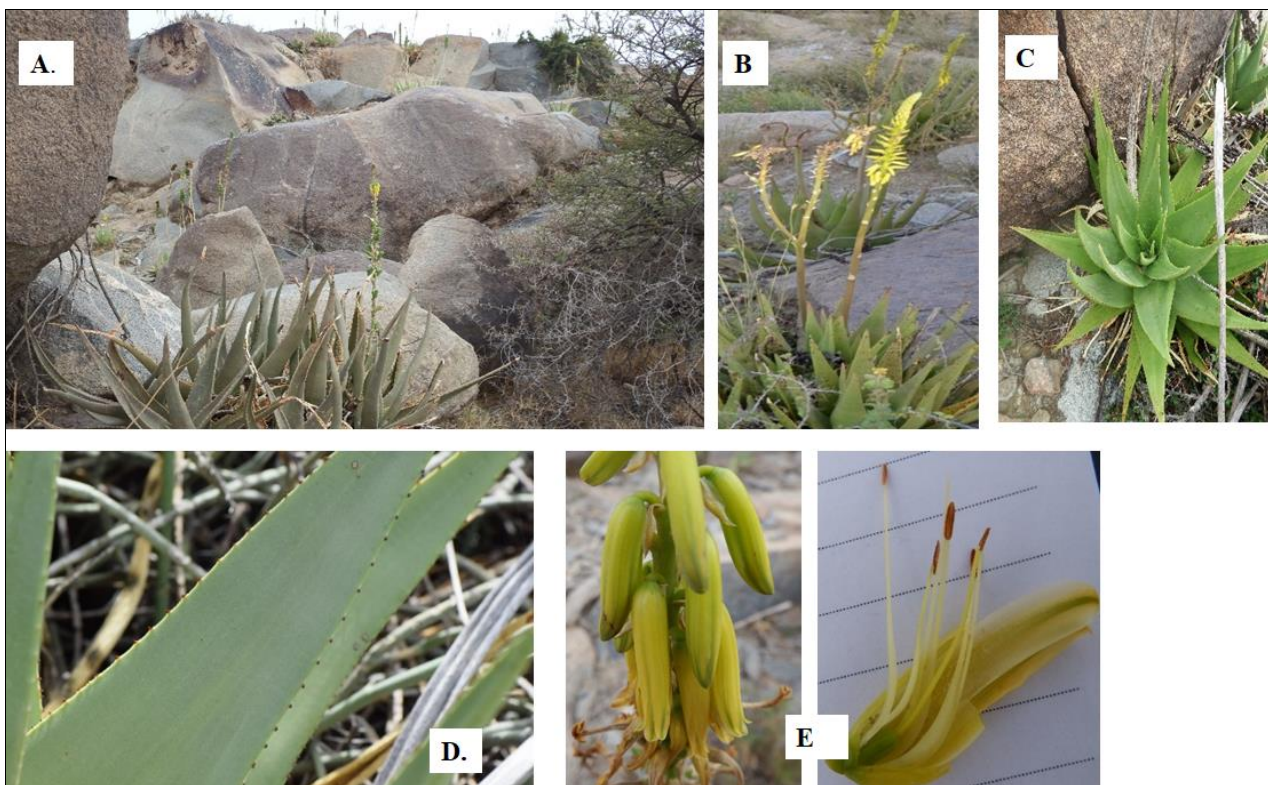


Fig 1: *Aloe castellorum* collected from Baljurashi, Saudi Arabia, April 2021 by Dr Abdul Wali Al-Khulaidi. **A.** Plant habitat; **B.** The whole inflorescence; **C.** leaves arrangement; **D.** leave showing the teeth on the leaf’s margins; **E.** Whole inflorescence, flowers including the stamens. (Photos by Dr. Abdul Wali Al-Khulaidi).



Plate 1: Habitat of *Aloe castellorum*, Baljurashi, Saudi Arabia, photo by the Author.

Results

Plant Description

Aloe castellorum – A perennial succulat plant, with solitary or branching rosettes narrow pale to bright green leaves, the leaves from 5 to 30 cm tall, the margin with tiny many widely space (between 3 to 5 cm) brown teeth. The inflorescences, with 3 to 5 branching spikes, the spike up to 150 cm. flowers are pale yellow, bracts from 5 to 10 mm. Fruita small up to 6 mm.

Plant Classification according to catalogue of life website (<https://www.catalogueoflife.org/data/taxon/C3KN>):

Name: *Aloe castellorum* J.R.I.Wood
Published in: J.R.I.Wood. In: Kew Bull. 38: 25. (1983).
 Checklist status: accepted species
Synonyms and Combinations: *Aloe hijazensis* Lavranos & Collen.

Classification

Kingdom: Plantae
 Phylum: Tracheophyta
 Class: Liliopsida
 Order: Asparagales
 Family: Asphodelaceae
 Genus: Aloe
 Species: *Aloe castellorum* J.R.I.Wood
Distributions: Yemen and Saudi Arabia

Plant assessment

To evaluate this plant using IUCN categories. The blue line connecting the points on the map (Fig. 2) represents the Extent of Occurrence (EOO) in both Yemen and Saudi Arabia. The Extent of Occurrence (EOO) value reported is the area within the blue line, measured in km² using ArcMap software, and is estimated to be around 4170 km².

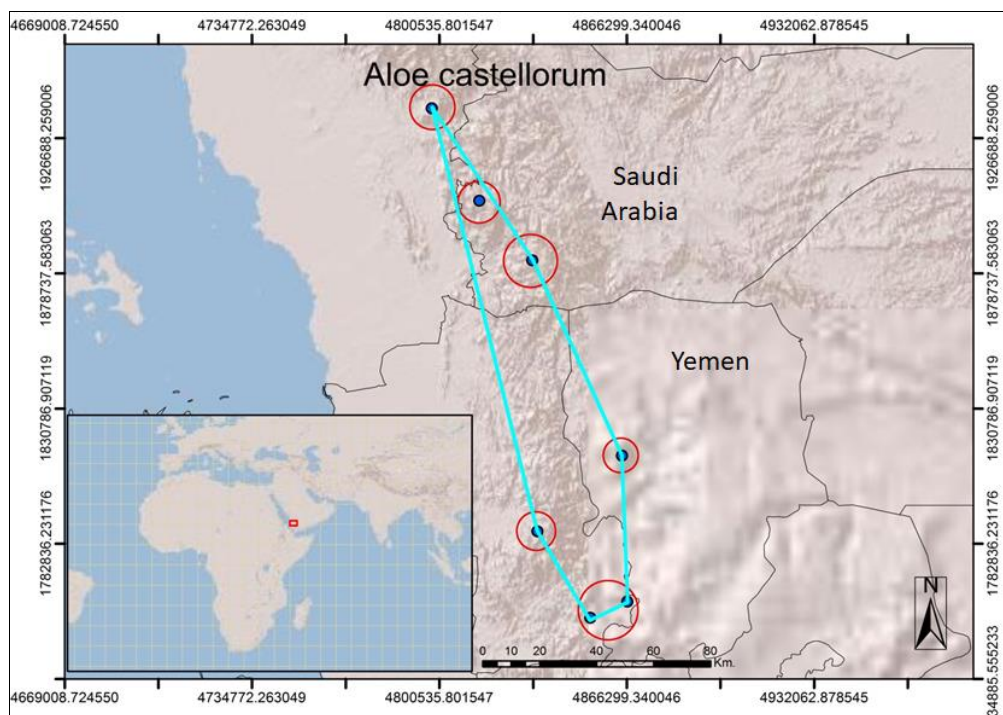


Fig 2: Conservation Assessment of *Aloe castellorum* in the Arabian Peninsula. Blue line = Extent of Occurrence (EOO), Red circles = is the Number of squares that contain at least one point (Area of Occupancy).

B1- EOO rating

The area value for EOO calculated above is compared with the thresholds set in Criterion B1 (fig. 2). The threshold value is Endangered (EN).

B2-AOO Area

Area of Occupancy (AOO)

in 6 locations and 7 cells = 7 * 4= 28 sqkm.

The red circles signify the six geographical zones, while the blue circles signify the Area Of Occupancy (AOO). AOO is the number of squares with at least one point, which was 6

with 7 cells. The blue occupied cells are depicted in a square grid (Figure 3) and are each 4 km². (2 x 2 km.).
 $AOO = \text{number of occupied cells} \times \text{area of individual cells}$
 $= 7 \times 4 = 28 \text{ km}^2$, so the criterion B2 threshold value is **ENDANGERED (EN)**.

AOO density is calculated as the number of 1- AOO subpopulations divided by the number of AOO cells, in this case, the AOO density is: $1 - 28/7 = -3$ (less than one), which is sparsely occupied (IUCN, [18])

(b) The most serious threats are the construction of houses, parks, and roads, as well as the collection of the plant for medicinal, cosmetic, and ornamental uses.

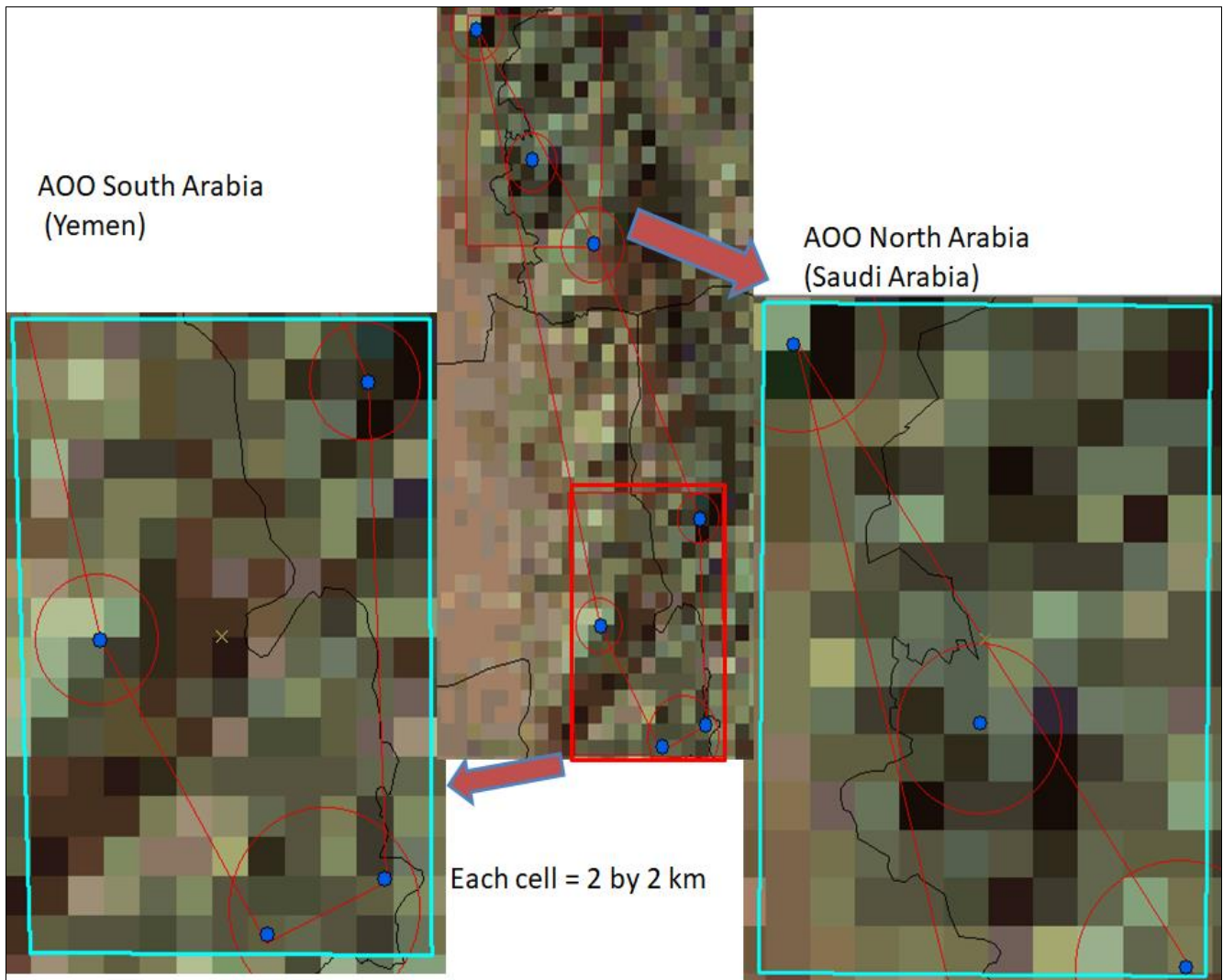


Fig 3: A grid map, each with 4 km². (2 × 2 km grid cell), in both Yemen and Saudi Arabia. The Red line is the Extent of Occurrence (EOO). The red squares circles are the Area of Occupancy (AOO) and represent 6 Ecological Zones. The blue square grids represent the area of the individual cell (7 cells).

Discussion and Conclusion

This plant was found at high elevations (between 1925 and 2034 m.) from Al-Baha region in southwestern Saudi Arabia into Yemen, where plants receive a reasonable amount of fog. It is noted as similar to the endemic plant of the Arabian Peninsula *Aloe vacillans* and the range of the two species is similar. Morphologically, *Aloe castellorum* is noted to have shinier green foliage than *Aloe vacillans* with its typical pale orange flowers (Wood, [31]. *Aloe castellorum* is often found in rocky outcrops and hills, with *Vachellia origena*, *Maytenus parviflora*, *Themeda triandra*, *Hyparrhenia hirta*, *Osteospermum vaillantii*, *Salsola tragus*, *Aizoon canariense* and *Juniperus procera*. A plant described by John Lavranos and Sheila Colenette in 1999 as *Aloe hijazensis* has been shown to be the same species as *Aloe castellorum* (Carter, et al., [10]; Chaudhary, [12]; McCoy, [21].

The study's findings are based on fieldwork in Yemen and the Al-Baha region of Saudi Arabia, as well as an evaluation of herbarium collections that provide coordinates and population-level data, as well as information found in reliable research papers, books, and online sources, as well as observations in the AREA, Taiz, Yemen nursery of this plant.

This assessment provides a realistic picture of the conservation status of *A. castellorum* in Yemen and Saudi Arabia. Complete conservation status assessments for other Arabian Peninsula Aloes will be provided in the future, helping to meet GSPC Target 2 (Botanic Gardens Conservation International, [9]). The information presented in this study enables conservation projects involving this species and other endemic *Aloe* species on the Arabian Peninsula to take conservation actions.

Several *Aloe* sites in the Arabian Peninsula are currently threatened by human activities such as the construction of roads, gardens, and houses, as well as land clearing for development or agricultural purposes (Al-Khulaidi, [4]). The majority of Arabian Peninsula Aloes are classified as Data Deficient (DD).

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