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Archives of *Austrocylindropuntia cylindrica* (Lam.) Backeb and management strategies for populations in Ermelo and Balfour in the City of Mbombela Municipality, Mpumalanga Province of South Africa

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Abstract
This study focuses on documenting *Austrocylindropuntia cylindrica* (Lam.) Backeb populations and developing management strategies for them in Ermelo and Balfour, within the City of Mbombela Municipality, Mpumalanga Province, South Africa. Two new sites in Ermelo and Balfour, located in the Gert Sibande District Municipality, have been identified. Biological invasions pose significant threats to biodiversity, exacerbating climate change, water scarcity, fire risk, erosion, and flooding. Data were collected through site visits from 2021 to 2023, involving walking and recording GPS coordinates. The species is categorized under Category 1a of NEMBA regulations. This study aims to enhance understanding of this invasive species and propose management strategies. Limitations of the study include the need for further research on the species' behavior in other countries. It is recommended to monitor additional populations and increase awareness of biological invasions.
Keywords: Biological Invasion, management, Threat, population

1. Introduction

The alarming rate of Invasive alien plants (IAPs) is recognized as one of the major threats to biodiversity, Climate change, agriculture, health, and socioeconomic livelihoods around the world (Adhikari et al,2019, Rai et al. 2022, Duncan et al,2023, Kumar et al,2023, Wilson et al.,2013). According to Richardson et al. (2003) and Saul et al. (2017), a few of the routes that lead to the introduction of invasive alien plants (IAPs) are transport stowaway, tourism, unscientific methods, biological pest control, however, this might be because of how people perceive alien invasive Not

all alien's invasive species have the negative impact some are beneficial to the society. According to Sakai et al. (2001), most invasions achieve effectiveness in the landscape after going through the phases of introduction, establishment, and uncontrolled proliferation (Adhikari et al.,2019, Kumar et al.,2023). Most incursions become effective in the landscape after going through the phases of introduction, establishment, and unchecked proliferation (Sakai et al., 2001).

The introduction of IAPs into a new habitat may be deliberate or accidental (Wilson et al.,2013, Novoa et al. 2016, Ka-plan et al. 2017, Rai et al,.2023] and, subsequently, some have become naturalized, while others have become invasive (Wilson et al.,2013). In addition, climate change is thought to exacerbate the situation caused by weeds and invasive alien plant species globally in the future (Sheppard et al, 2016, Rai et al,.2023). Thus, the success of IAPs is generally attributed to differences in ecological traits compared to native species (Van Kleunen,2015). It is estimated that over 383 invasive plant species must be controlled to prevent further damage of which about 44 (11.5%) species of herbaceous plants are declared weeds or invaders (Wilson et al.,2013,Novoa et al. 2016, Ka-plan et al. 2017). The objective of the research is to record and control all known populations of *Austrocylindropuntia cylindrica* in South Africa, to determine the distribution of *A.cylindrica* in South Africa, to raise awareness about the impacts of *A.cylindrica*.The study tries to answer the following questions: Which methodology can be used to control *Austrocylindropuntia cylindrica* and which populations recorded *Austrocylindropuntia cylindrica* in South Africa *Austrocylindropuntia cylindrica* (Lam.), belonging to the family Cacti and commonly known as Cane Cactus, is The synonym of *Opuntia cylindrica. Austrocylindropuntia cylindrica reproduce* Cacti form a distinct taxonomic group that mostly share similar physiological traits and habitat preferences that can result in dispersal with negative impacts (Novoa et al. 2015, Novoa et al. 2016, Ka-plan et al. 2017). *Austrocylindropuntia cylindrica* (Cane Cactus) is a spiny, branched, and shrubby cactus

native to parts of western South America (i.e. Ecuador and Peru) (Novoa et al. 2015, CABI, 2021).

Austrocylindropuntia cylindrica is recorded as naturalized and invasive in South Africa, Australia, and Italy (Smith and Figueiredo,2016; CABI,2021). *Austrocylindropuntia cylindrica* is a popular ornamental plant and was likely introduced to South Africa for the same reason (CABI, 2021). In South Africa, it has since escaped from cultivation, spread to open spaces, and become an environmental weed (Novea et al., 2015). *Austrocylindropuntia cylindrica* is a branch-like shrub up to 6cm in diameter with small flowers and a green-like stem covered by white spines. *A.cylindrica* has small red-like flowers up to 3.8 inches (Figure 1). A. cylindrica has many seeds covered with hard coats (Walters, M., Figueiredo, E., Crouch, N.R, Winter, P.J.D., Smith, G.F., Zimmermann, H.G., & Mashope, B.K., 2011). The leaves of these plants are small white spines, it has green-yellow fruits that are rounded and grow up to 9cm long. The South African Invasive Species Database and field guides for alien invasive plant species, such as Bromilow (2018) and Henderson (2020), will be used to confirm the known populations of *A. cylindrica*, as it is sometimes confused with *A. subulata*

According to reports, animals and birds that consume the fruits disperse the seeds of *Austrocylindropuntia cylindrica*. According to a study conducted by Mokotjomela et al. (2022), they stated that *A. cylindrical* was found near the homestead and at the dumping sites, indicating that the propagules were dispersed by humans. Any portion of the plant that hits the ground and becomes covered in dirt can sprout into a new plant, or cladotes. Fruit pieces and the stem of *A. cylindrica* can also easily travel to other locations and adhere to the skin or fur of animals (CABI 2021). According to the NEM: BA, Alien and Invasive Species Regulations, *Austrocylindropuntia cylindrica* is classified as an invasive alien species in Category 1a under South Africa. Comprehensive data on the threat posed by the *A.cylindrica* cactus in South Africa can be obtained by evaluating its distribution, potential for invasion, and viability of eradication. Information on the most effective management

approach to use in South Africa to manage the species will also be provided by the study. The study aims to close the information gap about the scarcity of data on numerous alien species in South Africa (Zengeya and Wilson, 2020).

Taxonomy and Description

Austrocylindropuntia cylindrica, also known as *Opuntia cylindrica,* is a species of flowering plant in the family Cactaceae. Commonly referred to as cane cactus, this family consists of a family comprising approximately 127 genera with about 1,750 known species of the order Caryophyllales.(Christenhusz and Byng,2017) The word cactus derives, through Latin, from the Ancient Greek word κάκτος (káktos), a name originally used by Theophrastus for a spiny plant whose identity is now uncertain. (Johnson et,.2019) Cacti come in a variety of shapes and sizes. Cacti are adapted to live in extremely dry environments, including the Atacama Desert, one of the driest places on Earth. (Johnson et al,.2019).

As a result, cacti display numerous adaptations to conserve water. There is a vast variety of shapes and sizes among cacti. Because of their adaption, cacti can survive in extremely dry conditions, such as the Atacama Desert, which is among the driest places on Earth. Cacti have numerous adaptations to preserve water as a result. For instance, nearly all cacti are succulents, which means that their fleshy, swollen sections are designed to hold water. *Austrocylindropuntia cylindrica* also known as (Cane Cactus) (Cactaceae) family is an invasive species that is native to western South America (Ecuador and Peru) and is recorded as invasive in South Africa, Europe, and Australia (Smith and Figueiredo,2016).

Austrocylindropuntia cylindrica is a popular ornamental plant. It was introduced to South Africa Intentionally. It was brought into South Africa as an ornamental plant. It has since escaped from cultivation and spread to open spaces and become an environmental weed. (Novea et al,2015). *Austrocylindropuntia cylindrica* is a branch-like shrub up to 6cm in diameter with small flowers and a green-like stem that is covered

by white spines. It has small red-like flowers up to 3.8 inches. It has many seeds that are covered with a hard coat (ABC Taxa,2011). The leaves of these plants are the small white spine, it have green-yellow fruits that are rounded and grow up to 9cm long. *Austrocylindropuntia cylindrica* is spread by seeds by birds and animals eating the cactus. Any part of the plant that attaches to the animal skin or falls into the ground has the potential to regrow on its own to form a new plant

Regulation of *Austrocylindropuntia cylindrica in South Africa*

Austrocylindropuntia cylindrica is listed as a category 1a invasive alien species in South Africa under the NEM: BA regulations (Environment South Africa,2019). According to Environment South Africa (2019), any alien species that falls under category 1a such species requires compulsory eradication. According to Chinnock (2015), all species of *Austrocylindropuntia, Cylindropuntia*, and Opuntia are considered Weeds of National Significance in Australia. In countries like Queensland, *A. cylindrica* is subject to a Category 3 restriction, meaning that "a person must not release these invasive plants into the environment, give away or sell as a plant or something infested with its seed. In Italy, *A. cylindrica* is also regarded as an invasive species after its first discovery in the country.

Reproductive Potential

Austrocylindropuntia cylindrica is an invasive alien plant in South Africa. Stressful situations like burning, chopping, or drought typically cause *Austrocylindropuntia cylindrica*. Many seeds are generated up to 3,000 per plant, and these seeds can travel great distances in the wind. According to Chinnock (2015), the primary means of plant dissemination for *Austrocylindropuntia* species is the breaking apart of plant parts, such as sections of fruits and stems. It was noted that floodwaters dispersed the similarly related *A. subulata* (Queensland Government, 2016).

Transmission of Vectors (Biotic)

Austrocylindropuntia cylindrica seeds can be dispersed by animals and birds that eat the fruit, but they can also be dispersed by any part of the plant that falls to the ground after attaching itself to an animal's skin or fur and quickly sprouting new growth (Invasive Species South Africa, 2019). Unaware that *Austrocylindropuntia cylindrica* is an invasive species, can lead people to sell or give it away as an ornamental plant, which can lead to its spread. The successful invasion of this weed also depends on its dispersion. Strategies. *Austrocylindropuntia cylindrica* seeds are dispersed by wind, water, animals, vehicles and human beings (Chinnock ,2015), According to Clements (2018) the size and number of seeds produced by invasive plants affect the species' ability to colonize new habitats and form a stable population. It aggressively colonizes disturbed habitats; roadsides; pastures; agricultural areas; urban areas; industrial areas; playgrounds; and roadsides in semi-arid, subtropical, tropical, and warmer temperate. The viability of the seeds and their dispersal are also major concerns for the successful invasion of this weed. Monroy-Vázquez et al. 2017 reported that the Opuntia spp. seeds require an after-ripening period in order to germinate, which results in their physiological dormancy. Furthermore, the hard seed coat on seeds, which is lignified, prevents germination.

Distribution and Habitat Suitability

Austrocylindropuntia cylindrica invades disturbed areas, riverbanks, shrublands, and open woodland in South Africa and disturbed areas, shrublands, and disturbed areas in its home continent. One of the hotspots and high-risk nations for cactus species is thought to be South Africa. According to Novia et al. (2015), *Austrocylindropuntia cyclindrica* spreads quickly from fractured portions of the part or cladodes. *Austrocylindropuntia cylindrica* is an issue since it reduces the nation's biodiversity and pasture's capacity for grazing. (Novia et al., 2015; Chinnock, 2015). There have been reports of *Austrocylindropuntia cylindrica* in a number of nations (Nora Sakhraou et 2022) This weed has spread geographically over the past few decades and is now posing a threat to much broader parts of the planet. In many regions of the world, even those where *Austrocylindropuntia cylindrica* has been for a long time, its density

and distribution are still growing [CABI,2023, Chinnock, 2015]. There have been reports of its present and possible geographic distribution in Mpumalanga and other eastern, northern, and southern African countries. 2015; Nova. The Northern Cape, KwaZulu-Natal, Mpumalanga, North-West, and Eastern Cape are the regions in South Africa. *Austrocylindropuntia cyclindrica* is mostly found in the Northern Cape, KwaZulu-Natal, Mpumalanga, North-West, and Eastern Cape regions of South Africa. Novia and associates (2015).It is present in the Province of Gauteng as well. The Global Biodiversity Information Facility (GBIF) provided the occurrence data for *Austrocylindropuntia cyclindrica* in South Africa that were used in this investigation. However, Category 1a designates it as an alien invasion.

Risk of Introduction for *Austrocylindropuntia cyclindrica* species

Austrocylindropuntia cyclindrica have at least Five known invasion hotspots: Italy, Algeria, South Africa, Australia, and Spain At least 57 of the estimated 1922 recognized cactus species have been documented as invasive (Novoa et al., 2015, Sakhraoui et al. (2022). However, there are large portions of the world with suitable climates that are vulnerable to future invasion, such as eastern Asia and central Africa.

Since this cactus species is widely used as an ornamental, there is a high risk of introduction. (Senanayaka,et al.,2024, Panetta et al.,2024). Germination responses of the invasive hedge cactus (Cereus uruguayanus) to environmental factors. Weed Science, 72(3), 241-246.). Propagation and management of ornamental and commercial cacti–a review. The Journal of Horticultural Science and Biotechnology, 99(3), 267-288. According to Novoa et al. (2015), the horticultural trade is the primary cause of Cactaceae species introductions to areas outside of their native ranges. Around the world, there are hundreds of specialized societies dedicated to cacti and succulents, as well as numerous periodicals with numerous web pages.

2.Methodology: Study Area

The study was conducted in Mpumalanga Province, specifically focusing on two populations located in Ermelo (Mkhondo Local Municipality) and Balfour (Gert Sibande Local Municipality). The vegetation in this area is characterized as grassland biome. Balfour, situated in Mpumalanga, South Africa, is a developing town known for gold mining and maize farming.

Distribution of *Austrocylindropuntia cylindrica* in South Africa.

In South Africa, *Austrocylindropuntia cylindrica* has been recorded in seven of the nine provinces: Eastern Cape, Northern Cape, North West, KwaZulu-Natal, Gauteng, and Mpumalanga (Chinnock, 2015; Novia et al., 2015; Henderson, 2020). This species is known to invade the Karoo and savanna regions and is frequently found near human settlements (Henderson, 2020). South Africa is noted for having highly suitable habitats for cactus species and a high likelihood of naturalizing alien cacti, making it particularly vulnerable to cactus invasions (Kaplan et al., 2017). A new population of *A. cylindrica* was documented in North West in 2023 and Balfour, Mpumalanga Province, in June 2024. South Africa's rich biodiversity is increasingly impacted by water scarcity, exacerbated by factors such as invasive alien plants, climate change, and flooding.

Distribution Map: *Austrocylindropuntia cylindrica*

Figure 2: Distribution Map of *Austrocylindropuntia cylindrica in South Africa*

Proposed Control Methods for *Austrocylindropuntia cylindrica*

The choice of management and control techniques for invasive alien plants (IAPs) should be guided by the specific objectives and intentions of the management plan. For agricultural fields affected by IAPs, it's crucial to apply methods that do not harm the crops (Kumar et al., 2013). To date, no eradication measures have been implemented for *Austrocylindropuntia cylindrica*. Surveys have indicated that the population in Ermelo might be under attack by a natural enemy or biological control agent. According to Zimmermann et al. (1979), the cochineal insect, *Dactylopius tomentosus*, could be an effective biological control for this species. Chemical control could also be considered if an effective herbicide is identified through trials. The most effective approach may involve integrating multiple strategies, including herbicides, and mechanical, and physical methods (CABI, 2011; Chinnock, 2001; Novia et al., 2015).

3.Results and Findings

Field trips began in 2019 after initial sightings of *Austrocylindropuntia cylindrica*. Extensive monitoring and surveys were conducted to identify additional populations in the affected municipalities and surrounding regions. In Mpumalanga, two localities of *Austrocylindropuntia cylindrica* were noted: one in Ermelo, covering 0.01 hectares, and a single clade in Balfour, Gert Sibande Municipality, near a homestead. Control efforts began in Ermelo in 2021. The first population was cleared in February 2023 at Piet Zyn Drift Farm, with follow-up monitoring in November 2023 revealing nearly complete mortality, though some regrowth occurred. The biomass was removed to expose living plants for further treatment. Additional sightings included Keurboschfontein Farm near Van Wyksdorp, where initial clearing occurred in 2018, covering approximately 85.3 hectares. In Mafikeng Nature Reserve, Northwest Province, a large clump and 46 small plants were cleared from an area of 0.008121 hectares. All recorded populations in Mpumalanga, Northwest, Eastern Cape, and Western Cape have been mapped with GPS coordinates, and the

hectares cleared were quantified. It was observed that not all residents are aware of this invasive species, highlighting a limitation in increasing local awareness in Gert Sibande and other municipalities. To address this, awareness campaigns and community forums are planned. Additionally, no specific herbicide for this species is currently registered.

4.Conclusion and Recommendations

Alien invasive plants, such as *Austrocylindropuntia cylindrica* also known as cane cactus or coral cactus, pose a significant threat to local flora and fauna. Naturalized in various regions of Australia and listed as a Category 1a species under NEMBA regulations in South Africa, this species is subject to stringent control measures. South African law enforces these regulations, and landowners must manage the spread of invasive plants to avoid legal consequences. It is recommended that promotional materials be developed to increase awareness and reporting of sightings, aiding in the effective planning and control of the species. Companies involved in herbicide manufacturing should include this species in their trials to identify suitable chemical controls. Due to the absence of a prescribed eradication method, further research on biological control options is also recommended

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References

1. Adhikari, P., Jeon, J. Y., Kim, H. W., Shin, M.-S., & Seo, C. (2019). Potential impact of climate change on plant invasion in the Republic of Korea. *Journal of Ecology and Environment*, 43, 36. [CrossRef]
2. Chinnock, R. J. (2015). Feral opuntia cacti in Australia: Part I. Cylindrical-stemmed genera: Austrocylindropuntia, Cylindropuntia and Corynopuntia.

Journal of the Adelaide Botanic Gardens, (No. Suppl. 3), 69 pp. http://flora.sa.gov.au/publications

3. Christenhusz, M. J. M., & Byng, J. W. (2016). The number of known plant species in the world and its annual increase. *Phytotaxa*.
4. Clements, D. R. (2018). Invasive weed species and their effects. In *Integrated weed management for sustainable agriculture* (pp. 65-88). Burleigh Dodds Science Publishing.
5. Duncan, P., Podest, E., Esler, K. J., Geerts, S., & Lyons, C. (2023). Mapping invasive herbaceous plant species with Sentinel-2 satellite imagery: Echium plantagineum in Mediterranean shrubland as a case study. *Geomatics*, 3, 328–344. [CrossRef]
6. Environment South Africa. (2019). Alien invasive plants list for South Africa. EnviroEditor. www.environment.co.za/weeds-invaders-alien-vegetation/alien-invasive-plants-list-for-south-africa.html
7. Invasive Species South Africa. (2019). Plants A-Z. In *Plants A-Z*, South Africa: Invasive Species South Africa. http://www.invasives.org.za/plants/plants-a-z
8. Johnson, A. T., Smith, H. A., & Stockdale, A. P. (2019). *Plant Names Simplified: Their Pronunciation, Derivation & Meaning*. Sheffield, Yorkshire: 5M Publishing.
9. Kumar, S., Meena, R., Tiwari, A. K., Singh, R., Patel, S. K., & Singh, G. S. (2023). Perceptions of impacts and management of invasive alien plants: A case study from Mirzapur, India. *Frontiers in Forests and Global Change*, 6, 1194076.
10. Novoa, A., Roux, J. J. le, Robertson, M. P., Wilson, J. R. U., & Richardson, D. M. (2015). Introduced and invasive cactus species: a global review. *AoB Plants*, 7, plu078. http://aobpla.oxfordjournals.org/content/7/plu078.full [DOI: 10.1093/aobpla/plu078]

11. O'Connor, T. G., & van Wilgen, B. W. (2020). The impact of invasive alien plants on rangelands in South Africa. In *Biological Invasions in South Africa* (pp. 459-487). Springer Nature.
12. Panetta, F. D., Campbell, S., Brooks, S., Brazier, D., & Chauhan, B. S. (2024). Germination responses of the invasive hedge cactus (Cereus uruguayanus) to environmental factors. *Weed Science*, 72(3), 241-246.
13. Rai, P. K. (2022). Environmental degradation by invasive alien plants in the Anthropocene: challenges and prospects for sustainable restoration. *Anthropocene Science*, 1(1), 5-28.
14. Sakai, A. K., Allendorf, F. W., Holt, J. S., Lodge, D. M., Molofsky, J., With, K. A., et al. (2001). The population biology of invasive species. *Annual Review of Ecology, Evolution, and Systematics*, 32, 305–332. [DOI: 10.1146/annurev.ecolsys.32.081501.114037]
15. Senanayaka, S. G. M. S. D., Senanayake, G., & Ratnayake, R. M. C. S. (2024). Propagation and management of ornamental and commercial cacti: a review. *The Journal of Horticultural Science and Biotechnology*, 99(3), 267-288.
16. Sakhraoui, N., Verloove, F., Essl, F., & Hadef, A. (2022). First record of Austrocylindropuntia cylindrica (Lam.) Backeb. and first data about the naturalization of Austrocylindropuntia subulata (Muehlenpf.) Backeb. in Algeria. *BioInvasions Record*, 11(2).
17. Shabbir, A., Zalucki, M. P., Dhileepan, K., Khan, N., & Adkins, S. W. (2023). The current and potential distribution of Parthenium weed and its biological control agent in Pakistan. *Plants*, 12, 1381. [CrossRef] [PubMed]
18. Sheppard, C. S., Burns, B. R., & Stanley, M. C. (2016). Future-proofing weed management for the effects of climate change: is New Zealand underestimating the risk of increased plant invasions? *New Zealand Journal of Ecology*, 40(3), 398-405.

19. van Kleunen, M., Dawson, W., & Maurel, N. (2016). Characteristics of successful alien plants. In *Invasion Genetics: The Baker and Stebbins Legacy* (pp. 40-56).
20. Van Wilgen, B. W. (2018). The management of invasive alien plants in South Africa: Strategy, progress and challenges. *Outlooks on Pest Management*, 29, 13–17. [CrossRef]
21. Van Wilgen, B. W., Measey, J., Richardson, D. M., Wilson, J. R., & Zengeya, T. A. (2020). *Biological Invasions in South Africa*. Springer Nature.
22. Wilson, J. R. U., Ivey, P., Manyama, P., & Nanni, I. (2013). A new national unit for invasive species detection, assessment, and eradication planning. *South African Journal of Science*, 109, 13. [CrossRef]
23. Zimmermann, H. G., Erb, H. E., & McFadyen, R. E. (1979). Annotated list of some cactus-feeding insects of South America. *Acta Zoologica Lilloana*, 33(2), 101-112.