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RESEARCH ARTICLE

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Historic herbarium specimens as biocultural assets: An examination of herbarium specimens and their in situ plant communities of the Agulhas National Park, South Africa

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Abstract

1. Globally there is a need for protected areas to conserve both biodiversity and heritage. Historic specimen localities, although significant to botanists, are not known or recognized under the global heritage umbrella; yet they form an important component of the protected area landscape.
2. We aimed to articulate the conservation and heritage value of herbarium specimens, and make the links between people, botanical culture and nature explicit in order to argue the case that historic specimens and their associated in situ plant populations are biocultural heritage assets.
3. This paper bridges the gap between biodiversity conservation and culture by confirming the presence of historic plant localities in the Cape Floristic Region of South Africa, from collections made prior to 1914.
4. Once confirmed, present historic plant localities can be included into protected area conservation management and heritage portfolios and ensure a continued contribution to knowledge generation through conservation of these historic sites.
5. Historic specimens and their associated in situ localities are valuable to both ecological study and conservation around the world and this paper highlights an emerging facet to science of the influence of people on the natural landscape.
6. We found this to be the case not only in an ecologically transformative way, but from a heritage aspect regarding the social nature of botanizing and discovering.
7. Historic specimen localities thus link the past with the current and future management of a protected area.

KEYWORDS

Agulhas Plain, biocultural heritage, Bolus, botanical collectors, Cape Colony, conservation, fynbos

1 | INTRODUCTION

European colonization (1500–1800) was a time of acquisition and nature was often seen as an assembly of objects. Such objects in the natural world include living and non-living specimens listed according to their contributions to science. In botany these take the form of dried plants collected, and kept as herbarium specimens, remaining as a permanent record that can be perpetually referenced (Daston, 2004). Plant collections in Africa, and South Africa, date back to some of the first exploratory voyages from Europe and many of these specimens have been designated as type specimens. Certain specimens are the first recorded collections of a species holding historic value. While some may have been retrospectively denoted as type specimens, meaning can be drawn from these early collections where they carry a certain scientific status and purpose, lending additional value to their role in biocultural heritage.

Herbarium specimens hold significant scientific value as objects of information representing the living world, unmatched as a historic baseline (Häuser, Steiner, Holstein, & Scoble, 2005). Historic botanical records are generally the longest standing record of a species occurrence used by scientists for many purposes (Canales et al., 2020; Greve et al., 2016; Lindborg, 2007; Soubiran, 2010; Wang, 2018; Willis et al., 2017) and provide more than just species information. Herbarium specimens, including type specimens, are used for comparative purposes, such as the prevalence of pests and diseases, monitoring temporal changes in climate (Primack, Imbres, Primack, Miller-Rushing, & Tredici, 2004) or phenology (Lister, Bower, & Jones, 2010; Park, 2012). Given an accession number for tracking they provide verifiable proof and credibility to biological and ecological science (Culley, 2013). These curated historical datasets can be used to investigate environmental history and answer fundamental conservation questions and form an important baseline for conservation managers.

Herbarium specimens are well recognized in the academic literature as scientific records in their own right (Dargavel, Evans, & Dadswell, 2014; Dosmann, 2006). However, the use of historical data do have a number of limitations and should be used with caution when undertaking contemporary research (Tessarolo, Ladle, Rangel, & Hortal, 2017). Historic herbarium records are presence only records, often with minimal descriptive notes to provide more information of habitat and associated species. We argue that their associated in situ plant populations carry heritage value, like archaeological artefacts and associated excavation sites (Purdie et al., 1996). Environmental humanities literature supports a view that objects and places hold more than a purely scientific value (cf. Argumedo, 2013; Ryan, 2015), and cultural relict plants are already recognized (Solberg, Breian, Ansebo, & Persson, 2013). Examples of biological and cultural sites include Cahokia, USA (Billington, 2004) and numerous sites in the Nordic region (Persson et al., 2014). Such aspects of cultural and biological heritage speak directly to the core mandate of the South African National Parks (SANParks) which '…is the conservation of South Africa's biodiversity, landscapes and associated heritage assets, through its system of national parks' (SANParks, 2013a).

1.1 | Scientific biocultural heritage

The United Nations Education, Scientific and Cultural Organisation (UNESCO) World Heritage Committee defines 'historic' as an object or site over 100 years old. Natural heritage was defined in 1972 (UNESCO, 1972) and was ratified by 187 countries in 2011 (Gfeller, 2013; Rodwell, 2012). The concept of biocultural heritage, first used in the Declaration of Belem (ISE, 1988; Posey & Dutfield, 1996) has become increasingly prominent in the literature thereafter (Gavin et al., 2015; Wilkes & Shen, 2007). Biocultural heritage can be defined as the knowledge and practices of indigenous people and their biological resources, from the genetic varieties of crops developed, to the landscapes impacted upon (Cornish & Driver, 2019; Harrison, 2015). Biocultural heritage is a holistic concept, where knowledge, biological diversity, landscapes and culture are inter-connected and inter-dependent (Mackenzie & Dilts, 2013). Biocultural heritage is the interwoven relationship between the natural environment (biodiversity) and a culture, it identifies objects making a contribution to human understanding of a specific culture (Gavin et al., 2015; Price & Lewis, 1993). In this study biocultural heritage is used to identify plant populations viewed in a historic context where human interactions with nature have added value to the development of scientific knowledge (Harmon, 2013). Historic plant populations constitute markers of the intersection of culture and biological heritage. Plant populations, where historic specimens were collected over 100 years ago, may be able to provide insight to research questions pertaining to the state of the environment, ecosystems and human communities at the time of collection, highlighting how these have changed over time.

Often living plant populations can provide information not obtainable from the dried herbarium specimen and, as stated by Rautenberg (2014, p. 2), and in support of our study:

> *…there is a unique scientific value in plants and animals around the world that live on the sites where they were first discovered, or where they have previously been studied.*

Biocultural heritage, used here, is both practical and theoretical (Maffi, 2005), identifying and defining plant populations having an associated historic value through their contribution to the development of scientific knowledge. Here we seek to illustrate historic herbarium specimens and their original collection sites are biocultural heritage assets giving a new recognition of the social human role and contribution of botanical collecting as applied to conservation.

The most commonly studied aspect of biocultural heritage is the value humans have placed on plants, animals and sites for economic purposes (Cocks & Dold, 2006). However, there is far more to biocultural heritage than the link between human needs and nature. Few studies have looked at the idea of objects of nature influencing the culture of a discipline such as science (Cowell, 2018). The notion of biocultural heritage has traditionally been used to describe the link between indigenous people and the environment as a means to retain their cultural identity (cf. Hill,

Cullen-Unsworth, Talbot, & McIntyre-Tamwoy, 2011). This study extends the notion of the value of biocultural heritage beyond indigenous people to all citizens according to a recognition of our collective biological and cultural identity rooted in science. Biocultural heritage has attracted interest in disparate fields of the humanities and social sciences (de la Bellacasa, 2010; Harrison, 2015), and as time passes and societies grow and change, the application of biocultural heritage should follow suit (cf. Cocks & Dold, 2006; Price & Lewis, 1993).

Our study was based in South Africa, a mega-biodiverse country having extremely high levels of floral endemism. It has been the destination of botanical explorers for centuries with herbarium specimens featuring in botanical publications since the 1700s (Glen & Germishuizen, 2010; MacOwan, 1890). The link between the collections made by early botanists and the scientific and historic value of these collections has not been closely examined in the South African context and it is only very recently (April 2019) that the South African government has formally recognized botanical specimens as 'objects which may be considered to be of heritage significance' (Section 32 of the National Heritage Resources Act (NHRA) Act 25 of 1999; NHRA, 1999). Using historic botanical collecting on the Agulhas Plain in what was then the Cape Colony of South Africa, we explore the value of historic herbarium specimens as biocultural heritage assets, with the aim of promoting a new discourse that recognizes the joint value of natural and cultural sites to science and conservation.

This paper establishes a connection between historic herbarium collections, associated narratives of early collectors and whether the plant populations (from which historic specimens were taken) are extant within a protected area. Here we use the contentious undertaking of European colonization (Pyenson, 1993) merely as a case study to look at herbarium specimens as objects which have informed science and enhanced scientific knowledge and culture. We acknowledge that early plant collection records provide little information on the local people who were employed as guides and whose local knowledge was no doubt imperative to the success of expeditions. Historic collections and records made by Europeans, foreigners to the lands they explored, and their written history has all the consequent biases of the time (Browne, 2001). Addressing these biases falls beyond the scope of our paper, which explores the role of these botanical collections as objects contributing to both nature and human history (Harmon, 2013; IUCN, 2010).

1.2 | The Agulhas Plain

Cape Town, like many early colonial coastal towns, was the gateway to the terrestrial interior (Hume, 1943). The major wagon routes used for passage along the Cape coast and the interior started as game trails and developed into travel routes used by indigenous people. The major route from Cape Town to the southern Cape coast was over the Hottentots Holland Mountains via Caledon (Figure 1; Rookmaaker & Svanberg, 1992). Famous botanical explorers such as William Burchell, Anders Sparrman and Francis Masson passed through Caledon, to Swellendam from where they explored the frontier regions of the Colony (Bradlow, 1994). They collected in the greater Cape Colony and did not collect in Agulhas as it was largely inaccessible with few roads to isolated farmsteads. Exploration of Agulhas took place when people began to establish larger farmsteads, south of Caledon (Figure 1). The Moravian Mission Station of Elim (34°35′S, 19°45′E) was established in 1825 and formed a central locale where travellers could rendezvous, find accommodation, hire guides and equipment, to explore the surrounding areas. Early plant collection records give little recognition to the native guides, who were important to the success of the collecting trips. Although their names were seldom recorded, it is important to recognize not only the contribution to scientific botanical knowledge of physical specimens but the myriad of

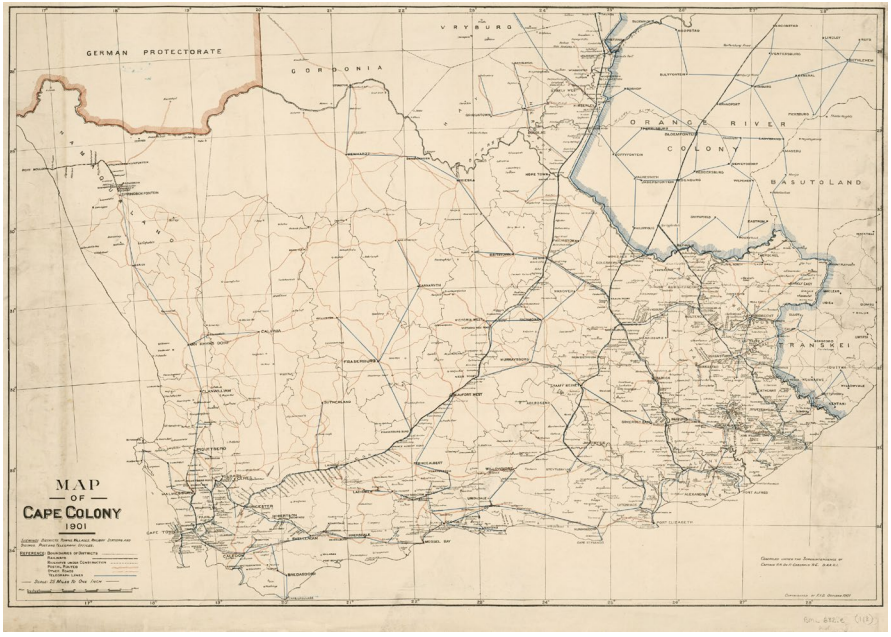

FIGURE 1 Map of Cape Colony (1901) showing districts, towns, villages, roads, railways, railways under construction, postal routes, telegraph offices and lines (P.H. Casgrain, British Army Field Intelligence 1901)

collectors, men and women, to whom this knowledge is owed both the collectors and guides (Barker & Barker, 1990; Hume, 1943). The presence of biocultural heritage is evident in the collections and the stories of the people who made them.

The main farmsteads visited by botanical explorers in Agulhas which are now within the Agulhas National Park were: Ratelriver, Rietfontein and Renosterkop.

2 | METHODS

2.1 | Study area

Our case study area was the Agulhas National Park, a protected area in South Africa. Proclaimed in 1999 to conserve the floristic diversity and endemism of the fynbos on the Agulhas Plain, hereafter referred to as Agulhas (Euston-Brown, 1999; SANParks, 2013a), it is currently 21,149 ha in size. The park is managed by SANParks, the national conservation arm of the government of South Africa. The park lies at the southernmost tip of the African continent, it is a linear park running approximately 45 km from east (34°49′S, 20°03′E) to west (34°35′S, 19°21′E) and 25 km inland from the coast. The Agulhas National Park has many historic sites within its borders, making use of historical records of shipwrecks, middens and farmsteads it developed a comprehensive heritage management plan.

2.2 | History of the farmsteads in Agulhas National Park

While contemporary focus is on the Agulhas National Park, early collectors collected on and around what were then private farmsteads owned by Dutch settlers in the early to late 1800s.

2.2.1 | Ratelriver

Ratelriver, one of the largest farms in Agulhas changed hands only four times between 1745 and 2003 when it was purchased by SANParks. Records from the owners of Ratelriver mention the extensive fields of fynbos flowers around the farmstead, and the records of herbarium specimens verify Ratelriver farm as an exceptional site for plant collection.

2.2.2 | Rietfontein

SANParks purchased the farm Rietfontein in 2003. The farm was originally a stock post although minimal grazing took place and very little cultivation was done, as the nature of the seasonal wetlands surrounding the farmstead were unsuitable for agricultural crops. This left the natural veld relatively undisturbed and able to recover naturally after wildfires (Gaertner, Richardson, Privett, & Baley, 2007). An assessment by the Agulhas Biodiversity Initiative (ABI) found the fynbos on the farm one of the most diverse in Agulhas (Euston-Brown, 1999).

2.2.3 | Renosterkop

The homestead on Renosterkop was small in comparison to Ratelriver and Rietfontein. Situated between foothills of coastal dune fields and inland salt pans, crop farming and grazing were limited. Once again the natural vegetation benefitted as it remained relatively intact in undisturbed pockets (Gaertner et al., 2007). The ABI botanical assessment notes the unique diversity of vegetation on the farm, in particular the limestone fynbos and salt pans to the north-west of the farmstead (Euston-Brown, 1999).

2.3 | Data accessibility

In order to obtain a practically workable number of specimens collected in this botanically rich area, only types specimens were used in this study. The online database of the Global Plants Initiative, JSTOR Plant (http://plants.jstor.org/), was used to search for type specimens collected in Agulhas. Search fields included country, locality, date from and date to, allowing for the 100-year heritage rule (Gfeller, 2013). We georeferenced the herbarium records (Wieczorek, Guo, & Hijmans, 2004) combining the data to produce a single GIS layer of plant collections. This was overlaid onto the Agulhas National Park boundaries with ArcView software (ESRI ArcView Version 10.3). The maps made show the regional situation of the Cape of Agulhas in South Africa, the Park boundaries and type collection sites and were used to select only those collections made in the current Park (Figures 2 and 3). As Bolus was the most prolific collector in Agulhas in the given time period, his records were cross referenced with historical literature regarding Agulhas and the Cape Colony in order to obtain more precise localities (Heydenrych, 1999; Theal, 1905).

The routes taken by early collectors, farmsteads visited and type specimens collected were located on the type specimen map for Agulhas National Park (Figures 2 and 3). By determining the habit and habitat requirements (Goldblatt & Manning, 2000) of the species collected, it was possible to predict where plant populations would most likely occur. Certain specimen labels included habitat descriptions and sometimes, listed features like limestone outcrops or marshy wetlands. Taking into account the occurrence of wildfires over the intervening years (Midgley, Hughes, Thuiller, & Rebelo, 2006), a localized target area with a 1 km radius was chosen. Three transects of 100 m were placed within the 1 km area, each transect was 4 m wide with markers placed every 20 m. Two observers worked side-by-side in 2 m strips and spent 8 min per 20 m section looking for the target plant species (Alexander et al., 2012). Field visits were undertaken between April and December 2014, to establish if the historic plant populations were still in the areas of what is now the Agulhas National Park. In order to allow the best possible chance of finding the species, sites were visited at the same time of the year

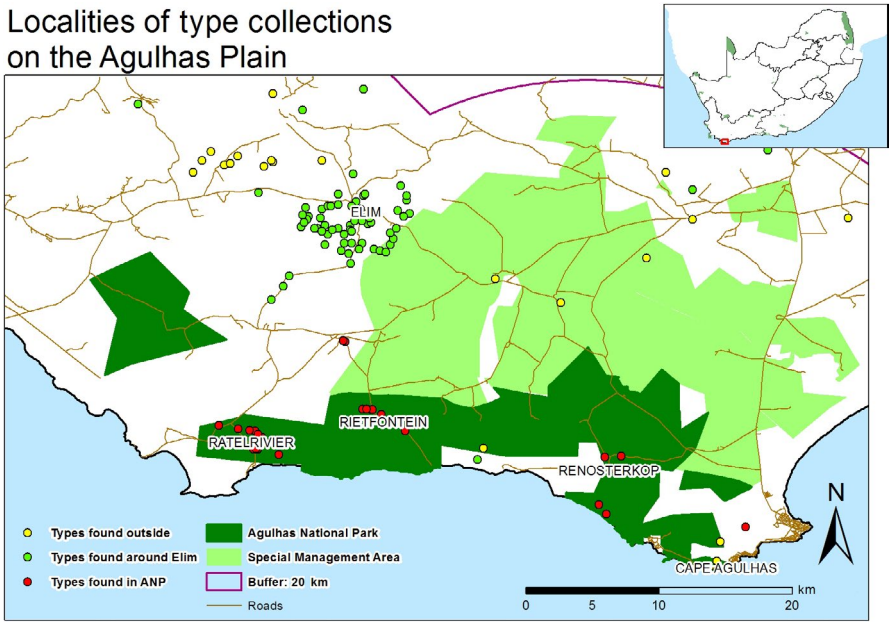

FIGURE 2 Map of the Agulhas Plain in the Western Cape Province, showing the Agulhas National Park, the Special Management. Type localities are shown inside and outside of the Park. Inset in the top right corner of the map shows the position of the Agulhas National Park in red within the country of South Africa

FIGURE 3 Map of the Agulhas National Park, showing the type localities found (in black) and not found (in red) within land managed by the Park

as written on the label and also during the peak flowering periods of the plants as these time periods may no longer coincide (Tingley & Beissinger, 2009).

3 | RESULTS

3.1 | Biography of three botanists in Agulhas National Park 1894–1897

Between 1600 and 1914 only four collection trips were made (1894, 1895, 1896 and 1897) where type specimens designated to the collections. These historic collections were made by three botanists, Harry Bolus, Rudolf Schlechter and Francis Guthrie (Table 1). A total of 127 type specimen records were obtained from the search of JSTOR Plant online database. There were 31 type specimens collected within the current Park boundaries, 82 in and around Elim and 27 in other areas outside of the Park (Figure 3). The following description of the collectors and their collections is an example of historic collections in Agulhas but is by no means necessarily the first or all the historic collections made in this area. Recognition must be given to local native people who gathered and collected in this area prior to European Botanical collection.

3.1.1 | Harry Bolus

Harry Bolus travelled to South Africa from England when he was 15 and settled in Graaff-Reinet. In 1864 he lost his son and at

TABLE 1 Current type collections originating in Agulhas National Park between 1600 and 1914, Taxon, Family, Collector, Red List status, original collection date and presence provided

Taxa	Family	Collector	Red List status	Date of collection	Found in 2014
Acrolophia micrantha (Lindl.) Pfitzer.	Orchidaceae	Schlechter	Least Concern	10/12/1896	Not found
Adenocline pauciflora Turcz.	Euphorbiaceae	Bolus	Least Concern	10/12/1896	Yes
Agathosma dielsiana Schltr. Ex Dümmer	Rutaceae	Schlechter	Least Concern	27/04/1897	Yes
Argyrolobium harmsianum Schltr. Ex Harms	Fabaceae	Schlechter	Endangered	27/04/1897	Not found
Cassine peragua L.	Celastraceae	Schlechter	Least Concern	28/04/1897	Yes
Erica accommodata Klotzsch Ex Benth.	Ericaceae	Bolus	Least Concern	13/07/1895	Not found
Erica aghillana Guthrie & Bolus	Ericaceae	Schlechter	Endangered	28/04/1897	Yes
Erica filipendula Benth. subsp. *filipendula*	Ericaceae	Bolus	Rare	16/07/1895	Yes
Erica filipendula Benth. subsp. *parva* E.G.H. Oliv. & I.M. Oliv.	Ericaceae	Guthrie	Least Concern	16/07/1895	Yes
Erica gracilipes Guthrie & Bolus	Ericaceae	Bolus	Critically Endangered	10/12/1896	Yes
Erica plukenetii L.	Ericaceae	Schlechter	Least Concern	12/12/1896	Yes
Erica propinqua Guthrie & Bolus	Ericaceae	Bolus	Least Concern	04/10/1894	Yes
Erica radicans (L. Guthrie) E.G.H. Oliv. subsp. *schlecteri* (N.E.Br.) E.G.H. Oliv.	Ericaceae	Schlechter	Endangered	27/04/1897	Yes
Erica saxicola Guthrie & Bolus	Ericaceae	Schlechter	Least Concern	10/12/1896	Yes
Ficinia latifolia T.H. Arnold & Gordon-Grey	Cyperaceae	Schlechter	Endangered	30/04/1897	Yes
Gladiolus carneus D. Delaroche	Iridaceae	Bolus	Least Concern	12/12/1896	Yes
Gnidia linearifolia (Wikstr.) B. Petersen	Thymelaeaceae	Bolus	Least Concern	09/12/1896	Not found
Leucospermum cordifolium (Salisb. ex Knight) Fourc.	Proteaceae	Bolus	Near Threatened	09/12/1896	Not found
Leucospermum heterophyllum (syn. Lemmerzianum) (Thunb.) Rourke	Proteaceae	Schlechter	Endangered	09/12/1896	Yes
Limonium scabrum (Thunb.) Kuntze var. *avenaceum* (C.H. Wright) R.A. Dyer	Plumgabinaceae	Bolus	Least Concern	12/12/1896	Yes
Mimetes saxatilis E. Phillips	Proteaceae	Schlechter	Endangered	25/04/1897	Yes
Ornithogalum dubium Houtt.	Hyacinthaceae	Schlechter	Least Concern	10/12/1896	Not found
Protea aspera E. Phillips	Proteaceae	Bolus	Vulnerable	04/10/1894	Not found
Restio calcicola (Mast.) H.P. Linder (syn. *Calopsis fruticosa*)	Restionaceae	Schlechter	Least Concern	12/12/1896	Not found
Restio dodii Pillans	Restionaceae	Schlechter	Vulnerable	28/04/1897	Yes
Roella arenaria Schltr.	Campanualceae	Schlechter	Vulnerable	10/12/1896	Yes
Roella compacta Schltr.	Campanualceae	Schlechter	Least Concern	12/12/1896	Yes
Senecio pillansii Levyns	Asteraceae	Bolus	Threatened	09/12/1896	Yes
Tetraria brachyphylla Levyns	Cyperaceae	Schlechter	Least Concern	28/04/1897	Yes
Thesium capituliflorum Sond.	Santalaceae	Bolus	Least Concern	10/12/1896	Yes
Thesium sertulariastrum A.W. Hill	Santalaceae	Bolus	Data Deficient	10/12/1896	Yes

the suggestion of his friend Francis Guthrie, took up botanizing to help him grieve (Bolus, 1894). In 1865 he moved to Cape Town to work at the South African College (now the University of Cape Town) founding the Bolus Herbarium in Cape Town. Botanizing was Bolus' passion and in 1895 he started fulltime botanical collecting. Bolus was a philanthropist, organizing expeditions and helping fellow collectors financially. Like Linnaeus he mentored other botanists, such as Rudolf Schlechter, working with them in the herbarium and taking them on field expeditions. Bolus shared his knowledge of the area and his botanical skills. Bolus, Rudolf Schlechter and his brother Max Schlechter jointly explored the Agulhas Plain in 1896 (Plate 1).

PLATE 1 Harry Bolus (seated left), Max Schlechter (standing) and Rudolf Schlechter (seated right) on a collecting expedition in 1896 (T. Oliver 2004)

3.1.2 | Rudolf Schlechter

Rudolf Schlechter was born in Berlin in 1872, studied horticulture and worked in the Berlin University Garden. He left Europe in 1891 for a botanical expedition to the Cape and worked as a gardener in the Cape Company Gardens, later as an assistant to Bolus, where he joined collecting trips on the Cape Peninsula (Glen & Germisthuizen, 2010). In 1892 Schlechter started collecting, in the southern and eastern Cape regions. Schlechter also collected in German New Guinea, Indonesia and Australia, and returned to Germany in 1921 describing new orchid species, having developed a love for this plant family while in the Cape of South Africa (Liltved & Johnson, 2012).

3.1.3 | Francis Guthrie

A lifelong friend of Bolus, Francis Guthrie, arrived in South Africa in April 1861 from London. Along with Bolus, Guthrie was employed at the Graaff-Rennet College and in turn followed him to Cape Town in 1875. He became professor of mathematics in 1876 at the South African College. Collecting mainly on the Cape Peninsula, he joined Bolus on expeditions to the southern Cape. Guthrie retired and died of cancer 3 months after his last collecting expedition to the southern Cape with Bolus. The strength and depth of relationships forged through botanizing and collecting in the wilds of the Cape is apparent in Bolus' diary (Bolus, 1894, p. 91) where he wrote:

> *Oct 19. F. Guthrie, my dear old friend, counsellor teacher, companion and close intimate died at about 11.30 pm this night…, from cancer of the stomach- an illness borne with wonderful courage, patience and resignation…*

3.2 | Results from revisiting sites in 2014

Bolus and Schlechter collected 81 specimens including 17 previously undescribed species. We found 31 historic specimen collections made between 1600 and 1914 at or within 100 m their type localities in what is today the Agulhas National Park (Table 1). On the first expedition to Agulhas, 4 October 1894, Bolus collected two specimens *Erica aspera* and *Erica propinqua*. Returning to the Ratelriver farm, in 2014, we found *Erica propinqua* only. The next historic excursion to Agulhas was in July 1895 where three type specimens were collected. In looking for these three in the Park, only one was found, *Erica filipendula* subsp. *filipendula* (Figure 4). We were unable to locate *Erica filipendula* subsp. *parva* and *Erica accommodata* near the Ratelriver homestead. Twelve of the 17 taxa, of the designated type collections, made in December 1896 by Bolus and Schlechter, were found growing at their historic localities. The habitats of *Restio calcicola* and *Leucospermum cordifolium* (now a popular cut flower and garden plant around the world; Leonhardt & Criley, 1999; Littlejohn, Walt, Berg, Waal, & Brits, 1993) were completely transformed and the populations are gone. The 1896 trip was to be the last trip to Agulhas for Bolus.

Rudolf Schlechter undertook a trip to Agulhas at the end of April 1897. Schlechter's trip is recorded in Bolus' journal from a letter written by Schlechter. Venturing further than Bolus, he visited the farm Renosterkop and the Cape of Agulhas. Schlechter arrived at the Cape of Agulhas from Bredasdorp and collected on the limestone hills around the southern point of Africa from 25 to 27 April 1897. First collecting the iconic *Mimetes saxatilis* now listed as endangered on the IUCN Red List (Raimondo et al., 2009). Schlechter resided at Renosterkop whilst collecting around Cape Agulhas, on the 28 April he collected *Cassine peragua* subsp. *barbara*. This species is a widely used landscaping plant, which reduces its risk of complete extinction. From Renosterkop he made his way along the coastal foot slopes of the Soetanysberg to Rietfontein, once again botanizing at Rietfontein Poort. Evident here is a pattern of returning to a favoured site and community, a process further instilling these sites with a depth of historic engagement. On this occasion, he added one species to his collection records at the Poort, *Ficinia latifolia* and collected seven other specimens. Schlechter sent Bolus 1,115 specimens, including duplicates for the Royal Botanic Gardens Kew. Closely following Schlechter's 1897 collection route 117 years later in 2014, eight of the nine specimens Schlechter collected are still at their localities within Agulhas National Park.

Only two of the historic localities of Red Listed species (Raimondo et al., 2009), sought were located. The flat fertile field where *Protea aspera* (Vulnerable) once grew, was ploughed at the turn of the century and the historic population was likely lost (Heydenrych, 1999).

FIGURE 4 Historic locality of *Erica filipendula* subsp. *filipendula* in Agulhas National Park. Inset is a close-up of the individual yellow flowered erica first documented in 1895 (C. Cowell 2014)

Argyrolobium harmsianum (Endangered) was not found as it is a post-fire species requiring fire for growth and flowering.

4 | DISCUSSION

Only Bolus' collection journals have been preserved intact, what is evident from them is the emergence of a network of knowledge-sharing and sense of community between botanical collectors and those who helped. Such as the Elim Mission Station which played a major role acting as a central hub in this remote environment and enabled explorers to meet each other and the local residents. In his collection register, Bolus mentions the collection of several species from his explorations of the vegetation around the village and on his trips to the farmsteads of Ratelriver and Rietfontein (Bolus, 1894). Throughout his writings he makes reference to the Elim community and the Agulhas farmers he visited, acknowledging the role the they played in the advancement of botanical knowledge (Bolus, 1894). This is an example of the intangible biocultural heritage embodied in herbarium specimens and their historic localities.

A reason for the lack of exploration of Agulhas Plain prior to the late 1700s was the scarcity of settlements in this area and not a lack of interest to explore and collect (Heydenrych, 1999). Economic needs resulted in stock stations being established in Agulhas (Gaertner et al., 2007) and access routes opening connecting remote farmsteads. Even then farming was relatively marginal and large farms resulted in limited disturbance to small areas with low stocking rates of domestic sheep (Hydenrych, 1999). The remaining natural areas on the old farmsteads of Ratelriver, Rietfontein and Renosterkop are testament to this rather marginal agricultural engagement. The ownership of farmsteads by a few key families (Lourens and Van Breda 1745–2003) resulted in the farms being managed in a similar manner reducing intensive use of individual farms.

Our research indicates that the wetlands around Ratelriver homestead were drained in the early 1900s for a canal to channel the Ratel River away from the homestead. The field data gathered in this study suggest that it caused a decline in species reliant on the seasonal inundation of the wetlands along with an increase in invasive alien *Acacia* species densities over time. Possibly in response to the 'gap' provided by the decline of the indigenous species. The scarcity of *Gladiolus carneus* in the wetland is a case in point and although the historic localities of *Erica plukenetii* and *Roella compacta* at Ratelriver were in good condition, the majority of the Ratelriver wetland habitat has been negatively affected by this disturbance and requires interventions to ensure these species persist. By identifying the human cultural impact on the wetlands, a greater understanding of the decline of the wetland species is gained. Here is a prime example of how biodiversity and culture (biocultural heritage) can influence the current understanding and future management of a wetland in a conservation area.

Humans are creatures of habit, repeatedly returning to a place (Marchette, Bakker, & Shelton, 2011), on closer examination of the collections made by Bolus and Schlechter, it was found they had often collected in or around the same spot on different occasions. This kind of repeat sampling by botanical collectors provides science with a temporal and spatial knowledge of what plant species occurred in a specific area (Rietfontein Poort) over a period. It also reflects the varying interests of botanists and the periods in which they collected (Benson & Eldershaw, 2007). Using this information, long-term analyses and studies can be undertaken to determine population dynamics including impacts of land transformation, alien species (Rouget, Richardson, Cowling, Lloyd, & Lombard, 2003) and climate change on floral populations.

Bearing in mind history is subjective and the writers often recount their stories selectively according to their own perspective, the written accounts of the botanical explorers provide only a glimpse of the original abundance of floral species. Nonetheless, the collection notes accompanying the herbarium specimen of the common garden

FIGURE 5 Rietfontein Poort in Agulhas National Park, the original wagon track ran between the two hills on the left of the picture, the current management road runs to the right of the hills. The inset is of *Erica gracilipes* (CR) growing in situ in the limestone rocks (C. Cowell 2016)

pincushion *Leucospermum cordifolium*, evoke images of an abundant species dominating large patches of the vegetation. The historic locality has been completely lost because of land transformation for wheat and other crops (Heydenrych, 1999). Here we can note that its biocultural heritage contribution has been lost to science. Yet this species is prolific across Agulhas in remnant pockets of natural vegetation and is secure from global extinction as a garden plant through the horticultural efforts of botanical gardens (Maunder, Higgens, & Culham, 2001). In contrast, the perennial shrub, *Senecio pillansii*, discovered close to the Ratelriver farmhouse and described by Bolus as common both on the farm and in Agulhas. It is still growing at its historic locality but no longer abundant in Agulhas, a result of land transformation, one of the most common threats to species survival (Allkin, 2017).

Historic herbarium specimens have the potential to shed light on current day conservation management of protected areas to conserve plant populations and habitats. However, without the associated narratives, the unique perspective provided is lost. Early botanical collectors took time to observe and capture the details of the areas they found themselves in and the species they were collecting. Together the narratives, herbarium specimens and localities have a historic value for scientific heritage and should be used to structure current nature conservation in terms of a site's historic and biodiversity significance. Using this information to highlight the importance of conserving an area for its intrinsic biological worth and its biocultural heritage to government agencies and conservation organizations, will safeguard this biocultural heritage for people to continue learning and studying. Ensuring the persistence of original texts, specimens, and in situ localities, will contribute to the advancement of scientific knowledge and aid protected areas in achieving their mandate to conserve the biodiversity of a region and the heritage of an area (Andreone, 2000; Phillips, 2002; SANParks, 2013b). Our research advocates for the education of scientists, conservators and the public regarding the value of biocultural heritage. Entrenching the idea of conserving historic populations as important heritage assets, in protected areas and surrounding communities.

Herbarium specimens can enable us to determine exactly who collected plant species and where along the expedition route collections occurred. Our work has shown it is possible to locate historic populations and assess their health. *Erica gracilipes* found at Rietfontein Poort in 1896 and now Critically Endangered, was found growing on the limestone rocks mentioned in the original herbarium labels (Figure 5). This population has healthy numbers and the information will be used to update the Red List of Plants (Raimondo et al., 2009). Biocultural heritage status of plant populations can also highlight threatened populations at a local level but not regional or global level (Solberg et al., 2013).

Two species collected at Rietfontein Poort flower prolifically following fire, suggesting there had been a wildfire in the area within two flowering seasons (Summer of 1894 or 1895) prior to collection of these specimens. Using historic collection notes, the fire history of an area can be determined further informing scientific research on fire and fynbos regeneration. The continued existence of historic localities enables monitoring for changes in population vigour, phenology and abundance. We suggest distribution models be investigated to estimate population movement in response to climate changes. Our findings will aid to inform Agulhas National Park conservation management of its threatened species, and enable them to conserve sites as biocultural heritage, fulfilling the full heritage and conservation mandate of SANParks.

5 | CONCLUSIONS

Biocultural heritage represented in herbarium specimens informs modern scientific epistemologies and the social character of science via narratives, sites and the living plants (Cocks, 2006; Zytaruk, 2011). The presence of historic specimens and present populations highlights the spaces where knowledge of the natural world was documented (Rautenberg, 2014). Biocultural heritage records enable us to focus attention on these areas and to continue to generate knowledge and understand changes over time that no other records can achieve (Crane, Herendeen, & Friis, 2004).

Biological and cultural diversity is inextricably linked by the botanical collections in Agulhas. The continued observation and collection of data and specimens is however, still required. Committed well-informed naturalists, ecologists and botanists are needed in the field, collecting the same types of data, so diligently collected by the early explorers. Students and scholars must be encouraged and supported in fieldwork and expeditions where knowledge, such as biocultural heritage is generated and to conserve and use this information to advance science. Concurrently a system needs to be developed supporting the capture, collation and curation of the data collected, making it available for research of biocultural heritage and biodiversity.

The grounds for protected areas to recognize the biodiversity and biocultural value of historic herbarium specimens and their associated in situ plant populations is evident, as it aids in the success of nature conservation (IUCN, 2010). Historic herbarium specimens are hugely valuable in our future understanding of the environment. The value of historic populations can only be realized when the information regarding their collection and conservation is shared with local and scientific communities, providing them a means to engage, participate and contribute to the recognition of biocultural heritage (Ryan, 2015). If society recognizes the value of the biocultural heritage (Mallarach & Verschuuren, 2019) and the conservation worth of historic populations, the value to protected areas increases (Crouch & Smith, 2011). The combined stories and narratives give depth to the collections and provide a fundamental knowledge that looks to the past whilst taking us forward. The understanding of historic herbarium specimens, in situ populations of plants and the collectors' narratives as being inextricably enmeshed, highlights they are indeed biocultural heritage. Together, they provide a unique perspective where the environment is viewed as historical evidence, going beyond merely seeing the biological but locating human experience and learning in a natural cultural environment. Historic herbarium specimens provide a glimpse of what the past state of a species was like and enables research to take place using this as a foundation.

In looking to the future, protected areas should look at the conservation and persistence of other subpopulations of plant species not only those that historic specimens were collected from. Conservation management activities such as alien clearing, erosion control and the use of prescribed fires is essential for the conservation of biodiversity but also important for biocultural heritage plant population sites. All herbarium specimens (type and non-type) are valuable as they may indeed be able to assist in determining whether species are at risk of going extinct (Bachman et al., 2019). Historic plant populations older than 100 years should be recognized as biocultural heritage assets, as they are sites where scientific (social and biological) knowledge was and is generated (Zytaruk, 2011).

CONFLICT OF INTEREST

The authors have no conflict of interest.

AUTHORS' CONTRIBUTIONS

C.R.C. and W.A.A. conceived the ideas; P.M.L.A. and C.R.C. designed field methodology; C.R.C. collected the data; C.R.C. and W.A.A. collated and analysed the biocultural heritage narratives; C.R.C. led the writing of the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

DATA AVAILABILITY STATEMENT

The data are sensitive and are of endangered species whose localities cannot be transformed; they also contain sensitive cultural and traditional knowledge of the local communities. The data are archived in the South Africa National Parks Data Repository System in South Africa, managed by Ms Judith Botha (Judith.botha@sanparks.org) and are available on request through an Access and Benefit Sharing agreement.

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