Plant poaching in southern Africa is aided by taxonomy: Is a return to *Caput bonae spei* inevitable?

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ABSTRACT

In recent years the poaching of, especially, succulent plants from the wild in South Africa has developed into an enormous, illegal industry, with the number of such plants confiscated increasing annually by over 250%. It has been estimated that more than 1.5 million plants have been illegally removed from the wild in the past three years. This conservation crisis has seen an unprecedented surge in poaching of representatives of families such as the Aizoaceae, Anacampserotaceae, Asphodelaceae, Crassulaceae, and several others, given that South Africa and neighbouring countries are host to about 45% of the known succulents of the world. Apart from annotated, geo-referenced (type and other) herbarium specimens, further easily accessible sources of information on accurate occurrences of species are type localities published in protologues of plant names, and online resources that aim to mobilise biodiversity data. We propose drastic measures regarding the non-disclosure of accurate locality information on specimens, in the literature, and on websites.

Keywords: conservation; exact location; succulents

INTRODUCTION

The description of plants new to current-era science is a time-honoured and very effective way in which taxonomists contribute to knowledge of the biodiversity of a country or region. Valid publication of a name for a new taxon requires adherence to a set of rules contained in the *International Code of Nomenclature for algae, fungi, and plants* (Turland & al., 2018), which includes the mandatory requirement for the deposition of one (or more) type specimens in, typically, a herbarium. Turland & al. (2018: Rec. 7A) further recommend that "[…] material on which the name of a taxon is based, especially the holotype, be deposited in a public herbarium or other public collection with a policy of giving bona fide researchers access to deposited material, and that it be scrupulously conserved." In plant taxonomy, emphasis on type specimens is inevitable because the application of names of taxonomic groups is determined by means of nomenclatural types (Turland & al., 2018: Div. I, Principle II).

Apart from having to prepare and deposit at least one type specimen when a new plant name is published, taxonomists also often cite and annotate other, often older specimens that are representative of the (new) taxon. This provides, at least to some degree, an indication of the geographical distribution of a species and a reflection of morphological variation found in that species.

In South Africa, the computerisation—"Electronic Data Processing", as it was known at the time—and subsequent electronic dissemination of herbarium specimen label information was initiated in the 1970s at the Botanical Research Institute, one of the forerunners of the South African National Biodiversity Institute (SANBI), with the development of the National Herbarium, Pretoria (PRE) Computerised Information System (PRECIS) (De Winter, 1970). As was anticipated, the immense utilitarian value of accessing and interpreting such information through increasingly expanded and refined large-scale datasets soon became evident, and positively impacted several other fields of biology.

Over the past 50 years the enhancement and manipulation of raw herbarium specimen data held in PRECIS, later the Botanical Database of Southern Africa (BODATSA), have resulted in the publication of numerous electronic and hardcopy resources, including, perhaps most notably, successively updated catalogues of the plants of South Africa, and beyond, in the *Flora of Southern Africa* (*FSA*) region (Namibia, Botswana, Eswatini, Lesotho, South Africa).

Elsewhere too, increasingly affordable and efficient publication and dissemination technology available for producing taxonomic and other outputs has benefitted from the growth of the worldwide web, with a concomitant proliferation of information being made readily available online. This includes, most recently at a global scale, the publication of electronic, web-based Floras, often with voluminous citation of type and other specimens (Smith & al., 2017). Taxonomy, in its broadest definition, is mostly now accessible—not always freely, though—to anyone, in particular the many end-users of such information.

The precision with which a plant can be located in its natural habitat based on specimen metadata and the availability of that information on the worldwide web and in the non-digitised published literature have served a useful purpose in taxonomy, plant geography, and other science-based activities, but have also enabled plant poachers to rapidly and with great ease locate populations or even individual specimens of virtually any newly described taxon. This, to some extent unanticipated, consequence of taxonomic endeavour is discussed, and suggestions are made to counter this development.

THE DISSEMINATION OF COLLECTIONS DATA

Herbarium collections serve many purposes beyond being one of the primary spaces where taxonomists intellectualise about relationships among plants and concomitant plant classification. Among other things, collections held by herbaria facilitate the study of plant morphology, and variation found in characters and character states, and usefully serve as reference material for plant identification. Herbaria additionally function as the repositories for voucher specimens for a range of botanical studies, including in anatomy, ethnobotany, cytology, chemistry, conservation biology, and vegetation studies.

Since plant specimens accessioned into herbaria, especially in the current era, are typically accompanied by often very detailed specimen labels, such metadata associated with the physical material are enormously useful in floristic, monographic, and phytogeographic studies. The specimens, including the information on associated labels, therefore provide a permanent record of time-lined plant occurrences and the metadata associated with correctly identified specimens are useful in proposing or testing phytogeographical patterns. A taxon therefore can be placed in a country or region, of whatever size, with ease and great accuracy. In addition, the exact occurrence of a specimen is nowadays easily recorded in the field given the wide use of comparatively affordable hand-held or vehicle-installed georeferencing equipment. This essentially enables anyone to relocate virtually the exact place from where a specimen was collected, typically to within a few metres.

In the pre-digital age, data recorded on a specimen label were only accessible through the scientific publications where the information was published or through direct access to the specimens in the repositories where they are held. Especially the scientific literature—typically journals and books—was mostly available through specialist libraries only because of the cost of such works, and access to herbaria was often limited to bona fide researchers. Plant collectors with ill intent therefore had no easy access to information on the (exact) localities where rare and endangered plants occur.

Over the past ca. 30 years, as digital platforms gained in prominence and sophistication as a communication medium, research projects and programmes, such as the African Plants Initiative, later the Global Plants Initiative (see Smith, 2004; Smith & Figueiredo, 2014), facilitated the imaging of type and other specimens, with the images made readily available online, sometimes behind a pay wall. Over the past three decades, this initiative was expanded and several herbaria now have dedicated institutional websites where images of their collections and data can be accessed, by anyone at no charge.

Disseminating specimen images and metadata associated with those specimens, and making scientific literature freely available, have been widely lauded as contributing to lifting the so-called taxonomic impediment (a general lack of taxonomists and taxonomic information and knowledge), an imposition on many institutions in the global south because of the past practice of in-country specimens virtually without exception being exported to foreign destinations. For different reasons, other parts of the world are also experiencing a taxonomic impediment. Globally there have been several initiatives, especially over the past two decades, aimed at mobilising digital biodiversity data, for example making specimen level information (primary species occurrence data) widely and freely available in a digital format that can be easily searched and analysed (Nelson & Ellis, 2018). As a result, there has been a concomitant increase in the number of research papers that cite online datasets, so providing evidence that these resources are benefitting taxonomy and other biodiversity-related research (Nelson & Ellis, 2018). The available data not only support and enhance taxonomic research, but also have an impact on conservation and related legislation. It has been shown that in regions where biodiversity data are not mobilised and easily accessible, these data are in essence not available to effectively influence policies aimed at protecting important species and, for that matter, important biodiversity areas (Pfeiffenberger & Uhlir, 2020). Digitisation and mobilisation of biodiversity data have underscored the crucial role that natural history collections perform in research and knowledge generation and distribution, and have further made this information available and easily accessible to citizen scientists and the general public (Nelson & Ellis, 2018).

Similarly, efforts to digitise biodiversity-related literature have increased over the past few decades. An ever-expanding amount of old and, sometimes, new literature containing specimen locality information and details about the distribution of taxa, are available online, often freely via open access platforms. There have also been international efforts to eliminate the need for authors to pay article processing fees to publish their articles and/or users having to pay to access scientific literature (Pearce, 2022). These endeavours aim to ensure that all scientific literature becomes available under an open access model and thus freely available to end-users. This will further improve the ease with which published specimen locality information can be accessed.

THE *FLORA OF SOUTHERN AFRICA*

Southern Africa, here defined as the region covered by the *FSA* project, i.e., Namibia, Botswana, Eswatini, Lesotho, and South Africa, is host to the richest temperate vascular plant flora globally. About 21,100 vascular plant species are indigenous to the region (Steenkamp & Smith, 2006: iv), with some 13,100 (ca. 62%) of these being endemics (Steenkamp & al., 2005; Van Wyk & al., 2005; Klopper & al., 2010; see also Klopper & Winter, 2022).

Apart from, inter alia, rich and diverse tree, bulb, "fern", and pooid floras, southern Africa is also host to the richest succulent flora in the world, with about 45% of the ca. 10,000 known succulent species of the world having been recorded from arid and mesic parts of the subcontinent (Smith & al., 1997). Many of these species are not only endemic to southern Africa; they are additionally in many cases narrow-range endemics.

Along with the considerable plant diversity found in southern Africa come, essentially at country-level, the mandate and responsibility to study, conserve and protect this diversity.

PLANT POACHING AND CONSERVATION CONCERNS

All around the world, theft of plants from the wild, driven by their horticultural value or a collector's completist desire to grow every species of a genus, have had disastrous consequences for conservation. Rare orchids, bulbs such as bluebells and snowdrops, ferns, and cycads are all threatened to a greater or lesser extent by illegal collecting. Cycads have been a source of income for illegal harvesters for decades and are now the world's most endangered group of plants (Gilbert, 2010). In South Africa, three cycad species are Extinct in the Wild, and only 2 of the indigenous 37 species are not in danger of becoming extinct (http://redlist.sanbi.org).

The beauty in the oddity of dwarf and other succulent plants, especially from South Africa, has intrigued plant enthusiasts for centuries. Succulents such as, most notably, aloes, haworthias (both Asphodelaceae), euphorbias (Euphorbiaceae), plakkies (Crassulaceae), and stone plants (Aizoaceae) have been cultivated for the horticultural trade for a long time (Van Jaarsveld & Smith, 1997; Klopper & al., 2013). However, this is in many instances a slow process and legitimate propagation methods often cannot satisfy the increasing demands for plants, especially for the international market.

More recently, the illegal poaching of sought-after plants from the wild has additionally become a comparatively easy way of generating income during times of economic downturn particularly in places with a low per capita annual income. The COVID pandemic and resultant global lockdown measures put in place especially from early-2020 to early-2022, have had a major impact on several aspects of peoples' lives, most notably increasing unemployment in several places. Gardening and landscaping as hobbies, and thus the demand for interesting plants, have increased during the pandemic in some regions. At the same time, the lockdown has evidently led to an escalation in plant poaching (Knoetze, 2020; Trenchard, 2021; Breslin & al., 2022; Dolley, 2022; Human, 2022) with poachers increasingly making use of local communities to obtain plants, while they themselves were unable to travel. Poachers often use social media platforms to contact locals with requests for plants. Unemployed people in rural areas, where opportunities for jobs are limited, are often easily tempted to remove plants from the wild for, usually, limited payment when compared to the commercial value of these plants (not to mention the ecosystem services value provided by the plants). Educating impacted communities to be proud and protective of their natural heritage is one of the challenges facing those who are trying to stem the tide of plant poaching. Nevertheless, education alone will not be a solution, when poaching is driven by economic necessity.

For the in situ conservation of succulent plants in South Africa, this has developed into a crisis with a sudden unprecedented increase in poaching of representatives of several families. A total of 97% of the species in the genus *Conophytum* N.E.Br., in the vernacular known as knopies or toontjies in Afrikaans, or as button(s) (plants) in English, which is endemic to the *FSA* region (Smith & al., 1998: 86–93), are listed as threatened with extinction (www.iucnredlist.org) (Figs. 1-3). Over the past three years, the number of succulent plants confiscated by South African law enforcement agencies has increased annually by over 250% (South African National Biodiversity Institute, 2022). SANBI estimates that over 1.5 million plants have been removed from the wild in the past three years (James, 2021; see Breslin & al., 2022 for an overview and Anonymous, 2022 for hot-linked references cited in Breslin & al., 2022; Tempelhoff, 2021). Even more alarmingly, as recently as 4 November 2022, it was reported that in *a single case*, three foreign nationals were arrested in South Africa for being in possession of 1.63 million flora items (Williams, 2022).

Fig. 1. Specimens of *Avonia ustulata* (E.Mey. & Fenzl) G.D.Rowley (Anacampserotaceae) that were poached from central South Africa. Out of 2000 specimens subsequently confiscated from the illegal trade, only 600 survived and are currently in cultivation in trays in a plant rescue and rehabilitation centre. Photograph: Gideon F. Smith.

Fig. 2. Plants removed from the wild often do not survive, as was the case with 1400 of the confiscated avonias (see Fig. 1). Photograph: Gideon F. Smith.

Fig. 3. Tens of thousands of poached and confiscated miniature vygies (Aizoaceae) cultivated in trays in a plant rescue and rehabilitation centre. Photograph: Gideon F. Smith.

IS A RETURN TO *CAPUT BONAE SPEI* INEVITABLE?

Efforts to aid plant conservation by not disseminating exact locality information are in place, with several "best practice guides" available with guidelines relating to sensitive species occurrence data (see Chapman, 2020); for example, on SANBI database websites, this information is obscured for sensitive and protected plants and only available on request. Certain users who require the information for academic or other valid reasons, such as practitioners involved in Environmental Impact Assessments, may apply to SANBI to request the locality information of species that are tagged for the areas in which they work in the Department of Forestry, Fisheries and the Environment (DFFE) Screening Tool. The worldwide online identification resource, iNaturalist, also hides localities of plant species that are deemed to be sensitive, but this feature arguably could be further improved. However, there are still sources of precise locality information freely accessible to determined collectors, including labels on plant specimens lodged in herbaria, and type localities published in the literature.

In centuries past, early collectors of plant material in southern Africa often provided the location from which material was collected simply as "*Caput bonae spei*", as "*Cap. b. spei*", as "*Cabo bona spei*", or even as "*CBS*" only, with these phrases all referring to "the Cape of Good Hope". This was one inevitable consequence of a lack of maps and of place names in the language(s) with which the early explorers were familiar. In addition, at least some of these collectors must have thought that it will be easy to later relocate a newly described species. After all, how rich can the southern African flora be? Taxonomic studies conducted subsequent to these early taxon descriptions have often had to spend many hours (days, weeks, months) in trying to decipher where what was collected, and more than two centuries later, some mysteries remain.

With the advent and continuous refinement of technology that allows the accurate recording of collecting localities (latitude and longitude to a level of, often, extreme accuracy) and associated habitat information, detailed herbarium labels have become the ultimate source of pinpointed plant occurrences, i.e., the exact coordinates of the point from where the plant was collected can be determined.

The usefulness and value of such detailed geographical information is unquestionable. Nevertheless, its free availability on the internet has been a source of concern, with some herbaria opting to not disclose locality information of some specimens, or even all their holdings of some species, such as cycads. As the locality information is typically given on the labels attached to specimens, those herbaria do not want to disseminate the images of the specimens concerned. In some instances there have been efforts to obscure label information, but this is a labour-intensive, expensive exercise that few herbaria can afford. Still, going this route is a significant obstruction to the work of bona fide researchers who presently mostly remotely access information, including about plant specimens and their associated metadata.

A further consequence of the illegal succulent poaching crisis is the tendency of people to hide the discoveries of new plant species, for fear of the plants being poached (immediately) once published. This is the case for a potential new species of *Brunsvigia* Heist. and two new species of *Conophytum* (P. van Wyk, pers. comm. on 22 September 2022). The conundrum is that nature conservation authorities need motivation for defining no-go areas for development (urban expansion, industrial sites, etc.), but since these new species have not been described, nor conservation assessments of them undertaken, it is not possible to afford them or the places where they grow official protection. Publishing these species would immediately alert collectors of the new species, prompting them to add them to the list of plants to be poached, and the demarcation of the areas as "no-go" for development could draw attention to where they occur.

As pointed out by Bach (1998: 187): "The more spectacular the description [of a new taxon] and the rarer the [conservation] assessment [of the taxon], the more profitable it will be for illegal collectors to take plants from habitat and smuggle them in international trade. The threat to wild populations is immediate and widespread." The recent up-listing of the Red List status of most *Conophytum* species to a category of threat of Critically Endangered, Endangered, or Vulnerable (https://www.iucnredlist.org/search?query=Conophytum&searchType=species) therefore may well have the unintended, but very real, consequence of increasing their value in trade, and may result in ill-intended attention to their natural geographical distribution ranges.

CONCLUSIONS

It is tempting to argue that the responsibility for conservation falls outside the domain of taxonomic endeavour. Taxonomists provide and curate the baseline data and derivative knowledge that is used by practitioners in the applied biodiversity disciplines. Without the foundational resources that taxonomists provide, it would be impossible for conservationists, policy makers, and other workers in the biodiversity sphere to effectively perform their roles. However, the very material studied by taxonomists has increasingly come under the threat of permanent eradication from the wild inter alia because of the diligence and accuracy with which they have usually gone about their business of studying plant diversity at taxon, community, and landscape levels, and then publishing the detailed results of these studies.

Arguably the majority of the online users of herbarium collections do not require knowledge of the exact location from where preserved specimens were collected. When examining images of the specimens online it is often sufficient to know only the "filed under" name on the specimen, the name of the collector, the collecting date, and the general area from where a specimen was collected. Exact coordinates of the collecting locality are of interest to those who want to search for the plant in situ.

To help combat further plant poaching initiatives being facilitated by, if not entirely based on, the accurate herbarium specimen records of taxonomists held in herbaria and similar natural history repositories, we propose that, for plants under threat or potentially threatened by illegal collecting, the following measures be implemented as a matter of urgency:

By authors publishing nomenclatural novelties

- Provide locality information about novelties only to bona fide researchers and herbaria.
- Publish only in journals that have a policy of not divulging information that could compromise the conservation status of novelties.

By herbaria and other holders of specimens and specimen-associated metadata

- Exact locality information is not given on specimen labels.
- Exact locality information is provided to the herbarium holding the specimen, to be associated with the record of the collection in their databases.
- Exact locality information is disclosed only to bona fide researchers.
- Locality information on labels appearing on scanned images available online is blocked.
- Exact locality information as part of specimen metadata is not made openly accessible in online resources.
- For highly threatened and poached plants (Category 1 according to Chapman, 2020) no locality information should be made freely available online, not even a vague indication of where the plants occur.
- Mechanisms to screen visitors to herbaria and those requesting specimen information must be developed and effectively implemented to ensure that they are bona fide researchers.

By the publishers of e- and hardcopy works that include the description of new taxa

- Exact locality information is not published as part of the protologues of names.
- No point data (GPS points) for specimen localities are included in publications.
- Paratypes and any other annotated specimens are no longer listed and published.
- Published distribution maps do not contain accurate points, but rather a polygon or points representing, at most, the centroid of quarter degree squares (25 × 25 km), for instance.

These measures will unfortunately have a negative effect on the ability of taxonomists and other bona fide researchers to do their work. It will also likely increase the taxonomic impediment, which we as taxonomists have worked so hard to counter during the past decades. However, implementation of the steps we propose is inevitable to ensure that our natural heritage is not obliterated by the same means that were meant to enhance taxonomic research and conservation.

It is true that the future assessment of species, including their possible relocation, under, for example, various climate change scenarios (see, for example, Young & al., 2016), would be impossible without access to at least some—ideally detailed—biological and ecological information about the species and the environmental parameters under which they grow. However, this information should be protected at all costs by the custodians, including herbaria, of the floral diversity of the region.

We realise that the measures we propose here to a large degree fall in the realm of policy-based decision-making and need to be negotiated by institutions in consultation with their staff and stakeholders, and by journals with their publishing houses, editors, and editorial boards. However, these are not new ideas. Many of these suggestions have already been implemented by some institutions and initiatives as part of best-practice guides and policies regarding sensitive species occurrence data (see Chapman, 2020). It is crucial though that more of these measures should be applied very soon, and more broadly. If this does not happen without delay, we may ultimately have no choice but to return to giving the location of newly described southern African plants simply as "*Caput bonae spei*".

AUTHOR CONTRIBUTIONS

GFS and EF initiated and wrote the first draft of the manuscript; JV and RRK contributed additional text to the manuscript. — GFS, https://orcid.org/0000-0002-5417-9208; EF, https://orcid.org/0000-0002-8511-8213; JV, https://orcid.org/0000-0001-5703-1762; RRK, https://orcid.org/0000-0002-0948-5038

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