AFRICAN HERBARIA SUPPORT TRANSFORMATION ON THE CONTINENT[1]

Gideon F. Smith,[2] *Jacobus P. (Koos) Roux,*[3] *Peter Raven,*[4] *and Estrela Figueiredo*[5]

ABSTRACT

The African Plants Initiative (API) was conceived as a web-based, electronic venture that would provide rapid access to images of type specimens of African plant names. This soon grew to also encompass images of living plants, associated taxonomic literature, artwork, and related texts. In many respects, Africa, which is host to a flora of over 50,000 species, for which about six times that number of alternative and incorrect names are available, has historically lagged behind the world in terms of both taxonomic capacity and access to the global electronic ether. Through the API, a consortium of 73 institutions from the North and South, 291,289 specimen images alone are now available for accessing through the Internet. In this regard, the API has been a pioneer in and has become a catalyst for facilitating the generation and dissemination of fundamental taxonomic information on African plants, a role it is increasingly fulfilling through the JSTOR Plant Science portals.

Key words: Africa, herbaria, North-South and South-South collaboration, specimens, taxonomy.

Herbaria, as archives and repositories for a country's or region's plant diversity, are vital for taxonomists who catalogue plant and genetic diversity and associated data. This information is useful for a wide array of end-users, such as conservationists, plant breeders, geneticists, phytochemists, ecologists, plant physiologists, human health officials, and ethnobotanists (Steenkamp & Smith, 2003). Although biological taxonomy is known for its classical and conservative roots, the electronic age has indeed proven to provide a variety of suitable vehicles for disseminating primary biodiversity information (Wheeler et al., 2004; Smith et al., 2007). In executing their duties, taxonomists are therefore nowadays increasingly making use of modern technologies to expedite service delivery.

The concept of having a type specimen permanently associated with a plant name was first introduced at the Fifth International Botanical Congress (IBC), which was held in the United Kingdom, at Cambridge, in 1930. A nomenclatural type (or typus) is defined as "...that element to which the name of a taxon is permanently attached, whether as a correct name or as a synonym" (McNeill et al., 2006: Art. 7.2). This element for extant plants may be one or more than one individual plant specimen(s), from a collector's single gathering, permanently preserved on one or more herbarium sheets. Therefore, as long as the type concept in modern plant nomenclature is followed by plant taxonomists, type specimens will remain of paramount importance as one of the primary sources of information in plant diversity investigations. In this regard, they also authenticate and document the taxon in scientific rigor. It is therefore not surprising that in December 2003 the African Plants Initiative (API) began with its primary objective to create high-resolution electronic images of as many type specimens of names published for African plants as possible, and to make these images and their associated metadata broadly available electronically to a global scholarly community (Smith, 2004; Demissew et al., 2005). Presciently, at the Fifth IBC, Harvey Hall proposed the making and distribution of photographs of types and producing an index to collections in different herbaria, suggestions that coincide with the primary objective of the API (Brooks & Chipp, 1931).

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[2] Biosystematics Research and Biodiversity Collections Division, South African National Biodiversity Institute, Private Bag X101, Pretoria, 0001 South Africa; John Acocks Professor of Botany, H.G.J.W. Schweickerdt Herbarium, Department of Plant Science, University of Pretoria, Pretoria, 0002, South Africa; Centre for Functional Ecology, Departamento de Ciências da Vida, Universidade de Coimbra, 3001-455 Coimbra, Portugal. G.Smith@sanbi.org.za.

[3] Compton Herbarium, South African National Biodiversity Institute, Private Bag X7, Claremont, 7735, South Africa.

[4] Missouri Botanical Garden, P.O. Box 299, St. Louis, Missouri 63166-0299, U.S.A.

[5] Department of Botany, P.O. Box 77000, Nelson Mandela Metropolitan University, Port Elizabeth, 6031 South Africa; Centro de Ecologia Funcional, Departamento de Ciências da Vida, Universidade de Coimbra, 3001-455 Coimbra, Portugal.

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This objective to create electronic images of type specimens of African plant names and to disseminate them electronically has now largely been achieved through collaboration among a consortium of African and northern, mostly European and American, botanical institutions holding significant collections of type specimens of African plants (Table 1). Currently, 291,289 images of specimens digitized for the API are available in JSTOR Plant Science (<http://plants.jstor.org>), as originating from Aluka (Aluka, 2009). Twenty African herbaria participated in this initiative and have contributed images of 51,822 specimens, which is ca. 18% of the total number of African specimen images accessible on the Internet via the JSTOR Plant Science portal (<http://www.aluka.org>). Over 70% of the images for African taxa come from South African herbaria. Projects are now underway to increase the participation of herbaria from other African countries, with a small grants program supported by the Andrew W. Mellon Foundation having been launched to enable this. Images and associated metadata generated by participants in the API remain the property of participating institutions, but are now also disseminated through JSTOR Plant Science, an online environment, which is part of ITHAKA, a not-for-profit organization that aims to provide online access to an archive of international scholarly resources (<http://www.ithaka.org>).

The API, however, did not intend to stop at scanning and disseminating images of type specimens. What started out as a purely taxonomic project soon emerged as a major initiative that can also be used to provide other, related information on plant diversity through the Internet. The preparation of electronic images of botanical artifacts is therefore only the first step in a process that has now developed into an indispensable electronic resource on African plants. The success of the API is a clear manifestation of the willingness of African herbaria to collaborate with their northern and southern colleagues. This drive is facilitating the sharing of plant diversity information and the rapid and affordable dissemination thereof. By expediting this, African herbaria will enable their taxonomists, who are confronted by an immensely rich flora of over 50,000 species (Klopper et al., 2006), to overcome the digital divide and misconceptions about their ability to contribute in a meaningful way through embracing new technologies.

A further significant contribution of the API is that broader environmental issues that have become the subject of dialogue between African and northern herbaria can now be addressed. In this regard, it supports the principles of the New Partnership for Africa's Development (NEPAD, 2004), which aims, among other things, to "1) anchor the development of Africa on its resources and resourcefulness of its people; 2) establish partnerships between and amongst African peoples; 3) accelerate regional and continental integration; and 4) build the competitiveness of African countries and the continent." Clearly, Africa is ready to assume responsibility for its own future and to combine its strengths in natural resources studies and to draw on its own innate abilities to manage these resources wisely for the benefit of all its peoples, indeed, for the benefit of the global village.

It is very encouraging that plant diversity sciences have attracted the support of the Andrew W. Mellon Foundation as a supportive partner in helping Africa to tackle some of the impediments that resulted from decades of exploitation, civil wars, corruption, and political maladministration. These impediments seriously impact the ability of many African countries that are signatories to the Convention on Biological Diversity (CBD) to respond to challenges presented to them.

As Africa takes another firm step toward developing a continent that can take its rightful place in the global arena, the API clearly acts as a catalyst to drive related scientific activities. Indeed, thanks to the API, African plant scientists now have an opportunity to mobilize their human power, resources, and infrastructure on an unprecedented scale. As with most, if not all, broad initiatives with the scope and dimensions of the API, progress is made in a stepwise manner. These steps, however, should be taken with the goal in mind to sustainably take ownership of the initiative and provide African taxonomists with the tools and knowledge to contribute toward, to manage, and to disseminate appropriate plant diversity information on the African flora. This sharing of information among participating countries, and ultimately with the broader botanical community, already contributes to a better understanding of the continent's significant botanical diversity, for example, through recent work conducted on the plant diversity of Angola (Figueiredo & Smith, 2008; Figueiredo et al., 2009; Smith & Figueiredo, 2010) and the continent's lycophyte and fern flora (Roux, 2009). Such improved knowledge should further stimulate renewed interest in the documentation of the continent's botanical wealth that is imperiled by human pressures. This essential and primary knowledge is vital if the natural resources of Africa are to be managed sustainably.

Table 1. African Plant Initiative partner herbaria (abbreviations follow Thiers, 2009) arranged according to the number of images submitted through the African Plant Initiative, the number of specimens imaged and uploaded to Aluka (2009), and the continents where located.

Herbarium	No. of specimen images uploaded	Continent	Total from continent
PRE	12,555	Africa	51,822
BOL	11,876	Africa	
NBG	4797	Africa	
NU	3853	Africa	
FHI	3163	Africa	
EA	2817	Africa	
SAM	2621	Africa	
GRA	2417	Africa	
GC	1612	Africa	
NH	1166	Africa	
RAB	1101	Africa	
YA	935	Africa	
IFAN	908	Africa	
TAN	693	Africa	
TEF	567	Africa	
ETH	379	Africa	
MHU	245	Africa	
KAW	60	Africa	
PRU	49	Africa	
SRGH	8	Africa	
K	59,821	Europe	231,171
P	48,232	Europe	
BR	20,884	Europe	
BM	17,374	Europe	
MPU	13,991	Europe	
B	9258	Europe	
S	8204	Europe	
G	7628	Europe	
M	7000	Europe	
HBG	3993	Europe	
FT	3868	Europe	
E	3786	Europe	
LISC	3096	Europe	
WAG	3038	Europe	
TCD	2481	Europe	
W	2126	Europe	
C	1808	Europe	
L	1523	Europe	
LISU	1435	Europe	
JE	1348	Europe	
COI	1326	Europe	
LD	1201	Europe	
G-DC	1019	Europe	
MA	962	Europe	
FI	940	Europe	
GOET	882	Europe	
HEID	807	Europe	
BC	764	Europe	
WU	521	Europe	
FR	467	Europe	
STU	466	Europe	
HAL	283	Europe	
KW	150	Europe	
U	138	Europe	
CGE	130	Europe	
AIX	99	Europe	
GZU	79	Europe	
MSB	30	Europe	
H	13	Europe	
MO	4509	North America	8,296
NY	1513	North America	
US	1022	North America	
PH	676	North America	
F	237	North America	
GH	72	North America	
MICH	72	North America	
CAS	63	North America	
A	47	North America	
LL	38	North America	
RSA	26	North America	
UC	13	North America	
DAV	5	North America	
TEX	3	North America	
	291,289		291,289

Now, through the API, innovation in plant taxonomy in Africa has been given a major boost with access to significant resources undreamed of in the past and impossible to visualize before now. Building on such a strong foundation, African plant scientists now have an opportunity not only to benefit from the advantages of global scientific integration, but indeed to be equal partners in providing access to previously untapped environmental resources for their own benefit. As with all the admirable principles underscoring NEPAD as a rapidly emerging peer review process for African states, it is also imperative that African taxonomists collaborate on the API, in equal partnership with their northern colleagues.

Multilateral cooperation on botanical matters is now possible at both a regional and global scale. In this regard, as government budgets constrict as a result of social demands, private and corporate investment in biodiversity science becomes increasingly important. Additional initiatives aimed at further improving conditions conducive to joint South-South and South-North scientific cooperation must be encouraged and supported at all levels. To achieve this, commitment to human resources development is of paramount importance. Indeed, human capital development was one of the primary aims of the Southern African Botanical Diversity

Network (SABONET) project, in many ways a forerunner of the API, which trained a cohort of over 200 African taxonomists and plant specialists (Steenkamp et al., 2006). Human capital improvement can therefore be achieved through placing education and training high on the projected development agenda. The API also contributes to promoting education and training in appropriate taxonomic methodologies, such as creating country-level checklists (Figueiredo & Smith, 2008) and e-technology used in creating images, databasing of associated metadata, and assisting in acquiring electronic infrastructure that will strengthen Africa's ability to participate in the API and to achieve its goals.

Strong regional networks of botanists, such as the one established through SABONET for southern and south-tropical Africa, have the potential to make immensely valuable contributions toward integrating the API with their day-to-day activities (Huntley et al., 2006). With this network in place, it now stands to reason that it should be expanded to the rest of Africa and be put to the test to deliver independently on further taxonomic outputs, beyond the scope of current project activities that include the imaging of specimens, literature, and artwork. With SABONET having been finalized and its output delivery consolidated, it has generated immense volumes of visible and tangible high-quality products (Klopper et al., 2006). With communication barriers now effectively abolished in the region, cross-border taxonomic activities are leading to the inevitable strengthening of electronic infrastructural development and concomitant improvement in technological proficiency. This will in turn lead to the achievement of even greater progress in human resources development. In this regard, the recent involvement in the API of the two southern African Lusophone countries, Angola and Mozambique is beginning to bear fruit with participating herbaria in these countries generating web-based content relating to their herbarium holdings, and joint South-South training courses in herbarium practice being planned.

A further imperative for Africa is the halting of environmental destruction, and this is where taxonomists and other biodiversity scientists can play a significant role. Only through the dissemination of useful information can the socio- and bio-importance of ecological services be emphasized, and this can only be achieved through integrated planning that addresses the basic needs for human well-being. The bioregional programs established for South Africa's Fynbos Biome—Cape Action for People and the Environment (CAPE) and the South African National Biodiversity Institute's Grassland Programme—are two excellent examples of environmental initiatives that use, among others, primary scientific information, including taxonomic data, in planning activities (Cadman et al., 2010: 145–151). Implementing change often takes time and involves risks. Our responsibility as taxonomists is to embrace the opportunities on offer, but we should not look elsewhere for leadership. Africa must take responsibility for its own future. On this road of development we must, simultaneously, accept the environmental and technological challenges that will be encountered and resolve them proficiently. The idea to digitize and disseminate herbarium specimen images electronically is by no means a new one. However, never before has this task been approached on such a massive scale and never has an indispensable environmental resource come into being in such a short amount of time. Appropriately, the focus of this global thrust has been initiated with the plants of Africa, a continent that is in the process of reinventing itself, among other things through having widely adopted the NEPAD (Klopper et al., 2002).

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