Biodiversity in the Patent System: South Africa

A country study of genetic resources and traditional knowledge in the patent system of relevance to South Africa

Prepared for:
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Contract Number: 81156131

July, 2013

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One World Analytics is a trading name of POMC Consulting Ltd. UK.

Introduction

This report presents the results of analysis of patent activity for genetic resources and traditional knowledge from South Africa. The report is divided into three sections:

Section 1 provides an overview of biodiversity in South Africa based on information from the Global Biodiversity Information Facility and introduces the patent data.

Section 2 provides a general overview of patent activity for species known to occur in South Africa in the period 1976-2010. This is followed by detailed analysis of patent documents that make reference to South Africa and data based on species that are limited to distribution in South Africa.

Section 3 provides a set of short summaries for species that are a focus of patent activity. This information will also be made available online for further research through the Access and Benefit Sharing Patent Index (ABSPAT).[1]

The report was prepared using large scale text mining of patent data for species names and country names. This data was then combined with taxonomic information from the Global Biodiversity Information Facility. Additional patent research was conducted using the commercial Thomson Innovation database and processed using a variety of software tools.

Patents are an important indicator of investments in research and development directed to the development of commercial products. The aim of the report is to identify potential opportunities for economic development in support of conservation by identifying existing research and development involving species from South Africa. The research did not investigate the terms and conditions under which patent applicants obtained the genetic resources and traditional knowledge disclosed in the patent document. Therefore the report does not consider the problem of biopiracy or misappropriation of genetic resources and traditional knowledge.

The research was limited to searches of patent data from the United States, the European Patent Office and the international Patent Cooperation Treaty in the period 1976-2010. As such, the research is limited to the major patent offices for this period. We do not consider patent activity prior to 1976 or after 2010 except through patent family information and citation data. As such the report provides a baseline for patent activity involving species from South Africa as a basis for further research.

Our research focused primarily on documents that make reference to South Africa and to cases where existing distribution data suggests South Africa is a likely source for the species. This imposes two limitations on the research. First, we focus on identifying species that are a focus of existing research and development. However, the report does not seek to provide the complete global patent landscape for an individual species. Second, because we focused on identifying species from a country we did not search patent data for references to regions (i.e. Africa) or sub-regions (i.e. Southern Africa) in the patent data. To address this issue we deliberately highlight cases where a species is distributed in more than one African country.

[1] ABSPAT is available at http://www.abspat.net

This report is one in a series of reports on patent activity for species from African countries. The following observations are based on the research for the six African country reports to date and form the main recommendations arising from the research.

Taxonomic Research:

1. There is a need to improve the availability of taxonomic information for each country. In the absence of taxonomic information it is not possible to identify genetic resources that are relevant to a particular country in patent data and any relevant opportunities for economic development. African countries could consider giving greater priority to taxonomic research and making taxonomic information available through GBIF;
2. Georeferencing of the coordinates for the locations of species is an important standard in modern biodiversity research. Georeference data can be used to identify where species have been recorded in a country and also where biodiversity research has been concentrated. In our view georeferencing is an underutilized tool for identifying where species are located as a basis for engaging with indigenous and local communities to consider potential development opportunities. We recommend greater attention to georeferencing and its use for engagement with relevant indigenous and local communities;
3. Taxonomic research does not attract investment because it appears to be remote from economic considerations. In practice taxonomic information is vital to identifying opportunities for development that is supportive of the objectives of the Convention on Biological Diversity and its Nagoya Protocol.
4. Taxonomic information is also important for the capacity of countries to monitor compliance with the Nagoya Protocol by improving baseline data on the species within a country. Advancing knowledge and understanding of biodiversity and the traditional knowledge of indigenous and local communities has an important role to play in long term monitoring under the Nagoya Protocol.

The Patent System:

1. Patent documents are frequently unclear on the precise origin or source of genetic resources and associated traditional knowledge. In addition very limited information is available on the terms and conditions of acquisition of genetic resources and traditional knowledge. This could be improved through enhanced disclosure of origin measures as advanced by the African Group and discussed in greater detail elsewhere;[2]
2. Species are commonly distributed in more than one country. It is important that African countries include requirements in access and benefit sharing agreements to clearly specify the source of genetic resources and associated traditional knowledge in any patent applications that may arise under the terms of an agreement. When combined with the enhanced disclosure measures noted above this would greatly improve capacity to monitor patent activity under the terms of the Nagoya Protocol;
3. One of the major issues that emerged in the research is the problem of *essential incorporation* of species into patent claims. Patent applicants frequently list very large numbers of species, or make reference to genera and families, with the purpose of incorporating all members of a genus or family into the scope of the patent claims. Typically these applications did not involve collection or use of many of the species that are listed. The aim of essential incorporation is to prevent others from using compounds, extracts or ingredients from these species in similar inventions or products. Where granted these patents are likely to have negative consequences for researchers

[2] Oldham, P & Burton G (2010) *Defusing Disclosure in Patent Applications*. UNEP/CBD/COP/10/INF/44

and producers in African countries seeking to develop and export similar products from these species. In our view, patent claims for components of organisms should be limited to the species from which the compound or extract was isolated by the applicants and not extend to members of the genus or entire families. Furthermore, in our view essential incorporation is anticompetitive and action should be considered to stop or severely restrict this practice.

4. In some cases patent activity may involve species that are vulnerable, endangered or CITES listed. In considering the possibilities for economic development identified in patent data it is also important to identify and assess the conservation status of the species concerned in order to support the objectives of the Convention on Biological Diversity.

Patents have frequently been viewed with suspicion within the biodiversity policy community as examples of the inequitable exploitation of resources from biodiversity rich developing countries. Our research demonstrates that patent data can also be turned to positive purposes to identify potential opportunities for economic development in Africa. We hope that this information will prove to be useful to African countries.

South Africa

Area:
1,219,090 sq. km
Coastline:
2,798 km
Climate:
Mostly semi-arid; subtropical along east coast; sunny days, cool nights.
Geography:
South Africa features a landscape dominated by a high plateau in the interior, surrounded by a narrow strip of coastal lowlands. The interior plateau consists of a series of rolling grasslands and rises abruptly to form a series of mountain ranges before dropping to sea level. In the north is a dry savanna subregion, known as the Bushveld. West of the Bushveld is the southern basin of the Kalahari Desert, which borders Namibia and Botswana.

Biodiversity in South Africa and Patent Activity:

Data for biological diversity for South Africa was obtained from the Global Biodiversity Information Facility (GBIF). GBIF provides open access to the most comprehensive data on species for a particular country that is presently available. All data is submitted by participating collections who share biodiversity information.

Using this resource we have obtained biodiversity records for species which occur in South Africa. It should be noted that the usefulness of this data in determining the actual distribution of a given species depends on the comprehensiveness of the data submitted by GBIF participants. Therefore we would stress that the absence of records should not be interpreted as indicating an absence of a given species, and similarly that a recorded species that only appears from one country should not be regarded as evidence of endemism. All reasonable efforts in identifying endemic species were made from alternative sources during the compilation of this report.

GBIF presently records 59,092 species names for South Africa. Of these 49,702 are accepted scientific names with the remainder made up of synonyms, homonyms or names that are not presently scientifically accepted. In addition, GBIF contains 10,306,146 georeferenced coordinates for species from South Africa. Accurate georeferencing of species collection records is an important standard in biodiversity related research. South Africa stands out for the number of georeferenced records for its species.

We identified a total of 275,517 documents containing species known to be distributed in South Africa. Of these 1,332 made some form of reference to South Africa. These documents were manually reviewed in MaxQDA software to identify documents specifying a source or origin in South Africa.

The 1,332 documents that made a specific reference to South Africa contained 6,415 species. As this suggests, many patent documents make reference to more than one species. The challenge therefore is to identify those species that originate from South Africa. These documents were manually reviewed in MaxQDA data analysis software. Through this process we were able to identify species where it was definitively stated that they had been collected, sampled or otherwise obtained from South Africa.

In addition, using GBIF distribution data we identified 325 species where GBIF presently records distribution only in South Africa. These species appeared in 2,648 patent documents where South Africa was not explicitly mentioned. The idea behind this was to identify cases where a species (based on available distribution data) was likely to have come from South Africa and thus be regarded as a species of likely or potential significance for South Africa. For the sake of simplicity we call this data 'Distribution'. These documents were then selected for further review.

Biodiversity and Distribution

Much of the data submitted to GBIF includes geographical coordinates indicating where the recorded species was located. Using this data we are able to show the physical distribution across South Africa of all GBIF recorded species. Plate 1 shows two maps: The upper map shows plotted points, each indicating a GBIF record. The points are coloured to indicate the kingdom to which the species belongs. It should be noted that this geographical information is raw data as submitted to GBIF by participating recorders. It has not been cleaned to remove any human errors when inputting to the GBIF database (an example of such an error might be where a longitudinal coordinate has been recorded as a + rather than a -). The lower map shows major settlements and roads, it also includes the location of some protected areas such as national parks and nature reserves - places expected to be of significance for biodiversity. A larger version of the distribution map can be found in the appendix of this country summary.

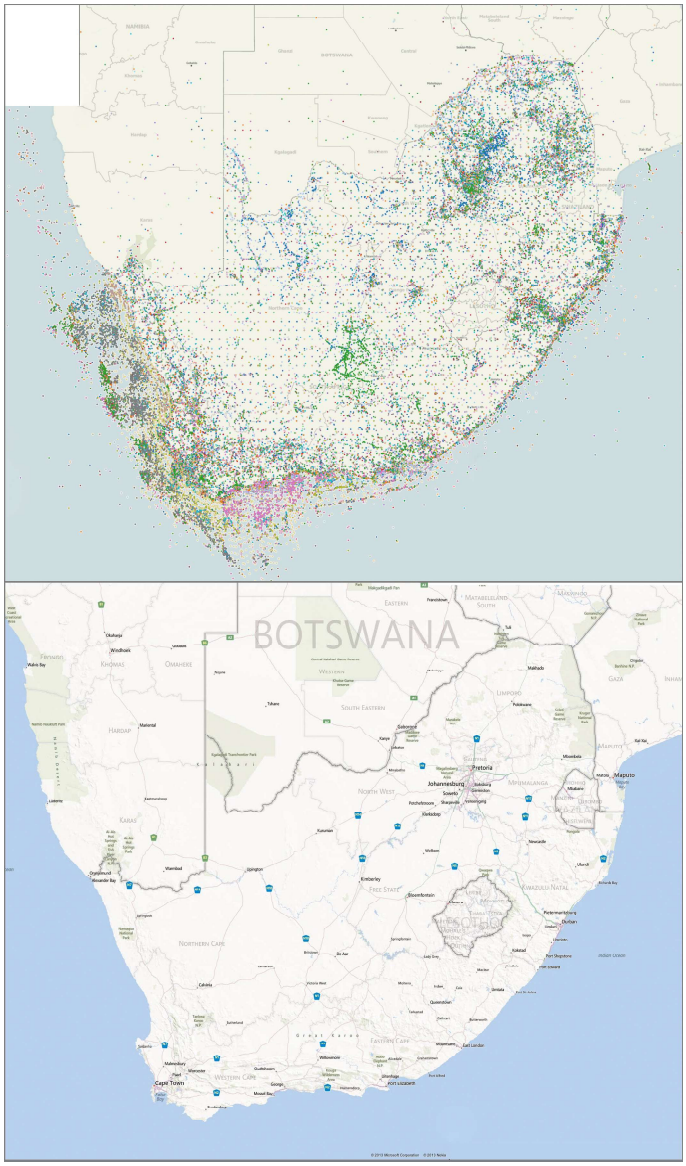
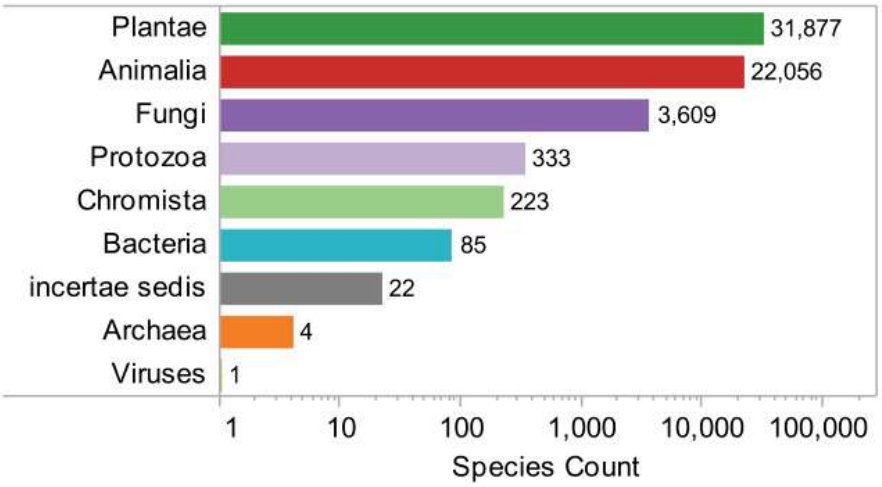


Plate1. Distribution of GBIF records from South Africa (upper map) and major settlements and roads (lower map) (map courtesy of Bing Maps). Each point represents a species record coloured by kingdom.

It is very interesting to compare the two maps. There are a very large number of records for South Africa and this is likely to reflect the level of economic development when compared to other African countries. The data is distributed well across the country with very high densities of records clustered about the major areas of population density such as Cape Town, Durban and Pretoria; places where there will be industry and research establishments. Also the coastal lowlands appear well surveyed. Another feature of these mapped distribution records are the strings of data points which cross the country. When compared with the lower map it can be seen that these strings of data points closely follow the routes of major roads. Lesotho and Swaziland are surrounded by South Africa and likely to contain the same species as recorded around their borders. There are many records of marine species. The Cape is renowned for its biodiversity due to the convergence of major oceanic currents. Fisheries, though small in terms of national GDP are important for regional economies. They exist around the entire coastline and particularly off the Western Cape and this may explain the very large number of records from this ocean area.

GBIF presently records 59,092 names for species known to be present in South Africa. This list is dominated by plants and animals which account for 53,933, as can be seen in Table 1. Other kingdoms are well represented, and this, perhaps, illustrates a very high level of recording and collection.

Table 1: Showing the number of species in South Africa by kingdom using GBIF data.



Using global data it is possible to examine the wider distribution of South African species. Plate 2 shows where records exist across the globe for such species. Species which are found in two or more countries are referred to as being 'cosmopolitan'. Each pie represents the number of occurrences of cosmopolitan species which are found in South Africa and is segmented by kingdom. It can be seen that South Africa appears to have many species which are endemic; the number of cosmopolitan species appears to be very small with only sub-Saharan and east Africa sharing significant numbers. This may be due to either the unique climate and habitats of South Africa or to the more complete catalogue of species recorded when compared to the relative paucity of records from other African countries. The number of species found beyond the African continent is very small indeed and it should additionally be noted that some of these records may originate from research institutions or collections and therefore do not represent native or naturalised distribution.

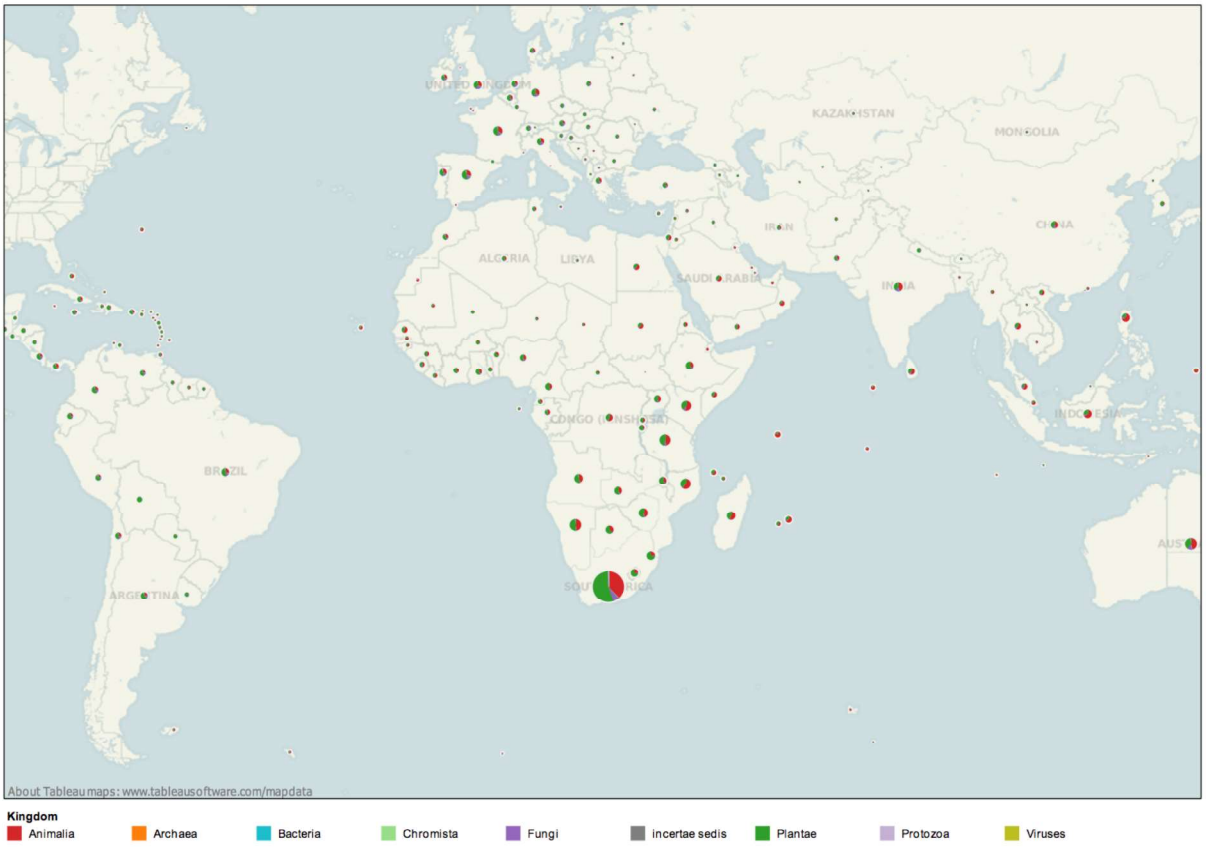


Plate 2: Global distribution of South African species shown by the number of species in GBIF.

Biodiversity in South Africa in the Patent System

As of 2013 a total of 11,283 documents in the main patent jurisdictions (European Patent Office, the United States, and the Patent Cooperation Treaty) specifically mention South Africa. This provides a general overview of references to South Africa in the patent system across all areas of invention. Only a proportion of these documents will also refer to species collected in, or sourced from, South Africa. In addition, patent applicants will make reference to species that originate from South Africa but will not mention South Africa as the source of genetic resources or traditional knowledge.

Our aim in this section is to provide a brief overview of patent activity for genetic resources of relevance to South Africa. We focus on patent activity in the main patent jurisdictions in the period between 1976 and 2010. We then examine the results of research to identify genetic resources and traditional knowledge that originate from South Africa. In approaching patent activity for genetic resources from South Africa we focus on three categories of data.

1. Species that are known to be distributed in South Africa but are also distributed elsewhere in the world. This provides an overview of global patent activity for genetic resources of relevance to South Africa.
2. Species where a direct reference is made to the collection or origin of a species from South Africa. This data is based on a review of patents that make reference to a species known to be distributed in the country and the country name.
3. Species where available distribution data suggests that a sample is likely to have originated from South Africa. This data is known as Distribution data and refers to cases where GBIF presently only records a species as occurring in South Africa and no other country. Because taxonomic information is incomplete, this data provides a clue rather than proof that a species originated from South Africa.

We begin our analysis with an overview of biodiversity that is known to occur in South Africa in the patent system and then turn to data on species originating from South Africa.

South Africa shares a significant proportion of its known biodiversity with other countries in Africa and around the world. Plate 3 provides an overview of patent activity for species that are known to occur in South Africa and other countries around the world. This overview provides information on trends in applications and grants, the top species appearing in patents that are known to occur in South Africa, top applicants or assignees and technology areas.

In total we identified approximately 6,415 species names in patent data from the major jurisdictions that are known to occur in South Africa. When model organisms including crops such as *Zea mays* (maize) and *Homo sapiens* are excluded this falls to 6,282 species names of which approximately 4,617 are accepted scientific names.[1] This data is relevant for South Africa because it demonstrates that researchers and companies are conducting research and development on species that are known to occur in South Africa. As Plate 3 makes clear research and development is taking place across a range of technology sectors and is targeted to a variety of markets.

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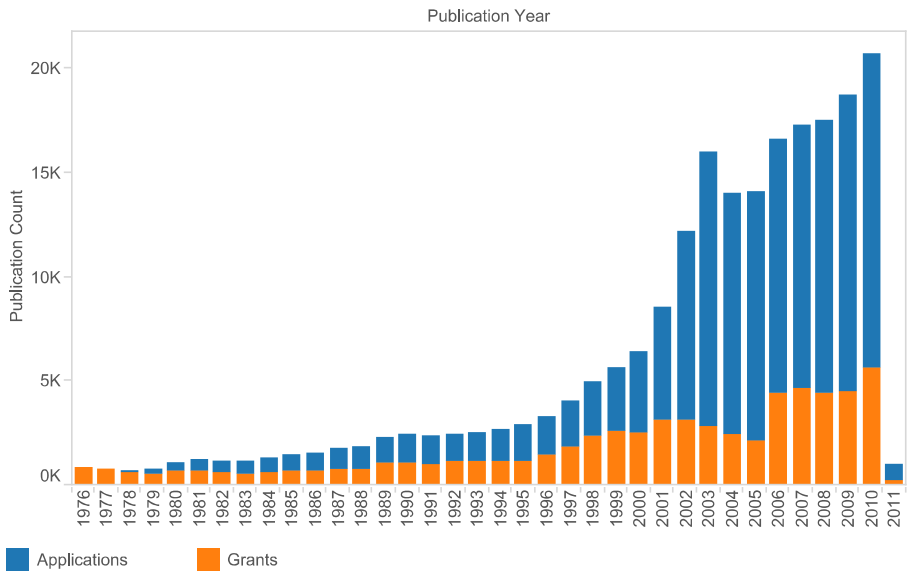
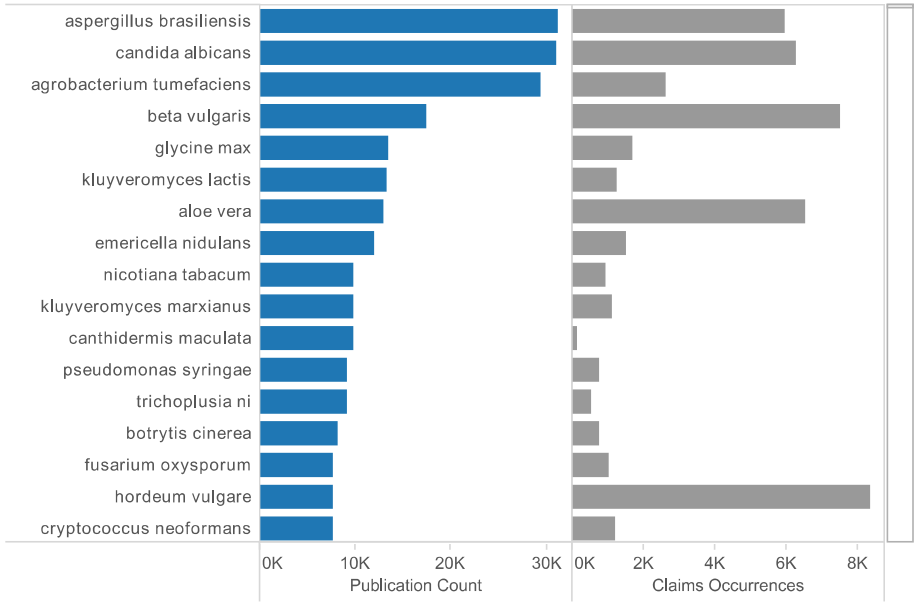
[1] The 6,282 figure excludes common model organisms such as *E. coli*, *Arabidopsis thaliana*, *Bacillus subtilis* and *Zea mays* (maize) that are globally distributed and are used as research tools in biotechnology. These species appear prominently in patent data for all almost countries and are therefore excluded.

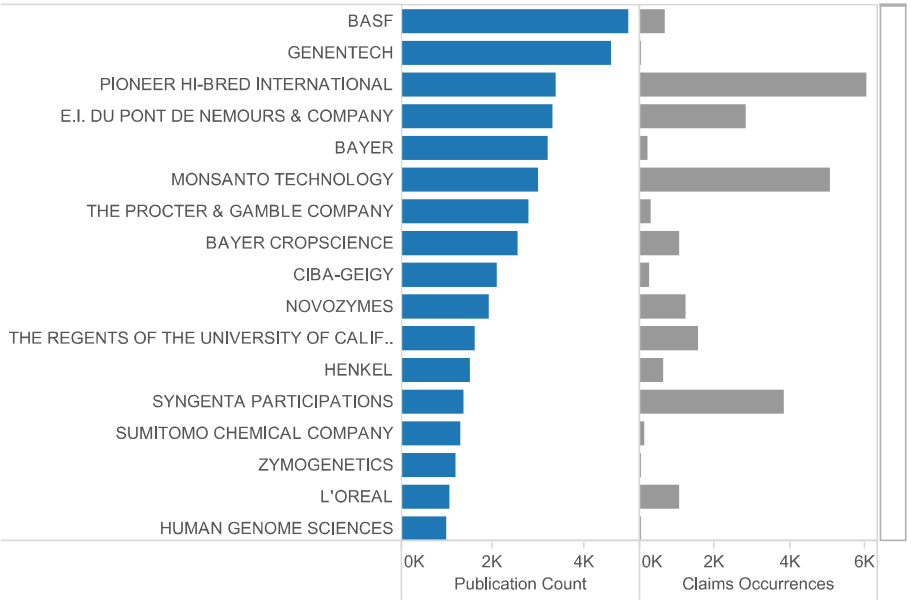
Trends



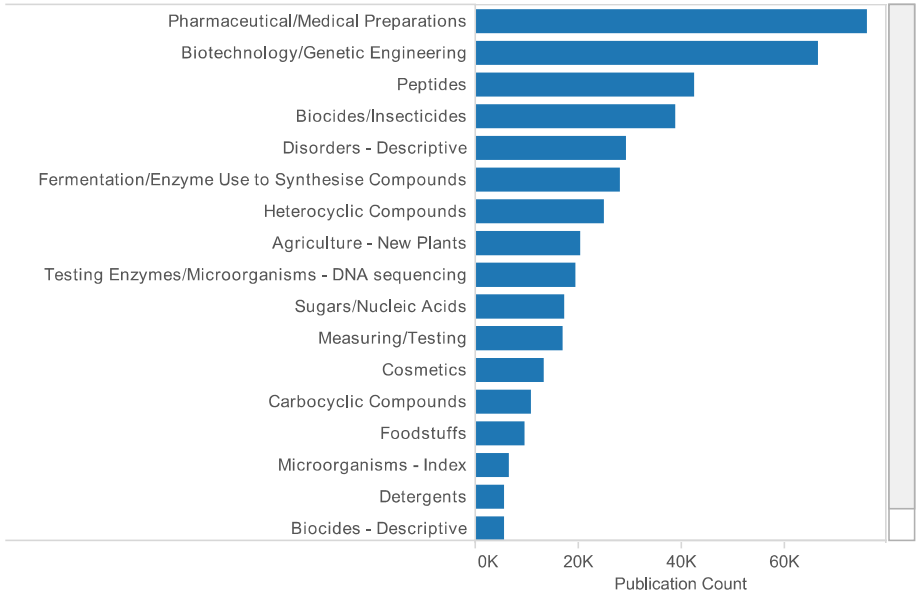
Species



Assignees



Technology Area



The top species of relevance to South Africa in global patent data include species used in biotechnology such as *Aspergillus brasiliensis* (formerly *Aspergillus niger*) and *Emericella nidulans* (*Aspergillus nidulans*). In total we identified 2,656 plant names in global data of relevance to South Africa with crops represented by species and varieties of beet (*Beta vulgaris*), soya (*Glycine max*), barley (*Hordeum vulgare*) and tobacco (*Nicotiana tabacum*). *Aloe vera* (formerly *Aloe barbadensis* or *Aloe petricola*) features; this and other aloes are used extensively for their pharmaceutical and cosmetic potential. Patent data for plants of relevance to South Africa also includes frequent references to hoodia species and the Bushwillow tree (*Combretum caffrum*) (not shown). Other species include several micro-organisms such the plant pathogen *Pseudomonas syringae* and species of Kluyveromyces which are used in genomic studies or for their ability to produce lactase enzymes.

The assignees in the overall data for species of relevance to South Africa range across a spectrum from biotechnology (i.e. Genentech), companies such as BASF and Bayer in areas such as biocides/insecticides, agriculture (i.e. Du Pont) and personal and household products such as Proctor and Gamble. More detailed analysis of technology areas revealed biopharmaceutical companies such as Oxigene Inc. which specialises in anti cancer treatments. The Morinaga Milk Industry Co. is conducting research and development of supplements which improve pancreatic functions and offer other health benefits. As this makes clear there are a wide range of general and specialised technology areas and markets of relevance to biodiversity from South Africa. To gain a more focused view of activity we now turn to the results of research to identify organisms appearing in patents that were directly collected in South Africa or where distribution data suggests that South Africa is the likely source.

Species from South Africa in Patent Data:

In total we identified 110 species of organisms that were directly sourced from, or potentially originate from, South Africa based on distribution data. An additional 44 species were retained as being of relevance to South Africa for a variety of reasons but are excluded from the statistics. Plate 4 displays the top species for South Africa from 37 selected species based on a manual review of patent documents. In the next section a summary is provided for these species. Species of relevance to South Africa for other reasons appear at the end of the summary under “Other Species”. This data will also be made available online to allow for further exploration of each case.

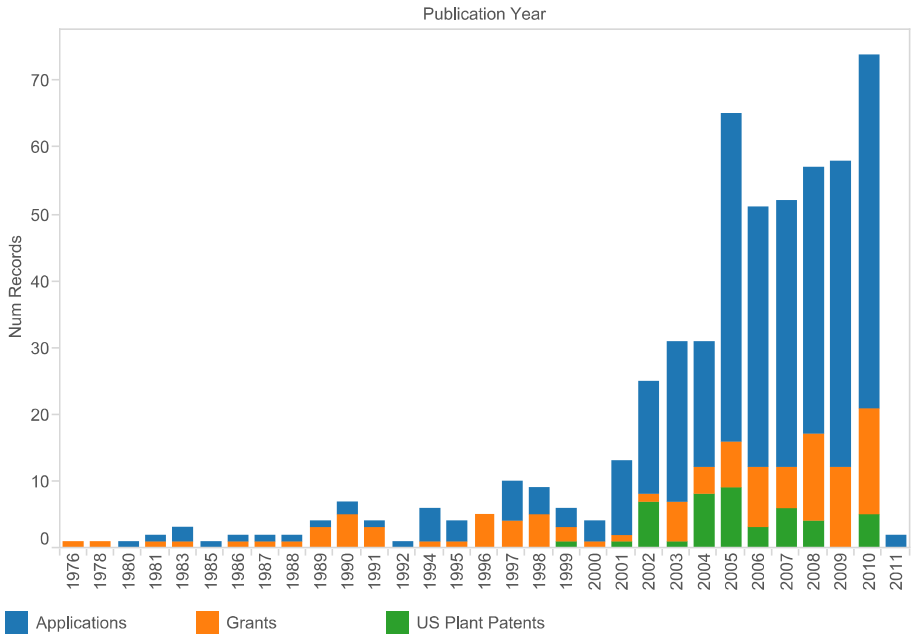
Plate 4 reveals that based on detailed analysis of patent documents, certain species move to the fore in the data compared with the global overview provided in Plate 3. It is notable that endemic plants are particularly prominent in this list. The top species is *Combretum caffrum*, commonly known as the Bushwillow tree. This tree is the source of combretastatin which is taken from the bark and is used to restrict the flow of blood to tumors. Work has been carried out by Arizona State University on improving the solubility of combretastatin A-4 through the development of prodrugs and trans-isomers (e.g.: US701897B1) and the biopharmaceutical company Oxigene in association with Baylor University has continued research and development in the application of these compounds in cancer treatment (e.g.: US20030149003A1). Oxigene has a combretastatin vascular disrupting agent product candidate in development under the name ZYBRESTAT focusing on thyroid cancer. Combretastatin is also now known as Fosbretabulin.

Aloe africana is one of a number of aloe species which feature in the species list. Aloe is a widely used plant for a variety of technologies including for cosmetic and skin care and pharmaceutical purposes. Morinaga Milk Industry Co Ltd has researched into a number of

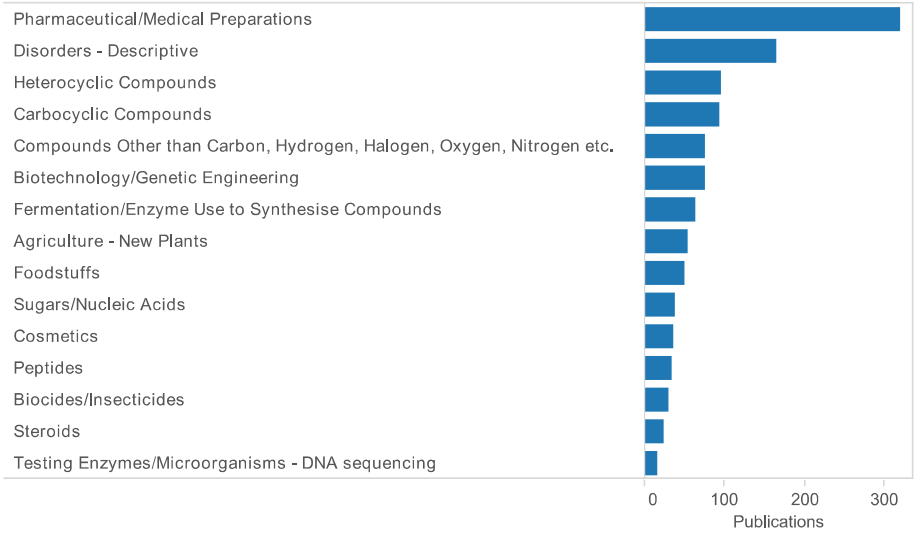
Species

Species	Kingdom	Distribution	Data Type
Combretum caffrum	plantae	Endemic	Distribution
Aloe africana	plantae	Endemic	Origin
Cyclopia species	plantae	Endemic	Distribution
Sclerochiton illcifolius	plantae	Endemic	Origin
Zantedeschia sprengeri	plantae	Cosmopolitan	Distribution
Sceletium tortuosum	plantae	Uncertain	Distribution
Hoodia species	plantae	Endemic	Distribution
Cryptococcus amylolentus	fungi	Uncertain	Distribution
Aspalathus linearis	plantae	Cosmopolitan	Origin
Cryptocarya Latifolia	plantae	Endemic	Distribution
Aloe petricola (Aloe vera)	plantae	Endemic	Origin
Sorangium cellulosum	bacteria	Cosmopolitan	Origin
Sceletium expansum	plantae	Endemic	Distribution
Plectranthus hilliardiae	plantae	Cosmopolitan	Distribution
Zygozyma oligophaga	fungi	Uncertain	Distribution
Ornithogalum multifolium	plantae	Endemic	Distribution
Nudaurelia omega virus	virales	Cosmopolitan	Origin
Hoodia gordonii	plantae	Cosmopolitan	Origin
Harpagophytum procumbens	plantae	Cosmopolitan	Origin
Hansenula philodendra	fungi	Uncertain	Distribution
Callitris arborea	plantae	Uncertain	Distribution
Bacterium xylinum	bacteria	Cosmopolitan	Distribution
Umtiza listerania	plantae	Endemic	Distribution
Spiloxene schlechteri	plantae	Endemic	Distribution
Protea pulchra	plantae	Endemic	Distribution
Hypoxis latifolia	plantae	Uncertain	Distribution
Crocosmia masonorum	plantae	Cosmopolitan	Distribution
Cephalodiscus gilchristi	animalia	Uncertain	Distribution
Siphonochilus natalensis	plantae	Endemic	Distribution
Scabiosa anthemifolia	plantae	Cosmopolitan	Distribution
Priestleya tomentosa	plantae	Endemic	Distribution
Ogataea kodamae	fungi	Uncertain	Distribution
Myxozyma vanderwaltii	fungi	Uncertain	Distribution
Lobostemon trigonus	plantae	Endemic	Distribution
Kluyveromyces delphensis	fungi	Cosmopolitan	Distribution
HIV Subtype C South African..	virales	Cosmopolitan	Origin
Eupenicillium alutaceum	fungi	Uncertain	Distribution

Trends



Technology Areas



uses for active compounds extracted from Aloe africana including for the treatment of diseases resulting from reduced pancreatic functions (US7531520B2) and for the treatment of hyperglycemia and its complications (US7754704B2). Another use of aloe is demonstrated by Proctor and Gamble Co in WO2001062265A1 in which they claim for an orally administered composition for the rehydration of mammalian skin. The species *Aloe vera* (formerly *Aloe petricola*) is a related species which has been very widely used in cosmetic products, Henkel & Co AG KAA uses a preparation made from *A. vera* as a hair dye (WO2006125619A1).

Cyclopia is the genus of leguminous plants better known as 'Honeybush'. This plant and extracts from it have a number of uses. The plant is taken as a traditional infusion, and the use of extracts from it are used as food supplements providing vitamins and minerals (for example US20080014305A1 - Albrecht CFDV). Other cosmetic and personal care uses for extracts include as an additive to a cleaner which can be used in a variety of toiletries (WO2010056232A1- Colgate Palmolive Co) and as an ingredient in a cosmetic towelette (EP1893293B1 - Conopco In DBA Unilever, Hindustan Unilever Ltd et al).

Monatin is an amino acid isolated from the root bark of the plant *Sclerochiton ilicifolius*. It is useful as it is a high intensity sweetener with potential to replace sugars. Cargill Inc (US20050112260A1) have developed tabletop sweeteners and beverages using monatin, as well as researching polypeptides and biosynthetic pathways for the production of stereoisomers of monatin (US20080020434A1). This plant and its byproducts demonstrate a potential for significant economic benefits as healthier alternatives to traditional sweeteners if taken up on a large scale.

Zantedeschia sprengeri is an herbaceous flowering plant in the family Araceae known as the Calla lily This species highlights the commercial importance of horticulture and the development of new varieties and cultivars of South African species. A number of new cultivars have been developed by Sande BV (for example US20070039082P1). Similarly Boeket Handelmaatschappij BV and Callas New Zealand Ltd (e.g.: USPP1564P3) undertake the same type of cultivar development. An aspect of the horticultural industry is that many new varieties may be developed from cultivars long established in another country though the wild variety originates from South Africa.

Species of the genus Hoodia are well known as an appetite suppressant and for its traditional uses by the San people. T & P Lovate Inc and Northern Innovations & Formulations Corp have developed an appetite suppressant as a part of a weight management composition (US20100124578A1). A process for harvesting and preparing Hoodia to make a steroidal glycoside composition for the same purpose has been developed by Conopco Inc DBA Unilever, Hindustan Unilever Ltd & Unilever NL (WO2008022875A1). We would emphasise that this data represents only part of the wider patent landscape for the Hoodia genus.

Only one species of animal is to be found in the most used list. This is *Cephalodiscus gilchristi,* a marine worm found in South African waters. This worm has been found to contain compounds, now named cephalostatins, which are powerful inhibitors of the murine P388 lymphocytic leukemia. Arizona State University and the Department of Health and Human Services of the US Government have undertaken research into the isolation and use of these compounds (US4873245A).

A number of micro-organisms - fungi, bacteria and viruses - appear in the data for SOuth Africa. The yeast *Cryptococcus amylolentus* occurs in a number of patents, often in a long list of species which can be used in processes. Yeast cells are used in methods for obtaining optically active epoxides and vicinal diols The Council for Scientific and Industrial Research in South Africa has been particularly active in this research (for example US20080199912A1). Another example of the use of micro-organisms is found with the bacteria *Sorangium cellulosum*. This species was first isolated from soil on the banks of the Zambezi River in South Africa. This species produces epothilone. This compound has been found to be effective in the treatment of cancers and its synthesis, isolation and purification have been the focus of inventions by Bristol-Myers Squibb Co (W02001064650A2).

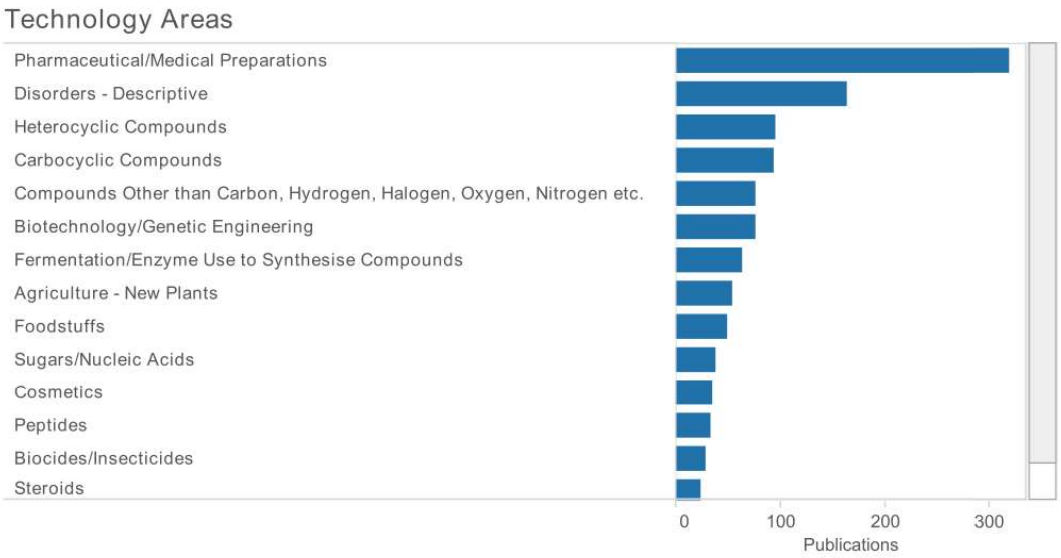
Full details of the species identified in the research are provided in the final section of this report. In considering this data we would note that while species endemic to South Africa merit close attention, cosmopolitan species that are native to several African countries may hold significant potential for collaboration in economic development and conservation.

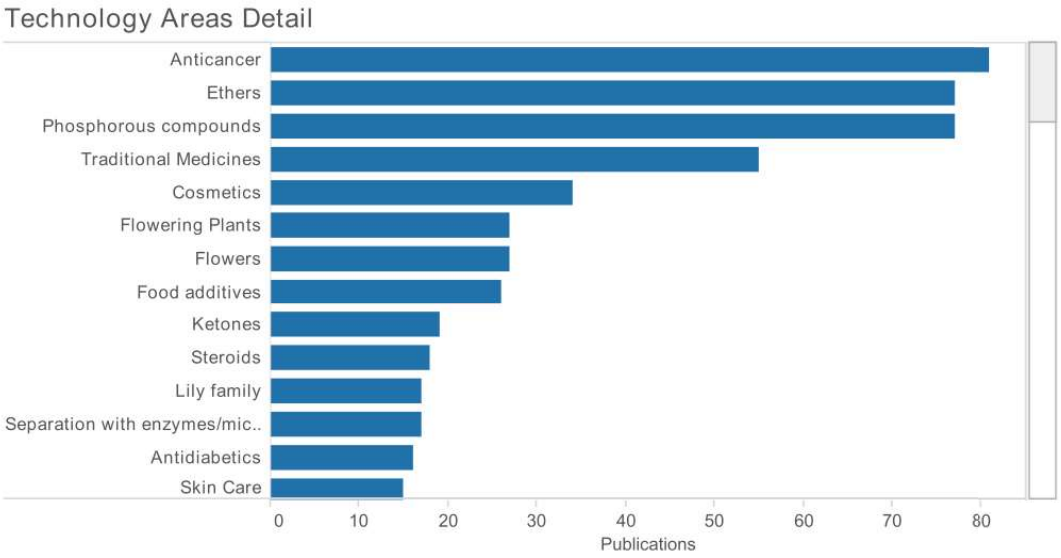
South Africa has a rich portfolio of species that appear in patents. It is important to emphasise that species may be involved in research and development in different areas of science and technology and may serve different markets. In some cases a species may be the target of a particular invention. In other cases a patent may suggest potential uses of a particular organism while in others, the species will be the direct focus of the claimed invention. We now turn to more detailed analysis of the technology areas involving species relevant to South Africa.

Technology Areas:

Table 2 provides a brief summary of the technology areas involved in patent activity for South Africa and is followed by a more detailed break down of activity.

Table 2: Technology Areas





The general overview of technology areas provided in Plate 1 emphasised pharmaceuticals, disorders (descriptive) and heterocyclic and carbocyclic compounds. The narrower dataset that focuses on species from, or likely to originate from, South Africa reveals the same pattern.

Patent activity for pharmaceutical preparations involves species such as the *Combretum caffrum* and *Aloe africana*, which were discussed above. Other species include *Hypoxis latifolia* which has potential as a source of new drugs with immuno-modulatory properties due to the generation of rooperol in the gut when consumed. *Lobostemon trigonus* is cited in a long list of plant species which can be used in a phytoceutical composition for the

prevention and treatment of circulatory disorders. A breakdown of technology areas for a sample of species is provided in Table 3.

Table 3: Species and Technology Areas

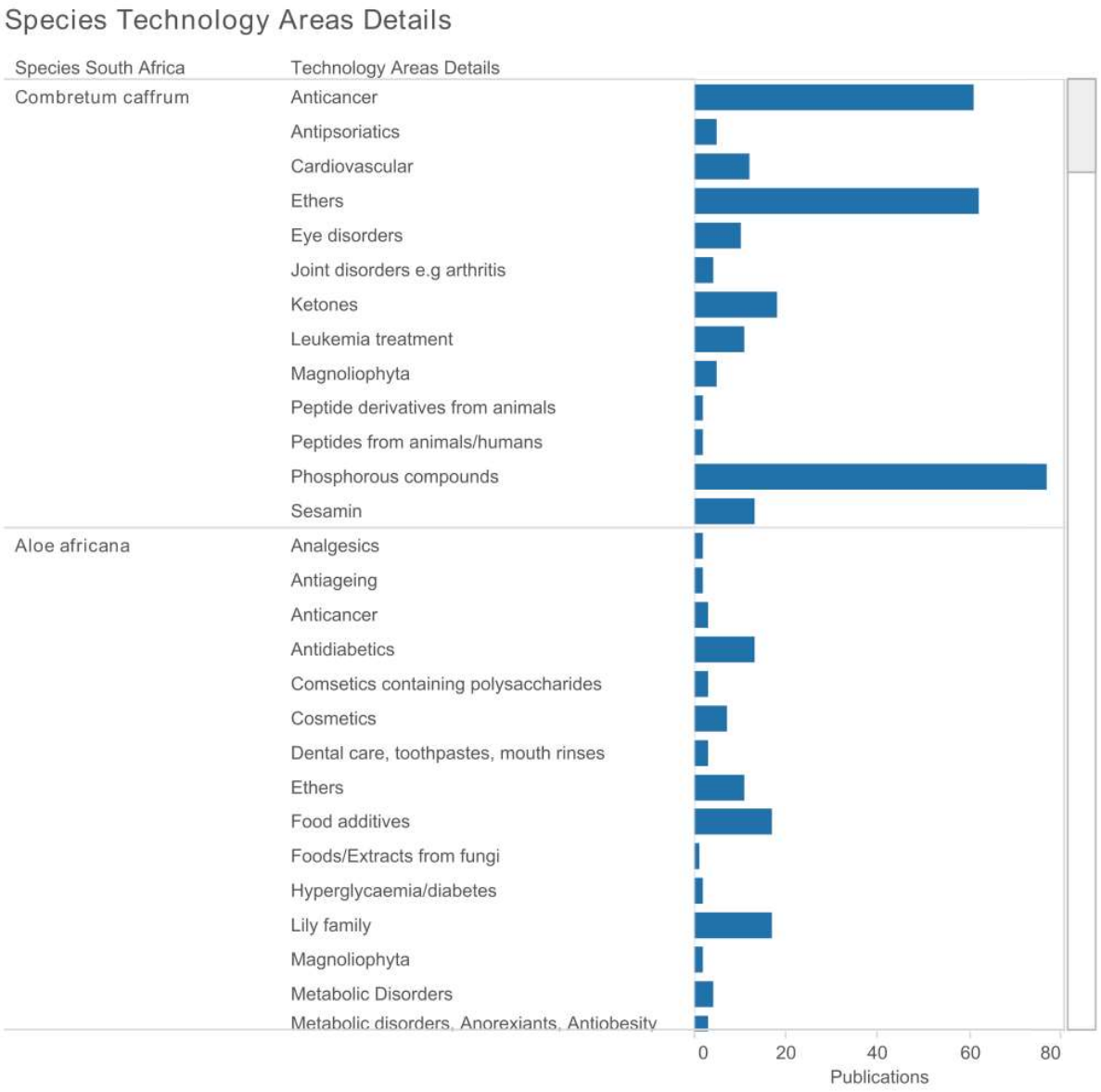


Table 3 usefully reveals the range of potential applications and technology areas where a species and its components may be deployed. As such a species may be a focus of activity for a range of different products and markets. However, in the case of threatened species there will be a need for careful stewardship and conservation of target species.

Patent Claims:

Additional insights can be provided by examining the types of claims that are being made in relation to the species. A patent application may contain multiple claims but is required to contain only one invention. The first claim sets out the major focus of the claimed invention and frames all other claims.

Patents are awarded for three main classes of invention:

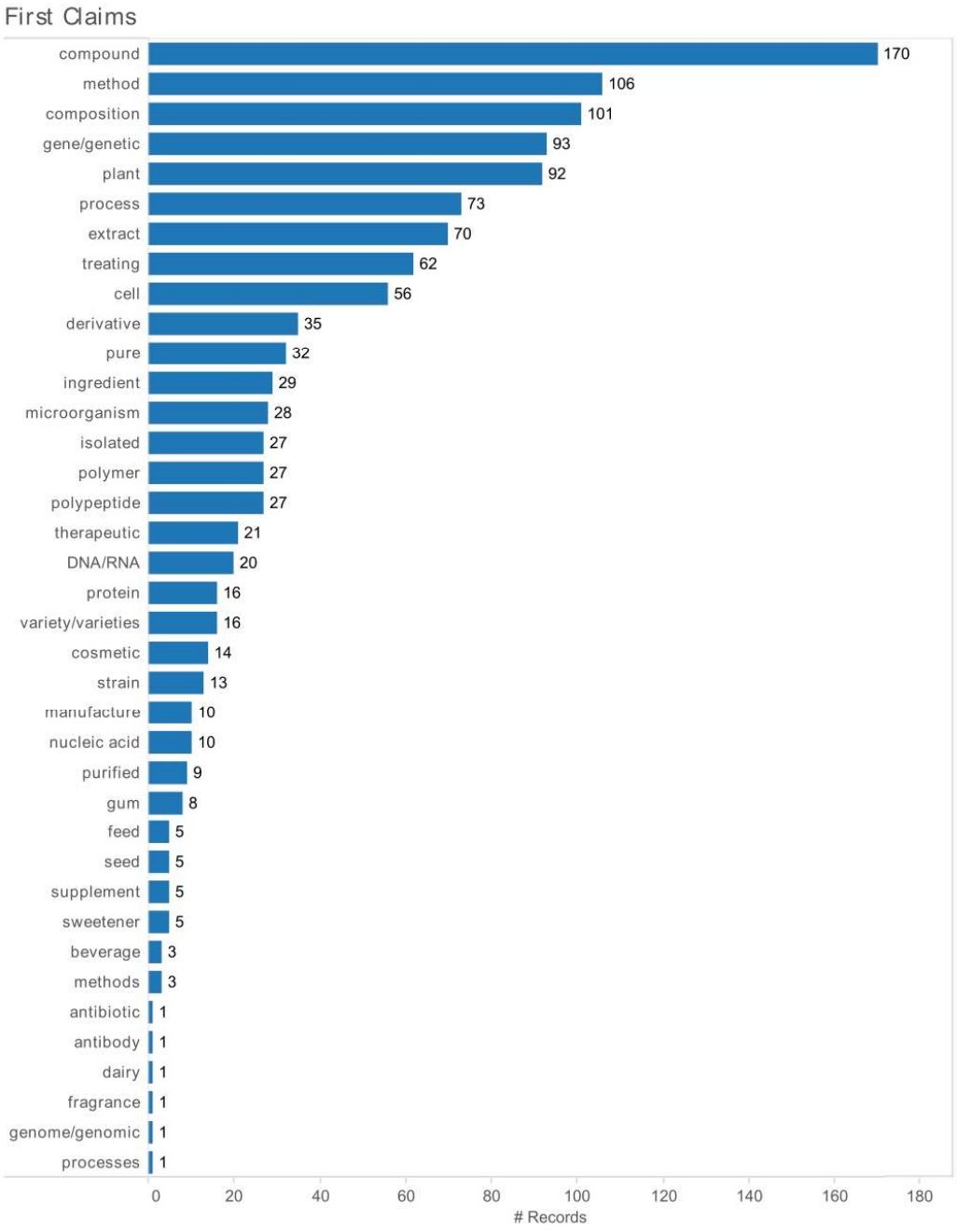
1. Compositions of matter;
2. Methods or processes;
3. Machines;
4. In some jurisdictions claims may be permitted for new plant varieties either under standard patent legislation or under specific legislation (i.e. US Plant Patents).

Table 4 displays a summary of the top terms appearing in patent claims relating to genetic resources for South Africa.

Table 4 reveals that the top category of patent claims reference compounds. These can encompass a variety of claimed inventions. For example, a pharmaceutical composition from components of Aloe plants claims “A method for inhibiting visceral fat accumulation, comprising administering an isolated compound represented by the following formula (1) to a target whose accumulation of visceral fat is to be inhibited” (US7846905B2). In this claim the compound is made from plant extracts, In contrast, the University of Pretoria claims a Phloroglucinol compound as “A phloroglucinol compound of formula 1:00R3’21R0ji512’A’ R wherein, R represents an H, OH, OCH3 or CH2CH3 group or a similar hydrocarbon derivative, or a pharmaceutically acceptable salt, ester or derivative thereof” (WO2001023342A1). In this invention the compound is used to treat tuberculosis caused by pathogenic bacteria and fungi and 28 named plants are screened to test activity against drug-resistant bacteria in the development of the compound. As this makes clear claims to compounds and how species are used within the claims may take a variety of forms.

The second category of patent claims is for methods, such as methods of producing a plant, a compound or other desired outcome. Method claims are frequently more restrictive in their coverage of genetic resources because the genetic component is only claimed in so far that it is relevant to performing the method. That is, it is the method that is the focus of the invention. Therefore it is the method, and the use of the claimed genetic or biological component in performing that method, that is the subject matter of protection.

Table 4: Terms Appearing in the First Claims of Patent Documents



The third major formal category of patent claim is for compositions of matter (compositions). Compositions are commonly extracts, compounds or combinations of ingredients (i.e. in pharmaceuticals or cosmetics and herbal medicines). Patent claims for compositions typically include a list of the compounds or ingredients that are the subject matter for protection. These claims are frequently broadly constructed such that the use of compounds from the species, the genus, and in some cases the family, are incorporated into the scope of the claims. While composition of matter claims may be constructed in various ways, broad claims may well impinge upon the ability of producers from a country

to export products containing the claimed components into markets where a patent is in force.

An example of this type of issue is provided by an application submitted by Coca-Cola Co relating to hoodia species for use in a composition with high potency sweeteners for use as a weight management product. The first claim of this application reads as follows:

“A functional sweetener composition comprising: at least one weight management agent; at least one high-potency sweetener; and at least one sweet taste improving composition.”

Claim 7 goes on to expand this claim by stating:

“The functional sweetener composition of claim 1, wherein the at least one weight management agent comprises at least one herbal extract selected from the group consisting of polyphenols, Garcinia Cambogia, Gymnema Sylvestre, Kola Nut, Citrus Aurantium, Yerba Mate Griffonia Simplicifolia, Guarana, Green Tea, myrrh, guggul Lipid, black current seed oil, green tea leaf, *extracts of the genera Hoodia*, Stapelia, Orbea, Asclepias, Trichocaulon, Camelia, and combinations thereof.” (WO2007061873A1) (emphasis added).

This type of claim, where granted, is likely to prove to be a problem because it refers to the use of an extract of any member of the genus Hoodia to manufacture a weight management product. It illustrates the type of problem that can emerge in broadly constructed composition of matter claims. We would note that patent claims in an original application are typically broadly constructed and may be modified, narrowed or rejected at the examination stage. It is therefore important to follow the progress of applications with particular attention to the modification of patent claims. We discuss broadly constructed claims further below in connection with the problem of essential incorporation of species into patent claims.

Patent activity that involves claims to a process or processes are similar to methods claims. Typically, these claims focus on the process for producing or manufacturing a desired product (such as a chemical, a cosmetic or a beverage). It is the process itself that is the focus of the invention. For example, Conopco Inc DBA Unilever, Hindustan Unilever Ltd and Unilever NL claim “Process for preparing a composition comprising one or more steroidal glycosides, comprising the steps of a) harvesting Hoodia plants, b) drying the cut plants, whereby exposure to UV light during the drying step is avoided, such that the total UV dose is less than about 0.5lJ/m2 to obtain dried plant material” (WO2008022875A1). However, patent claims for processes are typically constructed so that a component or product created using the process is included in the scope of protection. For example, the above application ends with the following claims “8. Process according to any one of the preceding claims, wherein the plants are selected from the group consisting of Hoodia gordonii, Hoodia currorii, Hoodia lugardii and mixtures thereof. 9. Process according to claim 8, wherein the plant is Hoodia gordonii ” The same component or product created using a different process would not logically fall within the scope of this type of patent. Once again it is important also to examine the modification of patent claims as they move toward patent grants.

Finally, one feature of patent activity involving species that originate from, or are distributed in South Africa is the appearance of species names in long lists of species, genera, or families, of organisms rather than evidence of the direct collection of an organism or sample in South Africa. This is characteristic of many patent applications

involving species from African countries but is unlikely to be particular to Africa. The purpose of these references can be described as incorporation of the referenced species, genus or family into the scope of the patent claims. That is, as in the case of *Cryptococcus amylolentus* mentioned above, any use of a specified compound or extract from the organism, genus or family is presented as falling within the scope of the claims. As we have suggested above, incorporation can provide useful clues on the potential properties and uses of organisms. The purpose of incorporation, from a patent lawyers perspective, is likely to be defensive. However, it is important to recognise the uncertainties and restrictions that essential incorporation of species, genera and families of organisms into patent claims may impose on producers from countries of origin in accessing markets.

As this brief discussion of patent claims suggests, it is important to pay close attention to both the type and the content of patent claims. In addition, it is important to establish whether a patent has been granted, the jurisdictions where a patent has been granted, and whether it is in force. This type of analysis is particularly important when considering the potential development of products for markets. However, detailed patent analysis such as freedom to operate, patent validity, patentability, patent infringement and patent landscape analysis requires specialist analysis beyond the scope of the present report.

Given the increasing importance of these issues for economic development the World Intellectual Property Organization has established a Patent Landscaping initiative under its development agenda that commissions specialist patent research at the request of member states. We recommend the WIPO Patent Landscaping initiative for detailed analysis of specific landscapes for species or genetic resources of interest.

Global Impacts and Global Markets:

We have seen above that a range of species are involved in patent activity of relevance to South Africa. However, it is important to note that many patent applications simply go nowhere. They may embody the hopes and ambitions of individuals, researchers, universities and companies but do not ultimately have an impact either in the patent system or in the market. A means for identifying important patents is therefore needed. Here we discuss two measures: a) patent citations, and; b) patent families.

Table 5 displays the citation scores by species and assignee for species relevant to South Africa. When a patent is filed and published it becomes prior art. Later patent applications that make claims for the same invention will find that the scope of what they claim as new, involving an inventive step, and useful will be limited by these earlier claims. This is recorded in the patent system as a citation. The more often that a patent is cited by later patent applications is a measure of the importance and impact of that patent within the patent system. In some cases a single patent application may attract over a thousand citations. Patent citation counts are therefore an important measure of the importance of patent activity because these scores reveal the impact of patent activity on other applicants.

In the case of South Africa, Table 5 reveals a selection of citation scores for species of relevance to South Africa organised by assignee and species. The top cited species receives 255 citations in 19 documents from Cargill Inc involving *Sclerochiton ilicifolius* for "Chewing gum compositions comprising monatin and methods making same" (WO2005016022A1 - 45 citations), also "Beverage compositions Comprising monatin and methods of making same" (WO2005020721A1 - 42 citations) and also "Monatin tabletop sweetener compositions and methods for making

same" (WO2005014839A2 - 31 citations). All three of these top cited patents are for products derived from monatin. Additionally US20080020434A1 (17 citations) concerns "Polypeptides and biosynthetic pathways for the production of stereoisomers of monatin and their precursors", and this clearly shows the development of methods for synthesizing monatin without the need to collect it from its natural source.

Documents describing work undertaken using *Aloe africana* by Carrington Lab Inc are the next most cited, showing 210 citations of 9 documents. US4917890A (52 citations) concerns "Processes for preparation of aloe products, products produced thereby and compositions thereof'. Specifically this document describes a process which produces substantially anthraquinone-free aloe gel. The high number of citations reveals the potentially important economic importance of high quality extracts from the species, and by inference the high economic importance of the species itself.

Belonogaster petiolata is a species of wasp which has been used by Res Assoc Biotechnology in the development of "Primers for synthesizing full length cDNA and their use" (EP1130094A2). This particular patent has been cited a total of 116 times. In the original patent a B. petiolata sequence is listed in the manufacturing process. The use of the resulting oligonucleotide in subsequent synthesizing of polynucleotides for further research would not, therefore, concern the named species. This example illustrates that on occasions a species of relevance to an initial patent document does not by necessity have relevance to subsequent work citing the original document.

Six documents from Arizona State University featuring *Combretum caffrum* have been cited 106 times. One document, US5569786A, which has been cited a total of 37 times, concerns the "Isolation, structural elucidation and synthesis of novel antineoplastic substances denominated 'combretastatins'". Natural combretastatins, as stated above, are derived from the bark of *Combretum caffrum* and they have powerful anticancer properties. They may therefore have significant potential commercial value. The synthesis of combretastatins, like the synthesis of monatin, would provide a means of developing the molecules without resorting to ongoing collection from their natural source.

Table 5: Species and Assignee Citing Patents

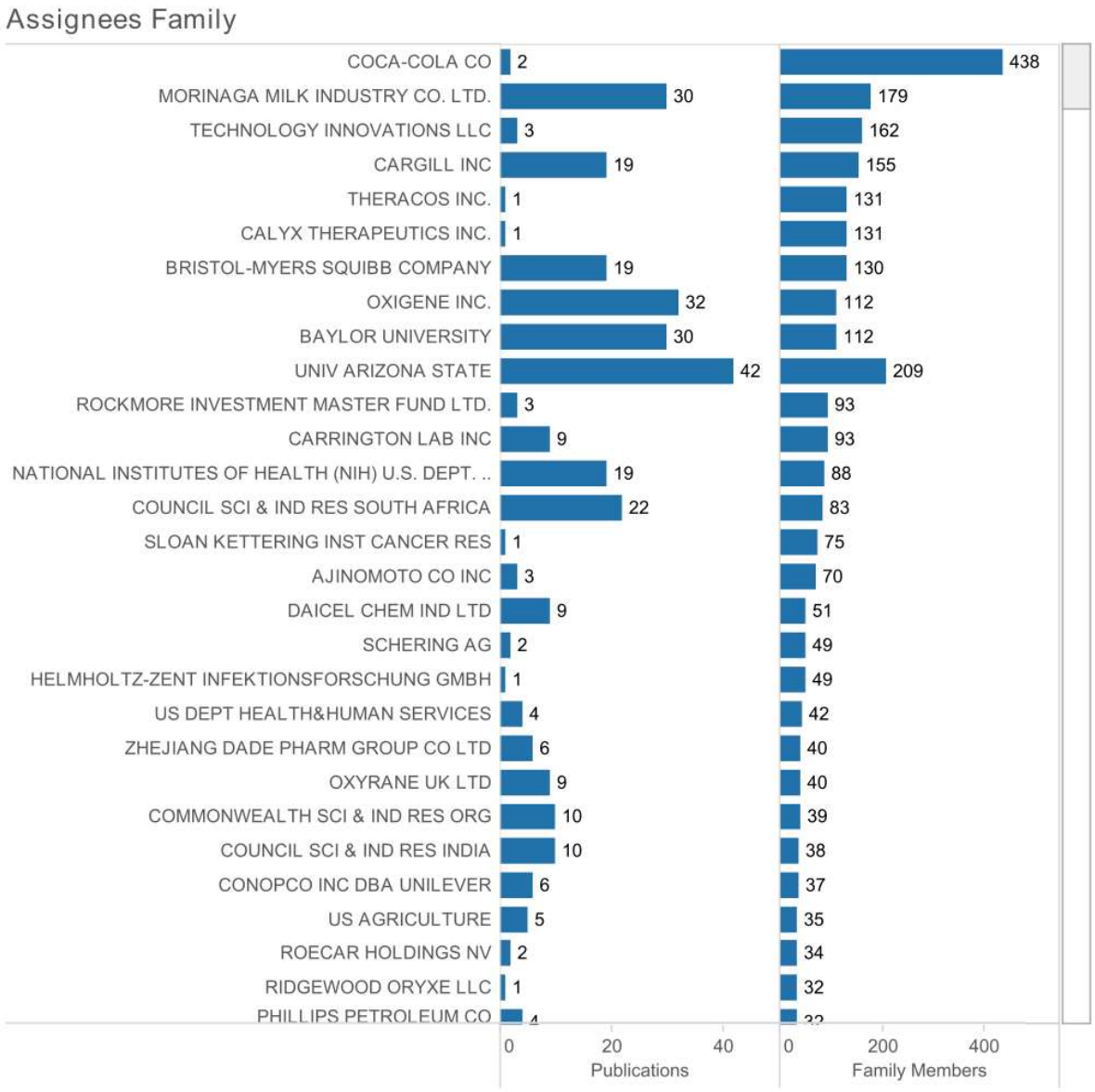
Assignees Citing

Patent Assignees	Species South Africa	Citing Patent Count
CARGILL INC	Sclerochiton ilicifolius	255
CARRINGTON LAB INC	Aloe africana	210
RES ASSOC BIOTECHNOLOGY	Belonogaster petiolata	130
ROCKMORE INVESTMENT MASTER FUND LTD. (COLLATER..	Aloe africana	127
HERIKKUSU KENKYUSHO KK	Belonogaster petiolata	116
HELIX RES INST	Belonogaster petiolata	116
UNIV ARIZONA STATE	Combretum caffrum	106
	Cyclopia species	0
BAYLOR UNIVERSITY	Combretum caffrum	91
ARIZONA BOARD OF REGENTS ACTING FOR AND ON BEHALF OF ARIZONA STATE UNIVERSITY	Cephalodiscus gilchristi	3
	Combretum caffrum	83
OXIGENE INC.	Combretum caffrum	71
ZHAO L	Sclerochiton ilicifolius	70
TECHNOLOGY INNOVATIONS LLC	Combretum caffrum	70
NATIONAL HEALTH RESEARCH INSTITUTES	Combretum caffrum	70
HICKS P	Sclerochiton ilicifolius	70
NATIONAL INSTITUTES OF HEALTH (NIH) U.S. DEPT. OF HEALTH AND HUMAN SERVICES (DHHS) U.S. GOVERNMENT	Cephalodiscus gilchristi	2
	Combretum caffrum	59
	Sceletium tortuosum	6
MCFARLAN S C	Sclerochiton ilicifolius	55
PINNEY K G	Combretum caffrum	50
LINDLEY M G	Sclerochiton ilicifolius	49
GOULSON M J	Sclerochiton ilicifolius	49
CANCER RES VENTURES LTD	Combretum caffrum	47
MCGOWN A T	Combretum caffrum	45
LAWRENCE N J	Combretum caffrum	45
HADFIELD J A	Combretum caffrum	45
EDVARDSEN K	Combretum caffrum	45
CHAPLIN D J	Combretum caffrum	45
WEINER D P	Sclerochiton ilicifolius	43
ROSAZZA J	Sclerochiton ilicifolius	42
PREZIOSO J	Combretum caffrum	42
MILLIS J R	Sclerochiton ilicifolius	42
GARNER C M	Combretum caffrum	42
CAMERON D C	Sclerochiton ilicifolius	42
ABRAHAM T W	Sclerochiton ilicifolius	42
GEVO INC	Myxozyma vanderwaltii	41
HEPWORTH L A	Combretum caffrum	40

A second measure of the importance of patents is provided by the size of patent families. Table 6 ranks assignees based on counts of numbers of patent family members. A patent family is simply a set of patent documents that link back to an original parent filing (known as a “priority” filing). These patent documents can be filed anywhere in the world and can be tracked using unique identifiers known as INPADOC numbers that link back to the parent document. In contrast with patent citations that provide an indicator of the impact of a patent on other applications in the patent system, the size of a patent family reveals how important a patent is to applicants. The reason for this is that they must pay fees each time they file a patent application that is linked to the parent (priority) application.

Patent family data of this type is useful in revealing the applicants who are most vigorously pursuing patent protection involving a species, or as is frequently the case, a group of species around the world. In this case Coca Cola Co claims for a “high potency sweetener for weight management and compositions sweetened therein”(WO2007061873A1 and US20070116840A1). The patent specifically claims for sweetened drinks which include herbal extracts, in this case Hoodia, and as can be seen from Table 6 these documents have a patent family comprising a further 438 documents. These patents have been taken out in countries such as Australia, Argentina, Canada, Europe, Japan as well as South Africa. The large global reach of this family of patents suggests that the company considers the invention to be of significant economic value across many markets. It also illustrates how a wealthy organisation may have a greater capacity to extend its reach on a global scale. The second ranked Morinaga Milk Industry Co is a leading dairy produce and beverage manufacturer in Japan. Their claims exclusively concern the use of the species Aloe africana. A number of different claims are made for food and beverage supplements for health and medical benefits. Examples are EP1808175A1 provides a “drug or food for improving pancreatic function”, US20100286104A1 “an agent for inhibiting visceral fat accumulation” and US20100035851A1 “an agent for improving insulin resistance”. The reach of their patent families which includes 179 documents covers China, Europe, Russia and North America. This example provides an indicator of the potential uses and importance of *Aloe africana* and the commercial significance that Morinaga Milk Industry places on its investment in research.

Table 6: Patent Assignees and Patent Families



Combretum caffrum has been discussed in this report already, but it provides an excellent example of another aspect of patent families. The molecule combretastatin was first identified in the early 1980s, as a result much research has subsequently been undertaken into this chemical with anticancer properties. Technology Innovations Inc, Cargill Inc, Theracos Inc, Calyx Therapeutics Inc, Bristol Myers Sqiubb Company, Oxigene Inc, Baylor University and Arizona State University dominate the table of patent families, each having families of over 100 documents around the world and all focusing on work with combretastatins. This illustration clearly shows that, while many families will focus on a product or method, sometimes it is a single species which can attain global significance and become the focus for many players and this can be identified by examining patent family data.

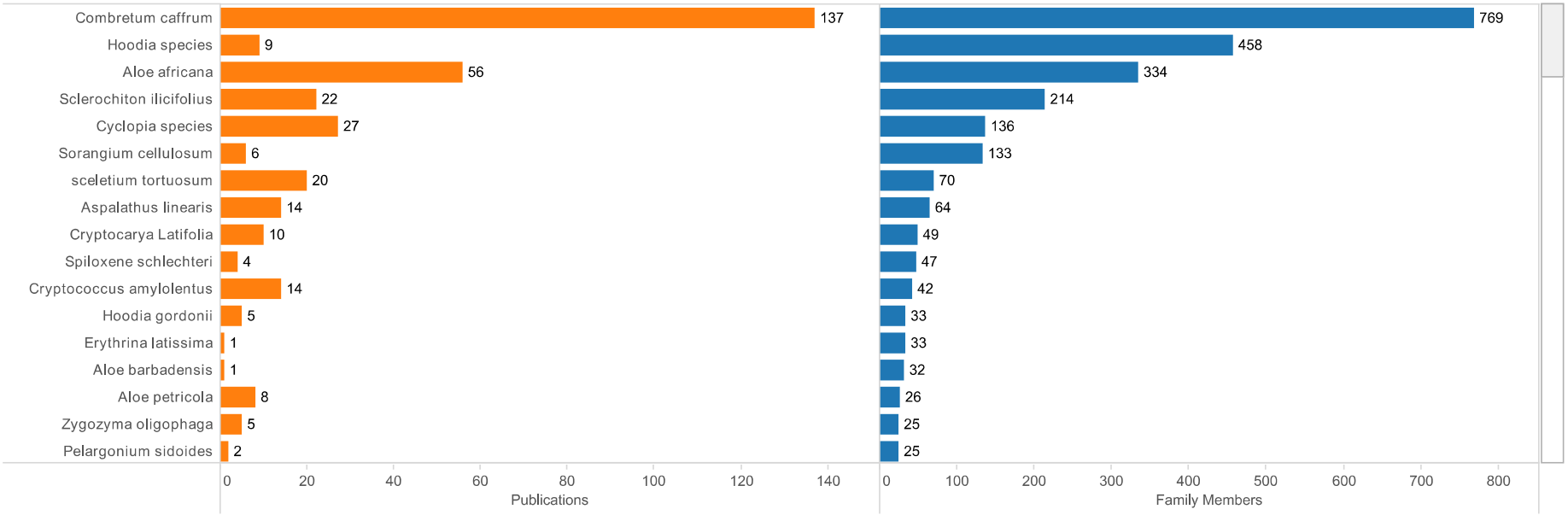
As this makes clear, while care is required in analysing why a particular species is referenced in a patent document, it is possible to trace the economic importance of particular patents to patent applicants using patent family data.

This type of analysis can be extended to the species level to consider the global impacts of patent activity and the position of patents involving a species in global markets.

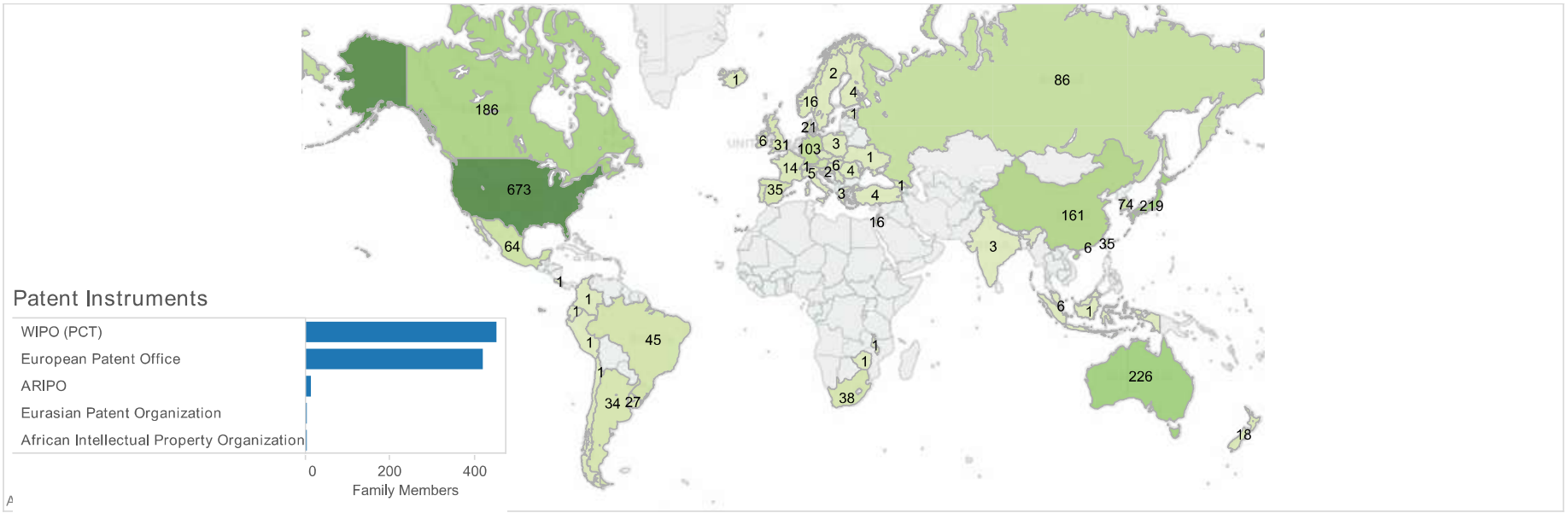
Plate 5 displays patent family data by species and a global map of countries where family members linked to the species have been recorded. Please note that the map does not display the geographical locations for regional and international patent offices. Plate 5 is useful because it reveals what might be called the global reach or careers of species. We can immediately see the prominence of *Combretum caffrum*, Hoodia species and Aloe africana along with *Sclerochitin ilicifolius* in this data.

Analysis of this type is also useful because it exposes the markets where protection is being sought as provided in the Family Countries map. As we might expect the United States is a primary market with Japan and Australia also featuring prominently. However, Germany, China and Canada are also emerging into this landscape. It is notable that available data suggests that patent applicants are only pursuing limited protection in South Africa itself and very little protection at all in the rest of the African continent. This suggests that South Africa may be considered by some as sufficiently economically developed that a strong protection is required, but opportunities may exist within internal markets in other African countries where patent protection is unlikely to prove to be a barrier. At the same time, patent data also suggests countries where markets may exist for products involving biodiversity from South Africa.

Species Family Members



Family Countries



Concluding Remarks:

In the course of preparing this series of country reports South Africa stood out as the most complex. South Africa has the largest number of species records of any country examined so far and the greatest amount of patent activity that makes reference to the country and those species. The particular geography, habitats and biomes found in this part of the continent have resulted in a large number of endemic species and, in the realm of plants in particular, these have proved to be of great interest to inventors from a wide range of commercial and research fields.

In a significant number of cases these documents refer to pharmaceutical and medical uses of plant extracts - from species which have traditional uses such as Hoodia to compounds such as combretastatins. Some species such as those of the Aloe genus have uses across different technological fields such as pharmaceuticals, food supplements, cosmetics and toiletries whereas others have commercial value as a food additive such as the super-sweetener monatin.

The purpose of this report has been to highlight the existing and potential role of species of relevance to South Africa for economic development in support of conservation. We would emphasise that our aim has not been to identify cases of biopiracy or misappropriation. In addition the aim of the research was not to identify the complete portfolio of patent activity for a particular species or genetic resource. We have focused on those patent documents that make direct reference to South Africa or where distribution data suggests that South Africa is a likely source.

The next section presents a series of summary cards for each species identified as particularly relevant during the research. An online interactive version of these cards will be made available through abspat.net to facilitate further research.