Biodiversity in the Patent System: Kenya

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

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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 Kenya. The report is divided into three sections:

Section 1 provides an overview of biodiversity in Kenya 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 Kenya in the period 1976-2010. This is followed by detailed analysis of patent documents that make reference to Kenya and data based on species that are limited to distribution in Kenya.

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 Kenya. 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 Kenya as a basis for further research.

Our research focused primarily on documents that make reference to Kenya and to cases where existing distribution data suggests Kenya 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.

Kenya

Area:
580,367 sq. km
Coastline:
536km
Climate:
Varies from tropical along coast to arid in interior
Geography:
Low plains rise to central highlands bisected by Great Rift Valley; fertile plateau in west. Kenya has a coastline on the Indian Ocean which contains mangrove swamps. Inland are broad plains and numerous hills. Central and Western Kenya is characterised by the Kenyan Rift Valley home to two of Africa's highest mountains. The Kakamega Forest in western Kenya is relic of an East African rainforest. Much larger is Mau Forest, the largest forest complex in East Africa.

Biodiversity in Kenya and Patent Activity:

Data for biological diversity was obtained from the Global Biodiversity Information Facility (GBIF). GBIF is an international government-initiated resource that provides open access to the most comprehensive quantitative data on species across time and space 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 Kenya. It should be noted that the usefulness of this data in determining the actual distribution of a given species is conditioned by 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 16,594 species for Kenya consisting of 14,681 accepted scientific species names and the remainder made up of synonyms, homonyms or species names that are not presently scientifically accepted. In addition, GBIF contains 149,900 georeferenced coordinates for species from Kenya. Accurate georeferencing of species collection records is an important standard in biodiversity related research.

We identified a total of 180,931 patent documents containing species known to be distributed in Kenya. Of these 927 made some form of reference to Kenya. These documents were manually reviewed in MaxQDA software to identify documents specifying a source or origin in Kenya.

The 927 documents that made a specific reference to Kenya contained 3,134 species. This is important because a patent document that contains a species name typically includes multiple species names. These documents were manually reviewed in MaxQDA data analysis software and through this process we were able to identify species where it was definitively stated that they had been collected, sampled or otherwise obtained from Kenya. We call the resulting data “Origin” in this report.

In addition, using GBIF distribution data we identified 41 species where GBIF presently records distribution only in Kenya. These species appeared in 324 patent documents where Kenya 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 Kenya and thus be regarded as a species of likely or potential significance for Kenya. Because taxonomic data is incomplete we would emphasise that this data simply provides a clue, rather than proof, that a species may have originated from Kenya. For the sake of simplicity we call this data 'Distribution'. These documents were then selected for manual review in MAXQDA software.

Biodiversity and Distribution

Much of the data submitted to GBIF includes geographical coordinates indicating where the recorded species was located. A total of 149,900 coordinates were available for Kenya. Using this data we are able to show the physical distribution across Kenya of all GBIF recorded species. Plate 1 shows two maps: The left 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 map to the right 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 report.

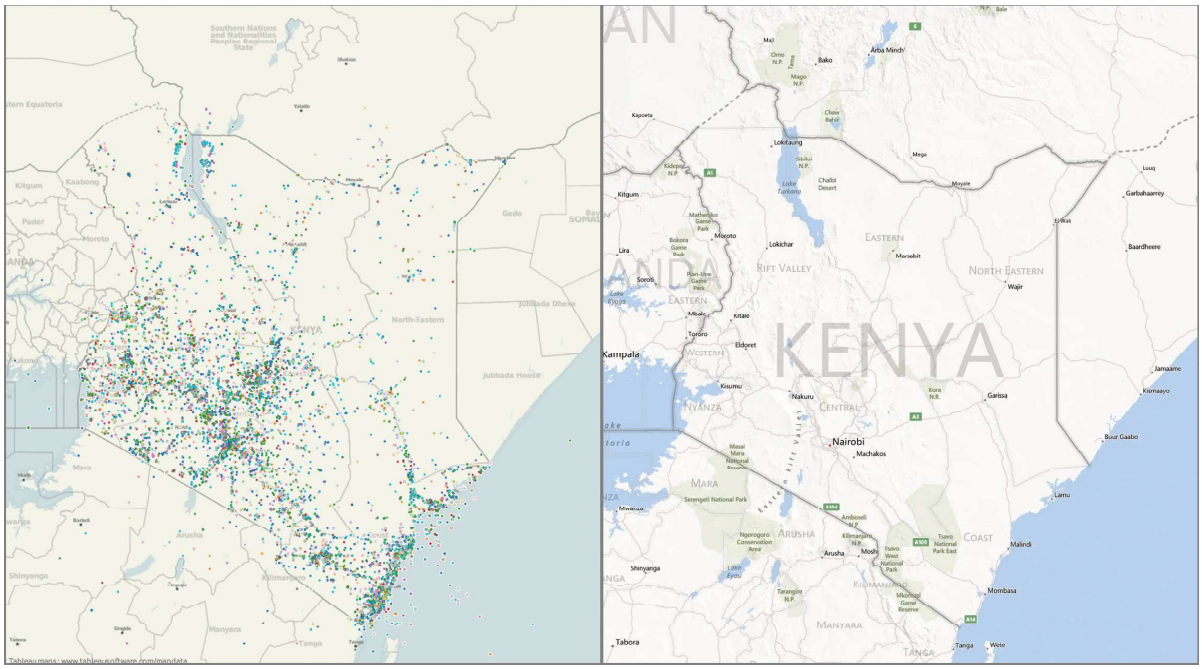

Plate1: Distribution of GBIF records from Kenya (left) and major settlements and roads (right) (map courtesy of Bing Maps). Each colour point represents a species record coloured by kingdom.

It is very interesting to compare the two maps. The distribution map shows that records are not uniformly dispersed across the country. The majority of records come from the

southern half of the country, in particular the highlands of the south west and Rift Valley region and also along the coast in the area of Mombasa. To the north east, in the lowlands, the records appear scarce and widespread. The south west is the area of densest human occupation. Another feature of these mapped distribution records are the strings of data points which cross the country. When compared with the right-hand map it can be seen that the strings of data points closely follow the routes of major roads. This pattern of records suggest that extensive recording has been carried out in the south west but that the eastern part of the country has further potential for recording to build an accurate picture of the biodiversity in that region. Other hotspots for density of records are seen in and around some of the country's protected areas. These include The Masai Mara and the Tsavo National Parks close to the Tanzanian border in the South and the Sibiloi National Park and Marsabit National Reserve in the North. Along the coast there are many marine records which indicate both human activity and diverse habitats such as mangroves and reefs. We would note that georeferencing of species data has an important role to play in facilitating the identification of where species are located in a country. While caution is required in the case of endangered species we would emphasise the wider importance of promoting georeferencing in enhancing knowledge and understanding of biodiversity in Kenya.

GBIF presently records 16,594 species known to be present in Kenya. This list is dominated by plants and animals which account for over 14,500 species as can be seen in Table 1. Other kingdoms are well represented, and this, perhaps, illustrates a fairly high level of recording and collection.

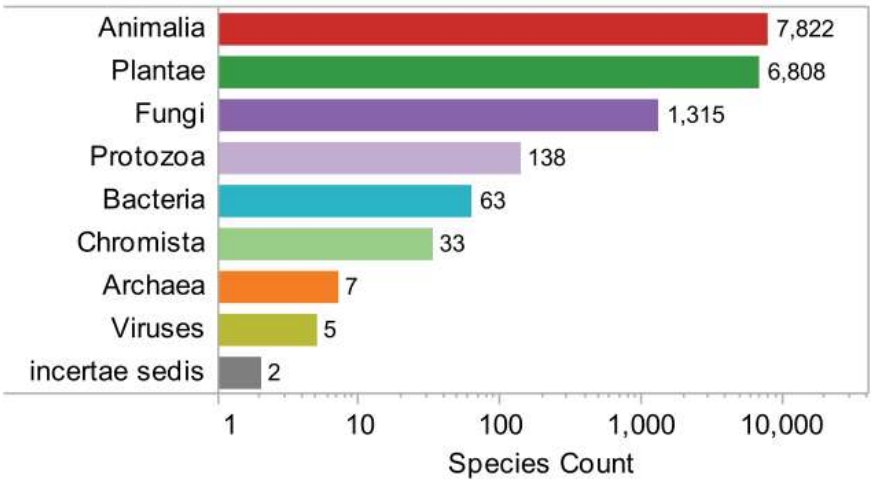

Table 1: Showing the number of species in Kenya by kingdom using GBIF data.

Using global data it is possible to examine the wider distribution of Kenyan species. Plate 2 shows where records exist across the globe for such species. Species that are found in two or more countries are referred to as 'cosmopolitan'. Each pie represents the number of species that are found in Kenya in a particular kingdom. It can be seen that a substantial number of species have a very wide regional distribution throughout sub-Saharan Africa and notably in those countries adjacent to Kenya with shared biomes. A smaller number have global distributions (it should be noted that some of these records may originate from research institutions or collections and therefore do not represent native or naturalised distribution).

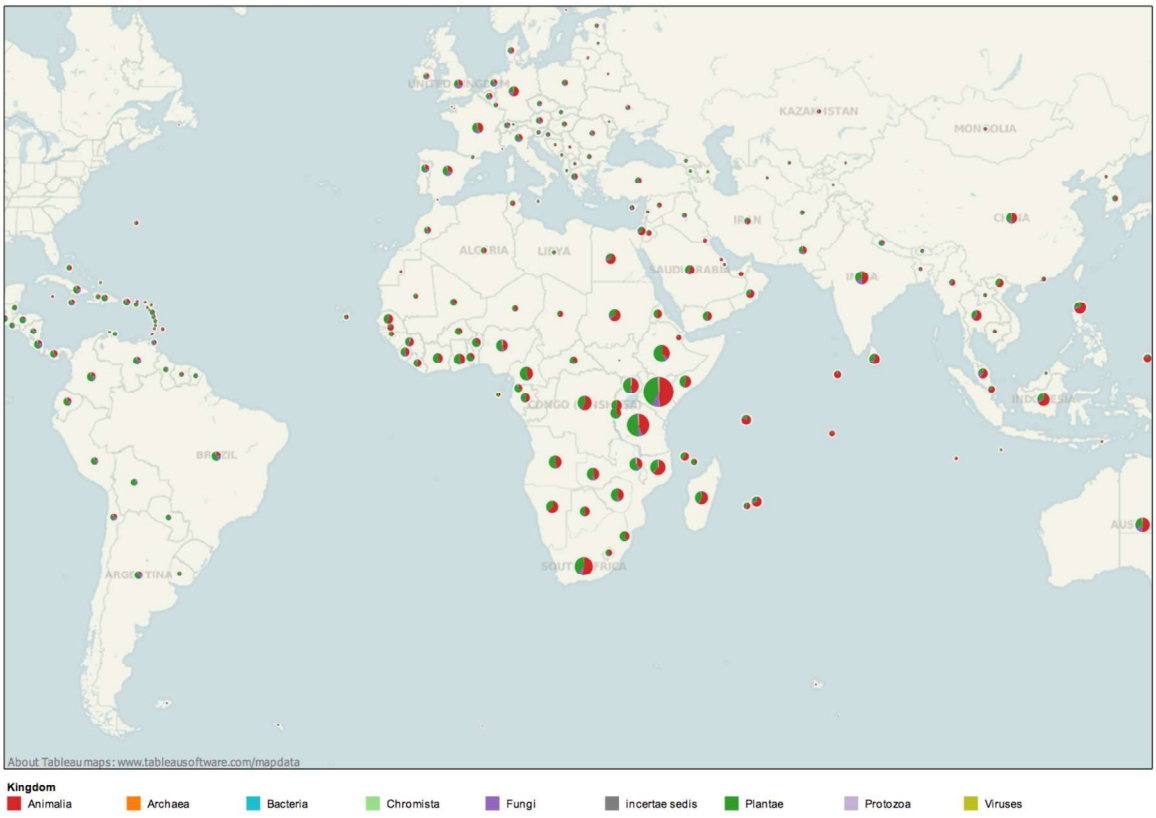

Plate 2: Global distribution of Kenyan species shown by Kingddom and the number of species recorded in GBIF.

Biodiversity in Kenya in the Patent System

As of 2013 a total of 3,300 patent documents in the main patent jurisdictions (European Patent Office, the United States, and the Patent Cooperation Treaty) specifically mention Kenya. This provides a general overview of references to Kenya 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, Kenya. In addition, patent applicants will make reference to species that originate from Kenya but will not mention Kenya 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 Kenya. 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 Kenya. In approaching patent activity for genetic resources from Kenya we focus on three categories of data.

1. Species that are known to be distributed in Kenya but are also distributed elsewhere in the world. This provides an overview of global patent activity for genetic resources of relevance to Kenya.
2. Species where a direct reference is made to the collection or origin of a species from Kenya. 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 Kenya. This data is known as Distribution data and refers to cases where GBIF presently only records a species as occurring in Kenya and no other country. Because taxonomic information is incomplete this data provides a clue rather than proof that a species originated from Kenya.

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

Kenya 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 Kenya 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 Kenya, top applicants or assignees and technology areas.

In total we identified approximately 3,134 species names in patent data from the major jurisdictions that are known to occur in Kenya. When model organisms including crops such as *Zea mays* (maize) and *Homo sapiens* are excluded this falls to 3,080 species names and 2,217 accepted scientific names.[1] This data is relevant for Kenya because it demonstrates that researchers and companies are conducting research and development on species that are known to occur in Kenya. 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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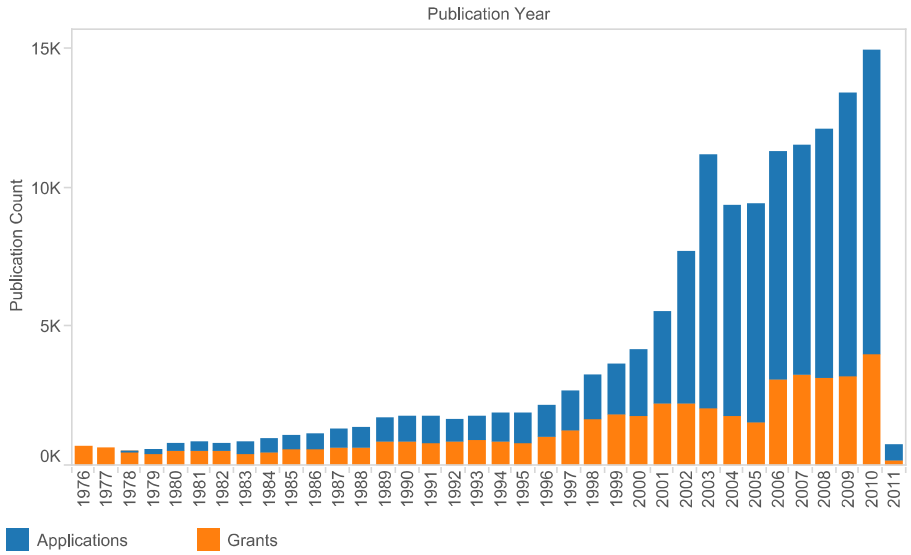
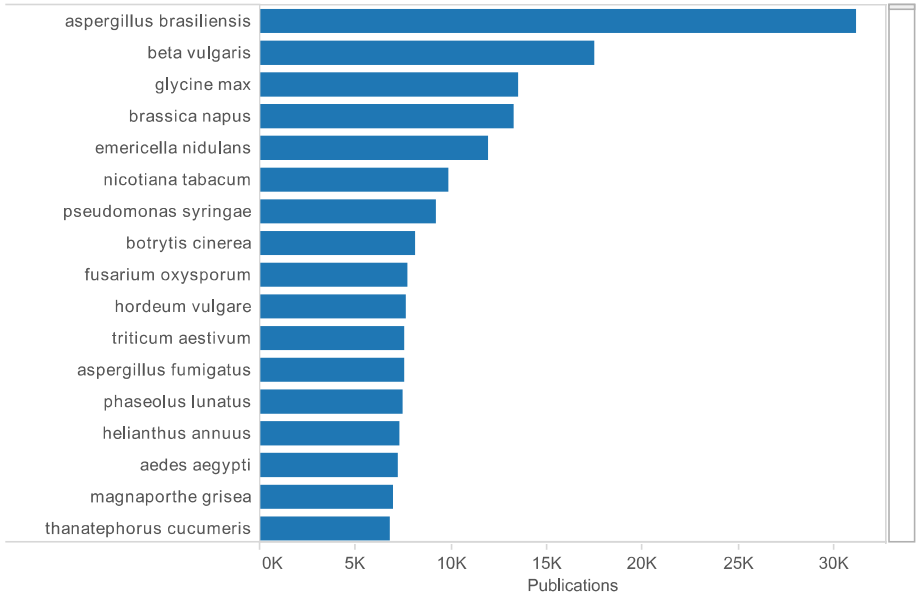
[1] The 3,080 figure excludes common model organisms such as E. coli, Arabidopsis thaliana, Bacillus subtilis and Zea mays (maize) that are globally distributed and are used as research tools in biotechnology. These species appear prominently in patent data for all almost countries and are therefore excluded.

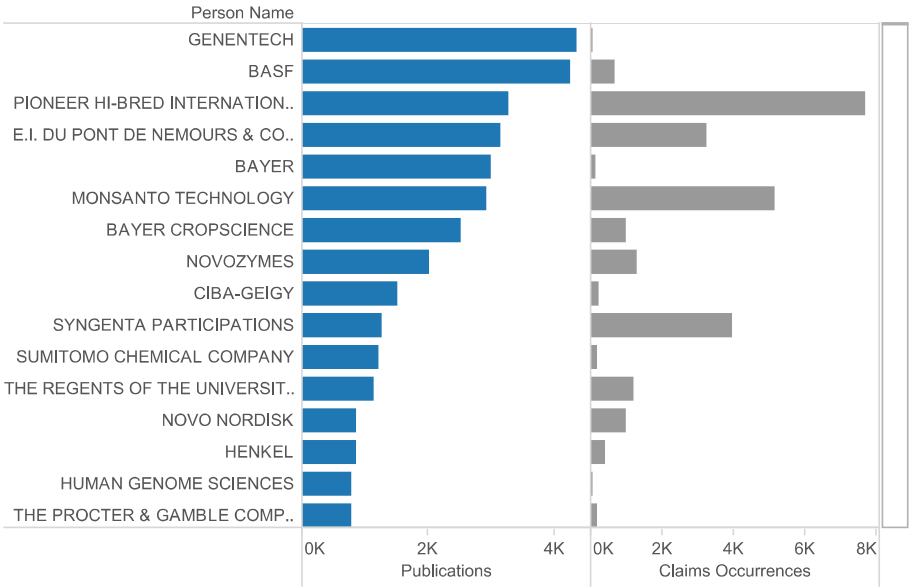
Global Trends



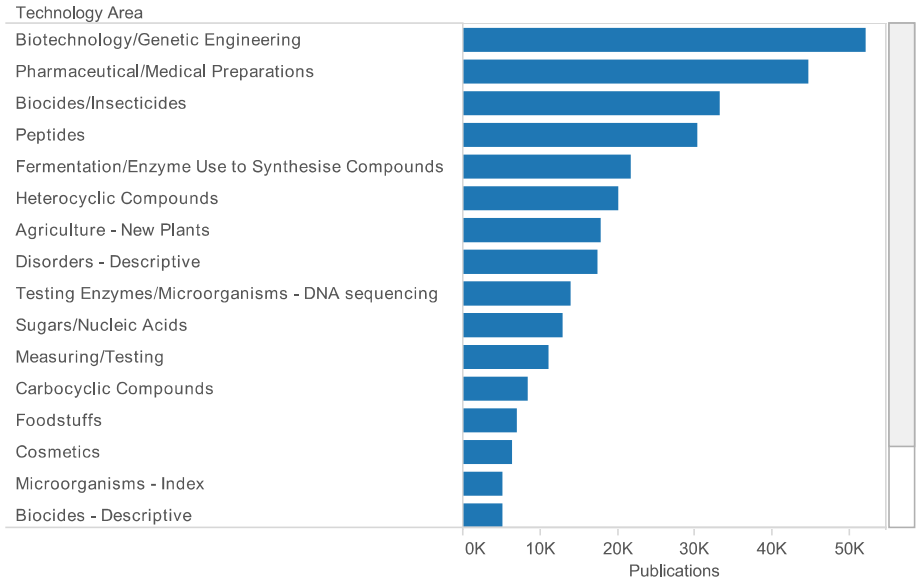
Global Species



Assignees



Global Technology Areas



The top species of relevance to Kenya 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 1,147 plant names in global data of relevance to Kenya with crops represented by species and varieties of beet (*Beta vulgaris*), soya (*Glycine max*), oilseed rape (*Brassica napus*) and tobacco (*Nicotiana tabacum*). Patent data for plants of relevance to Kenya includes frequent references to tea (*Camellia sinensis*) and coffee (*Coffea)* (not shown). Other species include the plant pathogen *Pseudomonas syringae* and strains of *Fusarium oxysporum and rice blast fungus* (*Magnaporthe griseus*). Insects are represented by *Aedes aegypti* (a mosquito vector for Yellow fever, dengue and chickungunya) along with species of tsetse fly (*Glossina*) which serve as vectors for sleeping sickness in humans and nagana in animals.

The assignees in the overall data for species of relevance to Kenya 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 pharmaceutical companies such as Mondobiotech which specialises in rare and neglected diseases such as amoebiasis, TB and leishmaniasis while the US Army is conducting research and development for leishmaniasis and plasmodium (malaria). As this makes clear there are a wide range of general and specialised technology areas and markets of relevance to biodiversity from Kenya. 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 Kenya or where distribution data suggests that Kenya is the likely source.

Species from Kenya in Patent Data:

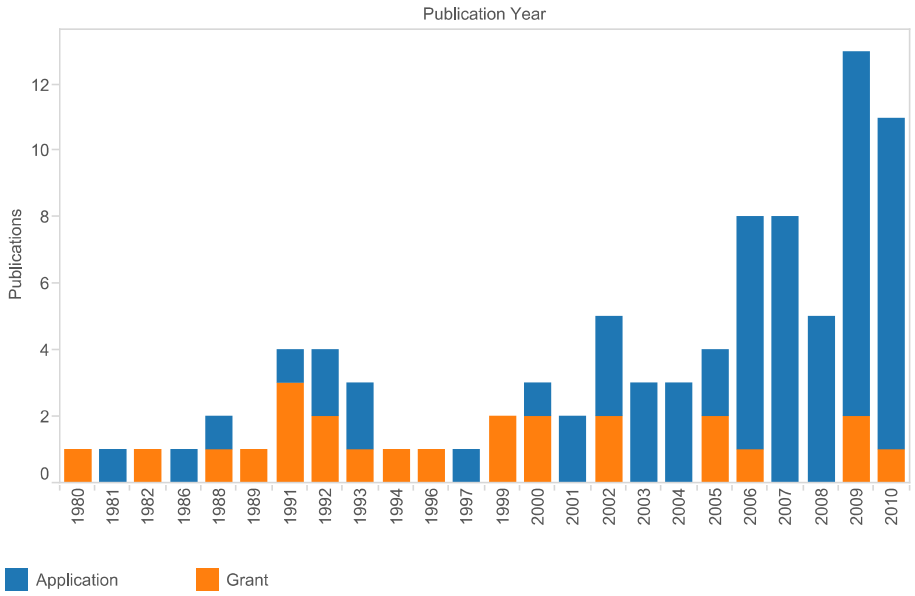
In total we identified 29 species of organisms that were directly sourced from, or potentially originate from, Kenya based on distribution data. An additional 14 species were retained as being of relevance to Kenya for a variety of reasons but are excluded from the statistics. Plate 4 displays the top species for Kenya from the 30 selected species based on a manual review of patent documents. In the next section a summary is provided for each species. Species of relevance to Kenya 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 overview provided in Plate 3. The top species is *Actinomadura kijaniata* a filamentous bacteria discovered in around 1981 in “African soil” that has been a focus of research and development in the pharmaceutical sector for anti-fungal antibiotics by Bristol Myers Squibb (i.e. US4870165A) and Schering Corp for Kijanimicin (EP33840A2). *Natrialba magadii* (also known as *Natrobacterium magadii*) is an archaeon that was originally isolated from the saline soda lake, Lake Magadi, after which it is named, in 1984 and appears in pharmaceutical and other patent applications. These include Archaeosomes for use as adjuvants in vaccines (WO2001026683A2) and the creation of stable liposomes from lipid extracts for use as adjuvants and carriers (WO1993008202A1). The emphasis placed on the use of this organism for an adjuvant is a useful reminder that patent activity in pharmaceuticals is not limited to compounds with activity but extends to carriers that enhance the effect of treatments (i.e. vaccine adjuvants).

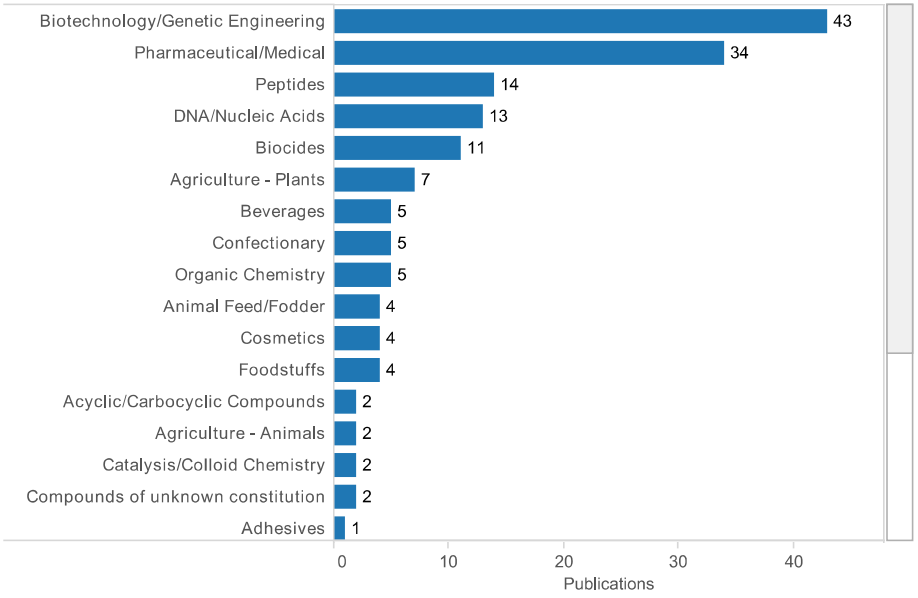
Species

Species	Kingdom	Data Type	Distribution Type	Publications
Natrialba magadii	Archaea	Distribution	Endemic	14
Actinomadura kijaniata	Bacteria	Origin & Distri..	Uncertain	13
Ganoderma simulans	Fungi	Distribution	Cosmopolitan	6
Acokanthera ouabaio	Plantae	Distribution	Cosmopolitan	5
Camellia sinensis	Plantae	Origin	Cosmopolitan	4
Impatiens uguenensis	Plantae	Distribution	Cosmopolitan	4
Natronococcus occultus	Archaea	Distribution	Endemic	4
Senecio keniodendron	Plantae	Distribution	Endemic	4
Aloe nyeriensis	Plantae	Distribution	Endemic	3
Moringa arborea	Plantae	Distribution	Endemic	3
Oreochromis spilurus	Animalia	Distribution	Cosmopolitan	3
Chrysanthemum cinerariaefolium	Plantae	Origin	Cosmopolitan	2
Gerbera aberdarica	Plantae	Distribution	Cosmopolitan	2
Monadenium rhizophorum	Plantae	Distribution	Endemic	2
Sesbania punctata	Plantae	Distribution	Cosmopolitan	2
Streptosporangium carneum	Fungi	Origin	Endemic	2
Anaerobranca bogoriae	Bacteria	Distribution	Endemic	1
Ascotricha amphitrica	Fungi	Origin	Cosmopolitan	1
Bacillus pumilus	Bacteria	Origin	Uncertain	1
Bacillus thuringiensis	Bacteria	Origin	Cosmopolitan	1
Euprosthenops sp	Animalia	Origin	Cosmopolitan	1
Halorubrum vacuolatum	Archaea	Distribution	Cosmopolitan	1
Moringa stenopetala	Plantae	Origin	Endemic	1
Phaeoramularia angolensis	Fungi	Distribution	Cosmopolitan	1
Pochonia chlamydosporia	Fungi	Origin	Cosmopolitan	1
Sesamum indicum	Plantae	Origin	Cosmopolitan	1
Trypanosoma brucei	Protista	Origin	Cosmopolitan	1
Vernonia galamensis	Plantae	Origin	Cosmopolitan	1
Zanthoxylum gilletii	Plantae	Origin	Cosmopolitan	1
Zebu cattle (Bos Taurus)	Animalia	Origin	Cosmopolitan	1

Trends



Technology Areas



Members of the genus *Glossina* (such as *Glossina fuscipes* and *Glossina brevipalpis*) appear prominently in distribution data for Kenya but are excluded from the data in Plate 4. Members of *Glossina* are typically tsetse flies and patent activity generally refers to biocides/insecticides that could potentially be applied to controlling tsetse flies. However, these species are not the direct focus of the invention and could distort the data. Another example is *Glossina brevipalpis* which is a vector for sleeping sickness (caused by *Trypanosoma brucei*). These examples serve as a reminder that research and development in patents may be relevant to neglected diseases. In addition a species may also be a host to other useful species. In the case of *Glossina brevipalpis* patent applicants make reference to an endosymbiont organism *Wigglesworthia glossinidia* as a potential rather than actual source of Phosphate acetyltransferase (PTA) involved in a method for a recombinant microorganism to produce biofuels (WO2008098227A2). In the case of *Phlebotomus duboscqqi,* a sand fly vector for leishmaniasis, patents may refer to biocides/insecticides that could be applied to this species. However, in other cases activity may refer to the isolation of genetic properties, such as a salivary gland polypeptide combined with an antigen, that can be used to prime an immune response in humans (WO2010021940A1). We include these examples in the category of other species of interest because they provide an insight into the range of possibilities for research and development that involve organisms responsible for major health problems in Kenya and other African countries.

A number of fungi are mentioned in the list. References to *Ganoderma simulans* focus on the use of a range of fungal species as a source of fish feed from fermenting fungi (i.e. WO2006119774A1), while in other cases they refer to possible medical uses of *Ganoderma* species (WO2006133707A2).

In the realm of plants, *Acokanthera ouabaio* (*Acokanthera schimperi*) is a focus of activity for pharmaceutical and medical development for conditions such as psoriasis (WO2010036973A1) and has historically been used as an arrow poison in a number of African countries. Kenyan tea (*Camellia sinensis*) appears regularly in patent documents both as a focus of experiments for new products and for new processes and methods of producing tea products. *Moringa stenopetala* (*Moringa oleifera*) is a tree that is commonly used as a food and companion plant in Kenya that appears in a patent application for extracts with anti-fungal activities (US20070264366A1). Other plants of Kenyan origin include *Vernonia galamensis* (also known as *V. pauciflora*) as a source of Vernonia oil (US20070202207A1). Of particular potential significance in tackling HIV is a traditional medicine from *Zanthozylum gillettii* which a patent applicant reports was used in a local clinical study on 20 HIV patients in Kenya (WO2004062679A1). Finally, the presence of *Chrysanthemum cinerariaefolium* reflects the importance of Chrysanthemum as a source of the natural insecticide pyrethrum. Patents in this area typically refer to Kenya as source of commercial natural pyrethrum through the Pyrethrum Board of Kenya.[2] The Pyrethrum Board was established in 1934. The website for the Pyrethrum Board estimates that up to 200,000 families in Kenya are engaged in cultivation and that cultivation does not require chemical inputs.

Other species of interest of direct origin from Kenya reveal the diversity of organisms that may become a focus of research and development. *Anaerobranca bogoriae* is a thermophilic bacteria named after Lake Borogi which appears in a patent application for

[2] http://www.kenya-pyrethrum.com/ . Recent press coverage in Kenya in 2013 has highlighted issues with management of the Board.

preventing retrodegradation of starch (WO2003002728A2). *Euprosthenops sp* is a genus of spider that appears in a patent application by the University of York in the UK which states that: “Adult Euprosthenops spiders were captured in Kenya and maintained under laboratory conditions in clear Perspex boxes.” The spiders then became the focus of research and development to identify a polypeptide involved in the formation of spider silk (WO2004016651A2). Finally, in the case of animals, the milk of Zebu cattle (*Bos taurus*) has been a focus of research and development using comparative analysis of different milk types to identify a milk product that is free of Beta casein A that can stimulate an immune response and minimise or reduce the onset of disease (US20020007497A1).

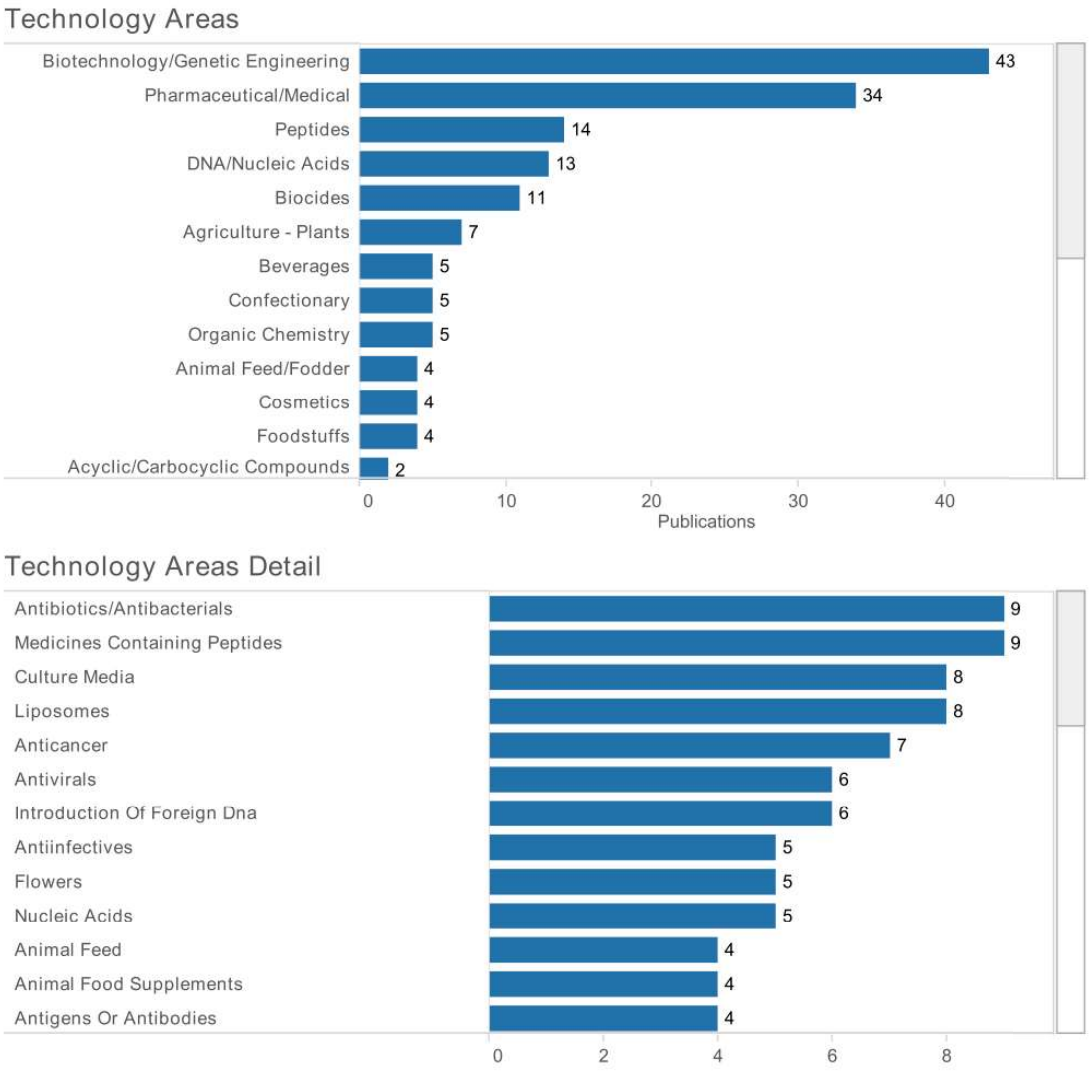
Full details of the species identified in the research are provided in the final section of this report. In considering this data we would note that while species endemic to Kenya merit close attention, cosmopolitan species such as members of the genus *Moringa*, *Vernonia* and *Zanthozylum*, that are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

Kenya 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 Kenya.

Technology Areas:

Table 2 provides a brief summary of the technology areas involved in patent activity for Kenya and is followed by a more detailed breakout of activity.

Table 2: Technology Areas



The general overview of technology areas provided in Plate 3 emphasised biotechnology and pharmaceuticals. The narrower dataset that focuses on species from, or likely to originate from, Kenya repeats this pattern.

Patent activity for pharmaceutical preparations involves species such as the cosmopolitan *Acokanthera ouabaio* (*Acokanthera schimperi*) which has traditionally had a range of uses including as an arrow poison. Other relevant species include *Natrialba magadii* (*Natronobacterium magadii*) and *Actinomadura kijaniata* discussed above and *Senecio keniodendron*, a plant found in the valleys and along the ridges of Mount Kenya, which is

mentioned as a potential source of superoxide dismutase for use in cosmetic, pharmaceutical and food compositions. The latter example provides a clue to potential use rather than an actual claimed use of the species (i.e. US7037697B2). The use of species as sources of enzymes for detergents is represented by *Spirochaeta africana,* a cosmopolitan bacteria found in alkali lakes. *Natrialaba magadii*/*Natronbacterium magadii* also fall into the realm of adhesives for a patent application for a molecular glue from a protein from the flagella of archaea. Finally, *Bacillus pumilis*, a bacteria isolated from an alkaline soda lake in Kenya, appears in patent activity for alkali tolerant xylanases (enzymes) for use in the pulp and paper industry (not shown). A breakout of technology areas for a sample of species is provided in Table 3.

Table 3: Species and Technology Areas

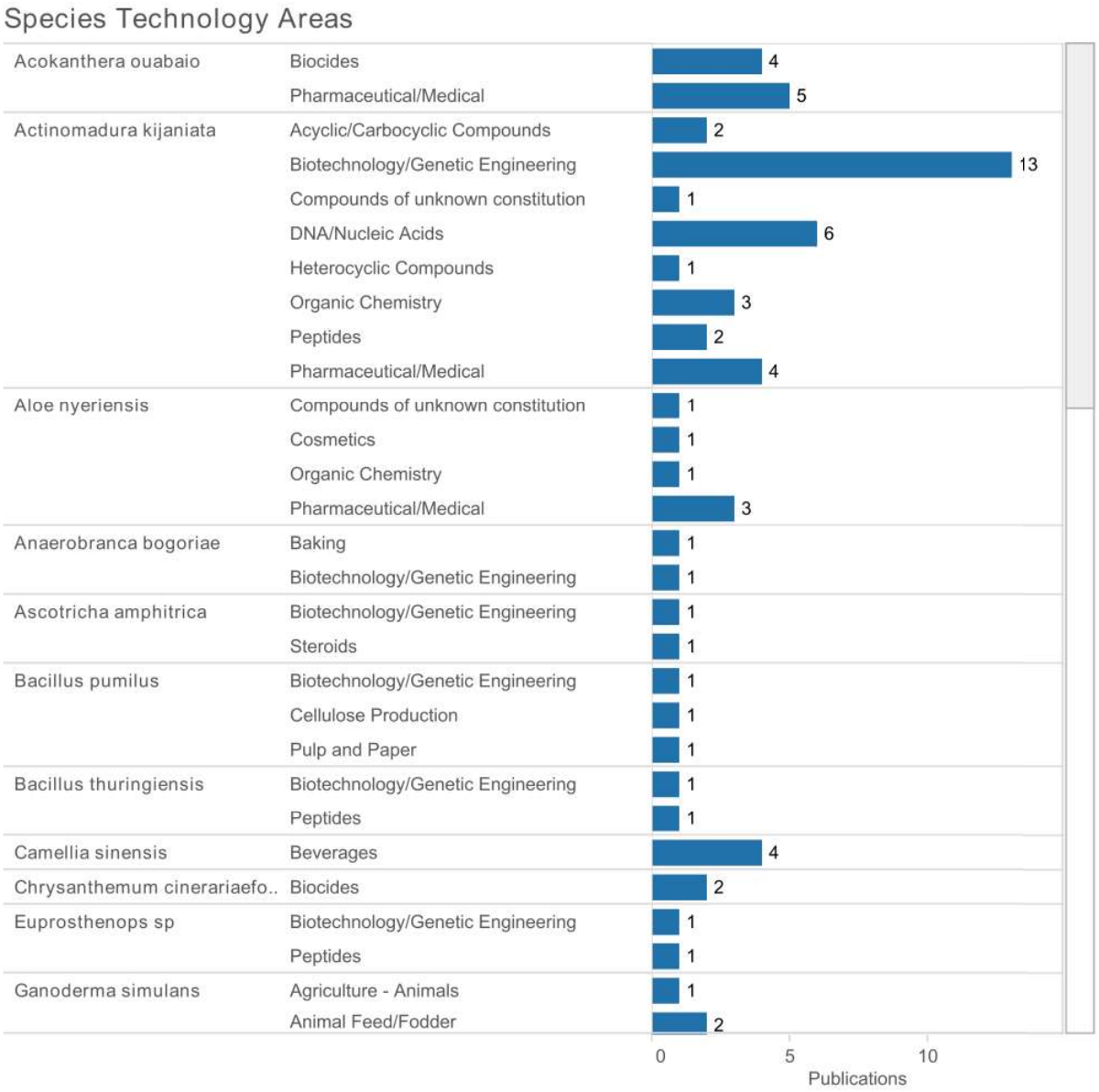


Table 3 usefully reveals the range of potential applications and technology areas where a species and its components may be deployed. As such a species may be a focus of activity for a range of different products and markets. However, in the case of threatened species there will be a need for careful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

a) Compositions of matter;
b) Methods or processes;
c) Machines;

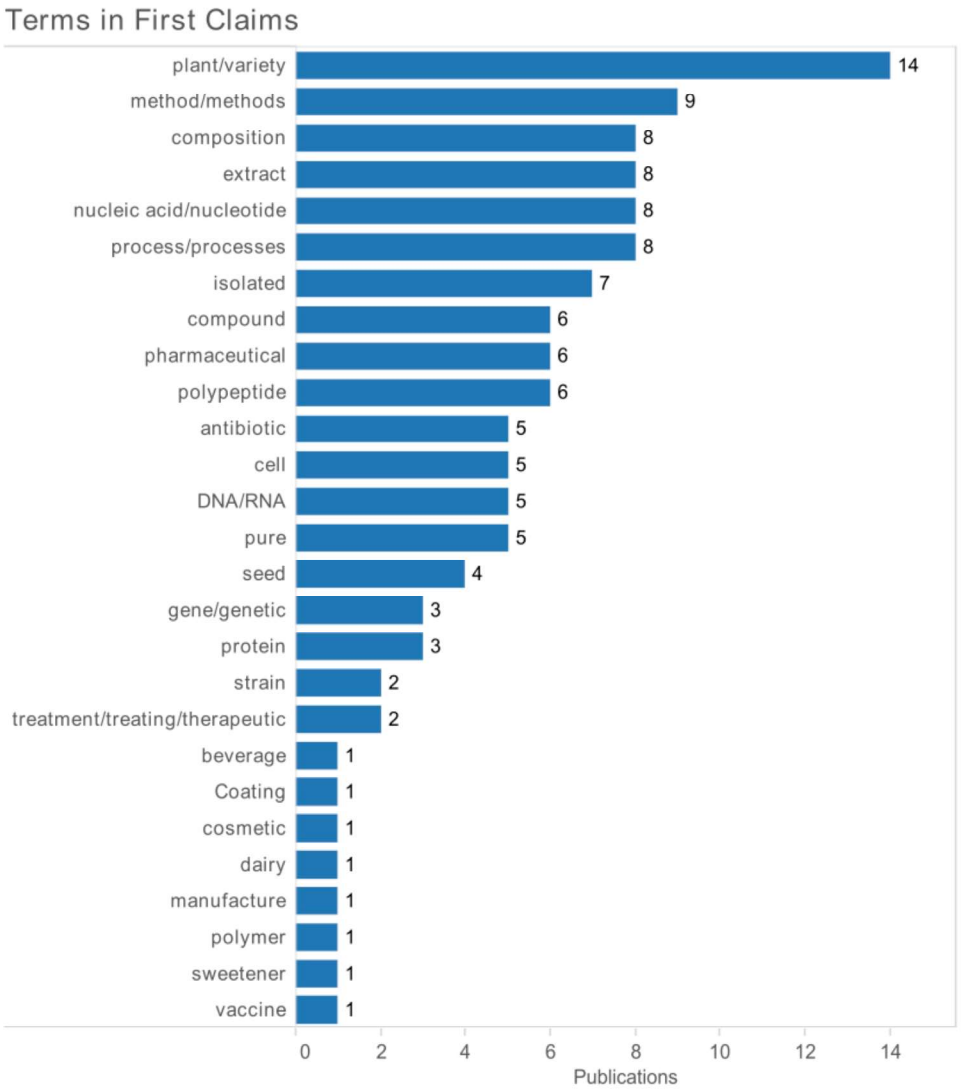
In some jurisdictions claims may be permitted for new plant varieties either under standard patent legislation or under specific legislation (i.e. US Plant Patents).

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

Table 4 reveals that the top category of patent claims reference plants or plant varieties These can encompass a variety of claimed inventions. For example, a nutraceutical composition from components of *Moringa* plants claims “A method of making a nutraceutical composition from components of the Moringa plant species comprising: processing portions of a Moringa plant; processing at least a portion of the seeds from the fruit of a Moringa plant; processing at least a portion of the fruit from the Moringa; and combining at least two of the said portions with at least one fruit or vegetable component to form a mixture” (US20060222682A1). In contrast, the Pan America Seed Company claims a “Bicolor impatiens” as “An Impatiens walleriana plant that has flowers comprising bicolor petals, wherein each petal exhibits the stardust trait, which is a color pattern characterized by (a) a white central area, (b) a pigmented petal border, and (c) a transition zone located between said central area and said pigment border, wherein said transition zone comprises graded pigment stippling, and said stardust trait is controlled by a single recessive gene” (US5986188A). As this makes clear claims to plants and plant varieties 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 a Patent Cooperation Treaty application submitted by an individual inventor relating to the cosmopolitan species *Zanthoxylum gilletii* for treating AIDs. The first claim of this application reads as follows:

1. "Use of a composition comprising:-an extract of a plant from the Zanthoxylum genus or, - at least one active substance contained in said extract, for the manufacture of a medicament for the treatment or prevention of at least one disease selected in the group consisting of viral diseases and opportunistic pathologies related to a viral disease." (WO2004062679A1)

This type of claim, where granted, is likely to prove to be a problem because it refers to the use of an extract, or active substance thereof, of *any* member of the genus *Zanthoxylum* to manufacture a treatment or preventative preparation for a selection of diseases. As of 2010 this application does not appear to be proceeding. However, it illustrates the type of problem that can emerge in broadly constructed composition of matter claims. We discuss this 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, in connection with tea, the Unilever Group claims "A process comprising the steps of: (i) harvesting a source of tea plant material comprising stem and leaf material;(ii) physically separating the stem material from the leaf material to provide a tea plant source rich in stem;(iii) treating the stem source with at least one conventional tea processing unit operation selected from withering, maceration, grinding, fermentation and firing" (US20080107774A1). 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 Unilever Group application ends with the following claim "A black tea according to claim 14, which comprises essentially 100% stem material." The same component or product created using a different process would not logically fall within the scope of this type of patent.

Finally, one feature of patent activity involving species that originate from, or are distributed in, Kenya 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 Kenya. 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 *Zanthoxylum gilletii* 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.[3]

Global Impacts and Global Markets:

We have seen above that a range of species are involved in patent activity of relevance to Kenya. 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 Kenya. 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 (i.e. *Thermus aquaticus* in biotechnology). 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 Kenya Table 5 reveals a selection of citation scores for species of relevance to Kenya organised by species and assignee. The top cited species receives 89 citations in 4 documents from IDEA AG involving *Acokanthera ouabaio* for a "Preparation for the application of agents in mini-droplets" consisting of a method for transferring a pharmaceutical through the skin using transferosomes made of lipids and surfactants (US6165500A).[4] The National Research Council of Canada receives a total of 78 citations for a set of 5 documents involving *Natrialba magadii*/ (*Natronobacterium magadii*) such as an application for Archaeosomes as adjuvants and carriers for Acellular Vaccines (i.e.WO2001026683A2). In addition the species is referenced in a highly cited patent from the National Research Council of Canada for the formation of stable lipid extracts from Archaeobacteria (WO1993008202A1). These patents make reference to multiple species of archaeobacteria.

Bristol Myers Squibb receives 26 citations for 7 applications referencing *Actinomadura kijaniata* in anti-fungal antibiotics. However, the top cited patent in this group refers to an antibiotic from a strain of *Actinomadura hibisca* that is similar to other members of the genus including *A. kijaniata* rather than *A. kijaniata*. As such patent activity may provide an indicator of the potential uses of a species even where it does not directly utilise the species.

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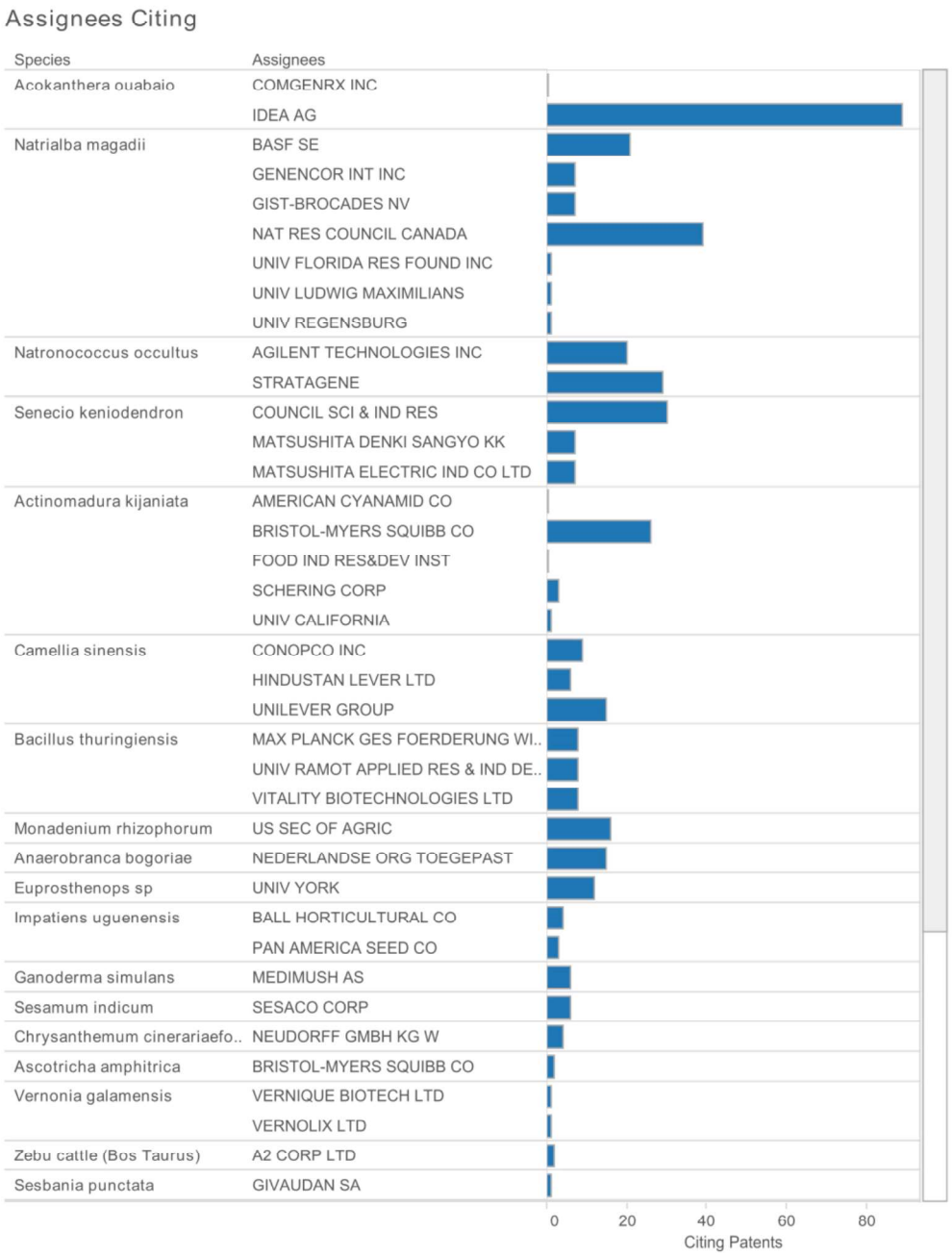
[3] http://www.wipo.int/patentscope/en/programs/patent_landscapes/

[4] Table 5 aggregates the patent scores by species and assignee. If an assignee has four documents with citations involving the species, the numbers are aggregated to arrive at the total.

Table 5: Species and Assignee Citing Patents



In some cases the potential uses of a species may be surprising. For example patent application WO2008098227A2 is concerned with biofuel production using recombinant microorganisms. This application is surprising because it makes reference to a tsetse fly (*Glossina brevipalpis)*. However, in practice the patent refers to *Wigglesworthia glossinidia*, an endosymbiont of *Glossina brevipalpis*, as a potential, as opposed to actual, source of Phosphate acetyltransferase (PTA) involved in a method for a recombinant microorganism to produce biofuels. This example usefully highlights that pestilential organisms may possess, or serve as hosts for, unexpected useful properties (see the Other Species section below). Finally, a patent application relating to a spider silk polypeptide from

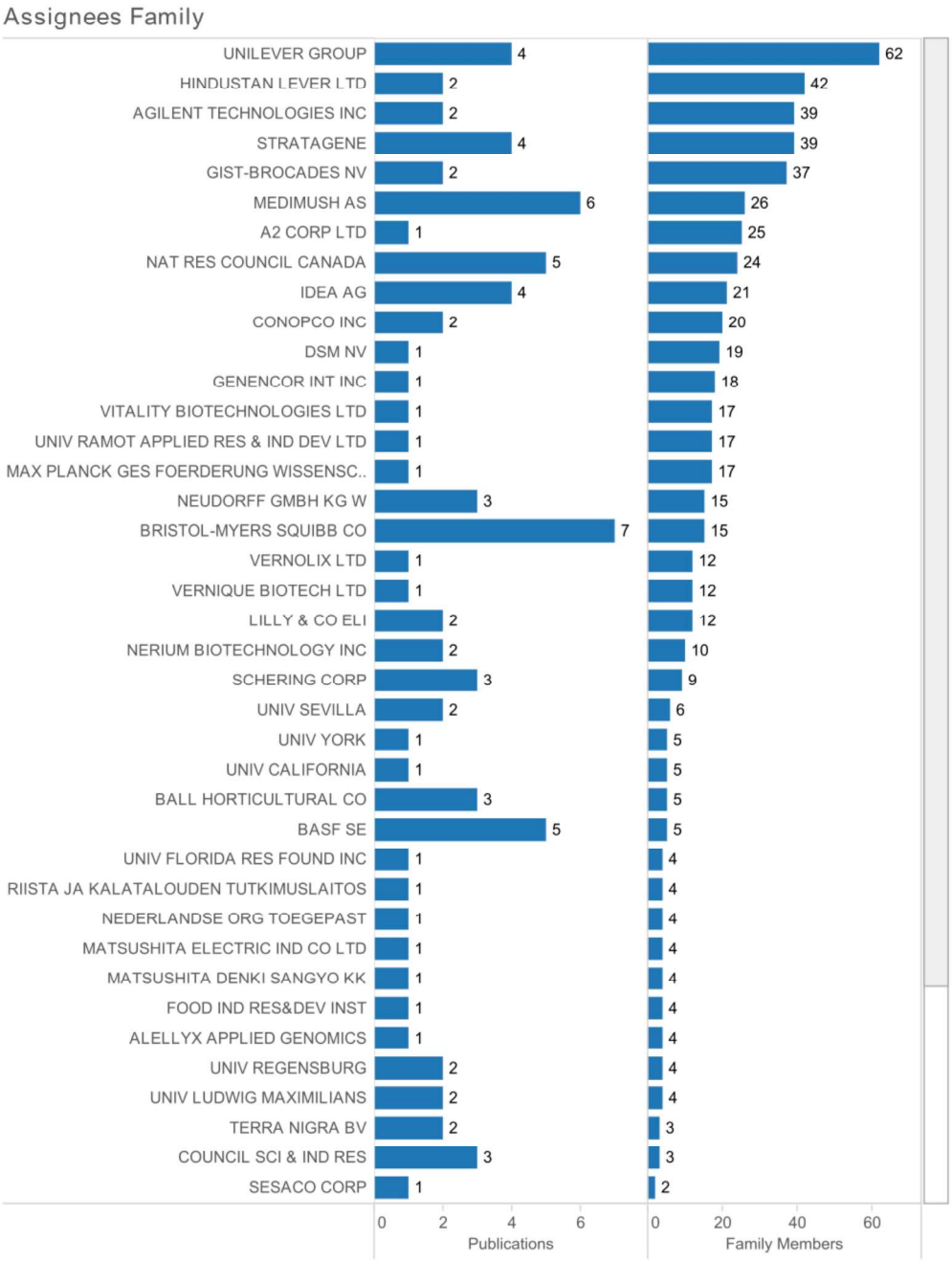
Euprosthenops sp was not ultimately granted but has received 12 citations including a patent grant to Spiber Technologies in Sweden for spider silk proteins from *Euprosthenops australis* which, while not recorded as occurring in Kenya by GBIF but is recorded as occurring in Namibia with the patent applicant stating a source of collection in South Africa (see US8278416B1). This example reveals that citation data can provide a route into the identification of other examples of relevance to Kenya and countries in the Africa region.

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.[5] 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 the Unilever group mainly focuses on processes for black tea manufacture using a mechanical process (WO2002069727A2) and a process for producing theaflavins. The latter patents involved flying Kenya Clone 35 tea from Kenya to the UK (US20080131558A1, WO2008065007A2). Patents within the Unilever Group involving tea do not involve direct research on the genetic properties of tea, but typically involve mechanical and other processes to create new products. The second ranked family member from Agilent Technology & Stratagene includes a reference to *Natronococcus occultus*, an extremophile isolated from Lake Magadi, in patents relating to reverse transcription polymerases and the synthesis of cDNA. In both cases the species is included in long lists of extremely thermophilic organisms. As such, this example provides an indicator of the potential uses and importance of such organisms in innovation.

[5] INPADOC stands for the International Patent Documentation Centre which established the system. INPADOC is now part of the European Patent Office.

Table 6: Patent Assignees and Patent Families



Patent activity by GIST-BROCADES in conjunction with DSM NV focuses on Alkali Tolerant Xylanases for use in detergents from *Bacillus pumilus* isolated from an alkaline soda lake in Kenya and possesses 19 family members. In conjunction with Genencor, this applicant also submitted an application focusing on detergents utilizing enzymes from *Natrialba magadii* isolated from Lake Magadi which has generated 18 family members around the world.

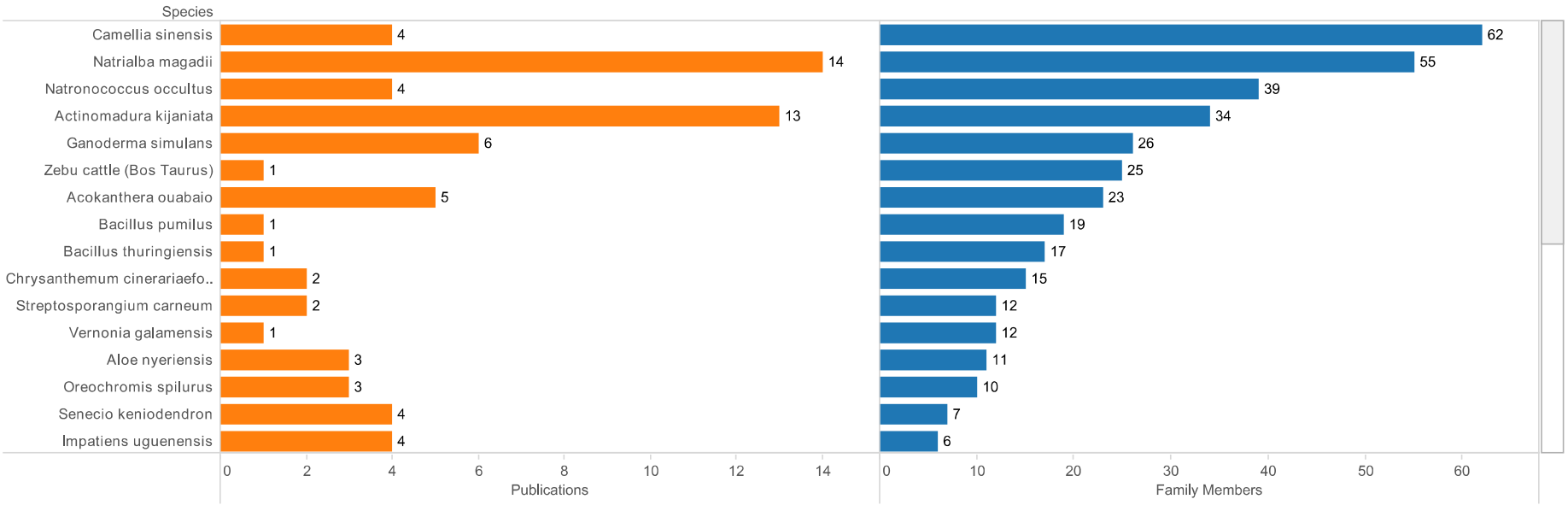
As this makes clear, while care is required in analysing why a particular species is referenced in a patent document, it is possible to trace the economic importance of particular patents to patent applicants using patent family data.

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.

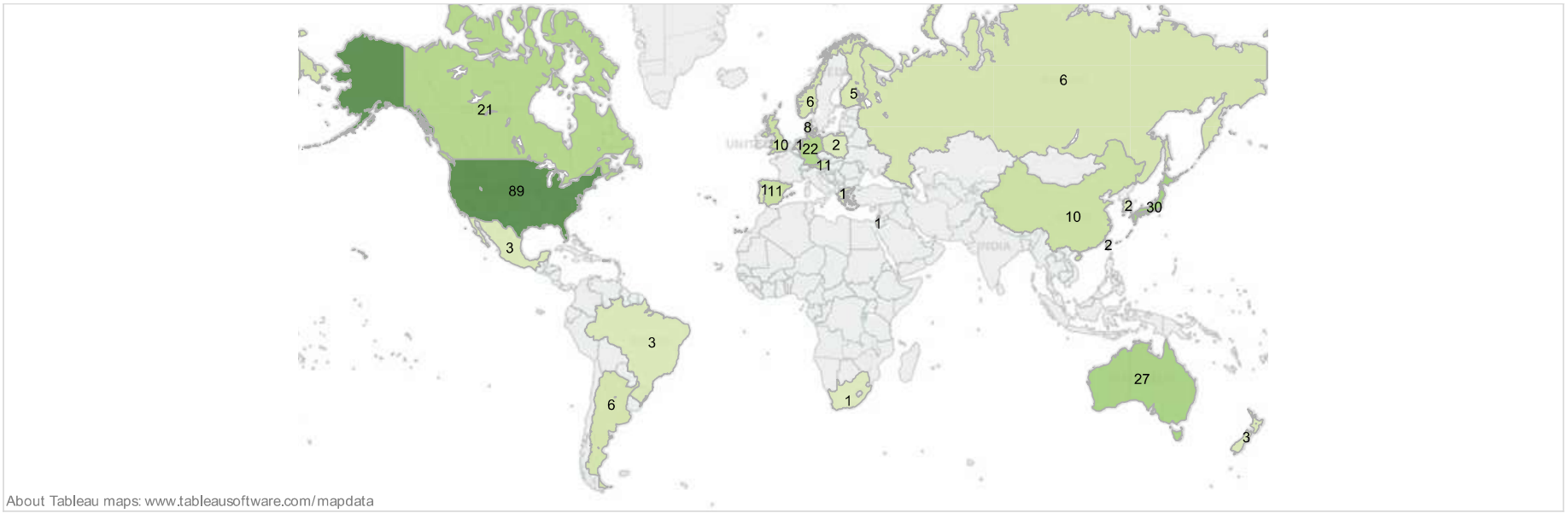
Plate 5 displays patent family data by species and a global map of countries where family members linked to the species have been recorded. Please note that the map does not display the geographical locations for regional and international patent offices. Plate 5 is useful because it reveals what might be called the global reach or careers of species. We can immediately see the prominence of *Camellia sinensis*, *Natrialba magadii* and *Natronococcus occultus* along with *Actinomadura kijaniata* 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, both China and Brazil are also emerging into this landscape. It is also striking that available data suggests that patent applicants are not pursuing protection in Kenya or other African countries with the limited exception of South Africa. This suggests that opportunities may exist within internal markets in Africa 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 Kenya.

Species Family Members



Family Countries



Concluding Remarks:

Of the Africa countries covered to date in this series of reports, Kenya has proven to be among the most challenging. The reason for this is that there are large numbers of documents that make reference to Kenya and a significant number of patent documents that make reference to Kenya and a species occurring in Kenya. In a significant number of cases these documents refer to pathogens, insect vectors such as tsetse fly or sandflies, or to major products such as tea or coffee. Furthermore, our research has revealed that a species of relevance to Kenya may appear in a patent document for a wide range of reasons where the species may not be the focus of the actual invention. For this reason we include a section on “Other species” at the end of the species summary section below.

The purpose of this report has been to highlight the existing and potential role of species of relevance to Kenya 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 Kenya or where distribution data suggests that Kenya is a likely source.

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