Biodiversity in the Patent System: Senegal

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

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Introduction

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

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

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 Senegal. 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 Senegal as a basis for further research.

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

Senegal

Area:
196,722 sq. km
Coastline:
531km
Climate:
Tropical; hot, humid; rainy season (May to November) has strong southeast winds; dry season (December to April) dominated by hot, dry, Harmattan wind
Geography:
Generally low, rolling, plains rising to foothills in southeast.
Senegal has a number of vegetation zones: Sahel, tropical rainforest and mangroves. Most of the southern arm of the country is classed as being of the Guinean forest-savanna mosaic.

Biodiversity in Senegal 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 of species across time and space presently available. All data is submitted by participating public collections around the world who share biodiversity information.

Using this resource we have obtained biodiversity records for species which occur in Senegal. 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 5,988 species for Senegal and 12,729 georeferenced records of the locations where these species occur in Madagascar.[1]

We identified a total of 127,971 documents containing species known to be distributed in Senegal. Of these, 532 made some form of reference to Senegal. These documents were manually reviewed in MaxQDA qualitative data analysis and tagging software to identify documents specifying a source or origin in Senegal.

The 532 documents that made a specific reference to Senegal contained 1,489 species. 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 Senegal.

In addition, using GBIF distribution data we identified 18 species where GBIF presently records distribution only in Senegal. These species appeared in 987 patent documents

[1] In total 6,327 species names were recorded for Senegal in GBIF including synonyms. These species are then compiled onto accepted scientific names.

where Senegal 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 Senegal and thus be regarded as a species of likely or potential significance for Senegal. For the sake of simplicity we call data where Senegal was specifically mentioned along with a species “Origin” data. We call data identified based only on distribution information “Distribution.” Based on further research we sought to establish whether an identified species was endemic to Senegal (Endemic) or known to be distributed in multiple countries (Cosmopolitan).

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 Senegal 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. The lower map also includes the location of the Niokola Koba National Park, a statutory conservation site which can be 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 Senegal (upper map) and major settlements and roads (lower map) (map courtesy of Bing Maps). Each colour point represents a taxonomic kingdom for a given record.

It is very interesting to compare the two maps. The distribution map shows that records are not uniformly dispersed across the country. The larger part of the country to the north and east is very poorly recorded. Most of the records come from the coastal regions and particularly in the area of Dakar and Kaolack, the most populous cities. There are significant records of marine species in the area of Dakar and along the coast north of that city. There are a number of marine protected areas along the Senegalese coast which reflects both the biodiversity of the seas along the West African coast and the threats to that diversity (through overfishing for example, as the West African coast is one of the most economically important fisheries in the world). In the south of the country, which is a part of the Guinean forest savanna mosaic, is the Niokolo Koba National Park. There is a notable increase in the density of records at this location. Another feature of these mapped distribution records are the strings of data points which cross the country. It can be seen that the strings of data points follow closely the routes of major roads. This pattern of record locations suggest that there are practical restrictions which have prevented collection of data across a broader geographical range. This in turn leads to the likelihood that biodiversity records for Senegal are far from comprehensive in describing the fauna and flora of the country.

GBIF presently records 6,327 species names known to be present in Senegal. This list is dominated by plants and animals which account for almost 6,000, as can be seen in Table 1.

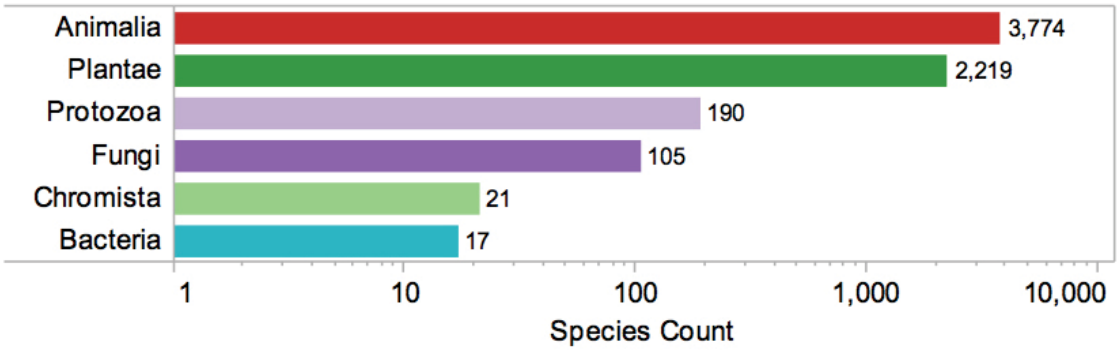

Table 1: Showing the number of species in Senegal by kingdom using GBIF data.

Using global data it is possible to examine the wider distribution of Senegalese 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 Senegal and is segmented by kingdom. It can be seen that a small number of species have a very wide global distribution (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). It can also be seen that many species are pan-sub-Saharan African in range, particularly across the Sahel in western Africa.

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

Senegal in the Patent System

As of 2013 there were 2,541 patent documents in the main patent jurisdictions (European Patent Office, the United States, and the Patent Cooperation Treaty) that specifically mention Senegal.[2] This provides a general overview of references to Senegal in the patent system across all areas of invention. Only a proportion of these documents will refer to species collected in, or sourced from, Senegal. In addition, patent applicants will make reference to species that originate from Senegal but will not mention Senegal 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 Senegal. We focus on patent activity at the main patent offices in the period between 1976 and 2010. We then examine the results of research to identify genetic resources and traditional knowledge that originate from Senegal. In approaching patent activity for genetic resources from Senegal we focus on three categories of data.

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

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

Biodiversity in Senegal in the Global Patent System

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

In total we identified approximately 5,445 species in patent data from the major jurisdictions that are known to occur in Senegal.[3] This data is relevant for Senegal because it demonstrates that researchers and companies are conducting research and development on species that are known to occur in Senegal. 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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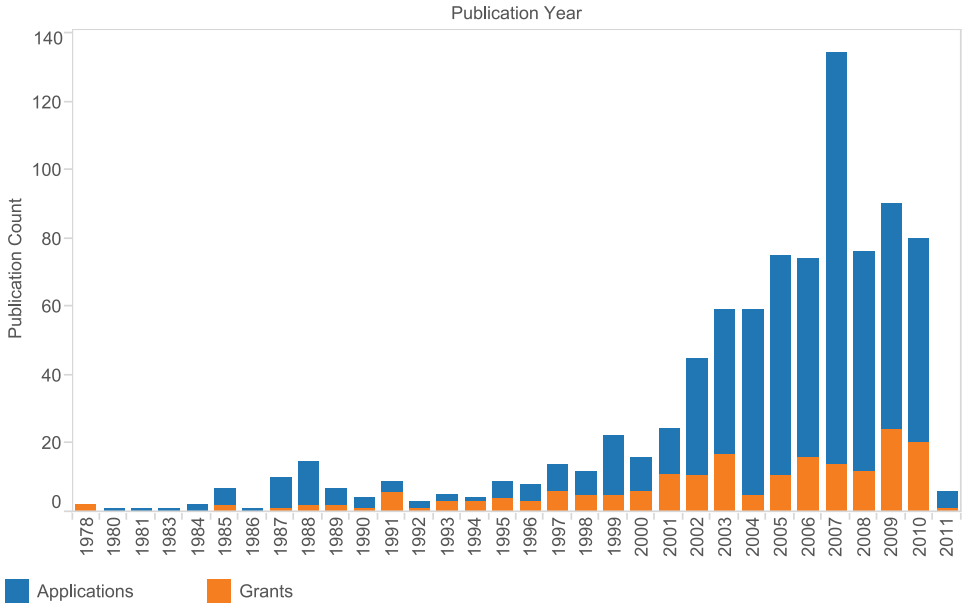
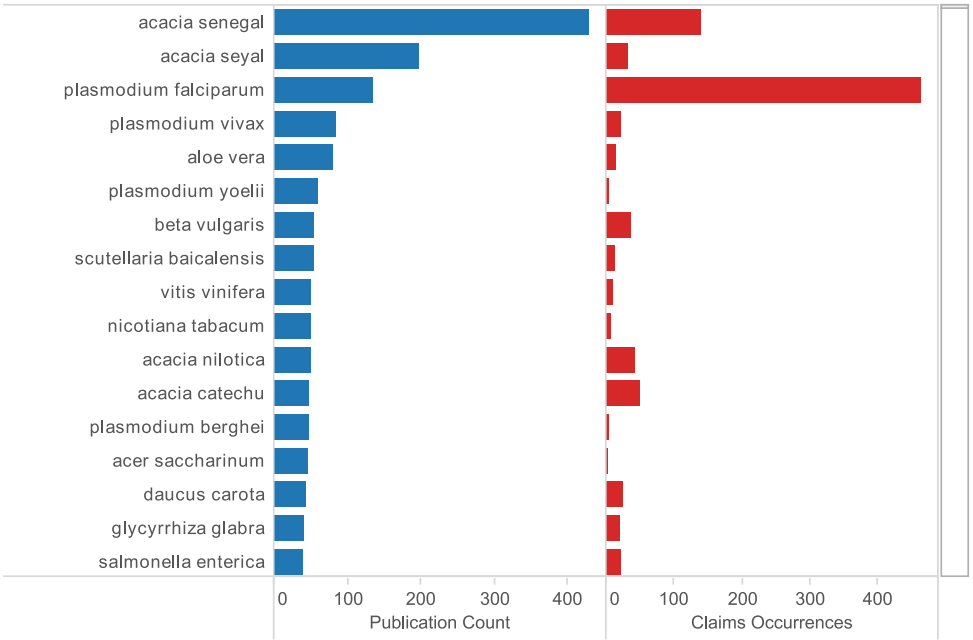
[2] Source: Thomson Innovation.

[3] In total we identified 5,515 species in the data. The 5,445 figure excludes common model organisms such as E. coli and Arabidopsis thaliana that are globally distributed and are used as research tools in biotechnology. These species appear prominently in patent data for all countries.

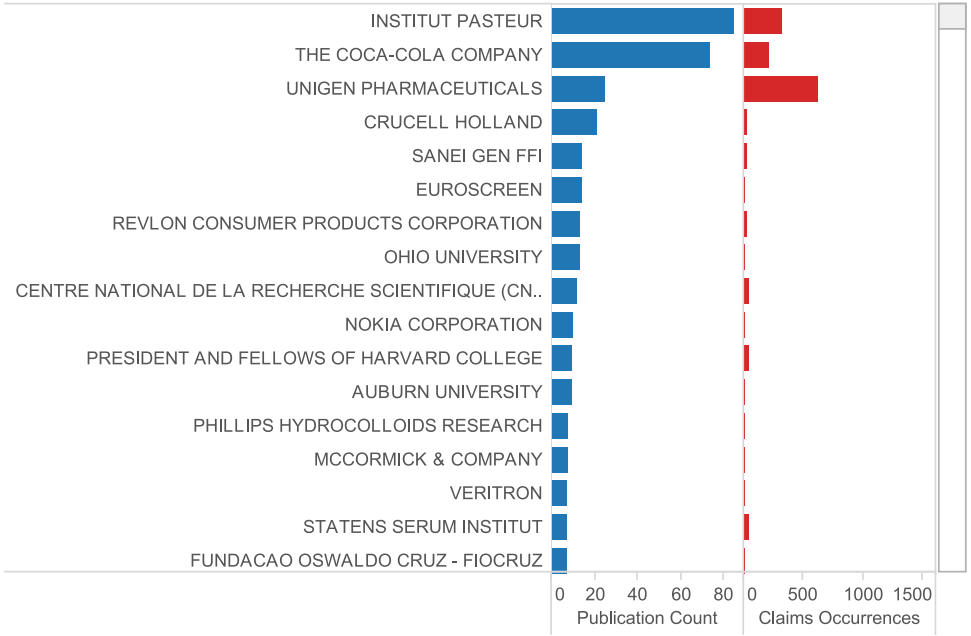
Trends



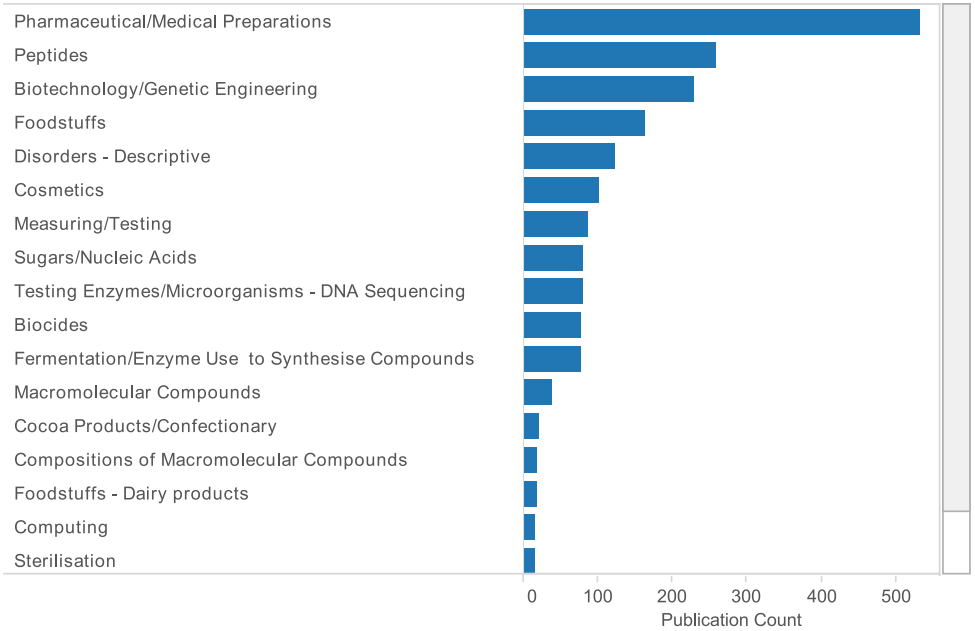
Species



Assignees



Technology Areas



The top species in patent activity of relevance to Senegal include *Acacia senegal* (a synonym for *Acacia galpinii*) and *Acacia seyal*. These two acacias are followed by *Plasmodium falciparum*, *P. vivax* and *P. yoelii* (malaria parasites). Two other species of note include *Aloe vera* (commonly used in cosmetics and other products) and *Scutellaria baicalensis* which is used in Chinese traditional medicine. As this brief list suggests, patent activity typically targets pathogens such as *Plasmodium* malaria parasites. In addition we observe important species with a range of uses such as *Aloe*, *Scutellaria*, *Vitis vinifera* (grape) and *Nicotiana tabacum* (tobacco plant).

The overview of patent applicants (assignees) reveals that top assignees include the Institute Pasteur and the Coca Cola company. In the case of the Institute Pasteur this is almost entirely attributable to their research and development on malaria (notably *Plasmodium falciparum*), viruses and bacteria. In the case of the Coca Cola company this reflects activity around *Acacia senegal* (*A. galpinii*) and *Acacia seyal*. As this makes clear, species may appear in the portfolios of different organizations for a variety of reasons.

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 Senegal or where distribution data suggests that Senegal is the likely source.

Species from Senegal in Patent Data

In total we identified 18 species of organisms that were directly sourced from, or potentially originate from, Senegal based on distribution data. Plate 4 displays the top species for Senegal that appear in patent data based on a manual review of patent documents. In the next section a summary is provided for each 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 patent data. With only two exceptions these species were identified in Distribution data and follow on research rather than through specific reference to the collection or sourcing of the species in Senegal.

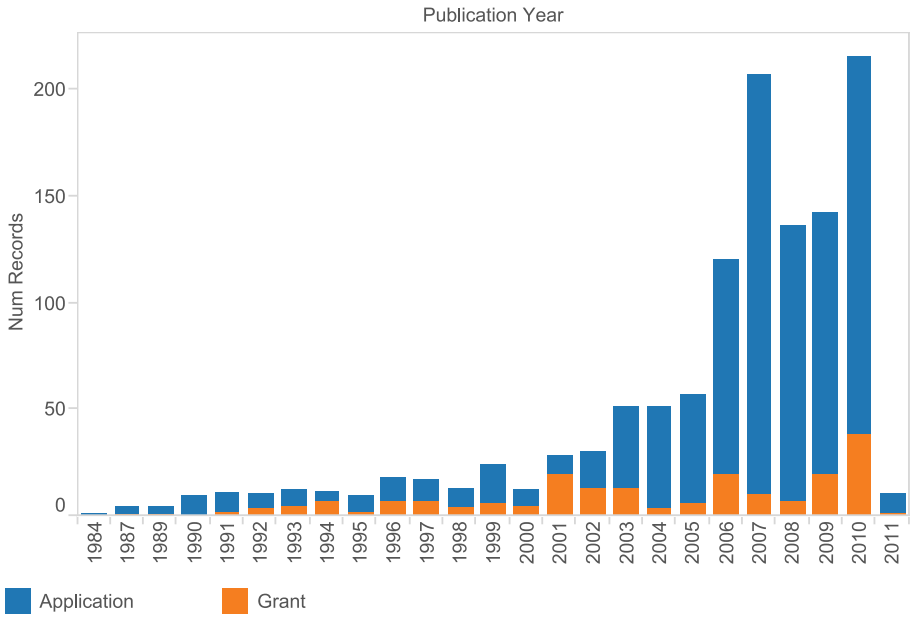
Balanites aegyptiaca is found in much of the Sahel-Savannah region of Africa and is a common tree in Senegal. It is the source of desert date with other parts of the tree reportedly used during famines. The fruit is used in traditional medicines and the bark is reported to have insecticidal and anti-parasitic properties in addition to use as an arrow poison. This species therefore has a wide range of potential uses. Patent activity making reference to Senegal in the main jurisdictions until 2010 was limited to 2 documents from Ben-Gurion University in Israel focusing on the identification and use of saponin compounds from the species (US20080287662A1, WO2006137069A2). The claimed potential uses of components of this species include pesticidal compositions, a method of controlling the growth of mosquito larvae, skin care and cosmetic products and an agrochemical among other potential products. However, no patent grant is presently recorded for these applications. Nevertheless, this is clearly an important species in Senegal and elsewhere in Africa. This is reflected in a wider portfolio of patent documents for this species consisting of 75 documents in the period to 2013.

Species

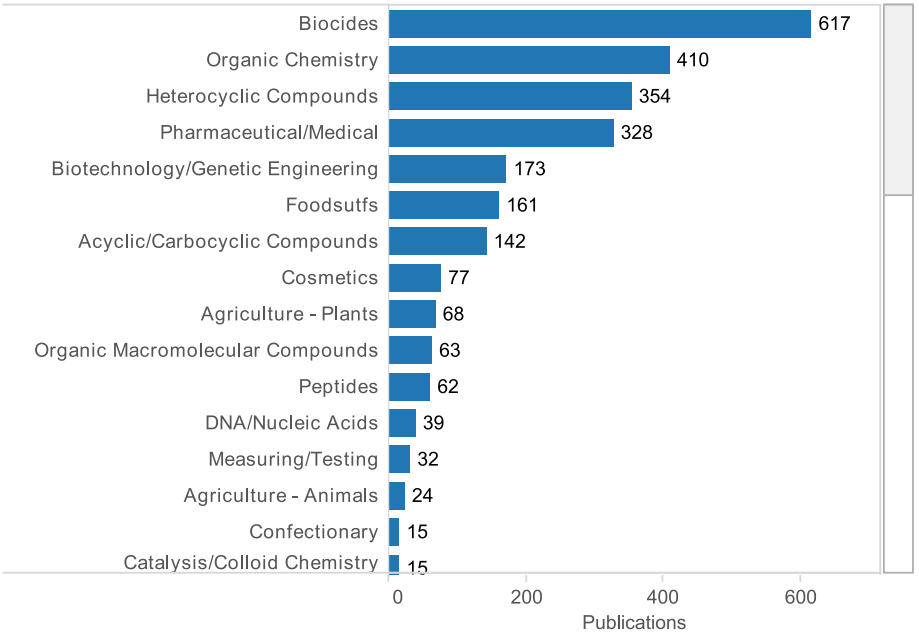
Species	Kingdom	Data Type	Distribution	
Cordylobia anthropophaga	animalia	Distribution	Cosmopolitan	598
Acacia senegal	plantae	Distribution	Cosmopolitan	429
Sinorhizobium saheli	bacteria	Distribution	Cosmopolitan	59
Rhizobium undicola	bacteria	Distribution	Cosmopolitan	58
Mycobacterium senegalense	bacteria	Distribution	Cosmopolitan	54
Leptosphaeria senegalensis	fungi	Distribution	Uncertain	24
Sinorhizobium terangae	bacteria	Distribution	Cosmopolitan	17
Allorhizobium undicola	bacteria	Distribution	Uncertain	14
Clostridium thermopalmarium	bacteria	Distribution	Uncertain	14
Hyalomma rufipes	animalia	Distribution	Cosmopolitan	6
Desulfohalobium retbaense	bacteria	Distribution	Uncertain	4
Leptosphaeria thompkinsii	fungi	Distribution	Cosmopolitan	3
Balanites aegyptiaca	plantae	Origin	Cosmopolitan	2
Callosobruchus subinnotatus	animalia	Distribution	Cosmopolitan	2
Halanaerobium saccharolytic..	bacteria	Distribution	Cosmopolitan	2
Merluccius polli	animalia	Distribution	Cosmopolitan	2
Aframomum melegueta	plantae	Origin	Cosmopolitan	1
Holarrhena floribunda	plantae	Distribution	Cosmopolitan	1

0 500
Publications

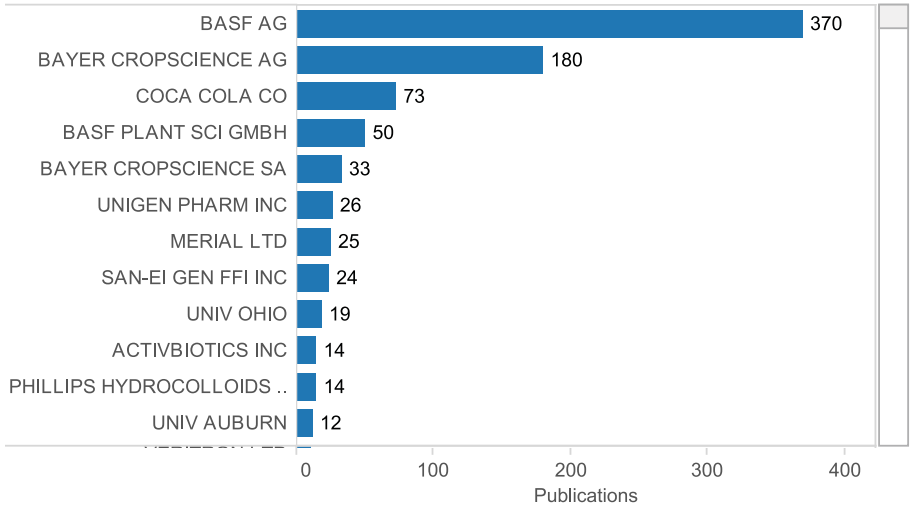
Trends



Technology Areas



Assignees



A second species originating from Senegal is *Aframomum melegueta*. This species is known variously as Grains of Paradise and Guinea pepper and was historically traded across the Sahara to Europe in the 14th and 15th Centuries before falling into disuse. Today, the species is used in meals as an alternative to pepper and is used in beers such as speciality beers produced by Samuel Adams in the United States and specialist gins. As such it occupies a niche in both the food and beverage industries. In 1998 Peya Biotech submitted an international patent application for "Aframomum Seeds for Improving Penile Activity" for use in combination with an alcoholic drink (WO2000035466A1). Once again no patent grant has been observed for this claimed invention. Instead, the data provides a useful indication that a species has potential for economic development. This is reflected in a wider portfolio of patent documents for this species consisting of 174 records in the period to mid-2013.

A third species of interest is *Desulfohalobium retbaense*. This species is an anaerobic sulfate-reducing Gram negative bacterium. The scientific literature reveals that this was isolated from the sediment of the pink hypersaline Lake Retba in Senegal.[4] In 2005 Luca Technologies submitted patent applications at the US Patent Office and under the Patent Cooperation Treaty (US20080182318A1,WO2009088760A1) The patent applications focus on creating materials with "enhanced hydrogen content from anaerobic microbial consortia including desulfuromonas or clostridia". The patent application actually focuses on using microbial consortia to transform carbonaceous materials in geological formations into molecular hydrogen that could then become the basis for fuel. *Desulfohalobium retbaense* is mentioned as one in a list of *Desulfohalobium* that it is claimed could be used for this purpose. As such the applications refer to the potential use of a species that is known to have been first isolated in Senegal rather than its actual use to address energy needs. The wider portfolio of patent documents for this species totals 8 documents in the period to 2013.

A fourth species of interest is *Holarrhena africana*, a shrub that is native to much of West Africa. This species has been a focus of patent activity for steroidal compounds to inhibit melanogenesis and skin pigmentation by Skinmedica Inc and the University of New York School of Medicine (US20100040568A1). The wider portfolio of patent documents in the period to 2013 consists of 3 documents, suggesting that, to date, this species has been a limited focus of research and development.

Finally, two species stand out at the top of the data for Senegal. The first is *Cordylobia anthropophaga*, a blow fly known as the Mango fly or Tumbu fly which causes Myiasis in large mammals including humans in Africa. Myiasis is a neglected disease and patent activity may potentially highlight possible approaches to addressing problems caused by the Tumbu fly that have not previously been considered within countries affected. In considering pathogens and pests in the data for Senegal it is important to recall that research and development directed to addressing problems in the African region could make an important longer term contribution to economic development.

The second species that features prominently in the data is *Acacia senegal*. We treat this example last for two reasons. References to *Acacia senegal* dominate references to the term Senegal in the patent system. However, as will be seen, in reality *Acacia senegal* is widely distributed in Africa and in a smaller number of countries around the world. What

[4] Ollivier, B et. al (1991) Desulfohalobium retbaense gen. nov., sp. nov., a Halophilic Sulfate-Reducing Bacterium from Sediments of a Hypersaline Lake in Senegal. *International Journal of Systematic and Evolutionary Microbiology*. 41 (1): 74-81

follows is a brief case history of this major species drawing directly on data from Kew Gardens and GBIF.[5]

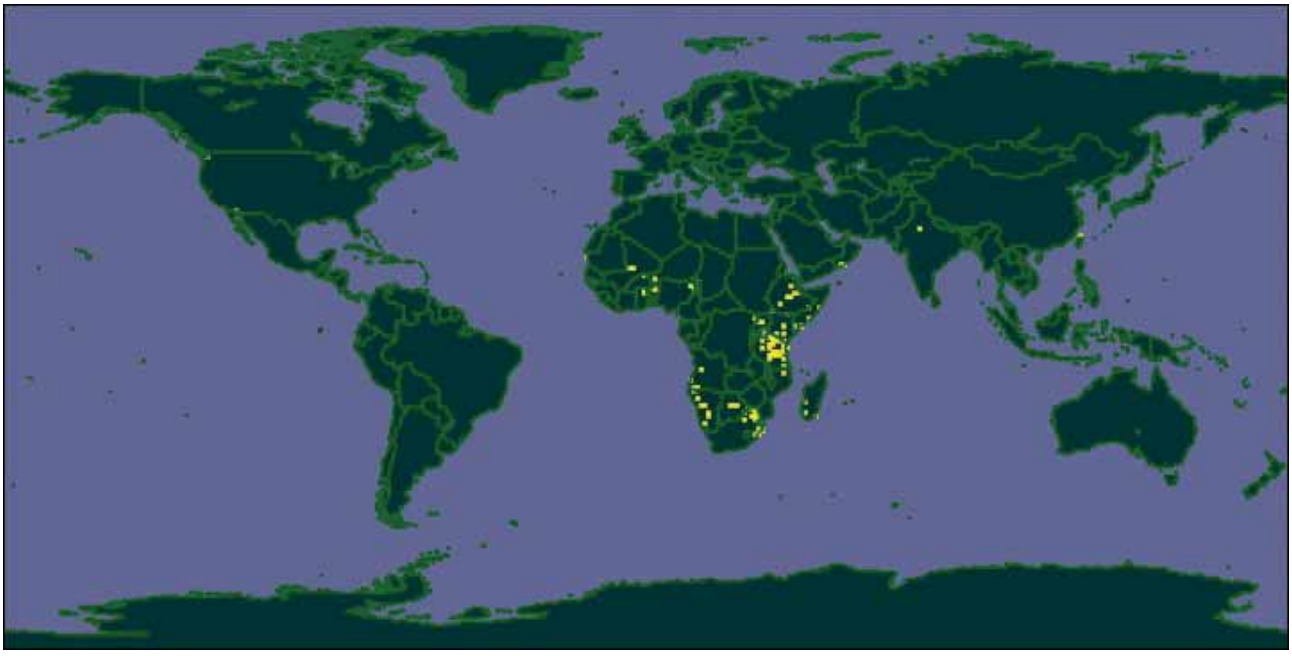
Focus Species: Acacia senegal

Conservation status:
None of the four varieties of this species are threatened. IUCN status is Least Concern.

Habitat:
Dry savanna (grassland) and Sahel (desert edge), scattered, often in thickets, and sometimes in extensive pure stands. It can tolerate five to eleven months of drought. It can survive temperatures of 45˚C, dry wind and sandstorms, but cannot withstand frost. The altitude ranges from 100 to 1700m above sea level in the Sudan to 1950m around Nakuru in Kenya.

About the Species:
Gum arabic is harvested from *Acacia senegal* because it has superior properties over other 'acacias', and hence it is this gum that has dominated the international trade. Currently the biggest markets for A. senegal gum are the European Union, North America (mainly the USA) and the Indian Subcontinent (mainly India). The UK imported 1,253 tons in 1998. Sudan, Nigeria and Chad are the three biggest sources of this gum.

Acacia senegal is found growing in Mauritania, Senegal, The Gambia, Ghana, Burkina Faso, Côte d'Ivoire, Mali, Niger, Nigeria, Cameroon, Democratic Republic of the Congo, Central African Republic, Rwanda, Chad, Sudan, Ethiopia, Somalia, Uganda, Kenya, Tanzania, Mozambique, Angola, South Africa, Namibia, Oman, Pakistan, and India. It has been introduced to Egypt, Australia, Puerto Rico, the Virgin Islands and elsewhere.



Occurrence overview for Acacia senegal (GBIF)

[5] http://www.kew.org/plants-fungi/Acacia-senegal.htm and http://data.gbif.org/species/2978697/

There are four varieties of *A. senegal*. These differ in the presence or absence of hair on the axis of the flower spike, colour of the axis, shape of pod tips, number of pinnae pairs, trunk branched or not branched from the base and shape of the crown, as well as their geographical distribution.

The germination of seed is slow and young plants usually have to contend with competition from grass and browsing stock. Those that survive begin to yield gum at three to four years of age. The best yields in West Africa come from trees 12 to 15 years old and up to 20 cm diameter. In Kordofan trees aged four years are opened for tapping, which continues to the age of 20 or older, but elsewhere in Sudan six to 18 years is usual. The best yields come from trees in areas with an annual rainfall of only 250 to 300 mm. Trees die at an age of 25 to 30 years, by which time they will have succumbed to borers and termites.

The Kew Gardens SEPASAL database records 196 local names for this plant, and other common names include: tur, tulh, harheyr (Jibbali), temmar (Dhofari arabic), Sudan gum, Kordofan gum (English), gommier, gommier vrai, gomme blonde, gomme blanche (French), khor (Punjab), kumta (Rajputana), Senegal gum, Somali gum (in the trade industry).

Uses:
The use of gum arabic (or gum acacia), which is derived from an exudate from the bark, dates from the first Egyptian Dynasty (3400 B.C.). It was used in the production of ink, which was made from a mix of carbon, gum and water. Gum arabic has been used for at least 4,000 years by local people for the preparation of food, in human and veterinary medicine, in crafts, and as a cosmetic. *Acacia senegal* produces the only acacia gum evaluated toxicologically as a safe food additive. Nowadays the gum is present in a wide range of everyday products. 60-75% of the world production of gum arabic is used in the food industry and in human and animal medicine.

In the food industry gum arabic is used as a flavour fixative and emulsifier, to prevent crystallisation of sugar in confectionery, as a stabiliser in frozen dairy products, for its viscosity and adhesive properties in bakery products, and as a foam stabiliser and clouding agent in beer.

In pharmaceuticals, it is used as a stabiliser for emulsions, a binder and coating for tablets, and as an ingredient in cough drops and syrups. A soothing and softening agent, gum arabic is extensively employed in folk medicines. Among many other uses, it is used internally for coughs, diarrhoea, dysentery, haemorrhage, and externally to cover inflamed areas.

Gum arabic is used in cosmetics as an adhesive for face masks and powders, and to give a smooth feel to lotions.

Industrially, gum arabic is applied as an adhesive, as a protective colloid and safeguarding agent for inks, sensitiser for lithographic plates, coating for special papers, sizing agent for cloth to give body to certain fabrics, and coating to prevent metal corrosion. Gum arabic is also used in the manufacture of matches and ceramic pottery.

Acacia senegal wood is locally valued for fuel wood and charcoal, although biomass yield per unit of land area is not sufficient to plant it for this. In construction the wood is used locally for poles and fence-posts, the light-coloured wood for tool handles and dark

heartwood for weaver's shuttles. Strong ropes are made from the bark fibres of the long surface roots. Where the trees are large (for example near the River Niger) they are cut into planks at least 12 cm thick for making canoes for hunting hippopotamuses. The wood is hard and heavy and takes a beautiful polish, with the sapwood being yellowish white and the heartwood nearly black and irregular. The wood is made into throwing-sticks which, in contrast to the Australian boomerang, can be made to fly straight and is used for hunting and displays at ceremonial events.

The dried and preserved seeds of A. senegal are used by people as vegetables. The leaves and pods are browsed by sheep, goats, camels, impala and giraffe. The seeds are sometimes eaten as a vegetable in India.

The flowers are a good source of honey, an important source of nutrition and income generation to support rural livelihoods in marginal lands.

Acacia senegal can help prevent desertification, through sand dune stabilisation and by acting as a wind break.

References & Credits

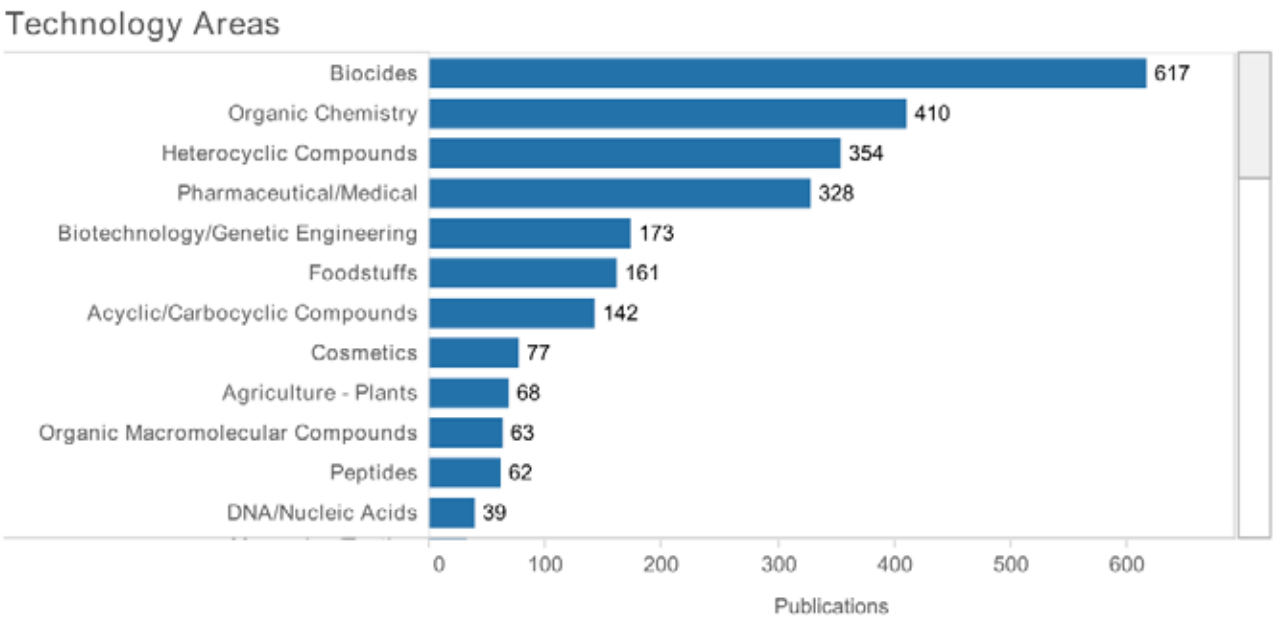
Burkill, H.M. (1995). The Useful Plants of West Tropical Africa: Vol. 3 Families J-L. Royal Botanic Gardens, Kew.
Fagg, C.W. & Allison, G.E. (2004). Acacia senegal and the gum arabic trade. FRP (Forestry Research Programme). Oxford Forestry Institute, Department of Plant Sciences.
Guillemin, J. B. A. Icones lithographicae plantarum australasiae rariorum. Paris (Treuttel et Wurtz), London, Strasbourg.
Spicer, N., Barnes, R. & Timberlake, J. (2007). Acacia handbook. DFID Forestry Research Programme, U.K.
Timberlake, J., Fagg, C.W., Barnes, R. (1999). Field guide to the Acacias of Zimbabwe. CBC Publishing, Harare.

As this focus example makes clear, *Acacia senegal* is a species with a wide variety of economic uses. In common with other major species, such as *Catharanthus roseus* (the Madagascan periwinkle) from Madagascar, it is an African species that has made a major contribution to the world and continues to be widely used. We now turn to the range of technology areas involved in patent activity for species from Senegal.

Technology Areas:

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

Table 2: Technology Areas



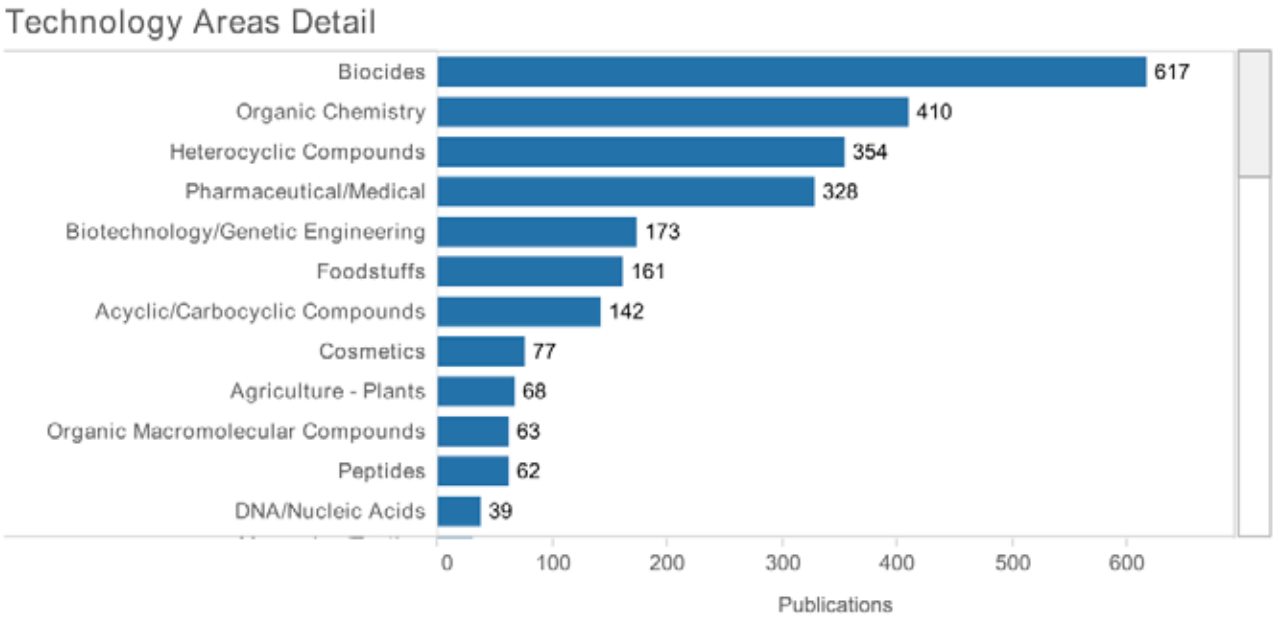
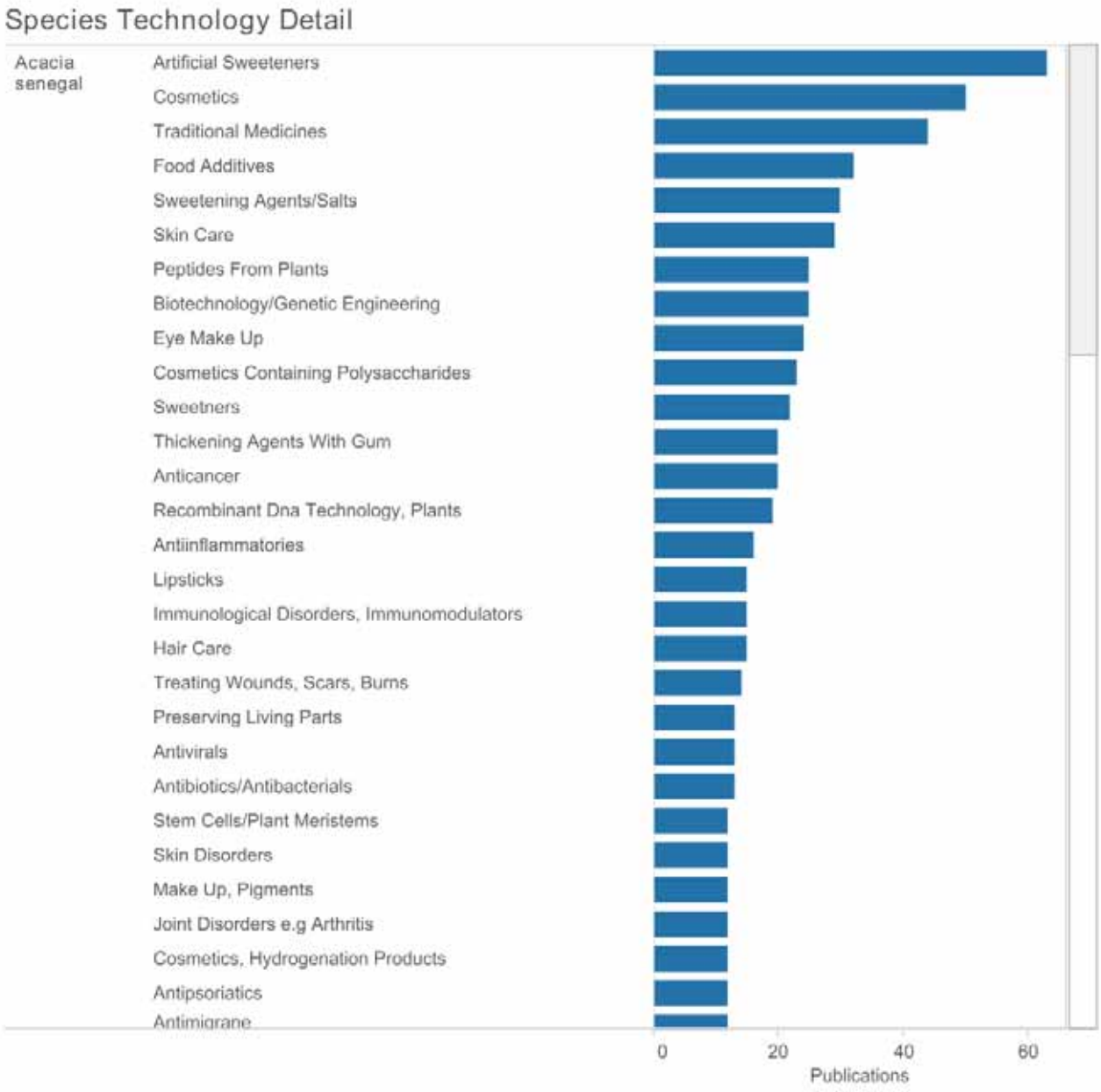


Table 2 reveals that biocides, associated with *Cordylobia anthropophaga,* top the technology areas involving species of direct relevance to Senegal. However, these are followed by pharmaceutical and medical preparations, foodstuffs, cosmetics and plants. In practice, single species may enjoy a career in different areas of science and innovation. Table 3 displays the technology areas associated with *Acacia senegal*.

Table 3: Species and Technology Areas



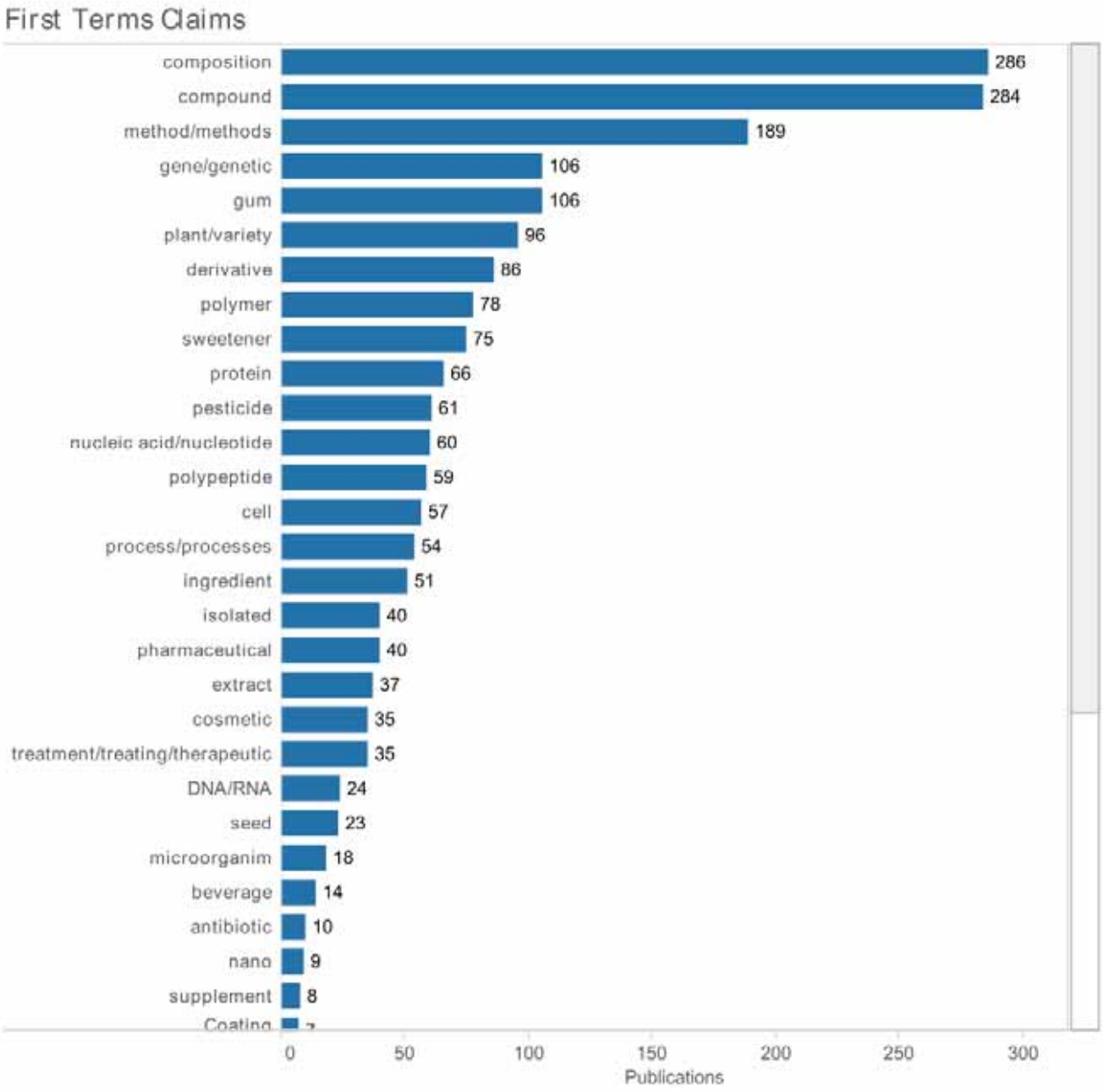

First Terms Claims
composition 286
compound 284
method/methods 189
gene/genetic 106
gum 106
plant/variety 96
derivative 86
polymer 78
sweetener 75
protein 66
pesticide 61
nucleic acid/nucleotide 60
polypeptide 59
cell 57
process/processes 54
ingredient 51
isolated 40
pharmaceutical 40
extract 37
cosmetic 35
treatment/treating/therapeutic 35
DNA/RNA 24
seed 23
microorganism 18
beverage 14
antibiotic 10
nano 9
supplement 8
Coating 7
0
50
100
150
200
250
300
Publications

Table 3: Species and Technology Areas

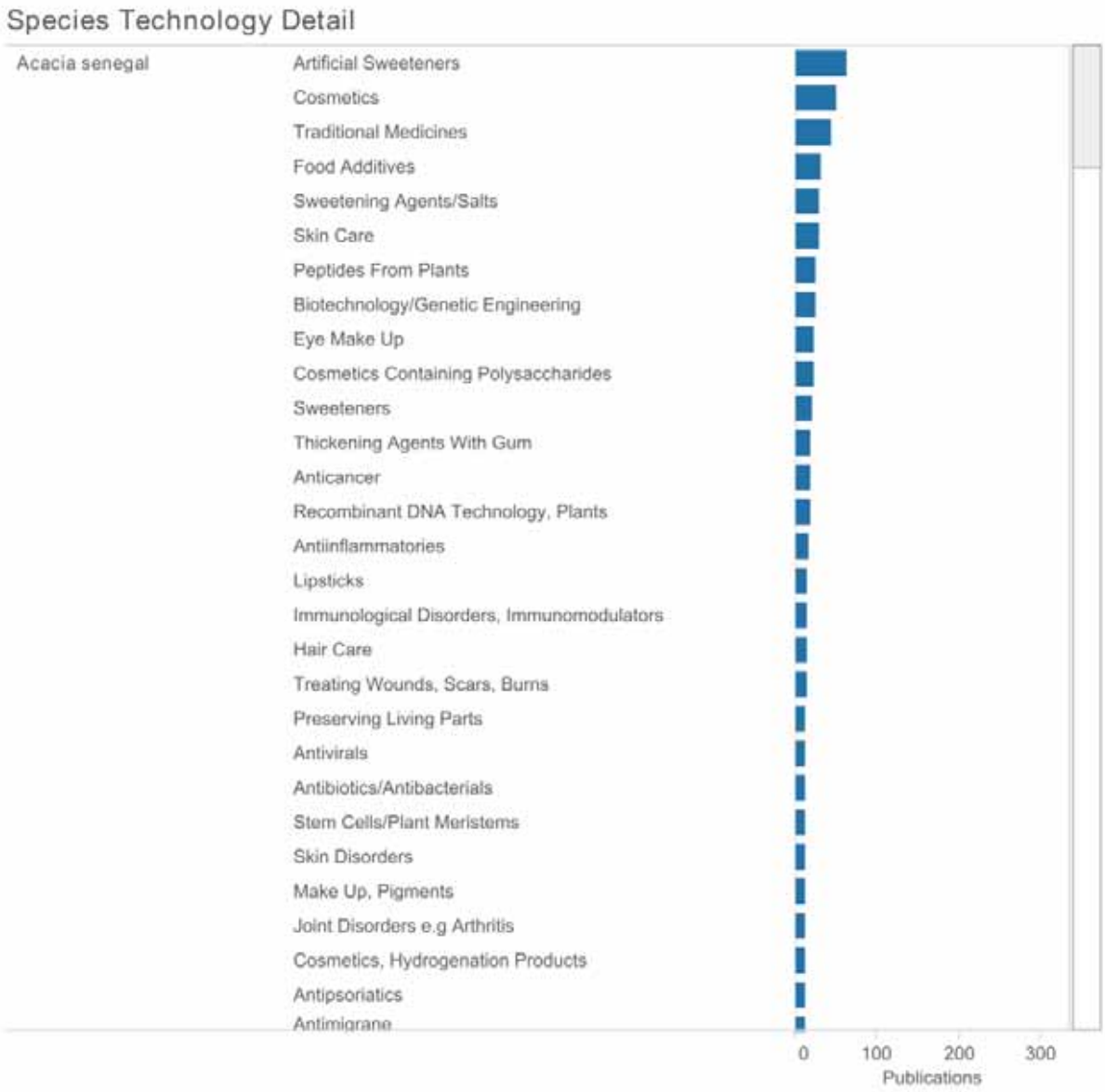


Table 3 usefully reveals the range of potential applications and technology area where a species and its components may be deployed. As such a species may be a focus of activity for a range of different products and markets. However, in the case of threatened species there will be a need for careful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

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

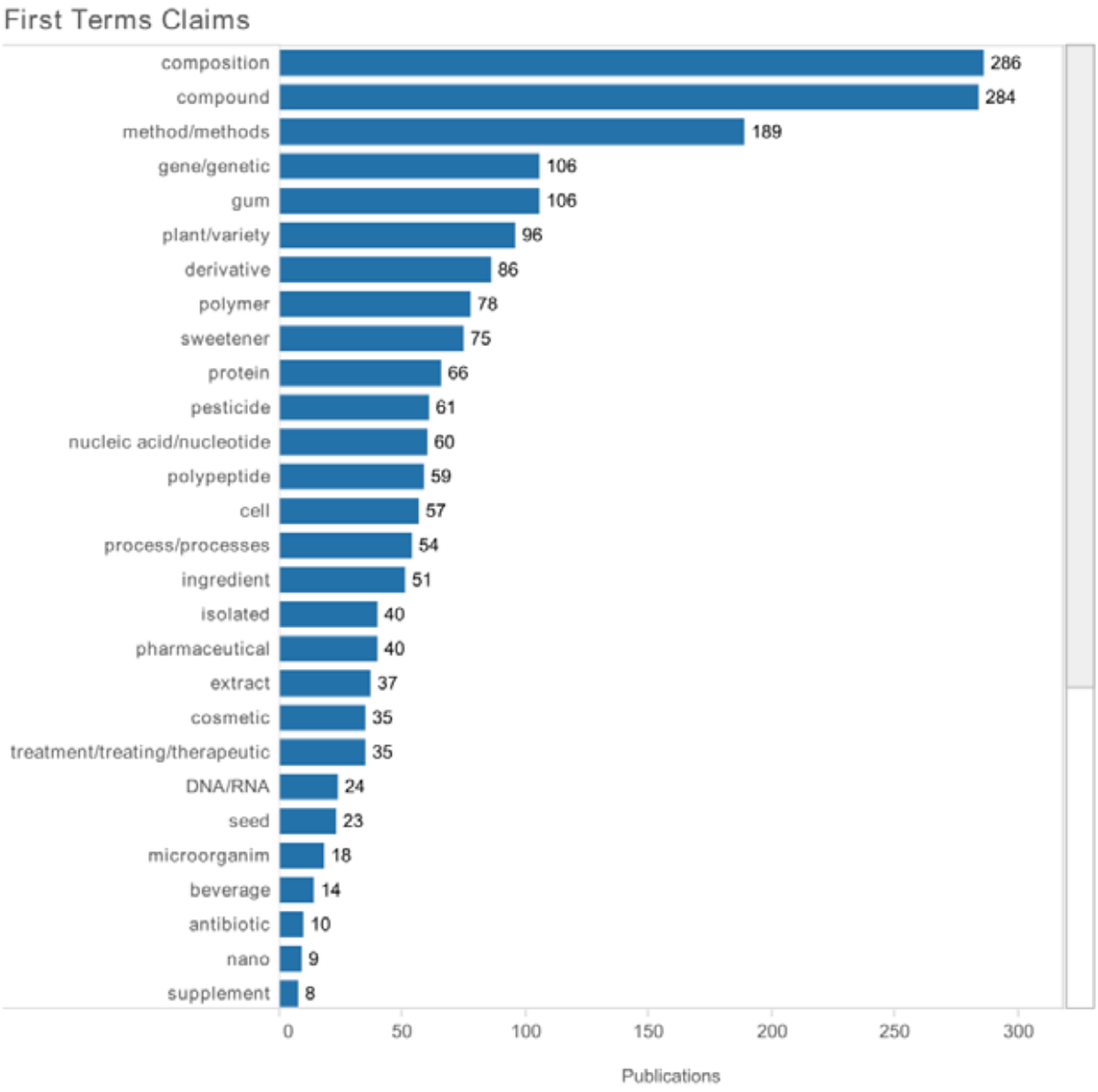


Table 4 reveals that the top category of patent claims is for compositions of matter (compositions). Compositions are commonly extracts, compounds or combinations of ingredients (i.e. in pharmaceuticals or cosmetics and herbal medicines). Patent claims for compositions typically include a list of the compounds or ingredients that are the subject matter for protection. These claims are also commonly 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.

The second major category 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 component in performing that method, that is the subject matter of protection.

A third category of patent activity involves claims to a process or processes. These types of claims are similar to methods claims. Typically, process claims focus on the process for producing a desired product (such as a chemical or a cosmetic). It is the process itself that is the focus of the invention (i.e. a process for producing gum arabic derivatives from *Acacia senegal*) rather than the genetic components. However, patent claims for processes are typically constructed so that a component produced using the process is included in the scope of protection. However, the same component produced using a different process would not logically fall within the scope of this type of patent.

Finally, references to plants or plant varieties can encompass a range of inventions. In the case of biotechnology and genetic engineering a plant produced through a genetic engineering approach may be claims by the applicant. In some jurisdictions, such as the United States, specific legislation may exist for plants such as ‘patent like’ US Plant Patents. These patents are confined to a single claim for a stable new variety of a given species and offer a lower form of protection than standard utility patents. We did not identify any examples of plant patents in the case of species of relevance to Senegal.

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 and the jurisdictions where a patent has been granted and is in force. This type of analysis is particularly important when considering the potential development of products for markets. However, 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 group under its development agenda that commissions specialist patent research at the request of member states.[6]

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

Global Impacts and Global Markets:

We have seen above that a range of species are involved in patent activity of relevance to Senegal. However, it is important to note that many patent applications simply go nowhere. A means for identifying important patents is therefore needed. Here we discuss two measures: a) patent citations, and; b) patent families.

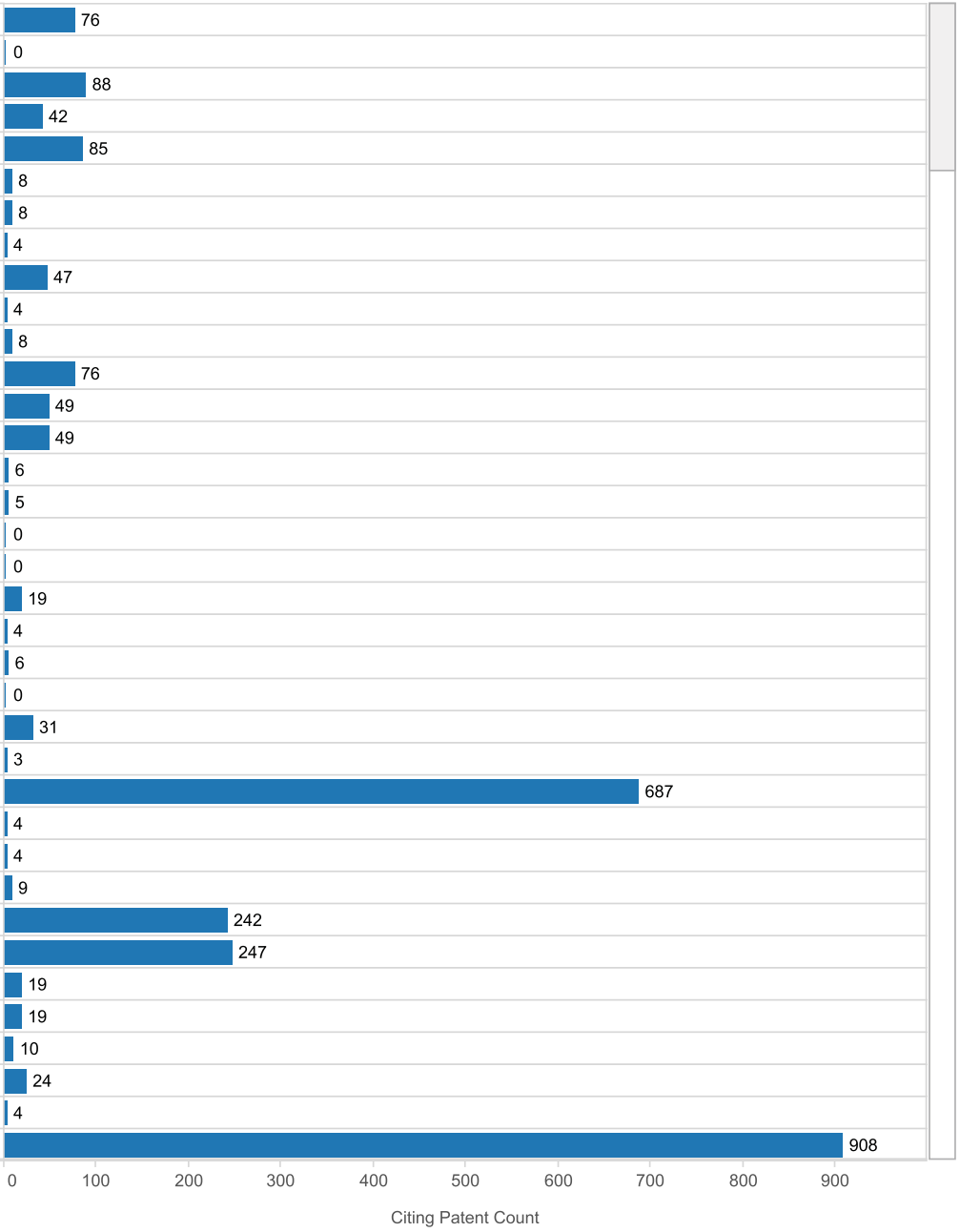
Table 5 displays the citation scores by species and assignee for species relevant to Senegal. When a patent is filed and published it becomes prior art. Later patent applications that make claims for the same invention will find that the scope of what they claim as new, involving an inventive step, and useful will be limited by the 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.

In the case of Senegal Table 5 reveals a selection of citation scores for species of relevance to Senegal organised by assignee and displaying the relevant species. In this case the top scores for patents cited by later patents are for Bayer Cropscience and *Cordylobia anthropophaga* (the Mango fly). In addition we see high scores for BASF Plant Science for *Sinorhizobium saheli* (also known as *Ensifer saheli*) and *Rhizobium undicola.* Both of these species are nitrogen fixing bacteria that exist in the roots of legumes. Examples of highly cited patents in which these species appear include methods for the production of multiple unsaturated fatty acids in transgenic organisms, suggesting that these organisms are of particular relevance in genetic engineering. As might be expected, *Acacia senegal* also features prominently in the data but is more widely distributed across applicants. This diversity suggests the range of technological areas to which *Acacia senegal* contributes.

Other plant species in the data such as *Balanites aegyptiaca* and *Aframomum melegueta* exhibit much lower citation scores with 4 citations each. However, this type of data can produce insights into technological developments of relevance to the species, or where a species is directly referenced in citing patents, a means to track developments involving the species. For example, a citing document for *Aframomum melegueta* (WO2002062364A1) focuses on an Antiviral Composition from Medical Plants for Combating HIV/AIDs. In the case of *Balanites aegyptiaca* two citing patent applications from Ephyla SAS published in 2012 refer to a Plant Extract for the Production of a Slimming Composition and Method of Control for Slimming (FR2962907A1, WO2012017141A1). The documents do not make reference to Senegal but do provide additional indicators of potential uses of the species.

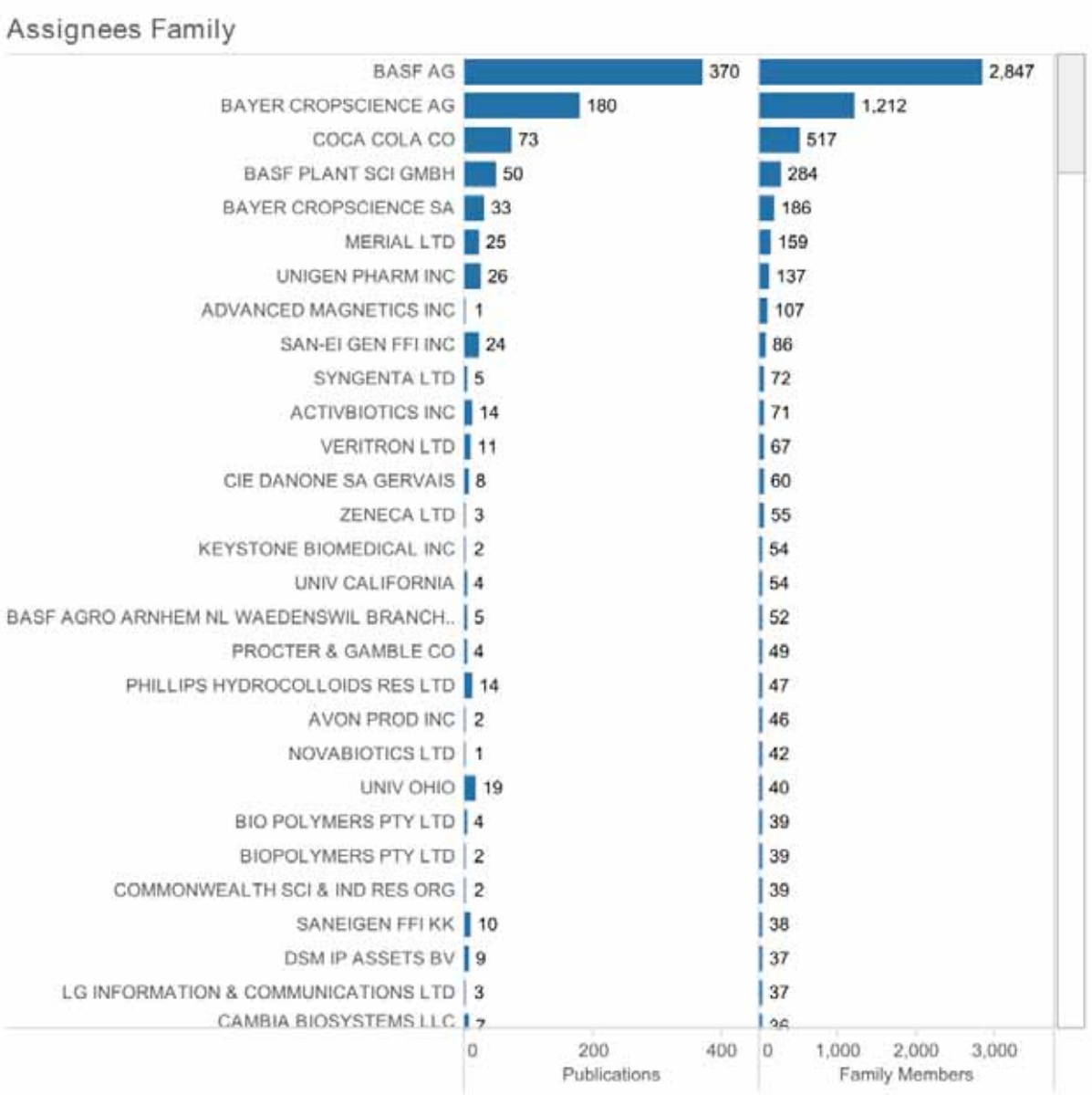
Assignees Citing

Patent Assignees	Species	Kingdom	Data Type	Distribution	Citing Patent Count
ABBOTT LAB	Acacia senegal	plantae	Distribution	Cosmopolitan	76
ACO HUD NORDIC AB	Acacia senegal	plantae	Distribution	Cosmopolitan	0
ACTIVBIOTICS INC	Mycobacterium senegalense	bacteria	Distribution	Cosmopolitan	88
ADVANCED MAGNETICS INC	Acacia senegal	plantae	Distribution	Cosmopolitan	42
ADVANCED REPRODUCTIO..	Acacia senegal	plantae	Distribution	Cosmopolitan	85
AETERMA ZENTARIS GMBH	Leptosphaeria senegalensis	fungi	Distribution	Uncertain	8
AETERNA ZENTARIS GMBH	Leptosphaeria senegalensis	fungi	Distribution	Uncertain	8
AGENCY SCI TECHNOLOGY ..	Mycobacterium senegalense	bacteria	Distribution	Cosmopolitan	4
AKESIS PHARM INC	Acacia senegal	plantae	Distribution	Cosmopolitan	47
ALBRIGHT & WILSON AUST..	Acacia senegal	plantae	Distribution	Cosmopolitan	4
AMERICAN MAIZE PROD CO	Acacia senegal	plantae	Distribution	Cosmopolitan	8
AMOCO CORP	Mycobacterium senegalense	bacteria	Distribution	Cosmopolitan	76
ANAEROBE SYSTEMS	Clostridium thermopalmarium	bacteria	Distribution	Uncertain	49
	Halanaerobium saccharolyticum	bacteria	Distribution	Cosmopolitan	49
ANDORA INC	Acacia senegal	plantae	Distribution	Cosmopolitan	6
ARKEMA FRANCE	Acacia senegal	plantae	Distribution	Cosmopolitan	5
ARTSANA SPA	Acacia senegal	plantae	Distribution	Cosmopolitan	0
ASSESSA IND COMERCIO E ..	Acacia senegal	plantae	Distribution	Cosmopolitan	0
AURORA FOODS INC	Acacia senegal	plantae	Distribution	Cosmopolitan	19
AVENTIS AGRIC	Cordylobia anthropophaga	animalia	Distribution	Cosmopolitan	4
AVON PROD INC	Acacia senegal	plantae	Distribution	Cosmopolitan	6
AWENYDD DIAGNOSTIC GM..	Acacia senegal	plantae	Distribution	Cosmopolitan	0
BANNER PHARMACAPS INC	Acacia senegal	plantae	Distribution	Cosmopolitan	31
BASF AG	Acacia senegal	plantae	Distribution	Cosmopolitan	3
	Cordylobia anthropophaga	animalia	Distribution	Cosmopolitan	687
	Sinorhizobium saheli	bacteria	Distribution	Cosmopolitan	4
	Rhizobium undicola	bacteria	Distribution	Cosmopolitan	4
BASF AGRO ARNHEM NL W..	Cordylobia anthropophaga	animalia	Distribution	Cosmopolitan	9
BASF PLANT SCI GMBH	Sinorhizobium saheli	bacteria	Distribution	Cosmopolitan	242
	Rhizobium undicola	bacteria	Distribution	Cosmopolitan	247
	Sinorhizobium terangae	bacteria	Distribution	Cosmopolitan	19
	Allorhizobium undicola	bacteria	Distribution	Uncertain	19
BATTELLE MEMORIAL INST	Acacia senegal	plantae	Distribution	Cosmopolitan	10
BAYER AG	Acacia senegal	plantae	Distribution	Cosmopolitan	24
BAYER AGROSCIENCE	Cordylobia anthropophaga	animalia	Distribution	Cosmopolitan	4
BAYER CROPSCIENCE AG	Cordylobia anthropophaga	animalia	Distribution	Cosmopolitan	908



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.[7] 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. Table 6 ranks patent family data by species and shows the global map for the distribution of patent documents linked to the species.

Table 6: Patent Assignees and Family Members



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

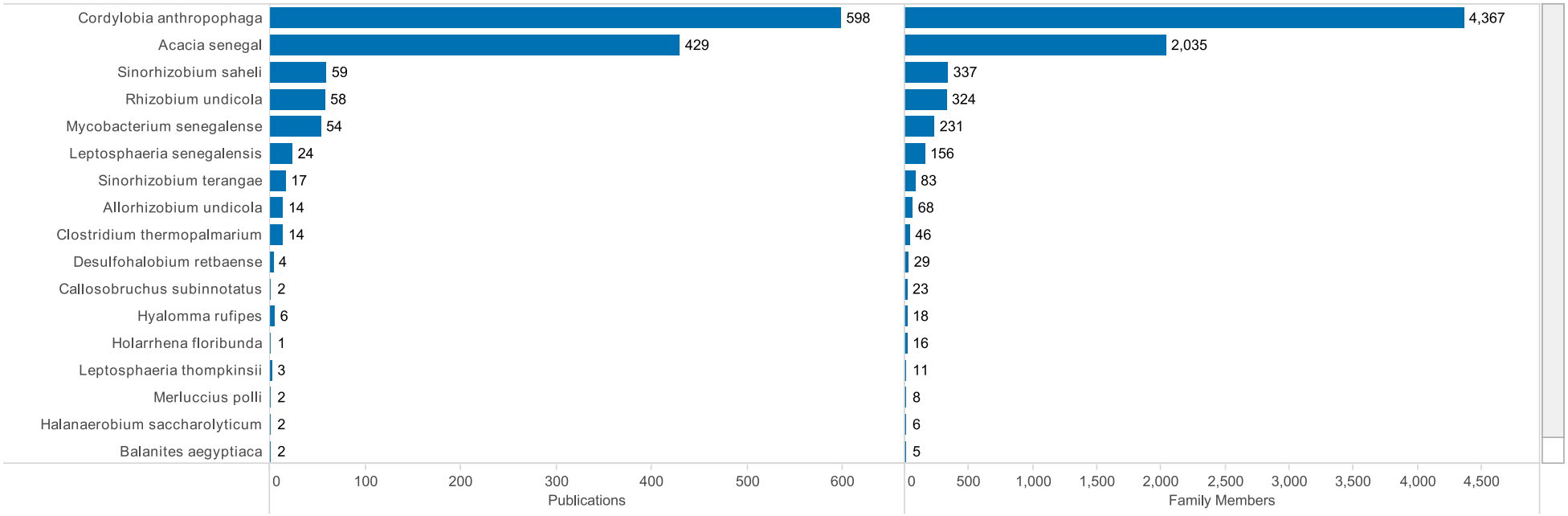
Patent family data of this type is useful in revealing the applicants who are most vigorously pursuing patent protection involving a species or, as is frequently the case, a group of species around the world. In this case BASF emerges top followed by Bayer Cropscience, both of whom are focusing on biocides for species such including *Cordylobia anthropophaga*. They are followed by Coca Cola which is focusing globally on sweeteners and gums including *Acacia senegal*.

This type of analysis can also 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 the results for 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.

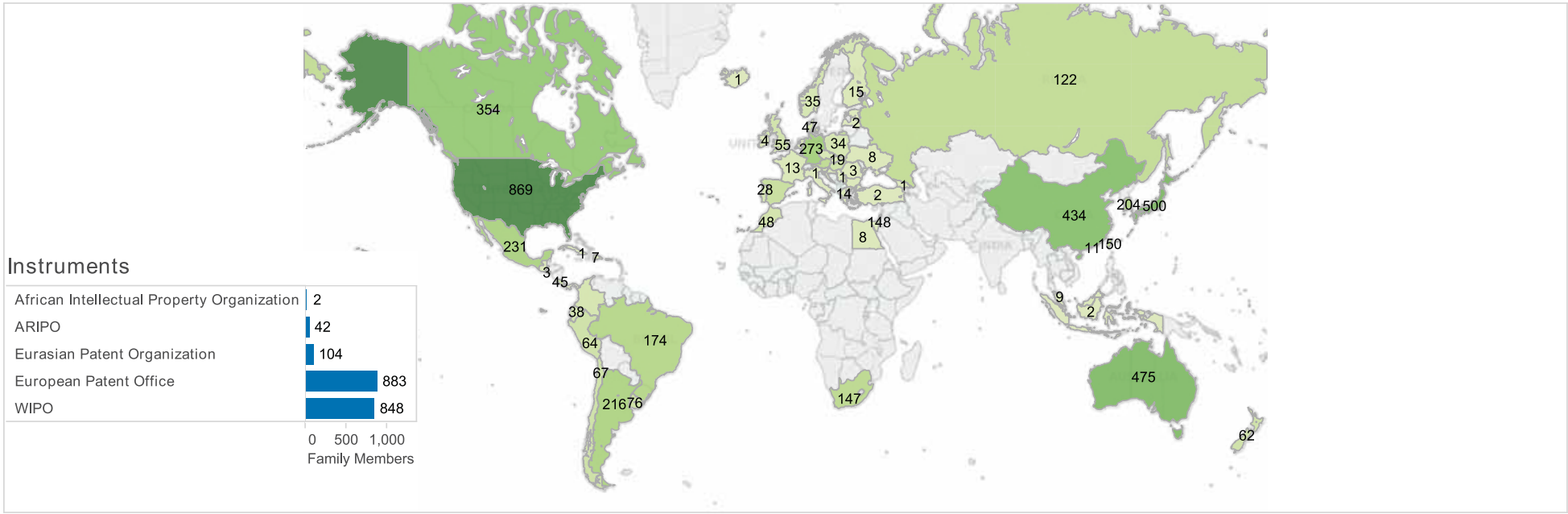
Plate 5 reveals that the species with the widest global reach are *Cordylobia anthropophaga* and *Acacia senegal*, followed by the bacteria used in biotechnology applications *Sinorhizobium saheli* and *Rhizobium undicola*. Our data suggests that two of the species are of interest for potential economic development, *Aframomum melegueta* and *Balanites aegyptiaca* are relatively neglected in the patent system relative to their potential longer term economic value. This observation is confirmed by wider research on the patent landscape for these two species in the period to mid 2013 in the main jurisdictions which revealed 174 total references to *Aframomum melegueta* and 75 for *Balanites aegyptiaca.* In addition we would recommend further research on *Holarrhena africana* which appears to be relatively neglected in the patent system.

As this analysis suggests, further research is desirable to establish the full patent landscape for species such as *Aframomum melegueta and Balanites aegyptiaca.* However, patent family mapping is also useful in identifying the major markets where protection is being sought for a given species or portfolio of species. Plate 7 reveals significant activity in markets around the world including South America and China. However, patent activity for Africa appears to be limited to South Africa, Egypt and Morocco. 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 Senegal .

Species Family Members



Family Map



Concluding Remarks:

This report has focused on identifying species in patents that originate from or are likely to originate from Senegal based on available distribution data. Our purpose has been to highlight the existing and potential role of these species for economic development in support of conservation. We would emphasise that our aim was not to identify the complete portfolio of patent activity for a particular species or genetic resources. In reality each of these species forms part of a landscape that stretches beyond the data presented in this report. Rather, the contents of this report and the next section presenting summaries for each species provide a basis for further exploration of the potential of Senegal species for economic development and conservation.

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

Species Summary Tables

The following summary tables describe the species and patent activity involving the species. This data falls into two categories:

a) Of Senegalese origin - Patents where a named species has been identified as having been obtained from Senegal.
b) With Senegalese distribution - Patents where there is no reference to Senegal but distribution data suggests that the species may have originated from Senegal (Distribution).

In reading these tables, note that the number of documents refers to the number of documents retained during research on the origin of species of relevance to South Africa. It does not refer to the wider patent landscape for the species consisting of the total number of documents making reference to the species, or its components, in the global patent system.

Species may appear in patent documents in this list for a variety of reasons:

1. Because they are a focus of the invention;
2. Because they are incorporated into the claims of the invention;
3. Because they are a target of the invention (i.e. pathogens or pests)
4. Because a reference to a species, including in very limited cases a literature reference, indicates that the species is of potential interest for economic development and merits further investigation.

Species that fall into the first two categories will be included in the summary section.

This report focuses on identifying species that are of potential interest for economic development and conservation based on their appearance in patent data. The data in this summary section should not be used to draw conclusions about misappropriation or biopiracy.

With Senegalese distribution

<table>
<tr><td>Species name:
Acacia senegal</td><td>Kingdom: Plantae</td><td rowspan="2">  </td></tr>
<tr><td colspan="2">Brief description of species:
A pan-African species, native to 25 African countries and Indian subcontinent. Introduced to many others (GBIF records 36 countries with occurrences). The source of gum arabic, 70% of the world’s supplies are harvested in Sudan.</td></tr>
<tr><td colspan="2">Distribution: Cosmopolitan</td><td>No of documents: 447</td></tr>
<tr><td colspan="3">Patent documents reference numbers shown in appendix 2</td></tr>
</table>

Of Senegalese origin

Species name: *Aframomum melegueta*	Kingdom: Plantae	
Brief description of species: Found across western Africa and southern Ethiopia. A member of the ginger family of plants. Used in cuisine. Pharmaceutical use for sexual dysfunction treatment.		
Distribution: Cosmopolitan	No of documents: 1	
WO2000035466A1		

With Senegalese distribution

Species name: *Allorhizobium undicola*	Kingdom: Bacteria	No Image Available
Brief description of species: Nitrogen fixing bacteria found in the roots of Neptunia natans.		
Distribution: Uncertain	No of documents: 14	
EP2159289A2 US2007292953A1 US2009038025A1 US2009083883A1 US2009106856A1 US2009249514A1 US2009300800A1 WO2006024509A2 WO2006136596A2 WO2007014844A2 WO2007031493A2 WO2007039424A1 WO2007107516A2 WO2008077570A1		

Of Senegalese origin

Species name: *Balanites aegyptiaca*	Kingdom: Plantae	
Brief description of species: Balanites aegyptiaca is found in the Sahel-Savannah region across Africa. It is one of the most common trees in Senegal. Extracts can be used as anti-parasitic for bilharzia		
Distribution: Cosmopolitan	No of documents: 2	
WO2006137069A1 US2008287662A1		

With Senegalese distribution

Species name: *Callosobruchus subinnotatus*	Kingdom: Animalia	
Brief description of species: The major insect pest of stored bambara groundnuts, in sub-Saharan West Africa		
Distribution: Cosmopolitan	No of documents: 2	
EP2092826A1 US2010071096A1		

With Senegalese distribution

Species name: *Clostridium thermopalmarium*	Kingdom: Bacteria	No Image Available
Brief description of species: A new thermophilic species of the genus Clostridium which was isolated from palm wine in Senegal		
Distribution: Uncertain	No of documents: 14	
EP0842298B1 US6107033A US2006223729A1 US2008311640A1 US2009081715A1 WO1997005282A2 WO2005034855A2 WO2006117019A1 WO2006119052A2 WO2009033114A2 WO2009120806A2 WO2010018387A2 WO2010027531A1 WO2010031793A2		

With Senegalese distribution

Species name: *Cordylobia anthropophaga*	Kingdom: Animalia	
Brief description of species: Mango fly, cause of myiasis in humans across central sub tropical Africa		
Distribution: Cosmopolitan	No of documents: 783	
Patent documents reference numbers shown in appendix 2		

With Senegalese distribution

Species name: *Desulfohalobium retbaense*	Kingdom: Bacteria	No Image Available
Brief description of species: Sulphate reducing bacteria isolated from hypersaline lake in Senegal		
Distribution: Uncertain	No of documents: 4	
US6531281B1 US2008182318A1 WO2005044742A1 WO2009088760A1		

With Senegalese distribution

Species name: *Halanaerobium saccharolyticum*	Kingdom: Bacteria	No Image Available
Brief description of species: Sulphate reducing bacteria first isolated from hypersaline lake in the Crimea.		
Distribution: Cosmopolitan	No of documents: 2	
US2008311640A1 WO2006119052A2		

With Senegalese distribution

Species name: *Holarrhena africana*	Kingdom: Plantae	
Brief description of species: A shrub or small tree native to much of west Africa. This species (a synonym for Holarrhena floribunda) yields large numbers of alkaloids		
Distribution: Cosmopolitan	No of documents: 1	
US2010040568A1		

With Senegalese distribution

Species name: *Hyalomma rufipes*	Kingdom: Animalia	
Brief description of species: Hard tick which may spread Crimean–Congo hemorrhagic fever to humans and infects livestock.		
Distribution: Cosmopolitan	No of documents: 6	
EP0120286A1 EP0249409A2 US2008306095A1 US2010179206A1 WO2005015993A1 WO2008154466A2		

With Senegalese distribution

Species name: *Leptosphaeria senegalensis*	Kingdom: Fungi	No Image Available
Brief description of species: Soil living fungus which can spread mycetoma in humans.		
Distribution: Uncertain	No of documents: 54	
WO2005016386A1 EP1800684A1 US2002028479A1 US2006002899A1 US2007167408A1 US2007248584A1 US2008248067A1 US2009130109A1 US2009136546A1 US2010129385A1 US2010303819A1 US2011020374A1 US2011021415A1 WO2001055445A1 WO2004020613A1 WO2004108753A1 WO2005037293A1 WO2006036817A2 WO2006084319A1 WO2006108241A1 WO2007071658A2 EP1567661B1 US2006292646A1WO2004047614A2		

With Senegalese distribution

Species name: *Leptosphaeria thompkinsii*	Kingdom: Fungi	No Image Available
Brief description of species: Soil living fungus which can spread mycetoma in humans.		
Distribution: Cosmopolitan	No of documents: 3	
EP1567661B1 US2006292646A1 WO2004047614A2		

With Senegalese distribution

Species name: *Merluccius cadenati*	Kingdom: Animalia	
Brief description of species: Synonym for Merluccius polli, Common name is the Benguela hake. A fish found around western Africa coast.		
Distribution: Cosmopolitan	No of documents: 2	
US5676986A WO1996019120A1		

With Senegalese distribution

Species name: *Mycobacterium senegalense*	Kingdom: Bacteria	No Image Available
Brief description of species: Mycobacterium senegalense is a rapidly growing Mycobacterium species, and has been reported to cause disease among cattle in east Africa		
Distribution: Cosmopolitan	No of documents: 64	
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With Senegalese distribution

Species name: *Rhizobium undicola*	Kingdom: Bacteria	No Image Available
Brief description of species: Nitrogen fixing bacteria that exists in the roots of legumes.		
Distribution: Cosmopolitan	No of documents: 70	
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With Senegalese distribution

Species name: *Sinorhizobium saheli*	Kingdom: Bacteria	No Image Available
Brief description of species: Also known as *Ensifer saheli*. A nitrogen fixing bacteria that exists in the roots of legumes.		
Distribution: Cosmopolitan	No of documents: 75	
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With Senegalese distribution

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Appendix 1.
Distribution map of GBIF records in Senegal by kingdom.

Appendix 2.

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