Biodiversity in the Patent System: Mozambique

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

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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 Mozambique. The report is divided into three sections:

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

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 Mozambique. 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 Mozambique as a basis for further research.

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

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[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.

Mozambique

Area:
799,380 sq. km
Coastline:
2470 km
Climate:
Mozambique has a tropical climate with two seasons, a wet season from October to March and a dry season from April to September. Climatic conditions, however, vary depending on altitude.
Environment:
Mostly coastal lowlands, uplands in center, high plateaus in northwest, mountains in west. The backbone of the country is the mountain chain which forms the eastern escarpment of the continental plateau.

Biodiversity in Mozambique and Patent Activity:

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

Using this resource we have obtained biodiversity records for species which occur in Mozambique. 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 10,963 species names for Mozambique. Of these 9,426 are accepted scientific names for species. The remainder are made up of synonyms, homonyms or species names that are not presently scientifically accepted. In this report we used all species names to search patent data. Variations of species names were resolved onto accepted scientific names where ever possible. In addition, GBIF contains 85,190 georeferenced coordinates for species from Mozambique. Accurate georeferencing of species collection records is an important standard in biodiversity related research.

We identified a total of 120,994 documents containing species known to be distributed in Mozambique. Of these, 121 made some form of reference to Mozambique. The 121 documents that made a specific reference to Mozambique contained 1,931 species names.[1] This is important because patent documents that make reference to a species typically make reference to other species. The challenge therefore is to identify those

[1] When major model organisms (such as E. coli and Homo sapiens) are removed this resulted in 1,896 species names of which 1,475 are accepted scientific names.

species that originate from Mozambique. These documents were manually reviewed in MaxQDA data analysis and tagging software. Through this process we were able to identify species where it was definitively stated that they had been collected, sampled or otherwise obtained from Mozambique. In addition, using GBIF distribution data we identified no species where GBIF presently records distribution only in Mozambique.

Patent searches were conducted in the whole text collections of the United States, the European Patent Convention and the international Patent Cooperation Treaty for the period 1976-2010. In order to enhance data capture using Thomson Innovation we expanded the search for documents making reference to Mozambique in all available patent jurisdictions worldwide from 1900 to May 2013 (i.e. Australia, China, Japan, South Korea, Canada etc). This led to the identification of 511 patent documents worldwide that mention Mozambique and includes our original 121 documents. This wider dataset was manually reviewed and tagged for species from Mozambique using MaxQDA software to expand data coverage.

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 Mozambique 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 statutory conservation sites such as national parks and nature reserves - places expected to be of significance for biodiversity. A larger version of the distribution map can be found in the appendix of this country summary.

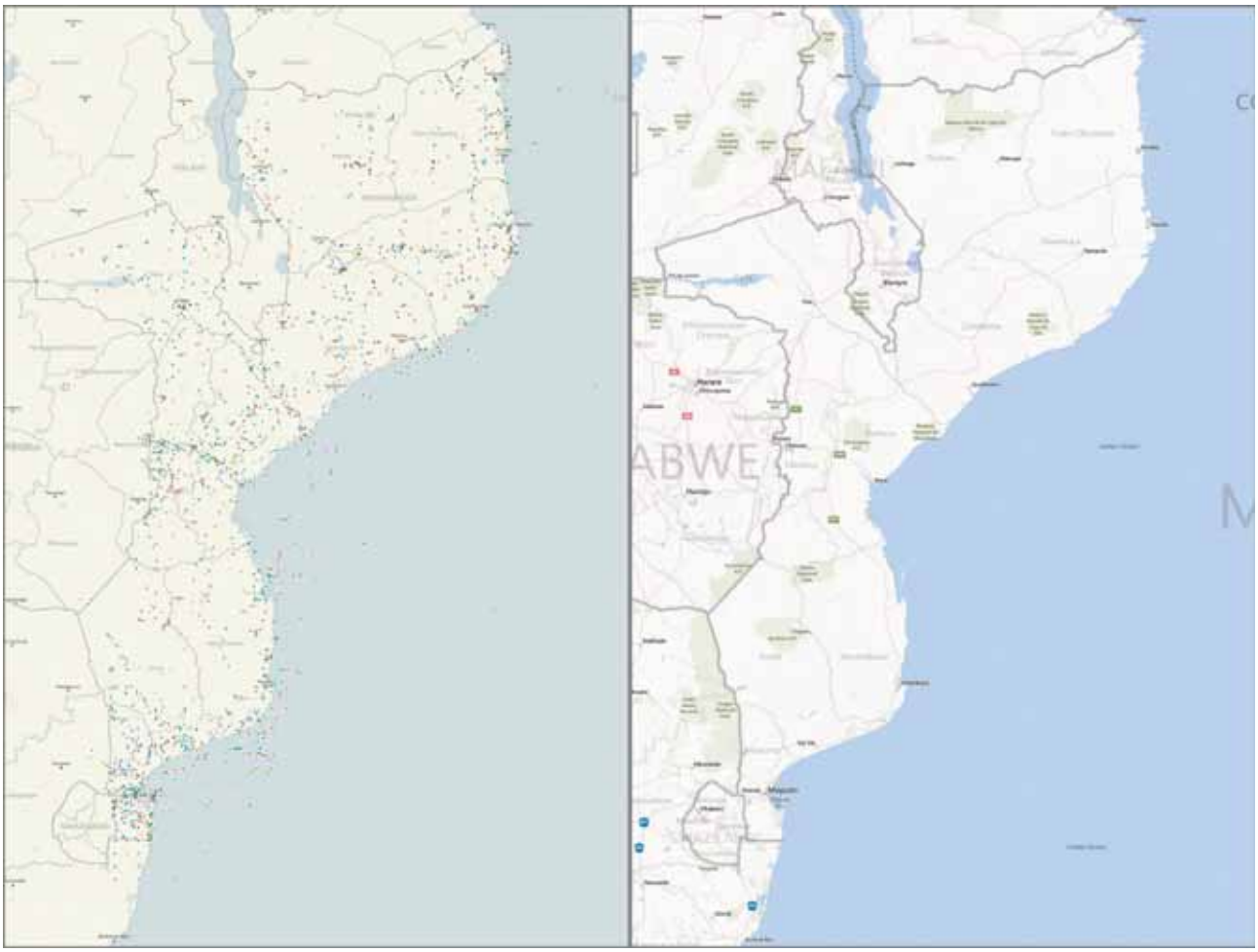


Plate1. Distribution of GBIF records from Mozambique (left) and major settlements and roads (right) (map courtesy of Bing Maps). Each colour point represents a species record point.

It is very interesting to compare the two maps. The distribution map shows that records are quite uniformly dispersed across the country, but that there are some denser clusters, most notably in the far south in the area of Maputo. There are also areas of density around other areas of human habitation. There is some correlation between routes of main roads and data points, but this is not as marked as in other countries. There is not a significant increase in the density of records in and around the numerous statutory conservation sites Mozambique has a long coastline and for its entire length there are marine species recorded. Marine fishing is of economic importance and these records reflect the diversity

offshore, especially in the south. The dispersal of record locations suggest that there is scope for increased levels of recording to create a more robust dataset. This leads to the likelihood that biodiversity records for Mozambique are far from comprehensive in describing the fauna and flora of the country.

GBIF presently records 10,963 name for species known to be present in Mozambique. This list is dominated by plants and animals which account for over 10,500, as can be seen in Table 1.

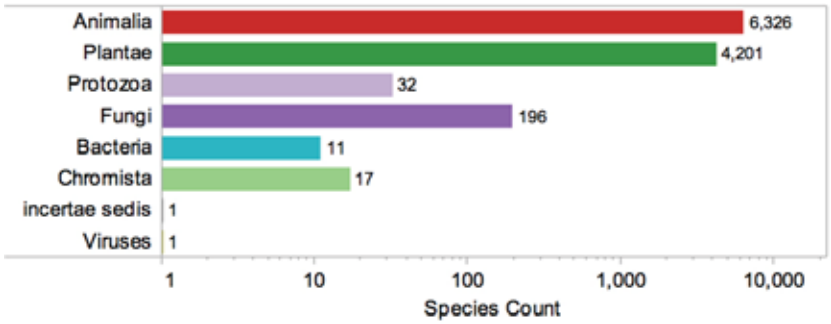


Table 1: Showing the number of species in Mozambique by kingdom using GBIF data.

Using global data it is possible to examine the wider distribution of Mozambican 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 Mozambique and is segmented by kingdom. It can be seen that a number of species have a 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 there are a large number of species which are widely distributed across southern and sub-Saharan Africa. Cosmopolitan species may include commercial crops such as coffee and rice as well as native and naturalised species.

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

Biodiversity in Mozambique in the Patent System

As of 2013 a total of 511 patent documents worldwide specifically mention Mozambique. This provides a general overview of references to Mozambique 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, Mozambique. In addition, patent applicants will make reference to species that originate from Mozambique but will not mention Mozambique 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 Mozambique. In providing a global overview of patent activity of relevance to Mozambique we initially focus on patent activity at the main patent jurisdictions consisting of the United States, the European Patent Convention and the Patent Cooperation Treaty in the period between 1976 and 2010. We then examine the results of research to identify genetic resources and traditional knowledge that originate from Mozambique in the 511 patent documents published worldwide that reference Mozambique. In approaching patent activity for genetic resources from Mozambique we focus on three categories of data.

1. Species that are known to be distributed in Mozambique but are also distributed elsewhere in the world. This provides the basis for the overview of global patent activity for genetic resources of relevance to Mozambique.
2. Species where a direct reference is made to the collection or origin of a species from Mozambique. This data is based on a review of 511 patent documents that make Mozambique and a species known to be distributed in the country.
3. Species where available distribution data suggests that a sample is likely to have originated from Mozambique. This data is known as Distribution data and refers to cases where GBIF presently only records a species as occurring in Mozambique and no other country. Because taxonomic information is incomplete this data provides a clue rather than proof that a species originated from Mozambique.

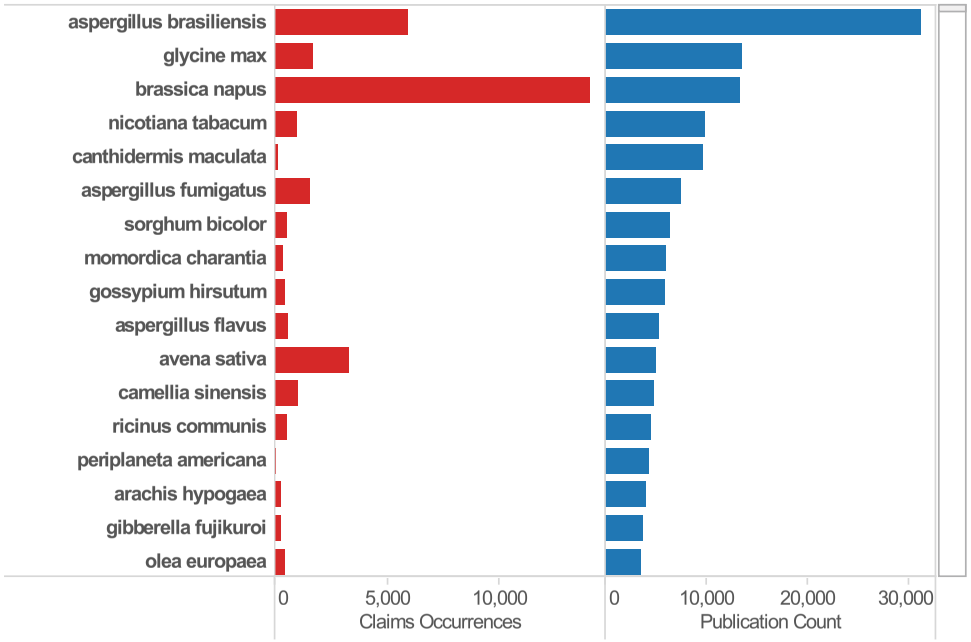
We begin our analysis with an overview of biodiversity that is known to occur in Mozambique in the patent system and then turn to data on species originating from Mozambique.

Mozambique 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 Mozambique and other countries around the world. This overview provides a global context for trends in applications and grants, the top species appearing in patents that are known to occur in Mozambique, top applicants or assignees and technology areas.

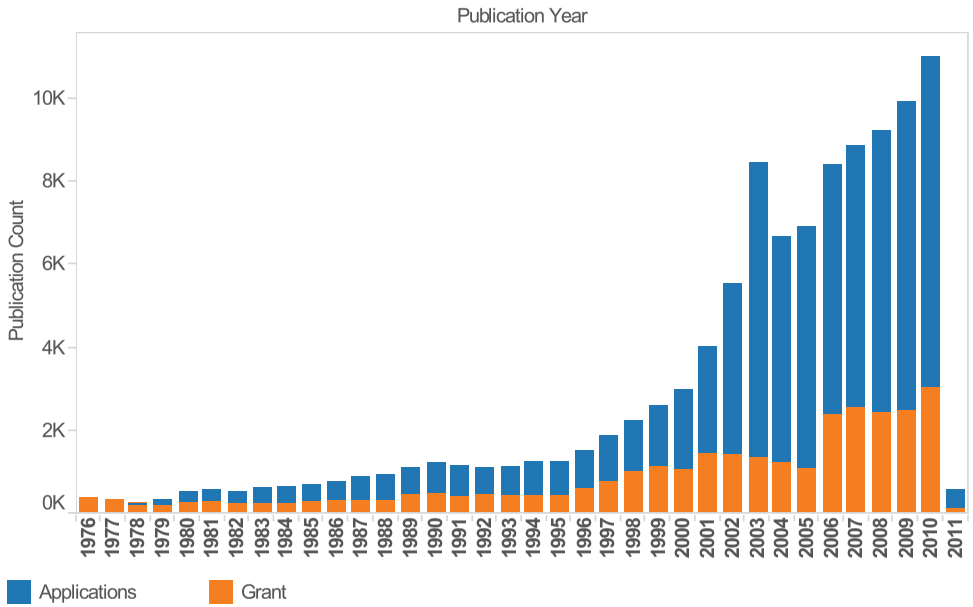
In total we identified approximately 1,931 species names in patent data from the major jurisdictions that are known to occur in Mozambique. When model organisms including crops such as *Zea mays* (maize) and *Homo sapiens* are excluded this falls to 1,896 species names and 1,475 accepted scientific names.[2] This data is relevant for Mozambique because it demonstrates that researchers and companies are conducting research and development on species that are known to occur in Mozambique. As Plate 3

[2] The 1,896 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.

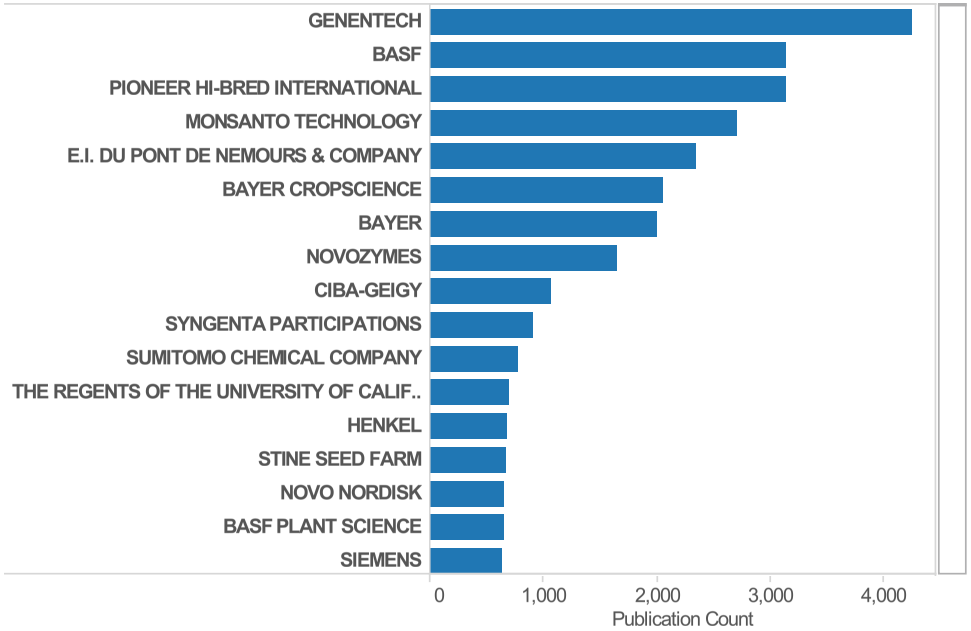
Species



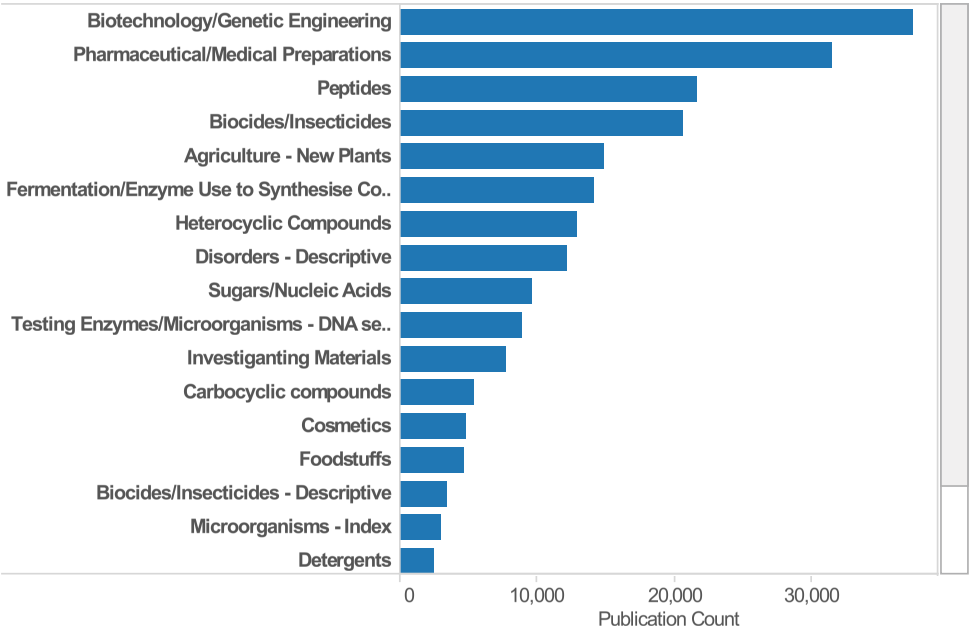
Trends



Assignees



Technology Area



makes clear research and development is taking place across a range of technology sectors and is targeted to a variety of markets.

The top species of relevance to Mozambique in global patent data include species used in biotechnology such as *Aspergillus brasiliensis* (formerly *Aspergillus niger*) and the infectious fungi *Aspergillus fumigatus* and *Aspergillus flavus* which affect both plants and animals. Another pathogen is *Gibberella fujiuroi*, a fungus which causes bakanae disease in rice. In total we identified 781 plant names in global data of relevance to Mozambique. Crops dominate the list of species with soya (*Glycine max*), oilseed rape (*Brassica napus*), sorghum (*Sorghum bicolor*), tobacco (*Nicotiana tabacum*), bitter melon (*Mormordica charantia*), cotton (*Gossypium hirsutum*), castor oil plant (*Ricinus communis*), oats (*Avena sativa*), peanut (*Arachis hypogaea*), olive (*Olea europaea*) and tea (*Camellia sinensis*). Other species include the Ocean Triggerfish (*Canthidermis maculata*) which reflects the large coastal territory of Mozambique The only insect represented is the American cockroach (*Periplaneta americana*), despite its name this is an African insect which now has global distribution due to human activity. It is regarded as a pest as it can taint food, has a very catholic diet and also can occur in large infestations.

The assignees in the overall data for species of relevance to Mozambique range across a spectrum from biotechnology (e.g.. Genentech, Monsanto and Syngenta), companies such as BASF and Sumitomo Chemical Co in areas such as biocides/insecticides and other agricultural concerns (i.e. Du Pont). More detailed analysis of technology areas revealed pharmaceutical companies such as Pharma Mar SA which specializes in searching for pharmaceutical products from marine environments. Suntory is a producer of alcoholic beverages and soft drinks which conducted research into gene encoding a protein that catalyzes biosynthesis of piperitol and sesamin to produce more productive sesame plants. Mary Kay Inc developed topical skincare products using extracts of plants. As this makes clear there are a wide range of general and specialised technology areas and markets of relevance to biodiversity from Mozambique.

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

Species from Mozambique in Patent Data:

In total we identified 10 species of organisms that were directly sourced from, or potentially originate from, Mozambique based on distribution data. Plate 4 displays the species for Mozambique 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, species identified as having been identified as being obtained from Mozambique or having Mozambican distribution are very different to those in Plate 3. This reflects the large number of cosmopolitan agricultural species found in the global data. The top species seen on Plate 4 is a strain of a *Micromonosporaceae* bacteria. This is a newly identified strain collected close to the Mozambique coast. The strain is the source of PM-93135 which has antibacterial properties and a new thiodepsipeptide which has anticancer activity. (Pharma Mar SA - WO1995027730A1).

Lippia javanica, a species of verbena, is a plant traditionally used in medicine. In this case R. De Wolff and Nonit LLC have patented an insect repellent using essential oils as an alternative to synthetic repellents.

Sesamum alatum is a wild variety of sesame. Suntory Holdings Ltd have researched the use of a catalytic enzyme and identified a gene which encodes that enzyme in a variety of sesame species (US2007271624A1).

Brackenridgea zanguebarica, a small tree/shrub from which bark extract has been used in traditional medicine as a cure-all. More recently the tree has yielded some anticancer treatments. EP0126691 (Inverni Della Beffa and S.O.R.I) relates to a method for extracting a compound containing sequoiaflavone from the tree for use as a therapeutic agent.

Elephantorrhiza elephantina is famous as being an ‘underground tree’, due to the nature of the plant which has nearly all of its biomass under the soil, showing just small stems with leaves and flowers above the ground. It grows in grasslands. CSIR (EP2214688A2) takes an extract from the plant for the pharmaceutical use of treating prostatic hyperplasia.

Rice (*Oryza sativa*) is grown across the world as a food crop. The variety ‘Gigante’ from Mozambique is notable for its resistance to rice yellow mottle virus. In research carried out by IRD (US7132514B1) it is being crossed with other varieties to capture markers of the locus of the gene with this resistance.

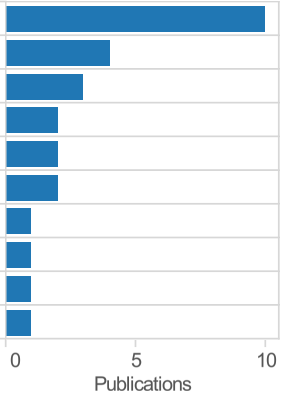
Biophytum petersianum, an annual herb which in Mali is used as a medicinal plant, grows throughout many sub-Saharan countries. A patent application for its use in a cosmetic skincare composition which includes a number of other plants was made by Mary Kay Inc (WO20102033634A2).

Millettia stuhlmanni commonly known as Panga panga, this is a widespread tropical tree used in the timber industry and is one of Mozambique’s major timber crops. Natcure Sciences (WO2011109353A2) claims an immunosuppressant extracted from the close relative *M. laurentii* for use against autoimmune conditions, transplant rejections and cancer. The patent applications claims that *M. stuhlmanni* is an alternative source for the immunosuppressant.

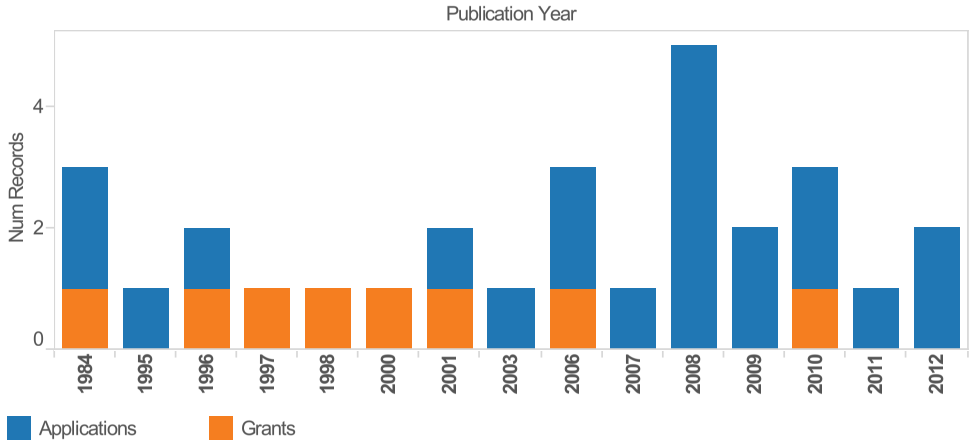
Sclerocarya birrea, the Marula, is a medium-sized deciduous tree, indigenous to the Miombo woodlands of Southern Africa, the Sudano-Sahelian range of West Africa, and Madagascar. A process of extracting novel antioxidants is the focus of patent application WO2006097806A1 by Pierre Charlier de Chily et. al..

Species

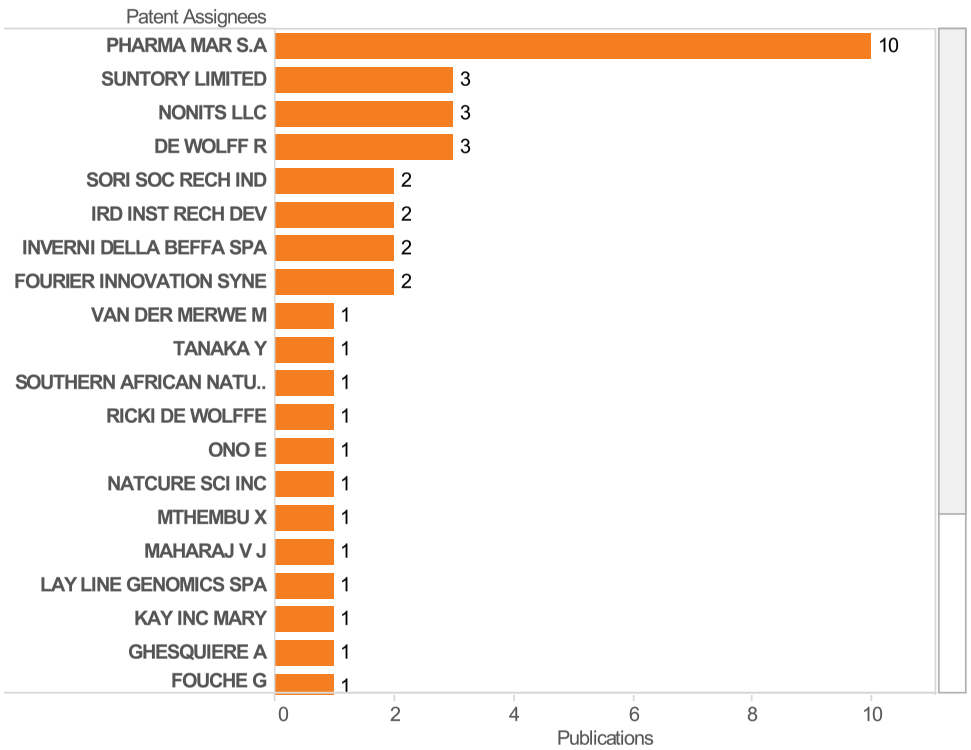
Species	Kingdom	Distribution	Data Type
Micromonospora sp strain	Bacteria	Uncertain	Origin
Lippia javanica	Plantae	Cosmopolitan	Distribution
Sesamum alatum	Plantae	Cosmopolitan	Distribution
Brackenridgea zanguebari..	Plantae	Cosmopolitan	Origin
Elephantorrhiza elephantina	Plantae	Cosmopolitan	Distribution
Oryza sativa (Var Gigante)	Plantae	Uncertain	Origin
Biophytum petersianum	Plantae	Cosmopolitan	Distribution
Millettia stuhlmannii	Plantae	Cosmopolitan	Origin
Nothobranchius rachovi	Animalia	Cosmopolitan	Origin
Sclerocarya birrea	Plantae	Cosmopolitan	Distribution



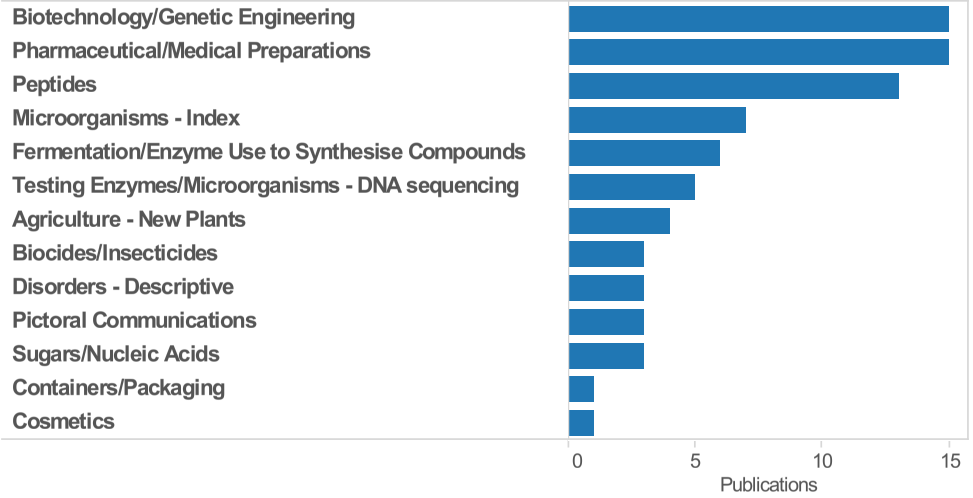
Trends



Assignees



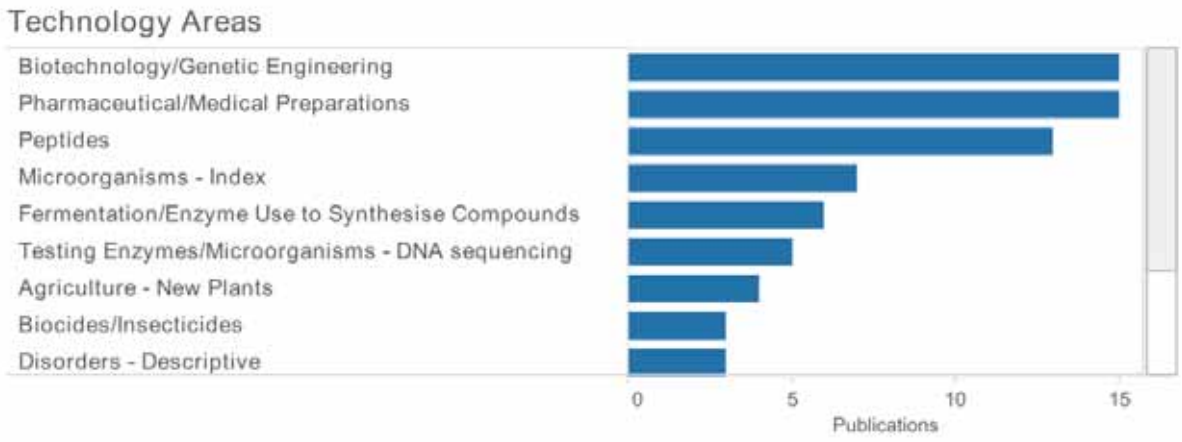
Technology Areas

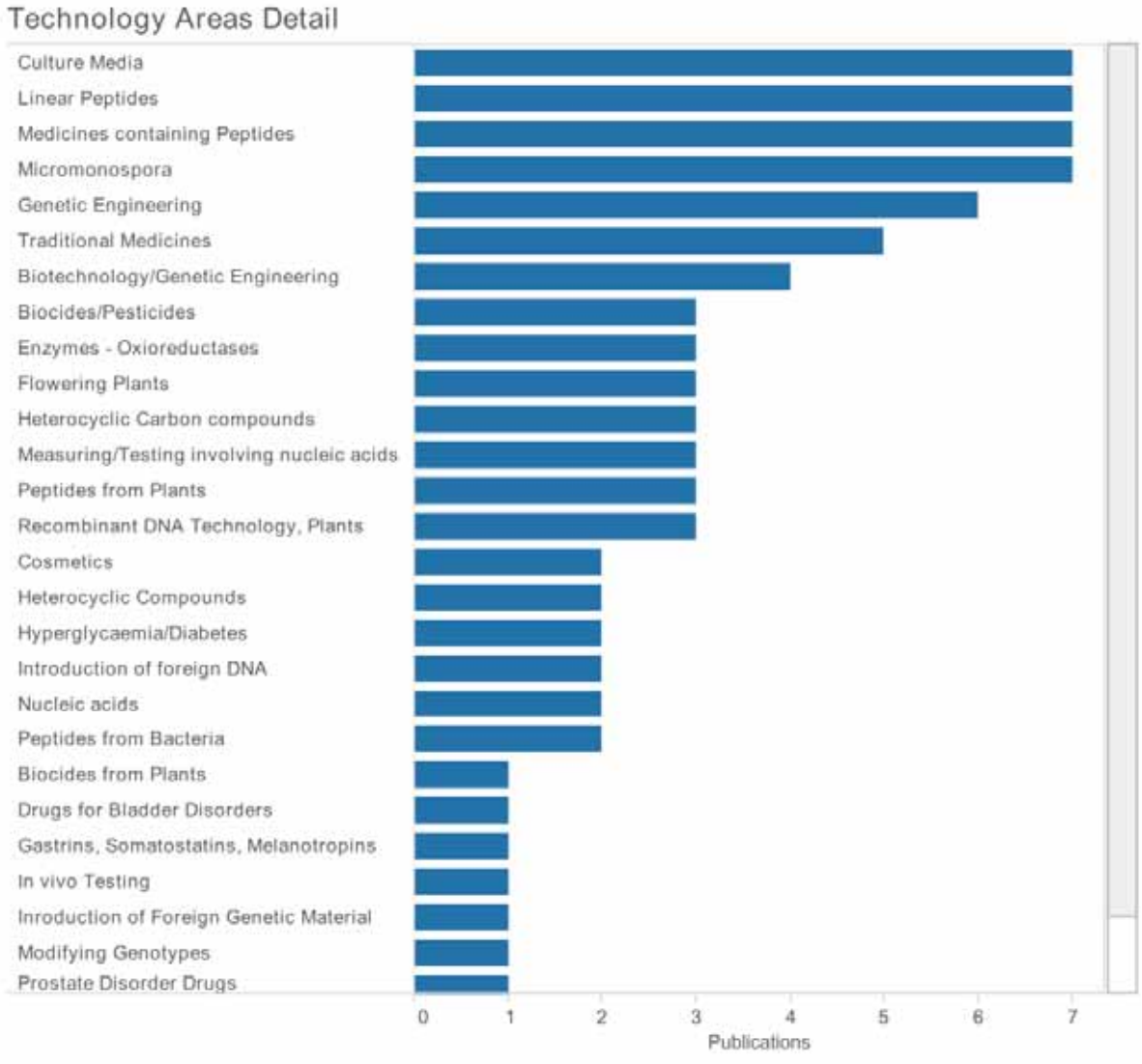


Technology Areas:

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

Table 2: Technology Areas



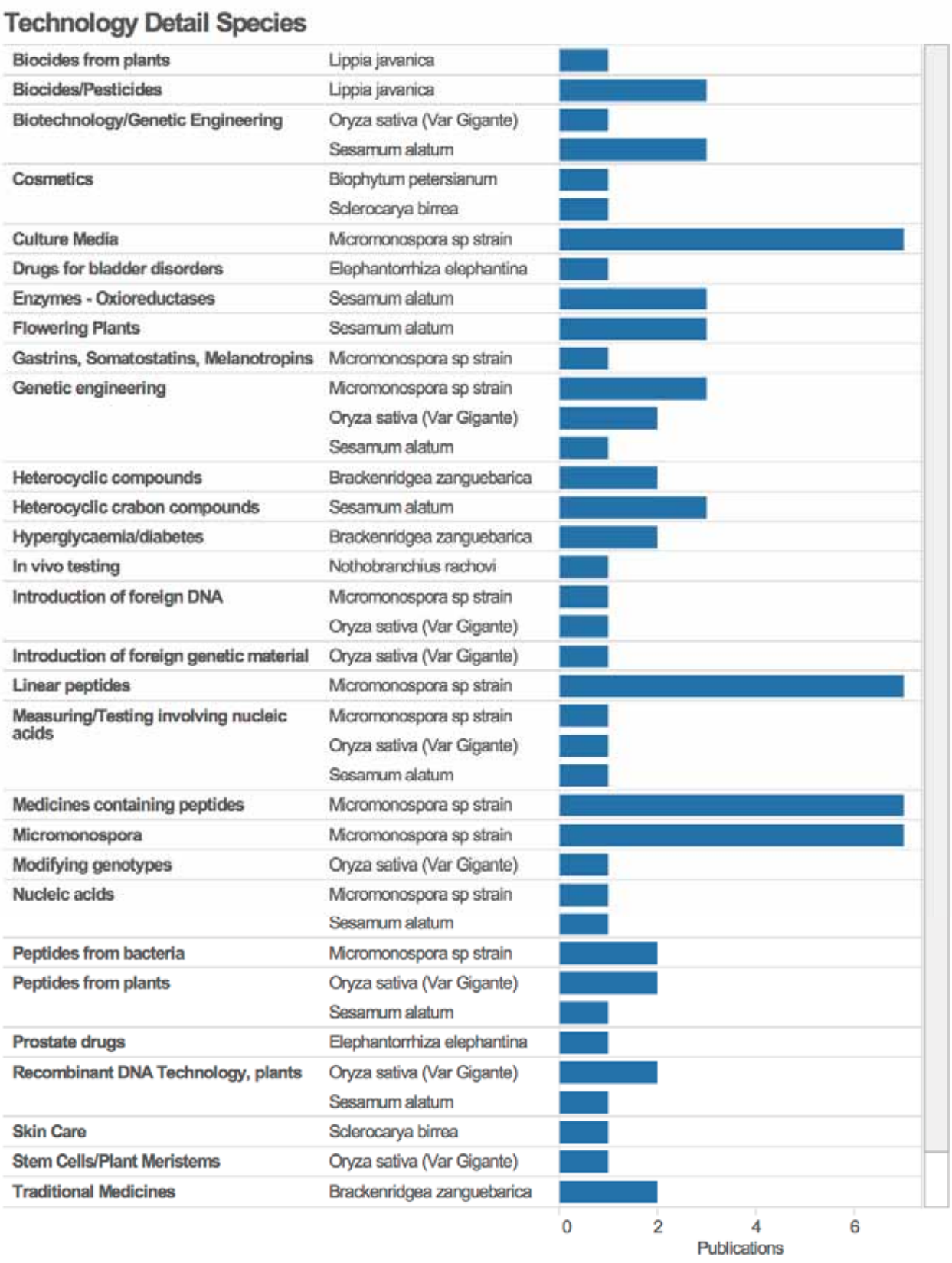


The general overview of technology areas provided in Plate 3 emphasised biotechnology/ genetic engineering and pharmaceuticals. The narrower dataset that focuses on species from, or likely to originate from, Mozambique repeats this pattern. It should be noted when looking at the visualizations of the data that, due to the small number of species and documents associated with Mozambique, many of the clusters of closely related technological areas refer to the same species and documents. For example: the first four top rated technology area details; culture media, linear peptides, medicines containing peptides and Micromonospora all refer to documents by Pharma Mar SA assigned documents relating to their work with *Micromonospora sp.* strains. Similarly, for example, species related to genetic engineering may also be related to pharmaceutical research and products.

Patent activity in the field of biotechnology and genetic engineering involves species such as the *Micromonospora sp*. strain isolated in the Indian Ocean and the two crop species *Oryza sativa* and *Sesamum alatum*. It is interesting to note that global data of species relevant to Mozambique shown in Plate 3 was also dominated by crop species and assignees with interests in genetically modified crops. Also the killifish *Nothrobranchius rachovi* was used in research into the genetic elements of aging. The use of plant extracts for pharmaceutical compounds is represented by *Brackenridgea zanguebarica* and *Elephantorrhiza elephantina,* both of which are plants used in traditional medicines. *Lippia javanica* is another species with traditional medicinal uses; in this case the use of essential oils was for a non-synthetic pesticide. Another pharmaceutically valuable species was the timber tree *Millettia stuhlmanni* from which immunosuppressant extracts were derived. Finally cosmetic products were derived from two species: *Biophytum petersianum* (a skin treatment) and *Sclerocarya birrea* (an antioxidant with several potential applications). A breakdown of technology areas for a sample of species is provided in Table 3.

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.

Table 3: Species and Technology Areas



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 Mozambique.

Table 4 reveals that the top two categories of patent claims reference compounds and compositions. These can encompass a variety of claimed inventions. For example, Pharma Mar SA claims “1. A compound referred herein as PM-93135, substantially free of any cellular debris of micromonospora sp. and having the following formula: and pharmaceutically acceptable salts thereof. 2. A pharmaceutical composition comprising the compound PM-93135 and a pharmaceutically acceptable carrier or diluent ” (US5681813A). As can be seen from this example the assignee claims a compound (PM-93135) and a composition in which the compound is used. In contrast, L. Ackerman and the Council for Scientific and Industrial Research of South Africa claim “The use of an extract of a plant of the genus Elephantorrhiza and at least one compound selected from quertcitin-3’)-glucoside, trans 3-0-galloyl-3,3’,5,5’,7 pentahydroxiflavan taxifolin-3’-0-glucoside, catechin and epicatechin in the preparation of a medicament…” (EP2214688A2). In this case the claim is for the composition alone, but includes compounds in addition to the named species. The phrase ‘use of an extract’ in the first claim suggests that it is not the extract itself which is the subject of the claim.

Compositions are commonly extracts, compounds or combinations of ingredients (e.g. 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.

The third category is genes/genetics. In the case of Mozambique, this category involves patent activity by Suntory Limited involving *Sesanum alatum* for a gene encoding an enzyme for catalysing biosynthesis of Lignan. In another case Mary Kay Inc is focusing on a topical skin care composition from plant extracts that inhibit the expression of the COX-1 gene. Patent claims in connection with genetics typically include references to a defined DNA or amino acid sequence (known as an SEQ ID) and may be constructed to claim similar sequences based on percentages of sequence identity. DNA related patent claims

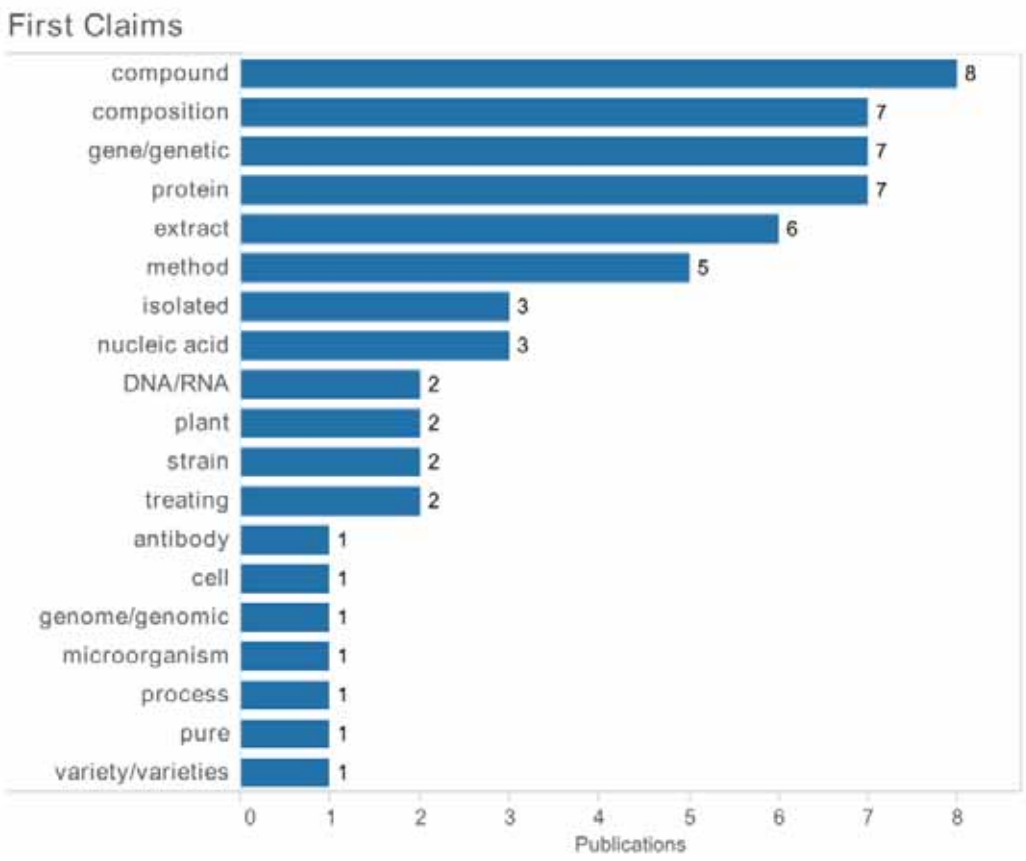
have generated considerable controversy because it is difficult to invent around a specific DNA sequence involved in the expression of useful products such as enzymes (proteins that function as catalysts) or sequences involved in diagnosing suspectibility to particular conditions (i.e. Breast cancer). The patentability of DNA has recently been the subject of a widely publicised US Supreme Court decision in *AMP v. Myriad Genetics* that naturally occurring DNA is not patentable subject matter. However, cloned DNA (cDNA) is patentable. In Europe DNA is treated as simply another chemical compound from the perspective of patentability. The majority of patent offices have significantly tightened the criteria for DNA related patent applications. Looking beyond important moral and ethical debates on DNA patents, the main issue raised is the difficulty of inventing around DNA patents for particular expression products and the ability of patent holders to block others from developing products that use protected sequences.

Another key 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.

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. WIPO has a valuable role to play in facilitating high quality research on issues of concern to developing countries, such as patent landscapes for particular compounds or drugs, and is recommended.

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



Global Impacts and Global Markets:

We have seen above that a range of species are involved in patent activity of relevance to Mozambique. 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 Mozambique. 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 number of times 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 (e.g. *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.

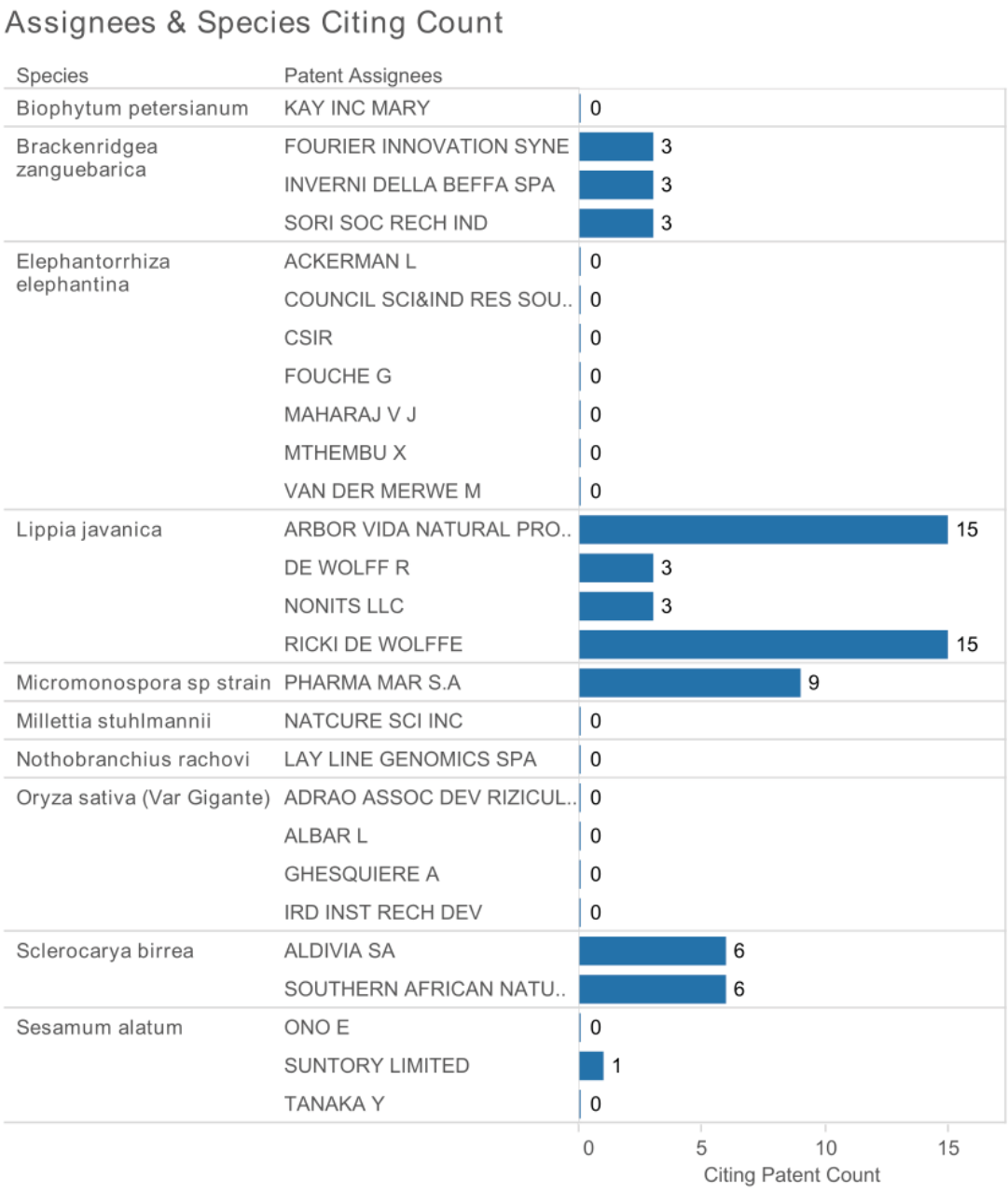
In the case of Mozambique Table 5 reveals a selection of citation scores for species of relevance to Mozambique organised by species and assignee. The top cited species

receives 15 citations in 1 document from Arbor Vida Natural products LLC & Ricki de Wolffe involving *Lippia javanica* for “Essential oil compositions for killing or repelling ectoparasites and pests and methods for their use thereof” (US20080193387A1). Pharma Mar SA receives a total of 9 citations for a set of 2 documents involving *Micromonospora sp.* strains wherein “A new thiodepsipeptide is isolated from a marine actinomycete” (WO1995027730A1 & US5849540A) for use as an anticancer treatment.

Aldivia SA and the South African Natural Products Trade Association receives 6 citations for one application referencing *Sclerocarya birrea* (Marula) for novel antioxidants and methods for obtaining them from various parts of the Marula tree (WO2006097806A1). In this document the antioxidants produced are listed as being of use in “food (e.g. kitchen oils), cosmetics (e.g. care creams), parapharmacy, nutraceutic agent, lubricants, paintings, inks and adhesives (cross linking agents), chemistry and lipid chemistry”. As such patent activity may provide an indicator of the potential technology area uses of a species.

None of these figures are particularly high, however they do indicate that there is further economic potential for the species connected to the above inventions.

Table 5: Species and Assignee Citing Patents



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.[3] 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.

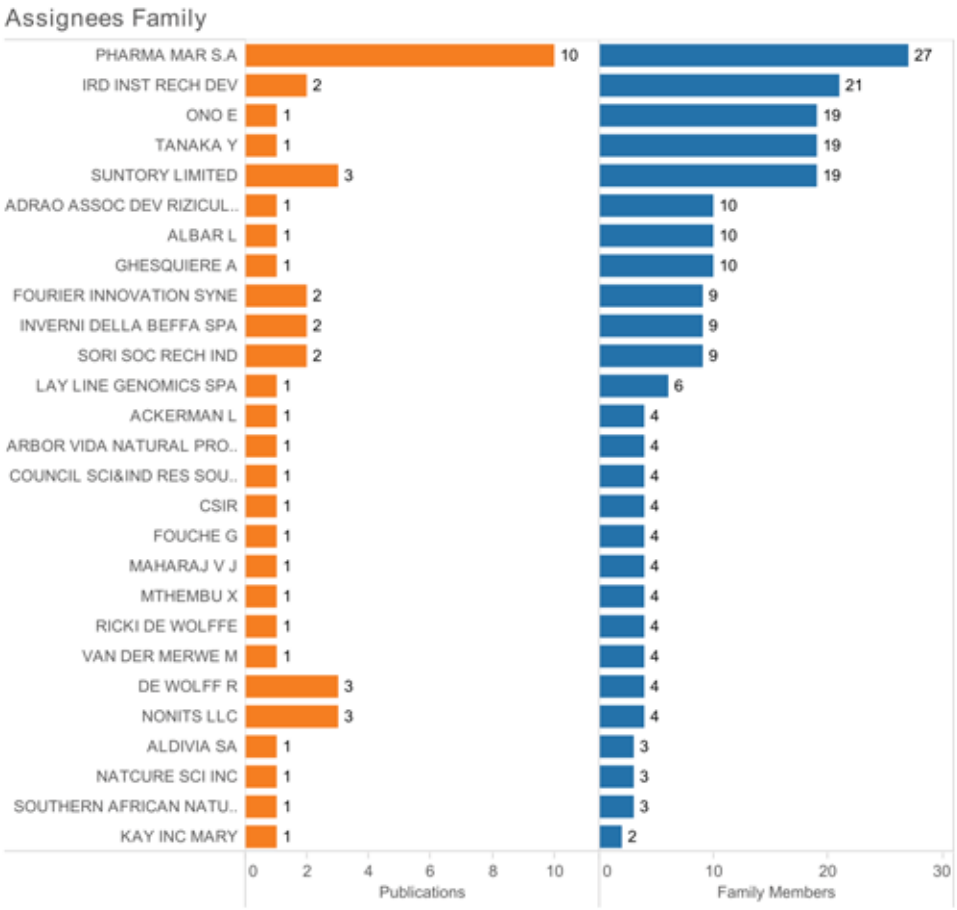
[3] INPADOC stands for the International Patent Documentation Centre which established the system. INPADOC is now part of the European Patent Office.

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 the Pharma Mar SA mainly focuses on methods of treating tumors with thiodepsipeptides obtained from *Micromonospora sp.* strains (e.g. US6214793B1) and the isolation of said thiodepsipeptide (e.g. US5681813A). Pharma Mar SA is a company which specializes in the search for novel compounds from marine environments for use in the pharmaceutical industry. As such it is clear that the discovery and development of the thiodepsipeptides is of significant economic importance to the core purpose of the company and has resulted in a family of 27 documents. It is also significant that this family of patents is the most cited as shown above. The second ranked family of documents is from IRD and involves rice (*Oryza sativa var. Gigante)* and a method for identifying molecular markers in a variety of rice from Mozambique which has the potential to produce new varieties of the crop which are resistant to rice yellow mottle virus. IRD is the French Institute of Research for Development. In an environment where genetic development of crops is of significant economic and social importance it is no surprise that this work has generated a family of 21 further documents across the world.

Suntory Limited has the next largest family group with 19 family members from three documents. One of these documents (KR2012029487A) is co-authored with E Ono and K Tanaka. As stated above this patent falls within the field of biotechnology and concerns the genetic encoding of an enzyme in sesame in order to affect the production within the plant of lignan by using the wild variant of sesame, *Sesamum alatum.*

The plant *Brackenridgea zanguebarica,* which has been used in traditional medicine for the treatment of snake venom among other ailments, is the focus of the invention for Fourier Innovation Syne, Inverni Della Beffa Spa and SORI Soc Rech Ind in EP126691A1 in which they claim for the method of extracting sequoiaflavines from the leaves and the use of the extract as a vasodilator for the treatment of circulatory complaints. This document along with FR2546065A1 has a family of a further nine documents and has been cited three times

Table 6: Patent Assignees and Patent Families

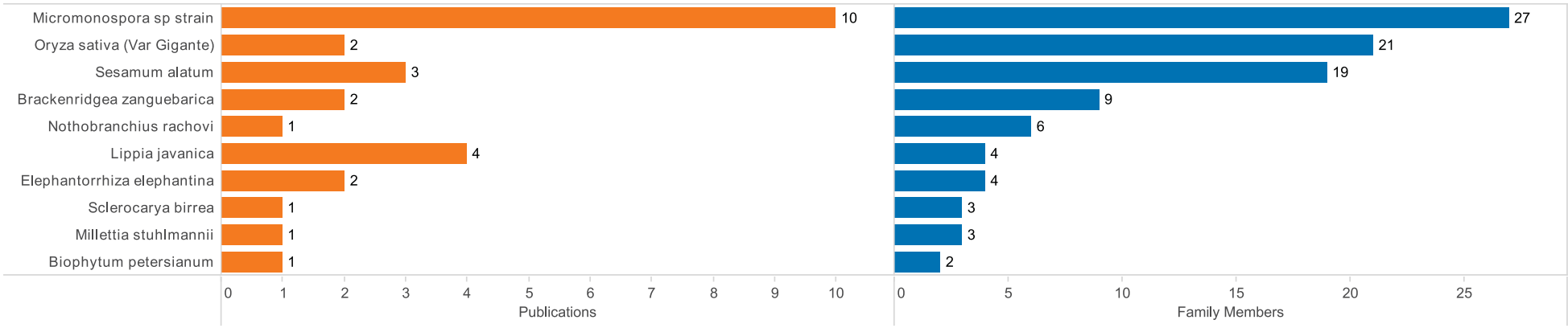


This type of analysis can be extended to the species level to consider the global impacts of patent activity and the position of patents involving a species in global markets.

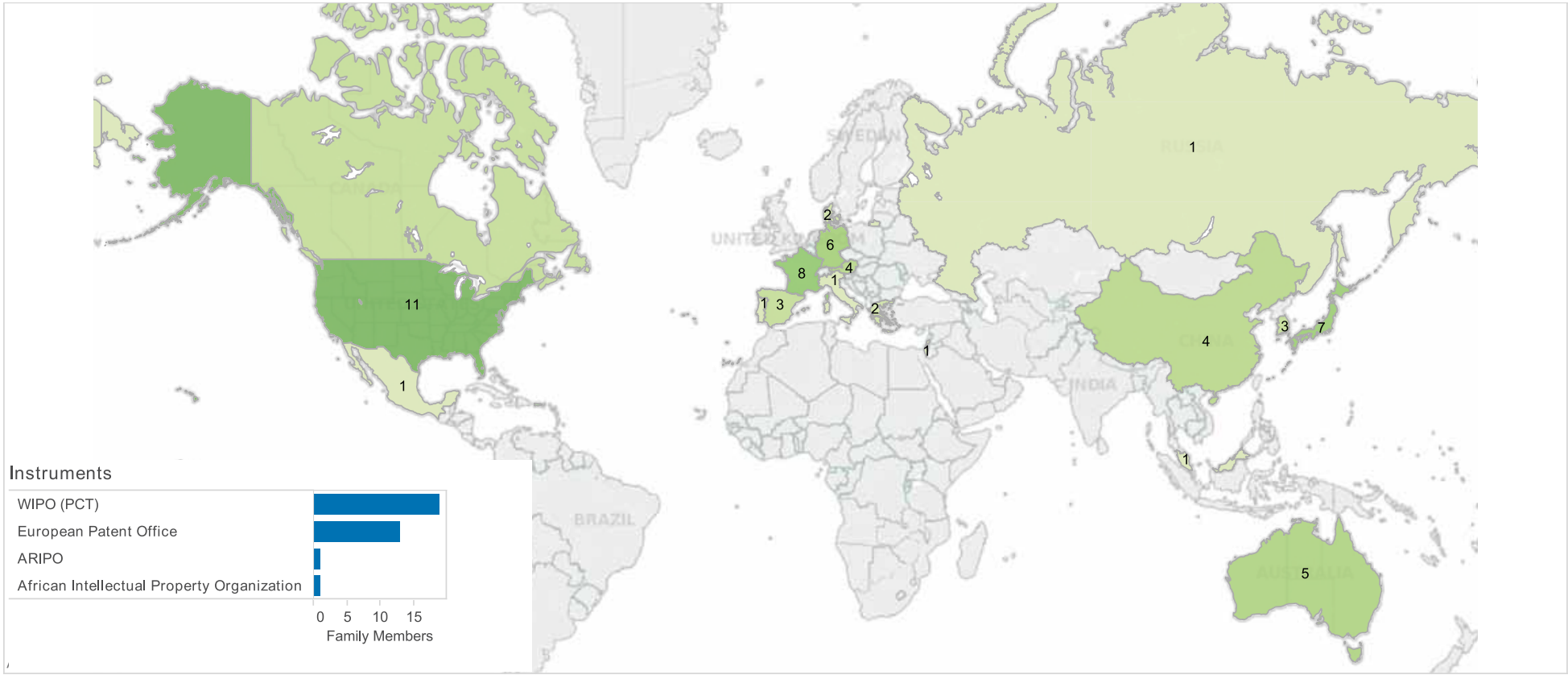
Plate 5 displays patent family data by species and a global map of countries where family members linked to the species have been recorded. Plate 5 is useful because it reveals what might be called the global reach or careers of species. We can immediately see the prominence of *Micromonospora sp.* strain and the crops *Oryza sativa* and *Sesamum alatum* 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 France also prominent. However, Japan, Germany, Australia and China are also emerging into this landscape. It is also striking that available data suggests that patent applicants are not pursuing protection in Mozambique or other African countries. 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 Mozambique.

Species Family



Family Countries



Concluding Remarks:

Mozambique has been striking due to the relatively low number of species found in documents where it has been explicitly stated that they have been collected in Mozambique, and the very low number of species where GBIF records suggest distribution is restricted to Mozambique. This is particularly surprising when it is considered that its neighbour South Africa had some of the highest figures obtained during the course of preparing the reports on African countries, and that Mozambique has a substantial coastline along the biologically-rich Indian Ocean. It is likely that the results of this analysis would be more extensive were the records submitted to GBIF more comprehensive.

The purpose of this report has been to highlight the existing and potential role of species of relevance to Mozambique 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 Mozambique or where distribution data suggests that Mozambique 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.

Species Summary Tables

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

a) Of Mozambican origin - Patents where a named species has been identified as having been obtained from Mozambique.
b) With Mozambican distribution - Patents where there is no reference to Mozambique but distribution data suggests that the species may have originated from Mozambique (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 Mozambique. It does not refer to the wider patent landscape for the species consisting of the total of 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 a target of the invention (i.e. pathogens)
3. Because they are incorporated into the claims of the invention;
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.

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 Mozambican distribution

Species name: *Biophytum petersianum*	Kingdom: Plantae	
Brief description of species: An annual herb which, in Mali, is used as a medicinal plant, it grows throughout many sub-Saharan countries and the genus includes over 50 species.		
Distribution: Cosmopolitan	No of documents: 1	
WO2012033634A2		
Detail: Extracts used in topical skin care formulations.		

Of Mozambican Origin

Species name: *Brackenridgea zanguebarica*	Kingdom: Plantae	
Brief description of species: A small tree that is used in traditional African medicine as a type of cure-all for many diseases, including the treatment of wounds.		
Distribution: Cosmopolitan	No of documents: 2	
EP0126691A1 FR2546065A1		
Detail: An extract of B. zanguebarica is used as a treatment for arterial and circulatory diseases.		

With Mozambican Distribution

Species name: *Elephantorrhiza elephantina*	Kingdom: Plantae	
Brief description of species: Low growing suffrutex, arising from a massive underground tuberous root. The branched root system often forms extensive colonies of visible plants.		
Distribution: Cosmopolitan	No of documents: 2	
US20100316748A1 EP2214688A2		
Detail: A medicinal use of a plant extract for treatment of benign prostatic hyperplasia (BPH).		

With Mozambican Distribution

Species name: *Lippia javanica*	Kingdom: Plantae	
Brief description of species: A tropical member of the verbena family. Used as a source for herbal medicines.		
Distribution: Cosmopolitan	No of documents: 4	
WO2008101131A1 US2008193387A1 EP2124576A1 CA2678357A1		
Detail: Pest repellent composition made from aromatic plants and utilizing L. javanica essential oils.		

Of Mozambican Origin

Species name: *Micromonospora sp. strain L-13-ACM2-092*	Kingdom: Bacteria	No Available Image
Brief description of species: Micromonospora is a genus of bacteria of the family Micromonosporaceae. They are gram-positive, spore-forming, generally aerobic, and form a branched mycelium; they occur as saprotrophic forms in soil and water.		
Distribution: Uncertain	No of documents: 10	
WO1995027730A1 US20090130675A1 US6214793B1 US5849540A US5681813A KR2008032641A EP702691B1 EP702691A1 DE69517761T2 AU2006274822A1		
Detail: The strain L-13-ACM2-092 was isolated from Mozambique soft coral, used against some cancer cell lines by the synthesizing of thiocoraline.		

With Mozambican Origin

Species name: *Millettia stuhlmanni*	Kingdom: Plantae	
Brief description of species: Commonly known as Panga panga, this is a widespread tropical tree used in the timber industry.		
Distribution: Cosmopolitan	No of documents: 2	
WO2011109353A2 US20130142895A1		
Detail: Immunosuppressant extracted from the tree.		

With Mozambican Origin

Species name: *Nothobranchius rachovii*	Kingdom: Animalia	
Brief description of species: Fresh water annual killifish from Mozambique and South Africa. Another species is subject to a patent concerning aging processes		
Distribution: Cosmopolitan	No of documents: 1	
WO2006106558A2		
Detail: Research into the genetic causes of aging using isolated natural populations of *Nothrobranchius* species.		

With Mozambican Origin

Species name: *Oryza sativa (Var Gigante)*	Kingdom: Plantae	
Brief description of species: Rice, cultivated in wet tropical, semi-tropical, and warm temperate areas around the world for the production of its cereal grain.		
Distribution: Uncertain	No of documents: 2	
US7132514B1 US20030093830A1		
Detail: The variety ‘Gigante’ from Mozambique is notable for its resistance to to rice yellow mottle virus and is being used to cross with other varieties to capture this aspect.		

With Mozambican Distribution

Species name: *Sclerocarya birrea*	Kingdom: Plantae	
Brief description of species: *Sclerocarya birrea,* the Marula, is a medium-sized dioecious tree, indigenous to the miombo woodlands of Southern Africa, the Sudano-Sahelian range of West Africa, and Madagascar.		
Distribution: Cosmopolitan	No of documents: 1	
WO2006097806A1		
Detail: Method for extracting anti-oxidants from Marula.		

With Mozambican Distribution

<table>
<tr><td>Species name:
Sesamum alatum</td><td>Kingdom: Plantae</td><td rowspan="2">  </td></tr>
<tr><td colspan="2">Brief description of species:
The annual winged-seed sesame.Sesamum is a genus of approximately 20 species in the flowering plant family Pedaliaceae.</td></tr>
<tr><td colspan="2">Distribution: Cosmopolitan</td><td>No of documents: 3</td></tr>
<tr><td colspan="3">US20070271624A120071122 US7811823B220101012 KR2012029487A_20120326</td></tr>
<tr><td colspan="3">Detail: Genetic modification of sesame using a wild variety.</td></tr>
</table>

Appendix 1.
Distribution map of GBIF records in Mozambique coloured by kingdom.