Communicating safely & effectively using plant names

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ABSTRACT

Professionals working in health, pharmacovigilance, ethnopharmacology and the herbal or pharmaceutical industries all need to access information about plants and to communicate with one another accurately about those plants.

Medicinal plants are used globally and are thus known by different names in different communities, generations and languages. Unfortunately neither 'Trade names' nor 'Pharmacopoeia names' establish the identity of the species effectively and thus become used inconsistently, their meaning evolving over time and become ambiguous. This paper sets out to establish why 'scientific plant names' are our only means for achieving clarity whilst pointing to obstacles to effective communication that currently arise through inappropriate use of such names.

A high percentage of the herbal medicine literature, including international legislation, unfortunately uses scientific names inappropriately and as a result is ambiguous or misleading. This paper describes some of the causes of these confusions and issues including that:

1. there are many more names than plants.
2. one name may refer to more than one plant.
3. names continue to change.
4. opinions differ.

Reference sources exist which can be used to avoid some of these pitfalls and provide answers to many questions and their strengths and weaknesses are reviewed.

This paper describes a new initiative to provide information services in support of professionals, including legislators, that work in health, pharmacovigilance, the herbal and

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pharmaceutical industries or that undertake pharmaceutical research. The services are being designed to help these audiences to use plant names appropriately and navigate safely the rich information sources that already exist for medicinal plants. Input from the user community is sought to ensure that the services built meet practical needs and are sustainable.

INTRODUCTION

As scientists we have a responsibility to communicate precisely and unambiguously with one another and with society as a whole. This is particularly true when dealing with matters that impact upon human health and that includes sharing knowledge about medicinal plants. As many readers will be aware there is frequently a lack of clarity and precision in the use of plant names within the herbal, pharmaceutical and medical literature. As evidenced below however, plant names are frequently misleadingly or ambiguously used. This occurs not only within research literature but even within international legislation intended to safeguard human health or within sophisticated online databases containing chemical or molecular research findings.

WHAT ARE SCIENTIFIC PLANT NAMES?

Generally people are aware that the 'scientific names' of plant species are usually binomials written in Latin: a genus name followed by a species name or 'epithet'. An example would be "*Ficus benghalensis*" where '*Ficus*' is the genus name and '*benghalensis*' is the species name. Many scientists are aware that to be more precise and reduce the chance of ambiguity, the binomial should be followed by the name of the person that first published that binomial; Linnaeus in this case, and which is typically abbreviated to "L.". Thus the complete scientific name for this plant is "*Ficus benghalensis* L.".

Having a name written in Latin consisting of three parts, however, is not sufficient for a plant name to be considered a "scientific" name. Were that the case then "Hocus pocus Bob" would be a scientific name: which it clearly is not.

For a name to be considered "scientific" it must have been formally published following the protocols and recommendations established by the ***International Code of Nomenclature for algae, fungi, and plants*** (***ICN***). The Code is revised every six years and was until last year known as the International Code of Botanical Nomenclature (2006). The code, in essence, formalizes the procedures to be followed by botanists when publishing a new plant. These stipulate that the author should a) provide a unique name, following the binomial convention, b) include a 'diagnosis' stating why this plant is different from other known plants and critically c) cite the physical specimen of that plant which the author has seen and studied in coming to their decision. The latter *type specimens*' are selected to demonstrate the new species' unique set of characteristics (Jeffrey, 1982). These specimens will be uniquely identified by the name of the collector and their collection number and will be stored in a specified herbarium while duplicates may be distributed to other herbaria around the world. Increasingly these "type

specimens" are also available digitally across the internet from resources such as the Global Biodiversity Information Facility (GBIF, 2012) or JSTOR Plant Science (JSTOR, 2012).

This reference to a "type specimen" is the key difference between a scientific name and a common name or other types of name, including trade names or those included in pharmacopoeias. Linking the name to the physical 'type' specimen establishes what that name means for all time. Common, trade or pharmacopoeia names by contrast can evolve over time and be used differently by people in different places. *Centella asiatica* (L.) Urb., for example, is generally called 'brahmi' in north and west India but known as 'mandukaparni' in Kerala. *Bacopa monnieri* (L.) Pennell, by contrast, is 'brahmi' in Kerala and 'mandukaparni' in north and west India (McGuffin et al. 2000).

It is important to clarify that pharmaceutical names (often appearing in pharmacopoeias written in Latin) are not scientific plant names. They are not published using the formal procedures described above and thus no mechanism exists to ensure that a name is always used to refer to the same plant. Confusion between scientific plant names and pharmaceutical names (in Latin), though lamentable, is understandable given that the latter often include the name of a plant (correctly published or not) with a suffix (or prefix) indicating the plant organ used (e.g. 'Radix Rehmanniae'). In this case since the plant name is of a genus it could imply use of many different species with different chemical profiles.

WHY SHOULD WE USE SCIENTIFIC PLANT NAMES?

Only scientific plant names a) are unique and formally published and b) have a meaning which is fixed for all time by reference to physical specimens. Thus only scientific plant names can refer unambiguously and consistently to a given plant species and thus must be used to achieve effective communication about plants. Disputes about the meaning of a scientific name can be resolved by reference to the type specimen. Disputes involving the meaning of a common name, by contrast, ultimately come down to opinion. Thus attempts to standardize their use are difficult to enforce. Despite best attempts (e.g. McGuffin et al. 2000) ambiguity will remain unless common names are standardized by mapping them onto their scientific equivalents.

The use of a historical (neutral) language like Latin brings some advantages. Far more significant benefits derive, however, from an internationally agreed standard approach to botanical nomenclature. Plants grow in many countries. Information about those plants will therefore be written in many languages using many different names. Medicinal plants may be traded internationally and legislation (regarding health, trade or conservation) may exist to control their use (typically citing the scientific name of the plant). We need a plant nomenclature which enables us to convey precisely the identity of a plant regardless of our language, nationality or discipline. We explore how to achieve this later in the article.

WHAT OBSTACLES DO SCIENTIFIC PLANT NAMES PRESENT TO COMMUNICATION?

Despite the protocols for creating and using scientific plant names (described above) there are issues which create obstacles to their effective use and which are explored in the following paragraphs.

Synonyms

To the best of our knowledge there are approximately 350,000 species of flowering plant (Paton et al 2008). More than 900,000 different scientific names have been published for these plants so far i.e. there are many more names than plants. Alternative names for the same plant ("synonyms") are far more frequent for plants that are widely used – such as medicinal plants. Some species have more than 50 different scientific names though most have fewer.

A common cause for synonymy will be that botanists working in past decades and in different countries both "discover" the same plant growing in different places, believe it to be a new species and publish a description and new name for that plant. Before the internet and easy travel they would frequently be unaware of one another's work. In a later study, however, a botanist with better access to published information and able to look at the type specimens of both plants would realize that these two 'species' are in fact one. This botanist would then publish their findings, placing the two names into synonymy: with the earliest being adopted as the 'accepted' scientific name (following the Botanical Code). One benefit of using an 'accepted' scientific name is that it reflects the current taxonomic position of that species (which synonyms may not) thus enhancing our ability to predict the biological and chemical properties of a plant based on their evolutionary relationships. Thus the accepted name of *Fallopia multiflora* (Thunb.) Haraldson (rather than its more widely used synonym *Polygonum multiflorum* Thunb.) demonstrates that other species of the genus *Fallopia* are most likely to share chemical traits (rather than other species of *Polygonum*).

Whether 'accepted' names are adopted by users in different sectors when talking to one another is to some extent a matter of choice (provided that their audience is aware alternative names exist for this plant). Thus where a scientific synonym is in common use within international trade (as is the case with *Polygonum multiflorum* Thunb.) any reluctance to change to the accepted name would be understandable for fear of causing confusion.

Multiple synonyms, however, obstruct users from finding all information published about that plant (since information may appear under any of its name). In this context, the accepted name is critical since it links the synonyms together. For example, Paton et al (2006) suggest that for one medicinal plant in the genus *Plectranthus*, less than 20% of available information was published using the most widely used scientific name of the species. The other 80% of publications used one or other of its synonyms.

When searching Google or even sophisticated online databases such as GenBank or PubMed managed by the National Center for Biotechnology Information (2012), a search with one name alone will retrieve only those publications or database records which used that particular name. You will fail to retrieve other research on that plant which was published under one of its alternative names. In an earlier study of the scientific plant names used within the US National Institute of Health's NCBI database we found that 11% of all records within the NCBI database are stored under names which are synonyms of others (Allkin 2006). Thus to find everything about a plant stored in PubMed, for example, you will need to know ALL of its synonyms and search the database using each name in turn. Where might you find an exhaustive and authoritative list of synonyms for a plant? The Medicinal Plant Name Services, described below, aim to provide this (and much more).

Homonyms

Homonyms arise when different authors working in different countries or epochs publish the same Latin scientific name without knowledge of each other's work. They will be looking at different type specimens and will normally, therefore, be describing different species.

Although homonyms are far less common than synonyms (c. 4% of plant names have homonyms) they can have much more serious consequences for those that are unaware of their existence. A publication that doesn't make explicit which of the two homonyms is intended will be ambiguous. Readers may as a consequence draw erroneous conclusions about either or both plant's chemistry.

Sadly, legislation is not free from such lapses. The EU Commission published decision #OJEC L 2.2.2002 L 33/31, stating that *"the botanical variety **Illicium anisatum** is scientifically recognised as highly poisonous"*. Their intention was to ban the import into Europe of the poisonous plant known by many as 'Japanese Star Anise'. The nomenclatural and taxonomic status of this name is complex. The currently accepted name of the poisonous species is *Illicium anisatum* Linnaeus. However, by omitting the author's name 'Linnaeus', the EU decision left room for ambiguity in its interpretation and implementation since the herbal literature refers to another name *Illicium anisatum* Lour. (not Linnaeus) as a synonym of the non-toxic Star Anise, *Illicium verum* Hook.f. It is thus possible to interpret the EU decision as banning the import of Star Anise which was not their intention. This situation is more complex still since there are further homonyms of the name including *Illicium anisatum* Gaertn. and *Illicium anisatum* Bartr. ex Michx., that, once the systematics are fully understood, might ultimately prove to refer to two further species with different chemistry and uses.

In the study of plant names in the NCBI database referred to above we found that 3.5% of scientific plant names used failed to cite authors and thus potentially link chemical, DNA or molecular records to a plant other than that intended.

You cannot rely on names in the literature

Authors of research papers from diverse fields such as phytochemistry or anthropology published over past decades clearly will not all have used plant names correctly. They may have included a plant name in Latin but without its author and thus referred ambiguously to two or more species. They may simply have misspelled a scientific plant name (particularly common in the author's name) or used a name which was never formally published and therefore not a scientific name at all (despite being written in Latin) and thus which have no type specimen associated nor scientific meaning. Alternatively of course they may have used a Latin scientific name (i.e. a good name) but applied it to the wrong plant (i.e. the identity of the plant they describe is questionable and the name 'misapplied' to the wrong species). Editors of scientific journals or large encyclopedic publications (in print or online) face a challenge in ensuring that all plant names cited are meaningful. A recent paper aimed at those sectors researching the use of Chinese medicinal plants (Chan et al. 2012) evidences the need for and provides guidelines to help researchers understand the complexities of Chinese medicinal plant names and employ them unambiguously.

More surprisingly, national and international legislation also contain errors even though these are intended to protect public health. We are aware of frequent examples from health regulators including those from UK, Europe, USA and Japan in which a piece of legislation cites a plant name which have never been published or is ambiguous. We validated the plant names appearing in several regulator's list of 'controlled plants'. In some lists the same plant appeared several times (under different synonyms) and, worse still, a contradictory legal status was assigned to that plant depending on which name had been used!

Given that scientists find it challenging to use plant names rigorously within their research papers it follows that it is at least as challenging for pharmacovigilance professionals working in poisons clinics to document cases of allergic or other adverse reactions and link them unambiguously to an individual plant. In many situations they may not attempt to record a scientific name and cite only the common name used locally. Such variable and unreliable use of plant names (and synonyms) means that it is difficult for such clinics to share records with one another. The World Health Organisation's Monitoring Centre in Uppsala attempt to collate and share such patient records across their network of national reporting centres, but clearly has a difficult task in reliably detecting all cases relating to a particular species.

Scientific plant names continue to change

It will come as no surprise to this audience that the names of plants used by botanists in past centuries will often have been replaced with a more modern equivalent. Taxonomists have always moved species from one genus to another or split or merged genera based upon chemical or molecular data and more sophisticated analyses. They do this so as to better reflect an increased understanding of the evolutionary relationships between plants

and so as to improve the predictive nature of the taxonomic hierarchy (for example our ability to predict which plants are more likely to share similar chemistry).

Plant names continue to change. For flowering plants at least 10 thousand name changes are published each year. According to the statistics from the IPNI website (IPNI, 2012) between two and three thousand names of newly discovered plants have consistently been published each year (since 2004 when their records began). In the experience of the editors maintaining Kew's World Checklist database (World Checklist, 2012) approximately four thousand names are placed in synonymy with one another each year. Thus, for example, a botanist may determine that two names, previously considered as separate plants, are in reality different names for the same species. The third major cause of name changes arises when taxonomists decide to move a species from one genus to another to better reflect their evolution and their shared morphological, chemical and molecular relationships with other species. This move will, given the "binomial" system described above, require that the name of that species is changed. The genus name will change although the species epithet will ordinarily be retained. Again evidence from management of the World Checklist database suggests that approximately four thousand of these "new combinations" are published each year.

Recognising that names will change with this frequency has two obvious consequences. The first, looking backward, is that perhaps over 10% of currently known scientific plant names will change every 10 years. In the early years the annual rate of publication fluctuated much more but nevertheless over a hundred years you might expect ALL scientific plant names to have changed (or some names to have changed many times). Looking forward there is a second, and possibly more significant consequence, namely that were you to build a complete and correct list of medicinal scientific plant names for a particular encyclopedia, journal or online database it will very quickly get out of date. On average more than 10% of the entries in your index would need to be updated each year in order to reflect current nomenclature and current understanding of their taxonomic relationships. It would be a poor use of scarce human resources for the medicinal plant community to make such an effort over and over again for multiple publications and data sets worldwide.

Opinions differ

Finally it must be pointed out that systematic botany is itself a developing science. Our understanding of plant relationships continues to improve and be enriched. The taxonomic opinions included in publications describing the relationships among a particular group of plants will not coincide with those published in the past. Those studying the plants from a single country (to produce a Flora for example) will have access to a different set of data to those working a year ago on the plants of a neighbouring country. They may therefore arrive at different decisions. One invaluable resource for those researching plants is the Tropicos database system from the Missouri Botanical Garden. For a non taxonomist, however, it may not be immediately obvious that within this one database are presented the results of different projects: the Flora of Peru, Flora of

China etc. The authors and editors of these projects are different, worked at different times using different approaches and may have different views as to the nomenclature of a plant found in more than one Flora. This diversity of opinion within a single database illustrates the scale of the challenge facing the pharmacovigilance officer or phytochemist in establishing what botanists believe to be the currently accepted name for a plant (and which names are synonyms of it).

Lack of a central reference resource

For these reasons amongst others medicinal plant names are frequently misused. Health professionals or others working with medicinal plants frequently fail to communicate effectively about their work either with one another or with the public and will also fail to retrieve reliably all published information about a given plant.

For those working in the field, the absence of a single authoritative and global reference resource for medicinal plant names (and their synonyms) is a real obstacle to reliable communication and information retrieval about plants. Some reference resources are available today which partially address the lack of such a resource. The following section lists some of these and outlines their different purposes and their relative strengths.

WHAT NAME RESOURCES CURRENTLY EXIST?

International Plant Names Index (IPNI)

The International Plant Names Index (2012) contains published scientific names (and their associated basic bibliographical details) for seed plants, ferns and fern allies. It is thus a database of scientific plant names rather than of plants. IPNI is the product of collaboration between the Royal Botanic Gardens, Kew, the Harvard University Herbaria and the Australian National Herbarium each of which previously held a digital plant name register which were merged to create a single database.

Currently the IPNI dataset contains more than 1.6 million published scientific names and is the most comprehensive source of such names with well over 95% of all names captured. Names thought to be missing are those recently published (there is a delay in their incorporation) and infraspecific names published before 1970 (which are being added). The data in IPNI are freely available from the website and the resource is actively curated with existing records being standardised and checked as well as new published names being entered. As a source of scientific plant name data IPNI is without parallel. It will enable you to answer the questions: Is this name validly published? Is this name spelt correctly? Who published it? When and where was it published? It will also enable users to establish whether homonyms of this name exist which you need to be careful about.

IPNI does not attempt, however, to answer questions about synonymy. It was not designed to do this and cannot be used for this purpose. As a source of name data IPNI is primarily of use to taxonomists undertaking systematic research and the website interface reflects this.

World Checklist

The World Checklist (2012) of Selected Plant families contains monographic (global) treatments of all the plants in 173 plant families. It provides information on the accepted scientific name and synonyms of every species (and subspecies) along with a list of those areas of the world in which the plant grows and basic information on its habitat. The database, available through the website, includes complete data for more than 120,000 plants (including more than 320,000 different scientific names).

The website allows the user to find a plant using any of its scientific names, discover what its current 'accepted' name is and to list all scientific synonyms. The website also allows users to list all the plants (from among those families covered) that are found in a particular country or continent.

The data set has been built over 16 years and in addition to the editing team at Kew counts upon the collaboration of 155 specialists from 22 countries who have contributed data or acted as reviewers. The global (rather than country by country) approach combined with peer review means that the data presented are considered reliable and the resource is the largest contributor of data about synonymy to those aggregating data sets such as the Catalogue of Life (2012) and GBIF (2012).

Despite its enormous value as an authoritative, comprehensive and genuinely global synonymised list of plants (with their distributions) this database has limitations. The most obvious of which is that it is currently only complete for 173 families. The remaining 50% of families are being carefully compiled to a similar standard but are not yet available for consultation. A second limitation for herbalists or the general public interested in medicinal plants is that the resource contains neither common names nor images of those plants.

Like IPNI the World Checklist is actively curated and behind the scenes work continues to compile checklists for the remaining families. A further 326,000 scientific names are already registered for about 60,000 plants and are currently being compiled into family lists or peer reviewed by systematic experts internationally.

Despite the incomplete nature of this resource it remains the most reliable source of answers for those seeking questions regarding synonymy and the distribution of plants in those families covered.

The Plant List (TPL)

The Plant List (2010) serves as a 'working list of all known plant species'. Version 1, was released in December 2010, and aimed to be comprehensive for species of vascular plant (flowering plants, conifers, ferns and their allies) and of *bryophytes* (mosses and liverworts). Like the World Checklist above it does not include algae or fungi.

TPL was created in response to the '2010 Target 1 of the UN Convention on Biological Diversity's Global Strategy for Plant Conservations' (CBD 2012; Paton & Nic Lughadha

2012). It was built through collaboration between the Royal Botanic Gardens, Kew and Missouri Botanical Garden who combined multiple checklist datasets held by these institutions and other collaborators. Both IPNI and the World Checklist (published and unpublished) data sets were included within TPL.

The Plant List provides the 'Accepted' scientific name for most species, with links to all 'Synonyms' by which that species has been known. It also includes 'Unresolved names' for which the contributing data sources did not contain sufficient evidence to decide whether they were 'Accepted' or 'Synonym'. Version 1 of TPL contains 1,244,871 scientific plant names of which more than a million are unique Latin 'binomials' the remainder being infraspecific names. Of the binomials included, 298,900 are 'Accepted', 478,000 are 'Synonyms' and 248,000 are 'Unresolved'. These latter names might best be regarded as "provisional species" since their author obviously considered them to be a distinct species when they published the name.

This was the first time, since Linnaeus published Species Plantarum (Linnaeus 1753) that a single list of plants of the world has been completed. An immediate consequence was that we have a clearer idea of how many plants might exist in the world. Were all the provisional species to eventually be confirmed as species then that number would be around 547,000. Were none of the provisional species to turn out to be species then the total number would be around 300,000. The true number (for vascular plants and bryophytes) will be somewhere between.

As a means for those working with medicinal plants to resolve nomenclatural and taxonomic questions, however, TPL is a very valuable resource since it provides family checklists for those families not included within the World Checklist. The lists for these families are not necessarily of the same reliability but they do serve a purpose. By assigning confidence levels to each name record included, TPL helps users judge the reliability of the information presented. Again, TPL contains no images or vernacular or pharmaceutical names.

A significant difference between TPL and the two other resources described previously is that it is not actively curated. Since it was built by merging static copies of various curated databases, to manually edit this data would duplicate the efforts of the authors of the contributing data sets. New versions of TPL are planned, nevertheless, which will merge new versions of the contributing databases with additional data sources.

MEDICINAL PLANT NAME SERVICES

From arguments in the previous sections we can appreciate why those working in herbal medicine or pharmacovigilance find it challenging to use scientific plant names appropriately. As a result their communication and retrieval of information about medicinal plants are neither reliable, safe nor effective. Their failure is, in part, a result of a certain naivety and lack of care about using scientific names, but it is equally the result of a inadequate efforts by the botanical community to communicate clearly with others. In the latter's defence, however, it is an immense task to bring together the millions of plant

name records from diverse books and journals in multiple languages and from all continents. Maintaining and sustaining such compiled data sets to reflect the latest taxonomic research is equally challenging. As outlined above, tools exist to address some of these basic information needs but none is yet complete for all medicinal plants and none has been designed with the particular needs of herbalists, pharmacists or health regulators in mind.

For this reason in November 2011, at the Royal Botanic Gardens, Kew, we began (after many years of planning) a new initiative to design and build a suite of Medicinal Plant Name Services (2012). These services will be targeted not at botanists but at professionals that study, regulate, trade or otherwise need to access information about medicinal plants or to communicate about them. The project has four primary objectives:

- To build a global plant name resource for medicinal plants
- To design and implement services aimed at a broad range of users from health workers, pharmaceutical research, herbalists and legislators
- To create a stakeholder group of interested organizations and individuals to help prioritise and design those services
- To achieve sustainability of these services beyond the end of the current funding

The Medicinal Plant Name Index (MPNI)

We look to build upon and expand Kew's existing plant name data resources by ensuring that our synonymy and distribution data for plants of wide medicinal use are complete and up to date. We envisage linking these validated scientific names with those names that are used in the most significant medicinal sources: other Latin names (even if these were misspelled), pharmacopoeia names and possibly other classes such as trade or common names widely used by our target audiences. Together with our stakeholder group we are evaluating what additional types of information we might most usefully include.

Rather than seeing MPNI as an isolated information resource, we see ourselves as being uniquely placed to provide a core component of a much wider global medicinal plant information network. Thus we seek partnerships with other organizations capable of providing other types of medicinal plant information (chemistry or trade data for example) for which we are not well placed to take the lead. Linking such national and international medicinal information resources, via a validated plant names backbone, would represent a significant step forward for the community that we aim to serve.

We are acutely aware that we must prioritise. Data collation has begun for those plants that are traded internationally and will expand according to the priorities of the stakeholder group.

The Information Services

We use the word "service" to indicate that we will be thinking of novel ways to provide access to information for a range of different users with a range of different needs. How

we build these services will also be shaped by opinions from our stakeholders but we envisage the following classes of Service.

1. A "Medicinal Plant Name Web Portal" will answer individuals' questions about a given plant name. The portal will be designed for our target audience and will link to existing sources of other information.
2. Name validation services will allow organizations or individuals with long lists of medicinal plant names stored in databases or publications to verify that the names in their lists are correctly spelt, reflect current taxonomic research, have complete synonymies included and do not list the same plant twice under alternative names. This service will also enable different agencies to map their own name lists onto those of their collaborators. Our purpose is not to impose a standard nomenclature but facilitate the exchange of information between different information sources.
3. Subscription services will provide organizations that build databases containing information about medicinal plants with the opportunity to obtain periodic downloads of validated plant name lists for their use.
4. Web-services (or API interfaces) enabling those with more sophisticated databases to build in live links from their IT systems directly to the Medicinal Plant Name Index and to extract the correct spelling of a scientific name, the accepted name or all synonyms of a plant as and when they need that information; assured of obtaining the most up-to-date and authoritative view possible without spending time and effort maintaining their own plant lists. These web-services might for example be used by journal editors to ensure that the plant names being entered into new published articles are valid scientific names or might be used by a research database to compile a list of all known synonyms of a plant before undertaking a search of the internet for published research involving that plant (an "intelligent Google" facility).
5. "Producing and disseminating "good practice" guidelines to advise the broader community on how to make the most effective use of plant names when communicating, publishing or retrieving information about medicinal plants, including those bodies creating data standards to address interoperability between health information systems.
6. "Producing and disseminating "good practice" guidelines to advise the broader community on how to ensure clarity and precision when using medicinal plant names to communicate, publish or retrieve information about those plants; including agencies creating data standards designed to facilitate data exchange between information systems.
7. Tailored consultancies for individual organizations such as advice on appropriate workflows for managing scientific plant names, support for information retrieval within Research and Development facilities, guidance on how to build bioinformatics systems to manage plant name records. We can also support Kew's other related services notably those on medicinal plant authentication (Royal Botanic Gardens, Kew 2012).

Stakeholder Engagement

We are forming a Stakeholder group to work closely with us to establish the priorities for data capture and design and test the information services that we build. This group will ideally have a good representation geographically and across disciplines. We are eager to speak to organizations willing to offer their time and advice.

Sustainability

To build a superb information resource and sophisticated services which have no use or further development beyond the end of our research funding would be a poor use of resources. Our strategic goal is therefore to achieve a level of long-term sustainability for these services by which we understand that a) some data will continue to be collated, edited and kept up to date; b) services will continue to be maintained and enhanced to meet new needs and to adapt to technological change and c) the services will become part of the information landscape in which professionals in the target fields will be accustomed to working.

Achieving sustainability is probably our biggest challenge and depends upon numerous factors of which the following are some threads. We seek

1 direct engagement with users from various communities to help improve the utility of the services and spread the word.

2. partnerships with other organizations who manage medicinal plant knowledge and have capacities and expertise complementary to our own and the mechanisms to link and integrate these systems.
3. to provide professional services through “service level agreements” with all users so as to define what level of service can be expected;
4. to provide free access to data for individuals and non-profit organisations whilst obtaining an understanding about how they use data derived from us.
5. to understand and document the cost savings which we can help organizations achieve by avoiding their own plant name compilation exercises and the need to maintain that set of names over time.
6. to charge for consultancy services tailored for individual organizations and to recoup costs from users so as to help support development of these services over time.

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