Part C: The Plant Collection – Linchpin of the Botanic Garden

Chapter 3: No plant collection without a strategy or policy

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Contents

CHAPTER 3: NO PLANT COLLECTION WITHOUT A STRATEGY OR POLICY

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3.0 DEFINITIONS

Accession: Plant material (individual or group) of a single taxon and propagule type with identical or closely similar parentage acquired from one source at the same time. For tracking purposes, an accession is catalogued and assigned a unique identifier (number or code) associated with additional information.

Acquisition: Plant material prior to being accepted into the plant collection and catalogued as an accession. The term can also denote the process of gathering plant material before its incorporation into the plant holdings of the botanic garden.

Collection policy: A written, accessible document outlining the purpose and scope of the plant collection along with specific guidelines for the botanic garden aiding acquisition, management and de-accessioning of the plant material.

De-accessioning: The process of removal of all or part of the accession from the botanic garden, while related plant information is retained in the database.

***Index* (pl. *Indices*) *seminum*:** A catalogue, published periodically by botanic gardens or arboreta, with seed gathered from the wild and/or through cultivation. Seeds are offered for free, or for exchange, to other botanical institutions.

Material Transfer Agreement (MTA): A document sent in advance outlining the conditions of transfer of plant material to another organisation. It specifies the donor's terms and restrictions on the use of the material by the recipient organisation that must be agreed prior to the plant material transfer.

Provenance: The original source of the plant material. The term is used both to denote a location (wild population or nursery-grown) and a concept (wild-collected or cultivated stock).

Taxon (pl. taxa): Group of plants that form a named unit. For example, *Dahlia dissecta* is one taxon, whereas *Dahlia dissecta* var. *sublignosa* is another.

3.1 INTRODUCTION

KEY MESSAGE

A collection policy is a fundamental and strategic document for any botanic garden. It guides the development and management of the plant collections, and prevents managers from straying from the collections' intended content and function.

The global botanic garden community holds an abundance of plant material and related data with great environmental, socio-economic and cultural relevance to research, conservation, education, display and amenity. However, botanic gardens need to be aware of current and future challenges when developing their collections and acquiring new plant material. At a time of rapid global change and unprecedented threats to plant diversity, high quality collections curated for a clear purpose are the backbone of any botanic garden. A comprehensive collection policy will articulate the rationale for the plant holdings of a botanic garden, and will provide informed guidance for management and future development of the collections.

3.2 CULTIVATING PLANTS FOR A PURPOSE

The term 'collection policy' refers to both, living (e.g. plants, seed, fungi, lichens) and non-living (e.g. data records, herbarium vouchers, photographs) elements maintained in botanic gardens. Plant material will come with associated, documented information as discussed in this chapter which characterises an institution as a botanic garden.

Why is a collection policy important?

A collection policy is a vital and strategic document for any botanic garden. Without such a policy, collections can easily stray from their intended content and function (Rae, 2006a; Rae, 2006b; Gates, 2007). A collection policy provides content and management guidance and ensures that plant holdings reflect the organisation's vision and mission (Chapter 1, Section 1.2.4). The absence of a clearly defined collection policy may result in inefficient use of core funds that can challenge the future justification and viability of an organisation. In spite of this, many botanic gardens have pursued an ad hoc approach to collections acquisition and retention. A global survey of botanic gardens (Aplin, 2014) revealed that 61% of 172 responding institutions had no formal, written policy guiding curatorial activity. A collection policy helps a botanic garden to:

- Set overarching principles and guidance, enabling staff to make decisions more efficiently without constant reference to senior managers;
- Create confidence and stability in collection development and management so that key decision-making is unaffected by staff turnover;
- Promote good governance to facilitate resources being targeted where they are most needed;
- Focus fundraising efforts and provide confidence to funders that money is wisely spent;
- Ensure plants are grown for their intended purpose and in the required quantities;
- Facilitate proactive or forward-thinking management;
- Provide an opportunity to review current curation practice and highlight opportunities for improvement and development;
- Enhance communication between departments.

3.3 SCOPE AND DEVELOPMENT OF THE COLLECTION POLICY

KEY MESSAGE

Every collection policy is different reflecting the specific vision and mission of the institution. The process of policy development, however, is similar with any botanic garden in that every stage should involve close stakeholder consultation and review.

3.3.1 Scope of the Collection Policy

There is no shortcut to developing a collection policy. Many aspects are specific to the institution and should be discussed with all relevant stakeholders. Collection policies vary in the amount of detail included but generally address a standard set of topics (Box 3.1). A typical collection policy will provide specific advice on the acquisition and transfer of material and standards of documentation, and may include specific topics, such as 'Collection of plant material in the field' and 'Procedure for labelling'. The collection policy often interconnects with areas beyond the direct responsibility of the living collections, for instance with the herbarium or the botanic garden's approach to interpretation (Chapter 7, Section 7.3). For this reason, it is important for all stakeholders involved in collection management to contribute to setting the scope of the collection policy prior to its development (Case study 3.1).

Staff of the Ethiopian Biodiversity Institute share ideas for developing a collection policy for Shashamene Botanic Garden during a BGCI training workshop. (Image: BGCI)

CASE STUDY 3.1

Developing collection policies for botanic gardens in Ethiopia

Kirsty Shaw, Richmond, United Kingdom

Situated in the Horn of Africa, Ethiopia holds one of the richest assemblages of plants on the African continent. The Ethiopian government, notably the Ethiopian Biodiversity Institute (EBI) which is mandated to coordinate work of botanic gardens in the country, as well as universities across the country, are committed to establishing and reviving botanic gardens across Ethiopia to develop their diverse collections. New institutions have been established, including the Gullele Botanic Garden in Addis Ababa as well as Shashamene Botanic Garden and Jima Botanic Garden. Projects have been initiated to revive existing arboreta that were initially set up to trial exotic species for forestry. A new, state-of-the-art seed bank has been built by EBI so collections can be duplicated within the country.

With multiple institutions at similar levels of development, Botanic Gardens Conservation International (BGCI) has partnered with EBI to deliver annual training courses to support botanic garden development in the country. Representatives from leading international botanic gardens deliver training alongside BGCI and EBI to share experiences and examples of best-practice. During an initial training workshop, the importance of developing a policy to guide collecting efforts was presented by Chicago Botanic Garden (CBG). Showcasing how CBG's own policy has led to the development of a collection with more than 2.6 million specimens from 9,200 taxa over a period spanning more than 4 decades, the importance of the local climate and soils in determining CBG's selection of species from around the world was highlighted. In a subsequent training workshop, a template for the development of a collection policy was presented by the University of Oxford's Botanic Garden and Harcourt Arboretum, whose plant holdings of more than 8,000 taxa are used in teaching, research and conservation.

Workshop participants were asked to consider the purpose of their botanic garden, and develop a draft collection policy for their institution using the headings in the template provided. The drafts were reviewed and discussed, and the benefits of assigning plants of a particular region or taxonomic group to each institution, and sharing material across institutions for maximum conservation impact, were highlighted.

During visits to three institutions situated in close proximity to each other – Wondo Genet College Arboretum, Shashamene Botanic Garden and the Wondo Genet Agricultural Research Centre Medicinal Plant Garden – participants discussed how these botanic gardens could share material and identify signature plants or collections that support the varying objectives of each institution, ensuring they support conservation of the local flora, whilst maintaining a unique identity. Working alongside colleagues within one's own region or country, and learning from the experiences of well-established institutions with a clear focus, will significantly contribute to a well-thought-out and tailor-made collection policy.

Box 3.1 Components of a collection policy (Adapted from Michener, 2011)

1. Collections' mission – this relates to the overall vision and mission of the botanic garden.
2. Collections' scope – for instance in relation to issues of invasive species or the relevance of specific collections based on conservation priorities.
3. Cost estimate – assessment of the funding needs for maintenance of the collections.
4. Acquisition and documentation standards – these relate to plant records management.
5. De-accession/plant disposal standards – these relate to plant records management.
6. Access, intellectual rights and ethics – for instance in relation to issues of traditional knowledge.
7. Evaluation – this relates to maintaining and increasing the value of plant collections.

3.3.2 Development of the Collection Policy

- **Initiating discussion**

Normally, a key individual leads and guides the process to develop the collection policy (Figure 3.1). This can either be a senior member of staff, or an independent consultant. Engaging an experienced consultant has its advantages if senior staff operate under time constraints. Consultants may also bring an objective approach but will need to have full access to pertinent information regarding the botanic garden's collections and strategic direction. They should also spend sufficient time with staff and other stakeholders for detailed discussions.

Senior staff should develop a list of topics to be included in the collection policy. This activity focuses the discussion for subsequent stakeholder meetings. These will comprise individuals from different disciplines with varied experience. It is important, therefore, to introduce the concept of the collection policy to the group, explaining the advantages to the organisation. All participants should be encouraged to discuss the extent of detail needed in the document. The meetings should yield a provisional list of topics to be included and provide an indication of the depth of information required.

- **Drafting and completing the collection policy**

Based on the information garnered during the discussion phase, a draft collection policy will be prepared. This document is then sent to all stakeholders for review and comment. The best use of time is for stakeholders to discuss their specialist areas with their peers (e.g. horticulturists, curators, education specialists) and provide feedback on the draft document. It is also helpful for all stakeholders to comment on other areas of the document where appropriate. Suggestions are then incorporated into a second draft and redistributed for additional comment. Depending on the complexity of the information to be covered, this may happen a few times before an acceptable draft is ready.

Following the distribution of the final draft to all stakeholders, a further stakeholder meeting will be convened where the final draft document is presented. This will allow an opportunity to resolve any outstanding issues prior to completing the collection policy.

Figure 3.1 Development stages of a collection policy

- **Periodic review**

Although the collection policy is a vital document for a botanic garden, it should also be regarded as a 'living' document, able to address emerging issues of local and global concern such as species extinctions in the wild and climate change. Consequently, the collection policy should undergo periodic revision, ideally at five-yearly intervals, to ensure its relevance in a changing world. Throughout the lifespan of the collection policy, botanic garden staff should be reminded of its contents and prompted to employ it rigorously thereby ensuring the policy's purpose and objectives.

3.4 PLANT ACQUISITION

KEY MESSAGE

Botanic gardens require plants for a diverse array of reasons. It is therefore imperative to base selection on a range of agreed criteria to maintain the focus of the plant collections.

Botanic gardens are dynamic places where plants are constantly added and removed. This section covers all major aspects and prerequisites for acquiring plants, types of plant material, sources of plant material and the management of potential risks associated with newly acquired plants. A global survey (Aplin, 2014) found that a majority of botanic gardens maintain plant collections for education and conservation and, to a slightly lesser degree, research. This may include the development of eye-catching displays or showcasing native plant species (and animals) in 'wild' areas to highlight the conservation purpose of a botanic garden. The collection policy will set out criteria for plant acquisition (Sections 3.4.1-3.4.5), acting as a filter to maintain focused plant holdings that reflect the objectives of the botanic garden. Accepting or rejecting plant material is an important undertaking that places acquisition at the heart of the collection policy.

Various ways of acquiring plant material exist, including collection from natural habitats, exchange between botanic gardens, donations from private collections or purchase from commercial enterprises. Prior to being formally accepted into the botanic garden collection, the plant material is termed 'acquisition'. This is defined as an individual or group of plant material of a single taxon with identical or closely similar parentage acquired from one source at the same time. The acquisition is given a unique number (Chapter 5, Section 5.5.2) allowing it to be tracked in the collection. This action is often referred to as 'accessioning'. Once established in the collection of the botanic garden the acquisition is named 'accession'.

Showcasing native orchids in the 'wild' areas of botanic gardens. (Image: Dave Aplin)

3.4.1 Prerequisites for Acquisition

In order to facilitate incorporating new plant material, botanic gardens are advised to ensure that the associated documentation demonstrates responsible and legal acquisition (Section 3.4.2). In addition, if plant material is sourced from another institution, recipient botanic gardens need to know that the type of material offered has sufficient associated information to fulfil its intended purpose. Botanic gardens may correctly list the provenance of an accession as 'wild-collected', yet lack specific collection data to confirm this. Therefore a conversation should take place between the provider and recipient botanic garden at an early stage to check if the plant material fulfils the expectations. Unfortunately, this type of communication often does not happen, and as a result, vital information fails to be exchanged (Aplin *et al*., 2007).

3.4.2 Acquisition and the Law

KEY MESSAGE

Botanic garden staff must ensure the acquisition, receipt and intended use of plant material conforms to national legislation and international treaties and agreements.

The first criterion for sourcing plant material and deciding whether to accept an acquisition is to ensure it has been legally obtained. This is a complex issue especially in the international context of laws and policies governing the exchange of plant material (Chapter 4). Special attention is required when receiving plant material from private individuals. Material should only be accepted if it had been collected legally and supplied with all the necessary documentation. Privately donated material should be accompanied with at least the minimum standards (Section 3.5) of data required by the receiving institution. Care should also be taken when receiving cultivars that might be subject to plant breeders' rights and protected by law (Chapter 4, Section 4.7).

Once established that the target material was legally obtained, the decision to proceed with the acquisition should be based on two key factors: First, the 'institutional need' or acquisition criteria for the taxon (Case study 3.2), and second, the quality of associated information accompanying the acquisition (Section 3.5).

CASE STUDY 3.2

Acquisition criteria at the Finnish Museum of Natural History

Marko Hyvärinen, Helsinki, Finland

Key criteria have been developed for accepting plants at Kaisaniemi and Kumpula botanic gardens in Finland. Staff at these institutions – part of the Finnish Museum of Natural History (FMNH) – viewed this as a positive, pro-active exercise that provides focus and accountability about the current holdings of the botanic gardens and helps guide future acquisition decisions that are largely independent of staff turnover. The ten criteria include:

1. **Research:** Acquisitions should have sufficient associated data to make them legitimately useful in research.

2. **Conservation:** FMNH principally focuses its conservation effort on species within Finland followed by those beyond its borders (e.g. Russia, Baltic countries, Central Europe). One particular interest is climate change. Genetic material enabling studies on assisted migration is favoured.

3. **Education:** Plants that fulfil the teaching obligations of FMNH and have wider education value. Academic topics of particular relevance include evolution and systematics.

4. **Display:** Providing an attractive public display throughout the year is important. On occasion seasonal annuals are cultivated solely for this purpose. In such cases, provenance information is deemed unimportant and the plants are not databased. However, these plants can only be cultivated at locations agreed on by a curator.

5. **Rarity in the wild and in cultivation:** Botanic gardens often have taxa seldom grown elsewhere. These are given special attention, and their cultivation requirements are recorded. This criterion is of enormous value to science, conservation and horticulture.

6. **Provenance – latitude:** Plants cultivated in the open air that principally come from areas of the world that, more or less, bio-climatically correspond to hemi- and southern-boreal zones in Finland.

Kaisaniemi Botanic Garden, central Helsinki, Finland. (Image: Mikko Heikkinen)

7. **Provenance – longitude:** Plants under glass primarily selected from areas that fall within the longitudes delimiting Finland (21°E to 29°E). This encompasses countries of South East Europe, the Balkan Peninsula and Turkey. Countries in Africa, particularly the eastern part of the continent such as Egypt, Ethiopia, Kenya, Uganda, Tanzania, Rwanda, Burundi, Malawi, Mozambique, Madagascar and South Africa are also included.

8. **Provenance – tropical islands:** Endemic flora from the world's tropical and sub-tropical islands.

9. **Economic plants:** Displays of economic plants engage the public and university students, helping them to form links between nature and everyday life. These include plants that provide examples of species (and sometimes their cultivars) suitable for cultivation in Finnish botanic gardens.

10. **Historic plants:** Although the goal of FMNH is to cultivate plants of documented wild origin, exceptions exist. Historic cultivars developed in the territory during the Russian period of the early 1800s are actively sought after and curated.

Best practice at FMNH is to select acquisitions capable of fulfilling a number of different acquisition criteria. These are termed 'multifunctional accessions' once in the collection. In so doing, the same accession used for display and education can also be utilised for research and conservation.

3.4.3 Acquisition Types and Source

KEY MESSAGE

Plant material sourced specifically for conservation and research should, with few exceptions, represent a good proportion of naturally occurring genetic variation if they are to serve restoration, population reinforcement and reintroduction programmes.

There is a vital need to understand the genetic diversity present in natural populations as well as in plant collections of botanic gardens (Griffiths *et al*., 2015). This will inform the effective management of germplasm as an insurance policy for the future (Rao and Hodgkin, 2002).

- **Acquisitions of seed**

The most common and best method for capturing and storing genetic diversity is from seed.

Collecting seeds from wild, natural populations

In order to establish a collection that can be used for legitimate conservation and research purposes, botanic gardens collect plant material from wild, natural populations. This approach is important because it differentiates collection from populations that have become naturalised in a given area and may have been subjected to different selection pressures compared with those in naturally occurring populations.

Collecting from such populations is a complex undertaking that needs to be well-planned. The collection team needs to understand that data recorded at the point of collection are as important as the collection itself because without this information the seeds are of limited future value. A number of detailed best practice procedures are available that highlight responsible collection, thus avoiding illegal practice and adverse ecological consequences for the natural population (Chapter 7, Section 7.1).

Collecting seeds from cultivated plants

Seed collection within botanic gardens should only be conducted on the understanding that it holds little value for research and conservation compared with wild-gathered seeds. This is especially true for short-lived taxa such as ephemerals, annuals and some perennials. The main reasons for this are:

- Cultivated plants are susceptible to hybridisation. This is particularly true in botanic gardens where a wide range of similar taxa is grown in close proximity. This may allow closely related species, which would naturally be geographically isolated to come into contact and hybridise. Successful hybrids may demonstrate hybrid vigour and subsequently escape into nature where they can become invasive.
- Cultivated plants encounter vastly different selection pressures from those in wild populations due to eco-geographic selection and the unwitting, natural temptation for horticulturists to select the 'best-looking' plants.
- Genetic variability of seeds collected from cultivated individuals will, in the majority of cases, represent a fraction of the potential found in natural populations.
- Documentation may be poor with a high frequency of collections having unknown provenance due to poor record keeping in the past.

Requesting seeds from exchange lists – *Index seminum* (pl. *Indices seminum*)

The distribution of seed material between gardens through seed exchange lists or '*Indices seminum*' is believed to have started in the late 16th century. Today, over 500 institutions distribute seed lists annually (Aplin *et al*., 2007). Typically, seed lists comprise wild collected and/or botanic garden gathered seeds (Aplin and Heywood, 2008). Generally, the use of botanic garden-gathered seeds should be limited to display and education, whereas well-documented wild collected seeds from natural populations can be used for research and conservation.

However, prior to acquiring the seed material, it is essential to check that all wild gathered seeds are accompanied by comprehensive field data prior to ordering. It is then the curator's responsibility to assess the information and decide if the seeds are fit-for-purpose. Experience has shown that data sometimes needs to be specifically requested from providers because it is not always standard practice to automatically supply it (Aplin *et al*., 2007).

Requesting seeds from seed banks

By their very nature, seed banks (Chapter 7, Section 7.1.3) store and distribute seed for specific research and conservation purposes. Accessions from specialist seed banks are likely to have as good or better data than those offered in many seed exchange lists (Aplin *et al*., 2007).

- **Acquisitions of vegetative material**

The majority of acquisitions will arrive as seed, but some will come as vegetative material. This may be because the taxon in question does not produce seed and cuttings are the only practical way of obtaining material, or plants are purchased or donated. In each case, it is the role of the curator to decide the merits of the acquisition before accepting it into collection (Case study 3.3).

CASE STUDY 3.3

Vegetative propagation from wild, natural populations at the Royal Botanic Garden of Jordan

James Hearsum, St Andrews, United Kingdom

On occasion, there will be good reason to collect vegetative material from wild populations for propagation. This may be due to a population being at imminent risk of destruction, taxa that rarely or never produce viable seed, intensively grazed populations where seed production is prevented or as an alternative method for increasing accessions of particular target taxa. The Royal Botanic Garden Jordan (RBGJ) uses vegetative propagation as one of its approaches for acquiring plants because many natural sites are heavily grazed.

Gathering vegetative material needs best practice techniques to ensure that the collection captures as much genetic diversity from the target population as is possible without endangering it. There are a number of important considerations that need to be taken into account when planning a trip of this nature.

- Material should only be taken where it will not jeopardise a parent plant or population.
- Sampling methodology needs to be developed to decide on the selection of material from populations and individuals.
- Vegetative propagation results in a clone of the parent plant. Therefore, *ex situ* genetic diversity can only be increased by sampling as many parent plants as possible. The aim is to collect as many cuttings as deemed necessary (prior propagation knowledge is helpful to guide the numbers required) from as many individuals within a target population as deemed appropriate.

Collecting vegetative material for propagation at RBGJ from a highly grazed location on Mount Nebo, Jordan. (Image: Dave Aplin)

- Material from each population should be bagged separately and given a unique number. If however, only a few individuals exist within a population (but sufficient material to justify collection) then each individual should be bagged and labelled separately.
- Prior knowledge is needed about the target taxa and the type of vegetative material required for the correct method of propagation.
- Vegetative material needs to be maintained in excellent condition in the field before arrival and processing at the nursery.
- As with other collections from the wild, prior informed consent (Chapter 4, Section 4.5.1) must be obtained, giving full details of the collection and its intended use.

3.4.4 Arrival of and Responsibility for New Acquisitions

KEY MESSAGE

Vigilance is needed when receiving new plant material. Prior to incorporation in the collection, the material should be kept initially in a quarantine area where the plants can be monitored for pests and diseases.

The arrival of plant material can be labour-intensive for nursery and curation staff. Consequently, it is imperative for collectors and staff receiving the plant material to maintain close coordination, to ensure clarity regarding specific instructions on the type and quantity of material acquired along with any special instructions if necessary.

Immediate care of new plant material and processing of its associated data is vital. As it can be easy to accidentally mix a batch of seeds and cuttings, great caution and attention at this point is essential.

• Receiving unknown taxa

Horticulture and curation staff are responsible for the care and upkeep of new material even prior to the curator accepting its addition to the collection. In the instance of a taxon being unknown, research will be required to investigate possible germination and cultivation requirements. If identification is not immediately possible, collection data highlighting the site and habitat (including neighbouring species) can provide vital clues. This information, together with broader investigation on traits of related taxa (if known) should provide a genetic and/or environmental basis to support any decision about subsequent cultivation. For these situations, there are a number of resources available to guide botanic garden staff in making informed decisions (Chapters 6 and 7).

• Biosecurity

The receipt of exotic plant material is a common way to introduce new plant pests and diseases. Placing newly acquired plants into designated, enclosed quarantine areas allows close monitoring and treatment of potential exotic pests and diseases to prevent accidental introduction into the wider collection or natural environment. These risks should also be considered in the context of climate change which has the potential to create additional, suitable habitat through the changing conditions (Symes, 2011).

Horticulture and curation staff will need to be regularly trained to recognise the early signs of potential problems and be aware of taxa that are susceptible to new pests and diseases. There will also need to be communication mechanisms in place to ensure all staff are aware of emerging threats. Increasingly, botanic gardens are developing specific policies for handling newly acquired plant material to help address and reduce risk. Further information on the introduction and care of new plant material which could present a potential pest and disease hazard is provided in Chapter 6, Section 6.8.

- **Threats from exotic, invasive plant species**

Botanic gardens have been responsible for a number of exotic invasive species that have escaped into the wild. These species have caused massive losses in habitat in many countries (Cronk and Fuller, 2014; Hulme, 2015). The invasive *Pittosporum undulatum*, for example, was initially spread by the network of British colonial botanic gardens (Dawson *et al*., 2008) in the 19th and 20th centuries. Botanic gardens therefore need to learn from the past, be vigilant about the collections they maintain and ensure they do not spread to areas beyond the botanic garden and threaten native wildlife.

It is difficult to predict which species are likely to become invasive, although common characteristics include isolation from natural enemies, rapid growth and early maturity, abundant production of seeds, ability to reproduce vegetatively, extensive seed dispersion and quick germination. Complexity is added in that there is often a lengthy lag phase between when a species becomes naturalised and represents no more than an innocent introduction, to when it may become highly invasive. In addition, climate change may provide opportunities for some exotic taxa to spread that otherwise are considered benign.

Curators should adopt routine monitoring to investigate the risk of the spread of exotic plants both within and in the area surrounding the botanic garden. Major guidance for developing a botanic garden policy on invasive plant species is provided by the Invasive Plant Species Voluntary Codes of Conduct for Botanic Gardens and Arboreta and the European Code of Conduct for Botanic Gardens on Invasive Alien Species (Heywood and Sharrock, 2013).

Fairy Lake Botanical Garden, CAS, Shenzhen, China, is specialised in research into the Asian longhorn beetle (Anoplophora glabripennis) to develop effective control strategies and policies. This species has been introduced to the United States in the mid 1990s, causing havoc outside its natural range to a number of trees including poplars, maples, willows and birches. (Image: Chris Malumphy)

3.5 STANDARDS OF INFORMATION

KEY MESSAGE

It is the information and documentation associated with the plant collections that makes a garden a botanic garden.

In order for curated germplasm to be considered of research and conservation value, accessions must comprise two vital elements: i) the living genetic material and ii) its associated data component. Botanic gardens may however have large disparities in data quality across their collections. Generally speaking, older accessions may have less associated information than more recent ones, as many taxa were collected prior to the institutionalisation of dedicated research and conservation programmes and/or before the operation of advanced plant record management systems (Chapter 5, Section 5.2).

3.5.1 Linking Accessions to a Database System

Each accession needs to be labelled and linked to a plant record system. Responsibility for labelling, entering and updating data is normally delegated by the curator. This may be the responsibility of a single member of staff, normally designated as plant records officer, or extended to a group of people.

It is vital that all information pertaining to a new accession is entered into the database as soon as possible and that the accession is given a unique code. In addition to the accession number, plants also need to receive a location code on arrival showing where they will be placed in the botanic garden (Chapter 5, Section 5.4.3).

3.5.2 Data Standards for New Material from Wild, Natural Populations

Those involved in plant collecting trips should be aware that gathering live material is only a part of the collection effort. Material derived from wild, natural populations must be accompanied with as much data as possible. Most information can be quickly captured *in situ* to avoid the onerous task of filling it in retroactively with potentially erroneous data.

It is essential to collect the right type of data and record them in a standardised way in a collection data form (Figure 3.2). Relevant information includes data on the taxon but also biotic and abiotic aspects of the collection site. This information is extremely valuable because it links the taxon with its natural environment and may yield important details for the regeneration or reintroduction of the taxon that may not be recorded elsewhere (Moss and Guarino, 1995). Consequently, it provides information to aid future conservation efforts beyond the life of the acquisition.

It is important that the collection data form is filled in as complete as possible while still in the field (ideally using a computerised device) and that the curator scrutinises each potential accession on arrival. The curator should be prepared to reject plant material if it arrives with sub-standard data. This is an important undertaking because all accessions incur a cost to the botanic garden (e.g. maintenance, heating, data recording) independent of the standard of associated data; once an inferior quality accession has been accepted into the collection it may reside there unnoticed for many years.

Figure 3.2 Example of a collection data form

Collection Data Form

Collection date: 13 / 07 / 2015

Accession ID: 2015-234
Collection no.: 13
PRO signature and date: Robert Robinson 10/10/2015

Collector(s)	Institution	Main Collector (Yes/No)
Green, D.	Mirpur National Botanic Garden	Y
Hasan, H.	Bangladesh National Herbarium	N

SITE DATA

Country	Sri Lanka
Major Area	Central Province
Minor Area	Udawattakele National Forest
Locality	70 yards west off the forest trail

Geo-reference Unit (circle one): UTM / Decimal Degrees / (Degrees & Decimal Minutes) / Degrees, Minutes & Seconds
Geo-reference Method (circle one): Map / (GPS) / Google Earth / Google Map
GPS Datum: WGS84

Latitude/Easting	7.29	UTM Zone No.	44
Longitude/Northing	80.64	UTM Zone Letter	N
Altitude (m)	512	Method Altitude Determined	Altimeter

HABITAT DATA

Habitat and Assoc. Species	Forest Myroxylon balsamum, Swietenia macrophylla, Acronychia pedunculata
Modifying Factors	Non-native invasive species
Land Form	Hill ridge
Land Use	Protected area
Geology	Precambian strata
Soil Colour	Munsell
Soil Texture	Loam

Slope°	10
Aspect	South
Soil pH	6
Drainage	Well-drained

COLLECTION DATA

Family	Calophyllaceae
Genus	Mesua
Species	ferrea
Infra-specific	
Vernacular Name	Cobra's saffron
Material Verified*	Flowering stem
Verified By*	Hasan, H.

Language	English
Date Verified*	12/08/2015
Institute*	Bangladesh National Herbarium

*Only to be completed if the collection has been verified

TYPE OF MATERIAL TAKEN

	Number of mature plants sampled	Number of mature propagules taken
Seed	65	55
Stem cuttings	10	15
Root cuttings		
Spores		
Plants		
Other.....		

ETHNOBOTANICAL DATA

Circle all applicable.

Food Food Additive Animal Food Bee Plant Invertebrate Food
(Materials Fuel) Social Use Vertebrate Poison Non-Vertebrate Poison
(Medicine) Environmental Use Gene Source

HERBARIUM DATA

Date Collected	10/08/2015	Voucher Number	13
No. of Specimens Collected	4	Plant Height (m)	15

Plant Habit: (Tree) / Shrub / Liana / Erect Herb / Creeping Herb / Climbing Herb.....

Plant Description: Greyish-green foliage, with large fragrant white flowers. The trunk base is 1 m diameter. Opposite leaves.

In advance of any collecting trip, all collectors should receive a copy of the collection data form along with any interpretation notes. It is the responsibility of the curator and expedition leader to make sure all participants understand the form, the type of data to be collected and the importance of filling in the form in full. This ensures a standardised approach to data gathering and provides valuable information that may help identify or further investigate newly discovered taxa.

3.5.3 Data Standards for New Material from Cultivated Origin

Not every botanic garden has a focus on research and conservation. Many devote the majority of their efforts on engaging the public. In so doing, they provide a valuable contribution to health, well-being and tourism, and provide a service to those who wish to discover more about plants, nature and the environment. In these botanic gardens, there is likely to be less emphasis on wild-collected material and a greater use of plants from cultivated origin. However, there is nevertheless the need for essential information including accurate taxon and family names, restrictions on the future use of material, source (where it was obtained from), number of plants, seeds, cuttings, etc. originally received, date when the plant material arrived in the botanic garden, accession number and location.

3.5.4 Standards for Record Keeping Once in the Collection

To ensure that changes in the plant collections are reflected in the records of the collections' database, a number of routine operations should be observed once an acquisition has been accepted into the collection. Standardised recording forms for updating collections with information such as scientific and common plant names, plant label data, location, propagation details, etc. are essential. They should be passed on to the plant records officer at regular intervals for database upkeep, and, in turn from the plant records officer to horticulture staff for updating information in the living collection (Chapter 5, Section 5.4).

3.5.5 Associated Information

- **Herbarium vouchers from cultivated accessions**

It is a worthwhile to prepare herbarium (Chapter 7, Section 7.1.3) samples from the living collections for a number of reasons:

- Cultivated plants can often be phenotypically different from those collected from the wild, making cultivated accessions particularly useful for identification purposes in living collections;

- For identification purposes, a wide range of features can be collected over time, e.g. buds, flowers, fruits, seeds, seedlings;

- Vouchers allow cultivated plants to be identified by visiting specialists at any time of the year and can be sent to willing taxonomists by post.

Representative material should be selected as appropriate, e.g. leaves, stems, branches, buds, flowers, cones, fruits, seeds and spores. Sterile collections (i.e. just leaves) should be avoided wherever possible. It is a good idea to research the most useful characteristics for aiding the identification of a particular target taxon.

Records of all vouchers taken from the living collection should be recorded in the database, indicating where they are deposited in the herbarium. It is recommended that vouchers are deposited in the general herbarium (if there is one) because they will then be seen by visiting taxonomists that can confirm identity. Many herbaria place vouchers from cultivated material in coloured folders to easily distinguish them from wild-sourced material. It is a good idea to insert a feedback form with each voucher to aid the return of updated information to the plant records officer, for updating the living collection database and associated material. This is particularly important where botanic gardens run the herbarium and living collection as separate entities.

- **DNA samples**

It is increasingly common to store material containing DNA from wild-collected specimens in order to assess the natural genetic variation within a given population. The extraction and storage of DNA is a technical process that not every botanic garden has resources to perform. To overcome this challenge, botanic gardens may choose to develop partnerships with laboratories (or other botanic gardens) which can provide this service. The Global Genome Biodiversity Network encourages the receipt of DNA from verified plant material for long-term storage.

- **Wood samples**

Samples of wood collected from cultivated plants can be valuable for research. Wood sections can often be dated precisely and may also be useful in verifying the identity of a species. Material can be gathered from routine tasks such as pruning or after storms or winter damage, or when a woody plant is removed from the collection.

The sample should be collected, preferably, from the trunk of the tree, to include a piece 5-10 cm thick, with its characteristic bark. In the case of large trunks, a section of bark and wood to the pith is sufficient. Each sample should be accompanied with the minimum set of data including information about where on the tree or shrub the piece of wood was removed from.

- **Photographic records**

A systematic collection of high quality digital photographs is a valuable data addition that aids scientific curation as well as education, display and marketing. A good digital single lens reflex (SLR) camera can achieve spectacular results and show features of the plant that may be overlooked otherwise. While no substitute for living plants or vouchers, high quality, close-up images can aid plant identification. This is especially true when good provenance data is available or when the genus has relatively few species. Photographs (that highlight salient identification features) can then easily be sent to specialists to help with identification (Case study 3.4). Image resolution should be as high as possible. Photographs taken with a digital SLR camera with over ten megapixels will be sufficient to produce a quality image of around 2000px in height and width. A tripod and a macro lens are necessary to achieve quality close-up shots of essential plant characters. Special photographers' light-tents enable close-up photographs to have an uncluttered and contrasting background.

Images linked to the living collections database can aid the duties of horticulturists in the botanic garden if the database is accessible through the intranet. Photographs can be used for multiple purposes, e.g. interpretation, display, publicity and marketing. Technological advances (for instance handheld barcode readers) can make use of images by allowing the public to download these while visiting the botanic garden.

Image files should receive a unique code that includes the accession number, not the taxonomic name, thus avoiding having to change file names at a later date if the accession is re-identified.

CASE STUDY 3.4

Quality images can facilitate taxonomic identification – Botanic Garden Meise, Belgium

Dave Aplin, Dorchester, United Kingdom

Images of salient characteristics can help or confirm a species' identification as they can easily be shared with taxonomic specialists in botanic gardens around the world. Once a name has been obtained, a note can be written in the database explaining the outcome of this remote method of identification or verification.

Several photographs of an unidentified species of *Clavija* (Primulaceae) were sent by the Botanic Garden Meise, Belgium, to Professor Bertil Ståhl at the University of Uppsala. On receiving the images the plant was identified as *Clavija cauliflora*. Coincidently Professor Ståhl was completing a monograph on *Clavija* and the e-mailed image highlighted the first functional female flowers of this taxon he had seen. In turn, preserved flowers were requested and provided, and offered valuable information for the monograph.

Clavija cauliflora grown at the Botanic Garden Meise – initially identified via photographs. (Image: Dave Aplin)

3.6 TRANSFERRING AND REMOVING PLANTS

KEY MESSAGE

A botanic garden cannot uphold high standards with ever-increasing numbers of accessions. There comes a point when less valuable plants, or specimens that have served their purpose, need to be removed from collection. This is a normal part of curation that helps maintain the focus and quality of the collection.

Plants enter a collection to fulfil a specific, or range of purposes. During an accession's time in the botanic garden, part or all may be donated to other organisations. Alternatively, the accession may be deemed to be of no further use or it might die. Through the processes of acquisition, transfer and de-accessioning, curators are able to maintain relevant, valuable collections for specific reasons. If material is to be transferred, maintaining close communication with the recipient institution(s) in order to ascertain that the material is fit for purpose, is vital prior to making the formal transfer arrangements. A short conversation can save many hours work if the accession is found to be unsuitable.

3.6.1 Transfer of Material

The transfer of material must be carried out in accordance with the access and benefit-sharing (ABS) provisions of the Convention on Biological Diversity (CBD), and more particularly, in compliance with the Nagoya Protocol – the legally-binding instrument that covers the transfer of living genetic material and national ABS legislation (Chapter 4, Section 4.5). Any transfer of material must be in accordance with the terms under which that material was originally acquired and such terms will need to be passed on to subsequent recipients. In addition, there may be further accession- or taxon-specific legislation or codes of conduct that must be respected, such as phytosanitary regulations (Chapter 6, Sections 6.3.3 and 6.8).

Prior to transferring plant material it is good practice to provide a document that sets out the terms and conditions of transfer, known as a 'Material Transfer Agreement' or MTA. Many botanic gardens will require the document to be signed and returned before material can be despatched. The following points will usually be included in a MTA:

1. Material is only provided to institutions working in the areas of research, conservation and education and not to individuals or commercial enterprises.

2. The recipient shall not sell, distribute or use for profit any of the material, its progeny or derivatives.

3. The recipient shall acknowledge (the donor botanic garden), as supplier, in all written or electronic reports and publications resulting from the use of the material, its progeny or derivatives. A copy may be expected to be sent to the donor botanic garden without request.

4. The recipient shall take all appropriate and necessary measures to import material in accordance with relevant laws and regulations and to contain the material, its progeny or derivatives so as to prevent the release of invasive alien species.

5. The recipient may only transfer the material, its progeny or derivatives to a botanic garden, university or scientific institution for non-commercial use in the areas of scientific research, education, conservation and the development of botanic gardens.

6. All transfers shall be subject to the terms and conditions of this agreement. The recipient shall notify the donor botanic garden of all such transfers.

In addition to the MTA document, information listing the accession number, the International Plant Exchange Network (IPEN) code if applicable (Chapter 4, Section 4.5.2) as well as the full scientific name should be presented. Once the MTA has been accepted and signed, the material can be transferred along with all information pertaining to each supplied accession.

3.6.2 Duplication of Accessions among Botanic Gardens and 'Safe Areas'

Botanic gardens are encouraged to duplicate accessions and share them amongst themselves as well as with other institutions. This helps safeguard vital germplasm from unforeseen catastrophe. Some botanic gardens are situated in areas where extreme weather events are a natural occurrence. Palm collections, for example, are often prone to damage by severe tropical storms. In an unlucky event, important accessions can be destroyed in minutes. In response to these threats, organisations and networks have been set up to help insure against extreme environmental hazards. For instance, the North American Plant Collections Consortium (NAPCC) – a network of botanic gardens and arboreta in North America – has adopted a programme to facilitate the curation of taxa (and accessions) in multiple botanic gardens across the continent. Combined inventories are analysed to identify gaps and redundancies while curatorial groups made up of representatives from each site govern collaborative activities.

Similarly, the International Conifer Conservation Programme at the Royal Botanic Garden Edinburgh has developed a network of over 200 'safe areas' for the cultivation of threatened conifers throughout

Montgomery Botanical Center, Florida – the day after Hurricane Wilma which destroyed half of its wild-gathered Syagrus botryophora palm collection. (Image: Harvey Bernstein)

Britain and Ireland. This strategy allows for the extensive *ex situ* conservation of trees that would otherwise be beyond the scope of a multifunctional botanic garden with limited space. It also enables taxa to be cultivated in areas that are environmentally more favourable than the domain of the botanic garden.

3.6.3 Accession Removal

The removal of plant material, or 'de-accessioning', is the process of permanently eliminating an accession from the collection. It is important to note that elimination often refers solely to the living material, while associated elements of the accession (e.g. herbarium vouchers, photographs or other data) may continue to be of value and may be retained.

There are various reasons why a living accession may be removed from the collection but the most likely causes are death and disease, or the results of an evaluation of the living collection. Accession removal is part of the normal routine work that helps focus resources on plants that are considered valuable to the organisation.

Before permanently removing accessions from the living collection, managers must consult their collections database to find out if there are any accession-specific donor restrictions about discarding material. Healthy, unwanted plants with no specific donor restrictions can be donated to other botanic gardens. It is best practice however, to provide a clear overview about why accessions have been considered obsolete. This allows potential recipient botanic gardens to make informed choices prior to acceptance of an acquisition and avoids the distribution of plants considered 'of little value'. In many cases, however, a suitable recipient may not be found, or it is impracticable to offer plants as they may simply be too large and unmovable. In these instances plants should be composted (Cronk, 2001).

Dead or unhealthy plants that cannot be saved should be discarded responsibly. It is best practice to investigate the causes of plant decline and/or death as this can contribute greatly to the knowledge of cultivating particular taxa and may curtail the spread of infestations to other plants. Many plant record management systems include fields that allow specific recording of such events (Chapter 5, Section 5.4.5).

3.7 EVALUATING LIVING COLLECTIONS

KEY MESSAGE

Only through evaluation can the suitability of a plant collection be assessed to address the current needs of an organisation. It represents one of the most important activities undertaken in the curation department, yet it in many botanic gardens this is seldom taken into consideration.

A botanic garden that aims to continuously improve quality and utility of its collections should ensure that evaluation forms an integral part of the collection policy and is part of the ongoing curation agenda. Evaluation or audits of living collections are here defined as a planned, documented activity conducted periodically by knowledgeable professionals to review the value of plants and/or management practices. It is also about assessing situations, and changing what needs to be changed (Rammeloo and Aplin, 2007; Aplin, 2013).

Audits as defined in this section do not include routine curatorial work such as inventorying, identifying and verifying, mapping and tree risk assessments. Instead they focus on strategic mechanisms to determine the value of accessions and collections to the host organisation, the public and/or funders.

Evaluations will be most effective when the botanic garden has a collections policy that guides collection development and curation, as this document provides the basis of the audit. The process can be used to evaluate, set goals, raise standards, target resources and provide justification of the botanic garden's value and sometimes even its survival. A range of audit types can be considered that specifically target living collections.

3.7.1 Important Considerations when Evaluating Living Collections

There are some important points that need to be considered prior to any audit. These help define the purpose and scope of the audit, inform stakeholders about what is happening and offer the chance to acquire information from individuals that has not been previously recorded. The points considered below can be used to guide most types of audit conducted on living collections:

- **Decide on agreed criteria for evaluation:**
  A prerequisite to evaluation is having a set of criteria used to judge the merits of each accession. This should ideally come from the living collection policy, a set of acquisition criteria and/or a minimum standards benchmark. If no such document exists then the first task should be to create one in consultation with relevant stakeholders.

- **Talk to stakeholders:**
  Plants matter but so do people. It is important to inform garden staff prior to and throughout an audit process, especially those who have tended the collection over the years. They may have important information about a particular accession or management procedure that has not been recorded.

- **Make a list of what is to be evaluated:**
  If the audit is focused on plants then make a list of all the accessions and their locations to be included in the review. Discrete groups, such as Cactaceae, trees or the seed bank provide manageable units to evaluate.

- **Ensure accessions are correctly identified and verified before auditing:**
  Correct identification of plants may seem to be an obvious priority but can sometimes be overlooked. A botanic garden needs to be sure that the basis of an evaluation is founded on hard facts and the most important one is knowing what is being evaluated.

- **Check nomenclature and synonyms:**
  Many plants have changed their classification over the last few decades. If the collection's nomenclature has not been updated then preparation for an audit is a good point to do this. At this stage it is good practice to search the entire holdings for any synonyms found because there may be duplicate taxa to those being evaluated but cultivated elsewhere in the institution under a different name.

- **Identify threatened plants:**
  It is important to review local, regional and international lists of threatened plants to help make informed decisions about retaining or discarding an accession.

- **Download and research plant records data:**
  Downloading and reviewing accession data is a key step in the evaluation process. Data is best downloaded into a spreadsheet for ease of sorting, manipulation and annotating.

- **Conduct internet research:**
  A valuable online search tool for the plant holdings of botanic gardens is the BGCI's PlantSearch database. This database is the most comprehensive global catalogue of plants held in botanic gardens and provides an indication of the number of institutions cultivating a particular taxon.

- **Identify donor restrictions for rejected accessions:**
  Depending on the type of audit, there is likely to be a list of plants that need to be de-accessioned at the end of the process.

- **Find new homes for or discard unwanted accessions:**
  Unwanted accessions with no restriction can also be donated to non-commercial enterprises such as municipal gardens, schools, hospitals and care homes. When no suitable place can be found to relocate the plants they should be composted.

Further guidance for evaluating plant collections is in 'Assets and liabilities: The role of evaluation in the curation of living collections' (Aplin, 2013).

Figure 3.3 Collection management questions that evaluations aim to answer

3.7.2 Evaluation Types

Evaluations can be designed to answer a range of questions (Figure 3.3) yielding invaluable information for curatorial management. The resulting recommendations on curatorial procedures provide good evidence on which to base change.

Examples of evaluation types undertaken at botanic gardens:

- **Evaluation of conservation and research values**

This evaluation type is not a quick and easy procedure. It evaluates associated accession data and concentrates of the potential usefulness of plants for conservation and research. If a botanic garden's aim is to improve the value of its holdings then this type of evaluation should be part of its ongoing curation agenda (Case study 3.5).

CASE STUDY 3.5

Conservation value of Cactaceae collection at the Botanic Garden Meise, Belgium

Dave Aplin, United Kingdom

One of the most common plant collections given the 'conservation' label are Cactaceae. Indeed, habitat modification and destruction, together with over-exploitation threaten many species. The vast majority of cacti taxa are therefore included either in Appendix 1 or 2 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

In 2006, the Cactaceae collection at the Botanic Garden Meise represented its largest living plant family under curation with over 5,000 plants (2,507 accessions) from 1,642 taxa. Some plants were maintained in a large public display glasshouse, but the vast majority were kept in glasshouses with no access to visitors. Analysis of the accession data highlighted 90% to be without data. Further, only 251 accessions were of wild origin of which only 21 had sufficient data to aid future, potential conservation efforts. This meant that only 0.84% of the entire Cactaceae collection (previously described as a 'conservation collection') could legitimately be given the conservation label. Clearly, over the years quantity had triumphed over quality.

Cacti experts Dr David Hunt and Dr Nigel Taylor spent two days evaluating and verifying the collection and came to the conclusion: "Two-thirds of the collection could be discarded without any loss in conservation or research value". Despite this sobering outcome, the audit also discovered a jewel in the collection, *Opuntia stenarthra*, a wild-collected Paraguayan species that had not been observed as a living plant for over a century.

Opuntia stenarthra, discovered in the cacti collection of the Botanic Garden Meise during an evaluation of the conservation value of the plant holdings. (Image: Botanic Garden Meise)

As a result of the audit, a large proportion of the collection was offered to other botanic gardens with a statement about the Meise findings to avoid accessions being cultivated elsewhere under the mistaken guise of conservation (Aplin, 2008; 2013).

- **Evaluation of cost-benefit**

This type of assessment, developed by the Montgomery Botanical Center, United States, is offered as a way to make objective allocations of space, staffing and funding to conserve plants through living collections. Specifically, it allows botanic garden managers to make informed decisions to:

- Determine the cost-benefit of keeping multiple plants of a given taxon;

- Provide effective practice to target funds where they are most needed;

- Give clarity about what is being curated;

- Justify the continuation of funding and the role of the botanic garden.

An important objective of living collection management is to maintain the maximum level of diversity with the greatest economic and logistic efficiency. An audit of cost-benefit helps collection managers do exactly this. This type of audit uses three defining indicators to gauge the effectiveness and efficiency of living collections including species imperilment, genetic representation and operational costs associated with maintaining accessions (Griffith and Husby, 2010; Cibrian-Jaramillo, 2013).

- **Evaluation of collection 'fitness'**

This type of audit looks at the collection as a whole and provides easy to understand information about its fitness in the form of statistics. Fitness in this instance refers to the quality of the collection, measured by the botanic garden's goals and objectives. Collection statistics are a valuable tool to monitor and measure progress (Rae, 2004). All botanic gardens should have a system of monitoring development towards their vision and mission (Chapter 1, Section 1.2.4). The typical living collection will comprise many thousands of accessions and an extensive amount of associated information. In order to make sense of this data, demonstrate the current fitness of holdings and set future targets, it is vital to summarise this information into easy to interpret, meaningful numbers.

Staff will visualise percentage figures more easily than describing the collection in general terms, for example "61% of our accessions are from wild-collected material" is more meaningful than "We have many wild-collected accessions". An added benefit to knowing the statistical information is that it has the potential to encourage staff to enhance the value of the collections: "Our target is to improve our total percentage of verified and identified holdings by 5% over the next two years". The type of criteria adopted to measure the collections will depend on the individual botanic garden, its aims and objectives, and on the focus of the plant holdings as outlined in its collection policy.

- **Evaluation of taxonomic groups**

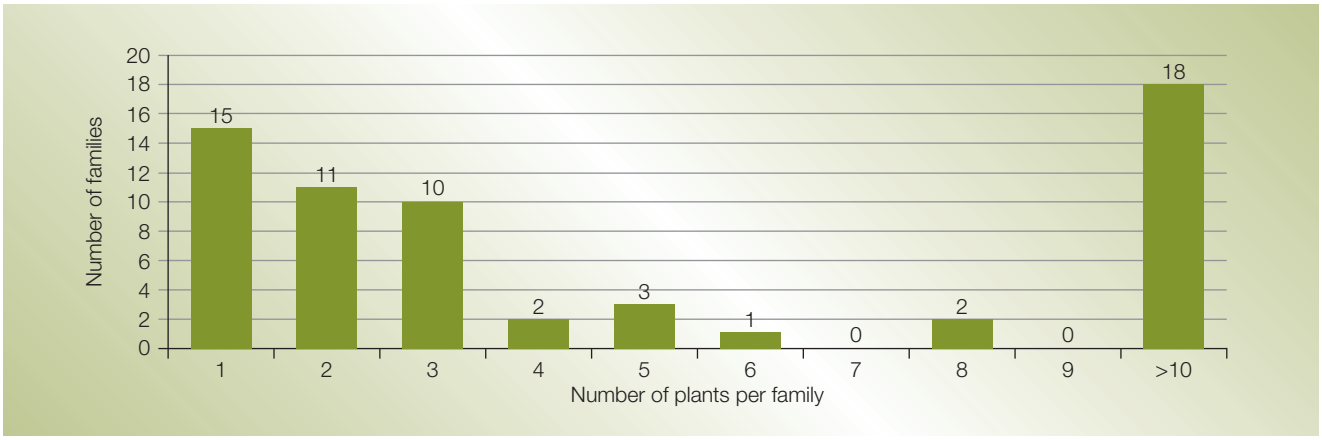
Some botanic gardens choose to focus on specific taxonomic groups because they are actively used by staff in research and/or education programmes. For example, a botanic garden may hold a living reference collection of a specific plant group utilised in its molecular work, or it may host the national collection of a particular genus. Over time, the number of taxa in the group will vary, and it is the role of this type of audit to highlight any unplanned losses or reduction in focus (Table 3.1).

Table 3.1 Audit results for the genus *Begonia* held at the Royal Botanic Garden Edinburgh

	Species	Taxa	Plants	Wild accessions	All accessions	Difference 3
1990		58	178	33	76	43%
1995		38	173	35	60	58%
2001		53	447	150	197	84%
2007	78	92	514	176	240	75%
2012	148	169	1321	351	496	73%
Difference 1		191%	624%	963%	552%	
Difference 2	90%	84%	157%	99%	107%	

The first column displays the year data was gathered for this inventory. Difference 1 represents the percentage difference between 1990 and 2001, the 'base' year when these audits started. Difference 2 relates to the percentage difference between the latest audit and the previous one. Columns 2 and 3 show the number of taxa and plants for each of the corresponding years. Columns 5 and 6 highlight the number of wild accessions and total accessions of this genus, respectively. The last column (Difference 3) highlights the percentage of wild-gathered accessions compared to total accessions. The figures show a rise since 1990 explained by increased focus on the genus for research purposes. The purpose of the five yearly audits is to monitor long-term trends in major project-related families and genera to highlight if major, unexpected, changes have taken place. The rapid rise in the number of *Begonia* taxa and plants between 2007 and 2012 was anticipated and expected as it was directly linked to a research project, but it also resulted in enhanced exchanges between the curatorial staff responsible for looking after the plants and the science staff working on *Begonia* to discuss resources and future projections (David Rae, pers comm).

Figure 3.4 Number of families versus number of plants per family, Meise Botanic Garden, Belgium



- **Evaluation of potential taxonomic vulnerability**

An audit of potential vulnerability attempts to assess the vulnerability of specific taxa within the living collection. Most botanic gardens attempt to grow as wide a range of plant families as possible. Therefore, it is sensible to look at the potential vulnerability of the families in living collections. For instance, an evaluation carried out at the Botanic Garden Meise, Belgium, found that 15 families are represented by a single plant, 11 by two individuals and ten families by just three (Figure 3.4). This information can be further examined qualitatively to determine if a family is at risk of being lost. For example, a family represented by a single plant of an established tree is likely to be regarded 'safe for now' whereas one represented by a solitary herbaceous perennial will have a greater risk therefore requiring priority attention.

3.8 CONCLUSION

Plant living collections are the centre of a botanic garden. They fulfil a range of diverse functions from scientific research and conservation to public engagement. The purpose of the collection policy is to guide strategic management of the plant holdings to ensure they are 'fit-for-purpose' and targeted.

Focusing a plant collection without a formal, written strategy is problematic, yet numerous botanic gardens lack a collection policy (Aplin, 2013). This can result in inefficiency that devalues the work of the institution. Maunder *et al.* (2004) have highlighted that, at least for conservation, botanic gardens are among the most extensive, yet underused, resources in the world.

A botanic garden's collection policy that defines its acquisition, retention and evaluation approach, is a formidable document that ensures that the plant holdings are aligned as closely as possible to the institution's mission and function. It provides clear criteria to acquire plants, supports decisions to evaluate and monitor progress, and gives confidence to remove accessions that have outlived their purpose. In conclusion, the adoption of a collection policy helps target a botanic garden's resources where most needed, and contributes to achieving a world in which plant diversity is valued and secure, supporting all life.

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