FIT FOR PURPOSE? THE VALUE OF CHECKING COLLECTION STATISTICS

DAVID RAE*

Collection statistics provide valuable evidence against which to judge the development or decline of live plant collections. At the Royal Botanic Garden Edinburgh (RBGE) a recent audit of the collections and review of key indicators have proved very useful and will now be used on a regular basis as a sort of 'health check' of the collections. Additionally, targets have been set to improve weak aspects of the collection and to drive up standards. It is intended that, over time, these measures will increase the value of the collections and ensure that they are 'fit for purpose'.

INTRODUCTION

Most botanic gardens have a collections policy which guides the content and development of their living collections. Rather few, however, check to see if the current content of the collection matches the guidelines laid down in the policy. Likewise, it seems that few curators analyse the collection, or even key genera, to check if accession numbers are going up, down or remaining static. The Royal Botanic Garden Edinburgh (RBGE) recently undertook a collections audit to track accession numbers for important families and genera over recent years and, from the obvious value of undertaking this exercise, is now developing an annual review of the collection. A number of key indicators, which collectively give an impression of the 'health' of the collection, are being developed and, where necessary, targets are being set for areas considered to be weak or in need of special attention. This process can be likened to an annual health check where a doctor might take the blood pressure, cholesterol level and weight of a patient to give an impression of their overall health. If suitable checks are selected such a process, when applied to living collections, can give an indication of 'fitness for purpose' – in other words the suitability of the collection to meet its needs.

COLLECTIONS AUDIT

The idea for the collections audit arose in 2000 at a time when concerns had been raised about the apparent reduction in the size of the living collection. The initial purpose of the audit was simply to analyse certain genera or families to find out if numbers of accessions or taxa had been dropping over time. A second purpose was to analyse the material coming into the collection to check if it matched our stated policy. The audit would therefore highlight major losses or groups of plants that were being neglected.

* David Rae is Director of Horticulture at the Royal Botanic Garden Edinburgh.
Address: Royal Botanic Garden Edinburgh, 20a Inverleith Row, Edinburgh, EH3 5LR.
Email: d.rae@rbge.org.uk

PROCESS

The first stage of the process involved informal discussions with curators and plant records officers in other botanic gardens to see if a similar type of analysis had been undertaken elsewhere and, if it had, what the methodology had been. It soon became apparent that no audit, or anything similar, had been undertaken and that RBGE would need to undertake the whole process from the beginning.

To start the process a meeting was called with representatives from all Divisions of the Garden (excluding Corporate Services). The general feeling of the group was very positive and all were agreed that the audit was a good idea and that it would produce valuable information that would be of significant interest to the long-term management of the living collection. Suggestions of what to include and how the work might be done were gathered and, after trialling the methodology, were presented to a second meeting of the group.

The suggestion was that numbers of taxa, individual plants, wild accessions and all accessions should be gathered for selected genera and families for the years 1990, 1995 and 2001. From these figures, trends in terms of percentage increase or decrease over an eleven year period could be generated. In addition, percentage increase or decrease in wild origin accessions compared to all origin accessions could be produced.

The work of developing a method to extract and collate the data described above from *BG-BASE*, the plant collections database used at RBGE, fell to Kerry Walter (*BG-BASE* co-Director and developer, resident at RBGE) and Phil Ashby (Senior Horticulturist with a particular interest in plant records). Once this had been developed the system was demonstrated and refined after which the process of working through the various families and genera started. This work was undertaken by Phil Ashby supported, for a while, by Natacha Franchon (Horticulturist based in the Indoor Department). In total, 105 genera and families were examined.

PLANTS INCLUDED

It would have taken too long, and would not have been worth, collating figures for every family and genus in the collection. The most sensible option seemed to be to focus on the most important groups of plants highlighted in RBGE's Acquisitions Policy, namely all the so-called H1 and T1 families and genera, and a selection of H2 and T2 families and genera. These codes are explained in full in Appendix 1. In general, H1 families or genera are RBGE's most important hardy plants, H2 plants are of intermediate importance and H3 are the plants of least importance. T1, T2 and T3 are the equivalent for tender, or glasshouse-grown plants.

PRESENTATION OF DATA

Tables 1 to 5, presented on the following pages, give examples of families and genera that were analysed. Line 1 of the table shows the generally acknowledged total number of genera and species in a family or, where a genus is presented, then the number of species in the genus. This simply gives baseline data against which the figures can be judged. The first column shows the years 1990, 1995 and 2001. Difference 1 (Diff 1) shows the percentage difference in numbers between 1990 and 2001 and Diff 2 shows the difference between 1995 and 2001. Column 2 shows the total number of taxa in the collection for each of the years shown in column 1. Diff 1 shows that (in Table 1) numbers increased by 15% from 1990 to 2001 (ie from 73 to 84) and that numbers increased by 4% from 1995 to 2001. The third column shows figures for individual plant numbers. Column 4 shows numbers of wild origin accessions and column 5 shows figures for all accessions (ie wild origin, garden origin or unknown origin). The last column shows the difference in percentage between wild origin accessions and all origin accessions – in other words the proportion of wild origin accessions against all accessions in percent. Again, in Table 1 it shows that the difference in 1990 was 35%, while it was 52% in both 1995 and 2001.

TABLE 1. Audit results for the family Aceraceae.

Aceraceae – 2 genera 113 species					
	Taxa	Plants	Acc Wild	Acc All	Diff 3
1990	73	286	53	153	35%
1995	81	497	108	207	52%
2001	84	441	122	234	52%
Diff 1	15%	54%	130%	53%	
Diff 2	4%	-11%	13%	13%	

TABLE 2. Audit results for the genus *Arisaema*. The figures show a large rise in numbers since 1990 which can be explained by the fact that special attention has been paid to acquiring arisaemas for research over the last few years.

Arisaema – 150 species					
	Taxa (a)	Plants	Acc Wild	Acc All	Diff 3
1990	21	56	32	36	89%
1995	18	65	37	43	86%
2001	39	264	116	125	93%
Diff 1	86%	371%	263%	247%	
Diff 2	117%	306%	214%	191%	

TABLE 3. Audit results for *Betula*. The large increase in numbers is due to a deliberate policy to increase wild origin material particularly at Dawyck Botanic Garden, but also at RBGE.

Betula – 35 species					
	Taxa (a)	Plants	Acc Wild	Acc All	Diff 3
1990	45	272	80	132	61%
1995	56	676	140	192	73%
2001	57	1461	155	239	65%
Diff 1	27%	437%	94%	81%	
Diff 2	2%	116%	11%	24%	

TABLE 4. Audit results for *Leycesteria*. The large increase in plants from 1990-1995 was due to the Chinese Hillside project. The subsequent decrease in plants was due to a plant records recategorisation from 'individual' to 'mass'.

Leycesteria – 6 species					
	Taxa (a)	Plants	Acc Wild	Acc All	Diff 3
1990	2	13	2	3	67%
1995	2	88	7	8	88%
2001	2	74	7	8	88%
Diff 1	0%	469%	250%	167%	
Diff 2	0%	-16%	0%	0%	

TABLE 5. Audit results for *Juniperus*. Increases were due to the ICCP (International Conifer Conservation Programme) safe site programme; losses were due to transplant losses.

Juniperus – 50 species					
	Taxa (a)	Plants	Acc Wild	Acc All	Diff 3
1990	37	421	114	151	75%
1995	47	1027	183	221	83%
2001	48	855	190	234	81%
Diff 1	30%	103%	67%	55%	
Diff 2	2%	-17%	4%	6%	

A selection of other tables are presented in Appendix 2.

OUTCOMES

The presentation of the tables shown above gave curators, for the first time, real, factual analytical data on the performance of key families and genera, at least in terms of numbers. It showed that, contrary to the perception of some, the collections were increasing in many key areas, not decreasing. It also showed very clearly that some families and genera had grown very considerably while others had remained static and a few had contracted. Satisfyingly, it demonstrated that in most cases where there had been a dramatic increase the family or genus had been subject to concentrated collecting for a specific purpose or research project and, conversely, where numbers had remained static or had declined it was because there was now less emphasis on the family or genus.

The final part of the audit involved curators annotating the tables giving reasons for changes where numbers had increased or declined by more than 10%. Some examples are shown in Tables 2-5. Examples of other responses include:

- Changes due to taxonomic reclassification (*Smilacina*)
- Losses due partly to name changes and also because some species are short lived in cultivation (*Gentiana*)
- Large increases due to the Chilean Hillside Project at Benmore Botanic Garden (BBG) and, to a lesser extent, with the 'associated' plantings which frequently accompany ICCP safe site plantings (*Nothofagus*)

It was felt by all concerned that this type of data was very helpful and certainly gave a factual basis from which to manage collections. It was from discussions following the collections audit that further 'health checks' were considered and devised. These are described below.

NEW ACCESSIONS AND DEATHS

While quality and value are ultimately more important than the simple size of a collection, numbers still do give an easily calculated measure of change. The size of a collection is a result of the number of new accessions compared to the numbers of deaths and to get a clear understanding of how a collection is developing, it is worth tracking annual accessions, annual deaths and total numbers.

At RBGE annual accessions were in the range of 3,000 to 4,000 during the 1980s and early 1990s. However, reductions in funding for expeditions, reductions in nursery staff along with the additional complications of accessing new plant material because of the Convention on Biological Diversity (CBD) had the effect of reducing new accessions down to about 1,000 in 2002. While a casual observer might conclude that this would correspondingly raise the collection by 1,000 accessions this, of course, is far from the case as deaths have to be taken into account.

Reasonably high numbers of plant deaths in botanic gardens are to be expected for many reasons. The size and complexity of a botanic garden collection inevitably means that it will include annuals, short-lived perennials, plants on the edge of hardiness and plants which are very demanding to grow and maintain. Unless figures are abnormally high, staff should not worry about high death rates and of recording and publishing them – they are not an index of failure! However, where there are concerns about the quality of plant care, it can be interesting to compare death rates for individual collections against others, or of one area of the garden against another. Death rates for RBGE are shown in Figure 1.

FIGURE 1. Death rates of taxa, accessions and plants at RBGE for the years 1990-2003. (Calculated for the period 1 April to 31 March for each year.)

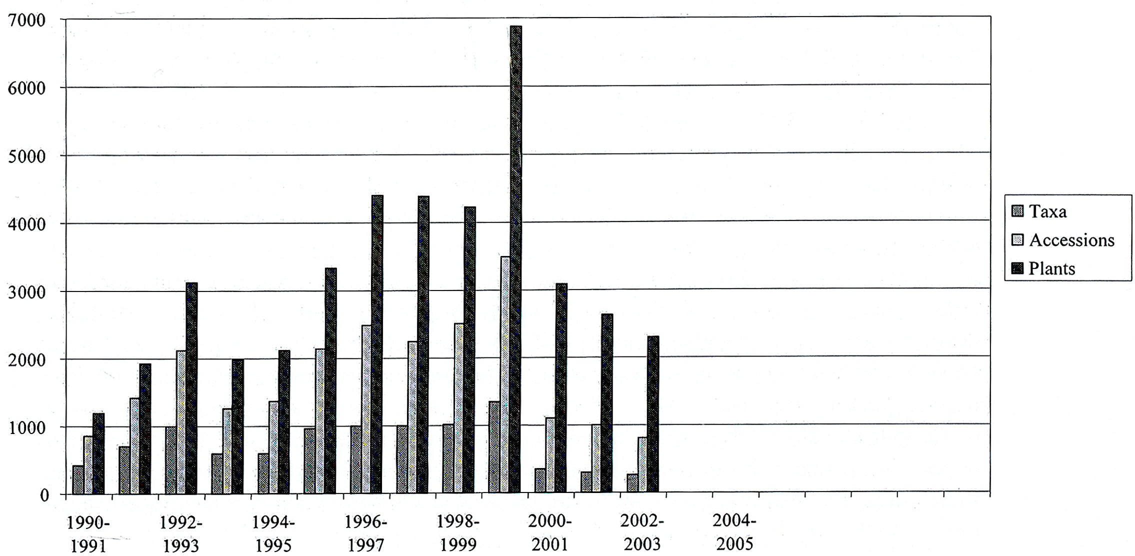

Figure 1 shows that death rates for taxa are running at about 600-700 per year at RBGE and that death rates for accessions at about 800-3,500 per year (annual average of 1,738 over the 13 year period shown in Table 6). With new accessions running at only 1,000 a year in very recent years, the result has been a slow decline in the size of the collection. It is only the careful analysis of collection figures, which is only possible with a comprehensive database, that can give a detailed picture of what is happening to a collection. At RBGE, for instance, general comments such as "the collection seems to be getting smaller" could only be investigated in detail by analysing new accessions against annual death over a number of years.

The result of this analysis has been an informal review of priorities and responsibilities. Nursery staff have reduced from six to three over the last ten years and so it would be impossible for them to go back to the days of handling 4,000 accessions a year. However, after discussions it was felt that they could certainly manage about 2,000 per year rather than the current rate of 1,000 per year. Taking deaths into account 2,000 accessions per year would allow the collection to grow at the acceptable rate of about 300 accessions per year. This would typically equate to about 100 new taxa. A new target to raise standards in this specific area has therefore been set – to acquire 2,000 new accessions per year. Discussions are now taking place to see how this might be achieved. Topics for discussion have included training younger staff in expedition techniques, creating opportunities for younger staff to take part in expeditions, finding new sources of finance, planning over a longer period of time and targeting geographical areas for special attention.

Percentage Wild Origin

Wild origin material is important because it means that a plant's exact locality and background are known. If the material is of 'garden' origin, i.e. from an unknown source such as a commercial nursery or other botanic garden, the material might be of hybrid origin and, even if not, its exact origin is probably unknown. Many species have very wide distributions and contain, accordingly, large variations in morphology or other variable features. Without knowing the exact origin of a plant, it is very difficult to draw firm conclusions about any aspect of its taxonomic or systematic status. It is for this reason that taxonomists and other botanic garden scientists prefer to study wild origin material from the collections.

At RBGE staff have concentrated on acquiring predominantly wild origin material for the last 30 or more years and during the last 10 years new accessions arriving at the Garden has been in the range 79%-92% wild origin. Despite this the collection still only contains 53.8% of wild origin material. The reason for the collection being relatively low in wild origin material, despite 30 years of effort in this area, is that prior to this the vast majority of the collection was of unknown or garden origin. Change in this area can be very slow because trees and shrubs have long life spans and, unless they are removed and replaced with wild origin material simply to improve the figures (which RBGE does not plan to do), it has to be accepted that it will take many years to make big changes.

Despite the slow progress in increasing wild origin material, RBGE is committed to supporting research by growing predominantly this material and will strive to push up the figures. Even allowing for the eventual death of long-lived non-wild origin trees it is unlikely that the collection could ever be more than about 80% wild origin. The reason for this is that some cultivars will always be grown for display, student plant identification classes and interest. However, due to the importance of wild origin material, another target has been created in the last two years – this time to increase the wild origin percentage of the collection by 1% per year.

PERCENTAGE VERIFICATION

Verification is the process of checking that the name attached to a plant is correct and it is important because it confirms the exact name of the plant. Without the confidence of being sure that the correct name is attached to a specimen, it is difficult to compare the specimen to other species or carry out any investigation into the plant because of the uncertainty of the status of the material being studied. Verification can be slow and time consuming but it is one of the fundamental tasks in curating and maintaining a botanic garden collection. Despite this, many botanic gardens do not verify their collections on a regular basis and, even if they do, very few could give figures for the percentage that has been verified.

A recent check at RBGE revealed that only 10,003 accessions had been verified equating to 24.2% of the collection. While this figure seems incredibly low, two factors should be borne in mind. First, a policy has been in place for some years stating that only wild origin material will be verified by scientific staff. As only 54% of the collection is wild origin, only just over half of the collection could ever be verified and so, in effect, the 24.2% could be more than doubled to just over 50% of the 'verifiable' material. Add to this the fact that current policy states that verification should be carried out at individual plant level. This means that if a number of plants are grown from a batch of seeds each individual has to be checked in case any rogue seeds had inadvertently contaminated the seed lot. These policies, along with the fact that verification is often very slow and time-consuming, have combined to give the low figure. Despite these reasons, it is now felt that effort should be devoted to increasing the percentage verification and so a target of 2% increase per year has been adopted along with suggested ways of streamlining the process (see *A new approach to targeting verification at the Royal Botanic Garden Edinburgh*, Cubey & Gardner, 2003)

GENETIC DIVERSITY

It is sometimes said of botanic garden collections that they are merely 'stamp collections' with one or two individuals of many species which are of little use in demonstrating diversity or in conservation projects. It would be a great generalisation, but nonetheless probably true, to suggest that more accessions per taxon within a collection equates with greater genetic diversity, compared with having fewer accessions per taxon. Having given some thought to these statements it seemed a worthwhile exercise to try and find out the average number of accessions per taxon across the whole of the collection at RBGE, and then see if the figure was greater in genera or families in which RBGE has a special interest or in which there are conservation programmes.

The calculations showed that there are 2.1 accessions per taxon for the whole collection but that for rhododendrons (a genus in which RBGE has had a long taxonomic interest) there are 3.4 accessions per taxon and for conifers (a group in which RBGE has a conservation interest) there are 4.8 accessions per taxon.

If the collection as a whole, or individual parts of it, need to be as 'fit for purpose' as possible it would be interesting to see if the figures shown above increase with time indicating, in general terms, that the collection was becoming more genetically diverse. While analyses such as these might well be incorporated into annual collection 'health checks' in the future, there are currently no plans to include targets of the type described elsewhere in this paper. At present the figures are simply being regarded as interesting and worthy of further investigation. It would also be very interesting to compare the figures given above with other botanic garden collections.

CONCLUSION

Statistical data generated from plant records databases can help track trends in collections and, if a number of specific factors are selected for annual comparison, they can be used for a type of collections 'health check'. At RBGE a recent collections audit gave an invaluable insight into recent trends within the collection and will now be arranged every five years to monitor change. Additionally, a number of other key factors have been selected for annual review and specific targets have been set to raise standards. Table 6 summarises the indicators selected for review.

TABLE 6. Collection indicators or factors selected for review and target setting

5 yearly audit	100 families and genera selected for comparison in trends
New accessions	Aim for 2,000 per year
Wild origin material	Increase by 1% per year
Verification level	Increase by 2% per year

RBGE believes that collection reviews of the type described will give early warning of developing problems and drive up standards in weak areas of the collection.

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REFERENCES

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APPENDIX 1

TABLE 7. Explanation of codes indicating relative importance of species in cultivation.

Code	Explanation
H1	Families with a substantial hardy content in which RBGE has decided to specialise. If space is available RBGE should be prepared to grow multiple, wild-origin collections of all genera and species.
H2	Families with a substantial hardy content which are related to H1 families, and families in which RBGE has had a long-standing interest but which are not actively worked on at present. Minimum 50% of genera and 25% of species. Multiple wild-origin accessions will not normally be grown, apart from species with a very wide geographical distribution.
H3	Mainly hardy families for which RBGE requires minimal representation. A few genera of each, with one or two species of each, will be sufficient.
T1	Tender families and also tender genera in H1 families in which RBGE has decided to specialise. Depending on culture requirements, space availability and size of the family or genus, RBGE should be prepared to grow multiple wild-origin collections of all genera and species.
T2	Families which are related to T1 families, and families in which RBGE has had a long-standing interest but which are not actively worked on at present. Minimum 10% of genera and 5% of species, depending on family. Multiple wild-origin accessions will not normally be grown, apart from species with a very wide geographical distribution.
T3	Tender families for which RBGE requires minimal representation. A few genera of each, with one or two species of each, will be sufficient.

APPENDIX 2

A small selection of the families and genera included in the audit follows:

1. H1 and T1 Families and Genera (arranged alphabetically by family)

Amaryllidaceae

Amaryllidaceae – 65 genera 725 species

	Taxa (a)	Plants	Acc Wild	Acc All	Diff 3
1990	131	740	95	225	42%
1995	186	866	198	340	58%
2001	194	906	215	360	60%
Diff 1	48%	22%	126%	60%	
Diff 2	4%	5%	9%	6%	

Caprifoliaceae

Abelia – 30 species

	Taxa (a)	Plants	Acc Wild	Acc All	Diff 3
1990	8	36	1	12	8%
1995	9	37	2	13	15%
2001	9	39	2	14	14%
Diff 1	13%	8%	100%	17%	
Diff 2	0%	5%	0%	8%	

Lonicera – 180 species

	Taxa (a)	Plants	Acc Wild	Acc All	Diff 3
1990	68	297	62	117	53%
1995	82	450	106	162	65%
2001	82	409	108	170	64%
Diff 1	21%	38%	74%	45%	
Diff 2	0%	-9%	2%	5%	

Viburnum – 150 species

	Taxa (a)	Plants	Acc Wild	Acc All	Diff 3
1990	50	231	48	102	47%
1995	55	340	80	135	59%
2001	55	285	75	130	58%
Diff 1	10%	23%	56%	27%	
Diff 2	0%	-16%	-6%	-4%	

Decrease in plants due to a plant records recategorization from 'individual' to 'mass'

Cupressaceae

Juniperus – 50 species

	Taxa (a)	Plants	Acc Wild	Acc All	Diff 3
1990	37	421	114	151	75%
1995	47	1027	183	221	83%
2001	48	855	190	234	81%
Diff 1	30%	103%	67%	55%	
Diff 2	2%	-17%	4%	6%	

Increases due to ICCP safe site programme; losses due to transplant losses.

Gesneriaceae

Aeschynanthus – 140 species

	Taxa (a)	Plants	Acc Wild	Acc All	Diff 3
1990	53	361	112	136	82%
1995	58	363	127	152	84%
2001	84	657	255	296	86%
Diff 1	58%	82%	128%	118%	
Diff 2	45%	81%	101%	95%	

Primulaceae

Primulaceae – 22 genera 825 species

	Taxa (a)	Plants	Acc Wild	Acc All	Diff 3
1990	202	1423	144	327	44%
1995	262	2122	275	482	57%
2001	252	2212	253	467	54%
Diff 1	25%	55%	76%	43%	
Diff 2	-4%	4%	-8%	-3%	

Umbelliferae

Umbelliferae - 446 gernera 3540 species

	Taxa (a)	Plants	Acc Wild	Acc All	Diff 3
1990	66	225	48	81	59%
1995	174	803	214	250	86%
2001	224	1481	306	348	88%
Diff 1	239%	558%	538%	330%	
Diff 2	29%	84%	43%	39%	

Zingiberaceae

Zingiberaceae - 52 genera 1100 species

	Taxa (a)	Plants	Acc Wild	Acc All	Diff 3
1990	114	360	141	208	68%
1995	119	368	164	231	71%
2001	162	638	316	400	79%
Diff 1	42%	77%	124%	92%	
Diff 2	36%	73%	93%	73%	

2. H2, T2, T3 families and genera

Araucariaceae

Araucaria - 18 species

	Taxa (a)	Plants	Acc Wild	Acc All	Diff 3
1990	11	62	17	27	63%
1995	11	529	40	63	63%
2002	12	1883	204	226	90%
Diff 1	9%	2937%	1100%	737%	
Diff 2	9%	256%	410%	259%	

Begoniaceae

Begonia - 900 species

	Taxa (a)	Plants	Acc Wild	Acc All	Diff 3
1990	58	178	33	76	43%
1995	38	173	35	60	58%
2002	53	447	150	179	84%
Diff 1	-9%	151%	355%	136%	
Diff 2	39%	158%	329%	198%	

Ericaceae

Ericaceae (Tropical) - 3400 (all)

	Taxa (a)	Plants	Acc Wild	Acc All	Diff 3
1990	73	207	139	147	95%
1995	58	239	90	102	88%
2002	57	215	84	89	94%
Diff 1	-22%	4%	-40%	-39%	
Diff 2	-2%	-10%	-7%	-13%	

Ferns and fern allies

Ferns and fern allies (Tender)

	Taxa (a)	Plants	Acc Wild	Acc All	Diff 3
1990	306	1481	445	578	77%
1995	463	2868	628	830	76%
2002	451	3403	647	815	79%
Diff 1	47%	130%	45%	41%	
Diff 2	-3%	19%	3%	-2%	