LIVING COLLECTIONS OF BOTANIC GARDENS AS A MEANS OF *EX SITU* CONSERVATION - A Case Study of African Violets (*Saintpaulia)* in Europe

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In all plant conservation, the priority is to maintain wild populations *in situ* (on site), which means that plants are conserved within their natural environment. Sometimes, as in the case of severely endangered *Saintpaulia* H. Wendl. (African violets), this is however, no sufficient. In that case, *ex situ* (off site) conservation in the form of live and *in vitro* collections and seed banks is necessary. In recent years, the role of botanic gardens in conservation and reintroduction of threatened plants, has been increasingly recognized. Botanic gardens throughout the world possess large living collections of species and accessions, but only vague assumptions of the utility of them in *ex situ* conservation have been made thus far. Whole plants, when kept *ex situ*, have advantages in education, research and display. On the other hand, living collections have the disadvantage of high maintenance costs, including high spatial requirements. Thus, usually only one or few genotypes are represented.

The goal of this study is to evaluate botanic garden live collections as a means of *ex situ* conservation with the genus *Saintpaulia* as a case study. As a result, an *ex situ* conservation plan for *Saintpaulia* is outlined. Workability of a network *ex situ* conservation activity in botanic gardens is also evaluated.

Four of the five most important European *Saintpaulia* holders were chosen as target botanic gardens: Helsinki University Botanic Garden (Finland), The National Botanic Garden of Belgium, The Botanic Garden of Uppsala University (Sweden) and the Royal Botanic Gardens Edinburgh (UK). The wild *Saintpaulia* collections of the gardens were reviewed and the identifications checked. Botanic garden databases were examined to trace clone accessions. Leaf cuttings from wild-collected accessions were planted in Helsinki University Botanic Garden.

Of the total 183 *Saintpaulia* accessions of the four target gardens 155 (85 %) were unique, and 126 of these were of known wild origin. They were chosen to *ex situ* conservation collection. Due to the varying quality of the data of origin of the accessions, five classes for the different quality of origin data were developed.

European botanic garden living collections of *Saintpaulia* proved to be a workable base of *ex situ* conservation for the genus. The amount of space needed to conserve the ideal of at least 50 unique accessions of each of the 26 *Saintpaulia* taxa is best possible to organize with the network *ex situ* conservation programme: each accession will be stored in at least two botanic gardens, but no garden will have all the accessions. *Saintpaulia* is an ideal genus for living *ex situ* collections: it is beautiful and well-known, small-sized and easy to grow and propagate. New *ex situ* accessions will be collected from the wild and finally reintroduced to their natural habitats. Further research needs to be carried out to find out the proper seed banking mechanisms for probably orthodox but dust-like seeds of *Saintpaulia* species. The lack of research on the basic biology and the population ecology of the genus hampers effective conservation work. Collaboration with amenity horticulture and the home countries of *Saintpaulia* is planned to utilize the genetic diversity of wild African violets in breeding new cultivars.

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1. Introduction

The threat to plant species has never been as great as it is today (e.g., Pitman & Jørgensen 2002).Still,all people depend on plants for food, clothing, shelter, and fuel. Even when we use things obtained from animals, plants are used indirectly, because all animals ultimately depend on plants for their energy. The increasing needs for genetic resources to be used in breeding of food plants and in development of new pharmacological products emphasize the demand for exploration and conservation of the declining plant diversity (Given 1994). It seems very likely that new plant materials of the future would more than pay for the costs of preserving species and developing sustainable harvesting or cultivation (Myers 1979, Hall *et al.* 1985, Munasinghe & McNeely 1994).

The preservation of genetic diversity is important, because it provides long-term evolutionary potential for changing environmental conditions (Dobson 2000). There is no clear-cut answer to the question, when losses of diversity become critical. At some point losses will affect local communities, and, at a higher level, they will affect global stability. Due to the limited amount of resources, priorities must be set in conservation. Human interests, vulnerability and efficiency are factors that must be taken into account when choosing species and areas for conservation (Vane-Wright 1996). Particular value needs to be placed on indicator species, which signal when there is something wrong with the health of an ecosystem, and on those species that are key biological links or on which many other species depend. The problem is, however, that there is not enough information on which species are critical. To be sure, it is best to avoid all extinctions unless the costs of doing so are unacceptably high (Given 1994).

In all plant conservation, the priority is to maintain wild populations *in situ (*on site), which means that plants are conserved within their natural environment (Anon. 2002a). Sometimes, as in the case of African violets (*Saintpaulia*) (Simiyu *et al.* 1996, Eastwood *et al.* 1998) this is, however, no longer sufficient. In that case, *ex situ (*off site) conservation in the form of live and *in vitro* collections and seed banks is necessary. In recent years, the role of botanic gardens in conservation and reintroduction of threatened plants, has been increasingly recognized (Du Puy & Wyse Jackson 1995, Hernández Bermejo & Clemente Muñoz 1996, Wyse Jackson &

Sutherland 2000). Living collections are the easiest way of *ex situ* conservation in botanic gardens as vast living plant collections already exist. However, the true value of the traditional living collections as biodiversity repositories has not been thoroughly assessed.

Living collections of whole, growing plants, in addition to their conservation value, can be utilized in education display and research (Given 1994), which are the traditional purposes of botanic gardens. Especially in the case of species taking time to reach reproductive maturity, mature specimens on hand are advantageous for research and education (Given 1994).

Living collections have the disadvantage of high maintenance costs, including high spatial requirements, especially in the case of trees (Hawkes 1992, Given 1994), and the ambition to display as diverse collection of plant species as possible usually shrinks the sample of one species to one or few genotypes. Annuals, on the other hand, have to be subjected to frequent controlled pollination and re-establishment, unless methods of vegetative propagation are available. In addition, whole plants often readily hybridise with related taxa and are vulnerable to various diseases and disasters. Also the daily routines of maintenance expose the collections to confusions, and the poor record keeping that is characteristic of some old botanic gardens significantly reduces the conservation value of their collections (Maunder 1991).

The goal of this study is to critically evaluate botanic garden live collections as a means of *ex situ* conservation and to develop methods to do this. I use African violets (*Saintpaulia* H. Wendl., Gesneriaceae) in European botanic gardens as a case-study. To provide a framework for the assessment of conservation collections consisting of live, growing specimen, I start with a review of the pros and cons of *ex situ* conservation in general and other available methods of *ex situ* conservation in particular. On the basis of the results of my evaluation of *Saintpaulia*, I outline an *ex situ* conservation plan for this genus. To my knowledge, this is the first *ex situ* conservation scheme that is based on live plants and a network between several botanic gardens.

2. E*x situ* conservation

*Ex situ (*off-site) conservation is preserving as wide genetic variability as possible outside the natural environment of the species (Given 1994, Engelmann & Engels 2002). E*x situ* conservation is an important support system for the conservation of natural habitats (*in situ* conservation or on- site conservation) as habitats are declining rapidly. Certainly the most famous form of *ex situ* conservation of plants are the living collections of botanic gardens, but seed banks (e.g., Phartyal *et al.* 2002) and in vitro culture (e.g., Da Costa Nunes *et al.* 2003) are other important possibilities. E*x situ* plant material can be collected as whole plants or as seeds, pollen, eggs, ovules and various tissues. Duplicate storage situated in another country and ideally in another continent is considered strongly advisable (Hawkes 1987). E*x situ* conservation can promote public awareness and provide opportunities for education and research beneficial to the species concerned (Ashton 1987, van Sloten & Reid 1992, Worley 1997).

2.1 Sampling of the collections

The objective of *ex situ* conservation is to maintain a collection containing as many alleles as possible and/or as diverse a range of gene combinations as possible (Marshall & Brown 1975, Hawkes 1987). Efficient sampling from the wild depends on good planning (Given 1994, Engelmann 1997). The acquisition of material for *ex situ* conservation ideally requires knowledge of the breeding system and biological population structure of the species in question (e.g., Engels & Visser 2003). Targeting the maximum diversity of habitats for collection will maximize the diversity of genes contributing to adaptation to the selection pressures imposed in the environments sampled. Moreover, the potential for differentiation increases with the degree of isolation. Thus, two small populations are likely to differ through random drift in all polymorphic parts of their genome. Against this, small populations are more inbred and contain less within-population variation. Hayward & Sackville Hamilton (1997) remind, however, that in acquiring the maximum genetic diversity of targeted taxa within the region, one has to compromise on the limited available resources. If the primary object is to combat genetic erosion occurring fast, the speed of undertaking a collecting expedition is of overriding importance.

According to Hayward and Sackville Hamilton (1997) it is not possible to recommend a specific proportion of the genetic variation present in a population, or in the species as a whole, that must be represented in the *ex situ* collection. In many situations, the size of the sample at a site may be set by the scarcity of individuals. The golden rule is that during collection a population is never deprived of more than 20 % of its seeds so that its reproductive potential is not significantly affected (Anon. n.d.). Still, sample size must obviously allow for poor germinability of seed, poor striking from cuttings, viability testing and the duplication and sharing of material among institutions. The volume of seed required for a stored sample may not be obtainable from a single visit to the site. Repeated sampling in the field will often be easier and cheaper than multiplying in the garden, unless the site is remote and inaccessible (Brown and Briggs 1991).

However, rules of thumb for the sample size have been given. Marshall and Brown (1975) find that if samples are selected at random, 50 - 100 individuals provide a 95 % probability of including all alleles with a frequency of at least 5 % in the population sampled. Chapman (1984) suggests that 50 unrelated individuals, taken from either one or several populations, will contain all but most uncommon alleles of a taxon with 95 % certainty. Hawkes (1987) recommends that in seed sampling, ideally about 2500 to 5000 seeds per taxon should be obtained. Where possible, collectors of the Millennium Seed Bank Project aim to collect a minimum of 20 000 seeds of each species banked (Anon. n.d.). Lawrence (2002) states that a sample of 172 plants, drawn at random from a population of a target species, is of sufficient size to capture all or very nearly all of the polymorphic genes that are segregating in a population, provided that their frequency is not less than 0.05. Some models have been developed to assess the sample size on certain populations (e.g., Brown & Schoen 1994), but they require good knowledge on the biology of the species, which in many endangered taxa (e.g., *Saintpaulia*) is unavailable.

The main possibilities for choosing individuals for a sample on a site are simple random sampling (each plant in the population is equally likely to contribute); stratified random sampling (the habitat is divided into obviously differing patches and random sampling is carried out in each patch); systematic sampling (the sampled individuals are equally placed on a grid or transect); and biased sampling, based on variation in appearance (Brown & Briggs 1991, Hayward & Sackville Hamilton 1997, Schoen & Brown 2001). The stratified random technique is probably the best due to the different gene combinations developed in individuals in different patches.

In addition, a number of technical considerations have to be kept in mind when carrying out sampling, such as timing, recording of the data of the site, storage material and viability (e.g., Anonymous 1995, Küden et al. 1995, Phartyal et al. 2002, Bonomi et al. 2004). Regular testing for viability is essential in maintenance of the collections.

2.2 How to choose species for *ex situ* conservation programmes

It is not possible to save every species from extinction; consequently care must be taken to ensure that limited resources are used efficiently. When choosing species for *ex situ* conservation, priority should be given to endangered species of global rarity, morphologically and genetically isolated species, monospecific genera and relict populations (Anonymous 1995). In addition, one should consider available funds, chances of success, the economic and cultural value for humans and the ease with which the species can be collected in the wild (Ashton 1987, van Sloten & Reid 1992, Given 1994, Worley 1997). African violets, the case studied here, meets many of these prioritization criteria, as clarified in section 3. The Genus *Saintpaulia* (p.).

2.3 Genetic problems of *ex situ* conservation

Genetic problems of *ex situ* conservation are the absence of natural evolutionary processes, artificial selection pressures, inbreeding depression and random genetic drift (Ashton 1987, Given 1994, Schoen & Brown 2001). These factors seriously hamper the reintroductions of plants to the wild. Due to the absence of the process of natural evolution, species conserved *ex situ* cannot evolve with respect to their natural physiological and biological environment. Furthermore, artificial selection pressures are imposed (e.g., Engelmann 1997, Given 1987), and some genotypes adapt to the artificial growing environment better than others.

Historically large, outcrossing populations that suddenly decline to a few individuals usually experience reduced viability and fecundity, known as inbreeding depression, after several generations (Lande 1988, Caughley 1994, Loew 2000, Oostermeijer 2003). Rapid inbreeding in small populations produces increased homozygosity of recessive deleterious mutants that are kept rare by selection in large populations, and by genetic drift such mutations may become fixed in small populations despite counteracting selection. However, high levels of inbreeding may be normal and non-deleterious in some animal species and many plants (Silvertown & Charlesworth 2001).

Each time an accession of an *ex situ* collection is subsampled or regenerated, genetic shifts occur by drift in addition to selection (Hawkes 1987) Drift occurs in two stages: first in the choice of seed to be used as parents of the generation of seed; and second in the number of progeny derived from each parent plant. Selection is rarely deliberate and artificial, except where an identifiable genetic variant is subsampled from an accession for separate conservation.

2.4 Reinforcement and reintroduction

Reinforcement is a measure to increase population size or diversity by adding individuals to an existing population (Anon. 1995). Reintroduction means the release and management of a species into an area in which it formerly occurred, but in which it is now extinct (e.g., Almeida *et al.* 2004). Even when a habitat is protected, populations may still disappear because fragmentation or other factors have so altered the ecological dynamics that the habitat may no longer be suitable for a given taxon (e.g., Gonçalves & Romano 2005). In such situations repeated re-introductions may be essential until such time that proper ecological conditions for survival are understood and effectively manipulated (Mistretta 1993). Besides, *in situ* conservation is not always possible in poor countries with rapid population growth.

Species reintroduction is a relatively high-risk and high-cost activity. It may, however, work out cheaper in the long-term than permanent maintenance in cultivation (Anonymous 1995) and it is certainly more feasible ecologically. Reintroduction and any associated restoration of the habitat should never be seen as a substitute for primary *in situ* conservation. In northern latitude countries with a relatively small and well researched flora, in relation to available finances and facilities, reintroductions are becoming more important. In contrary to the tropics, the major phases of land acquisition for conservation have passed (Maunder 1991). Botanic gardens are uniquely placed to undertake reintroduction projects for plants. They are often the only institutions to hold adequate and accurately named collections of plant germplasm. They have the requisite infrastructure and propagation facilities, together with the horticultural and other applied scientific skills of their staff needed to undertake practical aspects of a species reintroduction programme (Wyse Jackson & Sutherland 2000).

The aim of reintroductions is the establishment of a self-maintaining viable population. To be effective, re-introductions require a sound understanding of the genetics of populations and species (Mistretta 1993). Stock used for reintroduction should be of the original population or as close as possible. According to Maunder (1991), the use of multi-provenance populations could be sanctioned for taxa at very low numbers where inbreeding depression is suspected.

It is important to make sure that there are no plant diseases in propagules used in reintroductions. The holding of endangered taxa by botanic gardens creates logistical difficulties as its is becoming increasingly difficult due to phytosanitary and CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna) legislation to move plant material across international boundaries for repatriation prior to reintroduction (Maunder 1991). Although *in vitro* micropropagated material eases the problem, the subsequent weaning of such material can be difficult. E*x situ* conservation actors that operate within their national boundaries can more easily engender local support and have easier access to reintroduction sites.

When considering reintroduction activities, one should try to find out the cause of decline or local extinction of the species. Such factors must be removed or controlled before reintroduction. This may mean, for instance, elimination of introduced fauna and flora and creation of additional habitats and ecological niches for wildlife (e.g.,, Ashton 1987, van Sloten & Reid 1992, Given 1987). In some cases just removing the alien pressures of livestock or weeds will result in an increase in the regeneration of reduced populations or result in growth of dormant propagules or vegetative individuals reproducing. In other cases habit restoration is needed.

Comparative trials using different types of propagules are required. Provisional findings would suggest that reintroductions using seed as the main propagules will suffer high rates of loss, because they are vulnerable to predation and competition and unpredictable precipitation (Wells *et al.* 1989). Nursery grown material will need to be “hardened off” prior to planting, after planting the irrigation and protection of plantings should be considered.

There should be a long-term commitment to security of land-tenure and funding for monitoring and management. International coordination and planning between *ex situ* holders of plants and the managers of protected areas is also necessary. It must be kept in mind that most plant reintroductions can at present only be regarded as experimental; evidence is still awaited on their long term success.

2.5 Other means of *ex situ* conservation in botanic gardens

Seed banks are an excellent storage method and they need not be difficult to set up or expensive to maintain (Given 1994). For seed collections, a domestic freezer can be enough to start with (e.g., Vanderborght 2004, Gautier 2004). An alternative is to cryopreserve the seeds in liquid nitrogen -196°C (Sakai 2004). Drying can be done using chemical desiccants (e.g., Hu *et al.* 1998) Seed banks require little space: a tiny container of a few thousand seeds, is able to store most of the genetic variability of a whole plant population. Labour demands are also low. However, the seeds of different species may require different storage techniques (e.g., Bonner 1995), an important area of study as an increasing number of species require preservation. Information on seed storage behaviour is available for less than 5 % of higher plants (Phartyal *et al.* 2002).

The storage life of plant seeds is very variable, but a 200 year storage life may be widely achievable for orthodox seed (Hanson 1985, Engels & Visser 2003, Anon. n.d.). Seeds must be tested for viability at least every 10 years.

Few botanic gardens have expertise on seed banking at present, although seed banks could be an excellent and workable method of *ex situ* conservation together with living collections (e.g.,, Engelmann *et al.* 2002). The Millennium Seed Bank Project

MSBP (Anon. n.d.), an international plant conservation partnership catalysed by the Royal Botanic Gardens Kew is however, is a prime example of botanic gardens participating in seed banking. The MSBP aims to collect and conserve seeds from some 24 000 species, principally from the drylands, by 2010 and is thus working to meet targets set in the Global Strategy for Plant Conservation (Anonymous 2002a). The MSBP works with partners to facilitate seed banking of species in the country of origin. Duplicate collections are held for safety in the UK. MSBP Seed Bank Project is also utilized in raising public awareness, as visitors in Kew gardens have possibility to familiarize themselves with the procedures of seed banking.

Species with recalcitrant seeds are not suitable for seed banking (e.g., Smith 1995). The seeds of recalcitrant species are large, and they have no dormancy, i.e., they germinate at once. Reduction of temperature and humidity kills them quickly. Recalcitrant-seeded species are comparatively rare, but some important plants, for instance tea and coconuts, are among them. Consequently, such plants should be given higher priority for *in situ* conservation. They may also be stored in living collections and *in vitro (*Malaurie 1998, Said Saad & Ramanantha Rao 2001, Sunpui & Kanchanapoom 2002, Reed *et al*. 2004*).*

Field gene banks provide refuge for vegetatively propagated species and those species that are unsuitable for seed banking because they have recalcitrant and/or big seeds and whose existence is still threatened in the wild, e.g., coffee and bananas (e.g., Said Saad & Ramanantha Rao 2001, Engels & Visser 2003).

***In vitro* culture** is a process where cells, tissue, or organs are excised from a mother plant, surface sterilized and transferred to an artificial growth medium *in vitro* (e.g., Ashton 1987, van Sloten & Reid 1992, Worley 1997). By manipulation of physical and chemical factors, the growth and development of the plant material can be guided, resulting in different culture systems. The plant material is best maintained as organized systems where the morphological integrity of the starting material is maintained (tissue cultures or organ cultures) in order to reduce the risk of somaclonal variation (Engelmann 1997). Due to the totipotency of plant cells, complete fertile plants can in theory be regenerated from all living cells. The plants are formed through the formation of apical meristem.

Basically, there are three approaches to *in vitro* storage: storage of actively growing cultures, minimal growth storage and cryopreservation (Krogstrup *et al.* 1992). In actively growing cultures the plant material is maintained as actively growing tissue cultures. This requires monthly transfer of cultures to new media and implies a risk of loosing material due to contamination or physiological decay. The benefit of this method is that the material can be rapidly multiplied by micropropagation and in this way constitute a backup for a field grown active collection.

In using minimal growth storage the tissue cultures are exposed to growth-limiting chemical and physical factors such as retardants (e.g., abscisic acid, sorbitol and mannitol) and reduced temperature and light (Engels & Visser 2003, Engelmann 1997). In order to multiply this material, a long lag phase is needed to restore the normal physiology. The advantage of this procedure is the smaller amount of work in maintenance. However, minimal growth may impose definite selection pressures as well as environmental stresses, which can cause genetic modifications.

In cryopreservation material is exposed to -196°C liquid nitrogen and cellular metabolic activities cease due to unavailability of liquid water. Consequently genetic changes are minimized. Moreover, cultures are stored in a small volume, protected from contamination and require a very limited maintenance. Various material such as embryos, shoot tips and apical meristems have been cryopreserved (Sunpui & Kanchanapoom 2002, Da Costa Nunes *et al.* 2003, Moges *et al.* 2004). However, regeneration after thawing is sometimes problematic (e.g., Panis & Thinh 2001). Thus, cryopreserved collections are best in long-term storage (Reed *et al.* 2004). *ex situ* conservation *in vitro* is not very common in botanic gardens and many gardens lack the suitable equipment. *In vitro* culture is, however, the best possibility to conserve recalcitrant and big-sized species in botanic gardens.

Storing pollen is useful for self sterile plant species that do not flower simultaneously. Pollen storage is also a common practice in breeding programmes to bridge the gap between male and female flowering time and to improve fruit setting in orchards. Small size and desiccation tolerance render pollen grains particularly suitable for storage (Ashton 1987, van Sloten & Reid 1992, Given 1994, Worley 1997).

However, relatively limited use has thus far been made of pollen for long-term germplasm conservation (Engels & Visser 2003). Reasons for this include the short longevity of pollen grains relative to seeds, the small amount of pollen per flower in many species, cytoplasmic inheritance and cumbersome and time-consuming methods for testing viability. Cryopreservation may, however, be a solution for the longevity problem, but critical tests for acquiring long-term storage data are needed (Towill & Walters 2000). Moreover, one serious drawback of using pollen in germplasm conservation for the time being is that mature pollen grains cannot develop independently into whole plants. Thus a pollen sample cannot easily be renewed and new collections have to be made (Hoekstra 1995).

Gene libraries provide a means to conserve DNA sequences, even whole genomes, for research (Ashton 1987, Adams 1998, Engels & Visser 2003, Richards 2004). DNA storage is efficient and simple and overcomes many physical limitations and constraints that characterize other forms of storage. The genetic material thus conserved can be introduced to other extant genotypes, but whole individuals cannot be regenerated independently. Pollen preservation and DNA storage are interesting but not very topical means of *ex situ* conservation in botanic gardens.

3. The Genus *Saintpaulia*

The genus *Saintpaulia* belongs to the family Gesneriacae, which consists mainly of tropical shrubs and herbs. Other popular ornamental plants from the same family are Cape primroses (*Streptocarpus*) and gloxinias (*Sinningia*).The introducer of the genus *Saintpaulia* to Europe was Baron von Saint-Paul-Illaire, who worked as as a Regional Commissioner in the northern port of Tanga in the German East Africa (now Tanzania). The genus *Saintpaulia* was described as new to science 1893 by Hermann Wendland, the director of the Botanic garden of Herrenhausen in Hannover. The same year it was brought to the International Horticultural Exhibition in Gent, Belgium and the economical value of the genus was recognised. Nowadays there are thousands of cultivars mainly been bred from two natural species *S. ionantha* and *S. confusa* (Baatvik 1993, Eastwood *et al.* 1998). The annual wholesale value of *Saintpaulia* in the USA and the Netherlands alone is over € 50 million (Anonymous 1999a, b).

The genus *Saintpaulia* has been promoted as a flagship taxon, “the giant panda” of East African plant conservation, because of its popularity as a pot plant (Baatvik 1993; Simiyu *et al.* 1996; Eastwood *et al.* 1998) and the threatened status of the genus (Walter & Gillet 1998). Forests on the Eastern Arc are one of the biodiversity hotspots in the world on the basis of the high numbers of endemic species (more than 25 %) and conserving *Saintpaulia* preserves these valuable areas as a whole. In addition to ethical reasons, there are important economic incentives to protecting wild African violets: they can contribute to the development of amenity horticulture based on these much-loved plants (L. Schulman, pers. comm.) and, ideally, help in supporting the livelihood of local communities through germplasm sales and ecotourism (Kolehmainen *et al.*, unpubl.)

Tanzania and Kenya, the home countries of *Saintpaulia*, do not have financial possibilities to organize proper *in* and *ex situ* conservation (Rodgers 1998). That is why western countries must be involved. Besides, a considerable number of wild *Saintpaulia* accessions are already held by a number of European botanic gardens and by some private collectors, and all but three scientifically described taxa are included. However, the collections are not designed with *ex situ* conservation in mind and no systematic cross-referencing of the collections had been done before this study.

3.1 Species

There are 20 described species and four varieties (Table 1.) in *Saintpaulia*. The genus is endemic to Kenya and Tanzania. However, several populations, that do not seem to fit into any already described taxon, have recently been found (Simiyu *et al.* 1996, Clarke 1998, Eastwood *et al.* 1998, Kolehmainen *et al.*, unpubl.) In Kenya two populations have been distinguished from the other two Kenyan species *S. teitensis* and *S. rupicola*, already described by Burtt (1958, 1964). These are known as *S.* “Kacharoni” and *S.* “Mwachi”. In Tanzania possible new species are *S.* “Sigi Falls”, *S.* “Mafiensis”, *S.* “Pangani Falls” and *S.* “Mhonda”.

African violets are either rosulate or caulescent herbs whose leaves are more or less succulent (Burtt 1958, 1964). The flowers are zygomorphic with two upper and three lower lobes. *Saintpaulia* has a very short corolla tube and yellow protruding anthers, probably associated with buzz pollination (Harrison *et al.* 1999). The reward offered by the flower is pollen, not nectar. All species of *Saintpaulia* are enantiostylous (the style is strongly deflected to the left or right of the main floral axis), a feature often linked to buzz pollination. The fruit shape seems to be quite variable, even intraspecifically (Harrison *et al.* 1999). The capsules may be short and stout, or long and slender, but they are never twisted like in *Streptocarpus.*

The most important difference between the *Saintpaulia* species is type, posture and distribution of the hairs on the leaf surface (Burtt 1958, 1964). There are four basic types of hairs and the types appear in different combinations: long erect, long appressed, short erect and short appressed. The flower colour is a distinctive character only in a few species. Lindqvist and Albert (1999) suggest, the *Saintpaulia* taxa of the East Usambara region may be in active state of evolution and may deserve a status of metapopulation rather than a species group. Kolehmainen *et al.* (unpubl.) also observed high morphological variation both within and between localities during their study in East Usambara Mountains and adjacent lowlands. Apparent species hybrids were also found. Besides, the descriptions made by Burtt (1958, 1964) were often based on only a few specimens and in some cases only one was used.

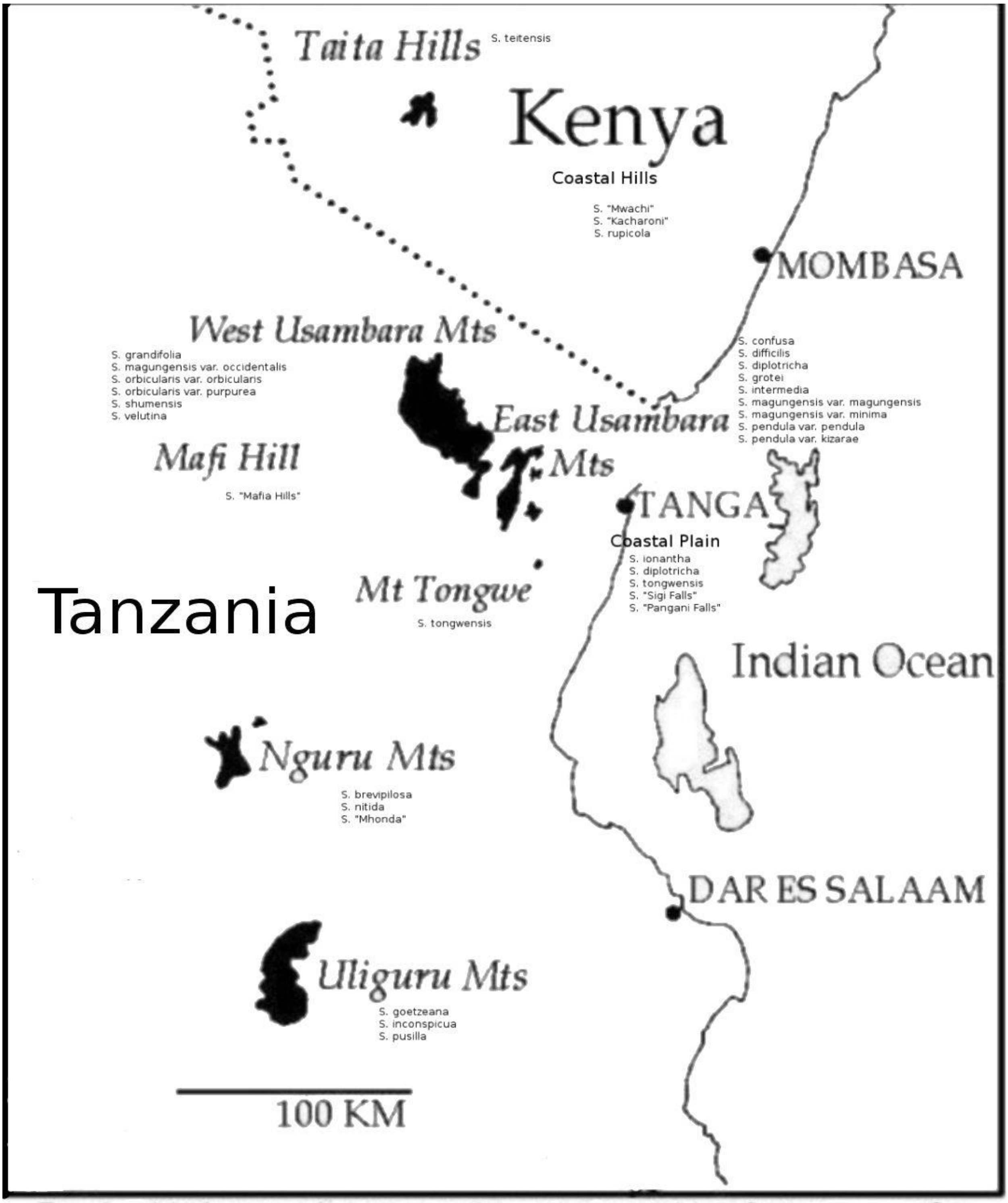
If the metapopulation status is correct, it has impacts on the sampling and record keeping of the *ex situ* accessions. If the availability of space restricts the size of the *ex situ* collection, as is usual with living collections, accessions must be chosen from different parts of the phylogenetic tree, and the importance of the metapopulations diminishes. If seed banking mechanisms are to be developed and extensive amounts of seeds can be stored, representation must be acquired from each partial population of the metapopulation and the partial populations stored apart so that they will finally be reintroduced into their original environment.

3.2 Distribution area and habitats

The genus *Saintpaulia* has a disjunct distribution in the Eastern Arc Mountains (Uluguru Mts – Nguru Mts – Usambara Mountains – Teita Hills) an in the coastal lowlands in South-East Kenya and Eastern Tanzania (Map 1.). The Eastern Arc mountains are believed to have remained geologically and climatically stable for the last 25 million years (Lovett 1998). The forests have been evolving in isolation from the west and central African forests for at least 10 million years and may have acted as a refuge for species during climatic changes at close of the Tertiary (10 million years ago) and in the Pleistocene (during the last 2,3 million years).

All the *Saintpaulia* species, except for *S. rupicola*, require moist and shaded conditions. They grow on steep rocks or in gorges along streams or as undergrowth in dense submontane or montane rain forest. *Saintpaulia. rupicola* thrives only at low altitudes, *S. diplotricha, S. grotei. S. confusa, S. intermedia* and *S. ionantha* occur at low as well as high altitudes and *S. tongwensis* is found between lowlands and 650 m altitude (Baatvik 1993, Clarke 1998). All the others occur mainly in rain forests between 800-2000 m altitude. Other plant species growing adjacent to *Saintpaulia* are epiphytic or epilithic orchids, mosses and pteridophytes (Johansson 1978). The majority of the *Saintpaulia* species grow on acidic, metamorphic gneisses or granitic rocks with a pH down to 4,8. A few species grow on lowland limestone rocks with a pH up to 7,3 (Baatvik 1993, Johansson 1978).

Individual species are restricted in their distribution, many endemic to one more or less isolated mountain or particular region. This, in addition to habitat specificity, renders the genus particularly vulnerable to extinction and is thus a reason to prioritize it in *ex situ* conservation. The restricted distribution of some African violet species may, however, be a reflection of the paucity of field surveys. Moreover, the species of Usambara Mountains often have local scattered populations whose genetic characteristics bring a peculiar addition to the inner genetic variability of the whole species (Möller & Cronk 1997b, Kolehmainen *et al.*, unpubl,). Eleven of the 20 species (+ two undescribed species) are only known form the Usambara Mts or the lowlands nearby . Two species (+ two undescribed species) are known from Kenya, three from the Uluguru Mts. and five species (+ one undescribed) from the Nguru Mts. Outlying populations are found in the Ukaguru Mts., in the Ulanga District of the Uzungwa Mts and possibly on Matumbi Mt in Rufiji District, each having one species. (Simiyu *et al.* 1996, Eastwood *et al.* 1998) One undescribed species is found on Mafi Hills (Map 1.).



Map 1. The distribution of *Saintpaulia*. (Based on the maps of Johansson (1978), Baatvik (1993), Kolehmainen (2000) and Watkins *et al.* (2002).

3.3 Phylogeny

Möller and Cronk (1997a, b), and Lindqvist and Albert (1999, 2001) have researched the phylogeny of *Saintpaulia* by using DNA techniques. Möller and Cronk (1997a) suggest the evolution of *Saintpaulia* from *Streptocarpus* subgenus *Streptocarpella*. The difference in flower and vegetative characters are probably due to ecological adaptation leading to a relatively rapid radiation of *Saintpaulia*. The close relationship between *Saintpaulia* and *Streptocarpus* subgenus *Streptocarpella* is supported by common morphological features (e.g., verruculose seeds) and cytologically, as both have the same chromosome number (2n=30).

According to Möller and Cronk (1997b) there is a strong correlation between the biogeography and the major clades of *Saintpaulia*. These authors suggest that the isolation of the populations has been a major factor in the differentiation of groups. The fragmented distribution of the genus may have two possible sources: either contraction from a formerly more widespread distribution or long-distance dispersal. All that is currently known about dispersal in *Saintpaulia* suggests that long-distance dispersal is highly unlikely. Dry and dehiscent capsules are unlikely to be consumed by birds for endozoochorous transport and species of *Saintpaulia* are understorey herbs of places sheltered from wind. It is therefore likely that the distribution of *Saintpaulia* has been different in the past. Although the present habitats are now separated by areas of inhospitable dry woodland and cultivations, there is evidence that in the Tertiary the climate of the region was much wetter and that moist forest was very widespread until progressive drying during the Pliocene (Livingstone 1982). Particular disjunct distribution (Uluguru Mts – Nguru Mts – Usambara Mountains – Taita Hills) is known outside *Saintpaulia* and is a common phenomenon (Lovett & Friis 1996).

Möller and Cronk (1997a), and Lindqvist and Albert (1999) disagree on the ancestral areas of *Saintpaulia*. Lindqvist and Albert suggest Ulugurus, Ngurus, Ukagurus, and Taita Hills as ancestral areas for *Saintpaulia*, not the Ulugurus alone (cf. Möller & Cronk 1997a). *Saintpaulia goetzeana, S. pusilla* and *S. teitensis* are the phylogenetically oldest species according to both Möller and Cronk (1997a) and Lindqvist and Albert (1999). The species diversity in the Usambara Mountains appears to be the result of rapid, recent (possibly Pleistocene) radiation due to climatic changes (Möller & Cronk 1997b). Lindqvist and Albert (2001) find *Saintpaulia shumensis*, the highest elevation species in the Usambara Mountains, the sister taxon to all remaining members of the Usambaras/lowland clade, which is otherwise poorly structured. They hypothesize that *S. shumensis* may show a relictual distribution in the Usambaras, as there appears to be a phylogenetic trend from higher to lower elevation among the major clades of *Saintpaulia*.

Lindqvist and Albert (2001) suggest that Usambaras/lowland *Saintpaulia* taxa may display more metapopulational rather than phylogenetically discrete species variation. If this is true, one could readily call into question the few morphological characteristics that have traditionally been used to delimit entities. Anthocyanin variation in flowers and leaves and trichome differences could represent polymorphism among the alleles of few genes within and among (meta)populations.

The phylogenetic information can be used in setting conservation priorities. Möller and Cronk (1997b) propose *Saintpaulia goetzeana, S. pusilla* and *S. teitensis* as particularly important for conservation of the full range of genetic diversity of the genus due to their phylogenetically basal position, and comparatively long branches leading to these species in the phylogenetic tree. On the other hand, the state of active evolutionary change of the Usambaras/lowland *Saintpaulia* taxa is of particular interest, and it therefore makes them candidates for special-purpose conservation. According to Lindqvist and Albert (1999), the highest priority for conservation of African violet genetic and morphological diversity should be given to the Nguru Mountains, as they hold two to three of the four major *Saintpaulia* clades identified. An additional prioritization suggestion derives from the finding that *Saintpaulia* taxa from Kenyan lowlands form a discrete subclade within the poorly resolved Usambaras/lowland clade, providing at least one clearly recognizable, geographically distinct, and reproductively isolated lineage of what may recently have constituted only metapopulational variation.

3.4 Threats

The biggest threat to the survival of African violets is degradation or destruction of the environment due to tree felling and quarrying (Baatvik 1993, Simiyu *et al.* 1996, Eastwood *et al.* 1998, Kolehmainen & Killenga 2005). The situation is especially alarming in the lowlands. Shading of trees is essential for *Saintpaulia* species (e.g., Johansson 1978). Without trees the environment becomes too dry for moisture requiring African violets, and the increased amount of light favours competitors. The risk of fire is remarkable where forest borders with slash-and-burn cultivations. The invasion of illegal gold miners to the East Usambara Mountains in years 2003 and 2004 destroyed stream and riverine habitats since trees were cut for building poles and firewood for mining camps both within and outside protected forests (Kolehmainen *et al.*, unpubl.). Also the over-collection of *Saintpaulia* for the specialist horticultural trade can have serious consequences on the status of already diminished populations (Eastwood *et al*. 1998).

3.5 The conservation status of *Saintpaulia*

Of the 24 described *Saintpaulia* taxa, 20 are currently on the IUCN Red List of Threatened Plants (Walter and Gillet 1998) because most of the *Saintpaulia* populations that inhabit the remaining forest fragments are reported to be isolated and small and many of the species are known from just a few localities. Fourteen of 20 taxa are given the status indeterminate due to the inadequate knowledge of distribution, population sizes, population genetics and ecology. Taxa that are not included on the list are *S. magungensis var. magungensis, S. nitida*, *S. brevipilosa* and *S. goetzeana*. Still, they cannot be considered to be safe.

In 1997 the Government of Tanzania gazetted the Amani Nature Reserve in the East Usambaras with a total area of 8 380 hectares. With this vital addition to the region's protected areas approximately 75 % of the surviving forest in the East Usambara is now legally protected. On the basis of the work conducted by Kolehmainen *et al.* (unpubl.), *Saintpaulia* is not in great danger in the East Usambara mountains. The safeness of the mountain areas is however threatened by the edge effect and human impact, especially forest fires, on forest margins. Moreover, the true extent of damage to the *Saintpaulia* localities by the gold rush in 2003 and 2004 is not known.

Very little is known about the current status of *Saintpaulia* in the Nguru, Uluguru, Ukaguru, Matumbi and Udzungwa Mts. In the Tanzanian lowland forest remnants the African violet is in extreme danger (e.g., Clarke 1998). All *Saintpaulia* species in Kenya are in immediate danger (Simiyu *et al.* 1996).

4. The role of botanic gardens

In recent years the status of botanic gardens in conserving plant species has strengthened. Botanic gardens play an important role in implementing the Convention on Biological Diversity (CBD) and other international treaties (Anonymous 2002a). In addition, the gardens have committed themselves to the conservation work through the International Agenda for Botanic Gardens in Conservation published by Botanic Gardens Conservation International (BGCI; Wyse Jackson & Sutherland 2000). There are approximately 1800 botanic gardens and arboreta around the world attracting 150 million people each year (Wyse Jackson & Sutherland 2000). Thus, besides *in situ* and *ex situ* conservation work, botanic gardens have an excellent opportunity to raise pulic awareness on the importance of preserving biodiversity.

4.1 International treaties and agendas and the role of botanic gardens

The Convention on Biological Diversity (CBD) came into force on December 1993. The objectives of this convention are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. The CBD is a binding international regulation for the 188 countries that are parties to it. The obligations are constantly evolving as parties negotiate further decisions that will be adopted at national level. The Global Strategy for Plant Conservation was adopted at the sixth meeting of the Conference of the Parties (COP) to the CBD held in the Hague 2002 (Anonymous 2002a). The main goal of the Strategy is to conserve the flora of the world. The Strategy provides a framework for actions at global, regional, national and local levels. It is supported by a wide range of organizations and institutions – governments, intergovernmental organizations, conservation and research organizations, universities and the private sector. The most innovative element of the

Strategy is the inclusion of 16 outcome-orientated targets, aimed at achieving a series of measurable goals by 2010. National governments are being invited to adopt their own targets within the framework of the Strategy.

In many cases, activities to reach the 16 targets are already under way or envisaged in existing initiatives e.g., activities under The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), CBD, The Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention) and the International Agenda for Botanic Gardens in Conservation published by Botanic Gardens Conservation International (BGCI).

Botanic Gardens Conservation International (BGCI) is an international organization with 500 member institutions in 112 countries (Wyse Jackson & Sutherland 2000). BGCI was founded 1987 as a part of IUCN under the name The IUCN Botanic Gardens Conservation Secretariat (BGGS). In 1990 the organization became independent and the present name came to use. Every third year an international conservation congress of botanic gardens is organized.

The primary concern of BGCI is to provide a means for botanic gardens to share information and news about their activities, programmes and any new advances made that benefit conservation and education (www.bgci.org.uk). BGCI provides technical guidance, data and support for botanic gardens around the world. In the database of BGCI there are over 10 000 rare and endangered species that are grown in botanic gardens. To ease the exchange of data of plant collections, BGCI has developed a particular electric form for this purpose.

Botanic gardens can implement the treaties and agendas in several ways. They can undertake work in plant systematics, floristics, inventories, monitoring, and in education and training in many relevant fields. Over 400 botanic gardens worldwide either manage natural areas or have areas of natural vegetation within their boundaries (Wyse Jackson & Sutherland 2000). This enables the gardens to carry on *in situ* conservation besides *ex situ* collections. *In situ* and *ex situ* activities can be combined in the Species Recovery Programmes (Anonymous 1995, Hernández Bermejo & Clemente Muñoz 1996). These may involve plant propagation, reintroduction, reinforcement and translocation projects or the restoration of destroyed or degraded habitats.

A botanic garden should review its collections both in terms of what is currently grown and what might be grown (Wyse Jackson & Sutherland 2000). After reviewing material is often found which is considerable conservation or scientific value. According to some authors (e.g., Heywood 1992, Hurka 1994, Anonymous 2002a) botanic gardens should concentrate on local flora in playing an active part in conservation programmes. They should establish proper *ex situ* collections for local wild plants, and in doing so, not only concentrate on threatened and endangered species. Additionally, gardens should consider growing duplicate conservation material from other countries or regions.

The relatively small numbers of gardens in floristically rich countries cannot handle the very large numbers of rare and endangered species on their own (e.g., Heywood 1992). most of them young foundations with limited facilities. The botanic gardens in Europe and North America should therefore explore ways of supporting their less fortunate counterparts in floristically rich regions.

4.2 The National Plant Conservation Strategy in Finland and the role of botanic gardens

In Finland there is a national plant conservation strategy under preparation ((L. Schulman, pers. comm.) It is based on the European plant conservation strategy developed by the Council of Europe and Planta Europa as a regional contribution to the Global Strategy for Plant Conservation (Anonymous 2002b). In the outline of the strategy, wild plant and fungus species are included and all organisations concerning flora conservation, such as the Ministry of the Environment, Finnish Environment Institute, a state forest enterprise Metsähallitus, Finnish Forest Research Institute, Finnish Museum of Natural History and botanic gardens are involved. As outlined in the draft national strategy, Finnish botanic gardens participate in the international *ex situ* conservation and can be coordinators of the *ex situ* conservation in Finland. In Finland, *ex situ* conservation is assessed inevitable for fewer species than elsewhere in Europe. The exact situation must, however, be evaluated and measures taken to organize *ex situ* conservation in botanic gardens and gene banks for species in need of it.

5. Material and methods

The base of my study was an extensive literature review on *ex situ* conservation and the role of botanic gardens in this. To assess the value, promises, and problems of botanic garden live collections in *ex situ* conservation, I chose the genus *Saintpaulia* as a focal group. This genus was chosen due to the threatened status (Walter & Gillet 1998) and the scattered distribution (e.g., Möller & Cronk 1997b) of the genus. Moreover, *Saintpaulia* is endemic to Tanzania and Kenya and it has high economical value in amenity horticulture (Anonymous 1999a, b).

Four of the five most important European holders of *Saintpaulia* (*sensu* Eastwood *et al.* 1998, Watkins *et al.* 2002, Schulman & Kolehmainen 2004) were chosen as research botanic gardens. The Botanic Garden of the University of Helsinki (HKI), where by the study was based, was among these. In addition to HKI, I visited, in the winter 2004/2005, The National Botanic Garden of Belgium in Meise (MEI); The Botanic Garden of Uppsala University, Sweden (UPP); and the Royal Botanic Garden Edinburgh, UK (ED). During the visits I reviewed the *Saintpaulia* collections of the gardens. I also familiarized myself with their databases, and reviewed the data available on each *Saintpaulia* accession. I checked the identifications of the accessions preliminarily and took notes and photographed the plants to allow future reference. I also met relevant staff of the gardens (Dr. David Aplin and Curator Thierry Vanderborght, MEI; Dr. Magnus Lidén, UPP; and Dr. Elspeth Haston and Dr. Michael Möller, ED) and interviewed gardeners (Viviane Leyman, MEI; Åsa Tysk, UPP; and Steve Scott, ED) about the health of the collections. In addition, I evaluated the potential of the gardens to utilise their *Saintpaulia* collection as part of their display for the general public. I also determined the technical requirements of *Saintpaulia* accessions when maintained as part of an *ex situ* conservation collection and evaluated the potential of the gardens to fulfill these requirements.

At the end of my visit I took leaf cuttings from those accessions that were registered as collected in the wild. These were planted in HKI upon my return. From MEI and

UPP I managed to obtain leaf cuttings of all wild-collected *Saintpaulia* accessions, but from ED I obtained only a part of their collection. I assessed the remaining collection of ED on the grounds of the data from the database of the garden, but the identifications of these accessions have not been checked as accurately as the others.

I checked the determination of all accessions that were transferred to HKI on the base of literature and with the help of my notes and photos. I then reviewed the data on the origin of the accessions, which I obtained from the databases of the donor gardens. By cross-checking the data I was able to separate between unique accessions and clones of the same genotype, which had earlier been transferred from one garden to others. The level of detail of the the data of origin of the accessions varied considerably. I therefore developed a nominal scale describing the accuracy and quality of the origin data as follows (example entries below taken directly from the corresponding database entries).

<u>Class 1</u>: the exact collection site, down to the level of population/stand, can be found on the basis of the information, e.g.,

> Kenya, Kilifi District, Kacharoni, 0328 S, 03945 E, 85 m, lithophyte on limestone rocks, in shade of riverine forest. Coll. B. Bytebier 28.09.1993, coll. number 107.

<u>Class 2</u>: the collection site can be found, but exact population/stand cannot be verified on the basis of the information, e.g.,

> Tanzania, Morogoro, Nguru Mts., Kanga F.R., 1100 m. Coll. T. Pocs.

<u>Class 3:</u> the region, district, or mountain area of the collection site known, e.g.,

> Tanzania, Lushoto District, East Usambara Mts. Coll. S. Mather, coll. number 2.

<u>Class 4</u>: accession registered as collected from the wild, but site data lacking, e.g.,

> Tanzania. Coll. S. Mather.

<u>Class 5</u>: no origin data, but accession can be determined as a certain species (i.e., not a cultivar)

The accessions to the *ex situ* conservation collection were chosen after excluding the accessions not of known wild origin (Class 5.). All the remaining classes were accepted due to the small number of accessions per species.

Voucher specimens for herbarium storage were not yet collected of the accessions studied here. This was due to two reasons. First, the accessions are still held as live specimens in each garden. Second, accessions multiplied by cuttings and brought to HKI were, at the time of writing, still too young to be sampled for the herbarium.

Vouchers can be collected in the future as part of the documentation and maintenance of an eventual *ex situ* conservation collection.

6. Results

6.1 Display and research

In HKI the possibility for the utilization of the collections in education and display and in raising awareness among public is good because of the distinct attractive *Saintpaulia* room with a little stream. At the moment UPP is closed due to renovation and will be opened again in 2007 (Å. Tysk, pers. comm.). In MEI and ED most of the *Saintpaulia* accessions are not shown to the public. The living collections of *Saintpaulia* were used for reseach in HKI and ED.

6.2 Technical requirements

African violets do not require much space: one pot needs 121 cm^2 of space. Hence, the ideal of having at least 50 (Marshall & Brown 1975, Chapman 1984, Hawkes 1987, Lawrence 2002) unique accessions of each taxon would require 18 m^2 of suitable growing space. However, all the research botanic gardens have difficulties in offering the space for the collection.

Saintpaulia is not very susceptible to pests and plant diseases (M. Pulkkinen, pers. comm., Å. Tysk, pers. comm.). The collections were in good health in HKI, UPP, and MEI; only minor damage from insect pests could be seen. In ED the accessions were growing moss and in need of repotting and removal of dead plant parts. The lack of care was due to lack of gardening staff (S. Scott, pers. comm.).

The maintenance of *Saintpaulia ex situ* collection can be maintained almost along normal daily routines of botanic gardens. Hybridization of the species is not a problem as the *Saintpaulia* are easily propagated by leaf cuttings. Almost all the cuttings collected during the garden visits were rooted successfully despite the dark season. However, the mix-up of different accessions is possible due to the falling off and striking of leaves from neighbouring pots. Wild-collected accessions also readily produce fruit and viable seeds, which can germinate in the pots. Seedlings must be removed to maintain the genetic integrity of the original accessions.

The daily management of any live plant collections predisposes the accessions for human errors. I found that HKI suffered from some confusions with accessions and labels. In ED one accession was registered on two different accession numbers. Confusions in other gardens were not noticed.

6.3 Structure and quality of *Saintpaulia* collections

HKI had 63 (76 %) unique *Saintpaulia* accessions of a total 83 wild accessions (unique here meaning that they were not represented in the collections of the other gardens). All (100 %) the unique accessions were of known wild origin, the classes of origin data being 58 x 1 and 5 x 2. However, 53 of the unique accessions of known wild origin were grown from seeds from only six different populations (Appendix 1.). Hence, many accessions are siblings and the genetic variation between them is small.

UPP had 7 (27 %) unique *Saintpaulia* accessions of a total 26 wild accessions. Six (86 %) of the seven unique accessions were of known wild origin, the classes of origin data being 2 x 1, 2 x 2 and 2 x 3.

MEI had 29 (83 %) unique *Saintpaulia* accessions of a total 35 wild accessions. Twenty-six (90 %) of the 29 unique accessions were of known wild origin, the classes of origin data being 13 x 1, 5 x 2, 6 x 3 and 2 x 4.

ED had 32 (82 %) unique *Saintpaulia* accessions of a total 39 wild accessions. Eleven (34 %) of the 32 unique accessions were of known wild origin, the classes of origin being 1 x 1, 5 x 2, 4 x 3 and 1 x 4. In ED 13 of the 17 cuttings I managed to get were unique and four of the 13 unique accessions were of known wild origin. On the grounds of the ED database I found seven accessions more that are unique and of known wild origin (Table 2.).

In total, 155 (85 %) of the 183 accessions of HKI, UPP, MEI, and ED were unique.

Of the 155 unique accessions, 126 (81 %) were of known wild origin, the classes of origin being 80 x 1, 31 x 2, 14 x 3 and 3 x 4. Of the total of 183 *Saintpaulia* accessions, 126 (69 %) were both unique and of known wild origin. All the accessions of known wild origin, except for the seven potential accessions from ED, were chosen as suitable accessions for *ex situ* conservation collection.

HKI and UPP had the most similar collections: 19 (16 %) of the 119 accessions suitable for a conservation collection were both in HKI and UPP. HKI and MEI shared two (2 %), HKI and ED two (2 %), UPP and MEI two (2 %), UPP and ED two (2 %), and ED and MEI five (4 %) accessions suitable for a conservation collection. One such accession was in all gardens, although with a different determination in ED (Appendix 1.). Two accessions were in three gardens. In Figure 1. are shown the number of new accessions contributed by each garden when one of the gardens is chosen as the starting point for the collection.

Best represented of the *Saintpaulia* taxa were *S. confusa* with 36, *S. difficilis* with 19 and *S. diplotricha* with 13 accessions suitable for a conservation collection. Others varied between 6 and 1 accessions. Twelve taxa were represented with only one accession. Four taxa were not included in the list of accessions suitable for a conservation collection: *S. goetzeana, S. inconspicua, S. pusilla* and *S.* sp. nov. “Mafia Hills”. However, ED had an accession determined as *S.* sp. nov. “Mafia Hills”, but the accession was not of known wild origin.

Only one clear misidentification was noticed: the accession 19960356-84 from MEI was labeled as *S.* cf. *nitida*, but redetermined as *S. intermedia* (Appendix 1.). The accession number 43 of the *ex situ* conservation collection was determined as *S. pendula* in ED, but in other three gardens as *S. magungensis var. minima*. The leaf cutting of the ED plant was, however, not potted in HKI, so comparison between the plants have not been done. In addition, some unusual accessions of taxa were found, especially the conservation collection accession number 11, *S. confusa,* with some of the hairs atypically erect. For that reason, the accession was redetermined as *S.* aff. *confusa*.

Saintpaulia seeds were stored only in ED. ED had seeds from 15 *Saintpaulia* accessions. Seeds were put into storage in the years 1998 – 2003. A new taxon that was not as a living plant is *S. goetzeana*, but the accession is not of known wild origin. None of the gardens had proper *in vitro* culture of the genus. In ED there were some tissues of *Saintpaulia* for research purpose.

Table 1. The number of gardens' *Saintpaulia* accessions before cross-referencing the collections, the number of unique accessions, origin ranks and the accessions suitable for *ex situ* conservation. HKI = Helsinki University Botanic Garden; UPP = Uppsala University Botanic Garden; MEI = National Botanic Garden of Belgium; ED = Royal Botanic Gardens Edinburgh * = The first number describes the total number of ED accessions based on the ED database, the latter is for the accessions with a leaf cutting potted at HKI and determination checked by M. Miranto. º = IN HKI determined as *S. confusa* + = determined as *S.intermedia* by M. Miranto & M. Schütt.

	TAXON	HKI	UPP	MEI	ED *	TOTAL	UNIQUE ACCESSIONS	ORIGIN RANK	THE MEAN RANK	*EX SITU* CONSERV. ACCESSIONS
1	S. brevipilosa	-	1	1	2 (1)	4	4	2, 3, 2, 5	3	3
2	S. confusa	33	1	4	-	38	37	2, 1, 2, 2, 10 x 1, 9x 1, 10 x 1, 5, 2, 2, 2	1.3	36
3	S. difficilis	15	1 º	2	3 (3)	21	20	2, 2, 1, 1, 2, 10 x 1, 3, 2, 3, 5, 3	1.7	19
4	S. diplotricha	13	3	-	4 (2)	21	17	5, 2, 2, 5, 2, 10 x 1, 1, 5	1.9	13
5	S. goetzeana	-	-	-	-	-	-	-	-	-
6	S. grandifolia	1	1	3	1 (1)	6	5	1, 1, 1, 1, 5	1.8	4
7	S. grotei	5	1	2	2 (1)	10	9	2, 5, 4 x 1, 5, 3, 5	2.7	6
8	S. inconspicua	-	-	-	-	-	-	-	-	-
9	S. intermedia	1	1	1	1 (1)	4	4	2, 5, 5, 4	4	1
10	S. ionantha	1	1	4	3 (1)	9	8	2, 1, 1, 4, 5, 5, 3, 5	3.3	4
11	S. magungensis	3	1	-	2 (0)	6	5	3, 5, 1, 2, 1	2.4	3
11b	S. mag. v. minima	1	1	1	1 (0)	4	2	2, 1	1.5	1
11c	S. mag. v. occidentalis	-	-	1	1 (1)	2	1	3	3	1
12	S. nitida	1	1	1 +	-	3	1	2	2	1
13	S. orbicularis	-	1	1	-	2	2	5, 1	3	1
13b	S. orb. v. purpurea	1	1	1	1 (0)	4	2	2, 3	2.5	2
14	S. pendula	2	2	1	3 (0)	8	6	5, 1, 2, 2, 5, 5	3.3	3
14b	S. pend. v. kizarae	1	1	-	1 (0)	3	2	4, 1	2.5	1
15	S. pusilla	-	-	-	-	-	-	-	-	-

	TAXON	HKI	UPP	MEI	ED *	TOTAL	UNIQUE ACCESSIONS	ORIGIN RANK	THE MEAN RANK	*EX SITU* CONSERV. ACCESSIONS
16	S. rupicola	1	2	4	2 (0)	9	8	5, 2, 2, 3, 1, 1, 1, 1	2	6
17	S. shumensis	-	1	-	1 (1)	2	2	3, 5	4	1
18	S. teitensis	-	-	1	2 (2)	3	1	1	1	1
19	S. tongwensis	1	1	2	2 (0)	6	5	3, 5, 2, 3, 2	3	3
20	S. velutina	1	1	-	2 (0)	5	3	5, 5, 3	4.3	-
21	S. sp. n. “Kacharoni”	-	-	3	1 (1)	4	3	1, 1, 1	1	3
22	S. sp. n. “Mafia Hills”	-	-	-	1 (1)	1	1	5	5	-
23	S. sp. n. “Mwachi”	-	-	1	1 (1)	3	2	1, 1	1	2
24	S. sp. n. “Sigi Falls”	1	1	1	-	3	1	2	2	1
25	S. sp. n. “Mhonda”	-	1	-	-	1	1	1	1	1
26	S. sp. n. “Pangani Falls”	1	1	-	-	2	1	2	2	1
	S. sp. nov.	-	-	-	1 (0)	1	1	5	5	
	S. sp. nov.	-	-	-	1 (0)	1	1	2	2	
	TOTAL	**83**	**26**	**35**	**39 (17)**	**183**	**155**		**2.1**	**119**

Table 2. Potential accessions for *ex situ* conservation collection in Royal Botanic Gardens Edinburgh.			
TAXON	ACC.	DATA OF ORIGIN	CLASS OF ORIGIN
S. diplotricha	19931278	Tanzania, Tanga Region, Foothills of East Usambara Mts., Kwamgumi F.R., 220 m. Leaves uppersides dark bottle green, undersides light green with very faint purplish wash on some leaves, obviously hairy. Leaves suborbicular / orbicular, margins crenate, slightly downturned. Rosette plants. Flowers very deep violet. Originally coll. by Cambridge 1992 Zoological Expedition. Received to ED 16.03.1993 from H. Tye as Saintpaulia indet., det S. Simiyu Jun 2003.	2
S. magungensis	19923185	Tanzania, Tanga Region, possibly Amani area, East Usambara Mts. Coll. S. Mather 01.07.1972, coll. number 8. Received to ED. 02.09.1992 from RBG Kew, their acc. 1987-1368.	3
S. magungensis var. minima	19594352	Tanzania, Tanga Region, top of hill at Marvera. Received to ED. 13.11.1959 from W.R. Punter as Saintpaulia sp. Det. B.L. Burtt Jun 1963.	2
S. pendula var. kizarae	19594354	Received to ED 01.07.1959 as Saintpaulia sp. from W.R. Punter, verified by B. L. Burtt June 1963. Collected directly from the wild, but no data.	4
S. rupicola	19850676	Kenya, Coast Region, Kaloleni, near Kilifi. On open rock faces at top of very high outcrop of limestone rocks. Coll. M. Creighton 01.07.1973. Received to ED. from S. Mather (11) 10.04.1985.	2
S. tongwensis	19850668	Tanzania, Tanga Region. Coll. S. Mather.. Received to ED 10.04.1985 from S. Mather, acc. number 2.	3
S. sp. nov.	19931279	Tanzania, Tanga Region, Foothills of East Usambara Mts., Kwamgumi F.R., 220 m. Leaves light green above, paler below, suborbicular / oval, very slightly crenate. Flowers rich, mid-violet. Originally coll. by Cambridge 1992 Zoological Expedition. Received to ED 16.03.1993 from H. Tye.	2

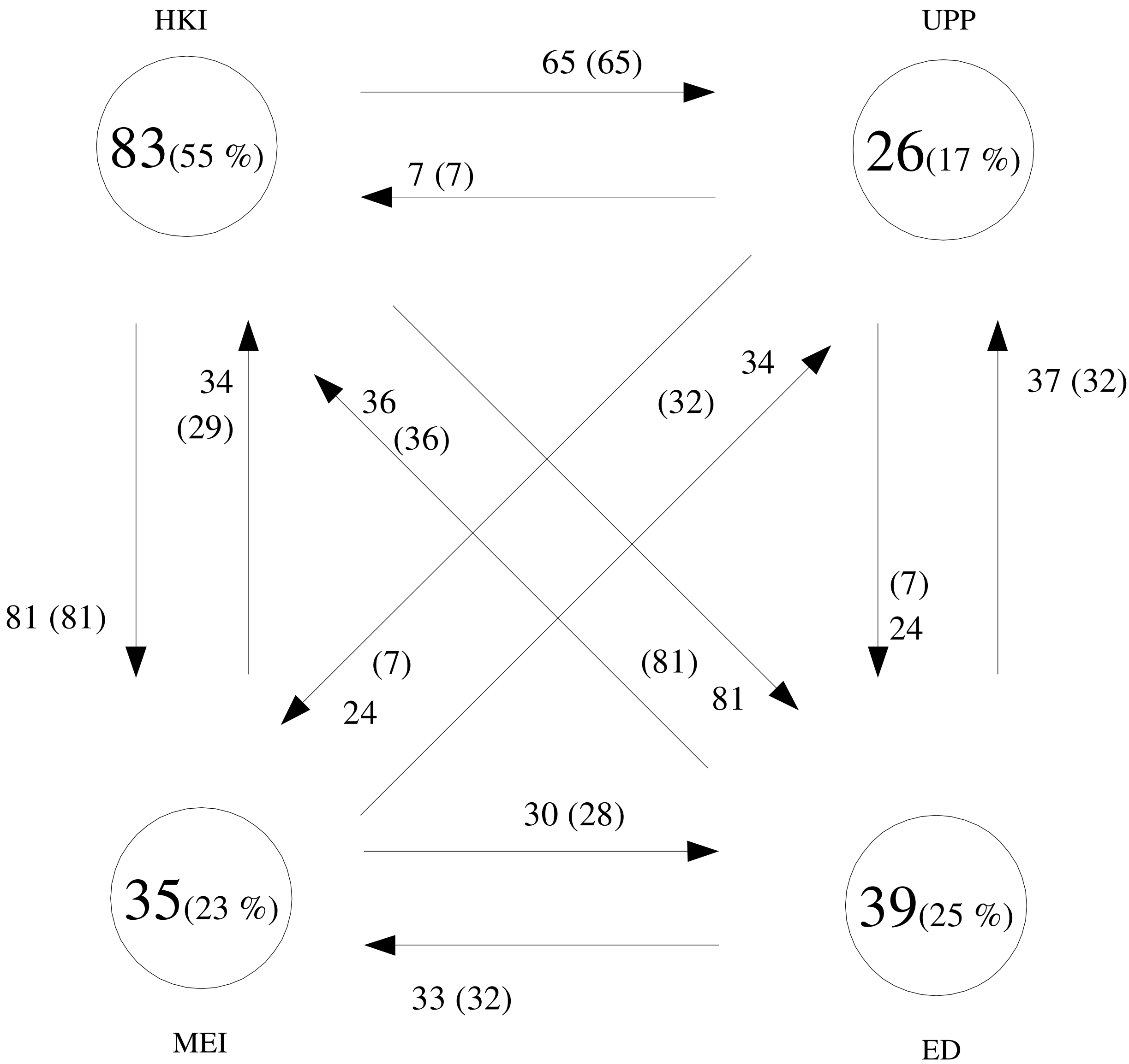


Figure 1. The number of new accessions added by each garden when one of the gardens is chosen as the starting point for the collection. In each circle is the number of *Saintpaulia* accessions in each garden before cross-referencing of the data on origin of the accessions. The percentage value in brackets in the circles indicates the proportion of each garden of the total 155 unique accessions. The numbers in brackets next to the arrows show the concrete transfers of unique accessions needed, starting from a garden that has the biggest number of new accessions. HKI= Helsinki University Botanic Garden; UPP =Uppsala University Botanic Garden; MEI = National Botanic Garden of Belgium; ED = Royal Botanic Gardens Edinburgh.

7. Discussion

Hawkes (1992) and Given (1994) mentioned the use in education, research and display as advantages of live *ex situ* collections. African violet collections offer an excellent possibility for display due to their attractiveness and famousness as a pot plant. From the research gardens only HKI had a considerable collection of wild African violets on display to the public, in other gardens most of the collection was in the areas only for the staff. MEI, UPP and ED should consider setting up a collection that would be shown to the public. Specific theme days for *Saintpaulia* and threatened plants as a whole could also be organized, and information material distributed. African violet collections can be used in education as an example genus of threatened plants. African violets are fast-growing and easy to propagate. This makes them handy for research, which in the case of *Saintpaulia* has been scarce.

The disadvantages pointed out by Maunder (1991), Hawkes (1992), and Given (1994) are not insuperable in the case of *Saintpaulia*. Although finding space for a large new collection is usually difficult for botanic gardens, the problem is not so bad in the case of small plant like *Saintpaulia*. The propagation of African violet is easy and maintaining the genetic integrity of the collections is easy; only the seedlings from the pots must be removed. When maintained properly, diseases are not common. In case of disasters it is essential to have duplicate collections in other gardens. A considerable danger to the collections are the human errors. According to my results, only HKI suffered from some confusions with accessions and labels. This may be due to the recent turnover of the gardener responsible to the *Saintpaulia* collections. All other gardens, however, seemed to have overcome this pitfall. Proper training for the staff responsible for an *ex situ* conservation collection is, nevertheless, needed. Training should include learning to distinguish species and procedures to avoid mix-up of the accessions. Practitioners should not be left to work on their own at the *ex situ* collections.

On the basis of this study, live *ex situ* collections are a good contribution to seed banks, especially if collections exist already in botanic gardens. Live collections work particularly well with small, beautiful and easily propagated plants.

The amount of clones in the accessions of the four gardens was quite small as 155 (85 %)of the 183 accessions were unique. The overview of overlaps between the different gardens' collections given in Figure 1. shows that some gardens share a considerable part of their accessions, probably due to traditionally tight cooperation, while others have only very few accessions in common. This may be considered somewhat surprising given that *Saintpaulia* is very easily propagated by cuttings and easy to distribute. Furthermore, this analysis helps in determining which garden would be a good starting point for an *ex situ* conservation collection. In the case of *Saintpaulia*, HKI has the greatest numbers of accessions and, thus, the least amount of material transfer is needed if HKI formed the base collections containing all conservation accessions.

The proportion of the accessions of known wild origin was also fairly big: 126 (69 %) of the total 183 accessions were unique and of known wild origin. The quality of the origin data was also satisfactory the mean class of origin being 2.1 (Table 1). During my stay in Belgium I also visited the Gent University Botanic Garden with a fairly large *Saintpaulia* collection. However, the scientific value of the collection is severely reduced because the origin data of the accessions had been lost and labels mixed during the change of the person in charge of the collections. The record keeping of the origin data is a thing in which a botanic garden cannot be too accurate! One good addition would be to keep record on accessions donated to other gardens. This was done only in ED and HKI. One problem with the databases of different gardens was non-uniform way of recording data and unclear abbreviations.

Although I have chosen 119 distinct accessions for the *ex situ* conservation collection, the genetic variability between accessions of one taxon varies much. For instance, the accessions 2005-0393 – 2005-0402 (*S. confusa*) in HKI include ten sibling accessions derived from seeds from soil samples. They are hence probably more similar to each other than accessions collected from distinct sites. Also, some other accessions may be collected from the same sites, e.g., the conservation collection accessions 2 & 3 and 4 & 5, (Appendix 1.), but this impossible to say with certainty only on the basis of collection data and without knowing the geography of the area.

I noticed one strange origin area among the accessions I analysed. It was determined as *S. rupicola* but collected from East Usambara although this species has been found only in Kenya (Baatvik 1993, Eastwood *et al.* 1998, Watkins *et al.* 2002). Maybe only genetic analyses will clear the mystery for sure. Genetic analyses should anyway be carried out to check the problematic taxonomy of the genus. It is possible that some species will be merged. *Saintpaulia difficilis* and *S. confusa*, and *S. magungensis* and *S. grotei* are probably the same species (J. Kolehmainen, pers. comm.). More data on the taxonomy will be acquired when M. Sc. Stella Simiyu (Kenya) finishes her doctoral thesis on the *Saintpaulia* taxonomy. Genetic analyses are also needed to assure the number of unique accessions.

Saintpaulia inconspicua, S. pusilla and *S. goetzeana* are lacking from the European botanic garden collections, but at least *S. goetzeana* is grown by *Saintpaulia* enthusiasts (I. Olevall, pers. comm.) and ED has seeds of it. The possibility to collect accessions of them from nature is uncertain, as the current distribution of *Saintpaulia* in other Eastern Arc Mountains than the East Usambaras is very poorly known (Kolehmainen *et al.*, unpubl.) This and the lack of information on the ecology and biology of the wild populations hampers effective conservation work. More information has been obtained and more is to be expected shortly from the University of Helsinki as a series of studies are being conducted on wild populations in the East Usambara Mountains, Tanzania (Kolehmainen *et al.*, unpubl.).

Further research needs to be carried out to find out the proper seed banking mechanisms for *Saintpaulia* species. The dust-like nature of the seed has meant that standard methods for seed testing and storage are not entirely suitable for *Saintpaulia* (Simiyu *et al.*1996), even if the seeds are in all likelihood orthodox (J. Kolehmainen, pers. comm.) Seed banking of *Saintpaulia* would be an important addition to the living collections to expand the genetic diversity of the collections.
Seed banks remain untouched for long periods, and are thus not as susceptible to various confusions as living *ex situ* collections with daily management. The absence of natural evolution process, artificial selection pressures, inbreeding depression and random genetic drift (Ashton 1987, Given 1994, Schoen & Brown 2001) are, however, a problem if seed bank collections need to be regenerated from the garden collection. Then, an expert is needed to lead the work. Better would be if a new seed bank collection could be collected again from nature to avoid genetic deterioration and adaptation to *ex situ* environment. For seed bank collection cryopreservation could be the best choise due to the long storage age, but if that is not possible, work can be started with freezers. The ideal amount of seeds that should be stored as in seed bank is 20 000 seeds per taxon (Anonymous n.d.).

In vitro propagation is used in the Cincinnati Botanic Garden for supporting i*n situ* conservation of African violets by selling *S. rupicola* as a test tube plant (www.cincyzoo.org). Moges *et al.* (2004) have researched the cryopreservation of African violet shoot tips. The work was successful, but seed banking is probably easier and demands less work. Micropropagation would, however, ensure getting disease-free plants for reinforcement and reintroduction purposes (Given 1994). Pollen and DNA storage are likely irrelevant in the near future in the case of *Saintpaulia*.

Schulman and Kolehmainen (2004) first mentioned the idea of a network approach to *ex situ* conservation of *Saintpaulia*. The idea of such a programme was further developed during this study in collaboration with L. Schulman. The draft programme was named Saving African Violets (*Saintpaulia*) *ex situ* (=SAVES *ex situ*). The goal of the programme would be to share the responsibility of protecting the natural genetic diversity of *Saintpaulia* between several gardens. In this way, problems relating to the maintenance of live collections could be alleviated. SAVES *ex situ* collection would located in partner gardens so that no garden has to find space for all accessions, but every accession is placed at least to two gardens. Thus far an agreement of collaboration has been set up with UPP, MEI, and ED. SAVES *ex situ* accessions have been chosen among these gardens' collections, as well as those of HKI, and specific SAVES *ex situ* accession numbers have also been given (Appendix 1.). In addition, Geneva Botanic Garden (Switzerland) and The Institute of Floriculture, Tree Nursery Science and Plant Breeding at the University of Hannover (Germany) have expressed their willingness to join the programme.

Network initiative is practical and often compulsory, as few gardens have space for extensive *ex situ* collections. This is the case with especially big-sized species. Coordinator garden must, however, be named, so that one garden is responsible for the entity. Another benefit of the network like *ex situ* conservation initiative is the smaller amount of the plants needed to be transferred for storage from garden to another. A separate *ex situ* conservation database solves the problem of non-uniform databases and the gardens could collaborate in producing leaflets and other information material for the public. This would save sparse resources.

SAVES *ex situ* initiative is conducted in close collaboration with projects concerning *in situ* conservation and population ecology of *Saintpaulia* (Kolehmainen *et al*, unpubl.). The work has interests in common also with development co-operation. Improving the income of the local people with the help of ecotourism would join the local people to the conservation of the *Saintpaulia* forests. Kolehmainen *et al.* (unpubl.) have preliminarily assessed the possibility for ecotourism in the *Saintpaulia* sites in the East Usambara. Before the start of eco-tourism a proper environmental risk assessment should be conducted. It would also be just and in accordance with the CBD that the home countries of *Saintpaulia* would get income from the sales of *Saintpaulia* cultivars whose annual wholesale value in the USA and the Netherlands alone is over € 50 million (Anonymous 1999a, b). Living *ex situ* collections are tempting to show to possible commercial partners. Most of the breeding potential is namely still unutilized, because the thousands of cultivars sold thus far have mainly been bred from two natural species *S. ionantha* and *S. confusa* (Baatvik 1993, Eastwood *et al.* 1998).

In the future, one Tanzanian, one Kenyan and some North American botanic gardens could also be included in the SAVES *ex situ* network. New accessions will be collected from the nature to at least reach 50 accessions per taxon if possible (Marshall & Brown 1975, Chapman 1984). Finally, the accessions will be reintroduced to their original habitats. According to the CBD the *ex situ* cultivation should preferably take place in the countries of origin. Controlled *ex situ* conservation of Kenyan taxa has been started at the East African Herbarium in Kenya (Simiyu *et al.* 1996). A collection of Tanzanian *Saintpaulia* has also been established in Tanzania (Eastwood *et al.* 1998). Finances from the western counties are required to upgrade the horticultural facilities at both the Amani and Dar-es-Salaam botanic gardens (Rodgers 1998). Collaborators from western countries are also able to raise public awareness and get funds.

SAVES *ex situ* network is one good way to achieve the goals of the Global Strategy for Plant Conservation (Anonymous 2002a). I hope this work will encourage others to develop *ex situ* programmes for other taxa to store in botanic gardens and finally to reintroduce to their original habitats.

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APPENDIX 1. Unique accessions with data of origin after cross-referencing the gardens' collections, the accessions suitable for *ex situ* conservation (SAVES *ex situ* accessions) and classes of data of origin. HKI = Helsinki University Botanic Garden; UPP = Uppsala University Botanic Garden; MEI = National Botanic Garden of Belgium; ED = Royal Botanic Gardens Edinburgh. ! = leaf cutting not received to HKI and the determination not checked by M. Miranto. * = potential SAVES *ex situ* accession

SAVES *ex situ* ACC. NUMBER	TAXON	HKI ACC. NUMBER	UPP ACC. NUMBER	MEI ACC. NUMBER	ED ACC. NUMBER	DATA OF ORIGIN	CLASS OF ORIGIN DATA
1	S. brevipilosa	-	1989-3044	-	-	Tanzania, Morogoro, Nguru Mts., S. Nguru F.R., 780 m, submontane riverine forest, on boulders along stream. Coll. S. T. Iversen 15.03.1983, coll. number 89000.	2
2	S. brevipilosa	-	-	19960340-68	-	Tanzania, Morogoro, Nguru Mts., Kanga F.R. Coll. S. Mather 1990, coll. number 10. Received to MEI from B. Bytebier 16.10.1996 via J. P. Hernalsteens.	3
3	S. brevipilosa	-	-	-	19700909	Tanzania, Morogoro, Nguru Mts., Kanga F.R., 1100 m. Coll. T. Pocs. Received to ED as Saintpaulia sp. cutting, verified by B. L. Burtt July 1971.	2
	S. brevipilosa !	-	-	-	19970107	Received to ED 20.01.1997 as S. confusa from M. Möller, verified by S. Simiyu June 2003. Not of known wild origin.	5
4	S. confusa	1997-0105	-	-	-	Tanzania, Tanga Province, Lushoto District, East Usambara Mts., Amani F.R., Amani, Kwamkoro, 900m, upstream, N slope 5º. Coll. T. Nurminen 12.11.1996, coll.number TN 121. Received to HKI as S. indet 1997., det. J. Kolehmainen 20.01.1999.	2
5	S. confusa	1998-0231	-	-	-	Tanzania, Tanga Province, Lushoto District, East Usambara Mts., Amani F.R., Amani, Kwamkoro, about 200 m from Kwamgoro forest office south fro Amani, by Kwamkoro river, shady forest floor. Coll. T. Nurminen. Received to HKI as S. difficilis seeds 1998, det. L. Schulman 13.6.2001.	1

SAVES *ex situ* ACC. NUMBER	TAXON	HKI ACC. NUMBER	UPP ACC. NUMBER	MEI ACC. NUMBER	ED ACC. NUMBER	DATA OF ORIGIN	CLASS OF ORIGIN DATA
6	S. confusa	1998-0643	1993-3148			Tanzania, Morogoro, Nguru Mts., Mhonda, growing on stones by the waterfall, rain forest. Coll. C. Grusell Feb. 1993. Cuttings received to HKI from UPP 21.09.1998 and April 2001.	2
7	S. cf. confusa	2001-0323	1987-3396 (named as difficilis)			Tanzania, Tanga Province, Muheza District, East Usambara Mts., Kwamboro-Kiganga F.R, 930 m, on vertical cliffs near a riverlet. Coll. A. Borhidi, S. T. Iversen & W. R. Mziray 09.05.1987, coll. number 87363. Cuttings received to HKI from UPP Apr. 2001 as S. difficilis, det. J. Kolehmainen, M. Miranto & M. Schütt 2004.	2
8: 8.1 – 8.10	S. confusa	2005-0393 – 2005-0402	-	-	-	Tanzania, Tanga Region, Muheza District, Amani Nature Reserve, Kwamkoro, about 150 m to SW from ANR Kwamkoro substation, near the water intake. About 500 m long population growing on rocks along a stream. Study site code KW 1. Seeds extracted from soil samples (collected 18.01.2004) and grown by J. Kolehmainen (code in the greenhouses KW1). Leaf cuttings of 10 unique accessions potted at HKI 18.04.2005.	1
9: 9.1 – 9.9	S. confusa	2005-0404 – 2005-0408, 2005-0410 – 2005-0413				Tanzania, Tanga Region, Muheza District, Amani Nature Reserve, Kwamkoro Arboretum. A small isolated rock outcrop (ca. 12 x 4 m) with a population of S. confusa. Study site code KW 4. Seeds extracted from soil samples (collected 06.01.2004) and grown by J. Kolehmainen (code in the greenhouses KW 4). Leaf cuttings of 9 unique accessions potted at HKI 18.04.2005.	1

SAVES *ex situ* ACC. NUMBER	TAXON	HKI ACC. NUMBER	UPP ACC. NUMBER	MEI ACC. NUMBER	ED ACC. NUMBER	DATA OF ORIGIN	CLASS OF ORIGIN DATA
10: 10.1 -10.10	S. confusa	2005-0415 – 2004-0424	-	-	-	Tanzania, Tanga Region, Muheza District, Amani Nature Reserve, Kwamkoro Arboretum, growing on rocks along a stream (population size ca. 100 x 4 m). Study site code KW 2. Seeds collected 30.01.2003 and sown by J. Kolehmainen (code in the greenhouses C). Leaf cuttings of 10 unique accessions potted at HKI 1.3.2005.	1
	S. confusa	-	-	19680463-..	-	Gent University Botanic Garden	5
11	S. aff. confusa	-	-	19960341-69	-	Tanzania, Lushoto District, East Usambara Mts.,near Amani, 900-1050 m. Coll. S. Mather. Received to MEI from B. Bytebier 16.10.1996 via J. P. Hernalsteens. In MEI. as S. confusa. Det. M. Miranto Oct. 2005.	2
12	S. confusa	-	-	19960342-70	-	Tanzania, Lushoto District, East Usambara Mts.,near Amani, 900-1050 m. Coll. S. Mather. Received to MEI from B. Bytebier 16.10.1996 via J. P. Hernalsteens.	2
13	S. confusa	-	-	19960343-71	-	Tanzania, Lushoto District, East Usambara Mts.,near Amani, 900-1050 m. Coll. S. Mather. Received to MEI from B. Bytebier 16.10.1996 via J. P. Hernalsteens.	2
14	S. cf. difficilis	2003-0698	-	-	-	Tanzania, Tanga Region, Muheza District, Amani Nature Reserve, Kwamkoro Arboretum. Seeds collected 30.01.2003. Seedlings received from J. Kolehmainen as S. confusa and planted at HKI 18.09.2003, det. J. Kolehmainen, M. Miranto & M. Schütt 2004.	2
15	S. difficilis	1998-0229	-	-	-	Tanzania, Tanga province, Lushoto district, East Usambara Mts., Amani F.R., Amani, Sigi River, moist river edge. Coll. T. Nurminen & J. Kolehmainen 21.02.1998, coll. number 576JK.	2

SAVES *ex situ* ACC. NUMBER	TAXON	HKI ACC. NUMBER	UPP ACC. NUMBER	MEI ACC. NUMBER	ED ACC. NUMBER	DATA OF ORIGIN	CLASS OF ORIGIN DATA
16	S. difficilis	2003-0004	-	-	-	Tanzania, Tanga region, Muheza District, Amani Nature Reserve, Ndola 1 (study site of the collector), on a rocky outcrop in submontane rainforest. Seeds collected by J. Kolehmainen 16.11.2002. Seeds sown at HKI 11.03.2003.	1
17	S. difficilis	2003-0006	-	-	-	Tanzania, Tanga region, Muheza District, Amani Nature Reserve, Ngua, on a rocky outcrop on the edge of the forest. Seeds collected by J. Kolehmainen 03.11.2002. Seeds sown at HKI 11.03.2003.	1
18	S. difficilis	2003-0697	-	-	-	Tanzania, Tanga Region, Muheza District, Amani, Mikwinini. Seeds collected 01.02.2003. Seedlings received from J. Kolehmainen and planted at HKI 18.09.2003.	2
19: 19.1 – 19.10	S. difficilis	2005-0448 – 2005-0457	-	-	-	Tanzania, Tanga Region, Muheza District, Amani Nature Reserve, near Mikwinini village. A large population on steep W-facing mountain slope. Study site code NG 1. Seeds collected 01.02.2003 and sown later by J. Kolehmainen (code in the greenhouses D). Leaf cuttings of 10 unique accessions potted at HKI 01.03.2005.	1
20	S. difficilis	-	-	19960345-73	-	Tanzania, Lushoto District, East Usambara Mts. Coll. S. Mather, coll. number 2. Received to MEI from B. Bytebier 16.10.1996 via J. P. Hernalsteens.	3
21	S. difficilis	-	-	19960346-74	-	Tanzania, Lushoto District, East Usambara Mts., 900-1050 m. Coll. S. Mather. Received to MEI from B. Bytebier 16.10.1996 via J. P. Hernalsteens.	2
22	S. difficilis	-	-	-	19872176	Tanzania, Tanga Region. Coll. J. Bogner 20.05.1986. Received to ED from Munich University. Their source München Botanic Garden.	3

SAVES *ex situ* ACC. NUMBER	TAXON	HKI ACC. NUMBER	UPP ACC. NUMBER	MEI ACC. NUMBER	ED ACC. NUMBER	DATA OF ORIGIN	CLASS OF ORIGIN DATA
	S. difficilis	-	-	-	19872169	Received to ED from Munich University. Their source Berlin-Dahlem Botanic Garden. Their source Geneva Botanic Garden. Not of known wild origin.	5
23	S. difficilis	-	-	-	19721415	Tanzania, Tanga Region. Coll. S. Mather I C 1.	3
	S. diplotricha !	-	-	-	19981689	Received to ED 10.07.1998 from J. Smith. From a cultivated plant not of known wild origin. Darker blue flowered form.	5
	S. diplotricha ! *	-	-	-	19931278	Tanzania, Tanga Region, Foothills of East Usambara Mts., Kwamgumi F.R., 220 m. Leaves' uppersides dark bottle green, undersides light green with very faint purplish wash on some leaves, obviously hairy. Leaves suborbicular / orbicular, margins crenate, slightly downturned. Rosette plants. Flowers very deep violet. Originally coll. by Cambridge 1992 Zoological Expedition. Received to ED 16.03.1993 from H. Tye as Saintpaulia indet., det S. Simiyu Jun 2003.	2
24	S. diplotricha	1999-0335	1987-3085	-	-	Tanzania, Tanga (T3), Muheza District, East Usambara Mts., Marimba F. R., 260 m, on W-facing vertical cliffs. Coll. S. T. Iversen, M. Steiner & R. P. C. Temu 11.01.1986, coll. number 86373. Leaf cuttings received to HKI from UPP 21.04.1999.	2
	S. diplotricha	1999-0338, 2001-0326	- (1992-3236)	-	19872172	Received to HKI from UPP as S. ionantha 21.04.1999, det. L. Schulman 13.06.2001.In HKI with two different acc. numbers due to a confusion. Received to UPP from ED 1992. Received to ED as S. ionantha from Munich University. Their source Berlin-Dahlem B. G. Their source Geneva B. G. Not of known wild origin. Accession no more left in UPP. In ED verified by B. L. Burtt 1997.	5

SAVES *ex situ* ACC. NUMBER	TAXON	HKI ACC. NUMBER	UPP ACC. NUMBER	MEI ACC. NUMBER	ED ACC. NUMBER	DATA OF ORIGIN	CLASS OF ORIGIN DATA
25	S. diplotricha	2001-0324	1987-3084	-	-	Tanzania, Tanga (T3), Muheza District, East Usambara Mts., Kwamgumi F.R.., 400m, on vertical, N-facing rocks in wet forest. Coll. S. T. Iversen 11.11.1986, coll. number 86607. Received to HKI from UPP 27.04.2001.	2
26: 26.1 – 26.10	S. cf. diplotricha	2005-0467 – 2005-0476	-	-	-	Tanzania, Tanga Region, Tanga Municipality, about 2 km to west from Amboni Caves along Mkulumuzi River. Scattered individuals growing on limestone rock. Study site code MK 1. Seeds collected 25.09.2003 and sown later by J. Kolehmainen (code in the greenhouses MK). Leaf cuttings of 10 unique accessions potted at HKI 18.04.2005.	1
27	S. diplotricha	-	1987-3083	-	-	Tanzania, Tanga (T3), Muheza District, East Usambara Mts., Kwamgumi F.R., 370 m, NW of Mhinduro Peak, on NW-sloping rocks, epiphytic or on the ground. Coll. A. Bohridi, C. K. Ruffo & R. P. C. Temu 11.11.1986, coll. number 86647.	1
	S. diplotricha	-	-	-	19872167	Holtcamp (Niehaus) 11.10.1983. Received to ED from Munich University, verified by B.L. Burtt.	5
28	S. grandifolia	2001-0325	1984-3486	-	-	Tanzania, Tanga (T3), Lushoto District, West Usambara Mts., 900 m, southern slope of the escarpment near Mashindei Village, forest remnants. Coll. A. Borhidi, M, Sebsere Demissen & S. Hedrén 23.03.1984, coll. number 841118. Det. T. Pócs. Leaf cuttings received to HKI from UPP 27.04.2001.	1
29	S. grandifolia	-	-	19960348-76	-	Tanzania, Lushoto District, West Usambara Mts., Ambangulu Tea Estate, 0504 S, 03825 E, 1300 m. Coll. Luke & Luke 14.08.1994, coll. number 3775. Received to MEI from B. Bytebier 16.10.1996 via J. P. Hernalsteens.	1

SAVES *ex situ* ACC. NUMBER	TAXON	HKI ACC. NUMBER	UPP ACC. NUMBER	MEI ACC. NUMBER	ED ACC. NUMBER	DATA OF ORIGIN	CLASS OF ORIGIN DATA
30	S. grandifolia	-	-	19960349-77	-	Tanzania, Lushoto District, West Usambara Mts., Ambangulu Tea Estate, 0504 S, 03825 E, 1300 m. Coll. Luke & Luke 14.08.1994, coll. number 3755. Received to MEI from B. Bytebier 16.10.1996 via J. P. Hernalsteens.	1
31	S. grandifolia	-	-	19960350-78	-	Tanzania, Lushoto District, West Usambara Mts., Ambangulu Tea Estate, 0503 S, 03824 E, 1100 m. Coll. Luke & Luke 15.08.1994, coll. number 3791B. Received to MEI from B. Bytebier 16.10.1996 via J. P. Hernalsteens.	1
	S. grandifolia	-	-	-	19970098	Received to ED from M. Möller, not of known wild origin.	5
32	S. grotei	1998-0642	1987-3091	-	-	Tanzania, Tanga (T3), Muheza District, East Usambara Mts., 750 – 1080 m. Coll. G. A. Protzen (Nairobi), coll-number 86840. Det. S. T. Iversen. Cuttings received to HKI from UPP 21.9.1998, 21.4.1999 and 27.4.2001.	2
	S. grotei !	-	-	-	19970106	Received to ED 20.01.1997 from M. Möller, his source Philipps Univ. Marburg B.G. Not of known wild origin.	5
33: 33.1 – 33.4	S. grotei	2005-0414, 2005-0445 – 2004-0447	-	-	-	Tanzania, Tanga Region, Muheza District, Amani Nature Reserve, Kwamkoro, near Kihuhwi subvillage, forming extensive clones on several rock outcrops. Study site code KI 1. Seeds collected 13.05.2002 and sown later by J. Kolehmainen. Leaf cuttings of 4 unique accessions potted at HKI 1.3.2005.	1
	S. grotei	-	-	19680464-..	-	Received to MEI from Gent University B.G. Not of known wild origin.	5

SAVES *ex situ* ACC. NUMBER	TAXON	HKI ACC. NUMBER	UPP ACC. NUMBER	MEI ACC. NUMBER	ED ACC. NUMBER	DATA OF ORIGIN	CLASS OF ORIGIN DATA
34	S. grotei	-	-	19960351-79	-	Tanzania, Lushoto District, East Usambara Mts., Amani Area? Coll. S. Mather, JJJ 1072. Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens.	3
	S. grotei	-	-	-	19872171	Received to ED from Munich University. Their source Berlin-Dahlem B. G. Their source Geneva B. G. Not of known wild origin.	5
35	S. intermedia	1999-0337	1992-3237	-	-19550404	Tanzania, Tanga Region, Kigongoi, N side of the Usambaras, large rock. Cuttings received to ED from P.D. Parker. Received to UPP from ED June 1992. Cuttings received to HKI from UPP 21.4.1999 and 27.4.2001. The accession was not seen in ED during M. Miranto's visit in Jan. 2005.	2
	S. intermedia	-	-	19680465-..	-	Received to MEI from Gent University B. G. Not of known wild origin.	5
	S. intermedia	-	-	-	19970101	Received to ED from M. Möller, his source Philipps Univ. Marburg B. G. Not of known wild origin.	5
	S. intermedia	-	-	19960356-84 (named as cf. nitida	-	Tanzania. Coll. S. Mather. Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens. In MEI as S. cf. nitida. Det. M. Miranto & M. Schütt Oct. 2005.	4
36	S. ionantha	1998-0731	2003-3010	-	-	Tanzania, Tanga Region, Amboni Caves. Coll. M. Nummelin April 1998. Leaf cuttings received to HKI 06.11.1998 as S. indet., det. L. Schulman 13.06.2001. Received to UPP from HKI 2003.	2
37	S. ionantha	-	-	19960352-80	-	Tanzania, Tanga Region, Amboni Caves, 0504 S, 03903 E, 50 m, lithophyte on limestone rocks, in shade in riverine forest. Coll. B. Bytebier 24.12.1994, coll. number 459. Received to MEI 16.10.1996 from B. Bytebier via J.P. Hernalsteens..	1

SAVES *ex situ* ACC. NUMBER	TAXON	HKI ACC. NUMBER	UPP ACC. NUMBER	MEI ACC. NUMBER	ED ACC. NUMBER	DATA OF ORIGIN	CLASS OF ORIGIN DATA
38	S. ionantha	-	-	19960353-81	-	Tanzania, Tanga Region, Amboni Caves, 0504 S, 03902 E, 50 m, lithophyte on limestone rocks, in shade in riverine forest. Coll. B. Bytebier 25.12.1994, coll. number 460. Received to MEI 16.10.1996 from B. Bytebier via J.P. Hernalsteens	1
	S. ionantha	-	-	19960354-82	-	Tanzania. Coll. S. Mather. White form. Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens.	4
	S. ionantha !	-	-	-	19970091	Received to ED 17.01.1997 from M. Möller, his source H. E. Wichert, his source Philipps Univ. Marburg B.G. Not of known wild origin.	5
	S. ionantha !	-	-	-	19970105	Received to ED 20.01.1997 from M. Möller, his source Weihenstephan. Not of known wild origin.	5
39	S. cf. ionantha	-	-	19960347-75	-	Tanzania, Tanga Region, Mkulumuzi Gorge (Coast). Coll. S. Mather 1988. Received to MEI as S. diplotricha from B. Bytebier 16.10.1996 via J.P. Hernalsteens, det. L. Schulman 25.07.2003.	3
	S. ionantha	-	-	-	19961886	Received to ED as S. amaniensis from Q. Cronk. His source Oxford Univ. B.G. Det. S. Simiyu June 2004. Not of known wild origin.	5
	S. magungensis !*	-	-	-	19923185	Tanzania, Tanga Region, possibly Amani area, East Usambara Mts. Coll. S. Mather 01.07.1972, coll. number 8. Received to ED 02.09.1992 from Royal BG Kew, their acc. number 1987-1368.	3
	S. magungensis !	-	-	-	19923187	Received to ED 02.09.1992 as Saintpaulia sp from Royal BG Kew, their acc. number 1983-8183. Verified by B. L. Burtt April 1994. Not of known wild origin.	5

SAVES *ex situ* ACC. NUMBER	TAXON	HKI ACC. NUMBER	UPP ACC. NUMBER	MEI ACC. NUMBER	ED ACC. NUMBER	DATA OF ORIGIN	CLASS OF ORIGIN DATA
40	S. magungensis	1997-0066	-	-	-	Tanzania, Tanga Province, Lushoto District, East Usambara Mts., Amani F.R., Amani, 2 km from the research station along a stream, 740 m, on steep slope. Coll. T. Nurminen, coll. number TN65. Received to HKI as S. pendula 1996, det. J. Kolehmainen 20.1.1999.	1
41	S. magungensis	1997-0103	-	-	-	Tanzania, Tanga Province, Lushoto District, East Usambara Mts., Amani F.R., Amani, Kwamkoro. On rocks along a stream. Coll. T. Nurminen, coll. number TN118. Received to HKI as S. indet. Dec. 1996, det. A. Koponen.	2
42	S. magungensis	2001-0335	1987-3082	-	-	Tanzania, Tanga (T3), Muheza District, East Usambara Mts., Mlinga Peak, 920 m, on shaded NW-facing cliffs. Coll. A, Bohridi, S.T. Iversen & C.K. Ruffo 05.11.1986, coll. number 85487. Received to HKI from UPP April 2001.	1
	S. magungensis var. minima ! *	-	-	-	19594352	Tanzania, Tanga Region, top of hill at Marvera. Received to ED 13.11.1959 from W.R. Punter as Saintpaulia sp., det. B.L. Burtt Jun 1963.	2
43	S. magungensis var. minima	1999-0339	1987-3086	19900945-..	19981691 (named as pendula)	Tanzania, Tanga (T3), Muheza District, East Usambara Mts., 1070 m, east of Mawera Tea Estate on NW-facing steep cliffs. Coll. S.T. Iversen & M. Steiner 12.11.1986, coll. number 86683. Received to HKI from UPP April 2001. Received to MEI from UPP 1990. Received to ED from J. Smith, his source UPP, acc. number 1987-3086. In ED named as S. pendula.	1

SAVES *ex situ* ACC. NUMBER	TAXON	HKI ACC. NUMBER	UPP ACC. NUMBER	MEI ACC. NUMBER	ED ACC. NUMBER	DATA OF ORIGIN	CLASS OF ORIGIN DATA
44	S. magungensis var. occidentalis	-	-	19960362-90	19850680 (?)	Tanzania, Lushoto District, Usambaras? Coll. S. Mather through brother Paddy MacNamara. Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens, det. C. Watkins 22.08.2002. Received to ED from S. Mather. The accessions of MEI and ED may be clones.	3
45	S. nitida	2001-0327	1993-3147	-	-	Tanzania, Morogoro, Nguru Mts., Mhonda, Manga, 1150 m. Coll. M. Gustavsson Feb. 1993. Received to HKI from UPP April 2001.	2
	S. orbicularis	-	2001-3056	-	-	Cape Cod Violetery, USA. Not of known wild origin	5
46	S. orbicularis	-	-	19960357-85	-	Tanzania, Lushoto District, Ambangulu Tea Estate, 0504 S, 03825 E, 1100 m. Coll. Luke & Luke 15.08.1994, coll. number 3788. Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens.	1
47	S. orbicularis var. purpurea	2001-0329	1992-3239	-	19583586	Tanzania, Tanga Region, West Usambara Mts., Ambangula. Received to ED from W.R. Punter as S. indet., det. B.L. Burtt June 1963. Cuttings received to UPP from ED June 1992. Cuttings received to HKI from UPP 27.04.2001.	2
48	S. orbicularis var. purpurea	-	-	19960363-91	-	Tanzania, Lushoto District, Usambaras? Coll. S. Mather through brother Paddy MacNamara. Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens, det. C. Watkins 22.08.2002.	3
	S. pendula !	-	-	-	19970103	Received to ED 20.01.1997 from M. Möller, his source Philipps Univ. Marburg B.G. Not of known wild origin.	5

SAVES *ex situ* ACC. NUMBER	TAXON	HKI ACC. NUMBER	UPP ACC. NUMBER	MEI ACC. NUMBER	ED ACC. NUMBER	DATA OF ORIGIN	CLASS OF ORIGIN DATA
49	S. pendula	1997-0078	-	-	-	Tanzania, Tanga Province, Lushoto District, East Usambara Mts., Amani F.R., near road to Amani, western slope 70°, 410 m. Coll. T. Nurminen, coll. number 79. Received to HKI as S. indet. Dec 1996, det. J. Kolehmainen 20.02.1999.	1
50	S. pendula	2001-0336	1987-3090	-	-	Tanzania, Tanga (T3), Muheza District, East Usambara Mts., Kwamkoro F.R. near Kimbo, 960 m, on steep cliffs in wet intermediate forest. Coll. S.T. Iversen, C.K. Ruffo & M. Steiner 27.10.1986, coll. number 86201. Cuttings received to HKI from UPP April 2001.	2
51	S. pendula	-	1987-3089	-	-	Tanzania, Tanga (T3), Muheza District, East Usambara Mts., Mtai F.R., 900 m, both on wet ground and on W-facing cliffs. Coll. A. Bohridi, S.T. Iversen & M. Steiner, coll. number 86736.	2
	S. pendula !	-	-	-	19981695	Received to ED 10.06.1998 from J. Smith. Not of known wild origin.	5
	S. pendula	-	-	19680468-..	20031341 ?	Received to MEI from Gent University B. G.. Not of known wild origin. Received to ED from MEI 11.11.2003. Probably the same accession, but no accurate data was available.	5
	S. pendula var. kizarae ! *	-	-	-	19594354	Received to ED 01.07.1959 as Saintpaulia sp. from W.R. Punter, verified by B. L. Burtt June 1963. Collected directly from the wild, but no data.	4
52	S. pendula var. kizarae	1999-0340	1987-3087	-	-	Tanzania, Tanga (T3), Muheza District, East Usambara Mts., Tutindi F.R., E of Kizara, 840-950 m, on SW-facing steep cliffs in intermediate rain forest. Coll. S.T. Iversen & M. Steiner 15.11.1986, coll. number 86797. Cuttings received to HKI from UPP April 1999 and April 2001.	1

SAVES *ex situ* ACC. NUMBER	TAXON	HKI ACC. NUMBER	UPP ACC. NUMBER	MEI ACC. NUMBER	ED ACC. NUMBER	DATA OF ORIGIN	CLASS OF ORIGIN DATA
	S. rupicola !	-	-	-	19970095	Received to ED 17.01.1997 from M. Möller. Not of known wild origin.	5
	S. rupicola ! *	-	-	-	19850676	Kenya, Coast Region, Kaloleni, near Kilifi. On open rock faces at top of very high outcrop of limestone rocks. Coll. M. Creighton 01.07.1973. Received to ED 10.04.1985 from S. Mather, acc. number 11.	2
53	S. rupicola	2001-0330	1989-3167	-	-	Kenya, Kaloleni, north of Mombasa, rock outcrops, coll. number 431-78004560 Bren. Received to UPP from Royal B.G. Kew. Cuttings received to HKI from UPP April 2001.	2
54	S. rupicola	-	2003-3011	-	-	Tanzania, East Usambara Mts. Coll. an unknown zoologist. Received to UPP from Isabell Olevall.	3
55	S. rupicola	-	-	19960358-86	-	Kenya, Kilifi District, Cha Simba, 0344 S, 03942 E, 200 m, lithophyte on limestone outcrops, growing in shade. Coll. B. Bytebier 29.09.1993, coll. number 121 Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens..	1
56	S. rupicola	-	-	19960359-87	-	Kenya, Kilifi District, Mwarakaya, 0347 S, 03942 E, 150 m, lithophyte on limestone outcrops, growing in shade. Coll. B. Bytebier 01.10.1993, coll. number 139 Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens..	1
57	S. rupicola	-	-	19960360-88	-	Kenya, Kilifi District, Cha Simba, 0344 S, 03942 E, 200 m, lithophyte on limestone outcrops, growing in shade. Coll. B. Bytebier 29.09.1993, coll. number 116 Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens..	1

SAVES *ex situ* ACC. NUMBER	TAXON	HKI ACC. NUMBER	UPP ACC. NUMBER	MEI ACC. NUMBER	ED ACC. NUMBER	DATA OF ORIGIN	CLASS OF ORIGIN DATA
58	S. rupicola	-	-	19960361-89	-	Kenya, Kilifi District, Cha Simba, 0344 S, 03942 E, 200 m, lithophyte on limestone outcrops, growing in shade. Coll. B. Bytebier 01.10.1993, coll. number 130. Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens.	1
59	S. shumensis	-	1981-3048	-	-	Tanzania, Tanga Province, Usambara Mts. Coll. T. Arnborg 10.05.1981. Det. T. Arnborg & S.T. Iversen.	3
	S. shumensis	-	-	-	20042093	Received to ED from C. Watkins. Not of known wild origin.	5
60	S. teitensis	-	-	19960369-00	20031340, 20042092	Kenya, Taita-Taveta District, Mbololo (Taita Hills), 0319 S, 03828 E, on rocks in rain forest. From Plant Conservation and Propagation Unit (PCPU 40), East African Herbarium 1993. Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens. Received to ED from MEI 2003 (20031340) and from C. Watkins 2004 (20042092), his source MEI.	1
	S. tongwensis ! *	-	-	-	19850668	Tanzania, Tanga Region. Coll. S. Mather.. Received to ED 10.04.1985 from S. Mather, acc. number 2.	3
	S. tongwensis !	-	-	-	19970090	Received to ED 17.01.1997 as S. difficilis from M. Möller, his source H. E. Wichert, his source Philipps Univ. Marburg B.G. Not of known wild origin.	5
61	S. tongwensis	2001-0331	1987-3397	-	-	Tanzania, Tanga (T3), Muheza District, East Usambara Mts., NE part of Tongwe F. R, 340 m, on vertical cliffs. Coll. S.T. Iversen, W.R. Mziray & E. Persson 02.05.1987, coll. number 87167. Cuttings received to HKI from UPP April 2001.	2
62	S. tongwensis	-	-	19960370-01	-	Tanzania, Pangani District, Mt. Tongwe ?. Coll. S. Mather, coll. number 4. Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens.	3

SAVES *ex situ* ACC. NUMBER	TAXON	HKI ACC. NUMBER	UPP ACC. NUMBER	MEI ACC. NUMBER	ED ACC. NUMBER	DATA OF ORIGIN	CLASS OF ORIGIN DATA
63	S. tongwensis	-	-	19960371-02	-	Tanzania, Pangani District, Pangani. Coll. L. Mwasumbi 1992. Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens.	2
	S. velutina !	-	-	-	19970100	Received to ED 20.01.1997 from M. Möller, his source Philipps Univ. Marburg B. G. Not of known wild origin.	5
	S. velutina !	-	-	-	19872179	Received to ED 01.07.1987 from Munich University. Not of known wild origin.	5
64	S. velutina	1999-0341, 2001-0332	1989-3166	-	-	Tanzania, West Usambara Mts., rain forest. Coll. number 359-7402880. Received to UPP from Royal BG Kew 1989. Cuttings received to HKI from UPP April 1999 and April 2001. In HKI with two different acc. numbers due to a confusion.	3
65	S. sp. nov. “Kacharoni”	-	-	19960365-93	-	Kenya, Kilifi District, Kacharoni, 0328 S, 03945 E, 85 m, lithophyte on limestone rocks, in shade of riverine forest. Coll. B. Bytebier 28.09.1993, coll. number 107. Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens.	1
66	S. sp. nov. “Kacharoni”	-	-	19960366-94	-	Kenya, Kilifi District, Kacharoni, 0328 S, 03945 E, 85 m, lithophyte on limestone rocks, in shade of riverine forest. Coll. B. Bytebier 28.09.1993, coll. number 108. Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens.	1

SAVES *ex situ* ACC. NUMBER	TAXON	HKI ACC. NUMBER	UPP ACC. NUMBER	MEI ACC. NUMBER	ED ACC. NUMBER	DATA OF ORIGIN	CLASS OF ORIGIN DATA
67	S. sp. nov. “Kacharoni”	-	-	19960390-21	20031339	Kenya, Kilifi District, Kacharoni gorge on Vitengeni river between Magogoni and Dida, 032700 S, 0394400 E, massive limestone gorge with heavily wooded slopes, herb attached to small crevices in rock outcrops. Coll. Pearce 18.02.1993, coll. number 459. Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens. Received to ED from MEI 2003, Index Sem. Yr Item.	1
	S. sp. nov. “Mafia Hills”	-	-	-	20031374	To ED received as S. “Majiensis” from Nat. Herb. of Tanzania 2003, uncertain.	5
68	S. sp. nov. “Mhonda”	-	1993-3154	-	-	Tanzania, Morogoro, Nguru Mts., Mhonda, above waterfall on the trail to Spirit Lake, growing on big boulders in shade. Coll. C. Grusell.	1
69	S. sp. nov. “Mwachi”	-	-	19960368-96	-	Kenya, Kwale District, Mwache F.R., 0400 S, 03932 E, 100 m, lithophyte on limestone outcrops, in shade of coastal forest. Coll. B. Bytebier 30.09.1993, coll. number 158. Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens.	1
70	S. sp. nov. “Mwachi”	-	-	(19960367-95)	20031342	Kenya, Kwale District, Mwache F.R., 0400 S, 03932 E, 100 m, lithophyte on limestone outcrops, in shade of coastal forest. Coll. B. Bytebier 30.09.1993, coll. number 157. Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens. Received to ED from MEI 2003, Index Sem. Yr Item. The accession had empty pots in MEI during M. Miranto's visit in Dec.. 2004.	1
71	S. sp. nov. “Pangani Falls”	2001-0333	1995-3093	-	-	Tanzania, Pangani Falls Power Station, north of Dar-es-Salaam. Coll. B. Pettersson Aug. 1995. Cuttings received to HKI from UPP April 2001.	2

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72	S. sp. nov. “Sigi Falls”	2001-0337	2001-3057	19960338-66 ?	-	NE Tanzania at “Sigi Falls” (apparently somewhere below the East Usambara Mts.). Received to UPP from a private collector who says this is S. “Sigi Falls” of the collection of Royal BG Kew. Cuttings received to HKI from UPP April 2001. MEI origin Tanzania, Tanga District, Sigi Falls (Coast). Coll. S. Mather, coll. number 14. Received to MEI from B. Bytebier 16.10.1996 via J.P. Hernalsteens. Accessions of UPP. & HKI and MEI may be clones.	2
	S. sp. nov. !	-	-	-	19970102	Received to ED 20.01.1997 as S. orbicularis from M. Möller, his source Philipps Univ Marburg B.G., verified by S. Simiyu June 2003. Not of known wild origin.	5
	S. sp. nov. ! *	-	-	-	19931279	Tanzania, Tanga Region, Foothills of East Usambara Mts., Kwamgumi F.R., 220 m. Leaves light green above, paler below, suborbicular / oval, very slightly crenate. Flowers rich, mid-violet. Coll. by Cambridge 1992 Zoological Expedition. Received to ED 16.03.1993 from H. Tye.	2