THE GENUS *SANSEVIERIA* (FAMILY DRACAENACEAE) IN ZIMBABWE

Ratidzayi Takawira
National Herbarium and Botanic Garden
P.O. Box A889
Avondale
Harare
Zimbabwe
rtakaw@ avu.org

Inger Nordal
University of Oslo
Division of Botany and Plant Physiology
P.O. Box 1066, Blindern
N-0316 Oslo, Norway
inger.nordal@bio.uio.no

Keywords: foliage ornamental, fibre, medicine, morphological variation, phenology, isoenzyme analysis

Abstract

A study of the genus *Sansevieria* based on gross morphological variation and enzyme electrophoresis was carried out to delimit the *Sansevieria* taxa that occur in Zimbabwe and to elucidate evolutionary relationships that exist in the genus. The study was based on living specimens from the wild and those in cultivation at the National Botanic Garden (Harare). Eight species *S. aethiopica, S. hallii, S. hyacinthoides, S. kirkii, S. pearsonii, S. singularis, S. stuckyi* including one new species *Sansevieria* sp. A were delimited. Isoenzyme data showed that in spite of the great variation observed in the genus, a close relationship existed between the *Sansevieria* species, suggesting high reticulate crossings among the ancestral groups. The study highlighted the importance of rescuing members of the genus growing in the wild from over exploitation by local communities, that has resulted in certain species like *S. stuckyi* and *Sansevieria* sp. A becoming locally extinct. By highlighting the diversity in species and habitat preferences in the wild, this study contributes to the field of horticulture an avenue through which wild *Sansevieria* species can be introduced into cultivation as ornamentals, thereby ensuring their sustenance.

1. Introduction

Sansevieria is a genus of xerophytic perennial herbs occurring in dry tropical and subtropical parts of the world. It consists of about 70 species with a distribution ranging from Africa through Asia to Burma and the islands of the Indian Ocean (Purseglove, 1972; Alfani *et al*.,1989). *Sansevieria* is known variously as bow-string hemp, snake plant, zebra lily, mother in law's tongue, cow tongue, leopard lily, devil's tongue, good luck plant, etc. (Turril, 1959; Cutak, 1966; Graf, 1963; Agnew, 1974; Pfennig, 1979; Everett, 1982; Koller and Rost, 1988).

Members of *Sansevieria* are of great economic importance as ornamentals, as a source of fibre and as medicine for curing different ailments. *Sansevieria* species are among major foliage ornamentals mainly due to the variegated and mottled leaves (Roy, 1956; Nazeer and Khoshoo 1984; Bos, 1998) and the interesting wide variation in leaf shape. *Sansevieria trifasciata* Prain. is the most common species found cultivated in gardens or pots, particularly *S. trifasciata* var *laurentii* (De Wild.) N.E.Br. The mottled, erect and stiff leaves of *Sansevieria* are used a great deal in artistic flower arrangements. *Sansevieria* are a source of white strong elastic fibre commonly used in the manufacture of rope, fishing lines, cordage, fine matting, bowstring, and clothing (Gangstad *et al*., 1951; Everett, 1982). In addition, Leighton (1917a, 1917b) and Hill (1952) stated the use of *Sansevieria* fibre in making fine paper. *Sansevieria* species are also used for a variety of medicinal purposes through out the genus' geographical range. Table 1 presents medicinal uses of *Sansevieria* species reported in literature.

Zimbabwe is a land locked country located in south central Africa between 15^{o} 40'

Proc. XX EUCARPIA Symp. on New Ornamentals
Eds. J. Van Huylenbroeck et al.
Acta Hort. 552, ISHS 2001

and 22° 30'S latitudes and 25° 15' and 33° 50' longitudes. It is bound by Zambia to the north, Mozambique to the east, South Africa to the South, Botswana to the West and shares a small boarder with Namibia at the Caprivi Strip. Figure 1 shows the location of Zimbabwe in Southern Africa and all the known localities of *Sansevieria* in Zimbabwe.

The specific aims of the study were to study the gross morphological variation patterns in the *Sansevieria* taxa of Zimbabwe, delimit all the taxa that occur in Zimbabwe and to study the phenology and molecular biology of the *Sansevieria* taxa in order to elucidate evolutionary relationships.

2. Materials and methods

2.1. Herbarium, fieldwork and morphological studies

Information on habitat, ecology, growth-habit and distribution was obtained from herbarium studies at the National Herbarium, Harare (SRGH), National Botanical Institute, Pretoria (PRE), Royal Botanic Gardens, Kew (K) and the British Museum (BM). Fieldwork was carried out all around Zimbabwe during the periods December 1996 to March 1997, November 1997 to March 1998 and January to February 1999. The plants collected during the field studies and the *Sansevieria* populations cultivated in the Botanic Garden formed the basis of the morphological study. Measurements taken included vegetative characters like phyllotaxy, number of leaves per plant, leaf texture, colour, shape, length, thickness and reproductive characters like inflorescence type, raceme and perianth tube lengths. Collections were made from a total of 114 localities countrywide.

2.2. Isoenzyme analysis

Tissue preparation and electrophoretic procedures followed methods modified from Morden *et al*., 1987), Wendel and Weeden (1989) and Borgen (1997). Nine enzymes were investigated; Aspartate aminotransferase (AAT), Aminopeptidase (AMP), Glucose-6-phosphate isomerase (GPI), Isocitrate dehydrogenase (IDH), Malate dehydrogenase (MDH), Phosphoglucomutase (PGM), 6-Phosphogluconate dehydrogenase (6-PGD) and Triose-phosphate isomerase (TPI). A 1 cm x 1 cm square area of green tissue from young, tender *Sansevieria* leaves was crushed in homogenising buffer (50 mM Tris-HCL buffer, pH 7.5). Seven to ten drops of the homogenising buffer were used. The succulent and fibrous nature of *Sansevieria* tissue necessitated use of sand grains to facilitate the homogenising process. An electric macerator was used to finely homogenise the tissue in the buffer. Care was taken in each case to store the homogenised tissue and the buffer in ice to prevent denaturation of the enzymes. The homogenates were absorbed onto paper wicks and applicated on 12.4% starch gels (3% sucrose). Electrophoresis was run at 4 °C. A total of 88 *Sansevieria* specimens were analysed.

2.3. Morphological data analysis

Both clustering and ordination analyses were performed on the morphological data set using the SPSS 7.0 statistical programme (Norusis, 1988). The two methods permitted a comparison among the groups resulting from the analysis. A phenogram was constructed using the unweighted pair-group method analysis (UPGMA) (Sneath and Sokal, 1973). Squared Eucledian Distance was applied as the similarity / dissimilarity measure.

3. Results

3.1. Field observations

Common *Sansevieria* habitats included termite mounds, riverbanks and rocky

outcrops. Some species grew in clumps at bases of trees. In some rare cases *S. pearsonii* was found growing as epiphytes on *Colophospermum mopane* tree trunks, throwing some aerial roots towards the ground or with the roots penetrating through the woody tissue of the tree. Plants that grew in the shade appeared thin and etiolated. In *S. aethiopica* and *S. hyacinthoides* the green and light green variegations on the leaves were distinct in plants that were growing in full sun, while those growing in the shade had very faint bands or none.

3.2. Leaf characters

Table 2 summarises the variation in the number of leaves, shape, leaf texture; colour and phyllotaxy observed in the *Sansevieria* taxa in Zimbabwe.

3.3. Phenology in *Sansevieria*

Seven *Sansevieria* species; *S. aethiopica*, *S. hallii*, *S. hyacinthoides*, *S. kirkii*, *S. singularis* and *S. stuckyi* flower between November and March, while *S. pearsonii* flowers between June and October. All the species produce cream flowers with a pink or purple tinge. Individual flowers have six perianth segments fused into a tube. The perianth segments curl backward at anthesis, and in the process increase the distance between the pollen and the stigma. The flowers emit a strong scent and each opens for only one night after which it shrivels. The flowers generally open in the late afternoon around 15.00 hours and close in the early hours of the following morning around 07.00 hours suggesting pollination is by nocturnal insects.

3.4. Multivariate analyses

The dendrogram obtained from the cluster analysis shows two main groups separated by a square Eucledian distance of 0.515 (Figure 2). One group is comprised of species *S. hyacinthoides* and *S. aethiopica* while the other is comprised of *S. kirkii*, *S. hallii*, *S. stuckyi*, *S. pearsonii*, *S. singularis*, *Sansevieria* species A and *S. singularis*. Generally the taxa cluster at relatively low Euclidean distance values with the largest Euclidean value of 0.515 and the rest at lower values. A canonical discriminant function analysis performed on the same data set confirmed the eight distinct groups corresponding to the taxa *S. kirkii*, *S. hallii*, *S. stuckyi*, *S. pearsonii*, *S. singularis*, *Sansevieria* species A and *S. singularis* (Figure 3).

3.5. Isoenzyme analysis

The six isoenzymes: AAT, GPI, IDH, MDH, PGM and TPI gave interpretable results. The phenotypic patterns obtained showed that all *Sansevieria* taxa are rather closely related, with *S. pearsonii* in a somewhat distinct position, having unique alleles in the isoenzymes IDH and PGM.

4. Discussion

Etiolation of species growing under shade suggests that the sun is essential for the development of variegation in *S. hyacinthoides* as evidenced by the near absence of variegations and the etiolation of the *Sansevieria* populations that grew in the shade.

*Sansevieria*s mainly reproduce vegetatively by means of rhizomes and they can also be easily propagated through leaf cuttings. The protogynous *Sansevieria* flower indicates that the stigma presents itself for pollination by pollen from neighbouring flowers or from flowers of other plants in the population while the anthers from the same flower are still enclosed inside the perianth tube. The reflexing of the tepals during anthesis, and the spreading of the stamens in the process, increases distance in space

between the pollen and the stigma excluding contact between the stigma and stamens of the same flower, suggest that *Sansevieria* is predominantly outcrossing.

Field studies on the genus *Sansevieria* in Zimbabwe revealed that *Sansevieria* species are among threatened taxa, the prime causes being habitat destruction as land is cleared for agricultural purposes, and overexploitation of members of the genus by local communities, mainly for fibre and medicinal use. *Sansevieria* species A last collected from eastern parts of Zimbabwe in 1962 could not be found in the wild as the previously known habitats have been turned into coffee plantations. Following this study, a description of *Sansevieria* species A has been written (Takawira, 2000) and recommendations have been made for this species to be added to the Red Data List of Zimbabwe.

The isoenzyme systems investigated (all except AAT) gave a higher number of bands than those expected for diploids. The band patterns obtained for GPI, IDH, MDH, PGM, and TPI show fixed heterozygosity, strongly indicating allopolyploidy (Kephart 1990). The undescribed species (*Sansevieria* species A) appears to be the most closely related species to *S. hallii* on the molecular level, a surprising result, considering the morphological differences between the two taxa. The close similarity observed between band phenotypes of the different species, combined with the evidence of allopolyploidy, could be an indication that reticulate evolution took place at an early stage during the evolution of the genus.

5. Conclusion

The genus *Sansevieria* in Zimbabwe is represented by eight species: *Sansevieria aethiopica, S. hallii, S. hyacinthoides, S. kirkii,* S. *pearsonii, S. stuckyi, S. singularis* and an undescribed species, *Sansevieria* species A. The study highlights the degree of variation found in the genus and poses a challenge for ornamental plant breeders to exploit the wide range of *Sansevieria* species that grow in the wild. The wide variety of *Sansevieria* species has potential for new markets when fully exploited and will provide the consumer with a wider range of *Sansevieria* species to choose from. Commercial cultivation of *Sansevieria* as ornamentals will go a long way in rescuing members of the genus *Sansevieria* from extinction. It will also ensure conservation of a genus with great prospects in medicine and fibre production before the species are overexploited to extinction.

Acknowledgement

The authors would like to thank NUFU (Norwegian Council of Universities' Programme for Development, Research and Education) PRO 32/96 for providing financial support for this study.

References

Agnew A.D.Q., 1974. Upland Kenya wild flowers: A flora of the ferns and herbaceous flowering plants of upland Kenya. Oxford University Press, London.

Alfani A., Ligrone R., Fioretto A., and Virzo de Santo A., 1989. Histochemistry, ultrastructure and possible significance of dead parenchyma cells with specialized walls in the leaf and rhizome of *Sansevieria*. Plant Cell and Environment 12: 249 – 259.

Borgen L., 1997. Isoenzymes-electrophoresis. Course compendium BB 300. University of Oslo.

Bos J.J., 1998. Dracaenaceae. In: K. Kubitzki (ed.). The Families and Genera of Vascular Plants 3. Springer-Verlag, Berlin, Heidelberg, New York.

Cutak L., 1966. Fool – hardy *Sansevieria*s. Missouri Botanical Garden Bulletin 54(6): 1-13.

Everett T.H., 1982. Encyclopedia of Horticulture Volume 9. Garland Publishing, Inc., New York & London.
Gangstad E.O., Joyner J.F., and Seale C.C., 1951. Agronomic characteristics of *Sansevieria* species. Tropical Agriculture Journal 28: 204 – 214.
Gelfand M., Mavi S., Drummond R.B., and Ndemera B., 1985. The Traditional Medical Practitioner in Zimbabwe: His Principles of Practice and Pharmacopoeia. Mambo Press, Gweru.
Graf A.B., 1963. Exotica. Roehrs Co., New Jersey.
Hedberg I., and Staugard F., 1989. Traditional medicinal plants: Traditional medicine in Botswana. Ipeleng publishers, Broadhurst, Gaborone.
Hill A.F., 1952. Economic Botany 2nd Ed. New York. McGraw-Hill Book Company.
Kephart S.R., 1990. Starch electrophoresis of plant isoenzymes: A comparative analysis of techniques. American Journal of Botany 77(2): 693-712.
Koller A.L., and Rost T.L., 1988. Leaf anatomy in *Sansevieria* (Agavaceae). American Journal of botany 75 (5): 615-633.
Leighton J., 1917a. Some suitable materials for paper-making. The South African Journal of Science 14(6): 287-288.
Leighton J., 1917b. Notes on fibre produced from some of the most useful indigenous and exotic plants in the Cape Province. The South African Journal of Science 14(10): 443-444.
Morden C.W., Doebley J., and Schertz K.F., 1987. A manual of techniques for starch gel electrophoresis of Sorghum isozymes. Texas Agricultural Experimental Station. A & M University system, Texas.
Nazeer M.A., and Khoshoo T.N., 1984. Cytology of some species of *Sansevieria*. Thunb. *Cytologia* 49: 325-332.
Norusis M.J., 1988. Scientific Package for Social Scientists, User's guide, SPSS Inc., Chicago.
Pfennig H., 1979. Grass-like to tree-like: *Sansevieria*s. Cactus and Succulent Journal of Great Britain 41: 56-60.
Purseglove J.W., 1972. Tropical crops. Monocotyledons 1. Longman groups Ltd, London.
Roy M., 1956. A cytological investigation of the different species of *Sansevieria* with the aid of the improved technique. Caryologia 8(2): 219-230.
Sneath P.H.A., and Sokal R.R., 1973. Numerical taxonomy. W.H. Freeman & Co., San Fransisco.
Takawira R., 2000. Biosystematic studies of the genus *Sansevieria* (Dracaenaceae) in Zimbabwe. Master of Philosophy (Mphil) unpublished Thesis, Dept. of Biological Sciences, University of Zimbabwe.
Turril W.B., 1959. *Sansevieria*. National Botanic Garden. Lucknow-India Bulletin 46: 1-29.
Watt J.M., and Breyer-Brandwijk M.G., 1962. The medicinal and poisonous plants of southern and eastern Africa. E & S Livingstone Ltd. Edinburgh and London.
Wendel J.F., and Weeden N.F., 1989. Visualisation and interpretation of plant isozymes p5-45. In: D. E Soltis & P. S. Soltis. (Eds). Isozymes in plant biology. p1-268. Dioscorides Press, Hong Kong.

Table1. Medicinal uses of *Sansevieria* species.

Species	Country	Medicinal use/treatment	Administration of medicine	Reference
S. thyrsiflora	South Africa	Treatment of haemorrhoids, expulsion of intestinal worms	Portion of root chewed and swallowed or boiled root eaten by patient	Watt and Breyer-Brandwijk, 1962
S. thyrsiflora	South Africa	To prevent miscarriage	Infusion of root taken	Watt and Breyer-Brandwijk, 1962
S. thyrsiflora	South Africa	Protection against lightning	Infusion of root taken	Watt and Breyer-Brandwijk, 1962
S. cylindrica	Congo	Charm plant	All parts of the plant used	Watt and Breyer-Brandwijk, 1962
S. kirkii	Tanzania	Healing of wounds	Powdered root applied to wound	Watt and Breyer-Brandwijk, 1962
S. kirkii	East Africa	Purgative	Decoction of rhizome used	Watt and Breyer-Brandwijk, 1962
S. thyrsiflora	Tanzania	Earache, toothache	Cut leaf gently heated, exuding juice dropped into aching ear/ tooth	Watt and Breyer-Brandwijk, 1962
S. pearsonni	Zimbabwe	Toothache	Leaf extract dropped on aching tooth	Gelfand *et al*., 1985
S. aethiopica	Botswana	To increase appetite in children	Root powder give to Children twice a day	Hedberg and Staugard , 1989
S. aethiopica	Botswana	Earache	Root extract squeezed into ear	Hedberg and Staugard, 1989
S. aethiopica	Botswana	Wounds and sores	Leaf extract squeezed directly onto wound/sore	Hedberg and Staugard, 1989

Table 2 Observations made on the vegetative characters of the Zimbabwean *Sansevieria* taxa

Taxa	No of Leaves	Shape	Leaf surface texture	Leaf Colour	Phyllotaxy
S. aethiopica	6-20	linear	rough	transversely banded with green and light green bands	rosulate, leaves erect or ascending spreading.
Sansevieria species A.	4-16	flat	smooth	green	rosulate
S. hallii	1-3	semi-cylindrical	rough	green and light green	rosulate and spreading
S.hyacinthoides	1-12	flat	smooth or rough	green and light green bands blotches or a combination of both	solitary, rosulate
S. kirkii	1-3	flat	smooth or rough	dark green, sometimes variegated with light green blotches or horizontal lines	solitary, rosulate with leaves embracing each other at base
S. pearsonii	1-12	cylindrical with channel at adaxial side	smooth or rough	green, marked with dark green interrupted lines between the grooves.	solitary or distichous (two ranked in one plane
S. singularis	1, rarely 2 or 3	cylindrical with wide channel at adaxial side	smooth	dark green	solitary
S. stuckyi	1, rarely 2 or 3	cylindrical with channel at adaxial side	smooth	green with faint horizontal light green bands	solitary

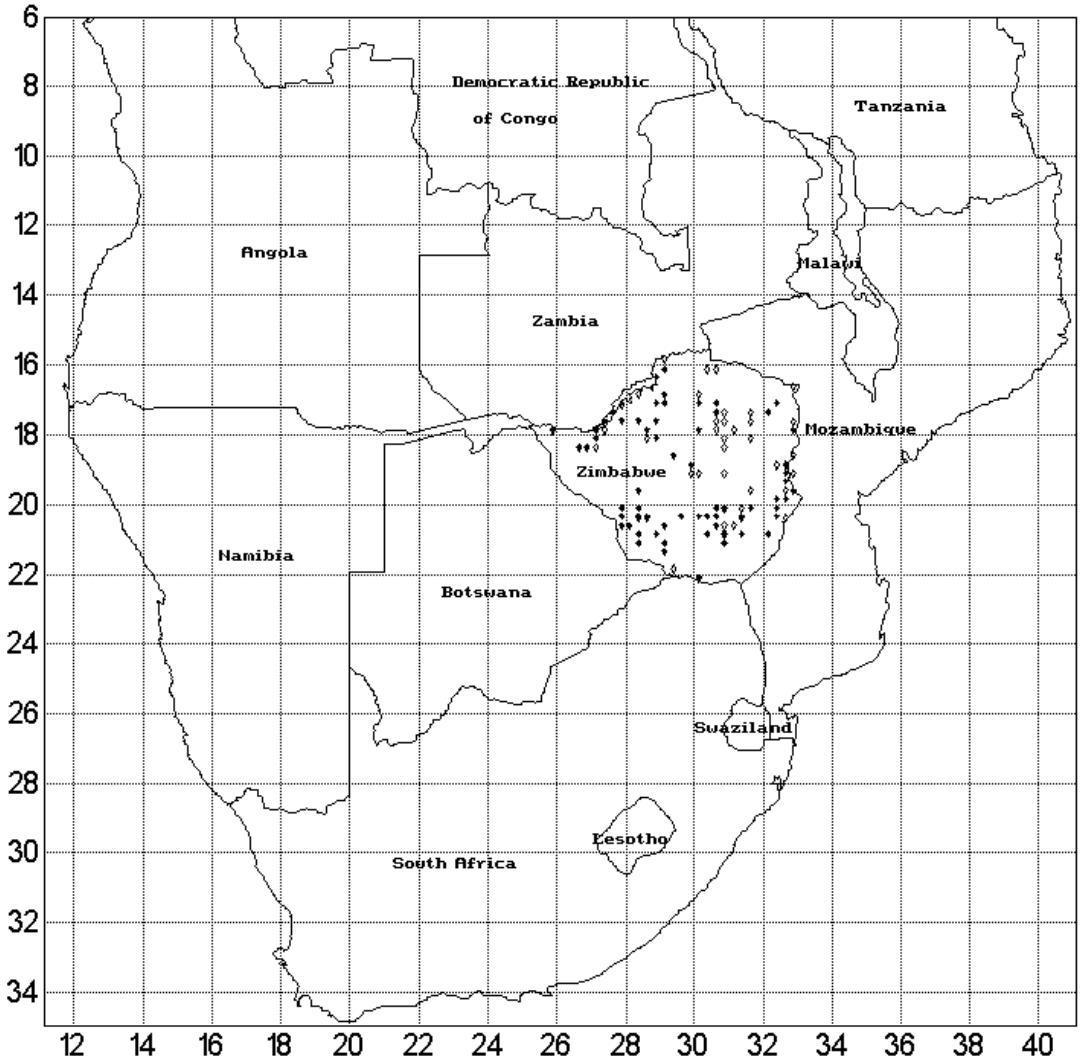

Figure 1. Map of the study area, Zimbabwe and its location in Southern Africa. The positions marked show the known localities of *Sansevieria* in Zimbabwe. Those marked in black indicate the localities visited by the authors during the study.

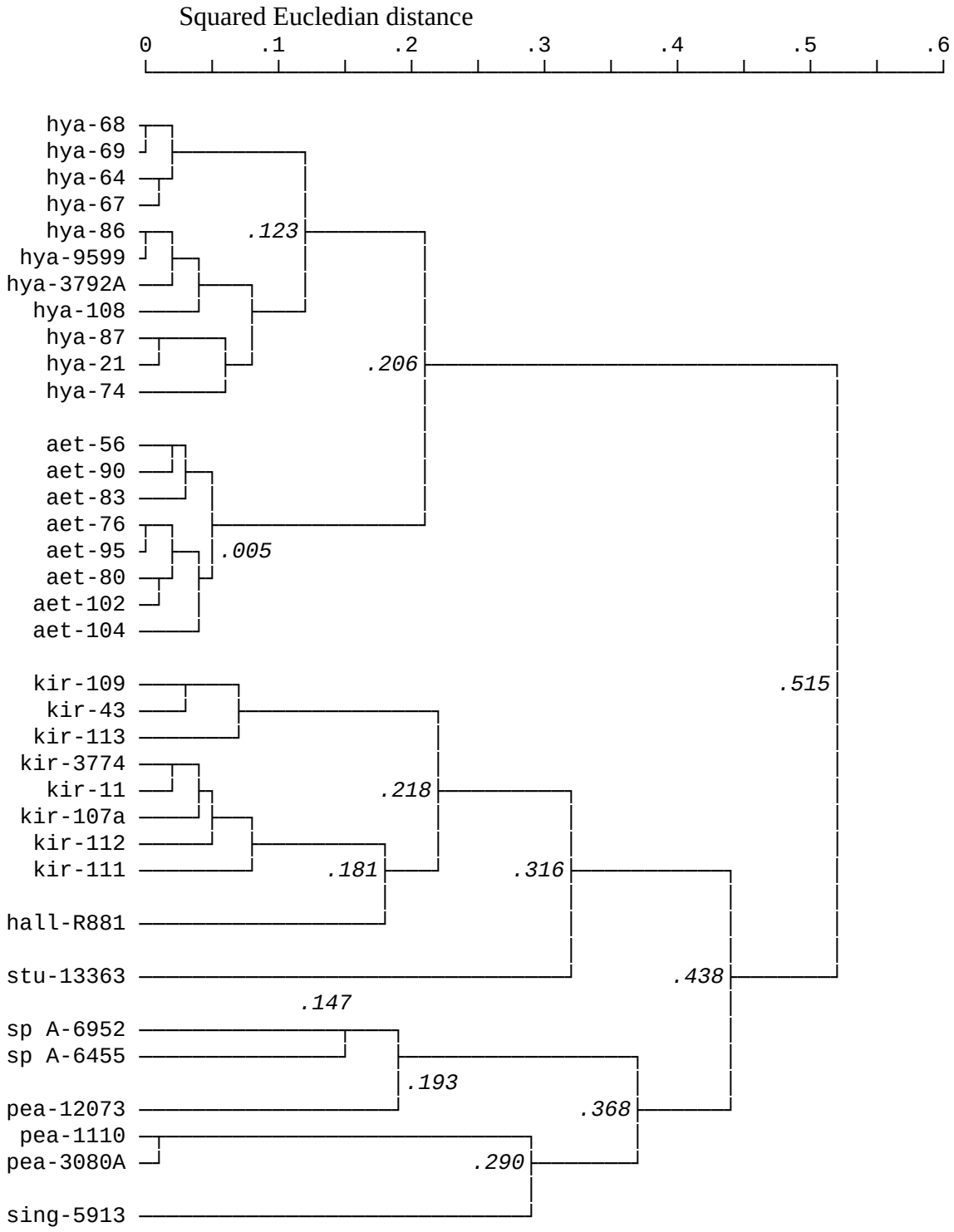

Figure 2. A UPGMA dendrogram based on 15 morphological characters and 35 individual populations of *Sansevieria*. The individual populations are labelled with population numbers and the first three or four letters of the taxon names (hya = *S. hyacinthoides*, aet = *S. aethiopica*, kir = *S. kirkii*, hall = *S. hallii*, stu = *S. stuckyi*, s.n. = *S.* species A, pea = *S. pearsonii*, sing = *S. singularis*). Squared Euclidean Distance was applied.

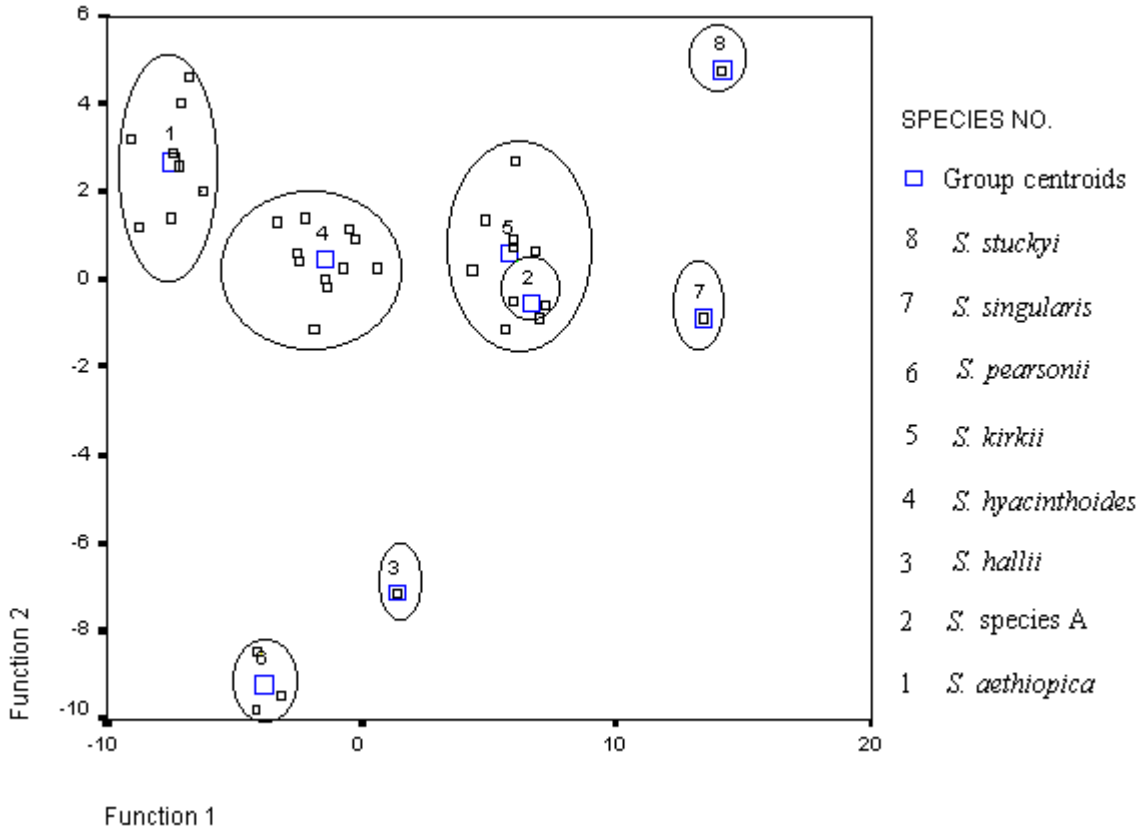

Figure 3. Canonical Discriminant Analysis (CDA) based on 13 characters and 35 individual populations of *Sansevieria*. The eight discriminating groups correspond to taxa. Function 1 and 2 account for 59.2 % and 18.6 % of the total variance. Group centroids are represented by the midpoint of the bigger squares.