AN ECOGEOGRAPHIC SURVEY OF THE GENUS *SESAMUM* (PEDALIACEAE) IN NAMIBIA

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ABSTRACT

An ecogeographic survey was conducted for the genus *Sesamum* in Namibia using specimen label information from herbarium specimens and, to a lesser extent, genebank accessions. The distribution of ten species was mapped and conclusions were drawn as to the ecology and phytogeography of the genus. The analysed data were also used to identify conservation and collection priorities for the future. It was found that some species flourish under very specific ecological and geographical conditions while other species are generalists that can grow in a wide range of habitats. The genetic diversity found within the genus is not adequately conserved by either *in situ* or *ex situ* methods. The centre of diversity for *Sesamum* is in southern Africa and, more specifically, Namibia and Angola. Certain areas in Namibia should be considered for the siting of genetic reserves for species in this genus.

INTRODUCTION

The increasing demand for food production across the world has led to the need for optimal use of all plant genetic resources that are available. Wild relatives of cultivated crops can play a leading role in future plant breeding programmes to improve crops. Many of these species are threatened by habitat destruction and other factors and therefore it becomes necessary to conserve them. It is essential to understand the habitat preferences and geographical distribution of these wild species if an effective conservation strategy is to be developed (Maxted *et al*., 1997). An ecogeographic survey or study is an ecological, geographical and taxonomic information gathering and synthesis process and an important tool in the planning of conservation efforts (Maxted *et al*., 1997).

The genus *Sesamum* belongs to the family Pedaliaceae, which consists of 17 genera and about 85 species. This family is found in the tropics, especially along coasts and in arid regions (Mabberly, 1997). The largest genus is *Sesamum* with 15 species in Africa and India. A good, recent revision of the genus is lacking, which is unfortunate as many of the taxonomic problems experienced in the genus remain unclarified (Ihlenfeldt, pers. comm.1998).

The diagnostic features of the genus *Sesamum* include: shortly pedicellate flowers with extra-floral nectaries (reduced flowers) at the base; a white, pink or purple corolla with the lowest lobe being the longest; the fruits are longitudinally dehiscent capsules and the seeds are winged or with a double, rarely single, fringe (Launert, 1988).

The specific value of wild *Sesamum* species lies in the fact that they are relatives of *S. indicum* (sesame seed), one of the world s most important oil crops (Smartt & Simmonds, 1995). Sesame oil and seeds are mostly used for culinary purposes but medicinal and other values are also reported.

As many *Sesamum* species are adapted to very dry conditions, and with the wide range of habitats that they inhabit, including poor soil types, they would be ideal for use in breeding programmes. The trait for drought-tolerance of *S. indicum*, for example, could be improved. The following *Sesamum* taxa encountered during the survey, occur in Namibia (Craven, 1999):

S. *abbreviatum* Merxm.
S. *alatum* Thonn.
S. angustifolium (Oliv.) Engl.
S. calycinum Welw. subsp. *baumii* (Stapf) Seidenst.
S. *capense* Burm. f.
S. marlothii Engl.
S. pedalioides Welw.
S. rigidum Peyr. subsp. *merenskyanum* Ihlenf. & Seidenst.
subsp. *rigidum*
S. schinzianum Asch.
S. *triphyllum* Welw. ex Asch.

According to Craven (1999), *Sesamum indicum* L. and *S. angolense* Welw. are also recorded as occurring in Namibia, but no records could be obtained for these two species during the survey.

MATERIALS AND METHODS

Although the survey was initially conducted for the whole of southern Africa, only the data for Namibia were extracted for this article. The survey was conducted according to the model given by Maxted *et al.* (1995), cited in Maxted *et al.* (1997):

Phase I: Project design:

- Identification of taxon expertise,
- Selection of target taxon taxonomy,
- Delimitation of target area,
- Identification of taxon collections, and
- Designing and building ecogeographic database structure.

Phase II: Data collection and analysis:

- Listing of germplasm conserved,
- Media survey of geographical, ecological and taxonomic data,
- Collection of ecogeographic data,
- Selection of representative specimens,
- Data verification, and
- Analysis of geographical, ecological and taxonomic data.

Phase III: Production phase:

- Data synthesis process from which the ecogeographic database, ecogeographic conspectus and the ecogeographic report were derived, and
- Identification of conservation priorities.

Specimen label information was obtained from the Herbarium of the Royal Botanic Gardens at Kew (K), and the National Herbarium of Namibia (WIND). Additional passport data were obtained from the following genebanks: The National Plant Genetic Resources Centre in Namibia, the National Department of Agriculture in South Africa and the Plant Genetic Resources Unit of the Agricultural Research Council in South Africa. Specimens were selected for their quality and quantity of passport data.

All the relevant data were entered into an ecogeographic database, which was constructed on Microsoft Access 2.0. The following fields were entered onto the database: species name; province and district in which the specimen was collected; altitude; coordinates; location data; collector's name; collector's number; date of collection; habitat; soil type; associated vegetation; rainfall; land-use of collection site; name of institute holding the specimen or accession as well as other interesting information. Microsoft Encarta was used to find some of the coordinates of localities that were not recorded on specimen labels, while charts were produced on Microsoft Exel during the analysis phase.

Distribution maps for this article were produced on MAPPIT. The National Atlas of SWA/Namibia (Van Der Merwe, 1983) was used to determine the soil type, rainfall, and vegetation for each record in the database. The Times Atlas of the World (1994) was used to find more coordinates as well as the altitude of each location.

A new file was created containing the coordinates for each species and exported to DBase IV in order to produce the distribution maps. A second file was created in which species names were matched with soil types, to determine the preferred soil type for each species. The same was done for rainfall, habitat and altitude. Data were also sorted to establish which other plant species were associated with each of the target taxa.

An ecogeographic conspectus was produced in which the available ecological, geographical and taxonomic data of each species were summarised. Due to the lengthy nature of the conspectus, it could not be included in the article but is available from the author upon request.

RESULTS

The geographical distribution of each of the species is depicted in Figures 1 - 10. From the maps, it is clear that some species are very localized in their distribution. *Sesamum pedalioides* and *S. angustifolium* have very restricted distribution areas in the Kunene and Okavango Regions respectively, while *S. alatum* and *S. triphyllum* have very scattered but widespread distributions. *Sesamum capense* is distributed along the western escarpment from the north to the south of the country. The distributions of *S. schinzianum* and *S. rigidum* overlap in the north-western Namib desert. Although *Sesamum marlothii* is also restricted to the north-western Namib, it does not extend all the way up to the Kunene river. *Sesamum abbreviatum* is restricted to the south-western Namib, while *S. calycinum* is largely confined to the Caprivi strip.

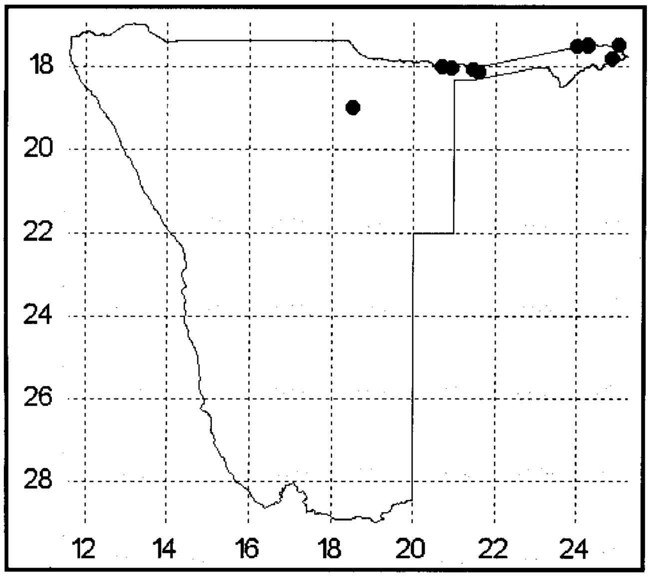

Figure 1. Distribution of *Sesamum calycinum*.

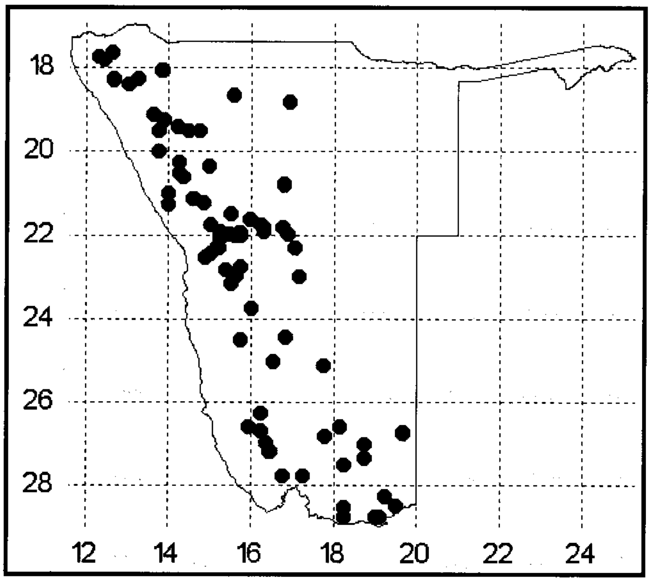

Figure 2. Distribution of *Sesamum capense*.

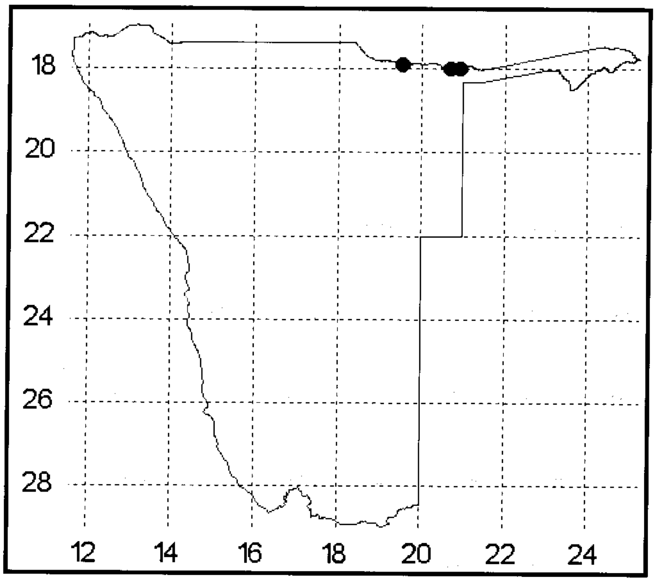

Figure 3. Distribution of *Sesamum angustifolium*.

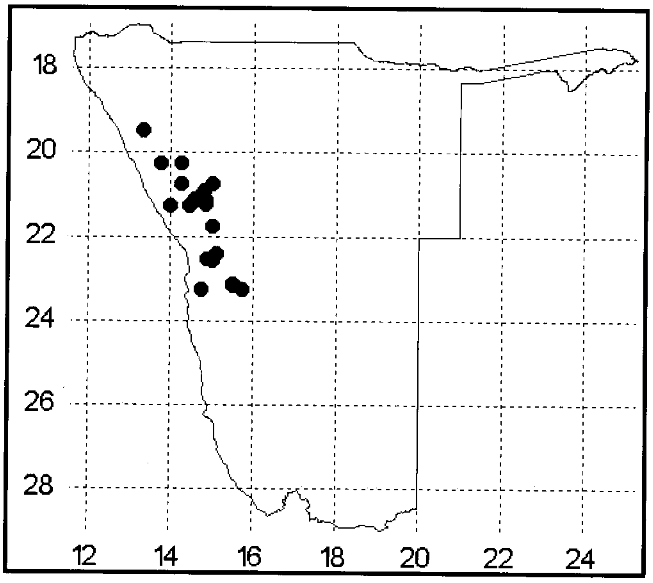

Figure 4. Distribution of *Sesamum marlothii*.

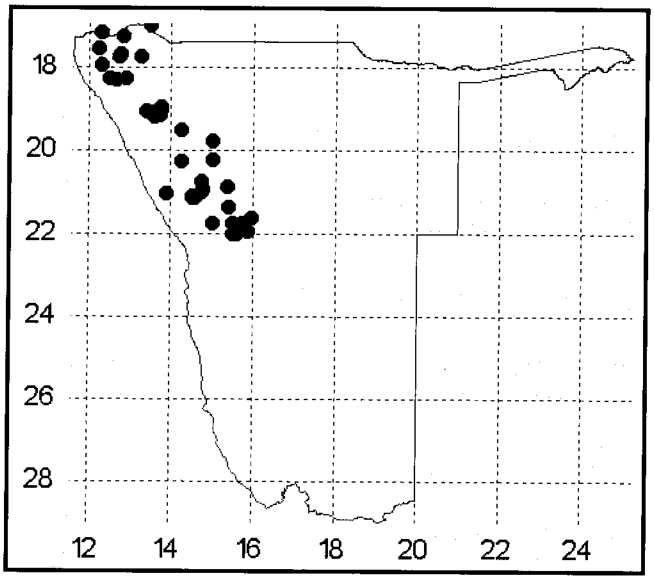

Figure 5. Distribution of *Sesamum rigidum*.

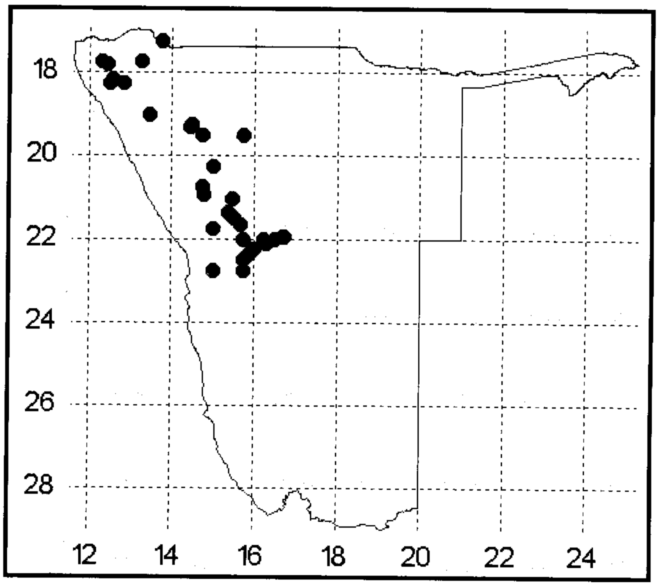

Figure 6. Distribution of *Sesamum schinzianum*.

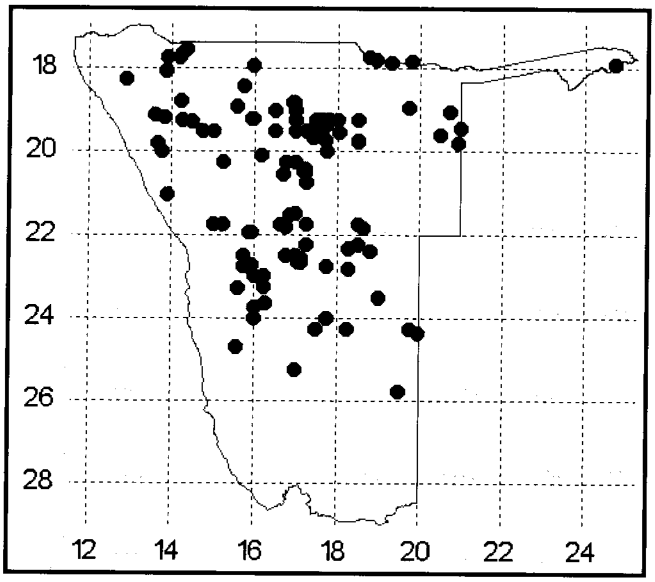

Figure 7. Distribution of *Sesamum triphyllum*.

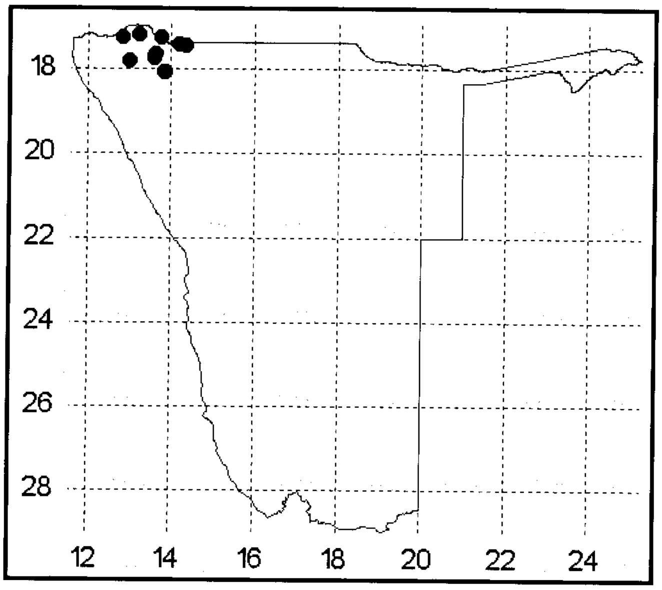

Figure 8. Distribution of *Sesamum pedalioides*.

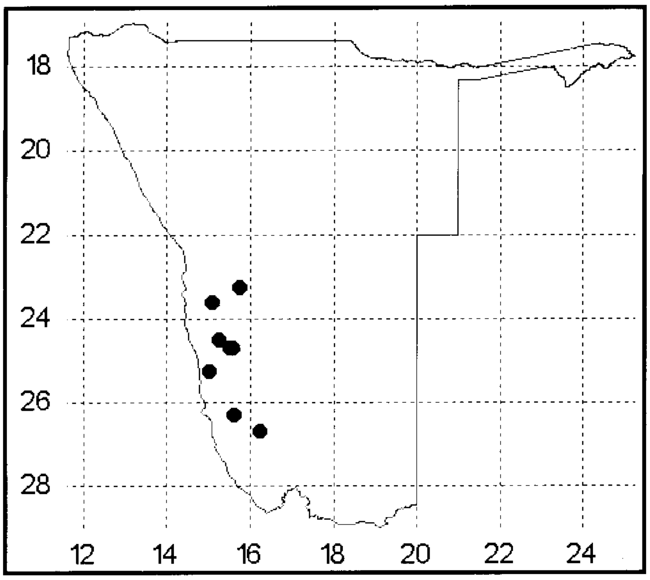

Figure 9. Distribution of *Sesamum abbreviatum*.

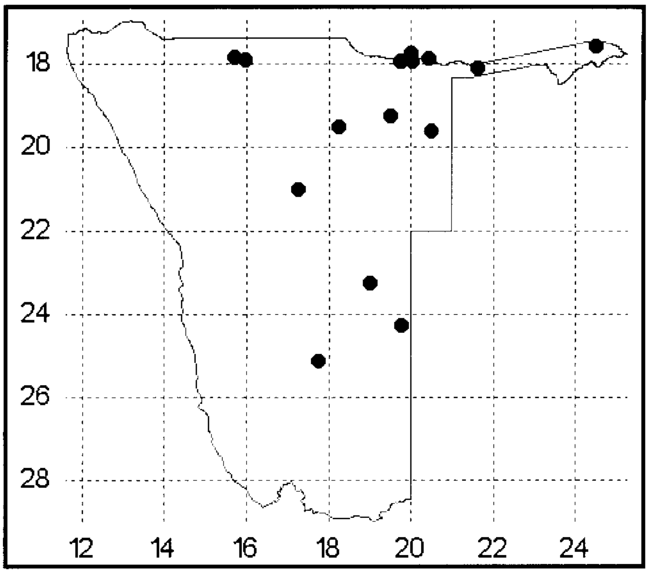

Figure 10. Distribution of *Sesamum alatum*.

The ecological preferences of each of the ten *Sesamum* species encountered during the survey are set out in Table 1. *Sesamum abbreviatum* and *S. marlothii* are endemic to Namibia. The centre of diversity for *Sesamum* species seems to be Angola and Namibia. Most species prefer an altitude of between 500m and 1500m. Lower rainfall areas (0-400mm annually) are preferred to high rainfall areas of up to 800mm annually. Schist, marble, granite and sandy soils are preferred to other soil types. More species inhabit mopane savannah vegetation and semi-desert and savannah transition vegetation than any other vegetation type.

The distribution of *Sesamum* species by rainfall in Namibia is shown in Figure 11. *Sesamum triphyllum* grows throughout the rainfall range. *Sesamum capense* grows in a wide range of rainfall areas, but does not flourish where annual rainfall exceeds 500mm.

Sesamum calycinum and *S. angustifolium* prefer somewhat higher rainfall areas of up to 800mm annually. *Sesamum alatum* also covers a wide range of rainfall ranges from 100mm to 800mm annually. The other species have specific rainfall preferences.

Figure 12 shows the distribution of *Sesamum* species by altitude in Namibia. Most species do not grow in areas with an altitude lower than 200m and altitudes of between 500m and 1500m are clearly preferred.

Table 1. Ecological preferences of *Sesamum* species found in Namibia

Species	Alititude (m) (m)	Rainfall (mm)	Soil	Vegetation and Habitat
S. rigidum	500 — 1500	100 — 300	schist, marble, granite and acid granite	mopane savannah vegetation, semi-desert and savannah transition
S. marlothii	500 — 1000	0 — 300	schist, marble, granite	desert, semi-desert and savannah transition
S. triphyllum	1000 — 1500	300 — 800	sandy soil	highland, mopane, mountain and thornbush savannahs, wide range of habitats
S. pedalioides	500 — 1500	300 — 400	acid granite	mopane savannah
S. alatum	1000 — 1500	400 — 800	sandy soil	woodlands, wide range of habitats
S. capense	1000 — 1500	50 — 300	schist, marble, granite, sandstone	semi-desert and savannah transition, mopane savannah
S. abbreviatum (insufficient data)	200 — 2000	0 — 200	littoral sands, loam, sandstone, schist	Namib desert, succulent steppe, semi-desertand savannah transition
S. schinzianum	1000 — 1500	200 — 400	schist, marble, granite and acid granite	mopane savannah, semi-desert and savannah transition
S. calycinum	500 — 1500	800 — 1600	dark alluvial sand and loam	forest savannah and woodland
S. angustifolium	0 — 1500	800 — 1600	dark alluvial sandy loam and sand	forest savannah and woodland

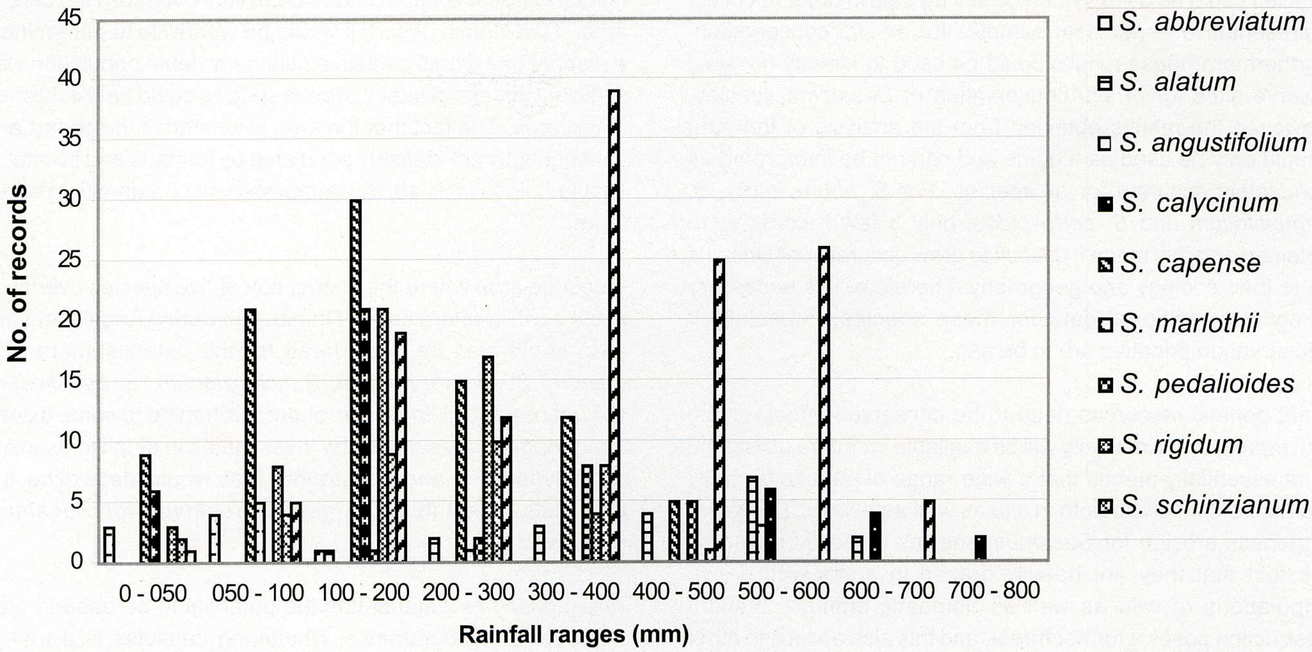

Figure 11. The distribution of *Sesamum* species by rainfall in Namibia.

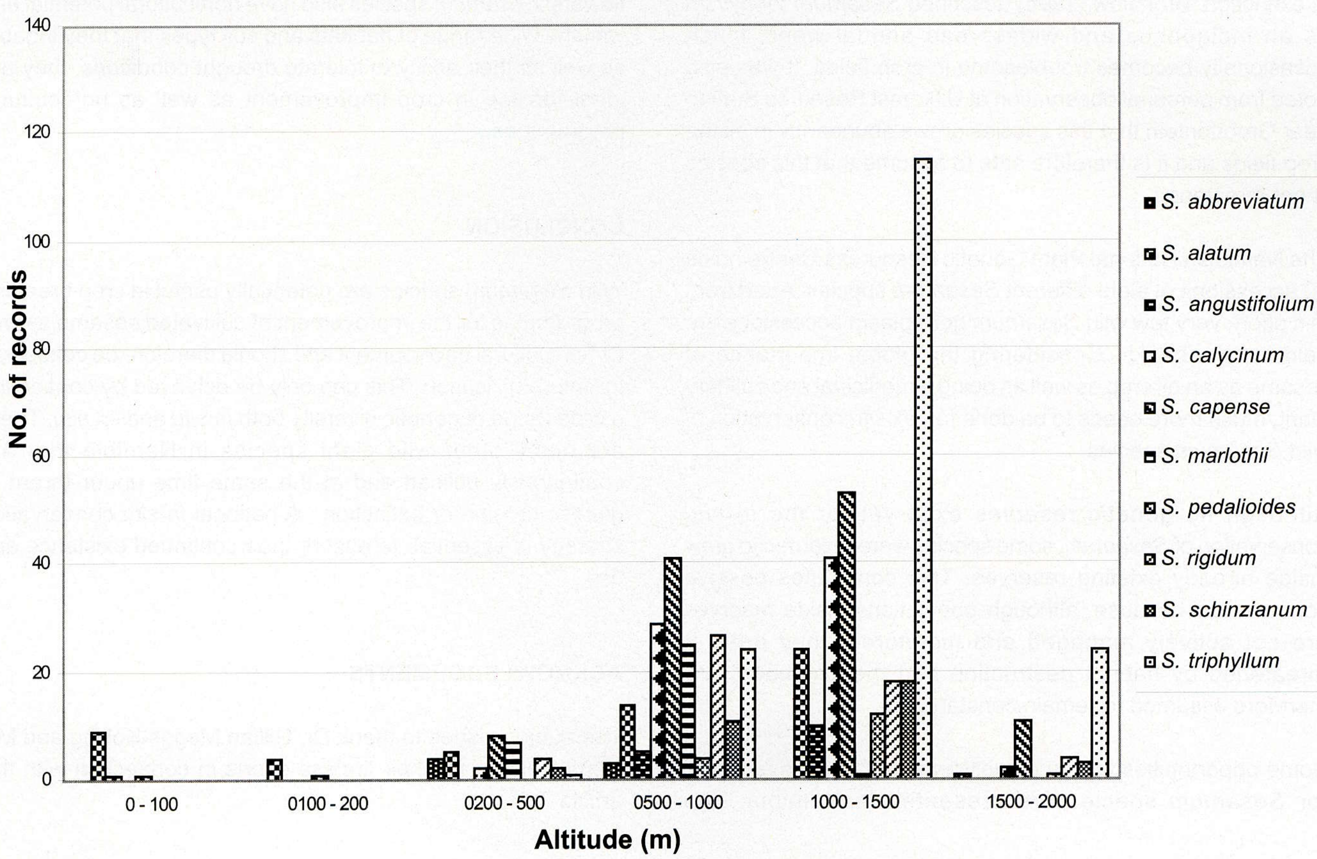

Figure 12. The distribution of *Sesamum* species by altitude in Namibia.

DISCUSSION

The ecogeographic information that was obtained for each species could be used to plan collecting trips in order to collect representative germplasm samples for *ex situ* conservation. Furthermore, these results could be used to identify possible reserve sites for *in situ* conservation of *Sesamum* species. However, the results obtained from the analysis of the data should only be used as a guide and can not be interpreted as completely accurate for all species. For *S. abbreviatum*, *S. angustifolium* and *S. pedalioides,* only a few records were obtained and this made it difficult to draw accurate conclusions as to their ecology and geography. Therefore, it is necessary to collate additional data for these species, especially if conservation priorities are to be set.

Plant genetic resources need to be conserved effectively so that more genetic diversity will be available for future utilisation. That essentially means that a wide range of genetic diversity should be conserved both *in situ* as well as *ex situ.* The threat of genetic erosion for *Sesamum* species is mostly posed by the fact that they are heavily grazed in areas with dense populations of wild as well as domestic animals. Habitat destruction poses a further threat, and this also applies to other plant species. The analysis of the ecogeographic data did not indicate that any of the species are threatened, but further work needs to be done in order to determine the conservation needs of each species. Especially populations of endemic species and species with a restricted distribution in Namibia like *S. calycinum*, *S. angustifolium*, *S. pedalioides*, *S. abbreviatum* and *S. marlothii* should be surveyed to determine if there is a threat of extinction. Bromilow (1995) described *Sesamum triphyllum* as an indigenous and widespread annual weed which occasionally becomes troublesome in crop fields. It was also noted from personal observation at Uitkomst Research Station near Grootfontein that this species grows abundantly in all the crop fields and it is therefore safe to assume that this species is not threatened.

The Namibian National Plant Genetic Resources Centre holds 30 accessions of eight different *Sesamum* species. Apart from this effort, very few wild *Sesamum* germplasm accessions are held in genebanks. Considering the global importance of sesame as an oil crop as well as being a medicinal and culinary plant, much more needs to be done for *ex situ* conservation of wild *Sesamum* species.

Although no genetic reserves exist yet for the *in situ* conservation of *Sesamum*, some species were recorded to grow inside already existing reserves. This constitutes passive conservation because, although populations inside reserves are not actively managed and monitored, they are not threatened by habitat destruction and their numbers are therefore assumed to remain constant.

Some opportunities for the establishment of genetic reserves for *Sesamum* species are presented in Namibia. The distributions of *S. marlothii, S. abbreviatum, S capense, S. rigidum, S. schinzianum* and *S. triphyllum* overlap in the central area of the Namib desert. It would be worthwile to determine if a reserve that would contain a minimum viable population with sufficient genetic diversity of each species could be established in this area. The fact that the area is located in the desert and consequently not densely populated by humans and livestock, should help to facilitate the establishment of a genetic reserve there.

A second area where the distribution of five species overlap is in the north-western part of Namibia bordering Angola and this area could also be considered for the establishment of a reserve. *Sesamum rigidum, S. schinzianum, S. pedalioides, S. capense* and *S. triphyllum* share this habitat to some extent. The proposed sites should be investigated in detail to examine the advantages and constraints that would determine the feasibility of establishing genetic reserves for *Sesamum* species.

Wild *Sesamum* material has the potential to be used in crop improvement programmes. Shattering capsules is a trait of *Sesamum* species, including the cultivated species, which causes a reduction in yield because many seeds are lost in this manner. By evaluating material from wild populations, a gene responsible for non-shattering capsules may be found, which could then be transferred to *S. indicum.* This would require the collection and safekeeping of a wide range of genetic diversity. With their rather conspicuous lilac, pink or white flowers, *Sesamum* species also have horticultural potential and with the wide range of habitats and soil types that they inhabit, as well as their ability to tolerate drought conditions, they are ideal for use in crop improvement as well as horticultural programmes.

CONCLUSION

Wild *Sesamum* species are potentially useful in crop breeding programmes for the improvement of cultivated sesame as well as horticultural development and should therefore be conserved for future utilisation. This can only be achieved by conserving a wide range of genetic diversity both *in situ* and *ex situ*. There are many other wild plant species in Namibia that are continuously utilised and at the same time under threat of genetic erosion or extinction. A national *in situ* conservation strategy is essential to ensure their continued existence and use.

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REFERENCES

BROMILOW, C. 1995. Problem plants of South Africa. Briza publications, Goodwood.

CRAVEN, P. 1999. A checklist of Namibian plant species. Southern African Botanical Diversity Network Report no. 7. SABONET, Windhoek, Namibia.

LAUNERT, E. 1988. Pedaliaceae (no. 125). In: Launert, E. (ed.), Fl. Zambesiaca 8,3. pp. 97-106. Flora Zambeziaca Management Committee, London.

MABBERLEY, D.J. 1997. The Plant Book, 2nd ed. Cambridge University Press. Cambridge.

MAXTED, N., B.V. FORD-LLOYD and J.G. HAWKES. 1997. Plant genetic conservation: The *in situ* approach. Chapman & Hall, London.

SMARTT, J. and N.W. SIMMONDS. 1995. The evolution of crop plants. 2nd ed. Longman, Essex.

Times Atlas of the World. Comprehensive Edition. 1994. 9th ed. Times Books, London.

VAN DER MERWE, J.H. (ed.) 1983. National Atlas of S.W.A. (Namibia), National Book Printers, Goodwood.