CHARACTERISATION AND EVALUATION OF COLLECTIONS OF SCARLET EGGPLANTS (*SOLANUM AETHIOPICUM* L.) FROM THE VEGECULTURE AREAS OF WEST, CENTRAL AND EAST AFRICA

A thesis presented to the Faculty of Science
in partial fulfilment of the requirements
for the degree of Master of Science

by

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DEDICATION

This thesis is dedicated to my son, Derek,who narrowly escaped death from a gunman when I was away carrying out this study.

ACKNOWLEDGEMENTS

I would like to express my gratitude to Professor J.A. Callow for giving me an opportunity to undertake this study.

I am especially grateful to my Government for nominating and giving me permission to attend this course. I am also grateful to the International Board for Plant Genetic Resources for the financial support rendered during my study.

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ABSTRACT

Scarlet Eggplant seeds (Solanum aethiopicum L.) from some West African countries, particularly Ghana and Togo, had been collected under the auspices of the International Board for Plant Genetic Resources (IBPGR). Some other seeds had been obtained from Uganda and other African countries.

A total of forty-four accessions of Solanum aethiopicum groups Gilo, Kumba and Shum and S. anguivi Lam were grown for characterisation and evaluation. A study of these collections was made using morphological and biochemical characters. Seventy-four vegetative and floral characters were recorded on each accession. The collected data were subject to Cluster Analysis and Principal component Analysis for numerical Taxonomy. The numerical taxonomy studies showed that species, groups and accessions could be identified by such means. Some morphotypes or cultivars can be differentiated. S. aethiopicum was shown to have a wide range of genetic diversity.

Five accessions belonging to groups Gilo and Shum were subjectively selected for studies of variations between and within accessions. Analysis of variance indicated that some characters could be used to differentiate accessions or cultivars, but not groups or species.

Leaves of different accessions, groups and species were analysed for amino acids, alkaloids and flavonoids. The results revealed that flavonoids are not good characters for differentiating the taxa under investigation. Higher amounts of essential amino acids were present than those found in other leafy vegetables like broccoli, cabbage and lettuce, but comparable to those in spinach. Alkaloid content in different accessions, groups

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or species did not show much consistent pattern.

Enzyme-etched seeds were used for scanning electron Microscopy (SEM). Differentiation was shown to be possible only between some species, but not between groups or accessions of S. aethiopicum.

Crosses between groups Gilo, Shum and Kumba were made. Fruit formation took place but study of the F_1 progeny will be necessary to confirm the interfertility of these taxa.

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1. INTRODUCTION

1.1. General Introduction

The family Solanaceae embraces 84 genera and almost 3,000 species which occur on every vegetated continent in the world (D'Arcy, 1979). *Solanum* is a very large and important genus in the Solanaceae, containing about a half (Attavian et al, 1983) to three-fourths (Gunn, 1974) of the species in this family and is mostly American in distribution (Simmonds, 1979).

The family had its origin in Central and South America, where about 40 genera are endemic. Some *Solanum* species including *S. aethiopicum* are of African origin (Harlan, 1975). The other centre of origin for *Solanum* species is Australia (Niakan, 1980). Crops of economic importance among *Solanum* sp. are potato (*S. tuberosum* L.) and eggplant (*S. melongena* L.). About 100 species of *Solanum* are native to Africa (Jaeger and Hepper, 1983, cited by Lester and Niakan, 1983). The most important crop plants among the *Solanum* species of African origin are *S. aethiopicum* L., *S. macrocarpon* L. and *S. scabrum* Mill.

1.2. Taxonomy of the Solanum species used in the current work

The basic chromosome number of *Solanum* is $x = 12$, and the majority of the species are diploid ($2n = 2x = 24$) (Niakan, 1980). Although potatoes (*Solanum tuberosum*) are the best known crop species of *Solanum* they are peculiar in bearing tubers, being mostly polyploids, and in other ways. The vast majority of *Solanum* species, including the eggplants are diploid ($2n = 2x = 24$).

The eggplants, S. aethiopicum, S. macrocarpon and S. melongena form a complex of species. Whereas it is fairly easy to distinguish members of the eggplant complex from other Solanum species, it has been difficult to establish the taxonomic limits, status and nomenclature of the taxa belonging to the eggplant complex, due in part to the anthropogenic factors involved with the introduction of the wild taxon into cultivation and the existence of weedy forms, and the genotypic variability and phenotypic plasticity of Solanum species (Pearce and Lester, 1979).

Groups of Solanum species have been gathered into sections and series (Niakan, 1980 and Teixeira, 1982) but still with some incongruity. In Lester and Niakan (1983) effort has been made to clarify some of the confusion arising from the earlier taxonomy and nomenclature of the eggplant complex, especially species of series Afroindica and Aethiopica of Section Oliganthes. In Table 1 a taxonomic classification of the Solanum species used in the present work is given.

Bitter (1923) examined the composition of the series Aethiopica of Section Oliganthes and series Melongena of Section Andromonoecum whereby several species were recognised, after Dunal (1852) had comprehensively looked at the genus Solanum. Both Dunal (1852) and Bitter (1923) looked on the hairiness and prickliness of the leaves of these species as some of the major morphological characters that were useful in their classification. Dunal relied heavily on the presence or absence of prickles for separating groups of species.

Pearce (1975) conducted a series of investigations on crossabilities among S. aethiopicum, S. gilo, S. integrifolium and S. olivare. She carried out pollen stainability studies of the F_1 and F_2 which were

observed to be between 68% and 99%. On the basis of these findings and other studies she concluded that these taxa should be relegated to four infra-specific categories within a single species (Lester and Niakan, 1983). Other workers like Omidiji (1975, 1979 and 1982) have, after several studies, concluded that there are no genetic barriers among the species of the Series Aethiopica. As such, there is no justification for according these species distinct specific status in the absence of reproductive barriers restricting gene flow between them. Lester and Niakan (1983) have asserted that Solanum aethiopicum L., S. gilo Raddi, S. integrifolium auctt. non. Poir and S. olivare Paill. et Bois all comprise a single domesticated species which should be known as Solanum aethiopicum L. They suggested that four main groups of cultivars may be recognised mainly S. aethiopicum L. Group Gilo to represent S. gilo Raddi including S. olivare Paill. et Bois, Group Shum to represent S. aethiopicum L. according to Bitter (= S. zuccagnianum Dun.), Group Kumba to represent S. aethiopicum L. according to Dunal, and Group Aculeatum corresponding to S. aethiopicum L. var. aculeatum Dun., S. texanum Dun., S. integrifolium auctt. non. Poir and probably Mala Aethiopica of Dodoens. It has also been suggested that S. anguivi is the progenitor of S. aethiopicum although there has been disruptive selection separating S. anguivi and S. aethiopicum. Phenotypic plasticity in Solanum is also remarkable, particularly in growth habit, leaf shape and colour, and prickliness, so much so that at different stages of growth, different parts of the same plant may be so diverse as to appear to belong to distinct species (Teixeira, 1982).

In my study, I have followed the grouping of S. aethiopicum L. namely Groups Gilo, Kumba, Shum and Aculeatum.

1.3 Distribution and Uses of S. aethiopicum L.

S. aethiopicum is cultivated in tropical Africa, especially in most countries of West Africa (Ghana, Nigeria, Upper Volta, Togo, Benin, Ivory Coast and Sierra Leone to mention but a few) and Eastern and Central Africa (Uganda, Kenya, Zimbabwe and Zaire). Different Groups of S. aethiopicum (Groups Shum, Gilo and Kumba) are grown for several purposes in various countries, but they are basically cultivated for their edible leaves and fruits. Group Shum is grown for its edible leaves, Group Gilo for its edible fruits while Group Kumba is for both fruits and leaves (Figures 1,2&3).

In Uganda, the leaves of Shum (Nakati) are steamed with the cooking type of bananas (matooke) or cooked in a pot after which they can be mixed with Sesame and salt. The fruits of Gilo on the other hand are placed in banana leaves and cooked with the bananas (matooke). When ready, they are mashed in a pot and cold water added and salted (Uganda Department of Agriculture Publication, 1974). The fruits can then be mixed with fried Sesame, fried onions or groundnut sauce. In other cases the fruits are sliced and boiled. The mode of preparation of the leaves and fruits within Uganda varies from region to region. In most areas where the african eggplants are eaten, they are harvested before the edible parts are physiologically mature.

1.4 Genetic Resources of Eggplants

The term 'eggplant' is commonly used for various plants which are otherwise called aubergine, brinjal, garden egg, melongene, gilo, scarlet eggplant, tomatoe fausse and many other names in diverse languages. Nomenclatural confusion also abounds in the scientific names of these

Figure 1: Fruits of Groups Gilo and Shum.

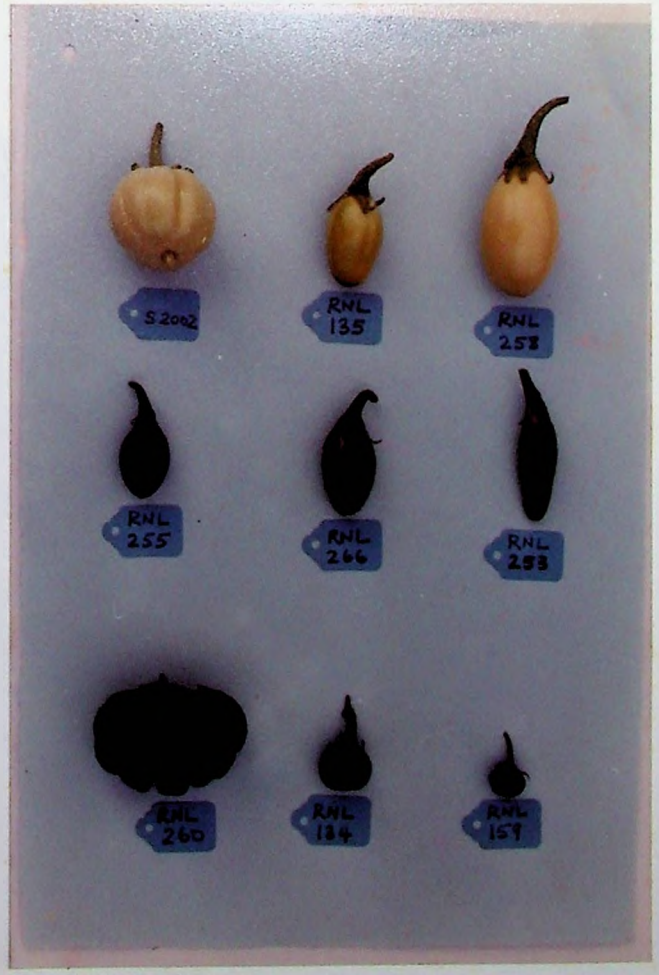


Figure 2: Fruits of Groups Gilo, Shum and Kumba.

Figure 3(a): Shum plant (RNL 159) growing outdoor.

Figure 3(b): Gilo plant (RNL 317) growing outdoor.

taxa and the names are frequently misused (Choudhury et al, 1983). Eggplants are cultivated in most tropical and sub-tropical areas. They, however, grow very well in the wet tropics.

The fruits of eggplants have a somewhat lower nutritional value than those of tomatoes. The intake of eggplant fruits per meal may be relatively high, up to 200gm/caput (IBPGR, 1977b). The eggplant is an important vegetable in central, south and south-east Asia and also in some countries of Africa. Primitive cultivars of S. melongena and other eggplant species in all tropical countries are being rapidly replaced by more advanced, high yielding S. melongena cultivars. The International Board for Plant Genetic Resources (IBPGR) has recommended the collection of other eggplant species for use in breeding and materials should be screened for the presence of genes for disease and pest resistance. Breeding work on eggplant species other than S. melongena is either scarce or non-existent, except for some testing of local cultivars of S. macrocarpon and S. incanum in the Ivory Coast and Ghana, screening of S. macrocarpon, S. aethiopicum to diseases in Nigeria and testing of local cultivars of S. quitoense in S. America (IBPGR, 1977b).

One of the objectives of IBPGR is the collection, conservation and evaluation of plant genetic resources with particular reference to species of major economic importance and their wild and cultivated relatives. West Africa is considered to be the centre of diversity of scarlet eggplant (Harlan, 1975). As already point out, species of Series Aethiopica are very important vegetable crops in Ghana, Nigeria, Ivory Coast, Upper Volta, Benin, Togo, Cameroon, Zambia, Malawi, Tanzania, Kenya, Uganda, Madagascar, Zaire, Rwanda, Mozambique and Zimbabwe (IBPGR, 1977b) and other African countries of lowland areas. Realising the importance of the eggplants in these countries, the IBPGR has organised

collection missions to counteract the growing threat of global genetic erosion. The collected plant materials need to be characterised and evaluated and the information provided to plant breeders and agronomists, the potential users of these genetic resources.

1.5 Morphological and biochemical characters

In order to be able to recognise and identify species and cultivars of a crop plant, it is important to have standardised descriptors. Morphological and biochemical characters have been used to describe the attributes of plant materials collected from their centres of diversity and elsewhere which are currently being kept in genebanks. Understanding of the taxonomic relationships between taxa is of vital importance especially to plant breeders who improve the quality of these crop plants. As Harlan puts it (Harlan, 1975), genetically domesticated races belong to the same biological species as their wild progenitors and are fully compatible with them when hybridised. The need for some system of classification is absolute, for it is only by first naming organisms and then grouping them in recognisable categories that one can begin to sort out and understand the vast array which exists (Stace, 1980).

Methods for computer-assisted data processing require that the information about individual accessions should relate to characteristics (descriptors) and their states. This secures a quick and efficient transfer of data into machine-readable form, space-saving storage of the information and the rapid and selective retrieval of data (IBPGR, 1977a). However, the development of effective international communication of data and information on plant genetic resources will be greatly facilitated if standardisation of the descriptive terminology can be agreed upon. Production of descriptors for most crops of economic importance is underway by the IBPGR. The descriptors for Eggplants are being produced

this year (Choudhury et al, 1983). The production of these descriptors is based on the morphological characters of these crop plants, but the knowledge of their biochemical characters is supplementary. In rice, for instance, both morphological and biochemical characters have been incorporated in the formulation of descriptors (IBPGR, 1980).

1.6 Aims of the present work

This research project was aimed at growing, characterising and evaluating collections of African eggplants (Solanum aethiopicum L. Bitt.) from the vegeculture areas of west and central Africa and making investigations into the relationships between and within African eggplants using morphological and biochemical characters. The information accruing from the study of the variation between and within accessions would be used to foster the current descriptors for Eggplants and the recognition of cultivars.

Table 1 Taxonomic classification of Solanum species relevant to the present work

(Modified from Niakan, 1980 and Bitter, 1923)

Taxon	Distribution	Relevance to present work
Subgenus Leptostemonum (Dun.) Bitt.		
Section Oliganthes (Dun.) Bitt.		
Series Afroindica Bitt.		
1. S. anguivi Lam.		
(= S. indicum (l.p.pt.) Nees)	Africa (Madagascar)	Wild species thought to be the progenitor of S. aethiopicum
Series Aethiopica Bitt.		
1. S. aethiopicum L. Group Shum	Africa	Cultivated species for its edible leaves and fruits
(= S. zuccagnianum Dun.)		
2. S. aethiopicum L. Group Gilo	Africa	Cultivated species for its edible fruit
(= S. gilo Raddi, S. Olivare Paill, and Bois)		
3. S. aethiopicum L. Group Kumba	Africa	Cultivated species for its edible leaves and fruits
(= S. aethiopicum L. sensu Dunn.)		
4. S. aethiopicum L. Group Aculeatum	Mauritius	Cultivated for its edible fruits
(= S. integrifolium auct. non Poir.)		
Section Andromonoecum Bitt.		

Table 1 continued

Series Incaniformia Bitt		
sub-series Melongena (Dun.) Bitt.		
1. S. melongena L.	India, China, S.E. Asia.	Cultivated for its edible fruit
Series Macrocarpa Bitt.		
S. macrocarpon L.	Tropical Africa	Cultivated for its edible leaves and fruits

2. MATERIALS AND METHODS:

2.1. MATERIALS:

2.1.1. Cultural practices:

Seeds of eggplants used during the study were obtained from the Birmingham University Solanaceae Collection and the International Board for Plant Genetic Resources (IBPGR) Collection. There were forty-four accessions in all although they later became forty-seven operational taxonomic units (OTU's) for numerical taxonomy. The plant materials used were mainly belonging to Solanum aethiopicum Groups Shum and Gilo (Table 1). The seeds had been collected under the auspices of the International Board for Plant Genetic Resources (IBPGR) from Togo, Benin and Ghana. A few were obtained from Uganda. These had their unique identifiers as RNL numbers (for example RNL 135). Two of the accessions used were actually from the Birmingham University Solanaceae Genebank and had 'S' numbers as their accession numbers (eg. S.2004). In both cases the collection numbers were maintained. (Table 2)

Twenty seeds of each accession were sown at the end of March 1983 in John Innes Potting Compost No.2 in 3½ inch plastic pots. The pots were kept moist by capillarity. A black polythene sheet was used to cover the soil until the seeds germinated. The sheet kept the soil surface moist and prevented algal growth that was otherwise forming a hard pan on the soil surface and thus interfering with the germination of the seeds. The glasshouse was kept warm at temperatures of around 15^{o}-20^{o}C.

About three weeks after sowing, five seedlings of each accession were pricked out into 3½ inch plastic pots containing John Innes

Compost No.2 and the seedlings were kept in the same glasshouse. After five weeks the seedlings were transferred to a Dutch lights glasshouse, which was not heated, for acclimatisation. Two weeks later they were planted out in the large M.Sc. glasshouse. Planting was in triple rows at a spacing of 18 inches (45cms) between the triple rows, 15 inches (37.5cms) between the rows and 9 inches (22.5cms) between plants within the rows (Figure 4). Each row comprised 10 plants, five per accession.

The plants were surface irrigated, using plastic tubes, throughout the growing period. Regular sprays and fumigations were administered to control pests especially whiteflies, lepidopterous caterpillars, aphids and red spider mites, as shown in Table 3. During the plants' growing period the glasshouse temperature had a minimum of 12°C and a maximum of 44°C. The plants showed a rapid growth as the temperature in the glasshouse was above 20°C most of the time.

The maximum plant height attained in the glasshouse by the termination of record taking was 1.7 metres as compared to 66cms for those plants growing in the open. No artificial fertilizers or manures were applied to the plants during the growth period.

Duplicate plant materials of the same accessions were raised for outdoor planting. Five seedlings of each accession were pricked out in 3½ inch plastic pots containing John Innes Potting Compost No.2. During the second week of June, these plants were transferred to a cold frame for acclimatisation before they were planted out in the field two weeks later. Spacing was at 3ft (90cms) between the rows and 2ft (60cms) between plants within the rows. The plants showed good growth as the summer temperatures were generally higher than those experienced

Table 2 : Solanum accessions used in the present work

Accession Number	Collector Number	Collector Name	Country of origin	Collector Identity	Correct Identity
RNL 011	BE 015	Holloway, Lester, Ayensu	Benin	S. gilo	S.a. Gilo
RNL 134	TO 199	Holloway & Teresa	Togo	S. aethiopicum	S.a. Shum
RNL 135	TO 200	Holloway & Teresa	Togo	S. gilo	S.a. Gilo
RNL 159	-	Bukenya	Uganda	S. aethiopicum	S.a. Shum
RNL 165	-	Bukenya	Uganda	S. gilo	S.a. Gilo
RNL 166	-	Bukenya	Uganda	S. gilo	S.a. Gilo
RNL 168	-	Bukenya	Uganda	S. gilo	S.a. Gilo
RNL 228	GH 207	Holloway & Adu	Ghana	-	S.a. Gilo
RNL 229	GH 210	Holloway & Adu	Ghana	-	S.a. Gilo
RNL 242	GH 227	Holloway & Adu	Ghana	S. gilo	S.a. Gilo
RNL 245	GH 230	Holloway & Adu	Ghana		S.a. Gilo/S. anguivi
RNL 252	GH 242	Holloway & Adu	Ghana	S. gilo	S.a. Gilo
RNL 253	GH 243	Holloway & Adu	Ghana	S. gilo	S.a. Gilo
RNL 254	GH 244	Holloway & Adu	Ghana	S. gilo	S.a. Gilo
RNL 255	GH 245	Holloway & Adu	Ghana	S. gilo	S.a. Gilo
RNL 257	GH 253	Holloway & Adu	Ghana	S. gilo	S.a. Gilo
RNL 258	GH 254	Holloway & Adu	Ghana	S. gilo	S.a. Gilo
RNL 260	GH 258	Holloway &Adu	Ghana	S. gilo	S.a. Kumba

Table 2 continued

RNL 266	GH 277	Holloway & Lartey	Ghana	S. gilo	S.a. Gilo
RNL 270	GH 285	Holloway & Lartey	Ghana	S. gilo	S.a. Gilo
RNL 271	GH 286	Holloway & Lartey	Ghana	S. gilo	S.a. Gilo
RNL 273	GH 288	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo/S. anguivi
RNL 285	GH 306	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo
RNL 286	GH 30&	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo
RNL 288	GH 310	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo
RNL 290	GH 313	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo near Kumba
RNL 292	GH 318	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo
RNL 293	GH 319	Holloway, Lartey & Asare	Ghana		S.a. anguivi/S.a. Gilo
RNL 294	GH 320	Holloway, Lartey & Asare	Ghana		S.a. Gilo/S. anguivi
RNL 296	GH 322	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo
RNL 297	GH 323	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo
RNL 300	GH 328	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo
RNL 302	GH 334	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo
RNL 304	GH 337	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo
RN1 307	GH 346	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo
RNL 308	GH 347	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo
RNL 309	GH 348	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo
RNL 310	GH 350	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo
RNL 314	GH 354	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo

Table 2 continued

RNL 315	GH 355	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo
RNL 316	GH 356	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo
RNL 317	GH 357	Holloway, Lartey & Asare	Ghana	S. gilo	S.a. Gilo
S. 2002	-	Omidiji	Nigeria	S. gilo	S.a. Gilo (almost Kumba)
S. 2004	-	Omidiji	Nigeria	S. gilo	S. anguivi/S.a. Gilo

Figure 4: Spatial arrangement of the plants in the MSc glasshouse.

Table 3 Spraying dates, chemicals and pests being controlled.

Spraying Dates	Chemicals	Pests sprayed against
30/6/83	Diptrex 80	Caterpillar (tomato moth)
7/7/83	Pirimor	Aphids
18/7/83	Acetellic	White fly
29/7/83	Rogor E	Red spider mites
5/8/83	Moristan	Red spider mites
19/8/83	Pynosect	White fly
19/8/83	Moristan	Red spider mites
22/8/83	Pirimor	Aphids

in previous years. Unlike the plants in the glasshouse, these plants did not suffer from insect attack and as such they were not sprayed with insecticides.

2.2 METHODS:

2.2.1. Study of morphological characters:

2.2.1.1. Evaluation:

The relative usefulness of different kinds of taxonomic data depends on the extent to which they reflect the morphological distinction of the various taxa. The materials used for the study of morphological characters were the plants grown in the M.Sc. glasshouse. Seventy four morphological characters were recognised and defined as shown in Tables 4 and 5 from cotyledon, leaf and stem, leaf hairs and inflorescence. These were based on the studies made by Niakan (1980), Teixeira (1982) and the current Descriptor List for Eggplants by Lester and Niakan and being published by the International Board for Plant Genetic Resources (Choudhury et al. 1983). Twenty-eight characters were added to the forty-six used by Teixeira (1982) bringing the total to seventy-four. Due to shortage of time, it was not possible to include the fruit characters, which were, however, represented by the carpel numbers. Observations on morphological characters were both at seedling stage and at flowering time between the second and fifth inflorescence.

Plant height, breadth and branch number were recorded just before the termination of record taking in August as these characters were continuously changing as the plants grew further. From the characterisation studies, it was possible to re-identify some accessions as shown in Table 2.

2.2.1.2 Numerical Taxonomy:

The same 74 characters which were used for evaluation were used for numerical taxonomy. Most characters were continuous variables although some were ordered or disordered multistate characters which were coded as well as possible. Shape differences were evaluated where appropriate by using ratios of two measurements. Measurements were standardised to a mean of zero and a variance of unity. The analysis was by Principal Component Analysis and by cluster analysis by Euclidean distance squared and Ward's clustering using the CLUSTAN II computer package (Wishart 1978 and 1982).

2.2.1.3 Variation between and within accessions:

During the study of variation between and within accessions five accessions were used (RNL 134, RNL 166, RNL 308, RNL 317 and S.2004). Some 22 characters of leaf and flower morphology were used, which included some shape measurement ratios as shown in Table 8. For each accession 5 plants were used as replications and two measurements of each character per plant were taken as duplicates thus constituting a split-plot design. As this study was superimposed on the set-up for the morphological studies, it was not possible to randomise these plants in the glasshouse as would have been required.

Whereas all the five accessions belong to the species Solanum aethiopicum, they however can be separated into two main groups namely Shum and Gilo. The Shum Group was represented by RNL 134, which has glabrous leaves and generally smaller plant habit than Gilo, and the rest of the accessions belonged to Group Gilo. It was found later, during the morphological studies, that although the accession S.2004 generally belonged to Group Gilo, it has some characteristics of S. anguivi. The Group Gilo was more typically represented by accessions

RN1 166, RNL 308 and RNL 317.

The analysis of results was carried out using the split-plot design analysis. The rows represented plots and blocks while sub-plots were represented by columns. Rows were equal to accessions, columns equal to plants and blocks or duplicates represented the leaves or individual characters being analysed. Two types of analyses were involved. The first one involved analysing the data for all the five accessions together while the second excluded RNL 134 and S.2004 leaving the 3 typical Gilo accessions. The analyses were made using a two-way classification method by a computer.

2.2.1.4 Herbarium material:

Mature leaves and flowering shoots were taken in duplicate from all accessions grown in the glasshouse. The plant parts were cut using a sterilised scapel as an effort to prevent a possible spread of viruses from plant to plant during successive cuts. These cut materials were labelled and placed between newspaper sheets, cushioned with polyurethane foam and pressed at a temperature of 40^{o}-50^{o}C with fan ventilation for forty-eight hours. They were then stored so that future workers can check the authenticity of the material investigated and to provide a direct comparative method of identification that is possible by no other means.

2.2.1.5 Scanning Electron Microscopy (S.E.M.) of Enzyme-Etched Seeds

The study was geared at investigating some seed characteristics of Solanum aethiopicum. Five seeds of each of five accessions in the Groups Gilo, Shum and Kumba were used.

The seeds were soaked in distilled water for two hours. The seeds were washed twice with distilled water and the water drained off.

The seeds were put in glass vials in 1 cm^3 aliquots of 1.0% Dryselase enzyme (Fluka) in distilled water (Lester and Durrands, 1983). The vials were kept in a stirred water bath at 30°C for twenty-four hours after which the seeds were washed with distilled water. They were given a second treatment for twenty-hours, thus preparing them for the first Scanning Electron Microscopy. A week later, the remaining seeds were given another treatment for thirty-six hours for the final Scanning Electron Microscopy using a Cambridge S600 Stereoscan SEM with 0KV accelerating voltage.

2.2.1.6 Regeneration:

Controlled self and sib-pollinations were made within most of the accessions with the help of a technician. The eggplants are self-pollinating. The flower buds were bagged to avoid cross-pollination. Pollen was collected either from the same flower or flowers on the same plant or accession onto a microscope slide and applied on the bagged flower buds as they were opening. There was no need for emasculation, especially in cases where the stigmas were fully exserted. The selfed flowers were labelled. Only the first flower bud on each inflorescence was chosen for selfing. This was based on the understanding that the first bud on each inflorescence is always hermaphrodite whereas subsequent buds might be functionally male.

2.2.1.7 Crossability studies:

Crosses were made between S. aethiopicum Group Gilo and both Group Shum and Group Kumba. All pollinations were made in the glasshouse. Emasculations were made at the late bud stage. Anthers were removed with forceps by opening the corolla tube from one end.

Pollen grains were taken from freshly opened flowers of the desired male parent by tapping the anthers on a glass slide and transferred

to the stigmas. Pollinations were done immediately after emasculation. The pollinated flowers were labelled and bagged with transparent cellophane bags. The bags were closed with paper clips to avoid foreign pollen contaminating the already pollinated stigmas. As soon as the fruits formed, the bags were removed.

2.2.2. Study of biochemical characters:

2.2.2.1 Chromatography of leaf phenolics:

Because of the weekly spraying of the plants to control insect pests and mites in the glasshouse which would affect the chemical analyses, the leaves for this study were picked from the plants growing outside in the open which had not been sprayed at all (because no pest and disease problems were encountered).

The leaves were collected in brown paper bags and dried in a forced-air oven at 40^{o}-50^{o}C for 48 hours. About 1gm of crushed leaf material was put in a sealed vial and covered with 0.5% HCl in methanol. The material was soaked overnight away from light, to extract.

Two dimensional chromatography was carried out on 25 x 25cm sheets of Whatman No.1 filter papers. The leaf extract was applied to the origin from a fine pipette until it filled the 1.5cm diameter circle, then dried. This was repeated 4-5 times. The papers were clipped in the Shandon holder and run in the first solvent of butan-1-ol: acetic acid: water in the ratios of 3:1:1 for 11-12 hours. The papers were then dried, after which they were run in the second solvent of 15% $^{v}/v$ acetic acid for two hours. The papers were again dried.

The ten chromatograms (5 of S. aethiopicum Groups Shum and Gilo and 5 of S. macrocarpon) were examined both in ultra violet light and in ultraviolet light with ammonia fumes. Any visible spots were circumscribed and their colours identified. The presence and the strength of each spot in each accession was recorded.

A master chromatogram was drawn for the two species together (Figure 5:). The Rf values for each spot was measured (Table 10).

2.2.2.2. Amino acid analysis of the leaves and fruits:

Samples for amino acid analysis were taken from leaves and fruits of the accessions grown in the field to avoid chemical contamination from the sprays which had been administered on the accessions growing in the glasshouse. The accessions used represented Solanum aethiopicum Groups Gilo, Shum, Kumba, S. macrocarpon Groups Macrocarpon and Dasyphyllum and S. incanum. The leaves and fruits were picked and dried in a forced air oven at 45°C for 24 hours. The dried materials were ground to a fine powder in glass vials.

The samples were sent to the Macromolecular Analysis Service at the University of Birmingham. Approximately 80mg of each sample were hydrolysed under vacuum in about 2.5 cm^3 of constant boiling HCl at 110°C for 24 hours. The samples were diluted with water and loaded directly onto a Locarte automatic amino acid analyser. The amino acids were separated on a strong cation exchange resin and visualised using ninhydrin.

2.2.2.3. Alkaloid analysis of the leaves

Solasodine is an important steroid alkaloid glycoside. It is important for the pharmaceutical industry for the production of steroid drugs for medical purposes especially for relieving skin inflammation.

Immature, young leaves of Solanum aethiopicum L. Groups Gilo, Shum, Kumba, S. anguivi, S. macrocarpon and S. melongena were analysed using Chandler's method (Chandler, 1981) but modified by Legg (pers. communication).

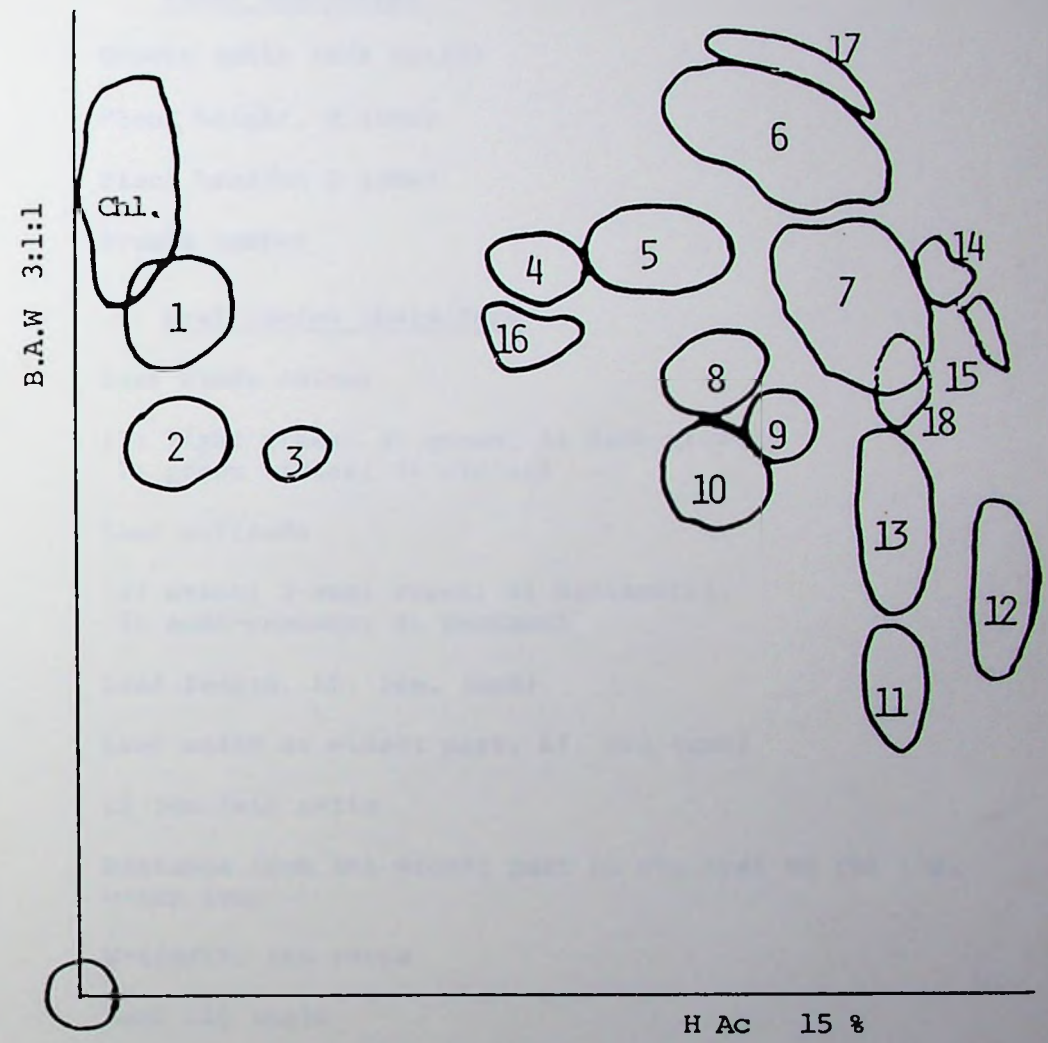


Fig.5. Master chromatogram

Table 4 : List and definitions of the morphological characters

(A = characters recorded and analysed by numerical taxonomy)

A

Plant characters

1. Growth habit (H/B ratio)
2. Plant height, H (cms)
3. Plant breadth B (cms)
4. Branch number

Leaf lamina characters

5. Leaf blade colour

   (1: light green; 3: green; 5: dark green; 7: green violet; 9: violet)

6. Leaf attitude

   (1: erect; 3 semi erect; 5: horizontal; 7: semi-pendant; 9: pendant)

7. Leaf length, Lf. len. (cms)
8. Leaf width at widest part, Lf. wid (cms)
9. Lf len./wid ratio
10. Distance from the widest part of the leaf to the tip, w-tip (cm)
11. W-tip/Lf. len ratio
12. Leaf tip angle
13. Leaf base angle
14. Leaf lobing (% of leaf width which is lobed)
15. Total leaf lobe number
16. Median lobe base width (cms)
17. Prickle number on upper lamina surface
18. Length of the longest prickle (cms)

Table 4 continued

19. Width of the longest prickle

20. Leaf hairs number on 10mm^2 of the lower surface

21. Leaf hairs number on 10mm^2 of the upper surface

22. Maximum hair rays number on upper leaf surface

Petiole and stem characters

23. Petiole length (cms)

24. Prickle number on the petiole

25. Petiole colour

(1: green; 3: green-violet; 5: violet; 7: dark violet; 9: dark brown)

26. Prickle number on 10cm length of main stem at medium height

Flower characters

27. Flowering time (days from sowing till first flower)

28. Corolla colour

(1: green-white; 3: white; 5: pale-violet; 7: light-violet; 9: bluish violet)

29. Number of flowers/inflorescence

30. Pedicel length of the lowest flower (cms)

31. Corolla lobe number

32. Length of radius of corolla to tip of lobes, Cor. len. (cms)

33. Length of radius to notch of corolla, Cor. Nt. L. (cms)

34. Cor. Nt. L/Cor. len. ratio

35. Corolla lobe width, Cor. Lb. W (cms)

36. Cor. Len/Cor. Lb. W ratio

37. Relative style length (mm longer than stamens)

38. Length of radius to tip of lobes of flowering calyx, Cal. len. (cms)

39. Length of lobes of flowering calyx, Cal. Lb. L. (cms)

Table 4 continued

40. Cal. Lb. L/Cal. len. ratio

Seedling characters

41. Germination period

(1 1 week; 3: 1-2 weeks; 5: 2-5 weeks; 7: 5-20 weeks; 9 20 weeks)

42. Hypocotyl colour

(3: green; 5: green-violet; 7: light violet; 9: violet)

43. Cotyledon length, Cot. Len. (cms)

44. Cotyledon width, Cot. wid. (cms)

45. Cot. Len./Cot. wid. ratio

46. Cotyledon colour

(3: green; 5: light violet; 7: violet)

Stem characters

47. Stem width at the base, st. wid. (cms)

48. Number of nodes to first inflorescence

49. Stem height to first inflorescence, Infl. 1. Ht. (cms)

50. Presence or absence of inflorescence bract

51. Internode length at medium height, Internd. L. (cms)

52. Length of longest prickle, pric. len. (cms)

53. Width of longest prickle, pric. wid. (cms)

54. Pric. L/W ratio

55. Prickle colour (1: green; 3: yellow; 5: violet; 9: brown)

Petiole characters

56. Petiole angle

57. Petiole hairs number on $10mm^2$

58. Length of the longest prickle, pric. len. (cms)

59. Width of the longest prickle, pric. wid. (cms)

60. Prickle length/width ratio

Table 4 continued

Leaf characters

61. Prickle number on lower lamina surface

Flower characters

62. Colour of the streak on the flower

(1: yellow; 2: white; 3: pink; 5: red; 7: blue; 9: violet)

63. Number of anthers

64. Shape of the androecium, andr. shape

(1: conical; 2: parallel; 3: spreading)

65. Stigma colour (1: green; 2: yellow; 3: orange; 4: red)

66. Number of carpels of outer part of fruit

67. Number of sepals

68. Number of prickles on the calyx

69. Length of the longest prickle on calyx, pric. len.

70. Width of the longest prickle on calyx, pric. wid.

71. Pric. L/W ratio

Petiole characters

72. Width of the longest prickle, pric. wid.

73. Pric. L/W ratio

Flower characters

74. Number of carpels of inner part of fruit

Table 5 : Characters name abbreviations

Character No.	Abbreviation	Character Name
1.	Habit	Growth habit (height/breadth ratio)
2.	Height	Plant height
3.	Breadth	Plant breadth
4.	Branch	Plant branching (number)
5.	Lf. col.	Leaf colour
6.	Lf. att.	Leaf attitude
7.	Lf. len.	Leaf length
8.	Lf. wid.	Leaf width
9.	Lf Len/Lf. wid.	Length/width ratio
10.	W-tip	Distance from widest part to tip
11.	W-tip/Lf. len.	W-tip/leaf length ratio
12.	Tip. ang.	Leaf tip angle
13.	Base ang.	Leaf base angle
14.	Lf. lob.	Leaf lobing (%)
15.	No. lobes.	Leaf lobe (number)
16.	Lob. wid.	Median lobe base width
17.	Lf. pric.	Leaf prickles (number) on upper surface
18.	Pric. len.	Leaf prickle length
19.	Pric. wid.	Leaf prickle width
20.	No. hairs (low)	Leaf hairs (number) on lower surface
21.	No. hairs (up)	Leaf hairs (number) on upper surface
22.	No. rays	Hair rays (number)
23.	Pet. len.	Petiole length
24.	Pet. pric.	Petiole prickles (number)
25.	Pet. col.	Petiole colour

Table 5 continued

26.	Stem pric.	Stem prickles (number) on 10cm
27.	Fl. date	Flowering date
28.	Cor. col.	Corolla colour
29.	No. fls.	Number of flowers per inflorescence
30.	Ped. len.	Pedicel length
31.	Cor. Lb. No.	Corolla lobe number
32.	Cor. len.	Corolla length
33.	Cor. Nt. L.	Corolla notch length
34.	Cor. Nt.L/Cor. Len.	Corolla notch length/corolla length ratio
35.	Cor. Lb. W.	Corolla lobe width
36.	Cor. Len/Cor. Lb. W.	Corolla length/corolla lobe width ratio
37.	Style	Relative style length
38.	Cal. len.	Calyx length
39.	Cal. Lb. l.	Calyx lobe length
40.	Cal. Lb. L/Cal. Len.	Calyx lobe length/calyx length ratio
41.	Germ. per.	Germination period
42.	Hyp. col.	Hypocotyl colour
43.	Cot. len.	Cotyledon length
44.	Cot. wid.	Cotyledon width
45.	Cot. Len./Cot. wid.	Cotyledon length/cotyledon width ratio
46.	Cot. col.	Cotyledon colour
47.	St. wid.	Stem width
48.	Infl. 1 Nod.	Number of nodes to first inflorescence
49.	Infl. 1 Ht.	Stem height to first inflorescence
50.	Infl. bract.	Inflorescence bract
51.	Internd. L.	Stem Internode length
52.	Pric. len.	Stem prickle length

Table 5 continued

53.	Pric. wid.	Stem prickle width
54.	Pric. len./pric. wid.	Prickle length/width ratio
55.	Pric. col.	Stem prickle colour
56.	Pet. angle	Petiole angle
57.	No. Pet. hairs	Hairs (number) on $10mm^2$ of petiole
58.	Pet. pric. len.	Petiole prickle length
59.	Pet. pric. wid.	Petiole prickle width
60.	Pric. len./wid.	Prickle length/width ratio
61.	Lf. pric. low.	Leaf prickles (number) on lower surface
62.	Streak col.	Colour of streak on flowers
63.	Anther n.	Anther number
64.	Andr. shape	Shape of anther tube
65.	Stigma col.	Stigma colour
66.	Carpel no. out.	Carpels (number) outer fruit
67.	Sepal no.	Sepal number
68.	Cal. pric. no.	Calyx prickle number
69.	Cal. pric. len.	Calyx prickle length
70.	Cal. pric. wid.	Calyx prickle width
71.	Cal. pric. L/W.	Calyx prickle length/width ratio
72.	Pet. wid.	Petiole width
73.	Pet len./wid.	Petiole length/width ratio
74.	Carpel no. in.	Carpels (number) inner fruit

3. RESULTS

3.1. Study of morphological characters

3.1.1. Numerical Taxonomy

Seventy-four characters on forty-seven operational taxonomic units (OTUs) were chosen for this study (Tables 4 and 5). The results obtained were analysed using Euclidean distance coefficient (D^2) and principal component analysis (PCA) as a measure of dissimilarity between OTUs. Cluster analysis was by means of Ward's method (Dunn and Everitt, 1982). The OTUs comprised S. aethiopicum L. Groups Gilo and Shum.

A combined analysis was also made for Groups Gilo, Shum, Kumba and a few accessions of S. anguivi (Data used with permission from N. Stavropoulos, 1983). The analysis was based on seventy-four characters and 106 OTUs using the same procedure as for the previous analysis.

Analysis 1: Groups Gilo and Shum (47 OTUs and 74 characters)

The principal component analysis showed the distribution of the OTUs based on their dissimilarities. The distribution pattern of the OTUs was along the central axis at one end. At the other end of the phenogram the OTUs were dispersed two main groups showing the extremes of dissimilarities. Most of the OTUs were concentrated along the central axis. (Figure 6)

The first principal component was chiefly influenced by prickle characters which were leaf, petiole and stem prickles. The most prickly accessions, which were at one end of the phenogram, were RNL 228B, RNL 253, RNL 293A, RNL 293B, RNL 294 and RNL 245. Most of these accessions had been identified as having characteristics of both

S. aethiopicum Group Gilo and S. anguivi. Most of the accessions at the other end of the phenogram, which represented the extreme absence of prickles, did not belong to Group Gilo. Accessions RNL 134 and RNL 159 belong to Group Shum. RNL 260 belongs to Group Kumba while S.2002 was identified as belonging to Group Gilo, but tending to Group Kumba. The ten prickle characters on which the dispersion of the OTUs in the first principal component was based, and their eigenvalues are shown in Table 6 . The eigenvalues for these ten characters were above + 0.180.

The second principal component was mainly influenced by some leaf, petiole, stem, calyx, hypocotyl characters and branch numbers. The ten main characters and their eigenvalues are presented in Table 6 . Dispersion of the OTUs at one end of the phenogram showed a concentration of the OTUs along the central axis with the extremities at the end characterised by accessionswith large leaves, petioles and calyx lobes on one side and those with small ones at the other.

Although the first and second principal components tended to disperse the OTUs, there was a continuum along the central axis. Most OTUs were concentrated along the central axis. All the same, it is possible to identify the dispersal patterns of the OTUs which apparently seems to coincide with the clustering pattern on the dendrogram.

The first category encompasses those accessions without prickles, with small leaves and medium to many branches. This group is represented by the two members of Group Shum and some members of Group Gilo (RNL 134, RNL 159, RNL 255A and RNL 254).

The second category comprised accessions without prickles, but with medium to large leaves and with few branches (e.g. RNL 166, RNL 260, RNL 165 and S.2002). Some of these accessions had violet petioles (RNL 165 and RNL 166). The third category had accessions with prickles and small to medium size leaves (RNL 309, RNL 253, RNL 314, RNL 245 and RNL 292). The last category was that of accessions with prickles and small to medium size leaves (RNL 285, RNL 310, RNL 290 and RNL 228B).

Although the principal component analysis showed the distribution of the OTUs based on dissimilarities, it was not easy to tell how closely related two OTUs plotted next to each other on the phenogram were. The principal component analysis tended to show general trends and to pinpoint that one OTU was distantly related to the other or that they were not related.

The cluster analysis using Euclidean distance squared and Ward's method showed the fusion of OTUs which were related. The cluster analysis did not, however, show much divergence from what had been displayed by the principal component analysis. The clustering pattern on the dendrogram basically displayed five main clusters. (Figure 7)

Cluster 1:

This cluster was composed of accessions RNL 011, RNL 258, RNL 300, RNL 296, RNL 308, RNL 254, RNL 255A and RNL 159. RNL 134 was fused onto this cluster at a higher level. All these accessions belong to Group Gilo except accessions RNL 159 and RNL 134, which belong to Group Shum. The members of this cluster were characterised by small glabrous leaves, absence of prickles and small flowers.

Cluster 2:

The cluster consisted of six OTUs (RNL 165, RNL 166, RNL 260, RNL 302, S.2004 and S.2002). These accessions had no prickles, had large leaves and big flowers. Some of them had violet pigmentation on the stems and petioles.

Cluster 3:

In this cluster were accessions RNL 168, RNL 242, RNL 315, RNL 316, RNL 229, RNL 317, RNL 286, RNL 297, RNL 266, RNL 270, RNL 252 and RNL 271. The accession RNL 304 was fused to this cluster at a higher level. This cluster was a mixture of those with and without prickles. They had medium to large size leaves and all belong to Group Gilo.

Cluster 4:

This was as large a cluster as cluster 3 and had 12 OTUs. However, accessions RNL 228A and RNL 255B later fused onto it. It was constituted by RNL 135, RNL 257, RNL 310, RNL 273, RNL 288, RNL 307, RNL 314, RNL 292, RNL 290, RNL 285, RNL 309 and RNL 294. These accessions had prickles and medium to large leaves.

Cluster 5:

This was the smallest cluster, made up of 5 OTUs namely RNL 228B, RNL 245, RNL 253, RNL 293A and RNL 293B. Three of these accessions were identified as having some characteristics of *S. anguivi*. Some of these characters were prickliness and a large number of flowers per inflorescence which are characteristic of *S. anguivi*, the progenitor of *S. aethiopicum* (Lester and Niakan, 1983).

Figure 6

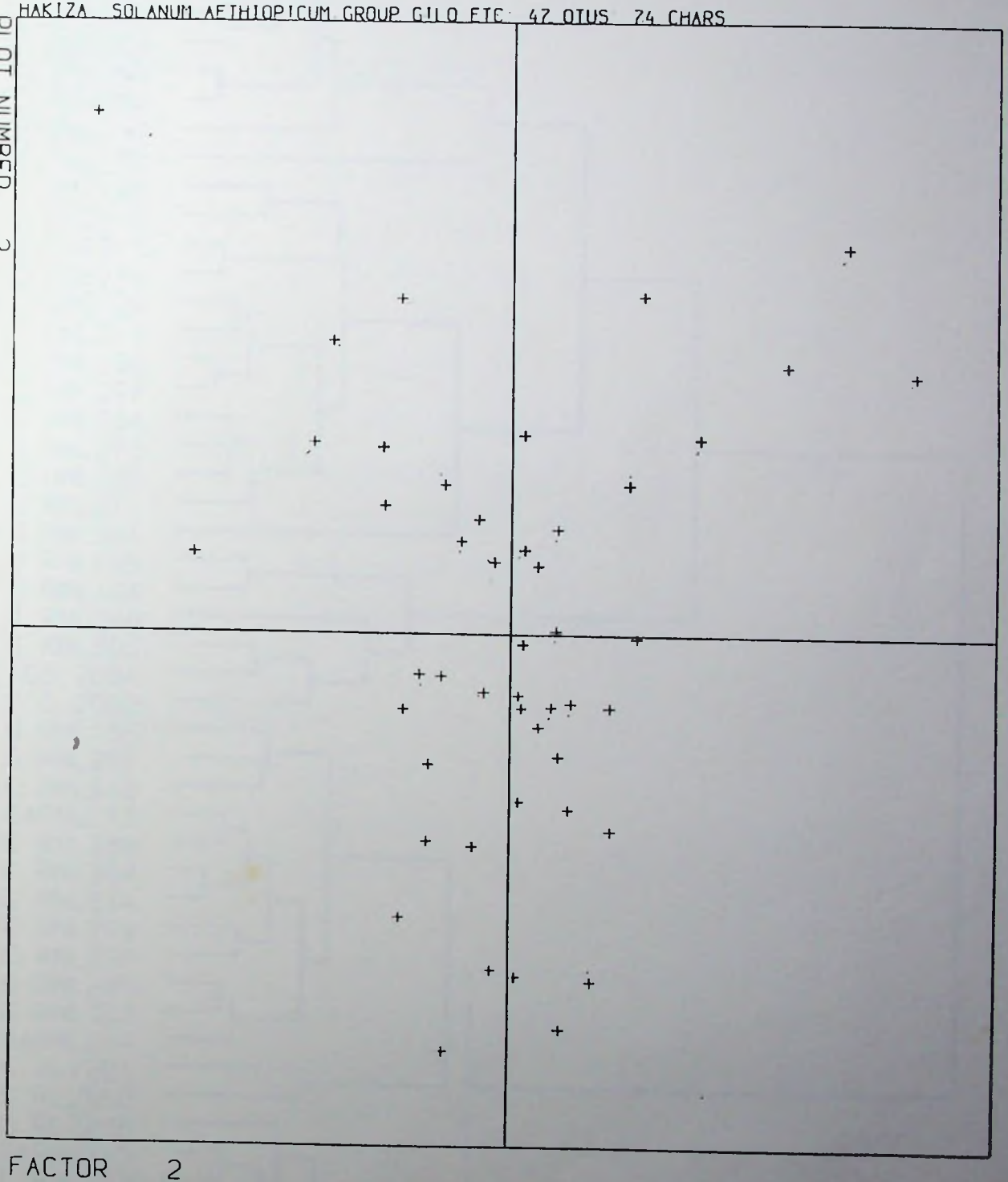

HAKIZA SOLANUM AETHIOPICUM GROUP GILO ETC 47 OTUS 74 CHARS
PLOT NUMBER 2
FACTOR 1
FACTOR 2

Figure 7

SOLANUM AETHIOPICUM GROUP GILO ETC 47 OTUS 74 CHARS

Table 6: The ten characters with the highest eigenvalues

Principal Component 1:

Character No.	Character Name	Eigen Values
17	Leaf prickle no. (upper)	.240
18	Leaf prickle length	.236
19	Leaf prickle width	.209
24	Petiole prickle no.	.208
26	Stem prickles no.	.258
52	Stem prickle length	.217
53	Stem prickle width	.180
58	Petiole prickle length	.186
59	Petiole prickle width	.189
61	Leaf prickle no. (lower)	.210

Principal Component 2:

4	Branch no.	-.201
7	Leaf length	.226
8	Leaf width	.257
10	w-tip	.229
16	Lob width	.247
25	petiole colour	.199
39	Calyx lobe length	.231
42	Hypocotyl colour	.247
47	Stem width	.199
72	Petiole width	.196

Table 6 cont'd

Principal Component 3:

Character No.	Character Name	Eigen Values
2	Plant height	.243
6	Leaf attitude	.187
14	Leaf lobing (%)	-.188
15	Leaf lobe (number)	-.213
20	No. of hairs (low)	.207
21	No. of hairs (up)	.180
29	No. of flowers/inflorescence	-.204
48	Inflor. 1 Nod	.180
49	Inflor. 1 Height	.273
57	No. of petiole hairs	.273

Principal Component 4:

1	H/B	-.196
11	w-tip	-.191
23	Petiole length	.225
25	Petiole colour	-.196
29.	No. of flowers/inflor.	.191
31	Cor. Lb. No.	-.225
51	Internd. L	.253
62	Streak colour	-.202
67	Sepal number	-.219
73	Pet. len/wid.	.284

Analysis 2: Combined analysis for Groups Gilo, Shum, Kumba and S. anguivi (106 OTUs and 74 Characters)

In this combined analysis 106 OTUs and 74 characters were used. There were 58 OTUs belonging to Group Gilo, 7 of Group Shum, 37 of Group Kumba and 4 of S. anguivi. The dispersion pattern of the OTUs on the PCA (Figure 8) followed a trend similar to previous one. At one end there was a narrow dispersal of the OTUs along the central axis while at the other end the dispersal was much wider.

The first principal component somewhat separated Group Gilo and S. anguivi from Groups Kumba and Shum (Figure 8). The ten main characters with eigenvalues higher than + 0.193 were tip angle, number of hairs on lower side of the lamina, number of hair rays, number of stem prickles, height to first inflorescence, stem prickle length and width, stem prickle length/width ratio, number of petiole hairs and number of carpels in the outer part of the fruit. The second principal component dispersed Groups Kumba and Shum to the extremities. The ten main characters for this principal component with eigenvalues higher than 0.176 were: leaf length, leaf width, distance from widest part of leaf to tip, leaf lobe number, lobe width, petiole length, corolla length, calyx, calyx lobe length and petiole width (Table 7). The OTUs in Groups Kumba and Gilo were lying astride the central axis forming a continuum in both groups. Group Shum was characterised by small leaves, small flowers and narrow tip angle while Group Kumba had large leaves and large flowers.

The dendogram (Figure 9) showed that members of the same group clustered together. The pattern was similar to that in the PCA. Five main clusters could be identified. The first one was solely composed of 32 OTUs belonging to Group Gilo. The second cluster consisted of 8 OTUs

also of Group Gilo which was later fused onto the first cluster. The third cluster was also composed of Group Gilo. Group Shum and S. anguivi were separate sub-clusters within the fourth cluster which was possibly formed on the basis of the OTUs having small leaves, small flowers and narrow tip angle. The fifth and largest cluster was that of Kumba with 36 OTUs, which consisted of four smaller clusters. At a higher level of fusion, clusters three and four joined Group Kumba which suggested a degree of relationship among Groups Kumba, Gilo (some) Shum and S. anguivi.

On the basis of both the principal components analysis and the phenogram, it can be concluded that although accessions of Group Gilo display a wide range of variation nevertheless they represent a continuum and Group Gilo is largely self-contained and discrete from the other Groups.

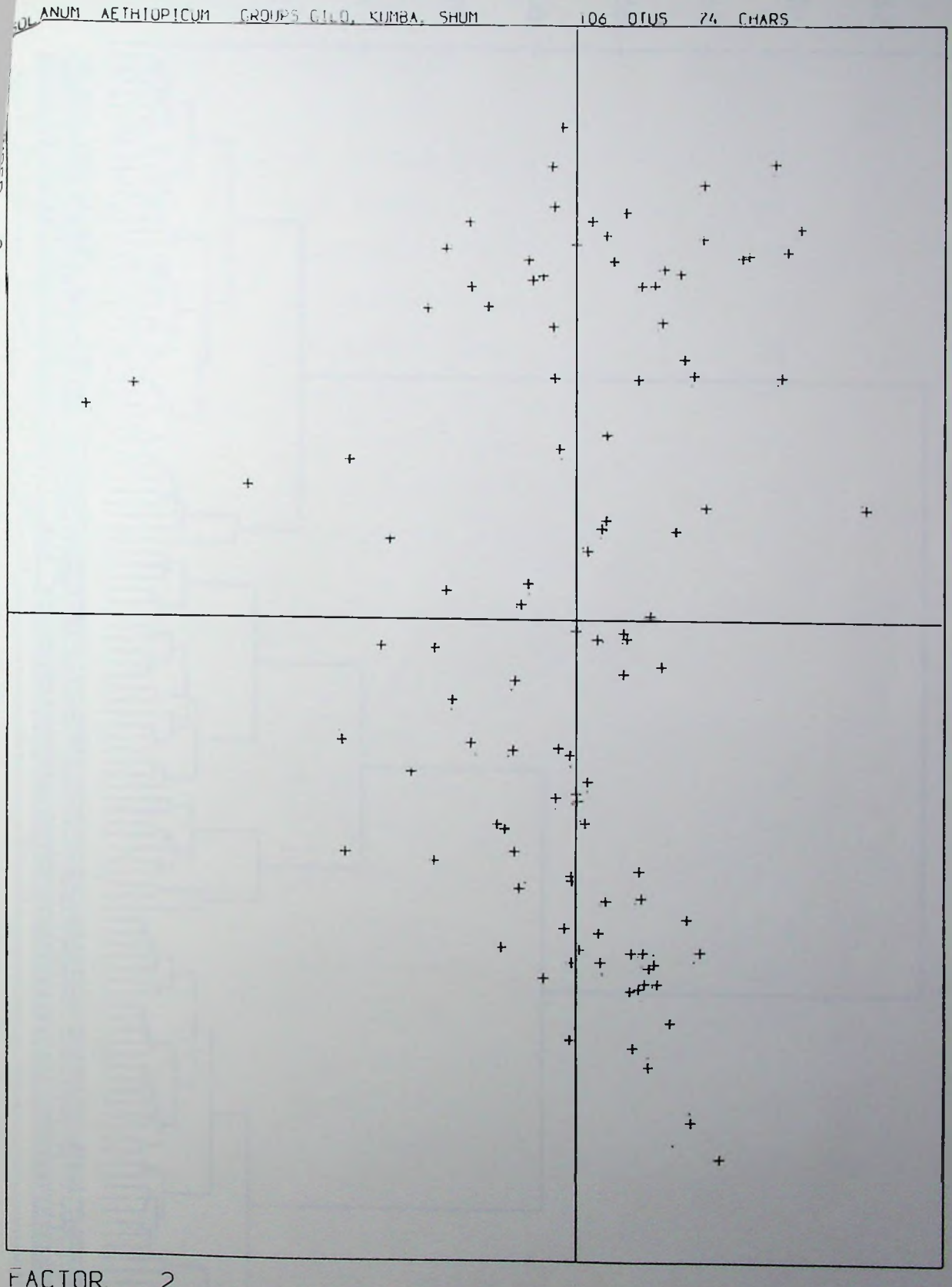

ANUM AETHIOPICUM GROUPS C,L,O, KUMBA, SHUM 106 OTUS 74 CHARS
FACTOR 1
FACTOR 2

Figure 8

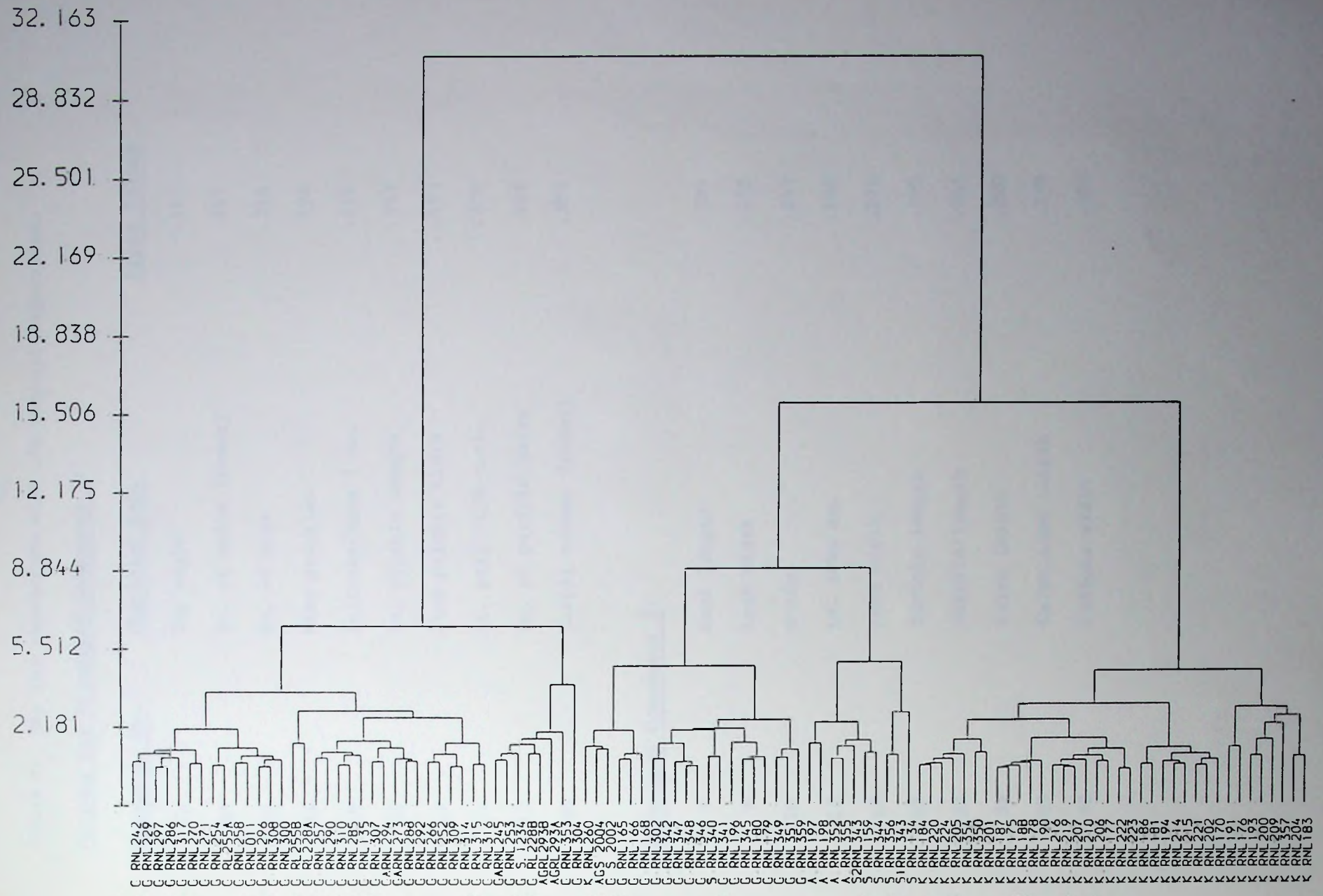

32.163
28.832
25.501
22.169
18.838
15.506
12.175
8.844
5.512
2.181
SOLANUM AETHIOPICUM GROUPS GILO, KUMBA, SHUM
106 OTUS 74 CHARS

Figure 9

Table 7: The ten characters with the highest eigenvalues

Vectors for Principal Component 1:

Character No.	Character Name	Eigen Values
12	Tip angle	-.192
20	No. of hairs (lower)	.217
22	No. of rays	.216
26	Stem prickles	.196
49	Inflorescence 1 Ht.	.219
52	St. prickle length	.212
53	Stem prickle width	.193
54	St. pric. L/W ratio	.200
57	No. of petiole hairs	.208
66	Carpel number (outer)	.204

Principal Component 2:

7	Leaf length	.300
8	Leaf width	.285
10	w-tip	.267
15	Lf. lobe no.	.188
16	Lobe width	.278
23	Petiole length	.195
32	Corolla length	.214
38	Calyx length	.200
39	Calyx lobe length	.176
72	Petiole width	.263

Table 7 cont'd

Principal Component 3:

Character No.	Character Name	Eigen Values
13	Leaf base angle	.182
14	Leaf lobing (%)	-.175
21	No. of hairs (upper)	-.218
24	Petiole prickle no.	.177
27	Flowering date	-.196
37	Rel. style length	.169
48	Infl. 1 mode	-.182
58	Petiole prickle len.	.199
64	Androeceum shape	-.198
65	Stigma colour	.231

Principal Component 4:

6	Leaf attitude	-.230
17	Leaf prickle (upper)	.205
32	Corolla length	-.192
33	Cor. notch length	-.190
38	Calyx length	-.193
39	Calyx lobe length	-.241
56	Petiole angle	-.213
58	Petiole prickle length	.231
59	Petiole prickle width	.244
61	Leaf prickle no. (lower)	.260

Plate I:

Young plants of Groups Shum, Gilo and Kumba

Plate II: Plants of Group Gilo growing in the open

Plate III:

Variations in flowers and fruits of S. anguivi and S. aethiopicum Groups Gilo, Shum and Kumba.

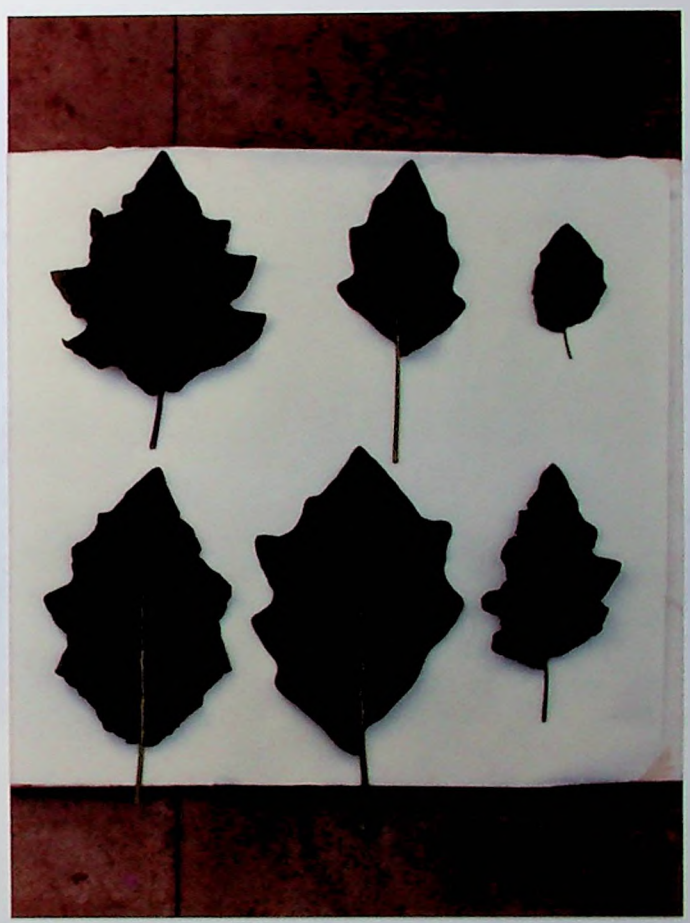


Plate IV:

Leaf form of S. aethiopicum Groups Gilo and Shum

Plate V:

Variations in fruits of S. anguivi, S. aethiopicum Groups Gilo, Shum, Kumba and Aculeatum, S. macrocarpon Groups Dasyphyllum and Macrocarpon and S. melongena

3.1.2. Variation within and between accessions

During the analysis of variance, the accessions (ACC.) were tested against plants within accessions. Plants within accessions (PL.w.acc.) were tested against the residual item, which was the interaction between the character being analysed and the plants within accessions (L x PWA). The character (L) and the interaction between the character and the accession (L x ACC) were tested against the residual item.

Table 8 contains the analysis of variance for all the 5 accessions together while Table 9 shows the analysis of variance for 3 accessions, which belong more typically to Group Gilo. The other two accessions (RNL 134 and S.2004) were left out in the second analysis on the basis that RNL 134 belongs to Group Shum and S.2004 has expressed characteristics for both S. anguivi and Group Gilo.

Realising that the study of variations within and between accessions was superimposed upon the study of morphological characters which did not have randomisation of accessions, analysis of results has only concentrated on variance within and between accessions. Interactions between the characters and accessions have been left out.

The results of statistical analysis for the 22 characters were observed to fall into four categories namely, Category one whereby the treatments were statistically significant both between and within accession for example 7 Corolla lobe width and 13 sepal number. In category two, the treatments were significant between accessions but not significant within accessions, for example, 2 pedicel length. Category three included characters which were significant within accessions but not between accessions as exemplified by 8 corolla

length/corolla lobe length ratio. The last category was where the treatments were neither significant between nor within accessions. This is illustrated by 11 calyx lobe length/calyx length ratio.

Some characters showed a similar trend in the two analyses while others behaved differently. Most characters which are represented by ratios fell under category four.

TABLE 8 ANALYSIS OF VARIANCE FOR ALL THE FIVE ACCESSIONS

No.	Character	Variance within Accession (S^2W)	Variance Ratio (F)	Level of significance	Variance between accessions (S^2b)	Variance Ratio (F)	Level of significance
1.	No. of flowers/inflore-scence	1.7900	2.7540	N.S	85.5499	47.7927	**
2.	Pedicel length	0.0758	2.0823	N.S.	0.6934	9.1477	**
3.	Corolla Lobe number	0.3201	1.3335	N.S.	6.3301	19.7809	**
4.	Corolla length	0.0394	1.4597	N.S.	0.8103	20.5792	**
5.	Corolla notch length	0.0330	2.1805	N.S.	0.1338	4.0589	*
6.	Corolla notch length/ corolla length	0.0085	1.7670	N.S.	0.0187	2.2140	N.S.
7.	Corolla lobe width	0.0306	3.4931	*	0.1438	4.6925	**
8.	Corolla length/Corolla lobe width	0.8420	4.1269	*	1.2797	1.5198	N.S.
9.	Calyx length	0.0510	6.1446	**	0.5569	10.9201	**
10.	Calyx lobe length	0.0230	4.0049	*	0.2719	11.8189	**
11.	Calyx lobe length/Calyx length	0.0069	0.7942	N.S.	0.0128	1.8488	N.S.
12.	Anther number	0.2700	0.8182	N.S.	13.4003	49.6315	**
13.	Sepal number	0.6000	3.7498	*	6.9301	11.5504	**
14.	Leaf length	5.4716	0.9563	N.S.	388.788	71.0558	**
15.	Leaf width	6.1130	0.9060	N.S.	251.516	41.1442	**
16.	Leaf length/width ratio	0.0218	1.0378	N.S.	0.1284	5.877	**

Table 8 continued

17.	W-tip	6.5703	0.8090	N.S.	125.9500	19.1698	**
18.	W-tip/leaf length ratio	0.0072	0.9303	N.S.	0.0078	1.0830	N.S.
19.	Lobe number	4.0200	2.9560	*	72.15	17.9478	**
20.	Petiole length	4.4301	1.0769	N.S.	60.0516	13.5555	**
21.	Petiole width	0.0031	1.0811	N.S.	0.1366	44.1851	**
22.	Petiole length/Petiole width	15.3226	1.4560	N.S.	21.9658	1.4336	N.S.

N.S. = Not significant

* = significant at 5% level

** = significant at 1% level

TABLE 9 ANALYSIS OF VARIANCE FOR THREE ACCESSIONS; RNL 166, RNL 308 and RNL 317

No.	Character	Variance within Accession (S^2W)	Variance Ratio (F)	Level of significance	Variance between Accessions (S^2b)	Variance Ratio (F)	Level of significance
1.	No. of flowers/inflore-scence	2.4833	4.2571	**	14.7	5.9195	*
2.	Pedicel length	0.1087	2.2906	N.S.	0.8195	7.5403	**
3.	Corolla lobe number	0.5	1.3637	N.S.	6.4335	12.8669	**
4.	Corolla length	0.07579	2.1477	N.S.	0.1401	1.8485	N.S.
5.	Corolla notch length	0.0478	2.6745	N.S.	0.0637	1.3340	N.S.
6.	Corolla notch length/ Corolla length	0.0072	1.7099	N.S.	0.0026	0.3654	N.S.
7.	Corolla lobe width	0.0494	4.0657	*	0.1898	3.8387	N.S.
8.	Corolla length/Corolla lobe width	1.3058	7.9652	**	1.7674	1.3535	N.S.
9.	Calyx length	0.0822	11.4645	**	0.0910	1.1075	N.S.
10.	Calyx lobe length	0.0351	4.6621	*	0.0285	0.8103	N.S.
11.	Calyx lobe length/Calyx length	0.0050	1.0217	N.S.	0.0014	0.2796	N.S.
12.	Anther number	0.3167	0.5757	N.S.	16.0331	50.6320	**
13.	Sepal number	0.9666	4.1423	*	7.6337	7.8972	**
14.	Leaf length	2.7865	0.4163	N.S.	29.9580	10.7513	**
15.	Leaf width	5.1903	0.7822	N.S.	35.5747	6.8541	*
16.	Leaf length/width ratio	0.0208	1.0236	N.S.	0.1690	8.1194	**

Table 9 continued

17.	W-tip	7.6121	0.6615	N.S.	27.8340	3.6566	N.S.
18.	W-tip/leaf length ratio	0.0108	1.0567	N.S.	0.0149	1.3842	N.S.
19.	Leaf lobe number	2.7865	0.4163	N.S.	29.9580	10.7513	**
20.	Petiole length	3.9377	1.1359	N.S.	3.7460	0.9513	N.S.
21.	Petiole width	0.0023	0.7646	N.S.	0.0337	14.7491	**
22.	Petiole length/Petiole width	14.6004	1.3965	N.S.	10.2739	0.7037	N.S.

Key:

N.S. = Not significant

* = Significant at 5% level

** = Significant at 1% level

3.1.3 Scanning Electron Microscopy (S.E.M.) of Enzyme-etched seeds

Scanning Electron microscopy of enzyme-etched seeds of Solanum aethiopicum, S. anguivi, S. macrocarpon, S. dasyphyllum and S. melongena were examined. S. aethiopicum was represented by Groups Gilo, Kumba, Shum and Aculeatum. It was intended to examine the possible differences between the Solanum species that can be seen from the seed characteristics. The seeds of these species were all C-shaped (Figure 10). The effectiveness of enzyme-etching seemed to depend upon the duration of seed treatment. Where the seeds were enzyme-etched for 24 hours followed by another 24 hours, the results were satisfactory. Seeds of Group Shum, however, showed incomplete etching. When the seeds which had been treated for 24 hours followed by another 24 hours were given yet another treatment of 36 hours, the cell wall was completely etched but in some cases parts of the fibrils were also destroyed (Figure 13).

After etching of the cell wall of the seeds by the enzyme, it was possible to look at some internal features of the cells. The pattern of the fibrils showed some differences among some species. The fibrils in S. anguivi and S. aethiopicum (Groups Gilo, Shum, Kumba and Aculeatum) showed a lot of similarities. Similarly, those of S. macrocarpon and S. melongena were more or less alike, but differed from those of S. anguivi and S. aethiopicum.

Taking S. anguivi and S. aethiopicum as one group, and S. macrocarpon and S. melongena as another group, comparative studies were made. Even though S. macrocarpon and S. melongena are taken as one group because of the features they had in common, it was apparent that they exhibited some differences.

Fibrils in S. aethiopicum and S. anguivi were heavy and curved when minimally etched as opposed to being very thin and straighter when over-etched. These variations could easily be seen in both Groups Kumba and Gilo even in the same micrograph (Figures 11 and 15). Walls with secondary layers showed characteristic depressions called pits. Some pits formed tall arches almost up to the fibrils, but others were rounder and lower down. Both extremes were found in both Kumba and Gilo. Each pit of a pair had a pit cavity and two cavities were separated from each other by a thin wall part, the pit membrance. As the cytoplasmic masses continued to thicken, the cavities became canals. The walls between cells showed a zigzag pattern. Group Shum seemed to have an enzyme resistant cuticular layer. When this was eventually etched the fibrils tended to become over-etched thus becoming thin and bristly.

The S. macrocarpon and S. melongena group was rather different from the S. aethiopicum and S. anguivi group. The walls showed much greater lignin thickness and had heavy shoulders. There were far fewer pits in the S. macrocarpon and S. melongena group and there was hardly any floor to the cells (Figures 16 & 17). The fibrils in this group were shorter, thinner and more bristly. However, the fibrils in S. melongena were parallel and fused into a curtain while those in S. macrocarpon were divergent, although they were sometimes fused into curtains, too at the base.

Suffice it to say that S. aethiopicum, S. macrocarpon and S. melongena can be fairly easily distinguished.

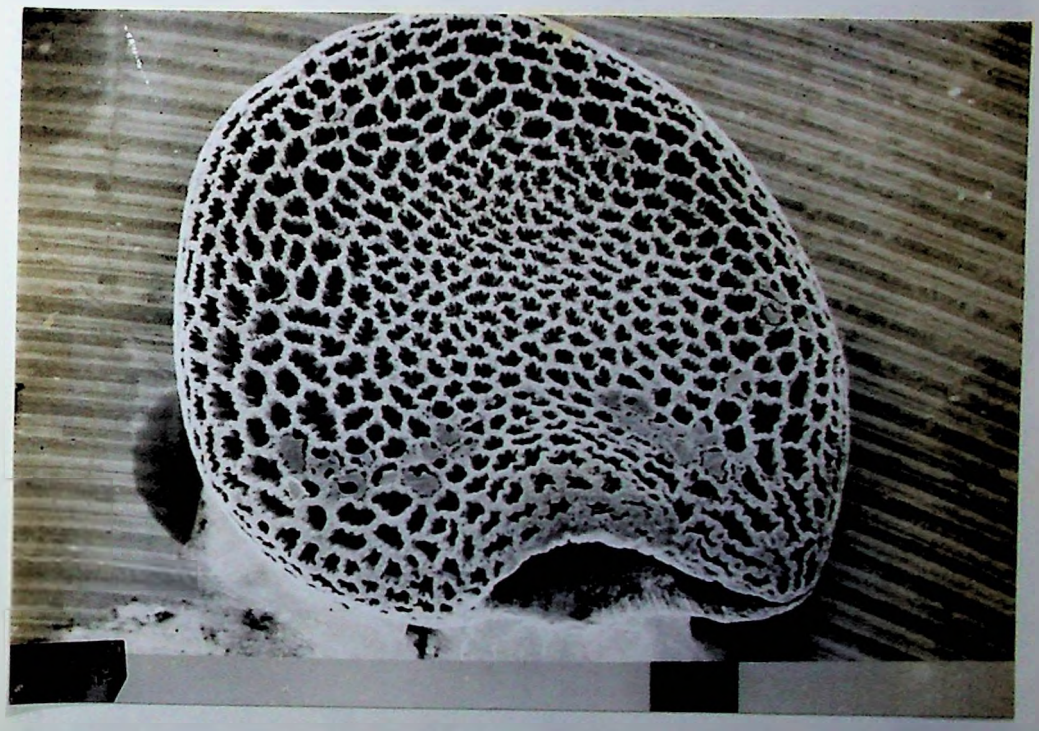


Fig. 10 SEM of seed coat of RNL349 S.a. Gilo

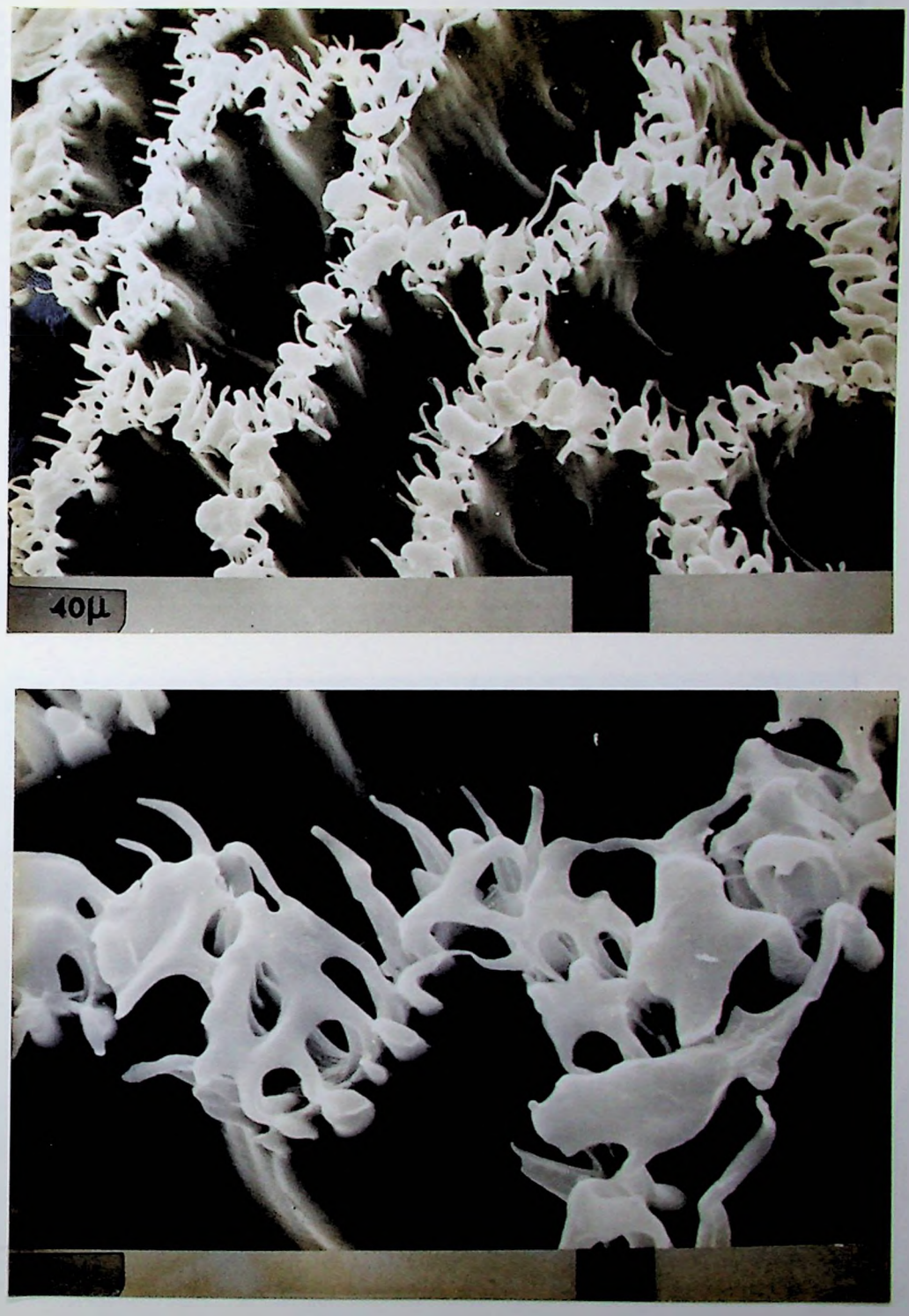


Fig. 11 SEM of seed coat of RNL349 S.a. Gilo

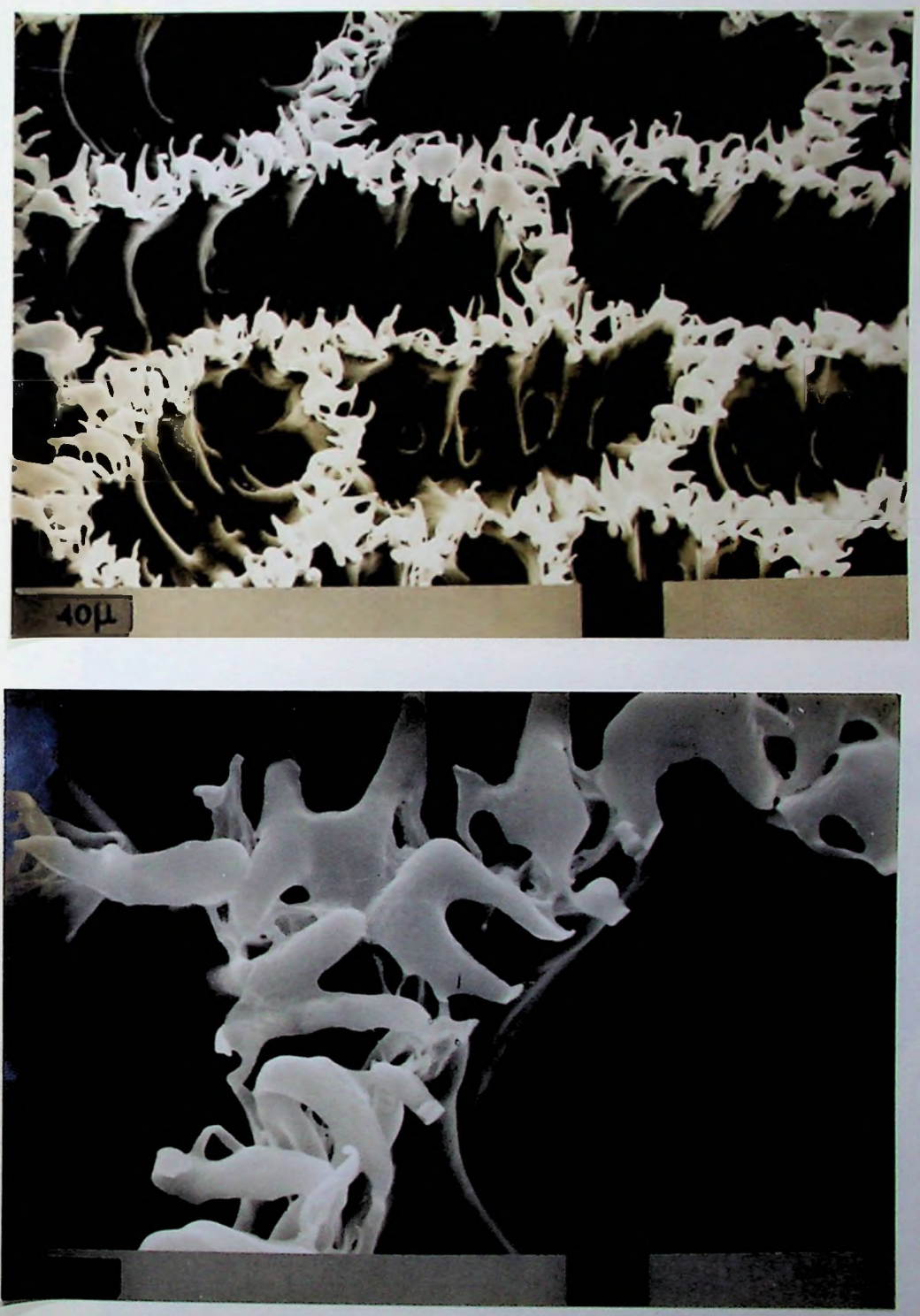


Fig. 12 SEM of seed coat of RNL 178 S. a. Kumba

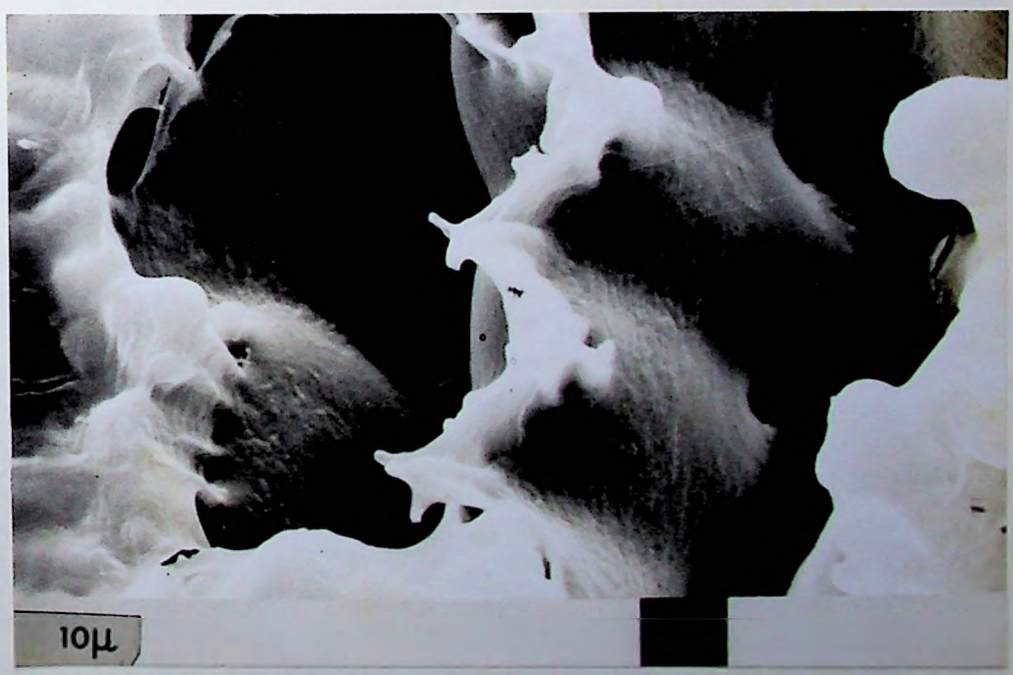


Fig. 13 SEM of seed coat of RNL 356 S. a. Shum

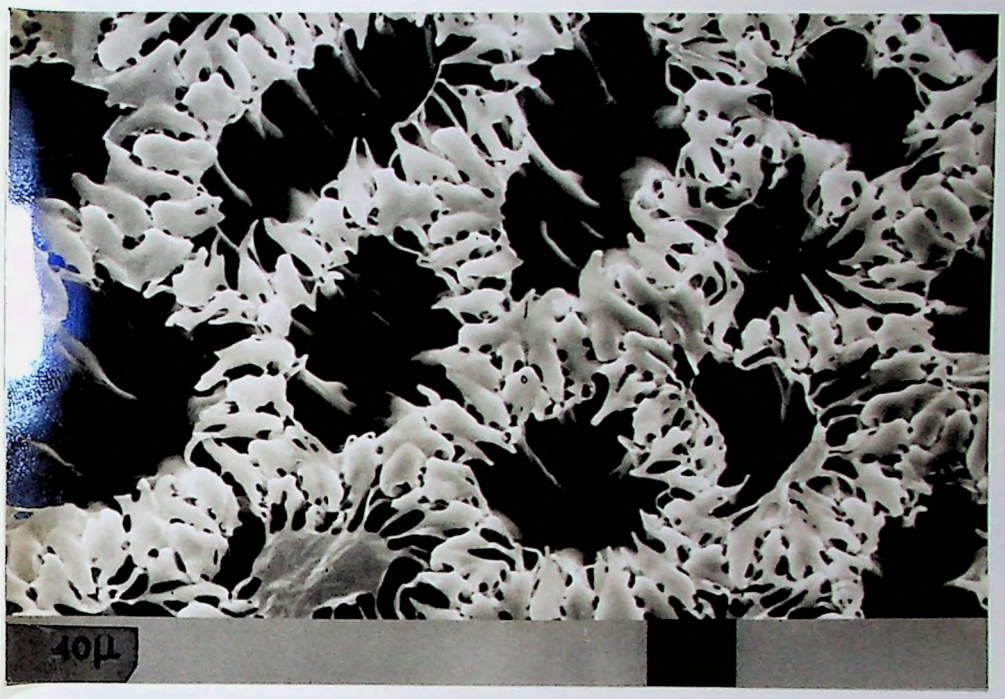
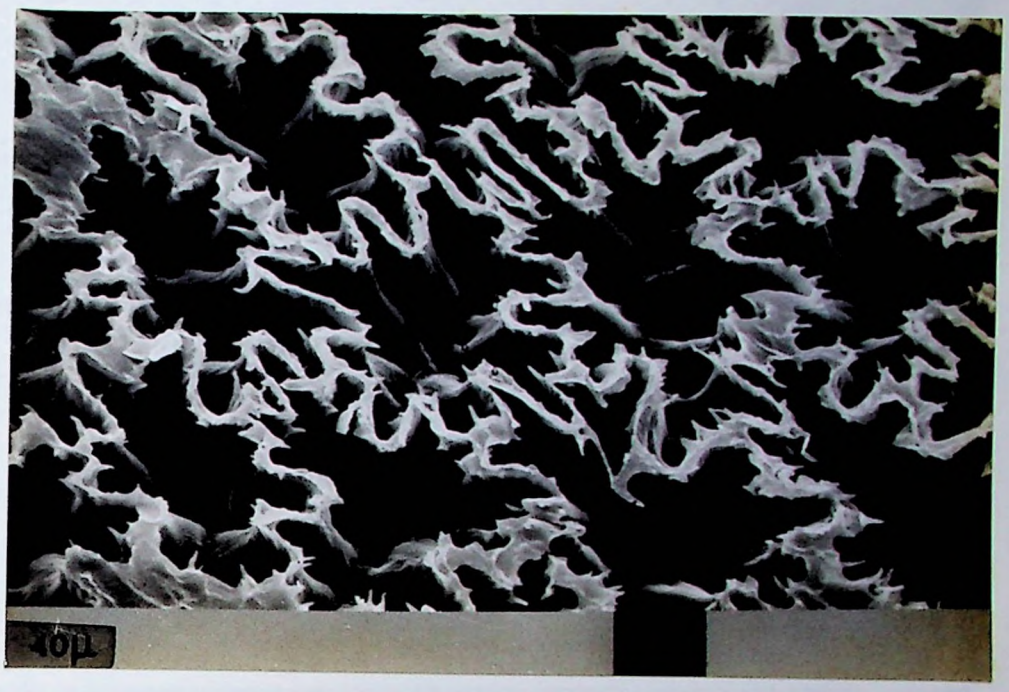


Fig. 14 SEM of seed coat of s.1331 S. a. Aculeatum

Fig. 15 SEM of seed coat of RNL 355 S. anguivi



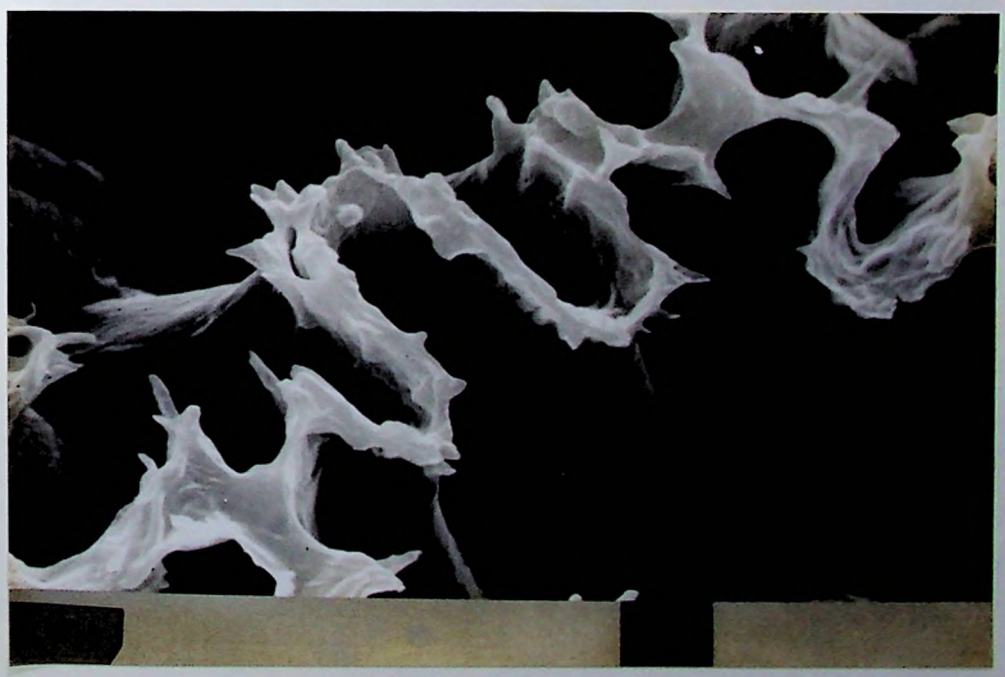


Fig. 16 SEM of seed coat of RNL 057 S. m. Macrocarpon

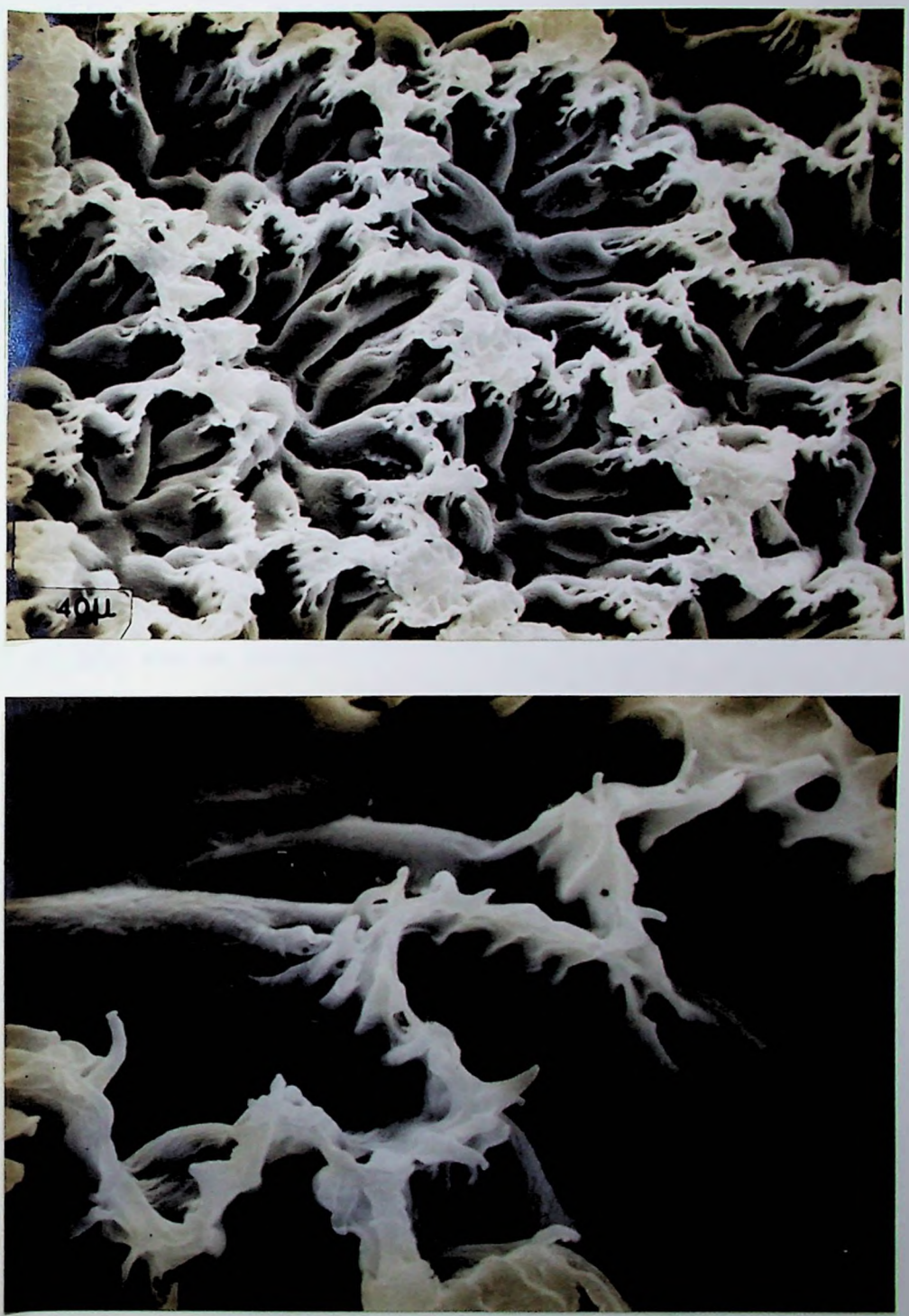


Fig. 17 SEM of seed coat of RNL 066 S. melongena

3.1.4. Crossability studies

In the crossability studies 21 accessions belonging to Group Gilo were used as female parents and 7 accessions of Groups Shum and Kumba were the pollen donors. The study was aimed at investigating crossabilities of three Groups (Gilo, Shum and Kumba) which are the major constituents of Solanum aethiopicum. The results of the crosses are shown below. Almost 50% of the crosses made formed fruits. There were more crosses made between Groups Gilo and Shum than Groups Gilo and Kumba. In both cases successful crosses were registered. The success of these crosses should be taken with caution until the seeds have been harvested and F_1 plants grown since parthenocarpic fruits are known to occur among crosses involving S. aethiopicum.

In all the crosses Gilo was used as the female parent. The results of the crosses are as shown below. The figures in the brackets show number of fruits/number of pollinations .

Gilo x Kumba

RNL 317 x RNL 205 (1/5); RNL 317 x RNL 184 (1/4); RNL 317 x RNL 194 (4/7);
RNL 317 x RNL 214 (1/2); RNL 316 x RNL 214 (1/2); RNL 315 x RNL 194 (1/3);
RNL 314 x RNL 214 (2/4); RNL 308 x RNL 176 (1/4); RNL 308 x RNL 194 (0/1);
RNL 297 x RNL 194 (0/1); RNL 297 x RNL 176 (1/3); RNL 300 x RNL 176 (1/2);
RNL 296 x RNL 176 (1/4); RNL 242 x RNL 191 (0/2); RNL 135 x RNL 205 (0/3);
S.2002 x RNL 184 (3/4); S.2002 x RNL 214 (2/2);

Average per cent success (fruit set) was 37.7%

Gilo x Shum

RNL 286 x RNL 159 (3/4); RNL 270 x RNL 159 (1/1); RNL 266 x RNL 159 (2/2); RNL 310 x RNL 159 (2/2); RNL 266 x RNL 134 (1/1); RNL 271 x RNL 134 (0/1); RNL 285 x RNL 134 (3/4); RNL 229 x RNL 134 (2/5); RNL 242 x RNL 134 (2/2); RNL 288 x RNL 134 (2/4); RNL 168 x RNL 159 (4/7); RNL 166 x RNL 159 (0/10); RNL 165 x RNL 159 (7/8)

Average per cent success (fruit set) was 56.9%

Fruit set per cent is not a particularly good basis for assessing the success of crossability. As such, it is quite important to wait until the normality of the seeds can be assessed and until F_1 hybrids are produced and pollen stainability examined before fair conclusions about the success of crossability can be made.

3.2. Study of biochemical characters

3.2.1. Chromatography of leaf phenolics

The results of chromatography are represented by the number of spots, R_f values, colour and intensity of the spots of leaf phenolics (Tables 10 & 11 and Figure 5). There were 18 spots observed in all. The R_f values, in the first solvent ranged from 0.33 to 0.99 while those in the second solvent ranged from 0.12 to 0.95. Some spots retained the same colour when examined under both u.v. and u.v. + ammonia. Other spots changed colour in the presence of ammonia fumes. Spots 16, 17 and 18 were only seen under u.v. + ammonia.

Spots 1, 2, 6, 7 and 12 appeared in all accessions. Spot 16 was present only in *S. melongena*. Equally, spots 14 and 15 were present in Group Shum only. Otherwise, there was no particular trend of distribution for the rest of the spots.

There was no regularity in colour intensity of the spots except spots 6 and 7 which consistently showed strong intensity in all accessions other than RNL 057. The total number of spots per accession ranged from 10 to 15. Although there were some few spots which were absent in some accessions, generally, most spots were present in all the groups of accessions used. From these chromatographic studies, it is difficult to pinpoint demarcations among the groups used, namely *S. aethiopicum* Groups Shum and Gilo, *S. macrocarpon* and *S. melongena*. Lack of strong, clear-cut differences among these groups, based on leaf phenolics, did not justify further investigations.

Table 10 R_f values and colours of leaf phenolics obtained from 2-dimensional chromatography of 9 accessions of Solanum species (1 accession of Group Shum, 3 accessions of Group Gilo 4 accessions of S. macrocarpon and 1 accession of S. melongena)

Spot No.	R_f Value		Colour of Spot	
	1st Solvent	2nd Solvent	u.v.	u.v. + ammonia
1.	0.72	0.12	Yellow	Yellow
2.	0.58	0.12	Light yellow	Yellow
3.	0.58	0.24	Light yellow	Yellow
4.	0.77	0.23	Light blue	Light blue
5.	0.79	0.61	Blue	Light blue
6.	0.91	0.74	Dark blue	Whitish yellow
7.	0.73	0.77	Light blue	Whitish yellow
8.	0.66	0.66	Pink	Pink
9.	0.60	0.73	Dark brown	Dark yellow
10.	0.55	0.66	Brown	Dark yellow
11.	0.33	0.89	Whitish blue	Light blue
12.	0.43	0.95	Whitish blue	Light yellow
13.	0.51	0.84	Whitish blue	Light yellow
14.	0.77	0.89	Greenish yellow	Pink
15.	0.70	0.94	Greenish yellow	Pink
16.	0.70	0.47	-	Light yellow
17.	0.99	0.75	-	Blue
18.	0.65	0.86	-	Blue

Table 11 Scores of colour intensity of spots of leaf phenolics as observed on chromatograms of Solanum aethiopicum Groups Shum and Gilo, S. macrocarpon and S. melongena under U.V. + ammonia

(0 = no spot; 1 = weak spot; 2 = medium spot; 3 = strong spot)

Spot No.	Group Shum	Group Gilo			S. macrocarpon				S. melongena
	RNL 159	RNL 315	RNL 317	S.2004	S.2045	RNL 057	RNL 142	RNL 096	RNL 066
1	3	3	3	3	1	1	1	2	3
2	2	1	2	2	2	1	1	2	2
3	1	2	2	1	0	0	0	1	1
4	1	0	1	2	2	0	0	0	1
5	1	0	1	2	2	1	0	2	1
6	3	3	3	3	3	2	3	3	3
7	3	3	3	3	3	2	3	3	3
8	2	3	3	2	1	0	2	0	2
9	2	2	2	2	1	2	1	2	2
10	1	1	0	0	0	2	1	0	0
11	1	0	1	2	2	0	0	1	1
12	3	2	3	3	3	2	2	2	2
13	2	2	0	1	3	0	0	2	2
14	2	0	0	0	0	0	0	0	0
15	1	0	0	0	0	0	0	0	0

Table 11 continued

16	0	0	0	0	0	0	0	0	2
17	0	2	3	2	0	3	3	1	3
18	0	0	2	1	0	2	1	2	3
Total No. of Spots	15	11	13	14	11	10	10	12	15

3.2.2 Amino acid analysis of the leaves and fruits

Results of the analysis are shown in Tables 12 and 13. The first column for each accession contains the amount of each amino acid found present in the sample on a percent weight per weight basis (dry weight). The second column shows the percent amino acid of the total protein in the sample.

The general pattern was that the amount of amino acids in the leaves was about twice as much as that in the fruits. Glutamine was consistently the highest except in the S. macrocarpon leaf where proline was the highest. Cystine on the other hand was not detectable in any of the samples. Among all the amino acids present, methionine was equally consistently the lowest. There were no appreciable differences in the amounts of amino acids present between the accessions. However, S. incanum registered the highest amounts of almost all the amino acids all through.

3.2.3 Alkaloid analysis of the leaves

The results from the spectrophotometric determination of solasodine showed no distinct pattern of relationship to the use of the leaves. Based on the mg/gm of fresh weight in S. aethiopicum Group Gilo was on the average 0.42. This was almost comparable to the amounts found in Group Shum (0.50 mg/gm fresh weight) and S. macrocarpon (0.35 mg/gm fresh wt.) S. anguivi had an average Solasodine content of 0.65 mg/gm fresh weight while S. melongena had 0.24 mg/gm fresh weight. Group Kumba on the other hand had an average value of 0.68 mg/gm fresh weight which apparently was the highest.

Groups Shum and Kumba, whose leaves are edible, showed relatively high solasodine content which would possibly indicate that selection for

edible leaves could have been based on high alkaloid content. Only some cultivars of S. macrocarpon Group Macrocarpon, with edible leaves, fit this pattern. S. melongena whose edible part of the plant is the fruit, had the lowest solasodine content in the leaves.

Table 12 Protein and amino acid content in gr/100gr w/w and amino acids as percentage of total protein of dried leaves and fruits of African eggplant taxa

Amino Acids	Dasy. 032 LEAF		Macro. 052 FRUIT		Macro. 052 LEAF		Shum 159 LEAF		Kumba 187 FRUIT		Kumba 187 LEAF		Kumba 214 LEAF		Gilo 315 FRUIT		Gilo 315 LEAF		S.incanum 337 LEAF	
Aspartic acid	1.69	10.10	0.73	9.85	2.10	9.33	1.79	9.32	0.90	9.90	1.98	9.56	1.98	9.04	1.27	10.90	1.85	9.69	2.05	10.1
Threonine	0.76	4.52	0.34	4.78	0.92	4.09	0.88	4.58	0.39	4.29	0.97	4.69	0.97	4.43	0.48	4.14	0.87	4.55	0.86	4.24
Serine	0.79	4.70	0.40	5.63	0.95	4.22	1.02	5.31	0.49	5.39	0.98	4.73	1.10	5.02	0.58	5.00	0.95	4.97	1.01	4.98
Glutamine	2.38	14.20	1.09	15.30	2.36	10.50	2.57	13.40	1.81	19.90	2.69	13.00	2.78	12.70	2.30	19.80	2.84	14.90	2.65	13.0
Proline	1.21	7.20	0.46	6.47	3.44	15.30	1.07	5.57	0.51	5.61	1.14	5.50	1.50	6.85	0.65	5.60	1.10	5.76	1.27	6.26
Glycine	0.83	4.94	0.33	4.64	1.00	4.44	0.93	4.84	0.37	4.07	1.01	4.88	1.08	4.93	0.46	3.96	0.93	4.87	1.05	5.17
Alanine	0.98	5.83	0.47	6.61	1.44	6.40	1.20	6.25	0.51	5.61	1.41	6.81	1.60	7.31	0.60	5.17	1.14	5.97	1.30	6.40
Cystine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Valine	1.03	6.13	0.44	6.19	1.32	5.87	1.16	6.04	0.51	5.61	1.23	5.94	1.32	6.03	0.68	5.86	1.08	5.65	1.24	6.11
Methionine	0.21	1.25	0.07	0.98	0.32	1.42	0.29	1.51	0.10	1.10	0.32	1.55	0.36	1.64	0.10	0.86	0.24	1.26	0.35	1.72
Isoleucine	0.86	5.12	0.38	5.34	1.07	4.75	0.99	5.16	0.46	5.06	1.04	5.02	1.13	5.16	0.62	5.34	0.94	4.92	1.05	5.17
Leucine	1.49	8.87	0.61	8.58	1.80	8.00	1.83	9.53	0.73	8.03	1.94	9.37	2.03	9.27	0.94	8.10	1.77	9.27	1.94	9.56
Tyrosine	0.71	4.23	0.22	3.08	0.93	4.13	0.93	4.84	0.29	3.19	1.00	4.83	1.06	4.84	0.36	3.10	0.92	4.82	0.96	4.73
Phenylalanine	1.09	6.49	0.35	4.92	1.41	6.27	1.27	6.61	0.43	4.73	1.37	6.62	1.40	6.39	0.60	5.17	1.26	6.60	1.35	6.65
Histidine	0.47	2.80	0.27	3.80	0.75	3.33	0.57	2.97	0.43	4.73	0.57	2.75	0.60	2.74	0.39	3.36	0.53	2.77	0.54	2.66
Lysine	1.14	6.79	0.53	7.45	1.27	5.64	1.41	7.34	0.66	7.26	1.54	7.44	1.49	6.80	0.87	7.50	1.34	7.02	1.28	6.30
Arginine	1.15	6.85	0.42	5.91	1.45	6.44	1.32	6.87	0.47	5.17	1.46	7.05	1.50	6.85	0.67	5.78	1.32	6.91	1.37	6.75
TOTAL	16.8		7.11		22.5		19.2		9.09		20.7		21.9		11.6		19.1		20.3	

Footnotes:

First column of each accession: Protein and amino acid content

Second column of each accession: Amino acid content as percentage of total protein

Table 13

Total Protein and essential Amino acids of leafy Vegetables

Essential Amino Acids (g) 16gm	Broccoli	Cabbage	Lettuce	Spinach	Eggplant
Cystine	1.1	1.1	-	1.6	0
Methionine	1.4	1.0	1.8	2.1	1.5
Lysine	5.1	3.1	3.8	7.3	6.7
Isoleucine	4.3	3.1	3.8	4.9	5.0
Leucine	5.5	5.3	6.3	9.5	9.1
Phenylalanine	4.1	3.0	5.1	6.1	6.5
Tyrosine	-	1.8	2.7	5.0	4.6
Threonine	3.7	3.8	4.1	5.3	4.4
Tryptophan	1.1	-	-	-	-
Valine	4.9	4.2	5.4	6.1	6.0

4. DISCUSSION

4.1. Study of morphological characters

4.1.1. Numerical Taxonomy

In order to summarise and make sense of the diversity of organisms the taxonomist customarily constructs a taxonomic hierarchy in which a taxon occupies a position in a nested scheme (Dunn and Everitt, 1982). The hierarchy is intended to illustrate that different species within a given genus are more similar to one another than to species of other genera. In the current study, however, the concern was with one genus, Solanum, and basically one species, S. aethiopicum. Other species, like S. anguivi, were included for comparative purposes. In the species S. aethiopicum, there were Groups Gilo, Shum, Kumba and Aculeatum. The study concentrated on the first three groups.

It might be possible to pose one question at this juncture that was raised at the onset of the study. Is it possible, through the study of morphological characters, to separate or identify Groups Gilo, Shum and Kumba in a conglomeration of accessions? When the data were subjected to Principal component analysis, to Euclidean distance squared and Ward's method of cluster analysis it was possible to observe a separation of the accessions belonging to different groups. Barring the fact that there was a continuum of accessions at the central axis and that there was no discrete separation, it is still possible to see a directional grouping of the OTU's in some clusters (Figures 6 and 8). The fact that there is no clear-cut separation or grouping implies that there are ties that keep them together. Evidence from S.E.M. and other studies also shows that Groups Gilo, Shum and Kumba have much in common that tend to show that they belong to one species, S. aethiopicum. It can be seen from Figures 8 and 9 that even S. anguivi is not distantly related to these groups.

The variations that have been expressed among various accessions in Group Gilo, for example, through cluster analysis,would support the submission that morphotypes or cultivars can be identified. OTU's which have similar characters tend to fuse with one another in the dendograms. An example can be cited (Figure 7) whereby accessions RNL 011, RNL 258, RNL 300, RNL 296, RNL 308, RNL 254, RNL 255A, RNL 159 and RNL 134 have formed one cluster. The OTU's are characterised, among others, by absence of prickles, small leaves and low lobing percentages. It might be argued that accessions RNL 159 and RNL 134 are after all belonging to Group Shum while the rest of the accessions belong to Group Gilo. Looking at the clustering pattern, it will be seen that these two accessions fused onto the rest a bit later (or at a higher level).

Numerical taxonomy aims at producing an objective classification but is partially dependent upon the nature and choice of characters. One of the unfortunate tendencies is the weighting of characters whereby some characters are given greater or lesser importance than others. (for example if several characters are highly correlated.)

This tends to distort the degree of relationship of the OTUs especially if one of the OTU's does not have these particular characters. This statement can be exemplified in the present study by prickle characters. Analysis 1 (Figure 6) had the first principal component being chiefly affected by ten prickle characters (Table 6). These were also found to be highly correlated and might have been due to pleiotropic expression of one or a few genes. This could have exaggerated the distinction between prickled and non-prickled OTUs. As such, care needs to be taken when choosing the characters for numerical taxonomy.

All in all, the study of morphological characters of the OTU's used in the current work showed that it is possible to identify or group morphotypes or cultivars within any of the Groups Gilo, Shum and Kumba. Secondly, it is possible to separate some of the accessions belonging to one group from the others. Thirdly, the separation of these accessions is not fully into discrete groups. They form a continuum indicating a close relationship among the groups constituting the species S. aethiopicum L. S. anguivi is also closely related to S. aethiopicum. Looking at the characters of S. anguivi and S. aethiopicum it might be possible to assess the trend of domestication of S. aethiopicum. Since fruit characters were not studied it might be tempting to draw a wrong conclusion.

4.1.2. Variation between and with accessions

Through the analysis of variance of twenty-two characters studied it was possible to assess whether some of the characters used both in numerical taxonomy and descriptor lists are useful in differentiating accessions. There were some characters which were significant between accesssions but not so within accessions (Tables 8 & 9). One would infer that such characters could be used effectively when separating accessions.

Among characters falling under this category were petiole length, petiole width, leaf length, leaf width, leaf length/width ratio, corolla length, pedicel length and w-tip. Looking back at the principal component analysis (Tables 6&7) most of these characters contributed highly to separation of the OTU's in the principal component during the combined analysis.

There were other characters which were significant both between and within accessions. Such characters would not be reliable, when separating accessions as even plants belonging to the same accession could be grouped into different accessions on the basis of such characters.

During the analysis of variance, one character, corolla length/ corolla lobe width, was significant within accessions but not between accessions. This implies that with such a character, there were more variations between plants within accessions than between accessions. Other characters were neither significant between accessions nor within accessions. These characters are therefore not likely to differentiate accessions very well.

Although the experiment for this study was not systematically designed, it indicates all the same that some characters might not be suitable as decriptors. However, a better designed experiment with ample randomisation is recommended and further studies encouraged.

4.1.3. Scanning Electron Microscopy of enzyme-etched seeds

In this study, it was found that within S. aethiopicum there were minor variations in the internal structures between groups especially the fibrils and the pits. Group Shum, however, seemed to have enzyme resistant cuticle which when eventually etched tended to be over-etched becoming thin and bristly. S. macrocarpon and S. melongena showed differences from S. aethiopicum and S. anguivi. The fibrils in S. macrocarpon and S. melongena fused into a curtain although they were initially parallel or divergent. S. aethiopicum, S. macrocarpon and S. melongena could be fairly easily distinguished while S. anguivi could not easily be distinguished from S. aethiopicum.

4.1.4. Crossability studies:

Formation of fruits between crosses of Groups Gilo, Shum and Kumba suggested that there were no genetic barriers between them. However, pollen stainability studies of F_1 would confirm the successfulness of these crosses. This tends to agree with the findings of Nsowah (1969), Omidiji (1982), Attavian (1983) and Lester and Niakan (1983).

4.1.5. Biochemical Studies:

From chromatographic studies, there were no variations within members of S. aethiopicum. There were very few variations between S. aethiopicum and S. macrocarpon and S. melongena. Most spots were common to all. Possibly, chromatography is not a good method for investigating variations between different types of eggplants.

Studies from the protein and amino acid content showed that the leaves had higher amounts than fruits (Tables 12 and 13). It was also found that the amounts of essential amino acids were comparable to those in other leafy vegetables (Table 13). The eggplant leaves had higher amounts of essential amino acids than those present in the leaves of broccoli, cabbage and lettuce, but almost the same as those found in spinach.

5. CONCLUSION

Conclusions may be drawn from the present studies in conjunction with previous work by other scientists. The areas studied included numerical taxonomy, analysis of variance between and within accessions and scanning electron microscopy of enzyme-etched seeds. Other studies were cross-ability between accessions, flavonoids, amino acid analysis and alkaloids.

There were three hypotheses at the onset of the study. The first one was that all the species of the eggplant were a single species, which included Solanum aethiopicum, S. macrocarpon, S. melongena and some other taxa. The second hypothesis was that these were three distinct species. The third was that each Group, Gilo, Shum, Kumba and Aculeatum which constitute S. aethiopicum, and S. anguivi were distinct species by themselves.

On the basis of the findings from morphological studies several conclusions can be drawn. The first and foremost is that there is a very wide range of genetic diversity with the species S. aethiopicum L. and that the groups within this species though distinct are closely related: Group Gilo has the widest genetic diversity. Members of Groups Gilo, Shum and Kumba are closely related to S. anguivi, which is probably the progenitor of S. aethiopicum (Lester and Niakan, 1983). The evidence emanates from numerical taxonomy and scanning electron microscopy.

During domestication, man selected different groups for different uses. Group Gilo was selected for its edible fruits, Group Shum for its leaves and Group Kumba for both fruits and leaves. There could have been disruptive selection pressures which tend to maintain S. aethiopicum and S. anguivi as separate taxa.

Evidence from crossabilities (Lester and Niakan, 1983) indicates that there are no genetic barriers between Groups Gilo, Shum and Kumba nor even S. anguivi. However, members of each group can fairly easily be identified and differentiated from the others.

Morphotypes or cultivars within each group can also be identified. From the preliminary studies of variations between and within accessions it was shown that some characters are useful in differentiating morphotypes, but other characters could be misleading and are not likely to be good descriptors.

From the plant genetic resources point of view, it is important to describe and name cultivars although most of the previous workers have made no attempts to name cultivars of african eggplants as is done with most other cultivated species.

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APPENDIX 1

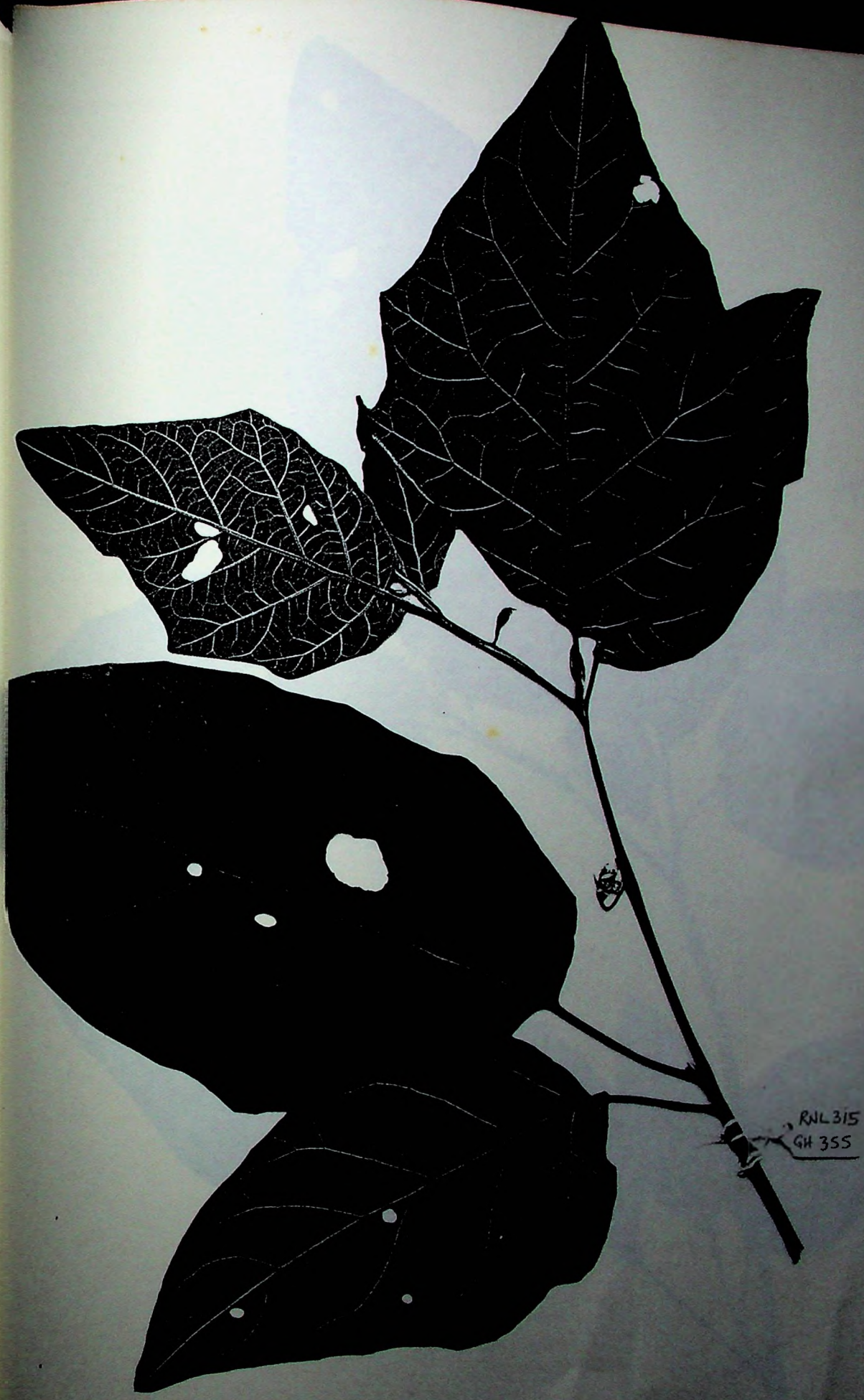
HERBARIUM SPECIMENS

RAL 134
E 192

Solanum aethiopicum Group Shum

Solanum aethiopicum Group Shum

Solanum aethiopicum Group Gilo



Solanum aethiopicum Group Gilo

Solanum aethiopicum Group Gilo

Solanum aethiopicum Group Gilo


S2002


290
Solanum aethi

Solanum aethiopicum Group Gilo

Solanum aethiopicum Group Gilo

Solanum aethiopicum Group Gilo

Solanum aethiopicum Group Gilo

Solanum anguivi / aethiopicum Group Gilo

Solanum aethiopicum Group Gilo

APPENDIX 11

RAW DATA

MORPHOLOGICAL DATA FROM ACCESSIONS OF SOLANUM AETHIOPICUM ETC 1983

(COMBINED DATA FROM MAKIZA & STAVROPOULOS SORTED BY TAXA)

CHARACTERS

OTU 50 60

SOLANUM AETHIOPICUM GROUP GILO

OTU																							
RNL011	19	07	71	0	115	010	008	125	1	80	080	000	000	000	00	1	04	1	3	04	6	00	000
RNL135	24	10	72	1	141	070	027	259	1	50	110	000	000	000	01	1	07	1	3	04	7	00	000
RNL165	22	10	66	0	103	000	000	000	0	90	100	000	000	000	01	5	07	1	2	03	5	00	000
RNL166	21	09	86	1	107	000	000	000	0	70	079	000	000	000	00	0	09	1	1	04	7	00	000
RNL168	22	08	94	0	131	000	000	000	0	60	115	000	000	000	00	0	06	1	4	05	6	00	000
RNL179	17	07	11	1	090	000	000	000	0	30	050	000	000	000	00	0	07	2	4	08	6	00	000
RNL180	12	07	08	1	100	000	000	000	0	45	085	000	000	000	00	0	08	2	4	06	7	00	000
RNL196	12	11	34	0	060	025	010	250	1	30	065	000	000	000	00	0	07	2	3	04	5	00	000
RL228A	16	14	99	0	099	030	016	188	5	30	078	010	005	200	05	5	06	1	4	02	6	00	000
RL228B	15	11	80	0	097	070	020	350	1	40	080	030	016	188	01	0	04	1	2	02	6	00	000
RNL229	15	08	67	0	114	060	027	222	1	70	200	010	003	333	00	0	06	1	4	03	6	00	000
RNL242	23	11	91	0	142	030	020	150	1	50	140	000	000	000	00	0	05	1	4	03	5	00	000
RNL252	15	09	61	0	070	025	010	250	1	45	055	010	001	999	00	0	06	1	4	3	6	00	000
RNL253	12	05	48	0	094	055	022	250	1	65	060	060	020	300	04	0	05	1	4	03	6	00	000
RNL254	15	07	37	0	135	050	012	417	1	60	093	000	000	000	00	0	07	1	4	04	6	00	000
RL255A	14	08	34	0	128	030	005	600	1	75	098	040	010	400	00	0	06	1	4	03	6	00	000
RL255B	19	13	99	0	126	051	012	425	5	80	060	000	000	000	00	5	05	1	3	02	6	00	000
RNL257	21	09	69	0	106	035	019	164	1	40	125	000	000	000	01	0	06	1	4	04	7	00	000
RNL258	20	08	65	0	118	000	000	000	0	60	130	000	000	000	00	0	08	1	3	04	6	00	000
RNL266	19	09	64	0	115	067	019	351	1	50	060	015	010	999	00	0	06	1	3	04	6	00	000
RNL270	16	07	53	0	107	040	016	250	1	60	045	000	000	000	02	0	05	1	3	02	5	00	000
RNL271	14	10	91	1	121	040	013	308	1	50	085	000	000	000	00	0	04	1	1	03	6	00	000
RNL285	19	10	85	0	121	040	012	333	1	60	080	000	000	000	02	0	06	1	3	02	6	00	000
RNL286	23	09	76	0	133	030	010	300	1	70	200	000	000	000	02	0	05	1	3	06	5	00	000
RNL288	17	10	88	1	135	015	010	150	1	55	103	000	000	000	00	0	05	1	3	04	5	00	000
RNL290	19	09	64	0	107	040	030	133	1	60	095	000	000	000	09	0	05	1	2	04	5	00	000
RNL292	16	09	97	0	145	040	010	400	1	45	068	002	005	040	03	0	05	1	3	08	5	00	000
RNL296	18	10	58	1	116	065	031	210	1	60	043	000	000	000	00	0	06	1	4	03	6	00	000
RNL297	22	11	62	0	117	030	006	500	1	60	093	000	000	000	00	0	07	1	3	05	6	00	000
RNL300	20	12	63	0	101	050	011	455	1	90	140	000	000	000	00	0	05	1	4	05	6	00	000
RNL302	14	10	40	0	064	030	000	000	0	80	028	000	000	000	00	0	07	1	4	05	7	00	000
RNL304	19	09	62	1	725	045	022	225	1	50	170	050	020	250	2	00	08	1	4	06	5	00	000
RNL307	13	13	94	0	117	035	007	500	1	80	130	010	006	167	04	0	07	1	4	03	6	00	000
RNL308	21	08	71	0	121	040	018	250	1	60	110	010	005	200	03	0	06	1	4	04	6	00	000
RNL309	16	09	91	1	142	040	010	400	1	70	170	010	001	959	01	0	06	1	4	04	5	00	000
RNL310	25	11	68	1	145	050	020	250	1	60	130	010	005	020	02	0	06	1	3	03	6	00	000
RNL314	21	12	95	0	119	040	012	333	1	90	125	010	001	999	02	0	05	1	3	02	5	00	000
RNL315	20	09	82	0	140	053	019	279	1	60	120	010	001	955	01	0	07	1	3	04	6	00	000
RNL316	17	08	64	0	126	040	011	364	1	50	088	010	001	999	02	0	08	1	3	05	5	00	000
RNL317	22	10	81	0	131	070	030	233	1	80	160	000	000	000	00	0	04	1	2	03	5	00	000
RNL341	25	15	50	1	080	000	000	000	0	33	045	000	000	000	00	1	09	2	1	05	6	00	000
RNL342	14	08	37	1	105	000	000	000	0	20	055	000	000	000	05	0	08	1	3	09	7	00	000
RNL345	17	09	47	1	075	000	000	000	0	42	035	000	000	000	07	1	10	2	3	06	5	00	000
RNL346	21	10	47	1	072	000	000	000	0	35	026	000	000	000	00	1	08	1	2	05	6	00	000
RNL347	17	11	37	1	073	000	000	000	0	35	080	000	000	000	00	1	08	1	1	04	6	00	000
RNL348	16	10	34	1	068	000	000	000	0	37	024	000	000	000	00	1	06	1	1	05	7	00	000
RNL349	15	14	74	1	075	010	003	333	1	35	120	000	000	000	02	1	06	2	4	04	5	00	000
RNL351	14	08	47	1	102	025	010	250	1	55	110	000	000	000	00	1	07	1	4	04	6	00	000
RNL353	16	13	77	1	084	040	020	200	1	32	120	040	020	200	15	3	10	1	3	02	5	00	000
RNL359	19	03	55	1	077	020	010	200	1	62	140	000	000	000	08	0	07	1	2	05	6	00	000
S1234	17	07	38	0	090	060	020	300	1	60	060	040	020	200	07	1	06	1	3	02	5	00	000
S 2002	23	07	21	0	086	000	000	000	0	60	030	000	000	000	00	0	08	1	3	08	5	00	000

SOLANUM ANGUIVI (& S.ANGUIVI - S.AE. GILO ?)

OTU																							
RNL197	17	12	63	1	090	020	005	400	1	30	023	000	000	000	00	0	05	1	2	03	5	00	000
RNL198	14	15	77	0	085	030	010	300	1	50	055	000	000	000	04	3	05	1	2	02	5	00	000
RNL245	16	11	92	0	104	050	015	333	1	50	050	037	016	231	14	0	05	1	4	02	7	00	000
RNL273	14	09	69	1	103	040	014	286	1	60	098	030	009	333	06	0	05	1	4	03	5	00	000
RL293A	17			0	123	060	014	429	1	40	070	040	010	400	04	5	05	1	4	03	5	00	000
RL293B	16	11	99	0	111	060	015	400	1	50	180	030	009	333	10	0	05	1	3	04	5	00	000
RNL294	15	10	94	0	115	060	017	353	1	50	088	030	013	231	05	0	05	1	2	03	5	00	000
RNL352	19	12	64	1	081	000	000	000	0	30	065	000	000	000	04	1	05	1	3	02	5	00	000
RNL355	20	12	63	0	077	000	000	000	0	65	070	000	000	000	00	1	05	1	3	02	5	00	000
S 2004	15	09	33	0	066	000	000	000	0	90	045	000	000	000	00	0	05	1	3	02	5	00	000

SOLANUM AETHIOPICUM GROUP SHUM

OTU																							
RNL134	14	08	46	0	071	000	000	000	0	70	000	000	000	000	00	0	04	1	3	02	6	00	000
RNL159	12	05	23	0	099	000	000	000	0	20	000	000	000	000	00	0	05	1	3	02	5	00	000
RNL340	25	12	38	1	077	000	000	000	0	45	000	000	000	000	04	1	05	2	2	02	5	00	000
RL343A	09	07	12	1	033	000	000	000	0	25	000	000	000	000	00	0	04	1	2	03	5	00	000
RL343B	12	13	42	1	097	000	000	000	0	40	000	000	000	000	00	3	05	2	2	02	5	00	000
RNL344	22	08	18	1	123	000	000	000	0	35	000	000	000	000	00	3	05	1	3	04	5	00	000
RNL356	21	06	36	1	057	000	000	000	0	45	000	000	000	000	00	3	05	1	2	02	5	00	000

SOLANUM AETHIOPICUM GROUP KUMBA

OTU																							
RNL170	16	04	15	1	070	000	000	000	0	40	000	000	000	000	00	3	15	1	4	15	6	00	000
RNL175	16	06	11	1	080	000	000	000	0	40	000	000	000	000	00	3	09	1	4	11	7	00	000
RNL176	14	08	26	1	100	000	000	000	0	45	000	000	000	000	00	3	08	1	4	10	8	00	000
RNL177	13	04	19	1	100	000	000	000	0	13	000	000	000	000	00	3	08	1	4	09	6	00	000
RNL178	16	07	13	1	095	030	030	010	0	45	000	000	000	000	00	3	10	1	2	07	7	00	000
RNL181	18	09	23	1	075	000	000	000	0	40	000	000	000	000	00	3	09	1	4	09	6	00	000
RNL183	19	07	19	1	095	000	000	010	0	30	000	000	000	000	01	1	12	1	4	15	8	00	000
RNL184	19	07	15	1	105	000	000	000	0	50	040	000	000	000	00	3	10	1	4	10	8	00	000
RNL186	17	07	20	1	150	000	000	300	0	30	000	000	000	000	00	3	12	1	4	11	7	00	000
RNL187	20	06	10	1	085	000	000	000	0	40	000	000	000	000	00	3	09	1	4	10	6	00	000
RNL188	15	04	13	1	100	000	000	000	0	37	000	000	000	000	00	3	08	1	4	09	6	00	000
RNL190	15	05	10	1	075	000	000	000	0	30	000	000	000	000	00	3	08	1	4	11	7	00	000
RNL191	16	07	19	1	070	030	020	150	5	45	000	030	020	250	02	3	08	1	4	10	7	00	000
RNL193	18	08	15	1	075	000	000	000	0	30	000	050	020	250	02	3	04	1	2	06	5	00	000
RNL194	13	09	41	1	085	000	000	000	0	34	000	000	000	000	00	1	05	1	4	08	6	00	000
RNL200	20	08	21	1	080	005	002	250	1	30	000	010	030	333	06	1	07	2	2	03	6	00	000
RNL201	15	07	17	1	090	000	000	000	0	57	000	000	000	000	00	3	12	2	3	13	7	00	000
RNL202	19	04	26	1	120	000	000	000	0	47	000	010	005	200	00	1	10	1	4	09	6	00	000
RNL204	16	06	29	1	085	030	020	150	1	30	000	000	000	000	00	1	07	1	3	10	7	00	000
RNL205	19	08	29	1	090	000	000	000	0	42	000	000	000	000	00	3	09	1	4	11	5	00	000
RNL206	17	08	22	1	090	000	000	000	0	57	000	000	000	000	00	3	07	1	4	05	6	00	000
RNL207	17	07	10	1	100	000	000	000	0	30	000	000	000	.000	00	1	07	1	4	07	7	00	000
RNL209	17	07	23	1	095	000	000	000	0	38	000	050	020	250	02	1	12	1	4	13	7	00	000
RNL210	18	07	28	1	090	000	000	000	0	27	000	000	000	000	00	1	08	1	4	08	8	00	000
RNL214	18	09	30	1	110	000	000	000	0	40	000	000	000	000	03	1	10	1	4	09	7	00	000
RNL215	17	07	12	1	075	000	000	000	0	55	000	000	000	000	00	1	08	1	4	07	6	00	000
RNL216	17	07	39	1	095	000	000	000	0	45	000	000	000	000	00	1	09	1	3	10	8	00	000
RNL219	15	07	24	1	095	000	000	000	0	50	000	000	000	000	00	1	10	1	3	10	6	00	000
RNL220	18	06	19	1	075	000	000	000	0	57	000	000	000	000	00	1	07	1	4	09	7	00	000
RNL221	20	04	28	1	096	000	000	000	0	40	000	000	000	000	00	1	14	1	4	08	7	00	000
RNL222	14	05	10	1	095	000	000	000	0	40	000	000	000	000	00	1	05	1	4	07	6	00	000
RNL223	17	07	18	1	100	000	000	000	0	45	000	000	000	000	00	3	10	1	4	09	6	00	000
RNL224	24	08	24	1	084	000	000	000	0	45	000	000	000	000	00	3	05	1	3	10	7	00	000
RNL260	24	06	22	1	115	000	000	000	0	45	000	000	000	000	00	0	05	1	2	10	7	00	000
RNL350	14	07	12	1	077	000	000	000	0	50	000	000	000	000	00	3	12	1	4	13	9	00	000
RNL354	18	10	24	1	073	000	000	000	0	60	000	000	000	000	00	3	08	1	4	11	8	00	000
RNL357	14	05	11	1	045	010	003	333	1	55	000	060	025	240	12	3	08	1	4	09	7	00	000

SOLANUM (OTHER SPECIES)

OTU																							
RNL358	16	07	37	0	140	070	020	350	1	60	010	090	050	180	04	0	6	1	1	05	3	03	030
S 1331	15	05	30	0	100	070	050	140	5	50	020	120	050	240	02	0	3	1	1	06	[illegible]	03	010
RNL182	17	09	27	0	080	030	010	300	1	45	080	030	015	200	07	0	05	2	1	03	5	08	050
RNL213	15	09	14	0	100	000	000	000	0	33	000	000	000	000	00	0	05	1	1	02	5	00	000
RNL326	09	[illegible]	55	0	026	040	010	400	[illegible]	65	050	040	015	270	00	0	05	2	1	07	4	20	070
RNL339	02	11	45	0	049	030	[illegible]	410	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CHARACTERS

OTU 70

SOLANUM AETHIOPICUM GROUP GILO

OTU					
RNL011	000	000	047	238	00
RNL135	000	000	051	149	00
RNL165	000	000	059	139	00
RNL166	000	000	059	142	00
RNL168	000	000	062	216	00
RNL179	000	000	070	143	03
RNL180	000	000	050	140	00
RNL196	000	000	040	230	00
RL228A	000	000	059	168	00
RL228B	000	000	069	155	00
RNL229	000	000	058	181	00
RNL242	000	000	061	164	00
RNL252	000	000	051	161	00
RNL253	000	000	061	190	00
RNL254	000	000	047	149	00
RL255A	000	000	047	223	00
RL255B	000	000	057	140	00
RNL257	000	000	075	180	00
RNL258	000	000	044	203	00
RNL266	000	000	058	128	00
RNL270	000	000	051	122	00
RNL271	000	000	057	177	00
RNL285	000	000	059	173	00
RNL286	000	000	062	141	00
RNL288	000	000	063	148	00
RNL290	000	000	075	133	00
RNL292	000	000	059	149	00
RNL296	000	000	060	143	00
RNL297 (struck through)	000	000	053	144	00
RNL300	000	000	058	195	00
RNL302	000	000	066	142	00
RNL304	000	000	045	224	00
RNL307	000	000	066	158	00
RNL308	000	000	043	173	00
RNL309	000	000	058	159	00
RNL310	000	000	070	154	00
RNL314	000	000	060	185	00
RNL315	000	000	059	122	00
RNL316	000	000	064	172	00
RNL317	000	000	058	211	00
RNL341	000	000	080	169	00
RNL342	000	000	060	108	00
RNL345	000	000	060	172	00
RNL346	000	000	070	193	00
RNL347	000	000	065	108	00
RNL348	000	000	030	180	00
RNL349	000	000	035	111	00
RNL351	000	000	050	100	00
RNL353	000	000	050	160	00
RNL359	000	000	060	091	00
S1234	000	000	050	206	00
S 2002	000	000	076	188	00

SOLANUM ANGUIVI (& S.ANGUIVI - S.AE. GILO

OTU					
RNL197	000	000	060	133	00
RNL198	000	000	050	170	00
RNL245	000	000	069	201	00
RNL273	000	000	054	144	00
RL293A	000	000	065	139	00
RL293B	000	000	070	179	00
RNL294	000	000	071	178	00
RNL352	000	000	053	105	00
RNL355	000	000	035	214	00
S 2004	000	000	067	172	00

SOLANUM AETHIOPICUM GROUP SHUM

OTU					
RNL134	000	000	027	170	00
RNL159	000	000	054	252	00
RNL340	000	000	080	130	00
RL343A	000	000	025	080	00
RL343B	000	000	060	141	00
RNL344	000	000	040	200	00
RNL356	000	000	030	107	00

SOLANUM AETHIOPICUM GROUP KUMBA

OTU					
RNL170	000	000	040	138	08
RNL175	000	000	060	133	06
RNL176	000	000	070	130	04
RNL177	000	000	050	090	03
RNL178	000	000	080	125	04
RNL181	000	000	080	104	05
RNL183	000	000	060	137	08
RNL184	000	000	060	200	05
RNL186	000	000	073	107	06
RNL187	000	000	060	167	03
RNL188	000	000	070	121	04
RNL190	000	000	080	104	07
RNL191	000	000	070	179	03
RNL193	000	000	070	136	02
RNL194	000	000	073	100	03
RNL200	000	000	070	129	00
RNL201	000	000	060	133	05
RNL202	000	000	080	144	03
RNL204	000	000	055	173	05
RNL205	000	000	060	167	08
RNL206	000	000	040	112	00
RNL207	000	000	050	134	04
RNL209	000	000	070	178	16
RNL210	000	000	030	134	03
RNL214	000	000	060	158	03
RNL215	000	000	070	107	04
RNL216	000	000	055	118	06
RNL219	000	000	060	133	05
RNL220	000	000	060	162	08
RNL221	000	000	070	107	03
RNL222	000	000	050	120	04
RNL223	000	000	040	138	04
RNL224	000	000	060	175	07
RNL260	000	000	062	201	00
RNL350	000	000	045	178	04
RNL354	000	000	040	218	09
RNL357	000	000	040	102	03

SOLANUM (OTHER SPECIES)

OTU					
RNL358	010	300	050	250	00
S 1331	010	200	050	150	00
RNL182	010	300	070	121	00
RNL213	000	000	070	038	00
RNL326	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
RNL339	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]