THE GENUS ASTROLOBA UITEWAAL.
(LILIACEAE)

By Pandora Roberts Reinecke, B.Sc. (Hons.).

Being a thesis in fulfilment of the regulations for the Degree of Master of Science, University of Cape Town.

June, 1965.

SUMMARY.

The present work was undertaken to provide a much needed taxonomic revision of the genus Astroloba Uitew. Type material of all previously described species appears to be completely lacking.

This revision was based almost entirely on living material collected by the author. Studies were made of morphological variation, geographical distribution, cytology and ecology.

The morphological studies were based on field population samples. As a result of these studies, seven species and three subspecies were established, of which three species and one subspecies are new : A. rugosa Roberts, A. hallii Roberts, A. smutsiana Roberts and A. foliolosa subsp. robusta Roberts. One new combination is made : A. foliolosa subsp. congesta (Salm-Dyk) Roberts. A new key to the species is given.

Because this genus is so little known, a large number of plates are included.

A new hybrid genus, X Astroworthia Roberts, was established for hybrids between the genera Astroloba and Haworthia Duval. This consists at present of one species, X Astroworthia bicarinata (Haworth) Roberts comb. nov.

THE GENUS ASTROLOBA UITEW.

INTRODUCTION AND APPROACH TO THE PROBLEM.

Astroloba Uitew. (1947), (formerly known as Apicra Duval) is a small genus of succulent plants confined to the South central, Southern and Eastern karoid areas of the Cape Province. Since Berger's work on the Aloinae (1908), the only work on the genus to date, has been done by overseas succulent enthusiasts who have been unable to study populations in the field.

The similar facies of all members of this genus makes the delimitation of species a difficult problem. Early type descriptions, as will be shown later, were in most cases inadequate, seldom accompanied by an illustration, and taken from living plants which were not preserved as herbarium specimens. This has resulted in considerable confusion over interpretation of the described species.

The present author found it necessary to begin this revision of the genus by establishing, de novo, what she herself considered to be taxa of at first unspecified status. Succulent plants make poor herbarium specimens and herbarium material of Astroloba, apart from being scant, is no exception to this rule. Accordingly, this revision has been based almost entirely on living material collected by the author.

In the field, plants of Astroloba do not occur singly but in varying numbers over limited areas where they are numerically conspicuous components of the vegetation. With a few exceptions, these populations are uniform. Groups of them have sufficient characters in common to justify the recognition of each group as a taxon of unspecified status. These groups of related populations were used by the present author as a working basis for her reassessment of the specific concept in Astroloba. In the text they are referred to as <u>entities</u>, and, until their taxonomic position has been established, they are indicated by an underlined epithet, e.g.: <u>bullulata</u>.

ACKNOWLEDGEMENTS.

The author wishes to extend her grateful thanks to the many people who have assisted in the present work.

This thesis was prepared under the supervision of Dr. E.A.C.L.E. Schelpe, and the author is most grateful to him for his kind help and guidance.

Most of the photographs of leafy shoots and flowers were taken by Dr. A.V. Hall, Mr. A. Fricke and Mr. D. Williams. The microphotographs were all taken by Mr. D. Williams. The author is very grateful to them for their patient co-operation.

A special debt of gratitude is owed to Mr. H. Hall of Kirstenbosch, who kept many of the plants collected by the author under cultivation at Kirstenbosch, and to Mr. J. Stayner of the Karoo Gardens, Worcester, who provided helpful information on field localities of species, and who was instrumental in bringing to the notice of the author, a locality for the naturally occurring hybrid X Astroworthia bicarinata (Haw) Roberts comb. nov.

The author also wishes to thank Mr. D. Comins for sending material from the Albany district.

The author is extremely grateful to Mr. Solms van Niekerk for the loan of a photocopying machine and other office equipment.

The undertaking of this research was made possible by the grant of a Fellowship from the Smuts Memorial Foundation.

Detailed knowledge of these entities made it possible to associate certain of them with previously described taxonomic categories. These are bullulata, spiralis, herrei, congesta, foliolosa and rugosa, (which was erroneously named Aloe aspera by Salm-Dyk (1836-63)). Other entities recognised by the present author are hallii, smutsiana and robusta.

Grounds for the superficial recognition of these entities are given below.

The entities spiralis and herrei are distinguished by the fact that both have an inflated perianth, and are separated by the presence of fine striations on the leaves of herrei, which are absent from the leaves of spiralis, and by the fact that the perianth in spiralis is very markedly transversely rugose.

The nature of the leaf surface divides the remaining entities into two groups.

The entities foliolosa, congesta and robusta have leaves with a glossy sheen. Of these three, the entity robusta has characteristically thick peduncles, long floral bracts and predominately sessile flowers. The leaves of the entity foliolosa tend to be shorter and more rounded than those of the entity congesta, as well as more patent and imbricate in arrangement.

The remaining entities have leaves with a matt sheen. of these, the entities bullulata, hallii and rugosa have some or all individuals with tuberculate leaves. The leaves of the entity rugosa are the smallest of the three, and have apices of the true marginate type (see page 14). Both the entities bullulata and hallii have the majority of leaves with keeled-marginate apices. The leaves of bullulata tend to be broader than hallii, and with the tubercles transversely arranged. In hallii the tubercles tend to be in longitudinal series, and further there are fine striations on the under surfaces of most leaves.

The remaining entity, smutsiana, has no tubercles and leaves with true marginate apices, but sometimes the leaves do have fine striations on their under surfaces towards the apex.

A short account of the plan of this thesis now follows. First a survey of the morphology and anatomy in the genus as a whole

is given. It is hoped that this will confirm for the reader the recognition by the author of the groups of populations referred to as entities. From this survey, similarities between certain entities are established and various groups are recognised.

A detailed discussion of the distribution of the entities then follows.

Because of the ease with which leafy shoots strike root, cytological material was readily available, and as far as possible a cytological survey was also made. An account of the cytology of the entities follows the account of entity distribution.

Then, a more detailed examination of the various groups of related populations is given. From this it is possible to assess their taxonomic position. This is followed by a survey of the literature and taxonomic history of the genus.

The thesis concludes with a key to, and descriptions of, the species according to the present author, accompanied by their synonomy and citation of specimens examined.

Note on representation of numerical data.

The actual measurements of the various characters are given in the appendix. In the text these are expressed in a more compact and comprehensive form in tables.

In each table the range covered by the measurement is divided into appropriate classes, and the number of individuals occurring in each class is shown. The range of classes and the number of individuals in each class are shown under the heading: "Class range of measurements." in the tables. These tables gives more information than the histograms usually used to demonstrate the same point, and, in the author's opinion, are easier to assess visually, especially when taking into consideration the unevenness of sample size often met with in a survey of a taxonomic nature. Also included is the range of actual measurements for each sample. In the text the class or classes including the greatest number of individuals is, for the sake of brevity, sometimes referred to as the "majority range".

It is felt that this gives an adequate picture of the variation patterns within each group. From these tables, the taxonomic significance of the various measurements may be determined by inspection of the data thus presented. It is felt that in this case there is no need for a further assessment by statistical methods.

ASSESSMENT OF CHARACTERS IN THE GENUS AS A WHOLE

Note. Throughout this survey, population samples collected by the author are described by a collecting number and preceded by the letter "R".

A. VEGETATIVE CHARACTERS.

1. PLANT HABIT AND GROWTH

All the species of Astroloba have a caulescent habit, with adventitious roots at the base of the stem, and crowded mucronate leaves, the bases of which completely encircle the stem. The number of stems constituting a single plant varies - up to fifty have been recorded. Stem lengths of up to 60 cm. have been recorded in plants growing supported by bushes, notably in the entity rugosa, but leafy shoots growing unsupported in the open are generally less than 30 cm. in height. As the leafy stem increases in length, the basal portion comes to lie on the ground and develops adventitious roots.

It has been observed that all species for the most part only flower once a year, producing usually a single raceme. The peduncles are persistent, and thus a count of leaves between them gives an estimate of the number of leaves produced annually. This is found to be between five and eight, indicating growth to be quite slow.

2. LEAF ARRANGEMENT.

Because of crowding of leaves at the growing apices and because the developing leaf tends to be triangular in shape, the under surface of a fully developed leaf is keeled, the keel extending from the leaf apex for about two-thirds of the leaf length. (See Figs. 1A, and 2A and B.)

The leaves are alternate and spirally arranged with the keel always slightly to one side of the leaf depending upon the direction of the genetic spiral. If this is acropetally anti-clockwise, then the keel is situated to the left of the leaf undersurface (see Fig. 1B) and vice versa.

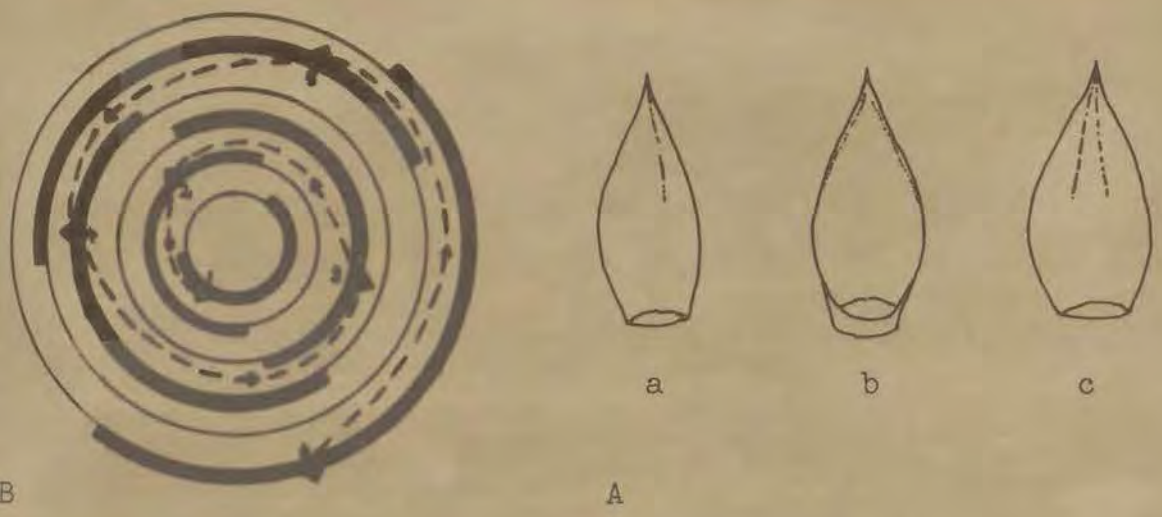


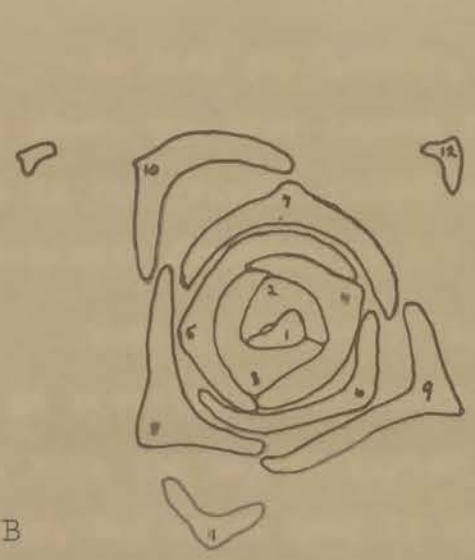
Fig.1.A: Leaves from a plant of the entity robusta (R67) X1; a lower side of leaf showing keel; b upper side of leaf; c lower side of leaf with two keels.

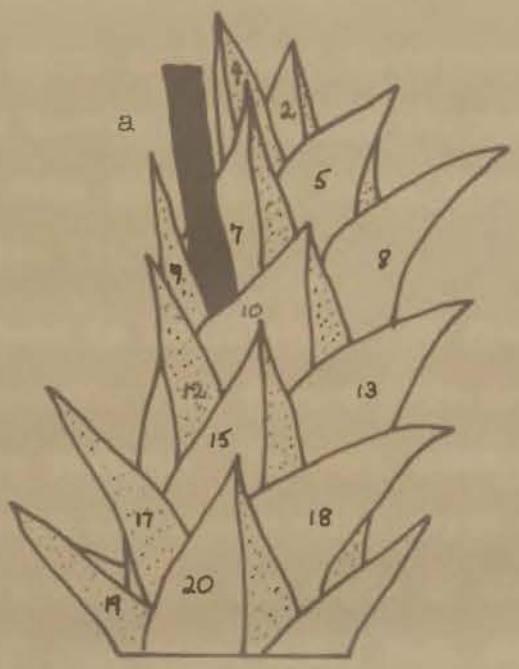
B: Diagram of phyllotaxy of six successive leaves from the apex of a shoot of the entity herrei (R46).

Plants of the entity rugosa from Dobbelaars Kloof (R21), with leaves in five straight ranks. (The spiral angle is 0-10°).

Plants of the entity smutsiana from the Ladismith-Barrydale Karoo. Here the five ranks of leaves are spirally twisted. In the specimen on the right, the leaves are so spirally twisted, that they appear imbricate.

PLATE 1.





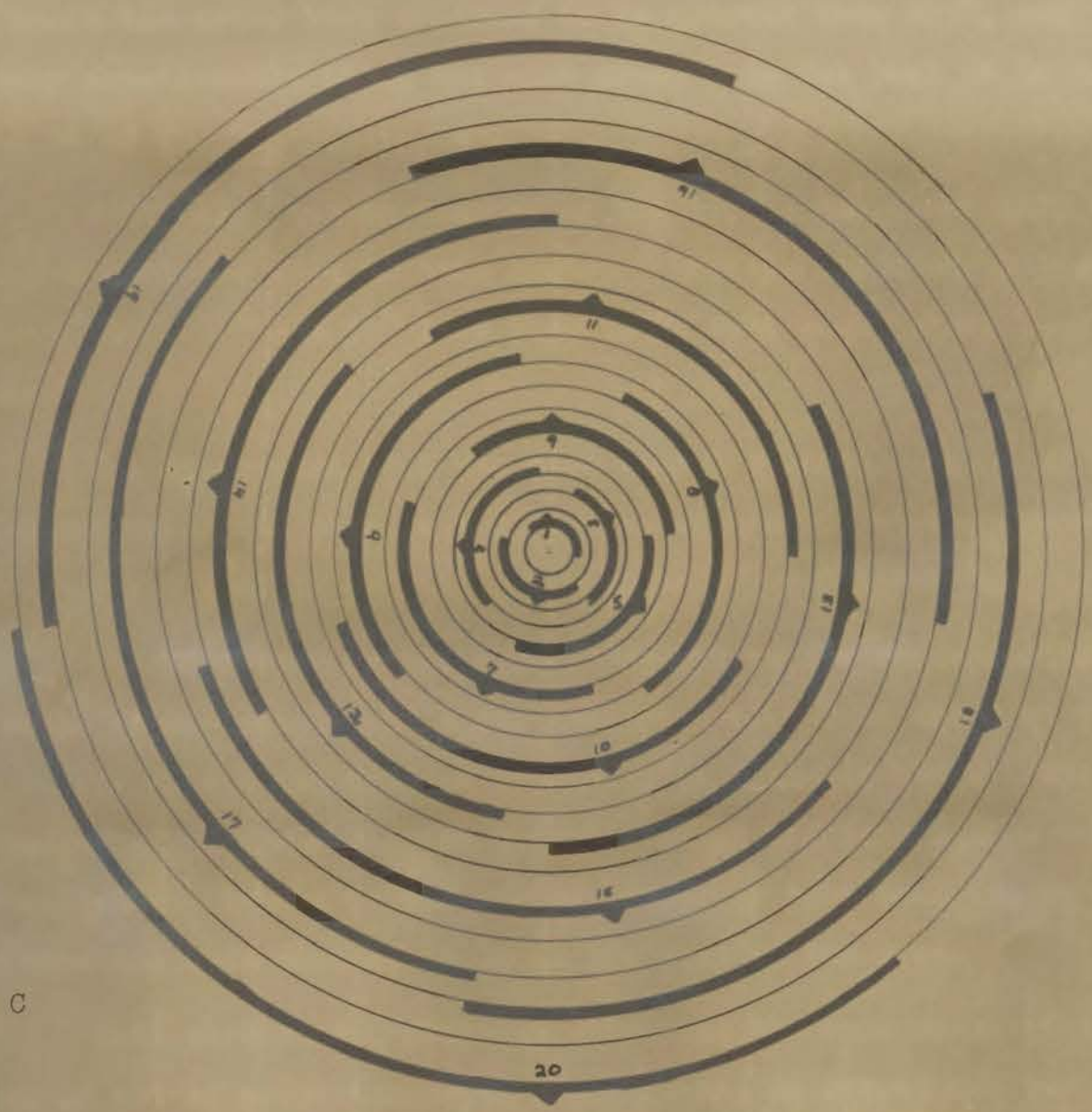


Fig.2.A: Apex of shoot of the entity robusta (R67), showing the leaf arrangement (X 1½). The keel side is shaded; a old peduncle base. B: Section through apex of shoot from same plant (X 3). C: Diagram of phyllotaxy of shoot A. The leaf numbers in A and C correspond.

In leaf phyllotaxy, if every sixth leaf is situated directly above the leaf formed five leaves before, and two complete turns of the genetic spiral are made to achieve this, then the phyllotactic fraction is 2/5 (Esau 1953).

Such is basically the case in Astroloba. If every sixth leaf is situated immediately above the leaf formed five leaves before, then the leaves appear five ranked. In most cases observed, however, the sixth leaf is situated not immediately above that formed five leaves before, but in such a way that the angle of the spiral between the two is less than 720° (See figs. 1.B., 2.C. and 3). This angle has never been observed to be greater than 720°, and may very considerably along the same stem. In the text it is referred to as the "spiral angle".

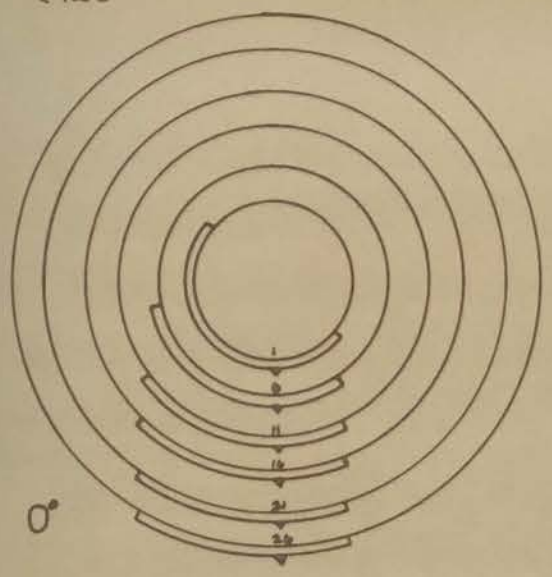
Naturally, the appearance of the leaf arrangement will vary depending upon the size of this angle. This is depicted in Figure 3, for 0°,10°, 20° and 30° less than 720°; only every sixth leaf is shown. (See also Plate 1).

The divergence from the five ranked condition is partly due to a twisting of the stem in a direction apparently always counter to that of the genetic spiral.

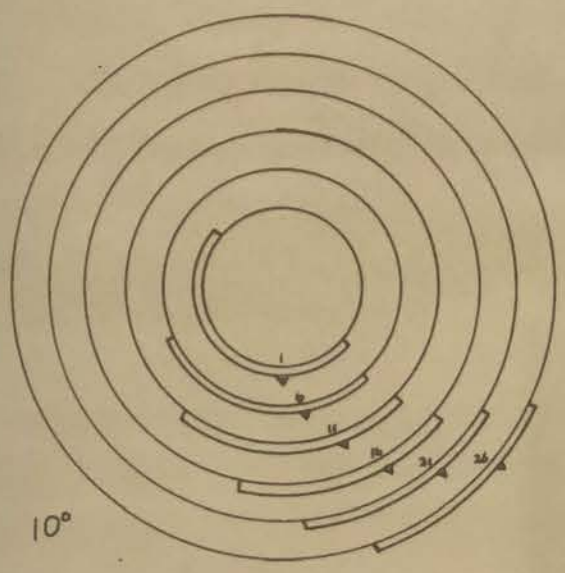
The direction of the genetic spiral varies amongst different stems of one plant, and a few instances have been observed where the genetic spiral had changed direction on a single stem. This was indicated by the change in orientation of the leaf keels. In some cases, the leaves in the region of change were smaller, in others they were the same size as those on the rest of the stem.

Leaf phyllotaxy, although affecting the appearance of the shoot, is not of great taxonomic significance in Astroloba, but the matter is dealt with in some detail because of the considerable emphasis placed on it by early taxonomists, as expressed in the descriptive phrases "five ranked","five ranked spirally twisted" and "so twisted as to appear imbricate", and in the specific epithets "spiralis" and "pentagona".

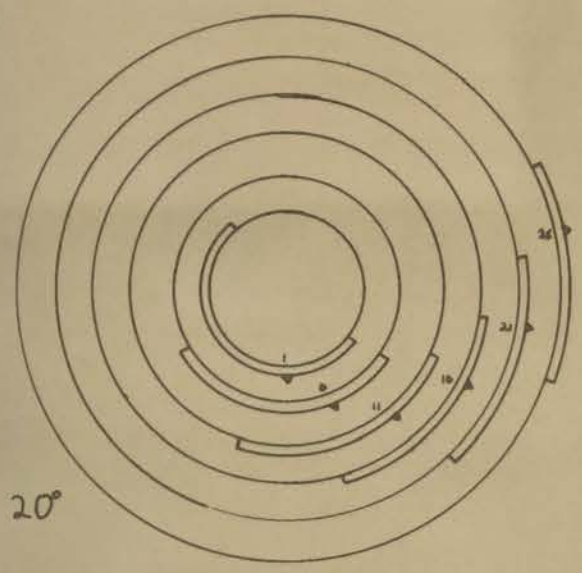
°<720°



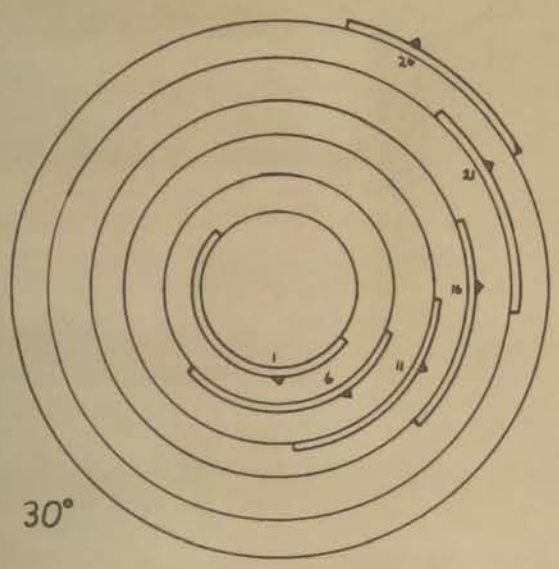
Spiral angle 0°, leaves in five straight rows.



Spiral angle 10°, leaves five-ranked, the rows in a slight spiral.



Spiral angle 20°, leaves five-ranked, but the rows in a marked spiral.



Spiral angle 30°, the five ranks of leaves so spiralled that leaf arrangement appears imbricate.

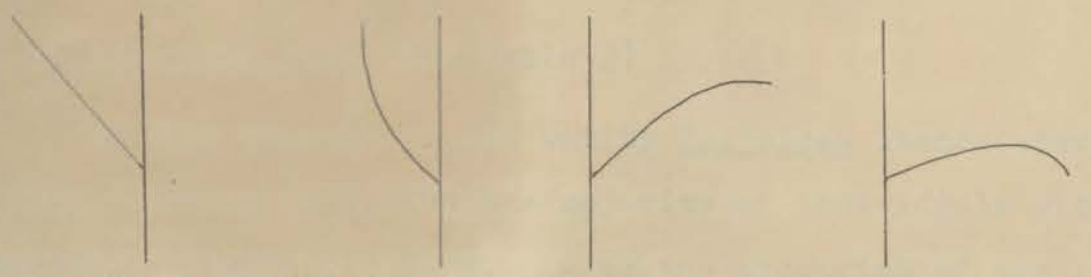
Fig.3. Diagram showing the effect of the size of the spiral angle on the leaf arrangement.

Approximate measurements were made of the angle by which the spiral of successive sixth leaves was less than 720°. A mean value of this spiral angle in each case was obtained by measuring the angle between a number of successive sixth leaves and dividing this by the number of spiral angles involved.

The angle the leaf makes with the stem and the curvature of the leaf apex, both of which also effect the appearance of the leafy shoot, show some slight differences depending upon species. In all samples, therefore, measurements obviously only approximate, were made of this angle, and the curvature of the leaf apices was noted.

Angle of leaf axil	30°	30-50°	50-70°	70-90°
Descriptive term	Erect	Suberect	Patent-erect	Patent

POSSIBLE CURVATURE OF LEAF APICES:-



Following angle of leaf with stem.	Curving upward.	Curving outward.	Curving downward. (In the case of some very patent leaves)

TABLE 1. Showing the possible angles made by the leaves with the stem, the curvature of the leaf apices and the associated descriptive phraseology. (See also Plate 2).

A number of previous authors give the diameter of the stem including the leaves. Some of the accounts, notably that of Baker (1896-97) indicate that the measurements were made from leaf tip to leaf tip, in which case the diameter would vary according to the curvature of the leaf apex, as well as according to leaf size. Here the diameter of leafy stems is omitted for this reason.

NUMERICAL ASSESSMENT OF LEAF ARRANGEMENT.

(See Appendix Table 1.)

All these measurements were made with an ordinary protractor and are therefore, considering the bulky nature of the objects measured, somewhat approximate.

Spiral angle (See Table 2)

As is shown in Table 2, the total range of values is quite extensive in all entities, being least in hallii (0-20°) and widest in foliolosa (0-50°).

The entities hallii, bullulata and rugosa, with a majority range of 0-10°, have most individuals with leaves in 5 straight or very slightly spirally twisted rows. With increase of the spiral angle, the leaves become more spirally twisted. In the entities robusta and congesta the majority of individuals have a spiral angle of 0-20°. The entity smutsiana, with a majority range (see page 3) of 10-30° has spirally twisted or imbricate leaves in most individuals, while the entity foliolosa has the greatest number of individuals with imbricate leaves. In the entities spiralis and herrei there is an even distribution of individuals with all types of leaf arrangements.

Angle of leaf with stem (See Table 2)

In this character, the entity foliolosa stands apart from the other entities in having the majority of individuals with leaves either patent-erect or patent. With the exception of one specimen of the entity robusta, no individuals from samples of other entities extend into the patent class.

In the other entities, the majority of individuals have suberect leaves.

Curvature of leaf apices (See Table 2)

Here, the entities bullulata and hallii stand apart in that in most individuals the leaf apices curve upwards. The entity bullulata is further distinguished by the fact that most of the leaf apices not only curve upward but to one side, - the side on which the keel is situated. The leaf apices also curve upwards in a few individuals of the entities, spiralis and congesta, but in the majority of individuals of these entities the leaf apices follow the angle the leaf makes with the stem. In the entities smutsiana, rugosa, foliolosa and robusta the majority of individuals have the leaf apex curving outward. The entity herrei has an even distribution of in-

Entity.	Class range of measurements. *						Total no. indiv.	Range actual measurements.
SPIRAL ANGLE. Class Interval 10°.								
	0	10	20	30	40			°
Bullulata	1	20	2	1	-	-	24	0 - 21
Hallii	3	18	3	-	-	-	24	0 - 16
Smutsiana	-	8	16	15	7	-	46	2 - 40
Spiralis	1	7	5	8	2	-	23	0 - 36
Herrei	-	6	8	5	-	-	19	10 - 30
Rugosa	1	13	6	2	-	-	22	0 - 25
Foliolosa	-	6	13	29	18	2	68	7 - 45
Congesta	-	18	27	9	3	2	59	1 - 41
Robusta	1	28	20	7	7	-	63	0 - 40
ANGLE OF LEAF WITH STEM. Class Interval 20°								
	30°		50°		70°			
	Erect		Sub-Erect.		Patent Erect.	Patent.		
Bullulata	-		24		-	-	24	35 - 50
Hallii	6		18		-	-	24	20 - 50
Smutsiana	1		38		7	-	46	30 - 60
Spiralis	7		17		-	-	24	25 - 60
Herrei	-		18		1	-	19	35 - 60
Rugosa	-		21		1	-	22	40 - 60
Foliolosa	-		-		40	32	72	55 - 85
Congesta	3		45		17	-	64	30 - 70
Robusta	1		53		10	1	65	30 - 55

CURVATURE OF LEAF APICES.

	Upward andto one side	Upward	Following angle of leaf with stem.	Curving Outward	Curving outward and downward.	
Bullulata	19	5	-	-	-	24
Hallii	-	21	3	-	-	24
Smutsiana	-	-	16	30	-	46
Spiralis	-	1	16	7	-	24
Herrei	-	5	5	9	-	19
Rugosa	-	-	4	18	-	22
Foliolosa	-	-	10	54	8	72
Congesta	-	5	40	19	-	64
Robusta	-	-	15	49	1	65

Table 2 VARIATION IN LEAF ARRANGEMENT IN GENUS AS A WHOLE

* i.e. the whole range covered by the measurements, which has been divided up into appropriate classes, the number of individuals in each class being shown.

Fig. 4. Leaves seen from upper side of a : hallii (R26); b: bullulata (ex hort); c: smutsiana (R3), (X 1). Note keeled marginate apex in a and b and true marginate apex in c.

Leafy shoots of the entity bullulata; with the leaf apices curving upwards and sideways; the sideways curvature is less marked in the specimen on the right.

Leafy shoot of the entity robusta with the leaf apices following the angle made by the leaf with the stem.

Leafy shoot of the entity smutsiana, with the leaf apices curving outwards.

(All scales in cm.)

PLATE 2.

dividuals with leaf apices curving upwards, following the angle of the leaf with the stem, or curving outwards.

A note on the shape of the leaf apex

In the entities hallii and bullulata, all of the plants examined had most or all of the leaves with apices in which, when viewed from the upper side of the leaf, the margin on the side to which the keel was situated, lost its identity as an edge towards the apex, the keel itself then "functioning as a margin". (See Fig. 4). Such an apex is referred to as "keeled marginate". In both these entities, the leaf apex is often "shouldered" just below the mucro.

In all other members of the genus, the margin of the leaf on the side towards which the keel was situated, retained its identity as an edge. This is referred to as a "true marginate" apex. In these entities the leaf apex varies from acute to acuminate below the mucro.

Summary.

From the foregoing it is seen that several entities do emerge with a distinctive leaf arrangement. These are the entities hallii and bullulata with the majority of individuals with leaves in 5 straight or slightly spirally twisted rows, and their apices curving upwards in the case of the entity hallii and upwards and to the side in bullulata; and the entity foliolosa, with the majority of individuals having patent leaves with apices curving outward. The entities hallii and bullulata are further rendered distinct by the shape of their leaf apices.

The remaining entities have intermediate forms of leaf arrangement, which at their extremes embrace the condition found in these three, with the notable exception of the curvature of the leaf apices in the entity bullulata, and the very patent angle of 46% of the leaves of the sample of the entity foliolosa.

3. LEAF SHAPE.

In all species, the leaf shape is basically the same, that is roughly deltoid and keeled, with an acute acuminate apex ending in a short mucro. The base of the leaf forms a complete sheath around the stem, a few mm. wide at its narrowest part (See Fig. 1A),

but excluding the thin sheathing part, the widest fleshy part of the leaf is generally found approximately half way along the length of the leaf. A few cases were found where two keels were present on the leaf under surface, a feature of no significance, although considered of some importance by early writers and expressed in the name Apicra bicarinata Haw.

For the record, imprints of leaf shapes, as viewed from the upper surface were made using an endorsing ink pad.

There is, on the whole, little difference in size between mature leaves in a single plant. This is seen in the following table (Table 3), for leaves from the stem of a specimen of the entity robusta (R64). As indicated by keel orientation, the genetic spiral changed directionnine mature leaves from the apex in this specimen.

	Leaf Length	Width at widest part	Orientation of keel
	cm.	cm.	
Apex	3.4	2.0	Right
	3.5	2.0	Right
	3.4	1.9	Right
	3.4	1.8	Right
	3.4	1.7	Right
	3.3	1.7	Right
	3.4	1.6	Right
	3.3	1.5	Right
	3.4	1.6	Right
	3.6	1.9	Left
	3.4	1.8	Left
	3.4	1.9	Left
	3.5	2.0	Left
	Leaf Broken		Left
	3.4	2.0	Left
	3.4	1.9	Left
Base	3.3	1.9	Left

Table 3 Size of mature leaves taken in succession from a single stem of a plant of the entity robusta from Prince Albert (R64)

For purposes of study two, sometimes more, mature leaves were taken at random from each plant and measurements of the folowing were made :-

i) Leaf length.

ii) Leaf width at the widest fleshy part, See under (v).

iii) The length breadth ratio was estimated.

iv) Distance of widest part from base and hence position of widest part in relation to the longitudinal halfway mark of the leaf.

These measurements proved to be of some taxonomic significance. For the sake of completeness, other measurements were made, but were found to be unimportant.

v) Basal leaf width (excluding sheathing part) and hence difference between basal width and maximum width.

vi) Length of keel. The orientation of the keel was also noted.

vii) Length of mucro (difficult to measure accurately).

In the Appendix the mean of these measurements is given for each plant.

NUMERICAL ASSESSMENT OF LEAF DIMENSIONS.
(See Appendix Table 2)

The length of the leaf, the length breadth ratio, and the place along the length of the leaf at which the widest point occurs contribute to the appearance of the leaf.

Leaf Length (See Table 4)

As can be seen in the table, the majority ranges are distinctive, but in most cases the total class range is wide with consequent overlap of measurements between the entities.

The entities with the longest leaves are bullulata and hallii both with a majority range of 3.0-3.5 cm., and the entity congesta with a wider majority range of 2.5-4.0 cm. The shortest leaves are found in the entities foliolosa and rugosa where most individuals have leaves between 1.5 and 2.5 cm. long. The remaining entities have most individuals with leaves of intermediate length.

Entity.	Class range of measurements.									Total no. indiv.	Range actual measurements.
	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5		cm.
LEAF LENGTH. Class interval 0.50 cm.											
Bullulata	-	-	3	6	13	4	-	-	-	26	2.3 - 4.0
Hallii	-	-	-	3	14	2	6	-	-	1	26	2.7 - 5.8
Smutsiana	-	9	31	21	7	2	-	-	-	-	70	1.8 - 3.9
Spiralis	-	1	11	11	3	2	1	-	-	-	29	1.9 - 4.2
Herrei	-	1	15	4	1	-	-	-	-	-	21	1.8 - 3.2
Rugosa	1	35	21	-	-	-	-	-	-	-	57	1.4 - 2.5
Foliolosa	8	49	36	1	-	-	-	-	-	-	94	1.4 - 3.0
Congesta	-	1	1	18	21	14	6	3	-	-	64	2.0 - 4.7
Robusta	-	1	18	29	19	13	-	-	-	-	80	1.8 - 4.0
GREATEST WIDTH OF LEAF. Class Interval 0.25 cm.											
	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75			cm.
Bullulata	-	-	5	3	7	6	4	1	-	26	1.3 - 2.6
Hallii	-	-	7	10	8	1	-	-	-	26	1.3 - 2.1
Smutsiana	2	7	35	17	9	-	-	-	-	70	1.0 - 2.0
Spiralis	4	9	16	-	-	-	-	-	-	29	1.0 - 1.5
Herrei	3	6	11	1	-	-	-	-	-	21	0.9 - 1.6
Rugosa	-	6	38	12	1	-	-	-	-	57	1.1 - 1.8
Foliolosa	3	25	44	16	4	2	-	-	-	94	0.9 - 2.1
Congesta	-	-	3	20	17	15	6	2	1	64	1.4 - 2.8
Robusta	-	1	19	19	32	7	2	-	-	80	1.1 - 2.4
LENGTH/BREADTH RADIO OF LEAF. Class Interval 0.25											
	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00		
Bullulata	-	-	6	15	2	2	-	1	-	-	26	1.28 - 2.72
Hallii	-	-	-	2	3	13	6	1	-	1	26	1.72 - 3.14
Smutsiana	-	2	15	26	16	9	2	-	-	-	70	1.14 - 2.31
Spiralis	-	-	-	3	9	5	7	3	2	-	29	1.57 - 2.90
Herrei	-	-	2	4	8	4	3	-	-	-	21	1.44- 2.42
Rugosa	1	12	28	14	2	-	-	-	-	-	57	1.00 - 1.83
Foliolosa	-	17	51	22	3	1	-	-	-	-	94	1.06 - 2.14
Congesta	-	-	10	26	20	6	2	-	-	-	64	1.35 - 2.33
Robusta	-	1	11	35	28	5	-	-	-	-	80	1.25 - 2.20

Table 4 VARIATION IN LEAF DIMENSIONS IN GENUS AS A WHOLE.

Leaf width at widest part and length-breadth ratio (See table 4).

The width of a leaf at its widest part affects the appearance of the leaf when considered in relation to the length. The greater the length-breadth ratio, the narrower the leaf. In a Astroloba, the values of this ratio range from 1.00 where the leaf width is equal to the length, to just over 3.00, where the width is roughly a third that of the length.

As the tables show, there is considerable overlap of both measurements in the various entities. However, the entities foliolosa and rugosa, with a majority range of 1.25 - 1.50 for the length-breadth ratio tend to have the broadest leaves, while the entity hallii, with a length-breadth ratio of 2.0 - 2.25, in the majority of individuals, tends to have the narrowest leaves. The entity spiralis, with a wider majority range of 1.75 - 2.50 for the length-breadth ratio also tends to have narrow leaves. The remaining entities have leaves with intermediate length-breadth ratios, but, as examination of the table shows, the majority ranges tend to differ slightly for the different entities.

Position of widest part of leaf in relation to longitudinal halfway mark. (See Table 5)

This character, estimated from the distance from the base of the widest part of the leaf, also determines the shape of the leaf. In the entities hallii, spiralis, congesta and robusta, the majority of individuals have the widest part of the leaf occuring 0.25 - 0.50 cm. below the halfway mark. In the entities smutsiana, herrei, rugosa and foliolosa, the majority range is 0.00 - 0.25 cm. below the halfway mark, while for bullulata it is wider being 0.00 - 0.50 cm.

Difference between maximum and basal width of leaf (See Table 5)

This is another factor determining leaf shape. As the table shows, the greatest difference between maximum and basal width is found in the majority of individuals of the entity bullulata, while the least difference between these measurements is found in the majority of individuals of the entities spiralis and herrei.

Entity.	Class range of measurements.								Total no. indiv.	Range actual measurements.	
	POSITION OF MAXIMUM LEAF WIDTH IN RELATION TO LONGITUDINAL * HALF WAY MARK. Class interval 0.25 cm.										
	Above 0	0	Below Half way mark 0.25	0.50	0.75	1.00	1.25				cm.
Bullulata	-	1	11	13	1	-	-	-	26	0.0	-0.6bel
Hallii	-	-	1	14	7	3	-	1	26	0.2	-0.6bel
Smutsiana	-	5	43	19	3	-	-	-	70	0.0	-0.6bel
Spiralis	-	-	7	17	2	2	-	-	28	0.1	-0.9bel
Herrei	1	-	14	6	-	-	-	-	21	0.1ab	-0.5bel
Rugosa	11	23	22	1	-	-	-	-	57	0.2ab	-0.3bel
Foliolosa	2	21	68	3	-	-	-	-	94	0.1ab	-0.3bel
Congesta	1	-	23	35	5	5	-	-	64	0.1ab	-0.7bel
Robusta	3	3	26	46	2	2	-	-	80	0.2ab	-0.7bel
	DIFFERENCE BETWEEN MAXIMUM AND BASAL WIDTH OF LEAF. Class Interval 0.25 cm.										
	.25		.50	.75	1.00	1.25					
Bullulata	1		5	8	8	1	3		26	0.20 - 1.30	
Hallii	1		6	15	4	-	-		26	0.20 - 0.90	
Smutsiana	-		25	37	4	1	-		67	0.30 - 1.10	
Spiralis	3		24	2	-	-	-		29	0.20 - 0.60	
Herrei	5		10	5	1	-	-		21	0.10 - 0.80	
Rugosa	-		21	30	6	-	-		57	0.40 - 0.90	
Foliolosa	-		17	62	15	-	-		94	0.35 - 0.93	
Congesta	-		3	48	13	-	-		64	0.40 - 1.00	
Robusta	-		7	39	29	5	-		80	0.25 - 1.00	
	LENGTH OF KEEL. Class Interval 0.50 cm.										
	1.0		1.5	2.0	2.5	3.0					
Bullulata	-		5	15	5	1	-		26	1.3 - 2.7	
Hallii	-		1	12	9	3	1		26	1.4 - 3.2	
Smutsiana	6		47	15	2	-	-		70	0.9 - 2.2	
Spiralis	-		10	14	4	1	-		29	1.2 - 2.9	
Herrei	1		17	3	-	-	-		21	1.0 - .18	
Rugosa	37		20	-	-	-	-		57	0.8 - 1.5	
Foliolosa	27		66	1	-	-	-		94	0.8 - 1.8	
Congesta	-		3	35	20	6	-		64	1.1 - 2.8	
Robusta	-		27	40	12	-	-		79	1.1 - 2.3	
	MUCRO LENGTH. Class interval 0.05 cm.										
	.05		.10		.15						
Bullulata	1		18		4		1		24	.03 - .20	
Hallii	1		12		12		-		25	.05 - .15	
Smutsiana	13		53		4		-		70	.03 - .13	
Spiralis	2		18		8		1		29	.04 - .16	
Herrei	-		13		6		2		21	.07 - .18	
Rugosa	31		25		-		-		57	.04 - .10	
Foliolosa	9		61		24		-		94	.04 - .15	
Congesta	5		50		8		-		63	.05 - .13	
Robusta	21		35		21		3		80	.03 - .20	

Table 5 VARIATION IN LEAF DIMENSIONS IN GENUS AS A WHOLE. Contd.

* (ab = above half-way mark, bel = below half-way mark.)

Keel length (See Table 5)

On the whole this depends partly upon leaf length and partly upon the distance of the widest part of the leaf from the base. The longest keels are found in the entities bullulata, hallii, spiralis congesta and robusta, the shortest in the entity rugosa.

Mucro length (See Table 5)

In a leaf with an acuminate apex, mucro length is somewhat difficult to measure as the mucro is not sharply distinct from the rest of the leaf.

As can be seen in the Table, there is little variation in the different members. The entity hallii, with a majority class of 0.05 - 0.15 cm. tends to have the longest mucros, while the entity rugosa, with the majority of individuals with mucros less than 0.05 cm. long, tends to have the shortest mucros.

Summary.

From this introductory survey of leaf characters in the genus as a whole, two entities with the shortest and broadest leaves stand out from the rest, namely rugosa and foliolosa, while the entity hallii is recognisable by having the longest and narrowest leaves of the whole genus. The remaining entities are intermediate in size and shape and, although the majority ranges for each entity may be slightly different, the overlap of measurements between entities is considerable. The characters of leaf size and shape, apart from the nature of the leaf apex, are thus not of primary taxonomic importance or value.

4. LEAF COLOUR AND ORNAMENTATION.

Colour of leaf as a whole

Leaf colour is difficult to describe and quite variable within different populations, often depending upon whether the plant grows in the open or under a thick bush.

The author has attempted to associate the colours with the Royal Horticultural Society colour charts, and these colours are quoted. It is felt, however, that with regard to greens, these colour charts are inadequate.

The basic colours of leaves of the entities hallii and smutsiana are similar, and may be likened to Agathia green (60/2, 60/3), Pod green (061/2 061/3), Veronese green (660/2, 660/3), and Sap green (62/2, 62/3).

The entities bullulata, rugosa and spiralis have similar but sometimes darker shades, including Scheeles green (860), and the entities bullulata and rugosa often have a garnet brown (2240) overtone.

The entity herrei has leaves of the colour of Paris green (58/3), Cyprus green (59/2, 59/3), Veronese green (660/2) and Pod green (061/1, 061/2).

In the entities congesta and foliolosa, the basic leaf colours are darker and may be likened to Scheeles green (860), Lettuce green (861), Fern green (0862) and Spinach green (0960). In the entity robusta, the leaves are of a whole range of shades, including all those mentioned, but they often have a greyish tint similar to Willow green (000862/3).

Colour of margins and keels, and striations.

In the entity hallii, the margins and keels of the leaf are a darker green, usually becoming reddish brown towards the apex of the leaf. The top third of the leaf itself may have a pale reddish brown or Garnet brown tinge. This appears to be correlated with degree of exposure to sunlight, as in plants growing in fairly thick bushes the reddish tinge is absent.

Faint longitudinal lines, up to 0.5 mm. broad and about 1.0 mm. apart, corresponding to the bundle caps of the vascular strands are visible on the lower side of the leaf, and sometimes also on the upper, either for the whole length of the leaf or only extending a short distance from the apex. In some leaves they may be absent, but they are always present on some leaves of any one plant. In colour these vein lines are darker than the rest of the leaf, (Paris green (58/1) and Cyprus green (59/1), and often have a reddish tinge.

In the entities bullulata and rugosa, no bundle cap lines are apparent, and the margins and keels are usually concolorous.

In the entity smutsiana, the margins and keels are concolorous or a darker green, and as in the entity hallii, the apices of

the leaf may have a pie reddish brown or garnet brown tinge. Of the 50 plants examined, 42 had some or all leaves in which longitudinal bundle cap lines were visible towards the apices on the underside of the leaf.

In the entity spiralis, the margins and keels are as in the entity smutsiana, and leaves with a reddish tinge towards the apex were observed in 8 of the 28 plants examined, and in 12 of them darker longitudinal bundle cap lines were faintly visible on the leaf underside.

In the entities hallii, smutsiana and spiralis, the mucro is often reddish brown even when the rest of the leaf does not have a reddish tinge.

In the entity herrei, fine darker bundle cap lines are always present either just visible or projecting as extremely fine ridges, on the leaf underside. The margins are generally concolorous or paler and very rarely is the tip of the leaf reddish.

In the entity robusta, margins and keels are usually paler or white, and in 42 out of 70 plants observed, faint darker green bundle cap lines were visible. In the entity congesta, margins and keels are concolorous, or paler, rarely whitish, and in 15 out of 63 specimens examined, faint darker bundle cap lines were apparent. In the entity foliolosa the margins and keels are similar to those of the entity congesta, and in 7 of the 75 plants examined, faint bundle cap lines were visible.

Tubercles and maculae:

In most leaves, the margins of the top half of the leaf have a double row, the keel a single row, of small tubercles. Measurements of tubercle dimensions were made using a micrometer eyepiece. However, this was not very satisfactory because in many instances the tubercles tend to coalesce into groups, or rise gradually from the surface of the leaf so that it is difficult to measure their true diamter or height.

In the entity rugosa all leaves of all 57 plants examined had concolorous shiny tubercles on the under surface of the exposed top part of the leaf. Sometimes tubercles were present on the upper side

towards the apex as well. The degree of tuberculation varied from about 5 per sq. 4 mm. to 30 per sq. 4 mm. These tubercles tend to be arranged in longitudinal series, up to 6 coverging in a single longitudinal group. The degree of tuberculation tends to be the same for all the leaves on any one plant. Where the leaves are sparsely tuberculate, the tubercles are generally less prominent.

In the entity bullulata, all the plants examined had some or all of the leaves with tubercles on them, and 6 out of 26 plants had some leaves with no tubercles. The tubercles may be irregularly scattered or more usually aggregated into groups of up to five which are often transversely elongated. These groups for the most part tend to be arranged in irregular, but distinct, transverse rows, with usually up to 4 such rows per leaf, and these rows are usually 0.2 to 0.5 cm. apart. In colour the tubercles may be concolorous, paler or whitish.

In the entity hallii, tubercles were found in some cases to be present on the underside of the leaf and very rarely on the upper side. When present, they generally occur longitudinally associated with the vein lines, and arise as small individual protuberances or converge in irregular longitudinal rows. The greatest number of tubercles per leaf observed was up to 12 longitudinal groups of tubercles per leaf, with up to 9 tubercles in the largest group. Not all the leaves of any one plant are tuberculate. Out of 25 plants examined, 13 had leaves with no tubercles, of these, 10 had a few whitish spots, sometimes slightly raised, on some of theleaves, and these were usually, but not always, associated with the vein lines. The remaining 12 plants had some or all of the leaves tuberculated to a greater or lesser degree. In colour the tubercles may be whitish, paler, concolorous, reddish or darker than the rest of the leaf.

In the entity smutsiana, none of the plants examined had any leaves with tubercles but 8 of the 50 specimens, were seen to have one or more leaves with, on the underside, up to about four very slightly raised, (0.05 mm. or less high), elongated shiny patches, darker in colour, about 0.5 mm. wide and up to 3.0 mm. long. Sometimes these longitudinal areas had several longitudinally arranged

minute projections.

In the entity congesta, similar longitudinal patches were observed in some of the leaves of 13 out of 64 specimens. Here, up to seven per leaf were observed, up to 5.0 mm. long and 1.0 wide. In the entity foliolosa, one out of 94 plants had leaves with similar elongated patches.

In the entity robusta, 20 out of the 70 plants examined had leaves with one to 15 whitish flecks up to 1.0 mm. in diameter on the undersurface of some of the leaves.

In the entity spiralis, no plants were observed in the field to have any such markings on the undersurface, but, under cultivation one specimen from Calitzdorp, R47, developed whitish flecks on some of the leaves, 0.05 to 0.10 mm. in diameter and sometimes very slightly raised, but of a height of less than 0.05 mm. (See Plate 25).

In the entity herrei, no markings of any sort were observed on plants in the field or under cultivation.

Tubercles of margins and keels:

As can be seen from the Table below, there is some variation in dimensions between the different entities.

Those entities with tuberculate leaf undersides, tend to have more prominent tubercles on the margins and keels.

Entity.	Diam. Tubercles mm.	Height Tubercles mm.
Tubercles from underside of leaf		
Rugosa	0.10 - 0.50	0.10 - 0.30
Bullulata	up to 2.00	0.10 - 0.35
Hallii	0.05 - 0.50	0.10 - 0.25
Tubercles of margins and keels		
Bullulata	up to 1.00	0.10 - 0.35
Hallii	0.10 - 0.50	0.10 - 0.25
Smutsiana	0.10 - 0.25	0.10 - 0.20
Spiralis	0.10 - 0.20	0.10 - 0.10
Herrei	0.10 - 0.15	0.10 - 0.10
Rugosa	0.10 - 0.50	0.10 - 0.25
Foliolosa	0.10 - 0.45	0.10 - 0.20
Congesta	0.10 - 0.30	0.10 - 0.15
Robusta	0.10 - 0.35	0.10 - 0.15

Table 6 VARIATION IN DIMENSIONS OF TUBERCLES FROM THE LEAVES OF ALL ENTITIES OF THE GENUS.

Summary

Thus it can be seen that the presence of tubercles on the undersides of the leaves tends to distinguish the entities rugosa, bullulata and hallii from the other members of the genus. These three entities are themselves distinguished by the transverse arrangement of tubercles in the entity bullulata and the longitudinal arrangement in the entities hallii and rugosa. Unlike the entities bullulata and rugosa, hallii has leaves with striations on the underside. These striations are always found on the undersurfaces of leaves of the entity herrei, often present as fine ridges, while they are also visible, but not as fine ridges in a large number of specimens of the entities smutsiana and robusta.

Leaf ornamentation is consequently of some taxonomic significance.

5. LEAF ANATOMY (See Plate 3).

Gross Astroloba leaf anatomy is similar to that of some species of Gasteria and Haworthia* and Poellnitzia rubriflora (L.Bol) Uitewaal. Certain anatomical details, notably the shape of epidermal cells, and the size and degree of lignification of bundle cap cells are of some taxonomic significance, as will be shown.

In all cases, leaves a comparable distance from the shoot apex were examined. Transverse sections cut half way along the length of the leaf were used, except in certain cases where sections were taken a few millimetres from the apex.

In transverse section, because of the keel, the leaves appear in outline as flattened, slightly curved triangles.

Epidermis

The epidermal cells in surface view are isodiametric or elongate, depending upon their situation, and five or six sided (See Fig. 5C). In longitudinal section, they are seen to be taller than broad, with a heavy thickening of cutin**impregnated cellulose on the outer part of the radial walls and outer tangential walls,

---

* Species examined were G. stayneri von Poell., G. beckeri Schönl., G. stayneri Schönl., and H. margaritifera (L) Haw.

** Schultz's solution was used to stain the epidermal cells.

which result in a gourd-shaped cell lumen. In some sections the demarcation between cutin impregnated thickening and original cellulose wall is clear cut, in others there is an infiltration of the one by the other. (See Fig. 8A). In most sections, the layers in which the thickening was laid down are visible as fine strata.

The outer faces of the epidermal cells may be almost flat to extremely convex to papillate, and this feature is of taxonomic importance (See Figs. 6, 7 and 8). It is best seen in epidermal cells from the lower epidermis of the upper half of the leaf. Towards the margins and keel, the epidermal cells become elongated, the cell lumen now resembling a long-necked gourd, and the outer faces become flattened. (See Plate 3). Towards the base of the leaf, the thickening of the outer epidermal cell walls and the resultant gourd shaped lumina become less marked.

The stomata are sunken, (See Fig. 5B), the numerous supra-stomatal depressions appearing as minute puncticula over the surface of the leaf. The epidermal cells surrounding the guard cells do not differ from other epidermal cells and thus are not of the nature of subsidiary cells (Esau 1960). In shape, the guard cells are of the common crescent type, with very noticeable rims of wall material impregnated with cutin above and below the stomatal aperture. (See Figs. 5B and C).

Tubercles

Where tubercles occur, when these are only very slightly raised, they are formed by groups of elongated epidermal cells with flat faces. When the tubercle is more prominent, however, it is formed by a mound of colourless or chlorophyll containing parenchyma enclosed by epidermal cells whose outer faces are often flatter than those adjacent to the tubercle. (See Plate 3). Tubercles generally do not have stomata, and this increases their shiny appearance.

Internal anatomy

Immediately below the epidermis is a layer of chlorenchyma, the component cells of which may be round to elongate,

Fig. 5.

A. Diagram of transverse section of leaf of the entity robusta (R1) x 6½: a stoma seen in perfect section; b vascular strands with centri-petal xylem; c chlorenchyma; d central water storage parenchyma.

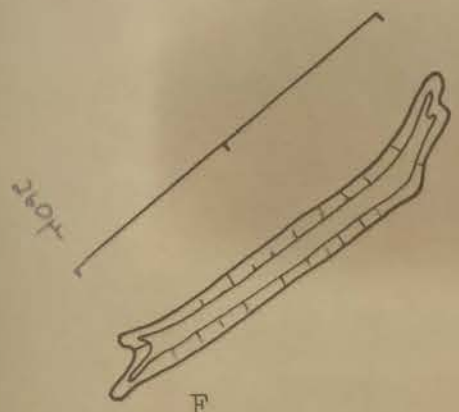
B. Section through epidermis showing sunken stoma: e cellulose part of cell wall; f outer thickening of cutin impregnated cellulose; g cuticle; h and i rims of cutin impregnated wall material below and above stomatal aperture; k guard cells.

C. Surface view of epidermal cells surrounding supra stomatal depression s, e and f seen in optical section, also t the neck of gourd shaped lumen.

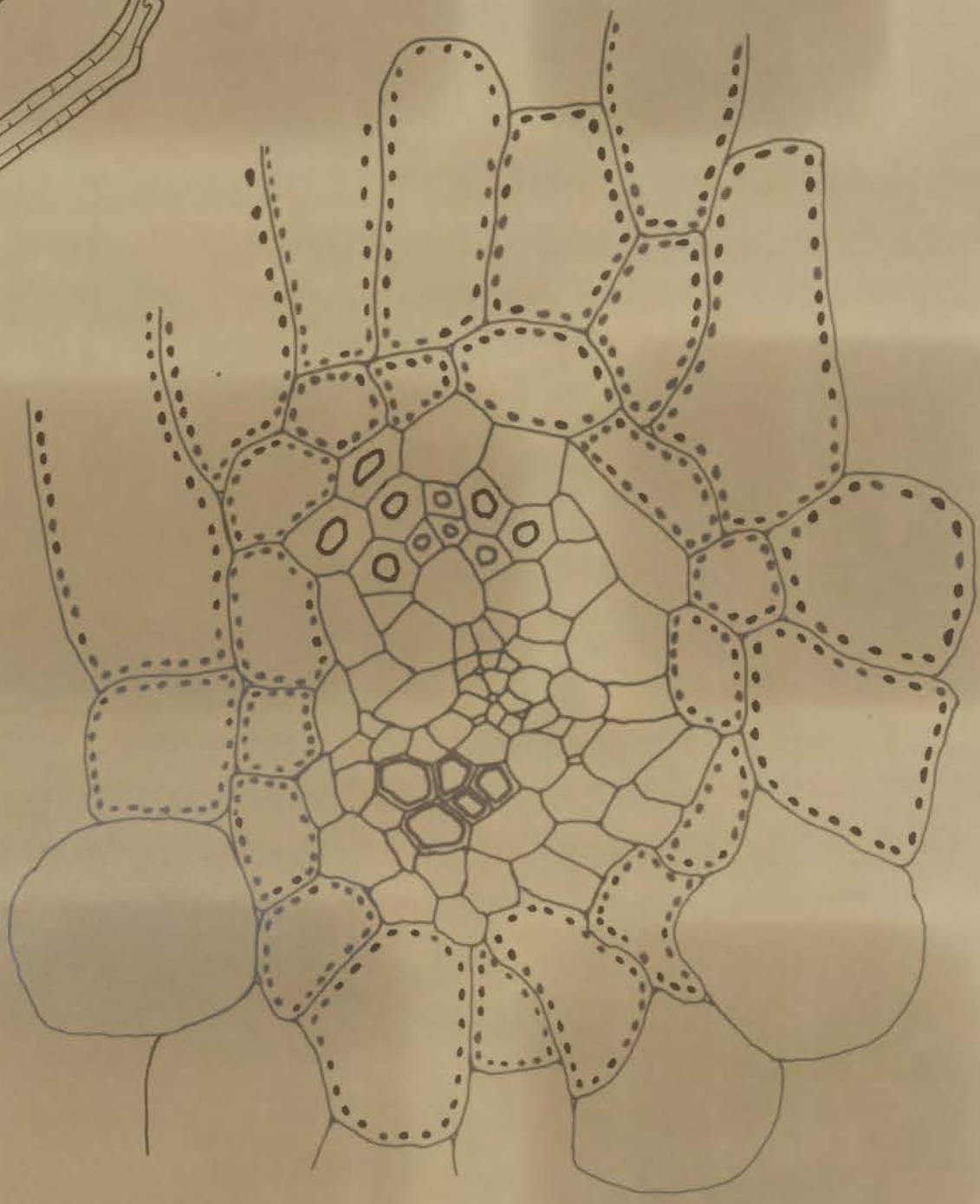
D. Epidermal cells with guard cells seen from below. B, C and D are also from the entity robusta.

E. Transverse section of vascular strand from a leaf of the entity congesta (R40).

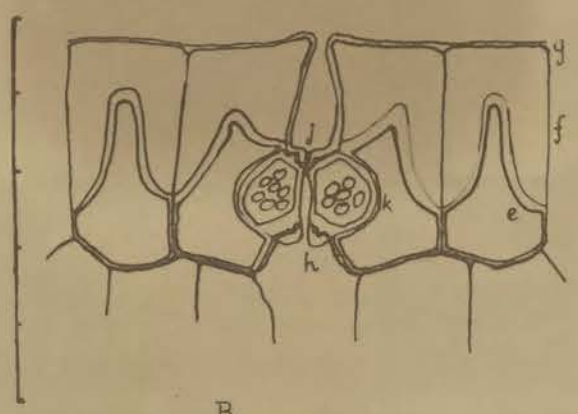
F. Fibre-sclereid from leaf of the entity smutsiana (R5) .



F

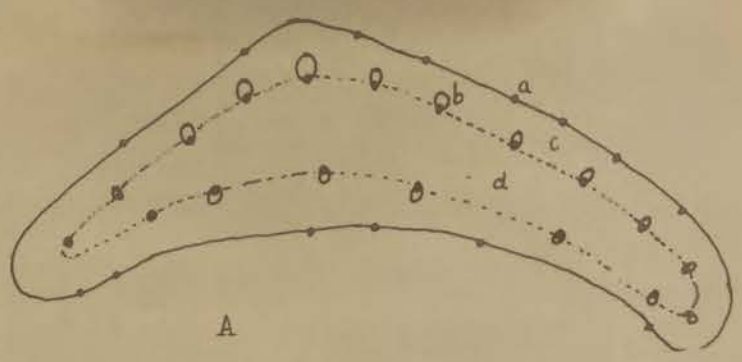


E

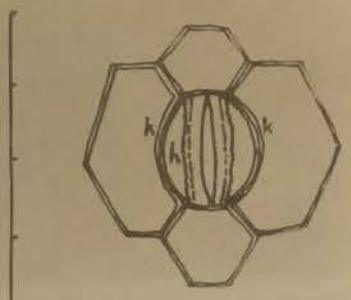


175μ

B

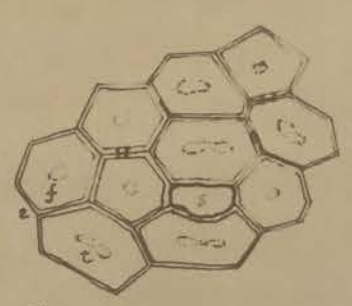


A



140μ

D



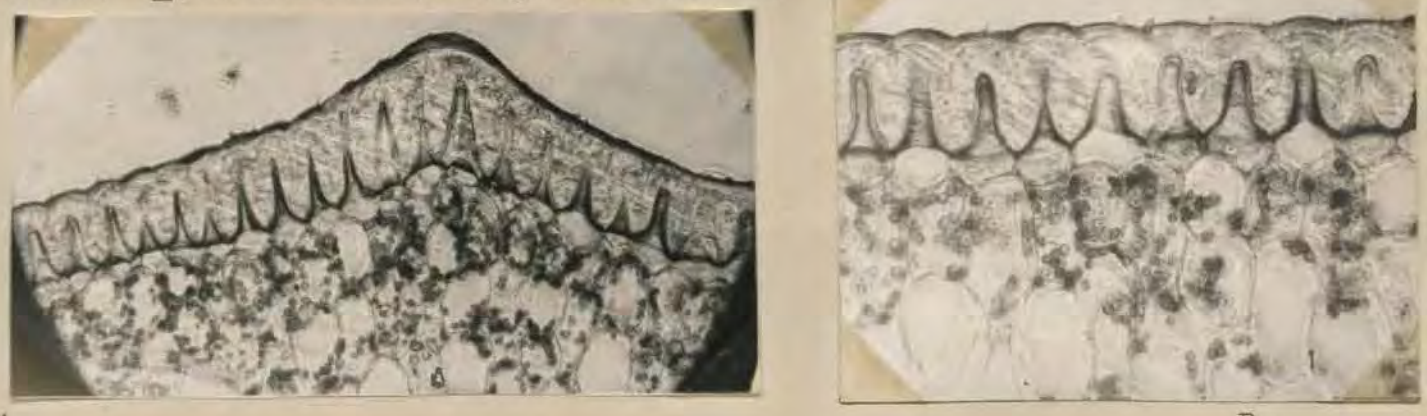
260μ

C

Fig. 5.

A. B.

T.S. Leaf of the entity rugosa showing: A, papillate epidermal cells; B, a section through a tubercle.



A. B.

T.S. Leaf of the entity congesta showing: A, epidermal cells of keel; B, cells from the lower epidermis.

A. B.

T.S. Leaf of the entity robusta showing: A, vascular bundle with heavily lignified fibre sclereids of the bundle cap; B, stomata from the upper epidermis.

T.S. Leaf of the entity smutsiana showing cells from the lower epidermis.

PLATE 3.

and in some instances, slightly lobed. There may be a few smaller, round or oval colourless cells between the chlorenchyma and the epidermal cells of the margins and keel.

The vascular strands are arranged in a flattened triangle at the junction of the chlorenchyma and the central mass of large colourless water storage parenchyma cells. (See Fig. 5A).

Details of xylem and phloem anatomy were not investigated, but, like other members of the Liliaceae, the xylem lacks the large conspicuous metaxylem vessels typical of the Glumiflorae. To the outside of the phloem in each strand (See Fig. 5E), is a cap of cells which vary in size, but for the most part are of quite a large diameter, and longitudinally elongated. These bundle cap cells may lignify as fibre-sclereids. The degree of lignification will be shown to be of some taxonomic importance, and in the text these cells are referred to as <u>bundle cap cells</u> rather than fibre-sclereids. Surrounding the vascular tissue and bundle cap is a sheath of chlorophyll containing parenchyma cells.

The vascular strands, including bundle caps, become smaller towards the leaf margins where some of the strands may lack bundle caps. The largest strands with bundle caps occur on the underside of the leaf near the keel.

In a number of species, the vascular strands including bundle caps affect the external character of the leaf in that they are seen externally as faint lines extending from the leaf apex for about a third to a half of the leaf length, or sometimes for the entire length of the leaf. In some instances a red pigment is associated with these "vein lines".

The number of vascular strands per unit leaf width, the size of the bundle caps and degree of lignification of bundle cap cells will be shown to be also of taxonomic significance in some instances.

<u>Assessment of Significance of Anatomical Characters</u>

<u>Epidermal Cells</u>

Examination of the surface of the top half of leaves of entities of Astroloba reveals two types of leaf - those with a glossy sheen and those with a dull sheen or a matt surface.

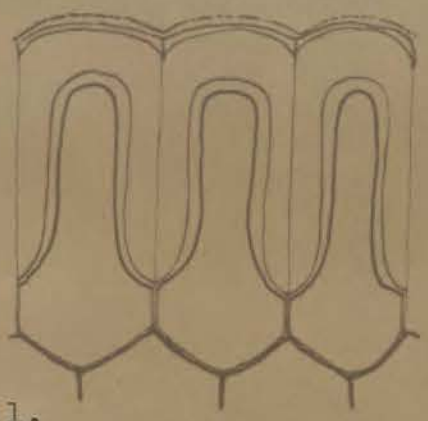
The entities congesta, foliolosa and robusta all have leaves with a glossy sheen, while the remaining entities have leaves with a dull sheen. A reason for this is found on examination of the epidermal cells in longitudinal section. In the leaves with a glossy surface, the outer surfaces of the epidermal cells are flush with one another, or only very slightly convex. In the matt leaves, the outer surfaces of the epidermal cells are markedly convex. A large number of transverse sections of leaves was examined and in all instances this was found to be the case, although it was not very marked in certain members of the entity smutsiana, (See Fig. 7C), but the leaves of these specimens still had a dull, not a glossy sheen.

Entities	Populations examined
bullulata	Matjiesfontein R2.
hallii	Koup R26; Rietvlei R48.
smutsiana	Ladiesmith/Barrydale R3 and 5.
spiralis	Oudtshoorn R7; Calitzdorp R47; Ladismith/Barrydale R6.
herrei	Hoekplaas R16; Prince Albert R46.
rugosa	Montagu R17, 22.
foliolosa	Waterford R10; Steytlerville R14.
congesta	Cradock R32; Adelaide R38 and 39; Dikkop Vlakte R40.
robusta	Klaarstroom R27; Nelspoort R28; Miller R8; Steytlerville R15; Molteno pass (leg. Hall).

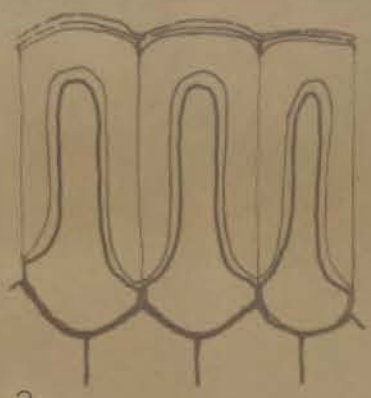
Table 7. Population samples of Astroloba in which leaf anatomy was investigated.

It can be seen in Figures 6, 7 and 8, that size and degree of development of the cutinised part of the cell wall varies considerably. In two sections of epidermal cells from leaves of a plant of the entity congesta (Fig. 6A. 1,2), the cutinised part of the wall had a thin outer layer which stained up a much darker colour.

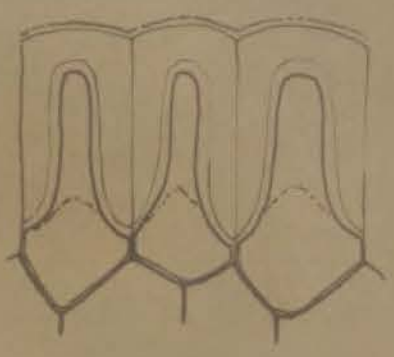
In the entity rugosa, the concave outer wall of the epidermal cells is in some instances papillate (See Fig. 8A).



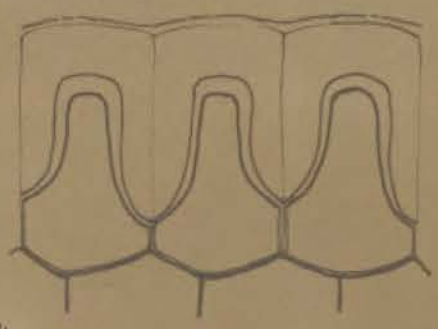
A.1.



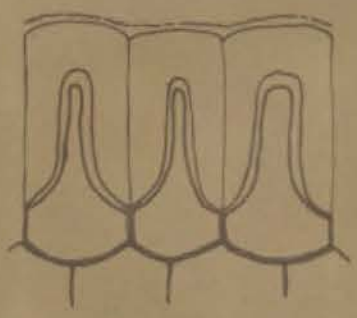
2.



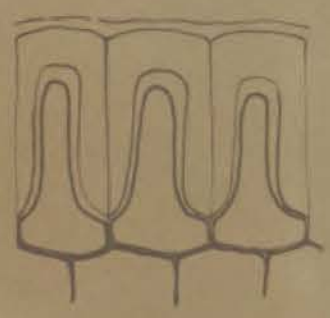
3.



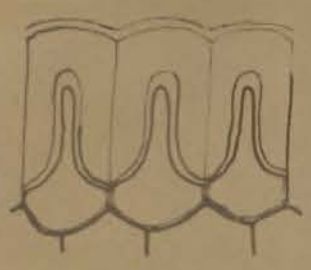
4.



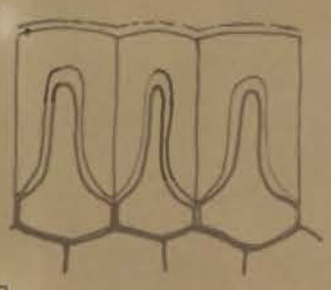
5.



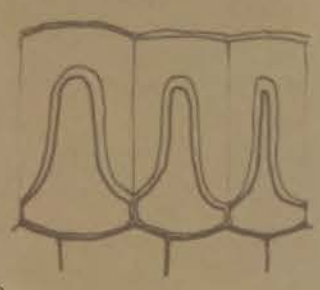
6.



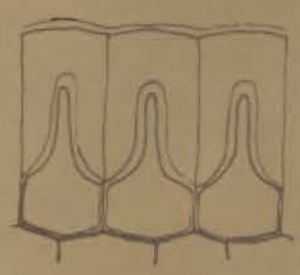
7.



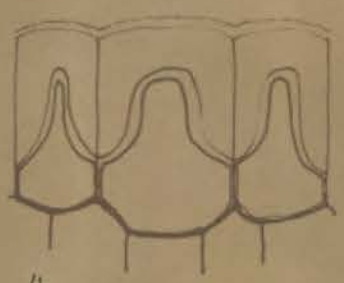
B.1.



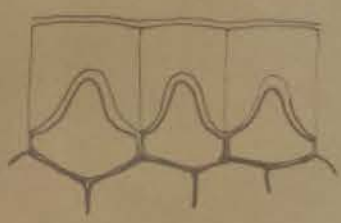
2.



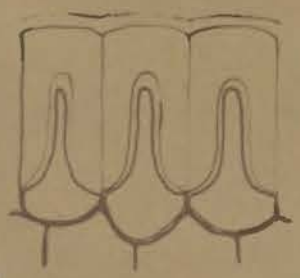
3.



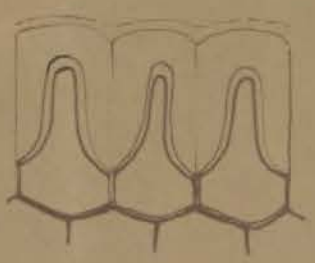
4.



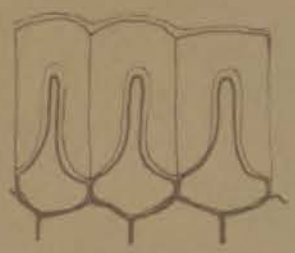
5.



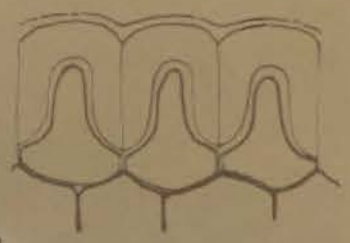
C.1.



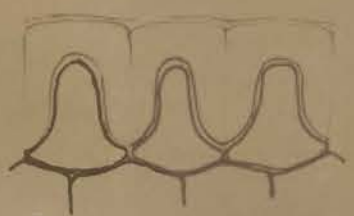
2.



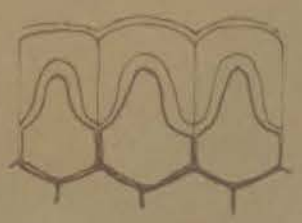
3.



4.



5.



6.

Fig.6. Cells of lower epidermis from top half of leaf seen in longitudinal section. Epidermal cells shown of: A the entity congesta; B the entity robusta; C the entity foliolosa.

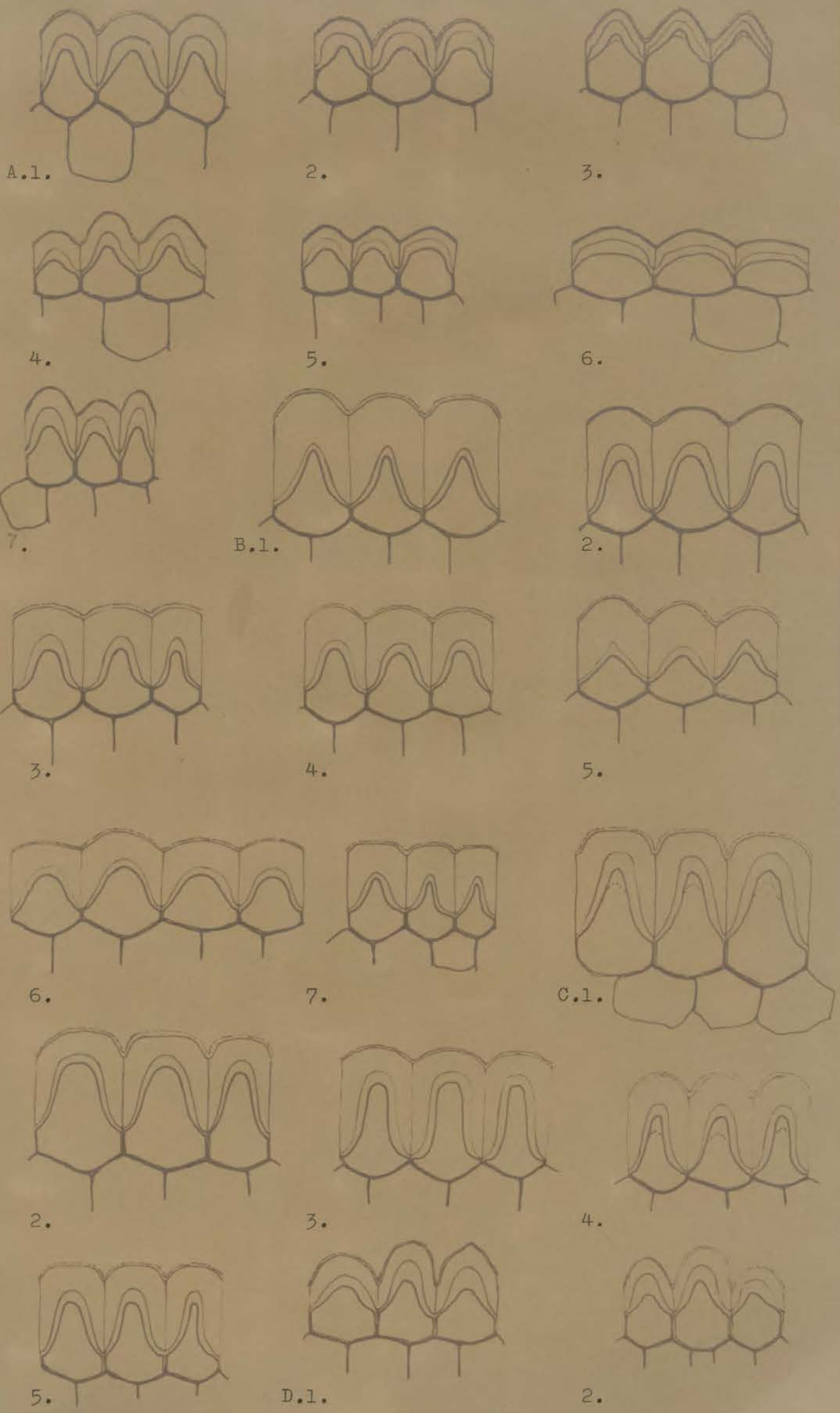
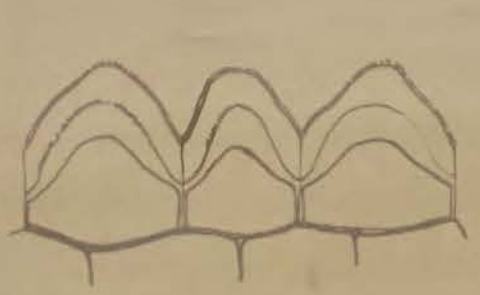
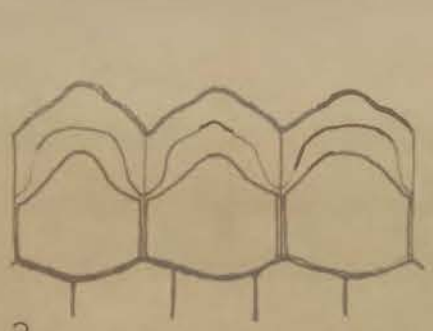


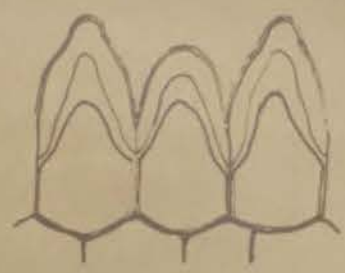
Fig. 7. Cells of lower epidermis from top half of leaf seen in longitudinal section. Epidermal cells shown of: A the entity herrei; B the entity spiralis; C the entity smutsiana; D putative hybrid, between members of the entities smutsiana and rugosa.



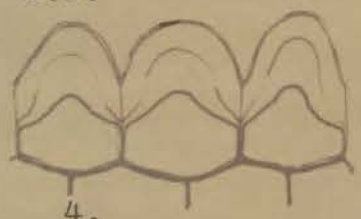
A.1.



2.

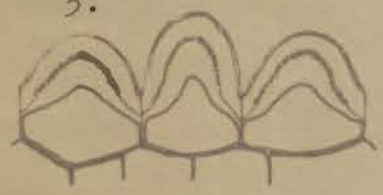


3.



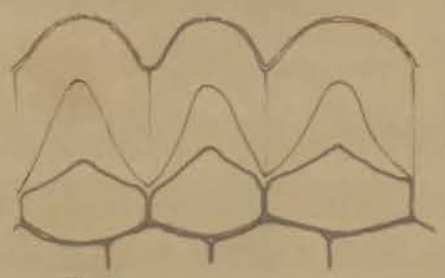
4.

5.

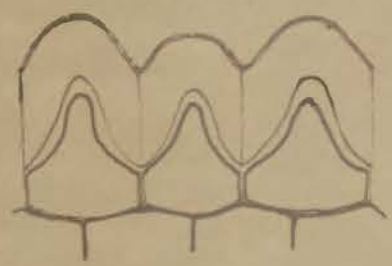


6.

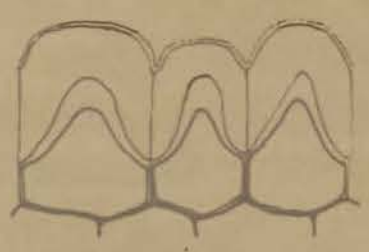
7.



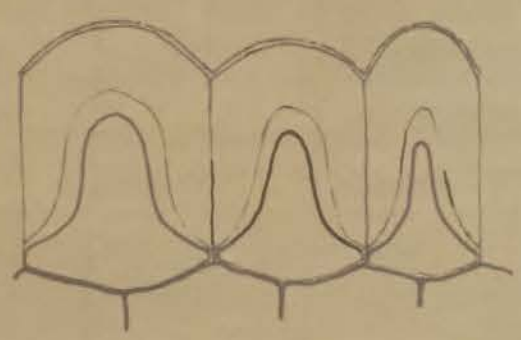
B.1.



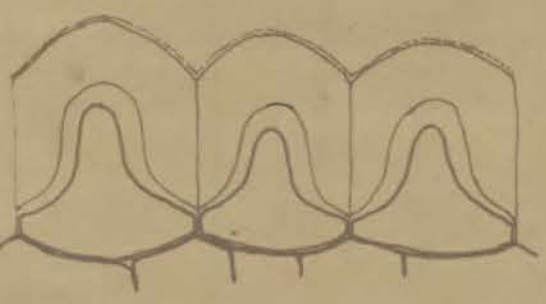
2.



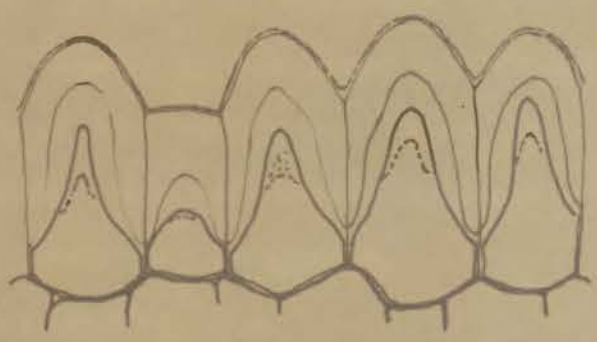
3.



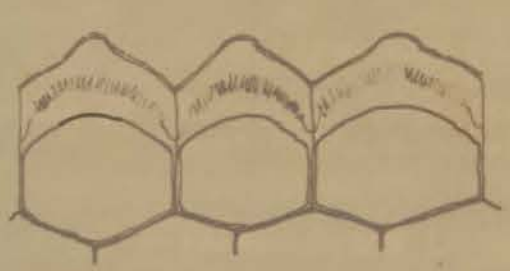
C.1.



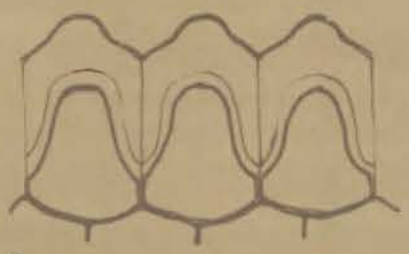
2.



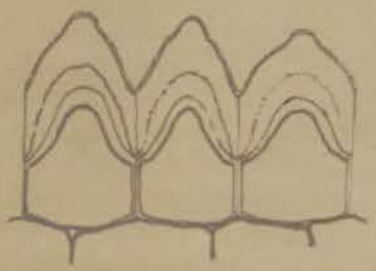
3.



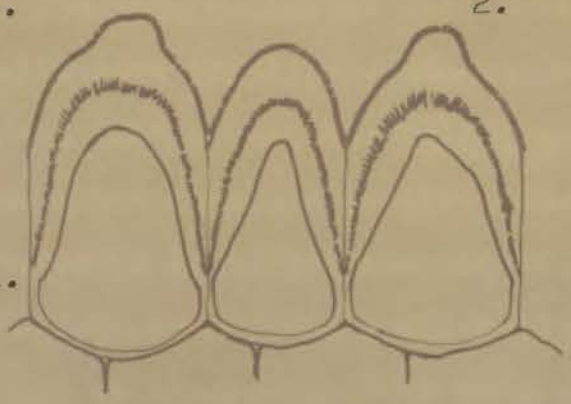
D.1.



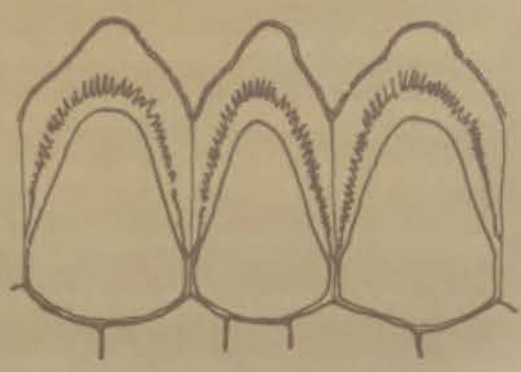
2.



3.



E.1.



2.

Fig.8. Cells of lower epidermis from top half of leaf seen in longitudinal section. Epidermal cells shown of: A rugosa; B hallii; C bullulata; D Astroworthia X bicarinata E Haworthia margaritifera.

As will be seen, the entities congesta, robusta and foliolosa have perianth and inflorescence characters in common as well, and it is felt that the glossy sheen to the leaf surfaces and the nature of the epidermal cells are of significance in rendering them distinct from other members of the genus.

Bundle Cap Cells

The degree of lignification of bundle cap cells was found to vary in the different entities. Transverse sections of the leaf were cut a short distance from the apex. This distance depended upon the length of the leaf as is shown in Table 8.

Leaf Length	1.5	2	2.5	3	3.5	4	4.5
Distance in mm. from apex at which section was cut.	3	4	5	6	7	8	9	10

		Bundle Cap Cells		
Entities	No. leaves examined	All lignified	Partly lignified	All unlignified
bullulata	20	-	-	20
hallii	20	20	-	-
smutsiana	20	20	-	-
spiralis	20	20	-	-
herrei	20	20	-	-
rugosa	20	20	-	-
foliolosa	10	-	5	5
congesta	30	-	22	8
robusta	30	-	30	-

Table 8. Variation in degree of lignification of bundle cape cells a specified distance from the leaf apex, (for all bundle caps).

It was found in the entities hallii, smutsiana, spiralis, herrei and aspera that at this level in the leaf all the bundle cap cells were lignified. In the entity bullulata none of them were, and in the entities foliolosa, congesta and robusta, some specimens had completely unlignified bundle cap cells, in others the degree of lignification varied.

In leaves where the bundle cap cells are incompletely lignified at the apex, it is found that at the base of the leaf

all bundle cap cells are lignified. The size of the bundle cap itself varies but this is not of prime importance.

It is of some interest that leaves with lignified bundle caps often dry with these strands forming a series of ridges. This is sometimes of use when dealing with herbarium material. Dry ridged leaves are found in the entities hallii, herrei and aspera and sometimes in smutsiana and robusta.

It was hoped that this character and bundle cap size would help to distinguish the entity smutsiana from the entity spiralis when they are not in flower, as, although the leaves of the latter are often narrower, it is difficult to distinguish between the two when only vegetative material is available.

A small sample of leaves of the entities herrei, spiralis and smutsiana were sectioned one third of the length from the apex. The area of the largest bundle cap in the ventral part of the leaf was roughly estimated in micrometre eyepiece units, and the shortest distance of this bundle from the lower epidermis was also measured.

The entity herrei was found to have the most and the largest bundle caps, which are also closest to the lower epidermis and this accounts for the appearance of the bundle cap lines as very fine ridges in many of the leaves. The difference between the entities sprialis and smutsiana howev er, is slight. This is sh own in a scatter diagram (See Fig. 9).

Summary

Thus, from the texture of the leaf surface and the shape of the walls of the outer epidermal cells, the entities congesta, foliolosa and robusta tend to be separated from the rest.

The entities hallii and bullulata with characteristic keeledmarginate apices in common, are further separated from one another on the grounds of bundle cap cells lignified at the leaf apices of the former, as opposed to unlignified bundle cap cells at the leaf apices of the latter.

The size of the bundle caps and their proximity to the lower epidermics tend to separate the entity herrei from the entity spiralis, although both have in common an inflated perianth tube.

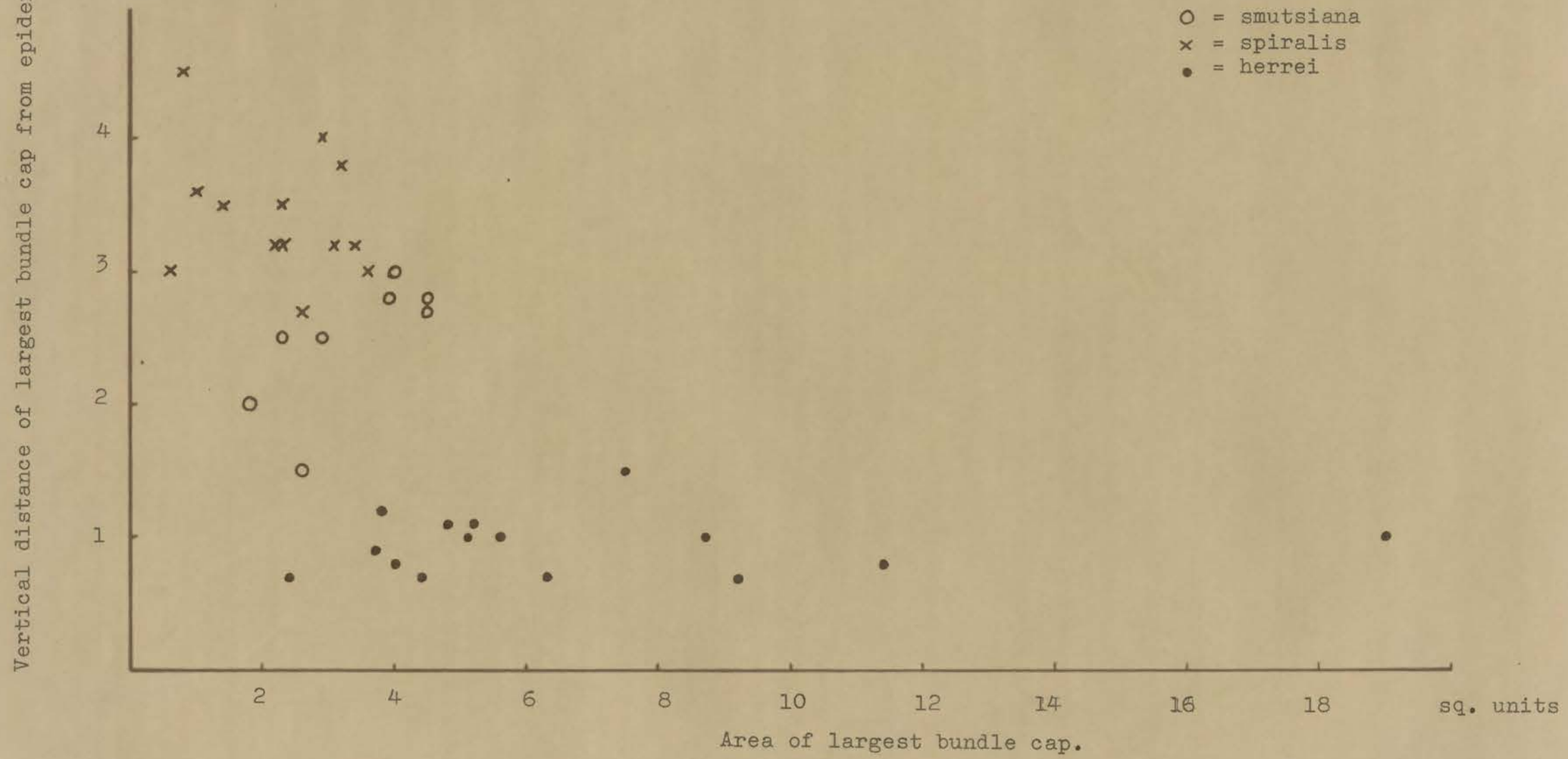


Fig. 9. Variation in the size of the largest bundle cap from the ventral side of the leaf and its distance in from the cuticle of the lower epidermis in the entities smutsiana, spiralis and herrei. (1 unit = 130µ). Leaves sectioned one third of the length from the apex.

In conclusion then, populations of the various entities can be recognised on a summation of their vegetative characters. Of these, however, only the shape of the leaf apex, the presence or absence of tubercles, and the nature of the outer wall of the epidermal cells as affecting the texture of the leaf, are of major taxonomic importance.

B. INFLORESCENCE AND FLORAL CHARACTERS

1. INFLORESCENCE MORPHOLOGY

In all species of Astroloba, the inflorescence is racemose with shortly pedicellate flowers. Each flower arises in the axil of a small bract and there are usually a few "sterile" or empty bracts on the peduncle below the raceme. Sometimes lateral racemes or unexpanded inflorescence buds are to be found in the axils of these bracts.

The peduncle is usually of the same length as, or slightly longer than the raceme, and while there is some variation in this measurement among different entities, it is not always a reliable taxonomic character, because growth in length may be influenced by external conditions. Further, specimens are often collected when the raceme is not fully expanded.

The base of the peduncle is flattened, owing to its origin in the axil of one of a number of crowded leaves. This flattened portion extends for about a centimetre and is expanded on either side into a thin wing of tissue with a width of 1 to 2 mm. and a margin which may be smooth, wavy, slightly serrated or crenellated, within the same entity. In the closely related monospecific genus, Poellnitzia, this wing is, however, rather distinctive.

Bract characters.

Sterile and fertile bracts are deltoid in shape, that is, widest at the base, and membranous with one to several central veins. Acropetally, these midrib veins decrease in thickness and number, so that at the apices of most inflorescences, the bracts become leathery and are thickened with chlorophyllous tissue about the midrib. Ih one instance, as will be shown, the number of midrib veins in the bracts is of some significance.

Bract length is a character which shows some variation in the different entities, and, as will be shown, is of some importance.

Pedicel length

Pedicel length generally decreased acropetally, but a few cases were seen in which pedicels some way from the base of the raceme were longer than those below them, or the pedicel second from the base was longer than the basal one. With the development of fruit there is an increase in pedicel thickness which may or may not be accompanied by an increase in length . Pedicel length too, will be shown to be of some significance.

In most instances the lowest flowers open in acropetal succession, but sometimes those from higher up are the first to do so. The successive opening of the flowers takes place one or two flowers at a time.

Measurements of inflorescence characters were made to include the following:-

i) Length of peduncle and length of flower bearing part, here termed "raceme".

ii) The number of "sterile" bracts below the raceme was noted, and this included those subtending axillary buds.

iii) Number of side branches or undeveloped buds found in axils of "sterile" bracts below raceme.

iv) Peduncle width at widest part of base and immediately below the raceme, where it is still slightly oval in section. In both instances, the wider diameter was measured. In the case of branched inflorescences this latter measurement was taken below the raceme terminating the main stem.

v) Dimensions of lowest "sterile" and "fertile" bracts. These included length, basal width and sometimes middle width. On a single inflorescence, there was little difference in these measurements amongst the lowest fertile bracts and so, where the lowest one was damaged, measurements were made of the one immediately above it.

vi) The lengths of the lowest pedicel or the one immediately above it, and one from the middle of the raceme, when it was fully expanded and flowering, were measured. In the case of fruiting racemes, the length of the lowest pedicel was noted. Sometimes it was possible to record the length of a lowest fruiting pedicel and a flowering pedicel from the middle of the same raceme.

Measurements of herbarium specimens are also given in the appendix, but consideration was given to the fact that in some instances these were no longer reliable due to shrinkage through drying, and where this was so, they were excluded in the assessment of the characters of the different groups.

Measurements of peduncle width and pedicel length were made with a vernier gauge, and those of bracts with a micrometer eyepiece.

Numerical assessment of inflorescence characters

(See Appendix Table 3)

Degree of branching of inflorescence (See Table 9)

Entity	Individuals with one or more branches to inflorescence.	Individuals with un-expanded infl. buds in the axils of sterile bracts.	Total number individuals.
bullulata	0	2	14
hallii	1	11	35
smutsiana	0	2	45
spiralis	1	4	45
herrei	0	0	22
rugosa	0	0	68
foliolosa	5	2	69
congesta	22	28	69
robusta	0	7	97

Table 9. VARIATION IN DEGREE OF BRANCHING OF INFLORESCENCE IN GENUS AS A WHOLE.
(Herbarium specimens included).

In most cases the inflorescence is unbranched. A very notable exception is the entity congesta which has a large number of individuals with branched inflorescences or unexpanded axillary raceme buds in the axils of the sterile bracts. A fair number of such buds are also found in the entity hallii.

Length of peduncle and raceme (See Table 10)

In all cases there is considerable overlap of these measurements in the different entities. The shortest peduncles are found in the entity robusta, (majority range 5 - 15 cm.) which also tends to have the largest number of individuals with racemes under 10 cm. in length.

The entity with the longest peduncles is spiralis (majority range 20 - 35cm.) which also has the longest racemes, together with bullulata and hallii.

Peduncle width (See Table 10)

There is an overlap of this measurement between the different entities. The widest peduncle base is found in the entity robusta (majority range 0.45 - 0.75 cm.) and in the entities bullulata, hallii and herrei, all of which have a majority range of 0.45 - 0.60 cm. The entity rugosa has the narrowest peduncle base with a majority range of 0.15 - 0.30 cm. Measurements for the other entities are intermediate.

The width of the peduncle below the raceme is greatest in the entity robusta, where the majority range is 0.30 - 0.45 cm. For the other entities with the exception of the entity hallii, where it is 0.15 - 0.45 cm., the majority range is 0.15 - 0.30 cm.

Number of sterile bracts. (See Table 11A).

The number of sterile bracts below the raceme is quite variable. The entities with the least number of sterile bracts are herrei and rugosa, which have the majority of individuals with 1 - 4 bracts. The other entities have the majority of individuals with 2 - 6 bracts.

Length of lowest sterile bract (See Table 11A).

The range of variation of this measurement is wide in most entities, and again there is overlap between the different entities. The longest sterile bracts are found in the entity

Entity.	Class range of measurements.									Total no. indiv.	Range actual measurements.
	PEDUNCLE LENGTH. Class Interval 5.0 cm.										
	5	10	15	20	25	30	35	40			cm.
Bullulata	-	-	2	7	1	3	-	-	-	13	14 - 30
Hallii	-	2	4	11	7	8	5	-	-	37	8 - 32
Smutsiana	-	3	11	14	6	4	-	-	-	38	8 - 29
Spiralis	-	-	-	5	12	16	10	5	-	48	16 - 39
Herrei	-	1	1	9	8	2	-	-	-	21	10 - 30
Rugosa	-	1	7	9	24	11	4	-	1	66	10 - 43
Foliolosa	-	3	24	30	11	1	-	-	-	69	9 - 28
Congesta	-	2	6	26	26	12	1	-	-	73	6 - 31
Robusta	2	34	44	15	2	-	-	-	-	97	5 - 21
	RACEME LENGTH.										
Bullulata	-	-	4	1	4	4	-	-	-	13	11 - 29
Hallii	-	1	7	14	12	1	2	-	-	37	8 - 32
Smutsiana	-	6	15	14	2	-	-	-	-	37	8 - 25
Spiralis	-	3	15	10	15	-	2	1	-	48	8 - 36
Herrei	-	-	5	4	3	2	-	-	-	14	13 - 28
Rugosa	1	14	19	11	1	2	-	-	-	48	5 - 27
Foliolosa	-	6	26	16	1	-	-	-	-	49	6 - 24
Congesta	-	2	31	27	7	-	-	-	-	67	8 - 25
Robusta	1	29	45	14	4	2	1	-	-	96	6 - 33
	WIDTH OF PEDUNCLE BASE. Class Interval 0.15 cm.										
	0.15	0.30	0.45	0.60	0.75	0.90	1.05				
Bullulata	-	-	1	8	-	1	-	-		10	0.44 - 0.80
Hallii	-	-	4	22	7	3	-	-		36	0.39 - 0.90
Smutsiana	-	15	22	-	-	-	-	-		37	0.22 - 0.42
Spiralis	-	6	19	5	-	-	-	-		30	0.26 - 0.56
Herrei	-	-	4	12	-	-	-	-		16	0.40 - 0.60
Rugosa	-	37	18	-	-	-	-	-		55	0.22 - 0.40
Foliolosa	-	7	43	5	-	-	-	-		55	0.26 - 0.50
Congesta	-	-	22	29	11	2	-	-		55	0.32 - 0.80
Robusta	-	-	1	22	29	8	5	4		69	0.42 - 1.10
	PEDUNCLE WIDTH BELOW RACEME.										
Bullulata	-	7	2	-	-	-	-	-		9	0.24 - 0.32
Hallii	-	18	16	-	-	-	-	-		34	0.17 - 0.44
Smutsiana	6	33	-	-	-	-	-	-		39	0.11 - 0.27
Spiralis	5	25	-	-	-	-	-	-		30	0.14 - 0.25
Herrei	-	17	1	-	-	-	-	-		18	0.20 - 0.32
Rugosa	6	49	-	-	-	-	-	-		55	0.14 - 0.28
Foliolosa	2	54	1	-	-	-	-	-		57	0.15 - 0.35
Congesta	-	47	16	-	-	-	-	-		63	0.20 -0.40
Robusta	-	14	38	19	7	-	-	-		78	0.28 - 0.73

Table 10 VARIATION IN DIMENSIONS OF PEDUNCLE AND RACEME IN GENUS AS A WHOLE (HERBARIUM MATERIAL INCLUDED.)

Entity.	Class range of measurements.							Total no. indiv.	Range actual measurements
NUMBER OF STERILE BRACTS. Class Interval 2 bracts.									
	2	4	6	8	10	12			cm.
Bullulata	-	5	6	3	-	-	-	14	3 - 7
Hallii	-	7	17	7	3	-	1	35	3 - 14
Smutsiana	1	12	20	5	1	-	-	39	2 - 10
Spiralis	-	15	23	7	-	-	-	45	3 - 8
Herrei	9	12	1	-	-	-	-	22	1 - 6
Rugosa	19	49	2	-	-	-	-	70	1 - 6
Foliolosa	1	26	32	8	1	-	-	68	1 - 10
Congesta	20	28	22	3	-	-	-	73	1 - 8
Robusta	9	49	32	8	1	-	-	99	1 - 10

	LENGTH LOWEST STERILE BRACT. Class Interval 0.20 cm.											
	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0			
Bullulata	-	8	6	-	-	-	-	-	-	-	14	0.42 - 0.73
Hallii	-	9	21	3	-	-	-	-	-	-	33	0.43 - 0.93
Smutsiana	-	13	17	5	1	-	-	-	-	-	36	0.42 - 1.05
Spiralis	-	2	15	15	4	3	-	-	-	-	39	0.52 - 1.40
Herrei	-	-	8	12	3	-	-	-	-	-	23	0.70 - 1.10
Rugosa	11	20	6	-	-	-	-	-	-	-	37	0.40 - 0.80
Foliolosa	-	4	32	23	6	2	-	-	-	-	67	0.56 - 1.30
Congesta	-	-	9	22	3	1	-	-	-	-	35	0.70 - 1.27
Robusta	-	-	4	11	28	25	17	6	4	1	96	0.75 - 2.15

	LENGTH LOWEST FERTILE BRACT. Class Interval 0.20 cm.											
Bullulata	8	7	-	-	-	-	-	-	-	-	15	0.35 - 0.53
Hallii	11	23	-	-	-	-	-	-	-	-	34	0.30 - 0.54
Smutsiana	20	15	-	-	-	-	-	-	-	-	35	0.30 - 0.60
Spiralis	3	25	12	1	-	-	-	-	-	-	41	0.32 - 0.86
Herrei	-	4	21	4	1	-	-	-	-	-		0.68 - 0.10
Rugosa	52	14	-	-	-	-	-	-	-	-	66	0.23 - 0.50
Foliolosa	2	41	34	4	-	-	-	-	-	-	81	0.40 - 0.90
Congesta	-	10	32	8	-	-	-	-	-	-	50	0.45 - 0.95
Robusta	-	2	20	30	36	7	1	-	-	-	96	0.43 - 1.50

Table 11A VARIATION IN DIMENSIONS OF INFLORESCENCE BRACTS IN GENUS AS A WHOLE (HERBARIUM MATERIAL INCLUDED)

robusta, (majority range 1.0 - 1.6 cm), the shortest in the entity rugosa, (majority range 0.2 - 0.6 cm). In the other entities the basal sterile bracts are intermediate in length, with varying majority ranges, as can be seen from the table.

Length of lowest fertile bract (See Table 11A)

This is somewhat shorter than the lowest sterile bract, and tends to vary in length with it.

Basal width of sterile bracts (See Table 11B)

Sterile bracts with the widest bases are found in the entities congesta and robusta, both with a majority range of 0.45 - 0.60 cm. The entities bullulata, smutsiana, spiralis and rugosa have sterile bracts with the narrowest bases (majority range 0.15 - 0.30 cm) and the remaining entities have the majority of individuals with intermediate measurements.

Basal width of fertile bracts (See Table 11B)

This measurement tends to be slightly less than that for the sterile bracts. Fertile bracts with the widest bases are again found in the entity robusta (majority range 0.30 - 0.60 cm) and in the entity congesta (0.30 - 0.45 cm). With the exception of the entity herrei which has a majority range of 0.15 - 0.45 cm., the remaining entities have most fertile bracts 0.15 - 0.30 cm. wide at the base.

Middle width of lowest sterile and fertile bracts (See Table 11B)

The lowest fertile bracts are, on the whole, narrower than the lowest sterile bracts, but the pattern of variation tends to be the same in both types of bracts. The entities robusta (majority range 0.2 - 0.3 cm) and congesta (majority range 0.1 - 0.3 cm) have the broadest bracts, while the most tapering bracts are found in the entities smutsiana and spiralis, both with a majority range of less than 0.1 cm.

Pedicel length (See Tables 12A and B)

The entities with the longest basal flowering pedicels are herrei, with a majority range of 0.4 - 0.8 cm, and bullulata, hallii and rugosa all with a majority range of 0.4 - 0.6 cm. The shortest basal flowering pedicels are found in the entities

Entity.	Class Range of measurements.	Total no. Indiv.	Range actual measurements.

BASAL WIDTH OF LOWEST STERILE BRACT. Class Interval 0.15 cm.

	0.15	0.30	0.45	0.60	0.75	0.90	1.05	1.20	cm.		
Bullulata	-	7	2	-	-	-	-	-	-	9	0.25 - 0.40
Hallii	-	18	13	2	-	-	-	-	-	33	0.19 - 0.47
Smutsiana	1	31	2	-	-	-	-	-	-	34	0.15 - 0.37
Herrei	-	7	11	4	-	-	-	-	-	23	0.28 - 0.50
Rugosa	-	22	3	-	-	-	-	-	-	25	0.18 - 0.36
Foliolosa	-	34	29	5	-	-	-	-	-	68	0.20 - 0.60
Congesta	-	-	9	17	8	-	-	-	-	34	0.35 - 0.75
Robusta	-	2	2	46	22	11	1	-	1	95	0.30 - 1.30

BASAL WIDTH OF LOWEST FERTILE BRACT. Class Interval 0.15 cm.

Bullulata	-	10	-	-	-	-	-	-	-	10	0.20 - 0.30
Hallii	-	31	2	-	-	-	-	-	-	33	0.19 - 0.40
Smutsiana	1	32	1	-	-	-	-	-	-	38	0.14 - 0.34
Spiralis	3	37	1	-	-	-	-	-	-	41	0.14 - 0.35
Herrei	-	10	19	2	-	-	-	-	-	31	0.30 - 0.50
Rugosa	-	31	-	-	-	-	-	-	-	31	0.20 - 0.30
Foliolosa	-	62	15	-	-	-	-	-	-	77	0.18 - 0.45
Congesta	-	3	42	4	-	-	-	-	-	49	0.28 - 0.58
Robusta	-	1	33	49	13	1	-	-	-	97	0.30 - 0.80

MIDDLE WIDTH OF LOWEST STERILE BRACT. Class Interval 0.10 cm.

	0.10	0.20	0.30	0.40	0.50			
Bullulata	2	5	2	-	-	-	9	0.08 - 0.23
Hallii	7	15	-	-	-	-	23	0.08 - 0.22
Smutsiana	24	12	-	-	-	-	36	0.05 - 0.15
Spiralis	27	8	-	-	-	-	35	0.05 - 0.15
Herrei	4	16	2	-	-	-	22	0.08 - 0.30
Rugosa	7	17	1	-	-	-	25	0.06 - 0.23
Foliolosa	14	41	9	-	-	-	64	0.08 - 0.36
Congesta	-	11	12	4	3	-	30	0.14 - 0.48
Robusta	-	21	49	20	4	1	95	0.17 - 0.52

MIDDLE WIDTH OF LOWEST FERTILE BRACT. Class Interval 0.10 cm.

Bullulata	3	6	-	-	-	-	9	0.08 - 0.16
Hallii	16	7	-	-	-	-	23	0.07 - 0.14
Smutsiana	30	5	-	-	-	-	35	0.07 - 0.13
Spiralis	39	1	1	-	-	-	41	0.04 - 0.23
Herrei	5	24	2	-	-	-	31	0.08 - 0.24
Rugosa	16	15	-	-	-	-	31	0.07 - 0.17
Foliolosa	34	41	1	-	-	-	76	0.06 - 0.22
Congesta	-	23	18	4	-	-	45	0.11 - 0.40
Robusta	-	27	58	12	-	-	97	0.14 - 0.40

Table 11B VARIATION IN DIMENSIONS OF INFLORESCENCE BRACTS IN GENUS AS A WHOLE. Contd. (HERBARIUM MATERIAL INCLUDED.)

Entity.	Class range of measurements.						Total no. indiv.	Range actual measurements.
	0.2	0.4	0.6	0.8	1.0			cm.
LOWEST FLOWERING PEDICEL IN FIELD SPECIMENS.								
Bullulata	-	1	8	-	-	-	9	0.37 - 0.53
Hallii	-	7	20	6	-	-	33	0.35 - 0.75
Smutsiana	3	31	3	-	-	-	37	0.14 - 0.48
Spiralis	4	11	2	2	-	-	19	0.17 - 0.80
Herrei	-	2	6	6	2	-	16	0.25 - 0.95
Rugosa	-	9	26	15	2	-	52	0.30 - 0.90
Foliolosa	23	22	-	-	-	-	45	0.09 - 0.38
Congesta.	16	15	-	-	-	-	31	0.07 - 0.40
Robusta	62	-	-	-	-	-	62	0.00 - 0.18
MIDDLE FLOWERING PEDICEL IN FIELD SPECIMENS.								
Bullulata	-	5	4	-	-	-	9	0.30 - 0.47
Hallii	-	21	12	-	-	-	33	0.28 - 0.59
Smutsiana	11	27	1	-	-	-	39	0.09 - 0.60
Spiralis	21	10	1	-	-	-	32	0.08 - 0.43
Herrei	-	2	8	4	-	-	14	0.23 - 0.70
Rugosa	-	21	20	4	1	-	46	0.28 - 0.92
Foliolosa	45	8	-	-	-	-	53	0.08 - 0.32
Congesta	37	4	-	-	-	-	41	0.06 - 0.28
Robusta	67	-	-	-	-	-	67	0.00 - 0.07
BASAL FRUITING PEDICEL IN FIELD SPECIMENS.								
Bullulata	-	-	2	-	-	-	2	0.39 - 0.42
Hallii	-	-	4	-	-	-	4	0.41 - 0.53
Smutsiana	-	10	1	-	-	-	11	0.24 - 0.43
Spiralis	3	11	2	-	1	-	17	0.17 - 0.82
Herrei	-	-	-	-	-	-	1	2.00
Rugosa	-	-	2	-	1	-	3	0.52 - 0.89
Foliolosa	2	15	-	-	-	-	17	0.14 - 0.38
Congesta	19	23	-	-	-	-	42	0.06 - 0.38
Robusta	35	-	-	-	-	-	35	0.02 - 0.15

Class Interval 0.20 cm.

Table 12A VARIATION IN PEDICEL LENGTH IN GENUS AS A WHOLE.

foliolosa and congesta, both with a majority range of 0.2 - 0.4 cm, and robusta with a majority range of <0.2 cm.

Pedicels become shorter acropetally and the entities with the longest pedicels from the middle of the raceme are again herrei (majority range 0.4 - 0.6 cm) and bullulata and rugosa, both with a majority range of 0.2 - 0.6 cm. The shortest pedicels from the middle of the raceme, which are <0.2 cm in length are found in the majority of individuals of the entities spiralis, foliolosa, congesta and robusta.

Unfortunately the samples of fruiting pedicels are small, but the variation pattern does not differ much from that of the lowest flowering pedicel.

The table showing range of variation in dried and herbarium material tallies with that for fresh material. Of interest is the very wide range of length of pedicel found in flowering and fruiting material of the entity herrei - from 0.25 - 200 cm.

Summary

In conclusion it can be seen that in all cases there is an overlap of the ranges of measurements of the various inflorescence parts for the different entities. Inflorescence characters cannot thus be considered to be of primary taxonomic importance. However, in a number of instances, the majority ranges do differ, and accordingly, certain inflorescence characteristics are discernable.

Long slender unbranched peduncles, long pedicels and small bracts tend to characterise the entity rugosa, while long stout unbranched peduncles, medium sized to large bracts and very long pedicels are typical of the entity herrei.

Very short pedicels tend to distinguish the entities foliolosa, congesta and robusta from the rest, lending support to the suggestion that these three entities be regarded as a distinct group because of their glossy sheen leaves. Congesta and robusta are further distinguished from the other entities by the high percentage of branched inflorescences in the former, and by short peduncles with wide bases and long bracts in the latter.

Entity.	Class range of measurements.						Total no. Indiv.	Range actual measurements.
	0.2	0.4	0.6	0.8	1.0			cm.
LOWEST FLOWERING PEDICEL IN HERBARIUM SPECIMENS.								
Bullulata	-	3	1	-	-	-	4	0.30 - 0.45
Hallii	-	1	-	-	-	-	1	0.33
Spiralis	1	9	1	-	-	-	11	0.20 - 0.42
Herrei	-	-	1	4	1	2		0.60 - 1.68
Rugosa	1	3	6	2	-	-	12	0.20 - 0.74
Foliolosa	9	5	-	-	-	-	14	0.08 - 0.29
Congesta	7	-	-	-	-	-	7	0.14 - 0.18
Robusta	12	-	-	-	-	-	12	0.00 - 0.08
MIDDLE FLOWERING PEDICEL IN HERBARIUM SPECIMENS.								
Bullulata	-	3	-	-	-	-	3	0.23 - 0.33
Spiralis	3	9	-	-	-	-	12	0.10 - 0.31
Herrei	-	1	4	-	2	1	8	0.39 - 1.10
Rugosa	2	9	1	-	-	-	12	0.18 - 0.58
Foliolosa	8	-	-	-	-	-	8	0.07 - 0.20
Congesta	7	-	-	-	-	-	7	0.07 - 0.15
Robusta	12	-	-	-	-	-	12	0.00 - 0.04
BASAL FRUITING PEDICEL IN HERBARIUM SPECIMENS.								
Spiralis	-	4	-	-	-	-	4	0.30 - 0.39
Herrei	-	-	-	-	1	-	1	0.83
Rugosa	-	-	2	-	-	-	2	0.53
Foliolosa	1	-	-	-	-	-	1	0.20
Congesta	1	-	-	-	-	-	1	0.15 - 0.33
Robusta	1	-	-	-	-	-	1	0.02 - 0.10

Table 12B VARIATION IN PEDICEL LENGTH IN GENUS AS A WHOLE. Contd.

2. FLORAL MORPHOLOGY

In Astroloba and the related genus Haworthia Duval, the six tepals of the perianth are loosely fused to form a tube, usually about a centimetre long and with a mean diameter of about 3 mm. The expanded free apical parts of the tepals, here referred to as lobes, vary in length from 1 to 3 mm. in Astroloba and 3 to 5 mm. in Haworthia. An inner tepal is in the posterior position.

In Haworthia, the lobes in addition to being longer than in Astroloba, open in such a way that the three anterior lobes are strongly up curved, resulting in a secondarily zygomorphic,* bilabiate flower. (See Plate 4). This feature is not strongly marked in some species such as H. margaritifera (L.) Haw and H. albicans Haw.

In Astroloba, the open arrangement of the lobes is much more regular, although sometimes the anterior outer lobe

* The term "Zygomorphy" implies a morphological asymmetry in the flower while "secondary zygomorphy" covers the situation in which there is an apparent lack of radial symmetry due to grouping of floral parts, themselves perfectly symmetrical, in the open flower.

tends to be out-curved through an angle greater than that formed by the two outer lateral lobes. (See Plate 4). The inner lobes tend not to open out as much as the outer ones and they are often somewhat hooded. The inner posterior lobe generally opens out more than the remaining inner lobes.

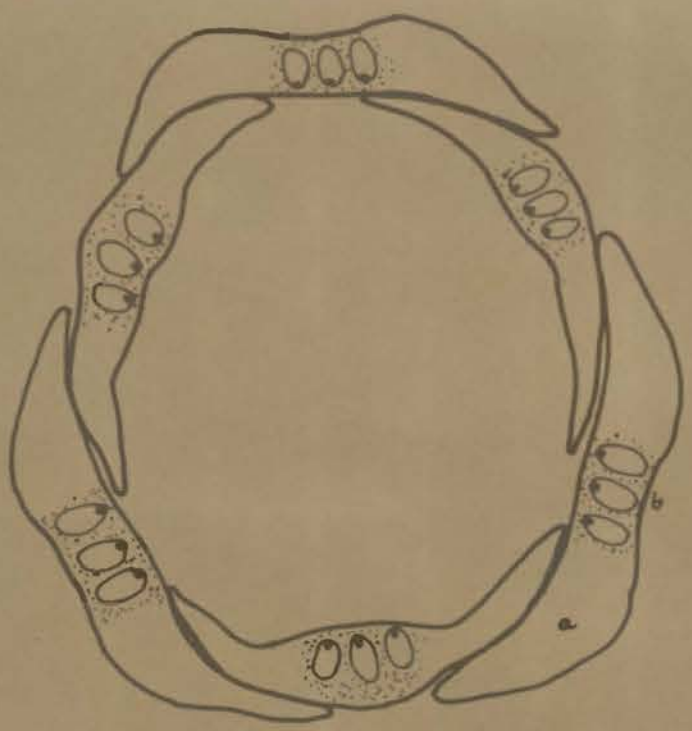
In Poellnitzia, von Poellnitz the third and mono-specific genus associated with this group of the Aloinae, the perianth tube is longer and bright orange-red in colour with connate yellow lobes, the side margins of which are revolute. The placing of P. rubriflora (L. Bol.) Uitew. in a separate genus on account of its unusual perianth is quite justified.

The colours of Astroloba flowers are indistinct, generally pale colours, difficult to describe - beige, olive green, pea green, glaucous green, yellow, sulphur yellow, cream and white. In cultivation under glass at Kirstenbosch, the perianth colours may become slightly paler, but on the whole do not differ very much from colours observed in the field.

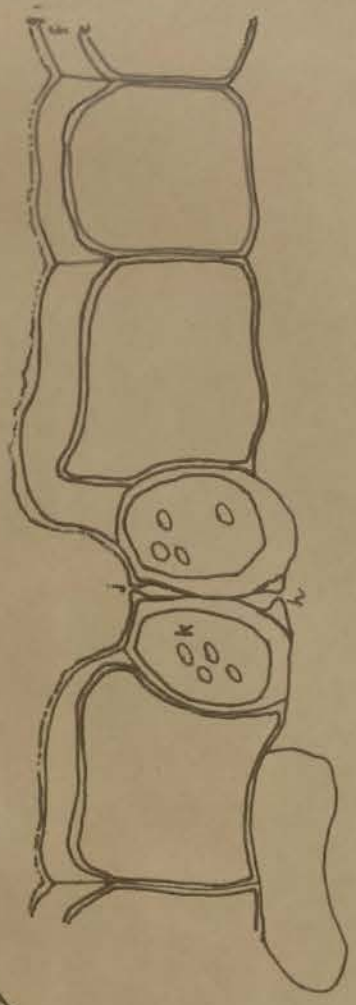
Perianth characters do indicate certain trends in the genus, and the most obvious character is that which distinguishes the entities herrei and spiralis from the other entities. Each tepal has a midrib of three central veins which converge to form an inverted V in the lobes, and the tissues surrounding these veins is pigmented. In the outer tepals, on either side of the midrib, there is an inflation of loosely packed parenchyma tissue, which may be white or faintly pigmented, the colouring becoming more intense towards the base of the tube. Save for the entities spiralis and herrei, this inflation is slight, (See Fig. 10). In these two, however, it is considerable (See Fig. 11). They may further be distinguished by the fact that in the entity herrei this inflation is generally smooth or undulating in appearance, while in the entity spiralis it tends to be transversely rugose. This will be discussed in more detail later.

Numerical Analysis of Perianth Characters in the Genus as a whole.

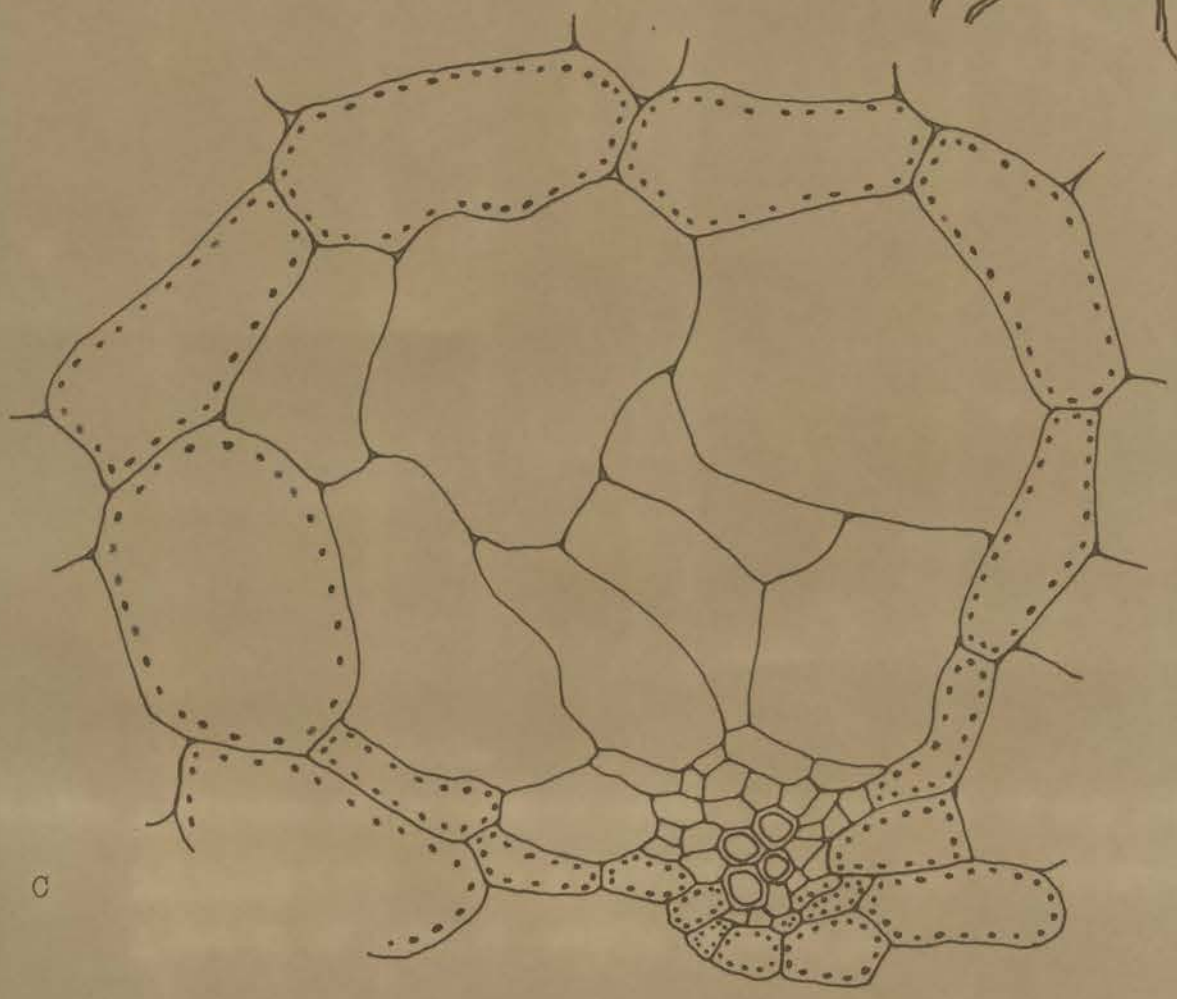
The measurements of perianth characters of individual populations are given in the Appendix Table 4. Whether the flowers



A



B



C

Fig. 10 A Diagram of transverse section of perianth of the entity rugosa (R17) X 30: a spongy parenchyma causing very slight inflation on either side of midrib in outer tepal, b midrib composed of three vascular strands, extent of pigmented tissue shown by stippling; B section through epidermis of perianth of same specimen showing stoma, labelling as for Fig.4.B; C transverse section of vascular bundle from midrib of tepal; note thin walled cells of bundle cap.

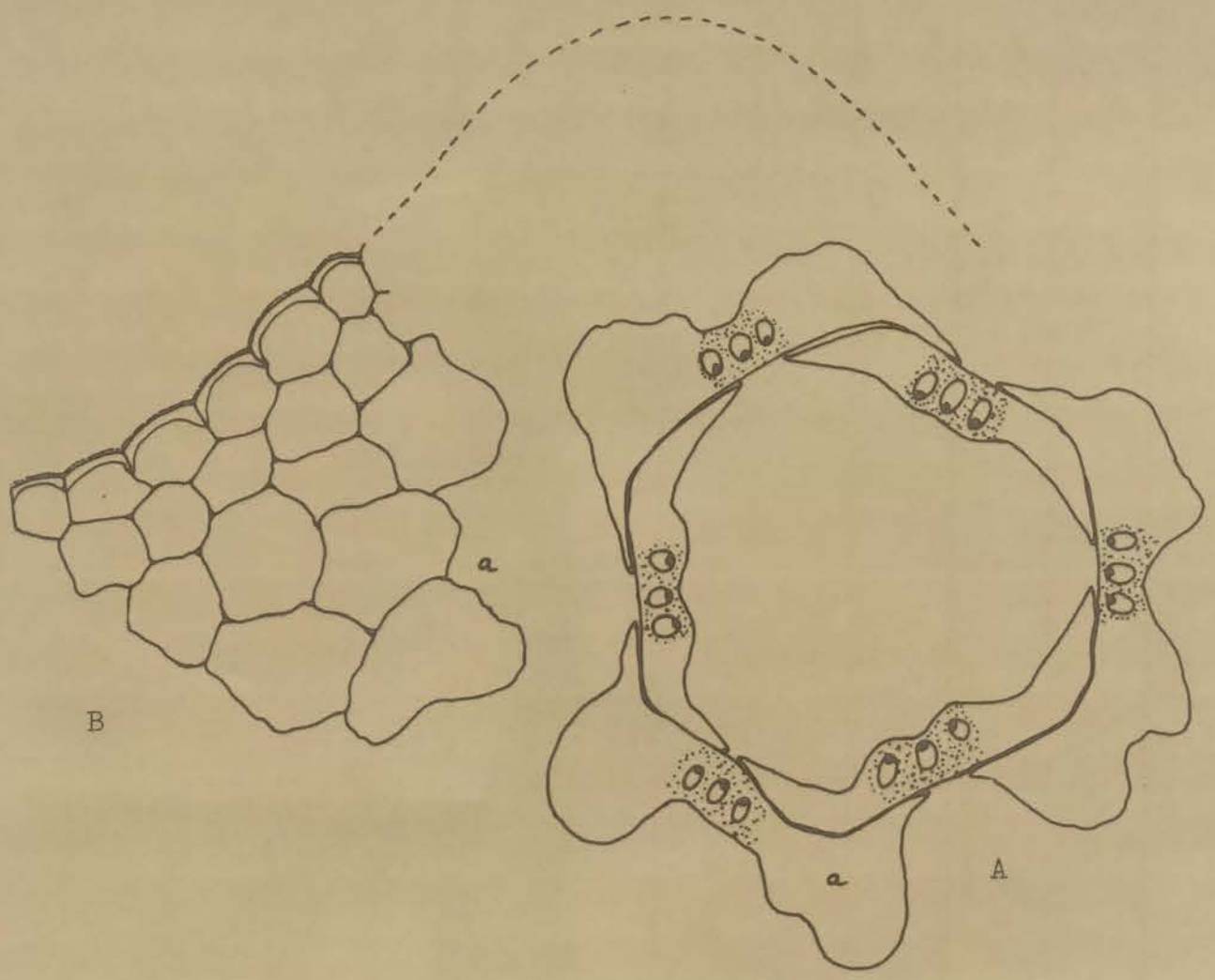


Fig.11. A Diagram of transverse section of perianth of the entity spiralis (R61) X 30: a inflation of spongy parenchyma; B detail of part of section through a.

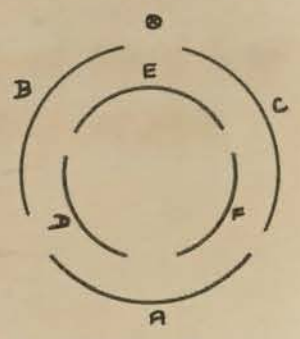
were measured from inflorescences growing in the field or from inflorescences which developed under cultivation is indicated in the table.

Perianth lobes. These are dealt with first. In colour, they are yellow, pale or whitish, in the open flower; the V of the vein endings usually with the same pigmentation as the midribs of the outer tepals. Apices of unopened buds are a deep salmon pink. The margins of the lobes are generally somewhat ragged or serrated, this being on the whole more marked in the inner lobes. Measurements of the length and width of inner and outer lobes were made using a micrometer eyepiece. The width of a lobe was measured half way along its length.

Dimensions of individual lobes vary slightly as is shown in Table 13 below.

Entity	Lobe length in cm.						Lobe width in cm.					
	A	B	C	D	E	F	A	B	C	D	E	F
robusta (R 43)	.23	.28	.30	.32	.32	.31	.30	.20	.20	.30	.31	.30
	.30	.30	.28	.37	.37	.36	.30	.30	.28	.40	.40	.40
	.28	.30	.30	.33	.32	.32	.19	.20	.20	.30	.32	.30
smutsiana (R62a)	.18	.15	.15	.15	.15	.14	.10	.13	.14	.15	.15	.15
	.14	.13	.13	.15	.15	.15	.10	.12	.13	.15	.15	.14
	.15	.16	.15	.15	.15	.15	.12	.13	.14	.14	.15	.13
hallii (R 54)	.19	.17	.17	.18	.19	.18	.12	.13	.15	.17	.18	.18
	.17	.16	.15	.18	.17	.18	.10	.13	.13	.18	.17	.18
	.20	.20	.20	.20	.20	.20	.15	.16	.16	.18	.20	.18

Table 13 showing variation in length and width of individual lobes taken at random from original measurements. The lobes are lettered as shown in the adjacent diagram.



These measurements are somewhat approximate in view of the fact that it is difficult to determine the exact extent of the length of a lobe. In the Table 4 of the Appendix, the mean of the measurements for each whorl are given and it is these which are used

in the analyses below.

Length of Perianth lobes (See Table 14)

There is little difference in length between the inner and outer perianth lobes throughout the genus.

Entities with the longest outer lobes are herrei (majority range 2.0 - 3.0 mm) and robusta (majority range 1.5 - 3.00 mm), while the shortest lobes are found in the entities smutsiana and spiralis, both with a majority range of 1.0 - 1.5 mm. The other entities have the majority of plants with outer lobes of intermediate length.

A similar pattern of variation is found for the length of the inner lobes. However it is of interest to note that about a third of the individuals of the entities foliolosa and congesta have inner perianth lobes 2.0 - 2.5 mm long, while for the entity robusta the majority range is 2.5 - 3.0 mm.

Width of perianth lobes (See Table 14)

In general, the inner perianth lobes are wider than the outer ones.

The broadest outer perianth lobes are found in the entity herrei, with a majority range of 1.5 - 2.5 mm, and the entities congesta, foliolosa and robusta, all with 1.5 - 2.00 mm as the majority range. The other entities have narrower lobes, the majority range in each case being 1.0 - 1.5 mm.

The broadest inner perianth lobes are found in the entities robusta (majority range 2.5 - 3.0 mm), herrei and congesta, (both with a majority range of 2.0 - 3.0 mm) and foliolosa, with a majority range of 2.0 - 2.5 mm. The narrowest perianth lobes are found in the entities smutsiana and spiralis, both with a majority range of 1.0 - 1.5 mm.

Thus in dimensions of perianth lobes, herrei, an entity with an inflated perianth stands apart with robusta, an entity with a smooth perianth, in having the longest and broadest lobes in the genus. The entities foliolosa and congesta, are distinguished from the remaining members of the genus by the possession of wider, if not longer lobes.

Entity.	Class range of measurements. 1.0	1.5	2.0	2.5	3.0	3.5		Total no. indiv.	Range actual measurements. mm.
LENGTH OF OUTER PERIANTH LOBES.									
Bullalata	-	2	7	-	-	-	-	9	1.5 - 1.9
Hallii	-	3	22	1	-	-	-	26	1.4 - 2.1
Smutsiana	-	30	4	-	-	-	-	34	1.2 - 1.8
Rugosa	-	12	12	-	-	-	-	24	1.4 - 1.8
Herrei	-	-	2	5	4	-	-	11	1.8 - 3.0
Spiralis	-	15	5	-	-	-	-	20	1.4 - 1.9
Congesta	-	-	22	8	1	-	-	31	1.6 - 2.8
Foliolosa	-	3	32	1	-	-	-	36	1.4 - 2.3
Robusta	-	-	7	7	10	-	-	24	1.7 - 3.0
LENGTH OF INNER PERIANTH LOBES.									
Bullulata	-	1	8	-	-	-	-	9	1.4 - 2.0
Hallii	-	4	20	2	-	-	-	26	1.5 ½ 2.2
Smutsiana	2	27	5	-	-	-	-	34	
Rugosa	-	13	11	-	-	-	-	24	1.4 - 1.8
Herrei	-	-	2	4	4	1	-	11	1.6 - 3.2
Spiralis	-	16	4	-	-	-	-	20	1.2 - 1.9
Congesta	-	-	18	10	3	-	-	31	1.8 - 2.8
Foliolosa	-	1	24	10	1	-	-	36	1.4 - 2.7
Robusta	-	-	-	5	12	4	3	24	2.3 - 4.0
WIDTH OF OUTER PERIANTH LOBES.									
Bullulata	-	7	2	-	-	-	-	9	1.3 - 1.8
Hallii	-	16	9	1	-	-	-	26	1.2 - 2.1
Smutsiana	6	24	4	-	-	-	-	34	1.0 - 1.9
Rugosa	-	22	2	-	-	-	-	24	1.2 - 1.7
Herrei	-	1	5	4	1	-	-	11	1.5 - 3.0
Spiralis	2	17	1	-	-	-	-	20	1.0 - 1.6
Congesta	-	1	28	2	-	-	-	31	1.5 - 2.2
Foliolosa	-	12	24	-	-	-	-	36	1.2 - 2.0
Robusta	-	-	9	2	3	-	-		
WIDTH OF INNER PERIANTH LOBES.									
Bullulata	-	-	9	-	-	-	-	9	1.6 - 2.0
Hallii	-	-	18	8	-	-	-	26	1.6 - 2.5
Smutsiana	-	20	14	-	-	-	-	34	1.2 - 1.9
Rugosa	-	2	22	-	-	-	-	24	1.5 - 2.0
Herrei	-	-	1	5	5	-	-	11	2.0 - 3.0
Spiralis	-	12	8	-	-	-	-	20	1.3 - 2.0
Congesta	-	-	1	17	12	1	-	31	2.0 - 3.2
Foliolosa	-	1	4	22	8	1	-	36	1.5 - 3.5
Robusta	-	-	-	3	17	2	2	24	2.2 - 4.0

Class Interval 0.50 mm.

Table 14 VARIATION IN DIMENSIONS OF PERIANTH LOBES IN GENUS AS A WHOLE.

The entities smutsiana and spiralis have the smallest lobes, while for the entities rugosa, bulluta and hallii, the lobe dimensions are of intermediate size.

Although the samples of herrei and bullulata are small, it is felt that in this case the measurements are sufficient to be indicative of the variation pattern of lobe dimensions within these entities. (See Plate 4).

The position of the lobes in the open flower (See Table 15)

The figures obtained by estimating with a protractor the angle (Fig. 12) through which the lobes curve outward from a projection of the line of the perianth tube,are very approximate.

It was found that the two lateral outer lobes open at roughly the same angle and so do the two inner laterals. In the appendix, then, four measurements, of the open angles made by the anterior outer lobe, outer laterals, posterior inner lobe, and inner laterals, are given.

Of all measurements made of perianth character these are the least reliable because both in the field and under cultivation the lobes do not always open to their fullest extent. Nevertheless, as is seen in Table 15 slight differences between the entities are apparent. Because of the fact that these measurements are only approximations a wide class interval of 30° is given in this Table.

Angle made by the outer anterior lobe

Reference to Table 15 shows that the most open anterior lobes are found in robusta (majority range $90 - 120^{\circ}$), and foliolosa and congesta, (both with a majority range of $60 - 90^{\circ}$). Entities with the least open anterior lobes are rugosa, herrei and spiralis, all with a majority range of $30 - 60^{\circ}$. The remaining entities have a majority range of $30 - 90^{\circ}$.

Angle made by outer lateral lobes

Table 15 shows that in some instances, the outer lateral lobes are less open than the outer anterior lobe. The most open outer laterals are also found in the entities congesta, foliolosa and robusta.

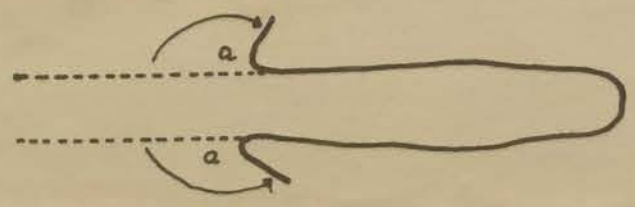


Fig. 12. Diagram showing angle a measured to indicate position of lobes in the open flower.

(X 1)

Flowers of the entity robusta, showing broad perianth lobes, which open out in a wide angle. In one of the flowers below, the anterior outer lobe curves back through an angle of 180°.

(X 1)

Flowers of the entity bullulata with smaller perianth lobes which do not open out as much as is found in the entities foliolosa, robusta and congesta.

PLATE 4.

Entity.	Class range of measurements.						Total no. indiv.	Range actual measurements.
	30°	60°	90°	120°	150°			°
ANGLE MADE BY OUTER ANTERIOR LOBE.								
Bullulata	-	3	3	1	-	-	7	30 - 90
Hallii	2	10	8	2	-	-	22	5 - 90
Smutsiana	3	9	8	-	-	-	20	10 - 80
Rugosa	4	9	4	-	-	-	17	0 - 70
Herrei	-	6	2	-	1	-	9	40 - 125
Spiralis	2	10	3	1	-	-	16	10 - 90
Congesta	-	3	13	6	2	1	25	30 - 180
Foliolosa	-	7	16	8	-	1	32	30 - 180
Robusta	-	3	3	8	3	2	19	40 - 180
ANGLE MADE BY OUTER LATERAL LOBES.								
Bullulata	1	2	4	-	-	-	7	20 - 80
Hallii	1	15	4	2	-	-	22	0 - 90
Smutsiana	3	8	9	-	-	-	20	10 - 70
Rugosa	11	6	-	-	-	-	17	10 - 55
Herrei	3	4	1	1	-	-	9	0 - 90
Spiralis	4	11	1	-	-	-	16	0 - 70
Congesta	-	5	12	7	-	1	25	30 - 180
Foliolosa	4	8	17	3	-	-	32	10 - 100
Robusta	-	4	4	6	4	1	19	30 - 170
ANGLE MADE BY INNER POSTERIOR LOBE.								
Bullulata	-	6	1	-	-	-	7	30 - 70
Hallii	9	8	5	-	-	-	22	0 - 80
Smutsiana	2	13	5	-	-	-	20	10 - 70
Rugosa	16	1	-	-	-	-	17	0 - 30
Herrei	9	-	-	-	-	-	9	0 - 10
Spiralis	8	8	-	-	-	-	16	0 - 50
Congesta	9	9	5	2	-	-	25	0 - 110
Foliolosa	2	16	10	4	-	-	32	0 - 90
Robusta	-	5	6	5	3	-	19	30 - 130
ANGLE MADE BY INNER LATERAL LOBES.								
Bullulata	3	4	-	-	-	-	7	10 - 45
Hallii	20	2	-	-	-	-	22	0 - 45
Smutsiana	14	6	-	-	-	-	20	0 - 45
Rugosa	16	1	-	-	-	-	17	0 - 30
Herrei	9	-	-	-	-	-	9	6 - 10
Spiralis	15	1	-	-	-	-	16	0 - 30
Congesta	11	7	5	2	-	-	25	0 - 110
Foliolosa	5	23	4	-	-	-	32	0 - 70
Robusta	-	6	8	2	3	-	19	30 - 130

Class Interval 30°.

Table 15 VARIATION IN POSITION OF PERIANTH LOBES IN OPEN FLOWER IN GENUS AS A WHOLE.

Angle made by inner posterior lobe

For all entities there is a tendency for this to be less open than the outer lobes. The entities with the most open inner posterior lobe are robusta and foliolosa, while the entities with the least open inner posterior lobe are aspera and herrei. The remaining entities are intermediate.

Angle made by inner lateral lobes

The inner lateral lobes tend to open out least of all the lobes. Again the entities robusta and foliolosa have the most open lobes. The entities congesta and bullulata are intermediate, while the remaining entities all have the majority of inner lateral lobes opening at an angle of 30^{o}.

Thus the entities robusta and foliolosa, and to a lesser extent congesta appears to have the most open perianth lobes in the genus.

Perianth tube (See Table 16)

Dimensions and shape of the perianth tube vary slightly and measurements were made, using a vernier gauge, of the following:-

(i) Basal diameter of perianth tube.

(ii) The diameter of the perianth tube half way along its length.

(iii) The diameter of the perianth neck - the point at which the lobes begin to diverge.

The perianth tube is in general slightly oval in section, the broadest diameter being along the anterior posterior axis, and measurements were made in this plane.

(iv) The length of the perianth tube was measured from the base to the neck.

Length of perianth tube

Entities with the longest perianth tubes are hallii and smutsiana, both with a majority range of 9 - 11 mm, while the shortest perianth tube is found in the entity herrei with a majority range of 5 - 7 mm. The remaining entities have perianth tubes intermediate in length.

Entity.	Class range of measurements.					Total no. indiv.	Range actual measurements.
LENGTH OF PERIANTH TUBE. Class interval 2.0 mm.							
	7.0	9.0	1.1				mm.
Bullulata	-	4	5	1		10	8.0 - 12.0
Hallii	-	7	22	1		30	7.8 - 11.3
Smutsiana	-	8	21	5		34	8.3 - 12.1
Rugosa	-	13	6	8		27	7.3 - 12.5
Herrei	8	3	-	-		11	5.7 - 8.0
Spiralis	-	13	6	3		22	7.3 - 11.9
Congesta	16	15	-	-		31	5.8 - 9.0
Foliolosa	3	31	2	-		36	7.0 - 9.9
Robusta	9	14	1	-		24	5.8 - 9.6
DIAMETER OF PERIANTH NECK. Class interval 0.5 mm.							
	2.0	2.5	3.0	3.5			mm.
Bullulata	-	10	-	-	-	10	2.3 - 2.5
Hallii	-	15	15	-	-	30	2.1 - 3.0
Smutsiana	15	17	2	-	-	34	1.9 - 2.8
Rugosa	12	14	1	-	-	27	1.9 - 2.6
Herrei	1	6	4	-	-	11	2.0 - 3.0
Spiralis	15	5	1	-	-	21	1.7 - 2.8
Congesta	-	7	19	4	1	31	2.3 - 3.6
Foliolosa	2	15	17	2	-	36	2.0 - 3.4
Robusta	1	4	17	1	-	23	2.2 - 3.2
MIDDLE DIAMETER OF PERIANTH TUBE. Class interval 0.5 mm.							
	2.5	3.0	3.5	4.0	4.5	5.0 5.5	mm.
Bullulata	-	2	4	-	2	- - -	8 2.9 - 4.1
Hallii	- -	5	10	7	1	- - -	23 2.8 - 4.1
Smutsiana	-	17	12	4	1	- - -	34 2.8 - 4.1
Rugosa	1	18	4	1	-	- - -	24 2.5 - 3.7
Herrei	-	-	-	6	3	2 - -	11 3.7 - 5.0
Spiralis	-	7	11	-	2	- - -	20 2.6 - 4.3
Congesta	-	8	12	10	1	- - -	31 2.8 - 4.3
Foliolosa	-	10	15	9	1	- - -	35 2.6 - 4.3
Robusta	1	11	10	2	-	- - -	23 2.4 - 3.8
BASAL DIAMETER OF PERIANTH TUBE. Class interval 0.5 mm.							
Bullulata	-	1	6	1	2	- - -	10 3.0 - 4.4
Hallii	-	4	17	5	4	- - -	30 2.8 - 4.3
Smutsiana	-	20	10	4	-	- - -	34 2.7 - 3.7
Rugosa	1	9	15	2	-	- - -	27 2.5 - 3.8
Herrei	-	3	3	2	2	- - 1	11 2.9 - 5.6
Spiralis	2	8	6	4	1	- - -	21 2.4 - 4.2
Congesta	5	20	4	2	-	- - -	31 2.2 - 3.7
Foliolosa	3	20	10	3	-	- - -	36 2.4 - 4.0
Robusta	2	15	6	-	-	- - -	23 2.3 - 3.3

Table 16 VARIATION IN DIMENSIONS OF PERIANTH TUBE IN GENUS AS A WHOLE.

Diameter of perianth neck

Entities with the widest neck are congesta and robusta, both with a majority range of 2.5 - 3.00 mm, while the entity spiralis, with a majority range of 1.5 - 2.0 mm has the most constricted perianth neck. The remaining entities have necks intermediate in diameter.

Middle diameter of perianth

The broadest mid diameter is found in the entity herrei, with a majority range of 3.5 - 4.0 mm, while in spiralis, the other entity with a marked inflation of the outer tepals, the majority range is 2.5 - 3.5 mm.

Of the entities with a smooth perianth, the broadest mid diameter is found in congesta and bullulata, (majority range 3.0 - 4.0 mm), while the narrowest mid diameter occurs in the entity rugosa with a majority range of 2.5 - 3.0 mm. Measurements for the remaining entities are intermediate.

Basal diameter of perianth

Entities with the broadest perianth bases are bullulata, hallii and rugosa, all with a majority range of 3.0 - 3.5 mm. The majority ranges for the entity spiralis, (2.5 - 4.0 mm), and the entity herrei, (2.5 - 4.5 mm) are more extensive. The remaining entities have the majority of individuals with perianth bases 2.5 - 3.0 mm in diameter.

Difference between diameter of base and diameter of middle of perianth. (See Table 17)

The middle diameter of the perianth is for the most part less than or equal to the basal diameter in the entities bullulata, hallii and rugosa. In the entity smutsiana the majority of individuals have the middle diameter equal to or greater than the basal diameter. In the other entities, the middle diameter of the perianth tube is greater than that of the base in the majority of individuals, this difference being most marked in the entity herrei.

Difference between diameter of middle and diameter of neck of the perianth tube. (See Table 17)

In all cases the neck of the perianth tends to be narrower than the middle. The greatest difference in diameter is

Entity.	Class range of measurements.									Total no. indiv.	Range actual measurements.
	-1.5	-1.0	-0.5	0	0.5	1.0	1.5				mm.
DIFFERENCE BETWEEN DIAMETER OF MIDDLE AND DIAMETER OF NECK OF PERIANTH TUBE.											
Bullulata	-	-	-	-	-	-	6	-	2	8	0.6 - 1.7
Hallii	-	-	-	-	-	2	12	9	-	23	0.5 - 1.4
Smutsiana	-	-	-	-	-	5	19	7	3	34	0.4 - 1.7
Rugosa	-	-	-	-	-	5	17	1	1	24	0.4 - 1.7
Herrei	-	-	-	-	-	-	-	6	5	11	1.1 - 2.0
Spiralis	-	-	-	-	-	-	5	11	4	20	0.7 - 2.0
Congesta	-	-	-	-	-	18	12	1	-	31	0.1 - 1.4
Foliolosa	-	-	-	-	-	7	23	4	1	35	0.3 - 1.9
Robusta	-	-	-	-	3	16	4	-	-	23	0.0 - 0.8
DIFFERENCE BETWEEN DIAMETER OF BASE AND DIAMETER OF MIDDLE OF PERIANTH TUBE *											
Bullulata	-	-	-	-	1	7	-	-	-	8	0.0 - 0.3
Hallii	-	-	-	6	5	12	-	-	-	23	-0.3 - 0.4
Smutsiana	-	-	-	14	12	8	-	-	-	34	-0.4 - 0.4
Rugosa	-	-	-	-	3	21	-	-	-	24	0.0 - 0.5
Herrei	-	-	6	3	1	-	1	-	-	11	-1.0 - 0.6
Spiralis	-	-	1	11	3	5	-	-	-	20	-0.7 - 0.3
Congesta	1	-	7	22	1	-	-	-	-	31	-1.6
Foliolosa	-	-	6	22	5	2	-	-	-	35	-0.9 - 0.2
Robusta	-	-	2	10	7	4	-	-	-	23	-0.8 - 0.3

Class interval 0.50 mm.

Table 17 SHOWING VARIATION IN SHAPE OF PERIANTH TUBE IN GENUS AS A WHOLE

* A negative value indicates that the base of the perianth is less in diameter than the middle.

found in the entities with inflated perianth tissue , namely herrei (majority range 1.0 - 2.0 mm) and spiralis (majority range 1.0 - 1.5 mm). The entities with the least difference in diameter between middle and neck of perianth are congesta and robusta, both with a majority range of 0 - 0.5 mm. The other entities are intermediate.

The varying diameter of the base, middle and neck of the perianth tube do tend to affect its appearance.

The entities bullulata and hallii have perianths similar in character in that they tend to be the longest in the genus, with the base of the tube for the most part being broader than the middle.

The entity rugosa, it is seen, has a perianth in general shorter in length than bullulata and hallii, but also with a similar basal diameter and a middle diameter narrower than the basal diameter. Here, howev er, the middle diameter is less than in the two other entities. The appearance of the perianth as a whole is consequently somewhat different.

In the entity smutsiana, the basal diameter tends to be less than in the entity rugosa, while the middle diameter is more or less the same, so that the middle part may be greater than, equal to, or in a few cases, less than the diameter of the base.

The entities herrei and spiralis, both with inflated perianth tissue have somewhat dissimilar perianth tube dimensions, the perianth tube being shorter and broader in herrei.

The entities congesta and robusta tend to have perianths with the widest necks, while these and the entity foliolosa tend to have the middle diameter larger than the basal diameter.

Length of stamens, ovary and style

In general these are too variable to be of any taxonomic significance but for the sake of completion ovary and style lengths are included in Table 4 of the appendix.

The length of the stamen varies within one flower since they do not all mature at the same time, and generally the three anterior stamens are slightly longer than the three posterior ones.

On the whole, the length of the longest stamen is roughly equivalent to or a fraction shorter than the length of the perianth tube.

Stamen length is not included in the Appendix Tables, but the variation in stamen length in flowers of two population samples is shown in Table 18.

Entity	Length of perianth tube	Length of stamens: Anterior			Posterior		
bullulata (R55)	.92	.82	.97	.85	.82	.80	.85
	.86	.75	.70	.73	.65	.72	.70
	.80	.80	.82	.78	.75	.75	.72
	.83	.80	.75	.75	.77	.73	.70
	1.00	.90	.80	.86	.75	.85	.75
	.98	.85	.70	.82	.80	.75	.75
	.94	.86	.90	.85	.70	.80	.70
	.89	.75	.80	.80	.70	.80	.70
robusta (R42)	.79	.70	.65	.70	.57	.65	.55
	.77	.60	.70	.70	.65	.65	.70
	.70	.70	.65	.70	.65	.60	.70
	.66	.65	.80	.75	.60	.60	.65
	.70	.70	.60	.60	.63	.70	.65
	.90	.70	.80	.85	.50	.70	.60
	.70	.65	.70	.70	.60	.60	.65
	.80	.70	.80	.70	.70	.65	.65
	.85	.70	.65	.70	.60	.60	.60

Table 18. VARIATION IN LENGTH OF STAMENS IN TWO POPULATION SAMPLES OF ASTROLOBA (THE CENTRAL FIGURE IN THE MEASUREMENTS OF ANTERIOR STAMEN LENGTH APPLIES TO THE ANTERIOR STAMEN FROM THE OUTER STAMINAL WHORL, WHILE THAT IN THE MEASUREMENTS OF THE POSTERIOR STAMENS IS THE LENGTH OF THE POSTERIOR STAMEN FROM THE INNER WHORL OF STAMENS.)

Perianth Colours (See Plate 5).

The colours of the perianth are hard to define but do vary somewhat in the different entities. Mention has been made earlier of the greatly swollen tissue on either side of the midrib in the three outer tepals of the entities spiralis and herrei.

In these two, the midribs of the tepals are a pale green, with a bluish or a beigey tinge, the inflated tissue on either side of the outer tepal midribs is white, and the lobes are a clear yellow, which may be bright or pale, but is always definitely yellow.

In the entities congesta, foliolosa and robusta, the colours of the perianth are similar for all three. The veins of the tepals are green with a slightly blue, beige or yellowish tinge, the vein endings in the lobes being of the same colour, but sometimes with a pinkish tinge. The rest of the lobe is white or pale cream, but never yellow. The tubular part of the outer tepals on either side of the midrib is greenish white or pale cream, becoming greener towards the base.

In the entity hallii, the colours of the perianth tube are similar to those of the above three, same that the tissue on either side of the midrib of the outer tepals often has a greenish, beige or greenish yellow tinge. The lobes may be a bright yellow, or more often a pale yellow or yellowish cream, and in a few instances, cream. When the lobes are yellow, the vein endings tend to be a reddish brown otherwise they are greenish, greenish beige or beige.

In the entity bullulata, the lobes in most cases are a bright yellow, or a pale yellow, and very rarely yellowish cream. No specimens with cream or whitish lobes were observed.

In specimens with bright yellow lobes, the midribs of the tepals are often green with a reddish brown tint.

In the entity smutsiana, the colour of the perianth is much the same as in the entity hallii, save that the lobes are white or cream.

In the entity rugosa, the midribs of the tepals are green with a beige or pinkish tinge. The three outer tepals of the perianth tube may be very slightly inflated on either side of the midrib. This tissue is white, cream or with a very faint pinkish or greenish tinge and it tends to be more distinct from the midrib than in the entities hallii, bullulata or smutsiana.

Summary

Thus on grounds of perianth characters, the entities herrei and spiralis stand apart from the other entities in the possession of markedly inflated tissue on either side of the midribs of the outer tepals, and the fact that the lobes are always yellow. However, the lobes of herrei tend to be longer and broader than those of spiralis, and the perianth tube tends to be shorter in length and broader than in spiralis.

The entities congesta, robusta and foliolosa tend to be distinguished from the remaining entities on the grounds of having the broadest and most open lobes which are never yellow in colour, and a perianth tube which is for the most part broader at the middle than the base.

The entities hallii and bullulata tend to have, in the majority of cases, a yellow tinge to the perianth tube and yellow lobes, and the width of the base of the perianth tube is for the most part equal or greater than the width of the middle.

The entity rugosa tends to have the least open lobes, which may have a pinkish or yellowish tinge, and a perianth tube in which the middle diameter is in nearly all cases less than the basal diameter, and this middle diameter tends to be less than that of the entities hallii and bullulata. Also the tissue on either side of the midribs of the outer tepals is sometimes slightly inflated.

The entity smutsiana tends to have a perianth tube with the middle diameter greater than the basal diameter and short lobes which never have a yellowish tinge.

But, with the exception of the inflated perianth of the entities herrei and spiralis, these variations in perianth character while tending to have slightly different peaks of expression in the different entities, cannot be used as taxonomic delimitants.

Left: inflorescence of the entity foliolosa, showing open flowers with white lobes, tips of unopened buds are a salmon pink. (X 1).

Right: inflorescence of the entity herrei, showing open flowers, with yellow lobes, and the three outer tepals of the tube with an inflation of parenchyma tissue. (Approx. X $1\frac{1}{5}$).

Left: Flowers of the entity smutsiana with smooth perianth tubes and cream lobes, and flowers of the entity spiralis with yellow lobes and perianth tubes with a marked inflation of the outer tepals, which is transversely rugose. (Approx X 2).

PLATE 5.

DISTRIBUTION OF ENTITIES.

In this account, Acock's classification of veld types (1953) is cited because a reference to his lists of species gives some idea of the vegetation with which Astrolobas are associated. Further, Acock's work is the only comprehensive survey to date on South African veld types, and his terminology is at present that most widely used.

The present author however, does not necessarily agree with all of Acock's classification of karoid types. It is felt that his use of the term "False" implies encroachment of karoid vegetation at an artificial rate which is by no means proven in all cases. Inaccuracies are to be found in the only listing of Astroloba species in the work, under "26 Karoid Broken Veld (b) The Little Karoo .... Apicra foliolosa, A. deltoidea and A. rubriflora." Poellnitzia rubriflora (L. Bol.) Uitew. occurs chiefly in the Robertson Karoo and the other two entities are found in the eastern part of the Great Karoo and marginal karoid - grassveld areas.

The map used to illustrate entity distribution is taken from that of the Botanical Provinces of South Africa, by R.S. Pinker, 1930 in Marloth's Flora (1932) See Fig. 13. In the distribution maps, only the position of the mountain ranges is shown, and the broken line indicates the approximate boundary between karoid areas and grassveld.

To permit assessment by the reader of adequacy of data on distribution, the distribution of the various entities is discussed at some length, and localities visited by the author are given in detail. It can be seen that herbarium records are few, and although the author attempted a comprehensive collection of the entities, the record cannot be regarded as complete. Collecting in karoid areas has its physical limitations, for one is more or less confined to areas which are not a great distance from roads.

Spelling and identification of localities in this text is taken from the Topographical Edition of the 1:500,000 map of South Africa. (1950-1958).


THE BOTANICAL PROVINCES
OF
SOUTHERN SOUTH AFRICA
GREAT NAMAQUA LAND
KALAHARI
Southern
BUSHMAN LAND
Approximate boundary between Karroid Areas and Grassveld
limit of Euphorbia
limit of Aloe dichotoma
Kamiesberg
LITTLE NAMAQUALAND
KARROID PLAINS
ROGGEVELD
GREAT KARROO
LITTLE KARROO
CAPE REGION
ATLANTIC OCEAN
INDIAN OCEAN
Bloemfontein
Cape Town
Port Elizabeth
Stellenbosch
Worcester
Oudtshoorn
Graaff Reinet
Cradock
Grahamstown
Colesberg
Hanover
Richmond
Fraserburg
Calvinia
Saldanha Bay
Simonstown
Mossel Bay
Knysna
Kompass Bg
Stormberg
Winterberg
Sneeuw B.
Koudeveldbergen
Langeberg
Outeniqua
Tsitzikamma
Queenstown
Molteno
Burgersdorp
Steynsburg
Middelburg
Tarkastad
Somerset E.
Bedford
Ft Beaufort
Bathurst
Alexandria
Port Alfred
E. London
Uitenhage
Humansdorp
Steytlerville
Willowmore
Prince Albert
Aberdeen
Beaufort W.
Victoria W.
Hutchinson
De Aar
Philipstown
Philippolis
Fauresmith
Edenburg
Smithfield
Zastrow
Springfontein
Bethulie
Aliwal N.
Hopetown
Douglas
Kakamas
Kenhardt
Upington
Goodhouse
Steinkopf
Ookiep
Springbok
Port Nolloth
Garies
Clanwilliam
Piquetberg
Hopefield
Malmesbury
Paarl
Robertson
Swellendam
Bredasdorp
Caledon
Riversdale
George
Ladybrand
Thabanchu
Wepener
Mafeteng
Maseru
Barkly
Elliot
Cala
Cathcart
Stutterheim
Komgha
Glen Grey
Herschel
16°
18°
20°
22°
24°
26°
28°
30°
32°
34°

Figure 13.

THE ENTITY CONGESTA. (See Fig.14).

Of all Astrolobas, this entity has the Eastern most distribution, occurring in areas transitional between karoid veld and grassveld.

The most Northerly record is from Rosmead (Bruwer s.n. No. 27629 in Herb. Bol. (BOL)), but the present author failed to find any populations of Astroloba in the vicinity of Rosmead.

Further South there are a number of records along the Fish River valley North of the Suurberg, where, according to Acocks, the vegetation is False Karoid Broken Veld (37). (The numbers in brackets are those given by Acocks for his different veld types.) Personal records of the author are: 19 miles North of Cradock, where the population consisted of a few plants growing under bushes over a small area of about 50 yards square, on a gentle North facing shaley slope; a prominent shaley hill just outside Cradock where the entity congesta was a dominant member of the community, growing alone or under bushes of Rhigozum obovatum; and Rayners Kop, where the locality was a stony North East facing slope and the plants were again locally very common, growing alone or with low shrubby bushes less than a foot in height.

To the West of this part of the Fish River valley lie the Tandjiesberg and Bruintjieshoogte, and to the East, the western part of the Winterberg, North of which the vegetation is bush or grassveld.

South of this part of the Fish River valley, topography and vegetation are varied, but, where patches of karoid broken veld occur, congesta populations may occur, as the author found along the road to Grahamstown, South of Adelaide, where, over small areas, the entity congesta was common, growing mostly under Rhigozum obovatum bushes on gentle North facing shaley slopes.

Further South, near Dikkop Vlakte a population of the entity congesta was found growing under somewhat different conditions, on a silty vlakte with low bushes of the karoid broken veld type - chiefly composites and shrubby mesems. (The word "mesem" is used in this context in the widest sense).

An extremely interesting locality was a North facing slope at the poort near Helspoort, where there was a very small patch of karoid broken veld which merged into a mixture of Succulent Mountain Scrub or Spekboomveld (25) and Valley Bushveld of the Fish River Scrub type (23(c)). In this small area, the entity congesta was extremely common, being a dominant member of the community and growing on its own in dense clumps. There are a number of herbarium records of congesta from this locality.

The easternmost record for congesta is "the top of Brakkloof", (Acocks 12049 PRE). The author visited the area, without success, but conditions under which plants of congesta might be found appeared to be similar to those near Helspoort. There are few records for congesta to the South of Helspoort, the southernmost one probably being from near Alicedale.

THE ENTITY FOLIOLOSA. (See Fig.14). (See plates 6 and 7).

This entity is found in the lower lying flat karoid areas between the Baviaanskloof - Groot Winterhoek ranges and the line made by the more arid Grootriverhoogte, Wolvefonteinberg, Klein Winterhoekberg and the Suurberg, and to the North of these as far as the Koudeveldberg, Sneeuberg and Tanjiesberg.

Following Acocks' classification, the vegetation types with which the entity foliolosa is associated are Great Karoo Karoid Broken Veld (26(a)) and Central Lower Karoo (30).

The most northerly record for foliolosa appears to be that of the author, 10 miles North of Graaff Reinet on the Middleburg Road. Around Graaff Reinet, the topography is extremely varied with resultant variations in vegetation. Near the town itself, a large population of foliolosa was found at the turn off to the Valley of Desolation. This locality had the appearance of having been an old flood plain, as it was flat and silty. Over an area of about a square mile, foliolosa was a dominant member of the vegetation, the plants growing in the open as compact tussocks, of up to 50 shoots, not more than about 20 cm. in height, often less. Vegetation was sparse, the other components being low shrubby composites and mesems.

The Tandjiesberg and Grootbruintjieshoogte seem to set the North Eastern limits to the distribution of foliolosa, while the

known Eastern limit appears to be along a line from Pearston to Voëlrivier.*

To the immediate North of the Klein Winterhoekberg - Suurberg ranges, a number of foliolosa populations were found by the author near Waterford and around Lake Mentz, in flat silty areas similar to those near the Valley of Desolation. Although the author did not find any specimens in these localities, there are herbarium records of the entity robusta from Lake Mentz, and East of Waterford. To date there are no records of plants of foliolosa to the East of this.

To the immediate North of the Grootrivierhoogte, the author found foliolosa populations in flat silty areas around Mount Stewart. From this locality too, but not found here by the author, is a record of the entity robusta. South East from Mount Stewart runs a silty flat bottomed valley, also possibly a former flood plain, between the Klein Winterberg and Eastern part of the Grootrivierhoogte and Wolvefonteinberg, along which populations of foliolosa occur.

South of this, to the North of the Groot Winterhoekberg is a record from Springbokvlakte, (NBg 171/59, in hort. Kirstenbosch) and the southernmost record south of the Suurberg, appears to be from Addo Bush. Two early records from unplaceable localities, but probably from this area are "Zwartkops Sundays River", Zeyher 4184 (GRA) and "Koegakammaskloof", Zeyher 1054 (GRA).

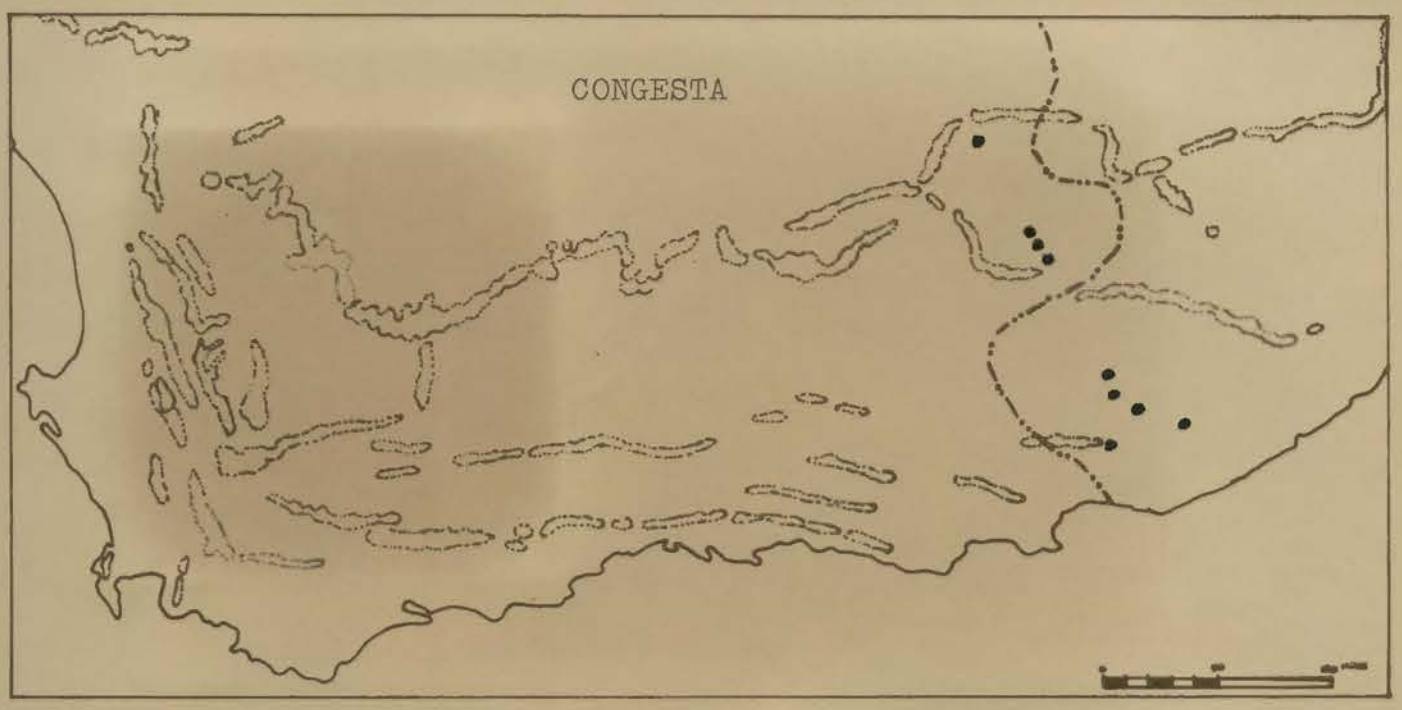
Acocks describes the vegetation around Addo as Valley Bush Veld, Addo Bush and Sundays River Scrub (23 (d) i & ii).

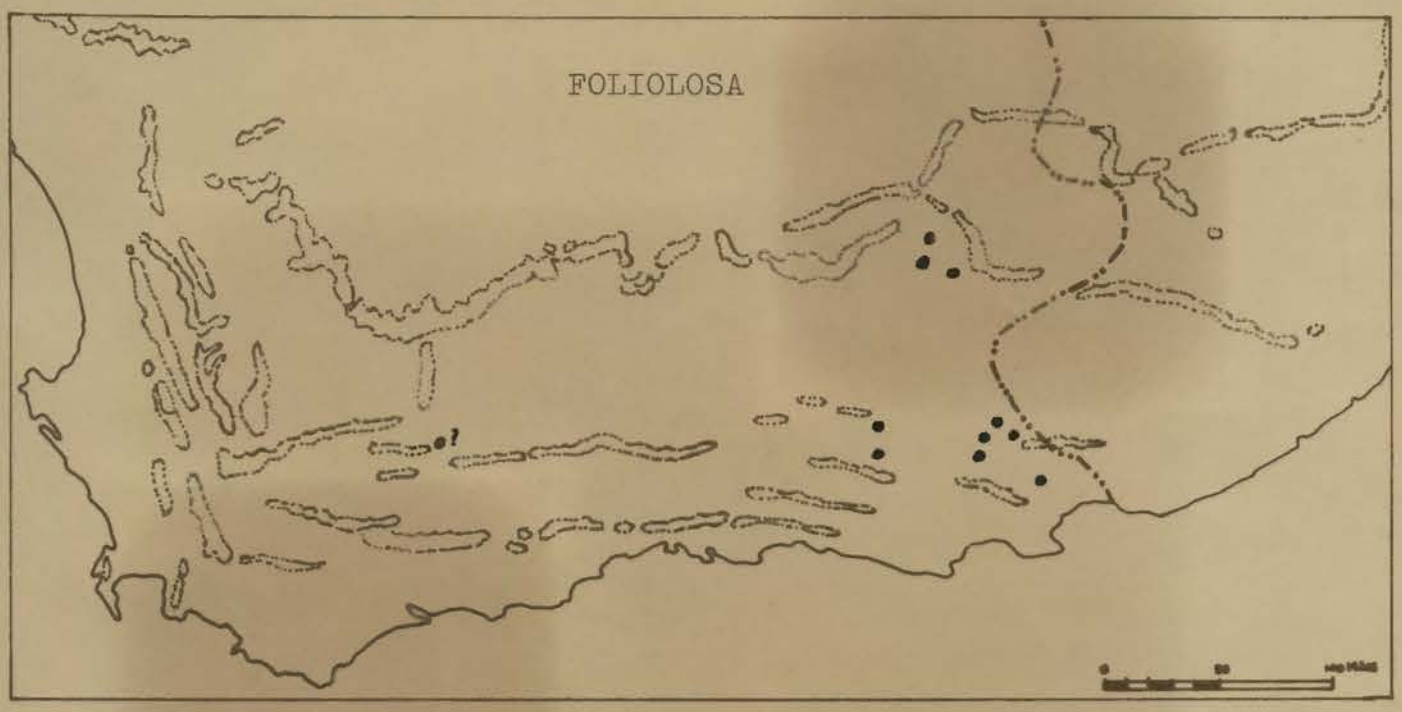
South of the Grootrivierhoogte lies a flat silty plain, the Steytlerville Flats, the vegetation of which Acocks typefies as Succulent Karoo, Steytlerville Karoo type (31(c)), possibly False Succulent Karoo derived from Central Lower Karoo.

Just outside Steytlerville on the Willowmore road, over an area of several square miles the author found a mixed population of the entities foliolosa, and robusta. The area is flat and silty rising to a low shale ridge to the South.

---

* Mr. Acocks has a record of localities of species of a large number of genera identified on the spot and not collected. The author obtained a copy of his records for Astroloba, which were most unfortunately later mislaid.





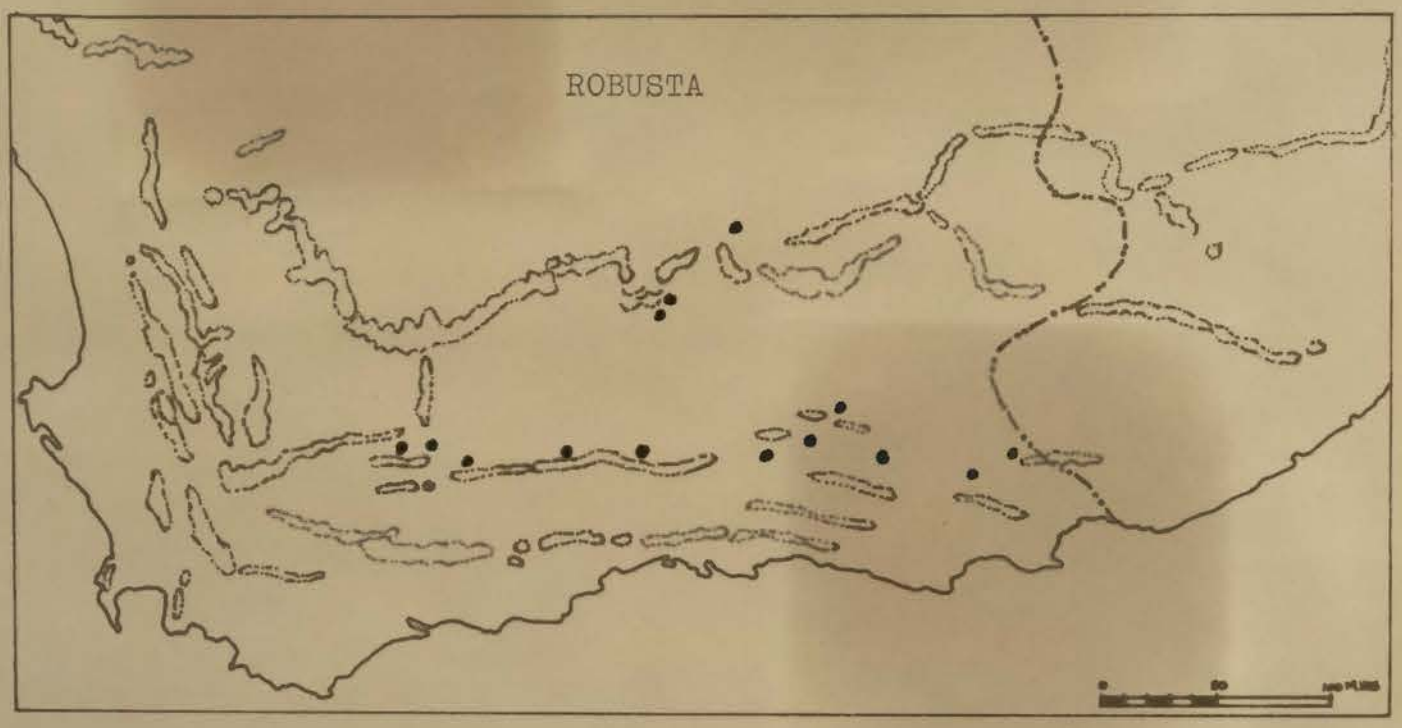


Fig.14. Showing the distribution of the entities congesta, foliolosa and robusta.

The vegetation of a shale ridge near Miller on which a few plants of the entity robusta (R8)were found.

A plant of the entity robusta from the above population growing with a bush of Rhigozum sp.

A population of the entity foliolosa (R10) on the farm Toekomst near Waterford.

Showing the habit of a plant of the entity foliolosa growing with a Rhigozum bush from the above population.

PLATE 6.

A general view of the sandy vlakte just outside Steytlerville showing the mixed population of the entities foliolosa (R14) and robusta (R15).

A single clone of the entity foliolosa (R14) from the same population. As the stems elongate so their bases come to lie on the ground and develop adventitious roots. These bases can be seen in the vicinity of the matchbox.

Showing the sparse vegetation on the ridge south of the sandy vlakte shown above.

PLATE 7.

Plants of both entities grew, not under bushes, both on the flat area and the slopes of the ridge, forming a conspicuous part of the sparse vegetation, other components being low bushes of mesems and composites on both vlakte and shale ridge, and in addition, creeping mesems on the vlakte.

Steytlerville and Mount Stewart appear to be the western-most records for the entity foliolosa, apart from an extremely discontinuous locality: "between Ladismith and Laingsburg" N.S. Pillans 877 (in Herb.H.Bolus) (BOL). This specimen was pressed after flowering in Mr. Pillans' garden. Examination of likely localities along the Graaff Reinet-Willowmore road was fruitless, and fairly extensive collecting in the Northern foothills of the Swartberg, and in places along the Ladismith Laingsburg road, revealed populations of other entities, but not of foliolosa.

It is of interest to note that Acocks, (loc.cit.p.115) considers a large part of the area between Aberdeen and Adelaide, to be False Karoid Broken Veld (37) or False Central Lower Karoo (38), having been previously marginal grassland. North of the Grootrivierhoogte, foliolosa occurs, according to existing records, only in these areas. If Acocks' theory is to be considered, then has there been a shift in foliolosa distribution with encroaching karoid vegetation or was foliolosa there previously with the former marginal grassveld types?

THE ENTITY ROBUSTA. (See Fig. 14). (See plates 6 and 7).

Of what may be termed the foliolosa group, (consisting of the entities congesta, foliolosa and robusta), and indeed of all Astrolobas, the entity robusta has the widest distribution.

The eastern-most records, near Lake Mentz, Mount Stewart and Steytlerville, have already been mentioned. It seems likely that in all these cases the plants were growing with or near plants of the entity foliolosa, and that the localities included flat silty areas.

The next recorded localities to the West of this are low lying shale ridges near Miller, where the plants were locally frequent growing under Rhigozum bushes in vegetation of the

Karoid Broken Veld type. This area lies to the North and North East of the Witteberg and Grootrivierhoogte, where the topography and consequently the vegetation, is more varied. An herbarium record, "Between Oudtshoorn and Willowmore", Stell. Univ.Gdns. 7859 (BOL), is the only record to date of a possible locality for robusta South of the Eastern Swartberg - Slypsteenberg series.

There are a number of records from the Northern foothills of the Swartberg where the vegetation is karoid broken veld, being more of the Great Karoo type (26(a)) East of Sevenweekspoort, and to the West, more related to the Little Karoo type (26(b)). Near Prince Albert, plants of robusta were a dominant feature of the vegetation over a small area, growing on undulating ground, the other components of the very sparse vegetation being Rhigozum obovatum, Pentzia sp. and other low shrubby composites and mesems.

To date, the southernmost record appears to be between the Witteberg and the Western end of the Klein Swartberg.

The author found plants further West near Laingsburg, on a shale ridge where only two plants were found growing alone not under bushes; and near Whitehill, and Matjesfontein where the plants were locally frequent growing in shaley undulating areas with vegetation of the Karoid Broken Veld type. At the Matjesfontein locality, the robusta population occurred next to a population of the entity bullulata on shale outcrops, members of each occurring over an area of about an acre, the margins of which overlapped.

To the North of this, are records from Beaufort West, and the foot of Molteno Pass, (H.Hall.2284). The Northernmost exact record to date appears to be a collection of the author 10 miles East of Nelspoort along the Murraysburg road. Here again the plants were locally frequent, either under bushes or alone, on a shaley North facing slope, associated with low bushes, up to a foot in height, of species of Pentzia, Eriocephalus and bushy mesems.

It is quite possible that populations of robusta do occur further North in similar areas.

THE ENTITY BULLULATA. (See Fig. 15).

The entity with the most westerly distribution is bullulata. It is found in the eastern part of the Tanqua Karoo, being recorded from karoid areas North of Ceres, and in the vicinity of the Roggeveld mountains.

The Western part of the Tanqua Karoo and the Succulent Karoo of the Namaqualand Coast Belt have been extensively surveyed by Mr. H. Hall of Kirstenbosch, who has found no plants of Astroloba in this area. Examination of possible localities along the Grootrivierhoogte - Blinkbergpass Road which runs along the eastern karoid foothills of the Cedarberg, also failed to reveal any Astroloba populations.

The author collected plants of the entity bullulata at a locality 35 miles North of Ceres on the Sutherland road, where the vegetation was intermediate between Succulent Karoo, Tanqua Karoo type (31(b)) and Great Karoo Karoid Broken Veld (26(a)). The area consists of a series of low shaley ridges with low shrubby mesems as the commonest bushes, and plants of bullulata growing with them, or, for the most part alone, and forming a fairly common constituent of the vegetation over a small area.

According to Acocks' typefication, the vegetation of the Roggeveld foothills is Western Mountain Karoo (28) rising to Mountain Rhenosterbosveld (43).

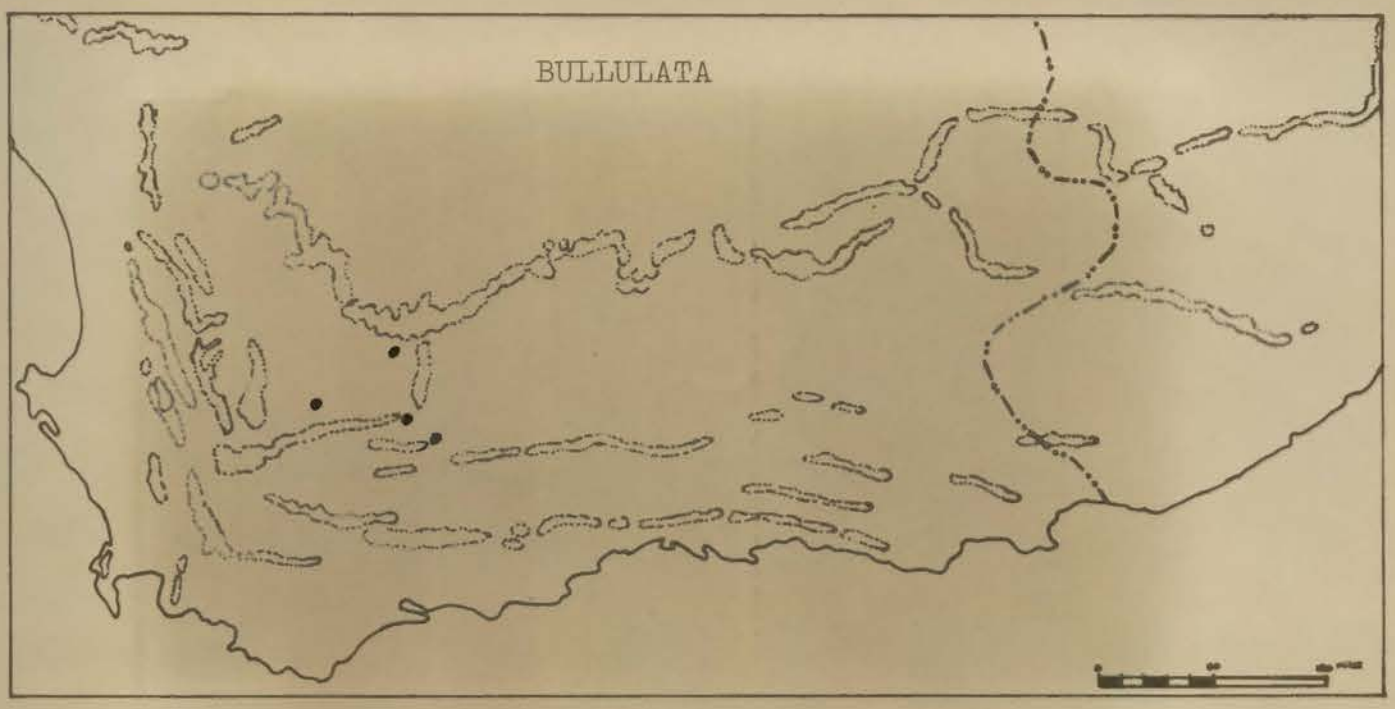
A more easterly record is near Matjesfontein where the author found bullulata plants again on shaley outcrops and growing adjacent to a population of robusta as described earlier.

The easternmost record is between Ladismith and Laingsburg, (No. 9363 in Herb. H. Bolus, BOL).

THE ENTITY HALLII. (See Fig. 15). (See plate 8).

The entity hallii, to date has only been found in two areas: near Koup, the type locality where it was first collected by Mr. H. Hall of Kirstenbosch, and on shaley ridges along the road from Laingsburg to Sevenweekspoort.

The Koup locality, was a low shale ridge to the West of the National road almost opposite the railway station. The



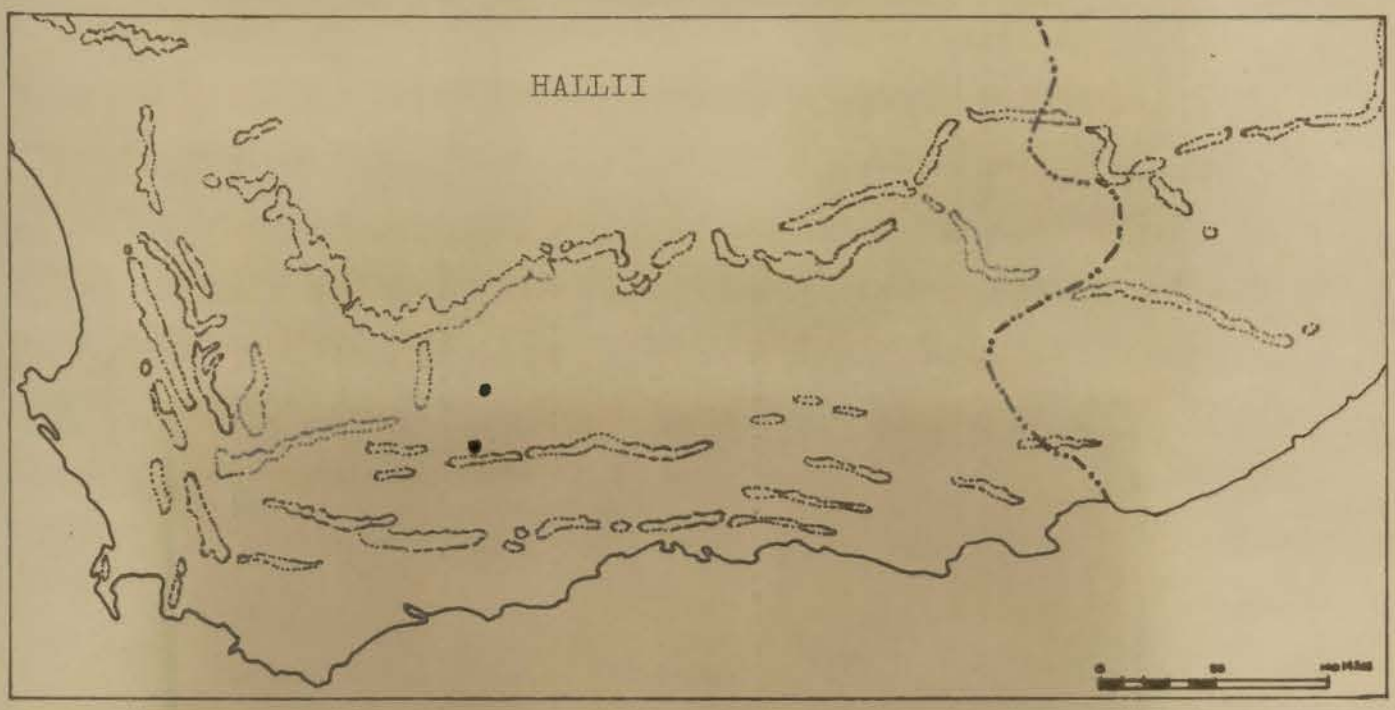


Fig.15. Showing the distribution of the entities bullulata, hallii and smutsiana.

The habit of a plant of the entity hallii from the population R42 near the farm Rietvlei in the Northern foothills of the Swartberg.

A plant of the entity hallii growing under a bush of Rhigozum obovatum from the population R26 on the shaley ridge near Koup.

PLATE 8.

vegetation was very sparse, and of the Great Karoo Karoid Broken Veld type (26(a)) with Rhigozum obovatum the dominant shrub, and a few trees of Euclea undulata and Carissa haemotocarpa. Hallii was locally very common occurring along the top and slopes of the ridge, with greater numbers on the Northern aspect. Most of the plants were growing under Rhigozum bushes, where they attained a height of 30 cm. or more.

South of the Sevenweekspoort-Laingsburg Road, along the shale outcrops, (which sometimes include quartzite and sandstone) and join with the northern foothills of the Klein Swartberg, the vegetation is more of the Little Karoo Karoid broken veld type. Euclea undulata, Carissa haematocarpa, Crassula rupestris, Euphorbia mauretanica, Galenia africana, Pteronia and Pentzia spp. and Cotyledon paniculata were common species in the localities where two populations of hallii were found by the author on northern aspects of shaley ridges. The plants were not as common nor as vigorous in habit as those from Koup. Here they were growing in rocky crevices unprotected by bushes, and averaging a height of under 20 cm.

THE ENTITY RUGOSA. (See Fig.16). (See Plate 9).

The entity rugosa appears to have the most southerly distribution of all Astrolobas. It is most common in the dry hilly areas around Montagu, where it is locally frequent on shaley North East facing slopes, associated with karoid broken veld of the Little Karoo type. In this area, the karoid broken veld vegetation merges into Renosterbosveld (43) with change of aspect or increase in rainfall.

The vegetation associated with rugosa in the Montagu Karoo is denser than that found in the shaley hills South of Laingsburg, although the constituent species are much the same. Here however more succulents are found and Dodonaea thunbergiana, which is apparently associated with karoid vegetation transitional between karoid broken veld and rhenosterbos, is a fairly common low tree. The entity rugosa does not occur in true Rhenosterbosveld, although scattered Elytropappus rhinocerotis may be found in the proximity of rugosa populations.

The area was quite extensively collected by the author along the Upper Baden, Pietersfontein, Rietvlei No. 2 and Dobbelaars Kloof roads. Plants of the entity rugosa grew alone in the open or under bushes; in several cases where the shade and protection afforded by a bush was considerable, leafy shoots of up to 50 cm. were observed.

No other entities of Astroloba were found in this area. Very locally, (two verified localities being known to the author), an intergeneric hybrid between rugosa and Harworthia margaritifera.

Apart from a dubious record "Bonnievale"Jan. 1937, N.J.S. van der Merwe 226 (BOL), there are no records of rugosa South of the Langeberg. The locality of this specimen, which consists only of a flowering spike is doubted, because there is another specimen, consisting only of a leafy shoot, "Montagu ex hort Bonnievale", Jan. 1937 N.J.S. van der Merwe 227 (BOL).

The north-western most record for rugosa is South East of Touws River, while to the North of the Montagu area lie the Waboomsberg, and to the North East the Warmwaterberg, where, with and increase in altitude, the vegetation changes to Rhenosterbos and Macchia.

Apart from a specimen, "Graaff Reinet", s.leg.4202 in herb. Marloth (PRE); the northernmost records for rugosa appear to be in the northern foothills of the Klein Swartberg under conditions similar to those for the hallii populations.

All other records come from the Little Karoo South of the Swartberg. The author found a population 23 miles South of Ladismith on the old Barrydale road, on a shaley knoll. Here the entity rugosa was locally common, growing for the most part in the open, over an area of about 40 square yards, associated with a sparse, much goat-eaten type of Karoid Broken Veld. About 200 yards away, for the extent of which distance there were no Astroloba plants, was a large population of plants of the smooth leaved entity smutsiana growing on an adjacent ridge. Amongst these was one plant with slightly tuberculate leaves and flowers intermediate in character between those of rugosa and smutsiana.

A general view of the vegetation found at the head of the Baden-Baden valley, near Montagu. Populations of the entity rugosa in this area are associated with this type of vegetation. A shrub of Dodonaea thunbergiana is in the left foreground.

A plant of the putative intergeneric hybrid between the entity rugosa and Haworthia margaritifera growing in situ next to a plant of the entity rugosa on the farm Rietvlei No. 2. near Montagu.

PLATE 9.

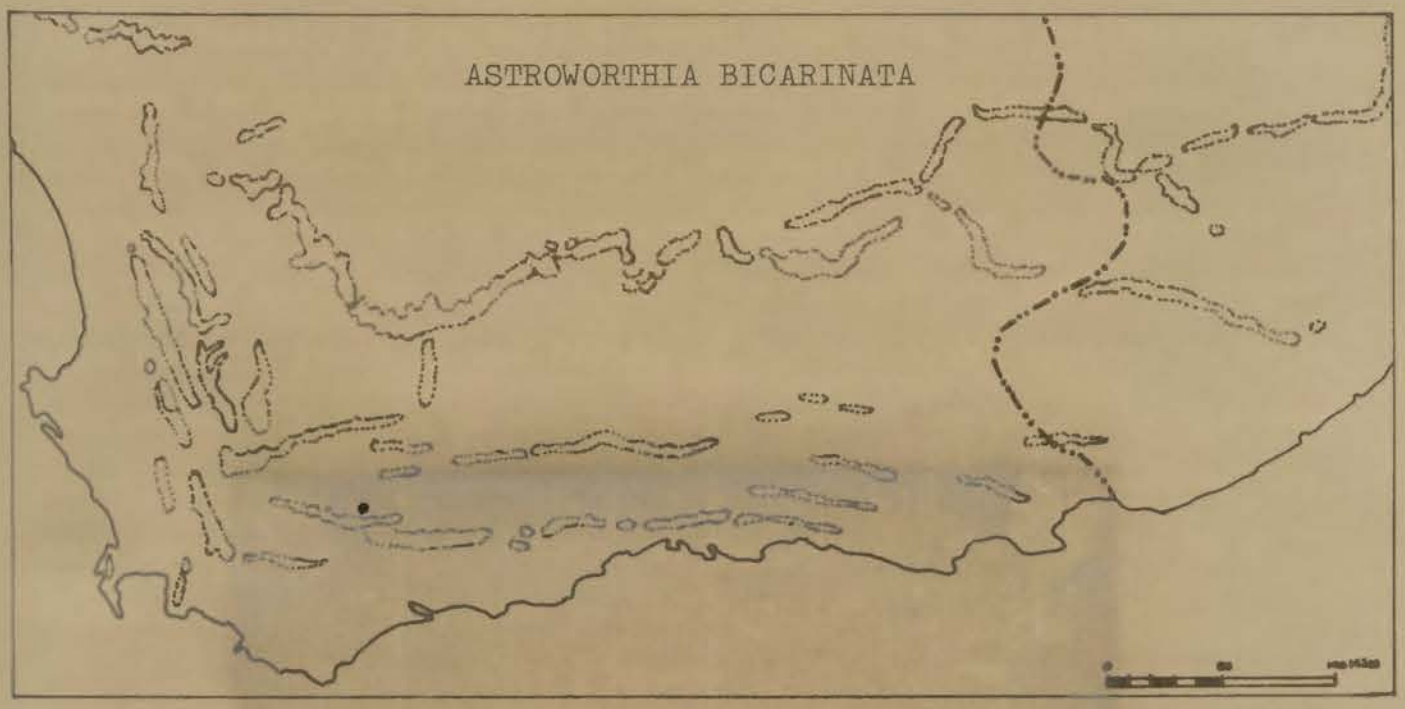


Fig.16. Showing the distribution of the entity rugosa, Astroworthia X bicarinata, (a hybrid between rugosa and Haworthia margaritifera), and Haworthia margaritifera. (Only the distribution of the parental form of Haworthia margaritifera is shown).

It is very likely that this plant is a hybrid between these two entities, but as yet no successful PMC squashes of meiotic pairing have been obtained which might confirm this cytologically.

The Ladismith Barrydale Karoo is bounded in the South by the Langeberge, in the East by the Groot river valley, and in the North East by the Rooiberge. The easternmost record, excluding the Marloth specimen, is "7 miles East of Vanwyksdorp" A.J. Joubert 111 (BOL). Around Vanwyksdorp, the vegetation changes from Karoid Broken Veld to Spekboomveld (25); where Portulacaria affra is dominant, no Astrolobas have yet been found.

The Marloth specimen from Graaff Reinet presents a problem, for its locality is so very discontinuous from the distribution pattern for rugosa thus far described. The Marloth specimen consists of three inflorescences, which are identifiable as belonging to the entity rugosa, on account of the long pedicels and fairly small bracts, although the racemes are somewhat longer than usually found in the field. The labelling appears to be in Schlechter's hand and there is no collectors number. On the same sheet, ruled off presumably indicating that it is not part of the same specimen is a leafy shoot of rugosa with the caption in a different hand: "collected by Dr. J. Muir".

Dr. J. Muir made a survey of the vegetation of the Riversdale area (1921). In the section on the Little Karoo, listed under leaf succulents are Apicra foliolosa and A. aspera, the latter described as growing in partial shade, which is certainly not typical of all members of populations observed by the present author. The rather poor specimen on the Marloth sheet is, however, the only known herbarium specimen of an Astroloba collected by Muir. What he meant by Apicra foliolosa is unknown.

It would simplify the distribution pattern for the entity rugosa greatly were it possible to consider the labelling of the Marloth specimen as a mistake. Are the grounds that there are no other records of this entity from Graaff Reinet or the intervening portion of the Great Karoo sufficient to do this? It is of interest to note that Berger (1908) writing of Apicra foliolosa cited amongst other specimens examined Marloth 4204.

Professor Jordaan of Stellenbosch, an authority on Marloth was unable to give any information about the numbers 4202 and 4204 in the Marloth collection.

THE ENTITY SMUTSIANA. (See Figs. 15 and 17).

Mention has already been made of the occurrance of the entity smutsiana in the Ladismith - Barrydale Karoo, where it has been found by the author to be locally frequent, growing on shaley ridges along the old Ladismith Barrydale road. Here the vegetation was sparse consisting chiefly of shrubby mesems and composites, notably Pentzia sp., so that for the most part the plants occurred alone, not associated with bushes. In some areas the shale ridges sloped down into flat silty areas, where creeping mesems were common. The easternmost records to date in this area are two localities between Adamskraal and Ockertskraal, along the Muiskraal - Ladismith road where the plants were locally frequent over small areas. The westernmost record is "Anysberg", Nbg, 784/63 Kirstenbosch hort.

Aspect did not seem to affect occurrance of the entity smutsiana in the Little Karoo, but on the shaley ridges along the Laingsburg - Sevenweekspoort road, no smutsiana populations were found facing the South.

A number of locally frequent populations of smutsiana were found in this area, between the farm Rietvlei and the Rooineck pass, of which only one collection was made, (Roberts 49). Mention has already been made of populations of the entities rugosa, hallii and robusta occurring in this area, and the associated vegetation described. Towards the Rooineck pass, however, on some shaley ridges, Rhigozum obovatum occurs as a dominant member of the vegetation. A population of smutsiana was found in such an area, where all the plants grew under Rhigozum bushes. One specimen had a leafy stem of 40 cm., the support of the Rhigozum branches enabling it to reach this length. At Rooineck Pass the vegetation consisted of very sparse shrubby mesems and composites, all six inches or less in height, and here smutsiana plants for the most part grew in the open.

Todate, these are the only records for smutsiana. Save for a search along the Prince Albert-Leeu Gamka road, which failed

to reveal any plants of Astroloba, the area to the immediate North of the Laingsburg Sevenweekspoort road was not examined.

THE ENTITY SPIRALIS. (See Fig. 17)

Plants from the smutsiana localities along the Ladismith Barrydale road were planted at Kirstenbosch, where most of them flowered at the end of the year producing inflorescences with smooth perianths.

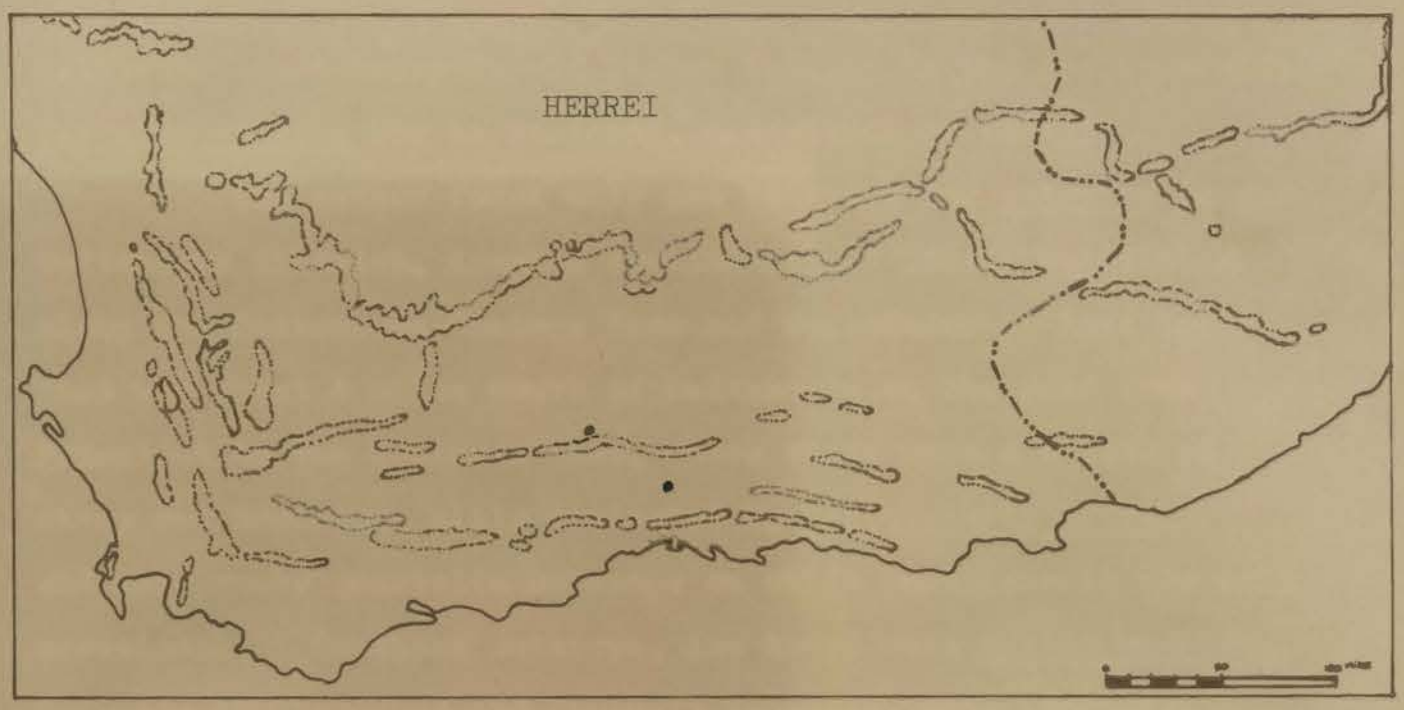
In December of the following year, 1960, a plant (Roberts 6) from the population (Roberts 5) which had not previously flowered, produced a raceme of flowers with the rugose perianth typical of the entity spiralis. The locality was visited the following February to collect flowering material of both entities, but no other plants of spiralis were found. (At this locality plants of smutsiana were in full flower as at the same time were spiralis plants from Oudtshoorn).

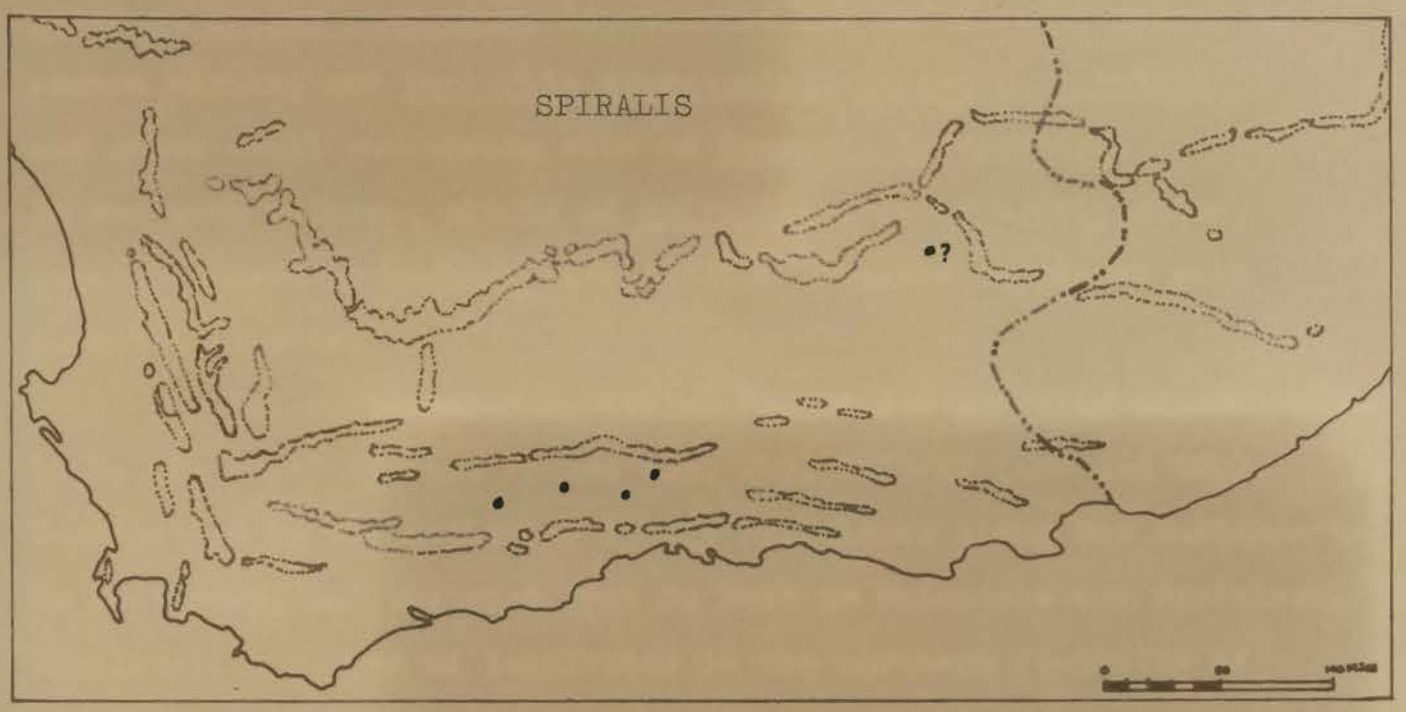
This is the only record of the author for the entity spiralis in this part of the Little Karoo, and to date, is the westernmost precise locality for this entity.

Proceeding eastwards the next locality for spiralis found by the author was approximately 5 miles South of Calitzdorp on a shaley hill to the West of the Rooiberg Pass road. This hill rose from a silty vlakte, strewn with quartzite pebbles on which creeping mesems were common, notably Glottophyllum and Opthalmophyllum spp. Vegetation on the shaley hill consisted of low shrubby composites and mesems together with spiralis plants which were locally frequent over a small area, growing alone or with bushes.

Between Calitzdorp and Ladismith, the vegetation is largely Spekboomveld (25) with Portulacaria afra dominant along the Huisrivier pass, and no plants of Astroloba were found here. South of this area rise the Rooiberge and North, the Swartberge.

The road from Calitzdorp to Oudtshoorn runs through cultivated land, the natural vegetation of which Acocks describes as Karoid Broken Veld Little Karoo type (26(b)). North and South of this extending to the foothills of the Swartberg and Outeniquas, and East-West from Ladismith to Uniondale Road, he considers the vegetation to be Spekboomveld or Succulent Mountain Scrub with a patch of succulent Karoo (31) to the immediate South of the





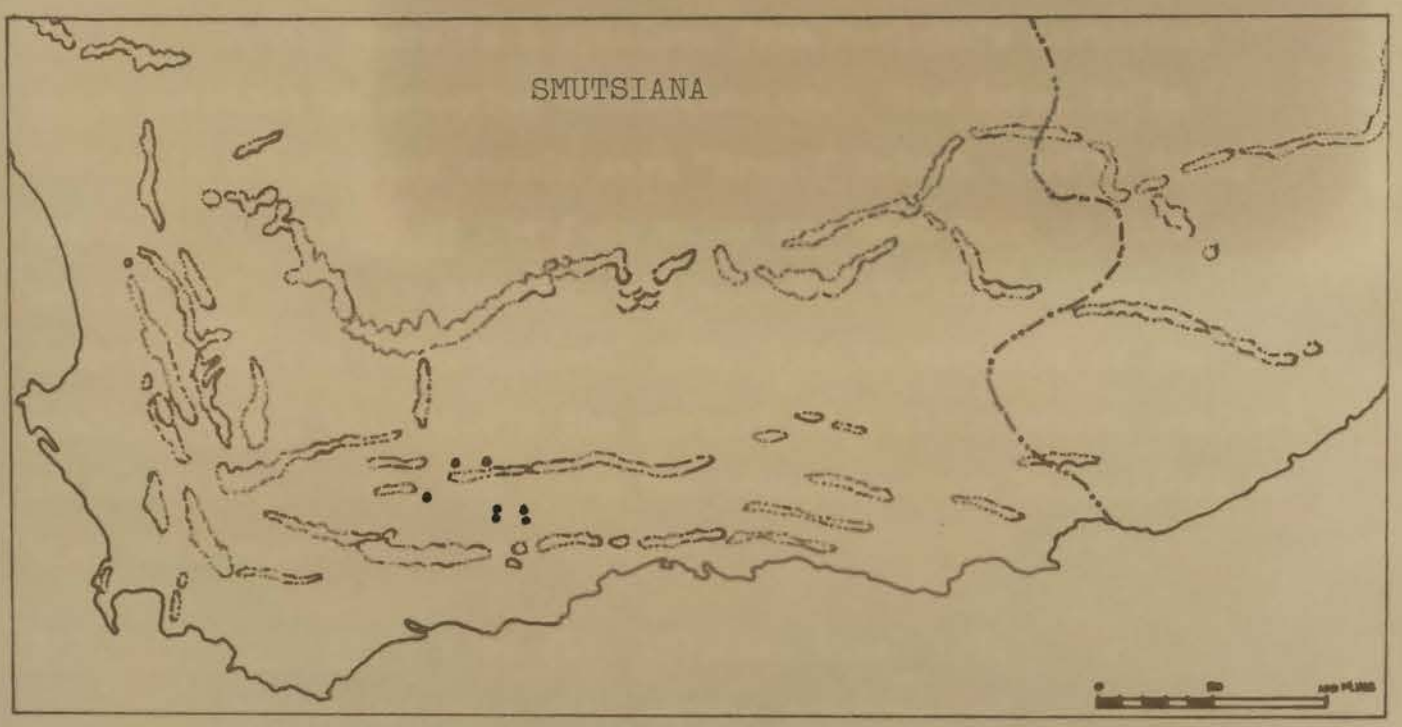


Fig.17. Showing the distribution of the entities herrei, spiralis and smutsiana.

Calitzdorp-Oudtshoorn Karoid Broken Veld. In the Spekboomveld, Portulacaria afra may be dominant, occasional or absent.

The author found only one locality for spiralis in the Oudtshoorn district, despite examination of likely localities along the Oudtshoorn-Montagu Pass and Oudtshoorn-De Rust Roads. This was about 4 miles South of Oudtshoorn on the road from Friesland to the Robinson Pass, where there were a series of steep red sandstone hills dominated by Portulacaria affra, and more rocky quartzite outcrops on which Portulacaria was only occasional. On these outcrops, low trees were Euclea undulata, Dodonaea thunbergiana and Nymannia capensis, with Pteronia pallens, Lycium austrinum, Acanthopsis sp. and shrubby mesems as common shrubs, and Euphorbia mauretanica, Crassula rupestris and other small succulents such as Crassula lycopodides. On one such outcrop, plants of spiralis, growing mostly alone, sometimes next to bushes, were locally frequent on slopes with northern aspects.

The westernmost herbarium record for spiralis appears to be "De Rust" P. Ross Frames s.n. Nbg. 2525/27 (NBG and BOL). Examination by the author of likely hillslopes along the Oudtshoorn-De Rust road, and the road from De Rust to Uniondale was fruitless. Similarly, a number of localities in the northern foothills of the Swartberg failed to reveal any plants of this entity.

Again there is a specimen from Marloth's herbarium which provides an annoying discontinuity. The label is in Marloth's writing and simply says "Graaff Reinet , coll: 5112," and nothing else. At its face value one must take it that Marloth collected it himself, and accordingly cite it as Marloth 5112 (in Herb. Marloth) PRE. As in the case of the entity rugosa, this upsets the picture of a distribution confined to the Little Karoo, but again the present author is inclined to view this record with some doubt.

THE ENTITY HERREI. (See Fig. 17).(See Plate 10).

Of the entities with convex outer walled epidermal cells, herrei, apart from the discontinuities of the Marloth specimens, has the easternmost distribution. To date, only two localities for this species are known.

The Hoekplaas locality for the entity herrei (R16). Note bushes of Pteronia, Pentzia and Eriocephalus spp, with plants of Aloe ferox, Carissa sp and Euclea undulata in the background. In the distance are the Kammanassie mountains.

The habit of a plant of the entity herrei from the population (R16). Tops of shoots appear to have been grazed. The plant is growing under a bush of Eriocephalus sp.

PLATE 10.

The first is about 10 miles West of Uniondale, near the farm Hoekplaas. To the West, South and East of Uniondale lie the Kamanassie, Outeniqua and Kouga mountains. Around Uniondale, the vegetation is Rhenosterbosveld (43), while to the North West towards De Rust it becomes Succulent Mountain Scrub, and North East towards Willowmore, Karoid Broken Veld.

The Hoekplaas locality was a shaley "vlakte" with vegetation of the Karoid Broken Veld type - low growing bushes of composites such as Eriocephalus, Pteronia and Pentzia spp. and shrubby mesems, with a few bushes of Euclea undulata and Carissa sp., and occasional plants of Aloe ferox. Here, over a small area the entity herrei was occasional, mostly under bushes.

The other known locality for herrei is 5 miles South East of Prince Albert along the Prince Albert Klaarstroom road. Acocks described the vegetation to the North of the Swartberg, East and West of Prince Albert as a narrow band of succulent Mountain Scrub (25). Near Prince Albert itself, there is quite a large area where Portulacaria affra is dominant, and where no Astrolobas were found, but in the kloof where the entity herrei grew the vegetation was more typical of the karoid broken veld type, with low shrubby mesems and composites, some succulents notably Crassula rupestris, and occasional low trees of Euclea undulata. The author found herrei growing on both sides of the kloof, i.e. with North and South aspect, where the plants were occasional growing alone or under bushes.

RAINFALL AND DISTRIBUTION OF ENTITIES

Rainfall statistics were taken from the publication by the Weather Bureau (W.B.20). Mean, maximum and minimum annual rainfall figures for selected weather stations near Astroloba localities are given in Table 21.

In some instances these figures may be considered to apply to the locality in question, in other instances the rainfall of the weather station is probably higher. An example is

afforded by the figures for weather stations near localities for the entity bullulata. (See Table 21). Nuwe Dam is more or less in Verlatenkloof, and Spes Bona is very near the locality on the Ceres Sutherland road (Roberts 24), so that figures for these stations may be taken as being very similar to those for the actual localities. However, there is a locality described as "between Ladismith and Laingsburg", (No. 9363 in herb. H. Bolus BOL). For the sake of completion figures are given for Laingsburg, Prinsrivier (between Ladismith and Laingsburg) and Ladismith, but the Ladismith figures are nearly 100 mm. higher than any of the other weather stations for bullulata localities. Sutherland is included because its rainfall is similar to that of Nuwe Dam and there are additional figures for this station of seasonal rainfall, expressed as a percentage per quarter, over a period of 30 years.

MEAN ANNUAL RAINFALL

In an attempt to give a rough visual picture of the average annual rainfall associated with localities of entities, for each entity a diagram was constructed indicating at the same time, along the horizontal axis: frequency of rainfall classes, the class interval being 50 mm, and along the vertical axis: the actual measurements of the selected stations within each class. (See Fig. 18). Stations far from the actual localities, such as Sutherland and Uniondale, which are included in Table 21 because of their seasonal variation records, are omitted. In the case of towns for which there is more than one average annual rainfall figure, the average of these is given, with the exception of Laingsburg, (104.4 and 135.1 mm).

The resultant picture is only approximate but it does show that most localities for the entities foliolosa and congesta are associated with the highest rainfall of all entities, of between 250-400 and 300-450 mm. respectively. The three records for the entity foliolosa in the 100-150 mm. class are included on account of the dubious locality between Laingsburg and Ladismith, (Pillans 877 BOL). For the third member of the foliolosa group, the entity robusta, most localities are associated with a rainfall of 150-250 mm.

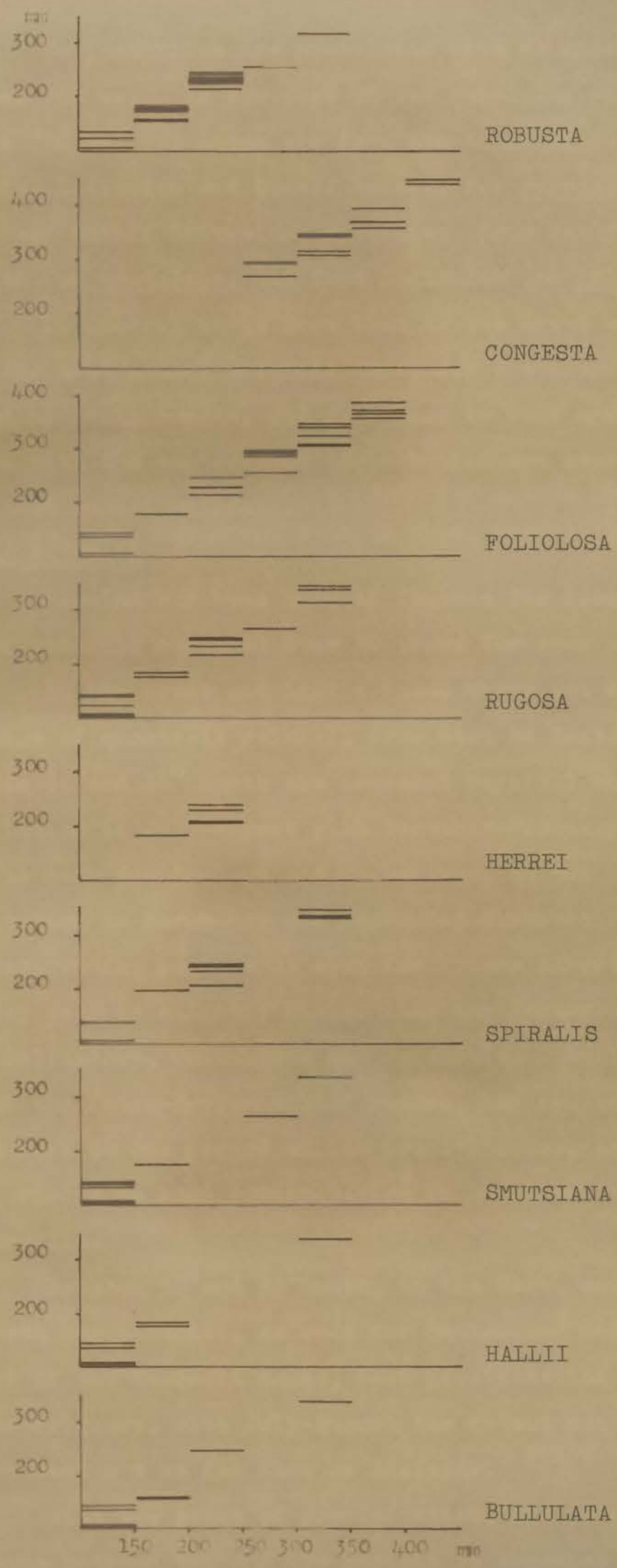


Fig.18. Showing the average annual rainfall for weather stations nearest localities for each entity. Each horisontal stroke denotes the average annual rainfall for a single station. On the vertical axis the actual measurement is indicated, along the horisontal axis, the measurements are grouped in classes with a class interval of 50 mm.

No localities are associated with an annual rainfall of less than 100 mm. In the case of the remaining entities, records of above 250 mm. per annum are from the towns of Montagu, Barrydale, Ladismith and Graaff Reinet, for rugosa; from Ladismith, De Rust and Graaff Reinet for spiralis; from Barrydale and Ladismith for smutsiana; and from Ladismith for hallii and bullulata.

In general it is seen that in the Great and the Little Karoo, the mean annual rainfall decreases southwards from the northern mountain ranges, and from East to West and thus the entities with the easternmost distribution are associated with the highest annual rainfall.

SEASONAL RAINFALL

Mention has been made of figures for quarterly percentages of rainfall obtained over 30 years for some stations.

In the Great and Little Karoo there are changes in the percentage of quarterly rainfall from West to East. Between latitudes 33°and 34° South the seasonal rainfall changes from most precipitation in July-August with December-February the driest months as seen for Montagu and Touwsriver, to two peaks of precipitation in March-May and September-November, with two drier intervening periods as seen for Prince Albert, (where the March-May peak is slightly higher than the September-November peak), Calitzdorp, Oudtshoorn and Uniondale. Still further East, North of the Kouga-Baviaanskloof ranges, the seasonal precipitation reverts back to one period of low precipitation, now between July-August, rising to most precipitation in December-March, as at Steytlerville.

Between 32°and 33°South, to the West, most precipitation is between March-August, as seen for Sutherland and Spes Bona, but East of the Nuweveld range, most precipitation occurs in December-February, with July-August the driest months as seen for Beaufort West and as far East as Adelaide.

With two peaks of precipitation, the percentage difference between wet and dry periods is somewhat less than when there is only one precipitation peak. But in all cases, with the exception of the Cradock station, where it reaches 25%, this difference is less than 20%.

For each entity, graphs of percentage seasonal variation in precipitation for the nearest weather stations were drawn (See Figs. 19, 20, 21). From these it is seen that, apart from the doubtful foliolosa locality "between Ladismith and Laingsburg", Pillans 877 BOL, the entities congesta and foliolosa occur in areas with maximum precipitation in summer. The entity robusta occurs in areas with all three patterns of precipitation, while the remaining entities have the maximum precipitation in winter, or two precipitation peaks, with the exceptions of the doubtful Graaff Reinet localities for the entities rugosa and spiralis, (respectively Nos. 4202 and 5112 in Herb. Marloth PRE).

FLOWERING TIMES

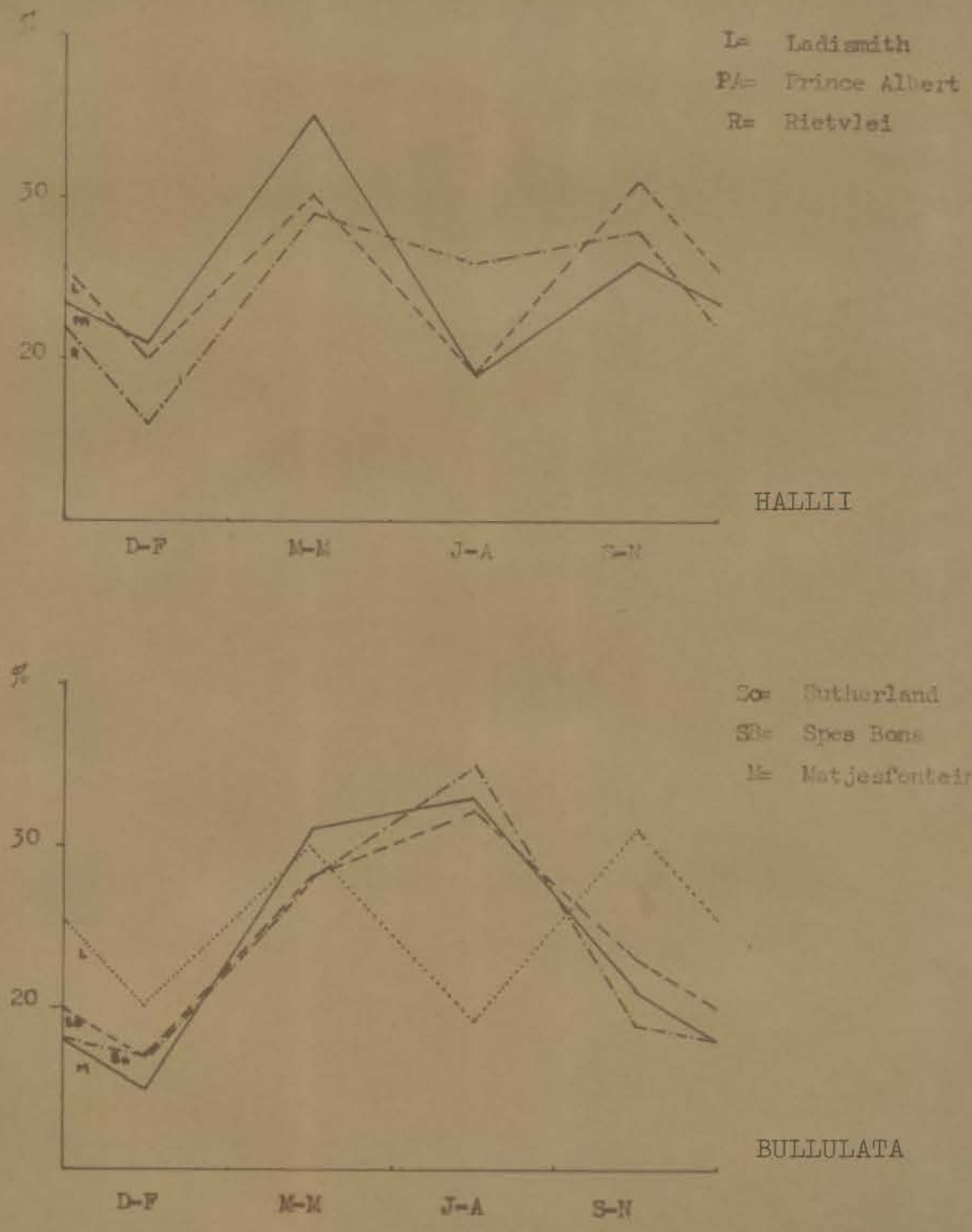
The flowers take about six weeks to develop from when the inflorescence buds are first visible to the opening of the lowest flowers. It may be a fortnight before the topmost flowers are open, and another month before all the fruits are mature. The flowering period may thus be considered as covering three months.

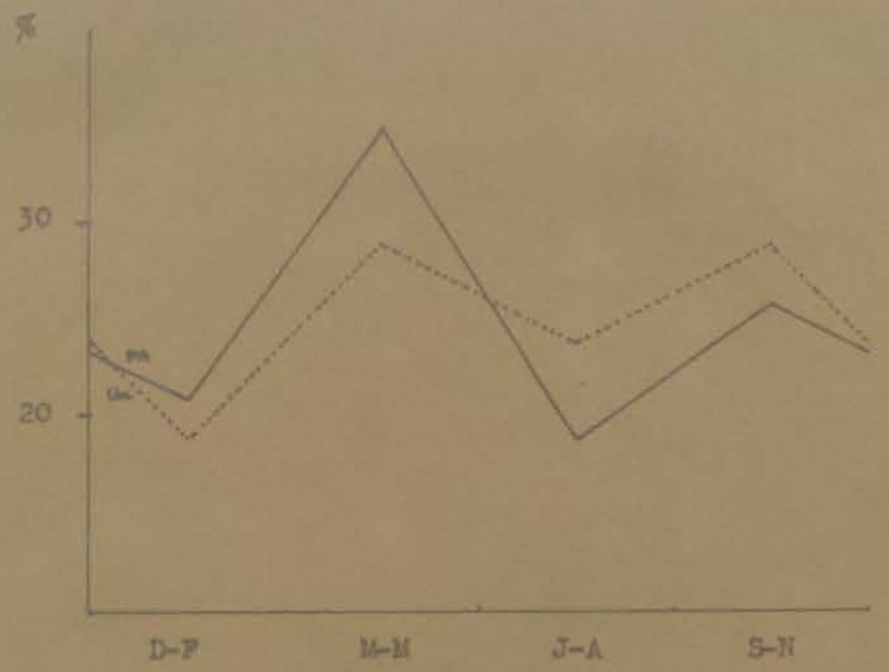
Histograms showing the extent of the flowering period were constructed separately for specimens flowering in the field and under cultivation in the following way. If the specimens were collected in bud, then the two months subsequent to the date of collecting are included in the histogram; if the specimens were in flower, then the month before and the month after are included, and if in fruit then the two preceding months. This data for all localities was included in one histogram. (See Fig. 22).

Of the foliolosa group, the flowering period for the entity foliolosa in the field starts in August and ends in March with peak blooming time in November and December, in the rainy season. The only two records of flowering under cultivation correspond to behaviour in the field.

The entity congesta in the field has peak blooming periods in September and January, just before and during the rainy season, with only one record of flowering in the dry season from Mortimer (June 1915 Davison Nbg 187/15 BOL). As is shown in

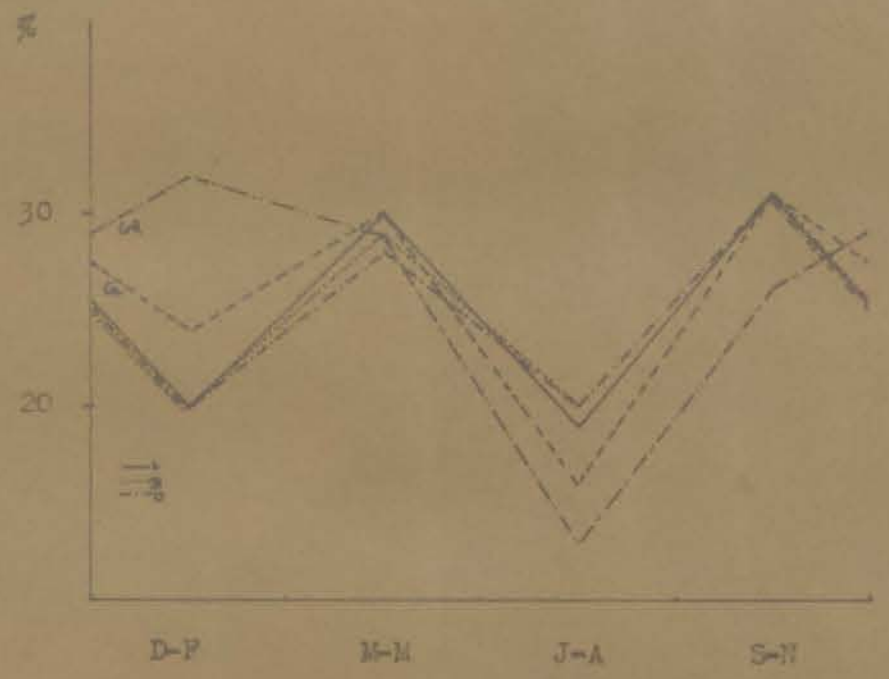
Fig.19. Showing quarterly precipitation expressed as a percentage for weather stations nearest localities of the entities hallii and bullulata.





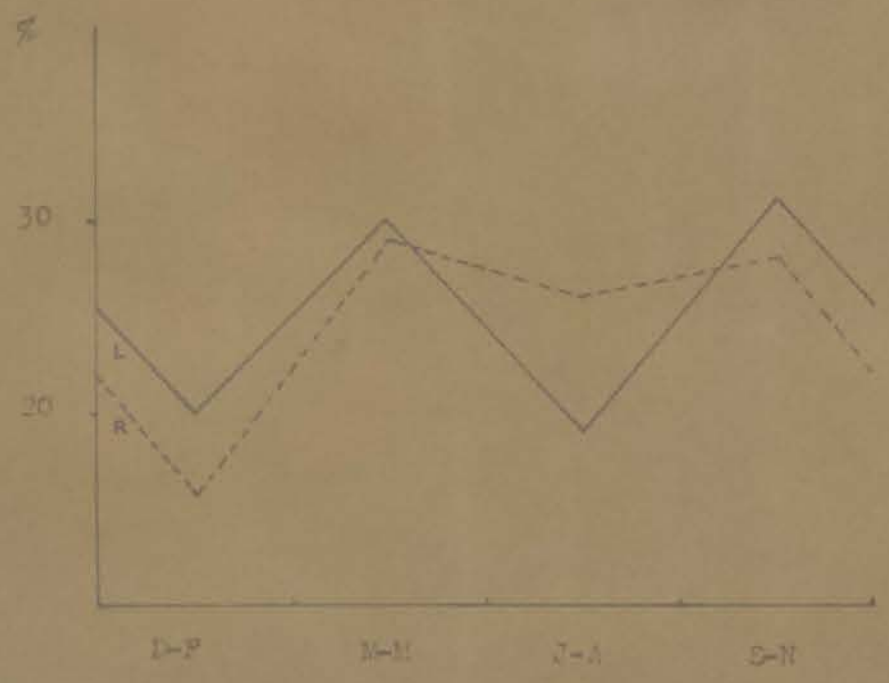
PA= Prince Albert
Um= Uniondale

HERREI



CR= Graaf Rienet
D= De Rust
C= Cuditshoorn
Ca= Calitzdorp
L= Ladismith

SPIRALIS



R= Rietvlei

SMUTSIANA

Fig. 20. Showing quarterly precipitation expressed as a percentage for weather stations nearest localities of the entities herrei, spiralis and smutsiana.

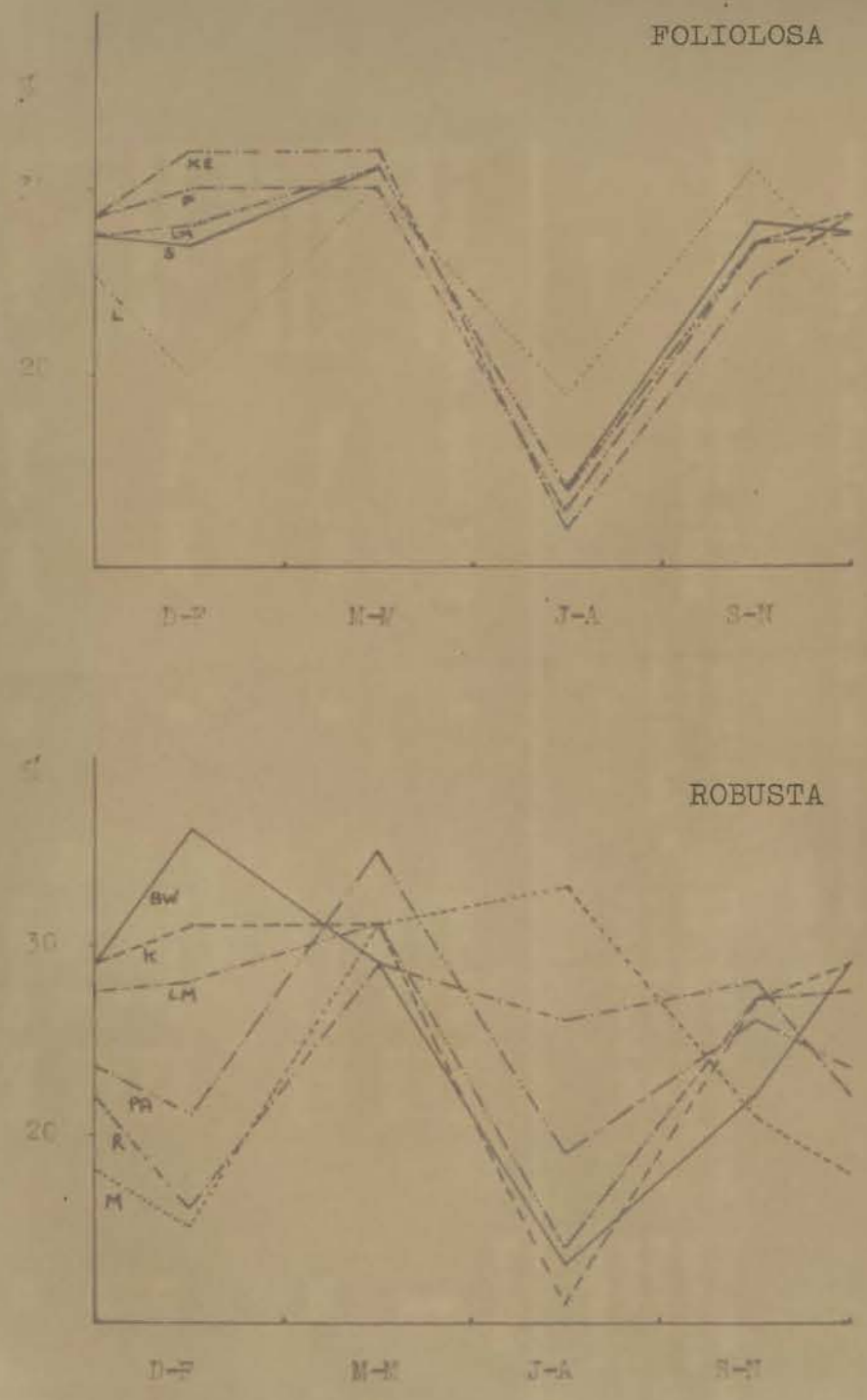


Fig.21. Showing quarterly precipitation expressed as a percentage for weather stations nearest localities of the entities rugosa, foliolosa, robusta and congesta.

Table 19, flowering months for the same locality varied from year to year.

Locality	Flowering and Fruiting	No buds, flowers or fruits
Helspoort	Jan., Feb. 1874 Aug. 1927 Sept. 1929, 60.	December 1959
Cradock	Sept. 1935 Dec. 1959	November 1960

TABLE 19. Showing condition of congesta plants at two localities in the field for different years.

The pattern under cultivation for the entity congesta is similar, with a shift in one of the peak periods to February-April. Interesting variations in length of time between flowering peaks were observed at Kirstenbosch, (see Table 20).

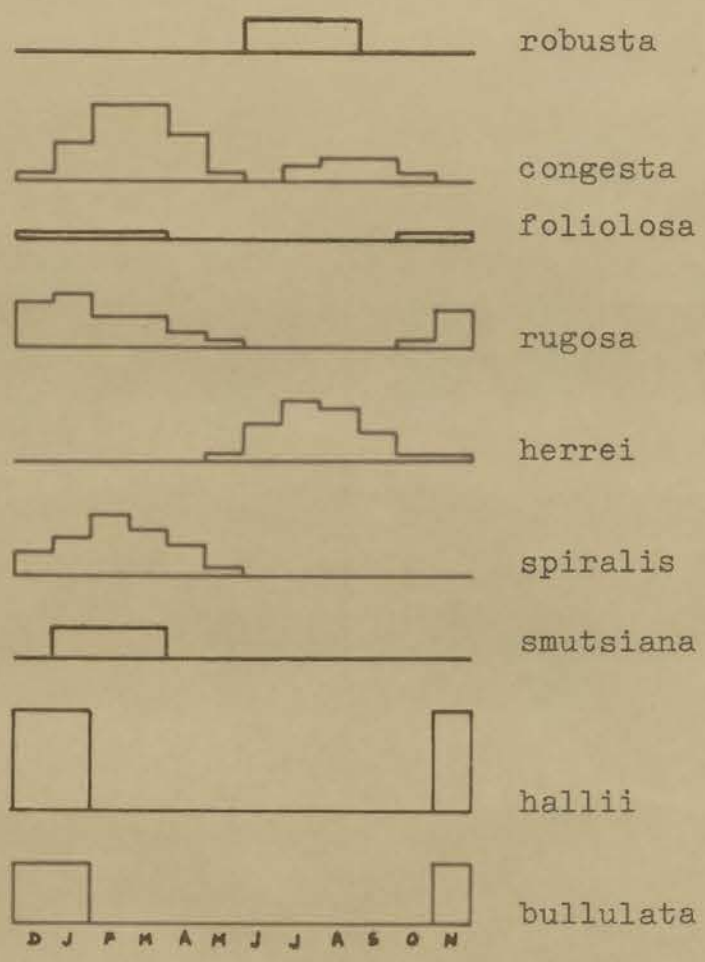
For the entity robusta, in the field, flowering times were observed to be from May to October, with peak blooming time in July and August, in the dry period before the beginning of the summer rainfall season or the second annual precipitation peak, depending upon locality. Under cultivation, for the few instances available, a similar pattern was observed.

Locality.	Date of collection	Condition when collected *	Flowering period in subsequent years under cultivation	Length of time between consecutive peak flowering periods
				Months
Dikkop Vlakte Comins 2064	April 1959	X	Jul-Sep 1960 Mar-May 1961 Dec-Feb 1962	8 9
On Adelaide Grahamstown Rd. Roberts 38, 39	Dec. 1959	X	Feb-Apr 1961 Jan-Mar 1962	10
Cradock Roberts 53	Nov. 1960	X	Feb-Apr 1961 " " 1962 " " 1963 " " 1964	12 12 12
Helspoort Comins 2065	Sept. 1960	FR	Jul-Sep 1961	11

TABLE 20. Showing variation between peak flowering periods for populations of congesta under cultivation at Kirstenbosch.

* See key to Table 21 for meaning.

UNDER CULTIVATION



IN THE FIELD

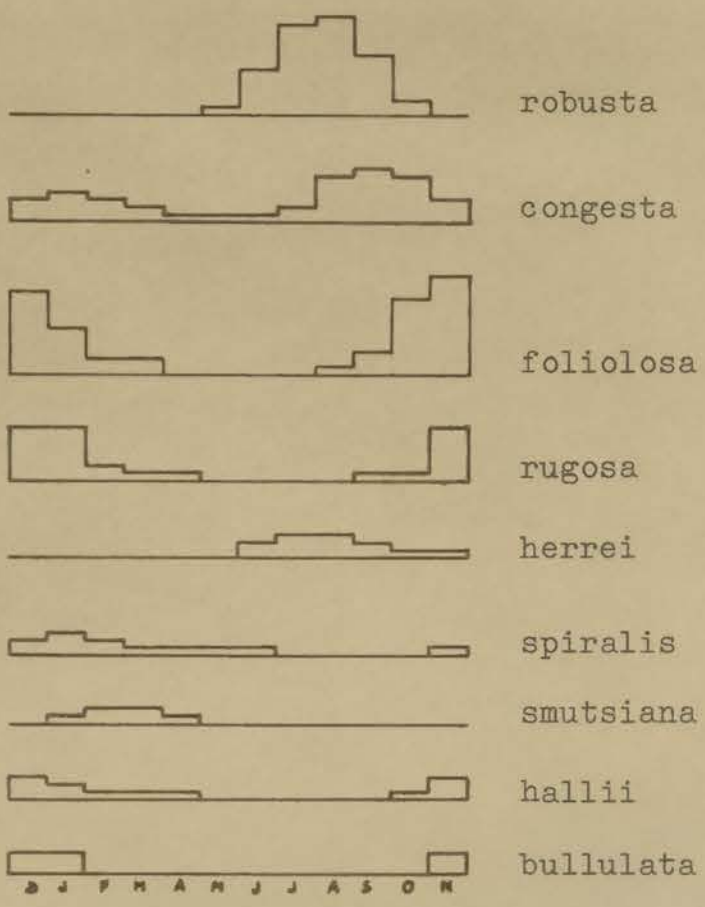


Fig.22. Showing flowering times of the entities of Astroloba.

The entity rugosa in the field has a flowering period from August to May, with peak blooming time in November and December, which apart from the doubtful Graaff Reinet locality, is in the driest season. A similar pattern is observed under cultivation.

In the field the flowering period for the entity herrei is from June to November, with July and August peak flowering times, in the period of low precipitation before the second annual rainfall peak, which as mentioned previously, is lower than the March-May one for Prince Albert. A similar pattern is seen under cultivation.

The entity spiralis in the field has a flowering period from November to July, with the peak flowering period in January. It is felt that were more data available, the extension of the flowering period to July would prove somewhat exceptional, as under cultivation, the flowering period was found to be between December and June, with February and March the peak blooming periods. With the exception of the doubtful Graaff Reinet locality, the peak blooming time occurs in the field in one of the two seasons of low precipitation.

In the field, the entity smutsiana has a flowering time of from January to April with February and March the peak flowering period, occurring just before one of the two annual rainfall peaks, with a similar pattern observed under cultivation.

For both the entities hallii and bullulata the flowering period under cultivation was from November to January. In the field this was similar for bullulata, but longer for hallii, being from October to April, with December the peak period. Peak flowering time in both cases was in the dry season.

TABLE 21.

The localities recorded for all entities, with rainfall data from the nearest weather stations. The mean, minimum and maximum annual rainfall, and annual rainfall expressed as a quarterly percentage over a period of years are given. Data on flowering times are also included.
(With regard to the column condition of the specimen at time of collection, U = unknown; X = no inflorescence buds, flowers or fruits; B = inflorescences in bud; F = plants in full flower; R = plants in fruit.)

Collector	Locality	Date of Collection	Condition when Collected	Subsequent Flowering in Cultivation	Nearest Weather Station	Mean	Rainfall Annual mm. Max.	Min.	Quarterly % D-F	M-M	J-A	S-N
	Foliolosa											
Long 1175(GRA)	Addo Bush	11.2.34	F		Addo	354.8	465.8	199.1	-	-	-	-
Long 1175(PRE)	"	11.2.34	X		Moira	383.5	500.6	187.4	-	-	-	-
Zeyher 4184(GRA)	Zwartkops Sundays River	Aug.1904	X									
Zeyher 1054(GRA)	Koegakammas Kloof	1904	F									
Barker 5100(NBG)	Kleinpoort	2.12.47	F		Kleinpoort	290.6	537.7	158.5	-	-	-	-
Nbg 171/59	Springbokvlakte	-	-	Feb.1961	Springbokvlakte	294.6	389.4	242.1	-	-	-	-
Roberts 11	Wolwefontein	Oct.1959	B		Wolwefontein	297.7	384.6	189.7	-	-	-	-
No.27628(BOL)	"	Dec.1933	X									
Roberts 10	Toekomst	Oct.1959	X		Waterford	247.1	348.7	106.9	-	-	-	-
Acocks 11997 (PRE)	nr. Klein Riet R. W. of Waterford	29.10.45	F									
Roberts 36,37	Lake Mentz	Dec.1959	F		Lake Mentz	256.3	361.4	106.4	28	31	14	27
Roberts 12	Baroe	Oct.1959	BF		Waaipoort	214.1	327.4	91.9	-	-	-	-
Roberts 13	Mount Stewart	Oct.1959	BF		Kranskop	177.8	294.4	88.6	-	-	-	-
Roberts 52B	Mount Stewart	Oct-Nov. 1960	F									
Roberts 14	Steytlerville	Oct.1959	BF		Steytlerville	228.6	430.8	74.7	27	31	14	28

Collector	Locality	Date of Collection	Condition when Collected	Subsequent Flowering in Cultivation	Nearest Weather Station	Mean	Rainfall Annual mm. Max.	Min.	% Quarterly D-F	M-M	J-A	S-N
	Foliolosa Contd.											
Roberts 43A	Steytlerville	July 1960	X									
Roberts 52A	Steytlerville	Oct-Nov. 1960	BF									
Paterson 40	Steytlerville	Nov.1911	F									
Roberts 34	Cranmere	Nov.1959	X		Cranmere	305.6	515.9	84.6	-	-	-	-
Roberts 35	10 miles South of Pearston on Waterford Rd.	Nov.1959	X		Pearston	370.6	477.5	130.6	30	30	13	27
van der Berg Nbg.540/23 (BOL)	Kendrew	April 1929	X		Kendrew Estate	285.2	153.3	117.6	32	32	12	25
Frith H/3606/59 (K) 4	Kendrew	May 1924	X		Kendrew S.A.R.	254.8	472.2	115.1	-	-	-	-
H.Bolus 5264A (BOL)	Kruidfontein	Sept.1870	BF									
H.Bolus 264(BOL)	Graaff Reinet	Aug-Oct. 1870	F		Graaff Reinet Gaol	346.2	545.1	147.1	-	-	-	-
Thode A621(PRE)	Graaff Reinet	Nov-Dec. 1925	F		Graaff Reinet Convent	345.7	573.3	165.9	32	29	13	26
Frith H/3606/59 (k) 5	Graaff Reinet	May 1924	X									
Roberts 29	At turnoff to Valley of Desolation	Dec.1959	F		van Ryne-velds Dam	324.1	511.0	164.8	-	-	-	-
60	"	Feb.1961	F									

Collector	Locality	Date of Collection	Condition when Collected	Subsequent Flowering in Cultivation	Nearest Weather Station	Rainfall Annual mm. Mean	Max.	Min.	% Quarterly D-F	M-M	J-A	S-N
	Foliolosa Contd.											
Roberts 30	10 miles N. of Graaff Reinet on Middleburg Rd.	Dec.1959	X		Bloemhof	301.2	496.1	127.0	-	-	-	-
N.S.Pillans	Between Ladismith and Laingsburg?		U	Aug.1907	Laingsburg	104.4	303.3	20.8	-	-	-	-
						135.1	195.6	73.7	-	-	-	-
					Prinsrivier	143.0	199.9	57.6	-	-	-	-
					Ladismith	337.0	515.1	176.0	20	30	19	31

Collector	Locality	Date of Collection	Condition when Collected	Subsequent Flowering in Cultivation	Nearest Weather Station	Mean	Rainfall Annual mm. Max.	Min.	% Quarterly D-F	M-M	J-A	S-N
	Congesta											
Dyer 975(PRE)	Hel poort	Aug.1927	F		Heatherton Towers	341.7	592.3	240.8	-	-	-	-
Dyer 2096(GRA)	"	Sept.1929	F									
Rosenborth Stell.Un.7851 (BOL)	"	24.9.47	F		Uplands	315.7	455.7	139.2	-	-	-	-
H. Bolus 2687 (BOL)	"	Jan/Feb	F									
H. Bolus 2687(K)	"	Feb.1874	F									
Roberts 41	"	Dec.1959	X	Aug-Oct. 1960								
Comins 2065	"	23.9.60	R	Aug-Sept. 1961								
Cruden 209(GRA)	Alicedale	25.3.17	F		Alicedale	394.2	723.6	152.1	-	-	-	-
Comins	Alicedale	1960	X									
Comins	Dikkop Vlakte	April 1959	X	July-Sept. 1960 March-May 1961 Dec.-Feb. 1962	As for Hellpoort							
Roberts 40	nr Dikkop Vlakte	Dec.1959	X									
Comins	Dikkop Vlakte	23.9.60	R									
Comins 2063	Krantz Drift	21.10.60	F		As for Hel poort							

Collector	Locality	Date of Collection	Condition when Collected	Subsequent Flowering in Cultivation	Nearest Weather Station	Mean	Rainfall Annual mm. Max.	Min.	% Quarterly D-F	M-M	J-A	S-N
	Congesta Contd.											
Acocks 12049 (PRE)	Top of Brakkloof	1.11.45	X		As for Hellpoort							
Roberts 38,39	12-18 miles from Adelaide nr. Friesland on Grahamstown rd.	Dec.1959	X	Feb-Apr.1961 Jan-March 1962, 1963 and 1964	Adelaide	448.0	681.0	220.5	32	30	10	28
					Clifton	366.5	500.4	180.1	-	-	-	-
					Wester-ford	438.9	523.7	195.1	-	-	-	-
					Seven-fontein	345.9	446.8	154.7	-	-	-	-
S.leg (GRA)	Fish River Rand	Oct.1896	X									
Davison, Nbg. 187/15 (BOL)	Mortimer	June 1915	F		Semaphore	310.9	542.5	118.1	-	-	-	-
Acocks 11928 (PRE)	Rayners Kop	25.10.45	X		Tarka Train-ing Farm	297.2	436.1	91.7	-	-	-	-
Roberts 33	nr.Rayners Kop	Dec.1959	F									
No.27632(BOL)	Cradock	19.9.35	F		Cradock (S.A.R.)	356.6	483.1	185.2	-	-	-	-
					(Gaol)	341.9	672.6	104.4	35	33	8	24
Cunningham(BOL)	Cradock	7.10.35	X									
Roberts 32	Cradock	Dec.1959	F									
Roberts 53	Cradock	Nov.1960	X	Feb-Apr.1961, 1962,1963 & 1964								
Roberts 31	19m N. of Cradock nr. Knutsford	Dec.1959	X		Fish River	268.0	496.6	87.9	-	-	-	-
					Fortuin-plaats	291.6	517.4	174.0	-	-	-	-
J.J. Bruwer (BOL)	Rosmead	25.10.37	X		Groot-fontein	365.0	623.3	184.7	-	-	-	-

Collector	Locality	Date of Collection	Condition When Collected	Subsequent Flowering in Cultivation	Nearest Weather Station	Mean	Rainfall Annual mm. Max.	Min.	Quarterly % D-F	M-M	J-A	S-N
	Robusta											
S.Schonland(PRE)	Lake Mentz	Aug.1921	F		Lake Mentz	256.3	361.4	106.4	28	31	14	27
Acocks 11995 (PRE)	5 miles E. of Waterford	29.10.45	X		Waterford	247.1	348.7	106.9	-	-	-	-
Compton 20323 (NBG)	Mount Stewart	5.12.47	X		Waaipoort	214.1	327.4	91.9	-	-	-	-
					Klipplaat	230.6	374.4	65.3	31	31	11	28
Dyer 4022 (PRE)	Steytlerville	Aug.1939	F		Steytler-ville	228.6	430.8	74.7	27	31	14	28
Roberts 15	Steytlerville	Oct.1959	X									
Roberts 43	Steytlerville	July 1960	F									
V.S. Rees Nbg. 1302/25 (NBG)	Miller	12.8.43	F		Fullarton	177.5	421.6	73.7	-	-	-	-
Roberts 8, 9.	nr. Miller	Oct.1959	X	Jun-Aug.1962								
Roberts 45	nr. Miller	July 1960	B									
Leipoldt 3062 (BOL)	Koppie Nr. Willowmore	July 1940	X		Willowmore	236.2	439.4	101.1	-	-	-	-
Stell.Univ.Gdn. 7849 (BOL)	Betw.Oudts-hoorn & Willow-more	12.8.47	F		Schilpads-been	242.6	398.3	138.2	-	-	-	-
Roberts 27	Klaarstroom	Dec.1959	X		Klaarstroom	178.3	374.4	61.2	-	-	-	-
Broom s.n. No. 11652 in Herb. Marloth (PRE	Prince Albert	Aug.1923	F		Prince Alb-ert	182.4	484.1	56.4	21	35	19	26
Roberts 64	Prince Albert	July 1961	F									

Collector	Locality	Date of Collection	Condition When Collected	Subsequent Flowering in Cultivation	Nearest Weather Station	Mean	Rainfall Annual mm. Max.	Min.	Quarterly % D-F	M-M	J-A	S-N
	Robusta Contd.											
Roberts 65	nr. Farm Vleiland	April 1962	X		Rietvlei	175.5	317.8	63.2	16	29	26	28
Roberts 67	nr. Farm Spreeufontein	April 1962	X									
Kirstenbosch trip.	"	Sept. 1961	X									
Roberts 1	nr.Farm Rietfontein 8 mi. from Laingsburg	May 1959	B		Laingsburg	104.4	303.3	20.8	-	-	-	-
					Laingsburg	135.1	195.6	73.7	-	-	-	-
No.27630(BOL)	Whitehill	Oct.1930	FR									
Roberts 57	nr.Whitehill	Dec.1960	X		Whitehill Rail	122.2	201.2	77.0	-	-	-	-
E.Oliver	nr.Whitehill	Aug-Sept.1960	FR									
Roberts 56	nr.Matjesfontein	Dec.1960	X		Hillandale	159.8	370.6	54.9	-	-	-	-
Bartlett 349(BOL)	"	-			Matjesfontein	155.8	345.7	68.3	15	31	33	21
Nbg. 3172/14(NBG)	Beaufort West	1914	F		Beaufort West Gaol	227.6	515.6	62.7	36	29	13	22
Taylor 921(BOL)	North of Beaufort West	30.9.35	F		De Hoop	230.4	372.4	149.4	-	-	-	-
H.Hall 2284	Foot of Molteno Pass	Aug.1961	FR	June-Aug 1962,1963, 1964	Lemoenfontein *	317.8+	591.8	131.8	-	-	-	-
Roberts 27	10 miles E. of Nelspoort	Dec.1959	X		Nelspoort	238.8	556.8	77.2	-	-	-	-

Collector	Locality	Date of Collection	Condition When Collected	Subsequent Flowering in Cultivation	Nearest Weather Station	Mean	Rainfall Annual mm. Max.	Min.	Quarterly % D-F	M-M	J-A	S-N
	Robusta Contd.											
	10 miles E.of Nelspoort	July 1960	F		Nelspoort Sanatorium	238.5	504.7	75.9	-	-	-	-

* In Nuweveld Mt.Range, rainfall therefore rather high.

Collector	Locality	Date of Collection	Condition When Collected	Subsequent Flowering in Cultivation	Nearest Weather Station	Rainfall Annual mm. Mean	Annual mm. Max.	Annual mm. Min.	Quarterly % D-F	Quarterly % M-M	Quarterly % J-A	Quarterly % S-N
	Hallii											
Matthews Nbg. 3479/14(BOL)	Prince Albert	March 1915	F		Prince Albert	182.4	484.1	56.4	21	35	19	26
Rennie Nbg. 1418/28(BOL)	Prince Albert Division	May 1929	X									
Joubert 97(BOL)	Ladismith	Jan.1934	X		Ladismith	337.0	515.1	176.0	20	30	19	31
No.27624(BOL)	Between Ladismith and Laingsburg	-	U	May 1904	Prinsrivier	143.0	199.9	57.6	-	-	-	-
Barker 109(BOL)	6 mi.from Laingsburg on Ladismith Rd.	Sept.1932	X		Laingsburg	104.4	303.3	20.8	-	-	-	-
						135.1	195.6	73.7	-	-	-	-
					Rondekop	101.1	153.2	41.4	-	-	-	-
Roberts 48	Approx.10 mi. from Seven Weeks Poort on Laingsburg Rd.	July 1960	X	Nov-Jan. 1960,1961, 1962 and 1963	Rietvlei	175.5	317.8	63.2	16	29	26	28
Roberts 52	"	Oct.1960	B									
H.Hall 202/53	Koup	1953	X	Nov-Jan. 1959,60,61, 62,63.	Koup	108.2	215.1	26.9	-	-	-	-
Roberts 26	Koup	Dec.1959	BF									
Roberts 54	Koup	Dec.1960	F	Nov-Jan.1961 1962 and 1963								

Collector	Locality	Date of Collection	Condition When Collected	Subsequent Flowering in Cultivation	Nearest Weather Station	Rainfall Annual mm Mean	Max.	Min.	% Quarterly D-F	M-M	J-A	S-N
	Bullulata											
Acocks 18396 (Photo)(PRE)	4 miles N.of Matjesfontein	June 1955	X		Matjes-fontein	159.8	370.6	54.9	15	31	33	21
Roberts 25	4 miles N.of Matjesfontein on Sutherland Road.	Dec.1959	F	Nov-Jan. 1961,62, 63.	Hillandale	158.8	345.7	68.3	-	-	-	-
Roberts 55	"	Dec.1960	F									
Roberts 24	Approx.35 mi. N.of Ceres on Sutherland Rd.	Dec.1959	F	Nov-June 1961,62.	Spes Bona	109.7	178.0	37.1	17	28	32	23
No. 27635(BOL)	Ceres Karoo	1946										
H.Hall Nbg. 285/55 (NBG)	Verlatenkloof	Feb.1956	U	Nov-Jan. 1959,60, 61.	Nuwe Dam	244.8	373.1	167.4	-	-	-	-
Logan sn. No.27635(BOL)	Roggeveld mts. nr. Sutherland	July 1936	X		Sutherland	224.8	265.7	122.4	-	-	-	-
					Sutherland (Gaol)	247.6	463.1	104.6	17	28	35	19
No.9363 in Herb. H.Bolus (BOL)	Between Ladismith and Laingsburg	-	U	May 1904	Laingsburg 1	104.4	303.3	20.8	-	-	-	-
					Laingsburg 2	135.1	195.6	73.7	-	-	-	-
					Prinsrivier	143.0	199.9	57.6	-	-	-	-
					Ladismith	337.0	515.1	176.0	20	30	19	31

Collector	Locality	Date of Collection	Condition When Collected	Subsequent Flowering in Cultivation	Nearest Weather Station	Rainfall Annual mm. Mean	Max.	Min.	Quarterly % D-F	M-M	J-A	S-N
	Rugosa											
Roberts A2	23 mi.from Ladismith on road to Barrydale	May 1959	X	Nov-Jan.1960 Jan-March 1961	Poortfontein	108.0	192.8	47.5	-	-	-	-
R.du Plessis (BOL)	7 mi.from Warmwaterberg on road to Barrydale	Aug.1955	X									
P.Ross Frames (BOL)	6 mi. N.of Barrydale	1926	U	April 1929	Barrydale	265.7	410.7	93.7	-	-	-	-
Nbg. 428/58	Barrydale	1958	X	20.12.60								
A.J. Joubert 111 (BOL)	7 mi. East of Vanwyksdorp	May 1939	X									
Compton & Lamb Nbg.2306/27 (BOL)	Muiskraal	1927	U	April 1929 (fruiting)								
F. Ferguson(BOL)	Riversdale +	13.6.29	X									
N.J.S. van der Merwe 227(BOL)	Montagu "ex hort.Bonnievale"	Jan.1937	X		Montagu	312.2	560.8	136.6	11	25	33	30
Hurling & Neil (BOL)	nr.Montagu	Nov.1931	X									
A.J. Joubert (GRA)	Montagu District	Dec.1932	X									
Nbg.668/60	Montagu	1960	U	13.12.60								
J. Neil(BOL)	4m.out of Montagu on Baden Road	Nov.1931	X									

+ obviously Riversdale District

Collector	Locality	Date of Collection	Condition When Collected	Subsequent Flowering in Cultivation	Nearest Weather Station	Mean	Rainfall Annual mm. Max.	Min.	Quarterly % D-F	M-M	J-A	S-N
	Rugosa Contd.											
Roberts A17	On hillside 1 mi. N.W. of upper Baden Montagu District	Dec.1959	F									
Roberts A18	4 mi. out of Montagu shallow	Dec.1959	F	Dec-Feb.1960								
Roberts A59	kloof off Upper Baden Road	Dec.1960	F	Jan-March 1961								
Roberts A23	2 mi. out of Montagu at Baden Rd. turn off	Dec.1959	F									
Roberts A50	Farm Rietvlei No.2, 7 miles out of Montagu	Sept.1960	X		Rietvlei (Nr.Montagu)	233.9	374.1	159.2	-	-	-	-
Roberts A19, A20.	On Pietersfontein Rd.Montague Dist.	Dec.1959	F		Hoek van die berg	184.4	292.9	68.8	21	28	23	28
					Bellair	121.7	268.5	58.7	-	-	-	-
Roberts A21, A22.	Nr. Farm Brak-water on Dob-belaars Kloof Rd.	Dec.1959	F	Nov-Jan. 1960								
N.J.S. van der Merwe 226(BOL)	Bonnievale	Jan.1937	F		Bonnievale	245.6	301.8	140.0	-	-	-	-
Malang Nbg. 1687/22(BOL)	Keisies Hoogte	May 1929	X									
A.J.Joubert (BOL)	12 miles S.E. Touwsriver	Sept.1932	X		Touwsriver	218.2	399.5	85.6	14	24	40	22
						249.7	483.9	152.1	-	-	-	-

Collector	Locality	Date of Collection	Condition When Collected	Subsequent Flowering in Cultivation	Nearest Weather Station	Rainfall Annual mm. Mean	Max.	Min.	% Quarterly D-F	M-M	J-A	S-N
	Rugosa Contd.											
S.leg No. 27638(BOL)	Ladismith	April 1929	FR		Ladismith	337.0	515.1	176.0	20	30	19	31
					Algerynskraal	140.0	213.1	45.0	-	-	-	-
					Poortfontein	108.0	192.8	47.5	-	-	-	-
A.J.Joubert (BOL)	Ladismith	Dec.1932	X									
N.S.Pillans 857 (BOL)	Between Ladismith & Laingsburg	-	U	Flowered in hort Nov. 1906	Prinsrivier	143.0	199.9	57.6	-	-	-	-
					Rondekop	101.1	153.2	41.4	-	-	-	-
Roberts 66	Nr. Farm Rietvlei on Laingsburg/ Seven Weeks Poort Road.	April 1962	X		Rietvlei (Laingsburg div.)	175.5	317.8	63.2	16	29	26	28
S.leg No.4202 in Herb. Marloth (PRE)	Graaf Rienet	Oct.1905	F		Graaf Rienet (Convent)	345.7	573.3	165.9	32	29	13	26
					(gaol)	346.2	545.1	147.1	-	-	-	-

Collector	Locality	Date of Collection	Condition When Collected	Subsequent Flowering in Cultivation	Nearest Weather Station	Rainfall Annual mm. Mean	Max.	Min.	Quarterly % D-F	M-M	J-A	S-N
	Smutsiana											
Roberts A3,4,5,	23-26 miles from Ladismith on old Barrydale Road.	May 1959	X	Jan-March 1960,61, 62,63.	Poortfontein	108.0	192.8	47.5	-	-	-	-
Roberts A62	"	Feb.1961	F		Barrydale	265.7	410.7	93.7	-	-	-	-
					Algerynskraal	140.0	213.1	45.0	-	-	-	-
P.Ross Frames Nbg.2155/26 (BOL)	14 mi. S of Ladismith	May 1929	X		Ladismith	337.0	515.1	176.0	20	30	19	31
Roberts 63,63A.	N.of Muiskraal, along Ladismith Road.	May 1961	X									
Nbg. 784/63	Anysberg	1963	U		Prinsrivier	143.0	199.9	57.6	-	-	-	-
P.Bond 259 (NBG)	Rooihoogte, Laingsburg	23.3.40	F		Rondekop	101.1	153.2	41.4	-	-	-	-
Roberts 51	Rooinek Pass Laingsburg Division	Oct.1960	X		Laingsburg	104.4	303.3	20.8	-	-	-	-
						135.1	195.6	73.7	-	-	-	-
Roberts 49	12 m. from Seven Wks.Poort on Laingsburg Road.	July 1960	X		Rietvlei, (Laingsburg Division)	175.5	317.8	63.2	16	29	26	28
Roberts Obs.	Several places between Rooinek Pass and Rietvlei Farm along Laingsburg/7 wks. Poort Road.	April 1962	X									

Collector	Locality	Date of Collection	Condition When Collected	Subsequent Flowering in Cultivation	Nearest Weather Station	Rainfall Annual mm. Mean	Max.	Min.	Quarterly % D-F	M-M	J-A	S-N
	Herrei											
A.Erasmus s.n. No.1368 in Herb. Marloth (PRE)	Prince Albert	20.8.29	F		Prince Albert	182.4	484.1	56.4	21	35	19	26
					Willow Glen	207.5	334.5	49.8	-	-	-	-
A.M.Krige s.n. No.13009 in Herb.Bolus (BOL)	nr.Prince Albert	1908	X									
J.P.H. Acocks 18412 (PRE)	5 mi. S.E. of Prince Albert	13.10.55	F									
Roberts 46	5 miles from Prince Albert on hill slopes by Klaarstroom Road.	July 1960	F	June-Aug 62, July-Sept 64.								
Roberts Obs.	"	Dec.1960	X									
Roberts 16	nr.Farm Hoek Plaas about 10 miles N.E. of Uniondale	Oct.1959	X	June-Aug 62, 63 July-Sept. 1964	Uniondale	325.1	714.0	171.2	19	29	24	29
					Uniondale	209.3	410.7	83.6	-	-	-	-
					Vetvlei	230.6	316.7	76.2	-	-	-	-
Roberts 44	"	July 1960	F		Rooirivier	240.8	362.0	141.7	19	29	23	29

Collector	Locality	Date of Collection	Condition When Collected	Subsequent Flowering in Cultivation	Nearest Weather Station	Rainfall Annual mm. Mean	Min.	Max.	% Quarterly D-F	M-M	J-A	S-N
	Spiralis											
Roberts 6	About 26 mi.from Ladismith on old Barrydale Road.	May 1959	X	Dec-Feb. 1960,61, 62,63.	Poortfontein	108.0	192.8	47.5	-	-	-	-
					Algerynskraal	14.00	213.1	45.0	-	-	-	-
A.J.Joubert(BOL)	Ladismith	Nov.1932	X		Ladismith	337.0	515.1	176.0	20	30	19	31
Roberts 47	About 5 mi. S.of Calitzdorp hill slope to W. of Rooiberg Pass Rd.	July 1960	X	Jan-March 1962,63	Calitzdorp	198.6	421.4	84.8	24.	30	16	31
Roberts 68	"	April 1962	X									
Roberts 7	About 7 miles S. of Oudtshoorn on Robertson Pass Rd.	Oct.1959	X		Oudtshoorn (gaol)	238.2	419.6	115.1	20	28	20	31
					Oudtshoorn (Convent)	231.6	305.8	140.2	-	-	-	-
					Oudtshoorn (Municipality)	245.1	458.7	105.2	-	-	-	-
Roberts 61	"	Feb.1961	F									
W.F.Barker 5096 (NBG)	Oudtshoorn District	6.12.47	F									
In Herb.Marloth 6510a (PRE)	Oudtshoorn	-	U	March 1925								
S.leg No.27625 (BOL)	Oudtshoorn	May 1929	F									
W.Taylor (GRA)	Oudtshoorn	Jan,1916	F									

Collector	Locality	Date of Collection	Condition When Collected	Subsequent Flowering in Cultivation	Nearest Weather Station	Mean	Rainfall Annual mm. Min.	Max.	% Quarterly D-F	M-M	J-A	S-N
	Spiralis Contd.											
Taylor Nbg. 130/16 (BOL)	Oudtshoorn	1916	U	March 1918								
H.Herre Stell. Univ.Gdns.11 (BCL)	Little Karoo		U	3.4.36								
P.Ross Frames Nbg.2525/27 (NBG)	De Rust	1927	U	7.3.43	De Rust	333.0	637.8	224.5	20	29	20	31
					Vlakteplaas	241.3	376.2	140.7	-	-	-	-
P.Ross Frames Nbg.2525/27 (NBG)	De Rust	1927	U		Rooikrans	205.2	396.5	90.2	-	-	-	-
In Herb.Marloth 5112 (PRE)	Graaf Reinet	-	F		Graaf Reinet Convent Gaol	345.7 346.2	573.3 545.1	155.9 147.1	32	29	13	26

CYTOLOGY

Previous history

Riley (1961) has compiled the most recent list of recorded chromosome counts for the genus Astroloba. His table, with literature references is given below. The species are arranged according to Jacobsen (1954).

Species	n no.	2n no.	References
A. aspera (Willd.) Uitew.	7	-	Ferguson 1926
as Haworthia aspera	-	14	Snoad 1951 a
A. bicarinata (Haw.) Uitew.	-	21	Resende 1937
A. congesta (Salm.) Uitew.	9	-	Marshak 1934
A. deltoidea (Hook.f.) Uitew.	7	14	Ferguson 1926
	-	14	Resende 1937
A. foliolosa (Willd.) Uitew.	-	14	Resende 1937
A. pentagona (Haw.) Uitew.			
as A. pentagona Willd.	-	28	Resende 1937
as Haworthia spiralis Haw.	-	14	Sato 1937, 1942
A. pentagona var spiralis (Haw.) Uitew.	12	-	Ferguson 1926
A. spiralis (L.) Uitew.			
as A.spiralis L. (Bak.)	-	14	Resende 1937, Konde and Magata 1943
A. sp.	7	-	Geitler 1935, Suto 1936
A. sp.	-	14	Riley 1959
Gasteria x Astroloba			
Gasteria x apicroides Bak.	-	ca 14	Ferguson 1926

Table 22: CHROMOSOME COUNTS OF SPECIES OF ASTROLOBA AND AN INTERGENERIC HYBRID.
(From Riley (1961), Tables 2 and 3)

It appears that in most cases the plants investigated came from private collections, not from plants collected in the wild. In view of this and in view of the existing confusion over the identification of some species, this list is not of great value.

Unfortunately, a number of the references were unavailable, notably that of Resende (1937) in which the somatic chromosome number of "Apicra bicarinata" was given as 2n = 21 No triploid plants were found by the present author in any field specimens. The cytology of specimens of what the present author considers to be an inter-generic hybrid between H. margaritifera and the entity rugosa, (originally described as Apicra bicarinata by Haworth (1819)), is dealt with later. The somatic number was 2n = 14 in all plants examined.

In the same paper, Resende gave the diploid number of a plant "Apicra pentagona" as 2n = 28. As will be shown later, the identity of the species "pentagona" is open to doubt. The only polyploid found by the present author was the entity spiralis (2n = 28). Resende, on the other hand gave the chromosome number of the plant he considered to be "Apicra spiralis" as 2n = 14. A similar observation was made by Kondo and Megata (1943).

Sato, also in unavailable references, (1937, 1942), gave a chromosome number of 2n = 14 for a plant he identified as Haworthia spiralis Haw. As is shown in this thesis in the account of the taxonomic history of the species the identity of "spiralis Haw" is open to doubt, but it is possibly a specimen either of what the present author describes as the entity hallii, or of the entity smutsiana.

Ferguson (1926) investigated plants of Astroloba, then known as Apicra from the Kew collection of succulants. She noted that the constriction in Chromosomes of the Aloinae is usually subterminal. Of the Apicras, she observed this in "Apicra Deltoidea". It is not clear, however, in the text or in the illustrations, (l.c.p.252, fig 9), whether or not this applied to all chromosomes of this specimen. She gave the average length of the long and short chromosomes in "A. deltoidea" as 7.0 and 2.4 μ respectively.

Riley (1961) quoted Ferguson (1926) as giving the haploid number of "A. pentagona var spiralis" as n = 12. In the original text of Ferguson's paper, however (l.c.p. 234 Table I), the haploid chromosome number of "pentagona spiralis" is given as n = 14. The discrepancy in Riley's paper is not an orthographic one as he also mentioned a chromosome number of n = 12 in the text, (l.c.p. 66 para. 2 line 2). Since he cited only one paper by Ferguson it would appear that Riley has made a mistake. It is very likely that the plant "pentagona spiralis" investigated by Ferguson was in fact a specimen of the entity spiralis.

A record of a haploid chromosome number of n = 9 observed by Marshak (1934) is also mentioned by Riley. Marshak investigated chromosome configuration in the first division of meiosis in "Apicra congesta" and found a variability in chromosome number, the usual count being n = 9 with six long and three short chromosomes. Marshak suggested that in "Apicra congesta" individual chromosomes may have been duplicated, but commented: "One hesitates to draw inferences about wild species from representatives grown so long under cultivation". He did not mention anywhere the possibility of difference in chromosome numbers being caused from lack of pairing at meiotic Metaphase I, and this cannot be suggested from his illustration.

No such unusual behaviour was observed by the present author in any member of the foliolosa complex, namely, the entities foliolosa congesta and robusta, all of which were found to have a diploid number of 2n = 14.

As a point of interest it should be noted that the plant of Astroloba listed, as "A.sp" in Riley's paper of 1961, whose chromosomes were counted by him in 1959, was collected "on the bank of the Great Fish River near the bridge at Commitees", (Riley 1959 p.84). From this locality, the plant may be identified as a specimen of the entity congesta.

There is a further point of interest in Riley's paper of 1961. He listed a hybrid Gasteria x Astroloba, "Gasteria x

apicroides Bak.", giving no reasons or references as to why "apicroides" should be an intergeneric hybrid. According to Baker (1896), who described the plant originally as Gasteria apicroides, it was a form allied to G.bayfeldii (Salm). Bak., differing in the way in which the leaves were borne. Both species were described from plants of unknown locality in South Africa.

Rowley (1954) actually transferred G. bayfeldii to the hybrid genus Gasterhaworthia, established by Guillaumin (1931) for hybrids between species of Gasteria and Haworthia. No one, however, appears to have given similar treatment officially to G. apicroides. Ferguson (1926) investigated the chromosome number of the plant as a species of Gasteria.

The present author has never seen a living specimen of G. apicroides Bak., but there is a specimen accompanied by a water colour in the Bolus Herbarium of a putative hybrid between the Genera Gasteria and Astroloba. The specimen, No.27647 (BOL) came from the Ferguson collection in Frames' garden. The leafy stem is shortly caulescent, with white spotted leaves 6 cm long, reminiscent of G. stayneri von Poelln, while the perianth tube is 13 mm long, pink and inflated at the base, green at the apex and straight with slightly outcurved lobes.

Investigations by the present author.

As is shown in this thesis in the account of the taxonomic history of the species, there has been considerable confusion over the identification of species of Astroloba and this probably applies equally well to those plants of Astroloba of which the cytology has been investigated by previous authors. Again, since in most cases the plants investigated have been long under cultivation, any divergences fromthe usual haploid number of n = 7 must be regarded as not necessarily pertaining to plants in the field, as Marshak (1934) so rightly observed, or they may, in fact, have been inaccurate counts!

All plants investigated by the present author were taken from sample field populations, and are listed in Table 23.

As pieces of leafy shoot strike root readily, the somatic chromosome number in root tips was investigated in each case.

Entity	Locality	No. of plants investigated	Diploid count
BULLULATA	Ceres - Sutherland Karoo R 24	3	2n = 14
	Matjiesfontein R 25	2	2n = 14
HALLII	Koup R 26	4	2n = 14
SMUTSIANA	Ladismith - Barrydale R 3	2	2n = 14
	Ladismith - Barrydale R 5	2	2n = 14
SPIRALIS	Oudtshoorn R 7	3	2n = 28
	Calitzdorp R 47	1	2n = 28
	Ladismith - Barrydale R 6	1	2n = 28
HERREI	Prince Albert R 46	2	2n = 14
	Uniondale R 16	1	2n = 14
RUGOSA	Baden - Baden R 17	1	2n = 14
	R 18	1	2n = 14
	Dobbelaar's Kloof R 19	1	2n = 14
	Rietvlei R 50A	1	2n = 14
CONGESTA	Cradock R 32	2	2n = 14
	S. of Adelaide R 38	3	2n = 14
FOLIOLOSA	Steytlerville R 14	1	2n = 14
	Waterford R 10	1	2n = 14
ROBUSTA	Nelspoort R 28	2	2n = 14
	Klaarstroom R 27	1	2n = 14
	Miller R 8	2	2n = 14
	Steytlerville R 15	1	2n = 14
X ASTRO-WORTHIA BICARINATA	Rietvlei R 50	1	2n = 14
	Kirstenbosch No.7262	1	2n = 14

Table 23. SHOWING DIPLOID CHROMOSOME NUMBERS OBSERVED IN ROOT SQUASHES OF PLANTS OF ASTROLOBA FROM FIELD POPULATION SAMPLES.

(All were treated with colchicine)

Method.

It was found that the most numerous metaphase stages were found in roots which had been excised at about eight o'clock in the morning. The roots were cut off about 3 mm behind the apex and placed in a 0.01% colchicine solution for 6 hours. (Riley, verb. com.)

They were then washed and fixed in a 3 : 1 absolute alcohol - glacial acetic acid solution for 12 to 24 hours. After that they were hydrolysed in N/10 HCl. at 60° for 6 minutes, then washed in distilled water and stained in Feulgen (La Cour), for 30 minutes, or until the root tips were purple and the rest of the tissue still white.

The root tips were squashed in 45% acetic acid and examined under the microscope. Photographs were taken of metaphase configurations in all entities except the entity smutsiana.

It was found that very good separation of chromosomes was obtained at metaphase if the roots were left in a colchicine solution for 12 hours (See Plate 11.). The chromosomes were, however, very much shortened.

Results. (See Plates 11, 12, 13 and 14).

Diploid counts for all plants investigated are given in Table 23. In all cases with the exception of the entity spiralis, the diploid count is 2n = 14, with four pairs of long and three pairs of short chromosomes. The entity spiralis with a diploid number of 2n = 28 is a tetraploid.

Insufficient good preparations were made to obtain an adequate picture of chromosome length or of the relative lengths of the arms of each chromosome on either side of the constriction. All the long chromosomes are subterminal, but there is some variation in the proportion of the length of the long arm to that of the short arm. In all entities one pair of long chromosomes, (two pairs in the tetraploid entity spiralis), has a ratio of roughly 4:1, while in the other pairs of chromosomes the short arm is shorter.

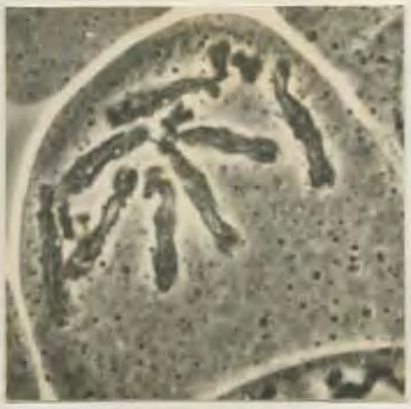
Entity	Locality	Long chromosomes 8 per somatic cell: No.chromosomes in which position of constriction is visible	Long chromosomes 8 per somatic cell: Ratio of length of long arm to length of short arm	Short chromosomes 6 per somatic cell: No.chromosomes in which position of constriction is visible	Short chromosomes 6 per somatic cell: Ratio of length of long arm to length of short arm	No.of cells observed
BULLULATA	R24	5 1	7:1 4:1	3	2:1	1
	R25	6 2	8:1 5:1	1	2:1	1
HALLII	R26	5 2	6:1 3:1	3	2:1	1
SMUTSIANA	R5	6 2	7:1 4:1	6	2:1	1
HERREI	R16	6 2	7:1 4:1	5	2:1	1
	R46	6 2	7:1 4:1	6	2:1	1
RUGOSA	R18,19	4 2 2	7:1 6:1 4:1	4	2:1	2
CONGESTA	R38	6 2	7:1 4:1	5	2:1	1
FOLIOLOSA	R14	1 1	8:1 4:1	4	2:1	1
ROBUSTA	R8	6 2	6:1 3:1	4	2:1	1
	R28	6 2	8:1 5:1	4	2:1	1
X BICARINATA	No.7262	4 2 2	7:1 6:1 4:1	4	2:1	1
SPIRALIS	R7	12 4	8:1 4:1	12	2:1	1

Table 24. SHOWING RELATIVE LENGTHS OF ARMS OF CHROMOSOMES AT SOMATIC METAPHASE.

Has 16 long and 12 short chromosomes per cell.

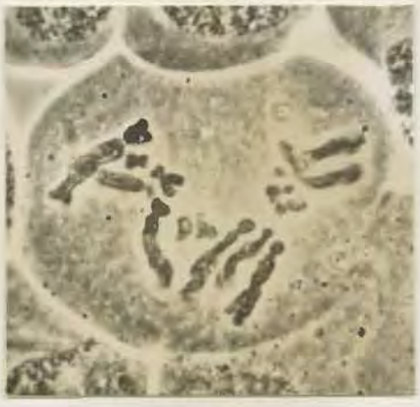
In the entities smutsiana, herrei and congesta, all the short chromosomes were subterminal, but whether or not this was the case for all the short chromosomes of the other entities was not clear.

These very approximate observations are shown in Table 24. It must be emphasised that these observations are very approximate and they must be regarded in this light.



R17 R22

Chromosomes from rootsquashes of the entity rugosa. Note the slight stickiness between two of the long chromosomes in the specimen on the left.



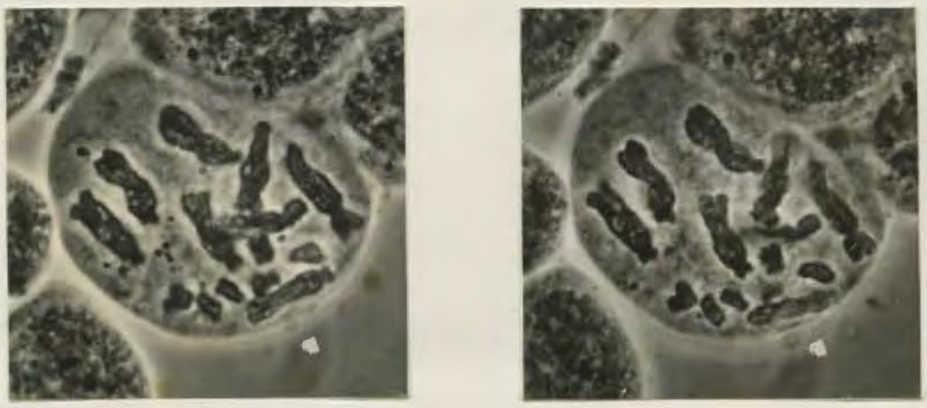
No. 7262

Chromosomes from a rootsquash of a plant of the intergeneric hybrid, referred to by the present author as x Astroworthia bicarinata, between the entity rugosa and Haworthia margaritifera.

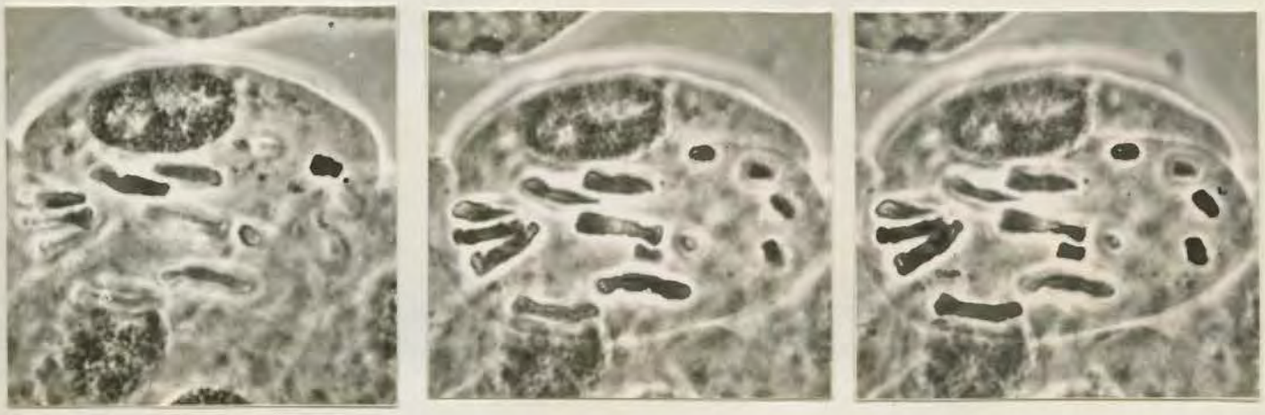
Ex hort. Kirstenbosch.

Chromosomes from a rootsquash of a plant of Poellnitzia rubriflora (L. Bol.) Uitew., after 12 hours treatment with colchicine. (All other specimens photographed were immersed in the colchicine solution for the time specified by Riley).

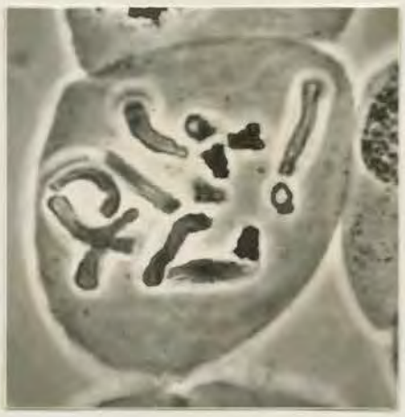
PLATE 11.



Chromosomes from a rootsquash of a plant of the entity congesta (R38) seen at two levels.



Chromosomes from a rootsquash of a plant of the entity foliolosa (R14) seen at three levels.



Chromosomes from a rootsquash of the entity robusta (R9).

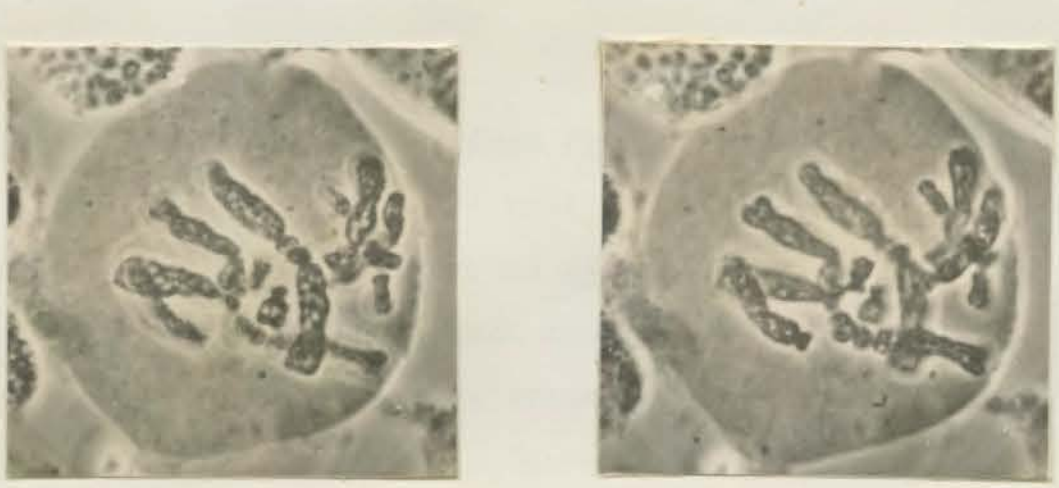
PLATE 12.

Chromosomes from a rootsquash of the entity hallii (R26) seen at three levels.

Chromosomes from a rootsquash of a plant of the entity bullulata (R24). Note the stickiness between some of the chromosomes.

PLATE 13.

Chromosomes from a rootsquash of a plant of the entity spiralis (R7), the only polyploid entity found in field specimens of the genus.



Chromosomes from a rootsquash of a plant of the entity herrei (R16) seen at two levels.

PLATE 14.

ASSESSMENT OF CHARACTERS IN POPULATION SAMPLES.

THE 'FOLIOLOSA' COMPLEX

From the introductory survey of the genus as a whole, a group of entities has been delimited, characterised by leaves with a glossy sheen, (due to the almost flat outer surfaces of the epidermal cell walls), inflorescences with long bracts and short pedicels, and flowers with smooth perianth tubes and broad lobes which are always white or cream in colour.

Three entities compose this group, namely foliolosa (formerly Astroloba foliolosa (Haw.) Uitew.), congesta (formerly referred to as Astroloba congesta (Salm-Dyk) Uitew.) and robusta, a new entity recognised by the present author. The complex as a whole is referred to as the foliolosa complex, as "foliolosa" was the first of the three to be described as a species.

Their distribution has already been discussed, and the problem is now to determine their taxonomic status from a survey of the patterns of variation found in the samples made of the various populations.

APPEARANCE OF LEAFY SHOOT.

Leaf Arrangement. (See Table 25) (See Plates 15, 16 and 17.)

Early authors considered leaf arrangement to be of some importance. Haworth (1804) described Aloe foliolosa as having "the thinnest most numerous and most crowded leaves of all the aloes", while Salm Dyk (1836-1863) wrote that Aloe congesta had the leaves in a very dense spiral, "more congested than in A. foliolosa". The keys of Baker (1896) and Berger (1908) incorporated leaf arrangement in delimitation of components of the foliolosa complex, either as species or varieties.

In the introductory survey, it was shown that the entity foliolosa, taken as a whole, did indeed have the most imbricate leaves in the genus, while in the entities congesta and robusta, the spiral angle for the majority of individuals was 0 - 20°.

This pattern is not always seen in samples of individual populations.

Locality	Class range of measurements.						Total no. indiv.	Range actual measurements.
	0	10°	20°	30°	40°			°
CONGESTA.								
N. of Cradock R31	-	1	3	1	1	-	6	9 - 33
Cradock R32	-	4	5	5	-	-	14	8 - 28
Rayners Kop R33	-	5	4	-	-	-	9	5 - 20
S. Adelaide R38,39	-	5	11	-	-	-	16	5 - 20
Dikkop Vlakte R40	-	-	2	-	-	2	4	13 - 41
Helspoort R41	-	1	1	3	2	-	7	15 - 36
Krantz Drift (Commins 2063)	-	2	1	-	-	-	3	1 - 17
FOLIOLOSA.								
Graaff Reinet R29	-	4	4	4	3	-	15	7 - 33
nr. Pearston R34	-	-	1	1	-	-	2	20 - 29
Lake Mentz R36,37	-	-	3	8	3	1	15	16 - 45
Waterford R10	-	-	-	2	1	-	3	30 - 36
Wolwefontein R11	-	-	1	2	5	1	9	18 - 45
Baroe R12	-	-	-	1	-	-	1	21
Mt. Stewart R13	-	1	-	4	3	-	8	7 - 40
Steytlerville R14	-	1	4	7	3	-	15	9 - 36
ROBUSTA.								
Steytlerville R15	-	8	9	1	-	-	18	1 - 25
nr. Miller R8,9	1	12	2	-	-	-	15	0 - 20
Klaarstroom R27	-	-	-	1	-	-	1	28
Prince Albert R64	-	6	3	-	-	-	9	2 - 15
E. of Laingsburg R1	-	-	1	-	-	-	1	19
E. of Nelspoort R28	-	1	2	3	7	-	13	6 - 40
Nr. Molteno Pass (Hall 2284.)	-	1	3	2	-	-	6	5 - 30

Class interval 10°

Table 25 **VARIATION OF SPIRAL ANGLE IN FIELD SPECIMENS OF THE FOLIOLOSA COMPLEX.**

The foliolosa populations sampled have over two thirds of individuals with a spiral angle of more than 20°, with the exception of those from Graaff Reinet and Steytlerville, (at the Northern and Southern known limits of distribution for this entity). In these two, a half and a third, respectively, of the samples have a spiral angle of less than 20°.

Of the congesta populations sampled, four out of seven have a third or more individuals with a spiral angle of over 20°.

In the entity robusta, the majority of individuals in the populations have a spiral angle of less than 20°, with the exception of those from East of Nelspoort and near the Molteno Pass, both near the northernmost known limits of distribution for robusta. It is of interest to note the large number of individuals of robusta with a spiral angle of 0 - 10° in the samples from Steytlerville, and near Prince Albert and Miller, localities near the South Western limits of distribution of the entity foliolosa.

Angle of leaf with stem. (See Table 26)

In his type description of Aloe foliolosa, Haworth (1804) described the leaves as "horisontal". Salm Dyk (1836 - 1863) observed that the leaves of Aloe congesta were "very patent", while Hooker (1873) in his account of a new species, Aloe deltoidea, (which, as interpreted by Baker (1881) is synonymous with A. congesta), described the leaves as "quite horisontal".

In the introductory survey, it was shown that in the entity foliolosa taken as a whole, the leaves were either patent-erect or patent, while in the other entities, the majority of individuals had sub-erect leaves.

For the most part this is found to apply to samples of individual populations in the foliolosa complex. All individuals of population samples of the entity foliolosa have patent-erect or patent leaves.

In the congesta and robusta population samples, two thirds or more individuals have sub-erect leaves, with the exception in the case of the latter, of the Molteno Pass sample, where the majority of individuals have patent-erect leaves. Compared with the entity

Locality.	Class range of measurements				Total no. indiv.	Range actual measurements
	30°	50°	70°			
	Erect.	Sub Erect.	Patent Erect.	Patent		
CONGESTA.						
N. of Cradock R31	-	6	-	-	6	40 - 50
Cradock R32	1	8	5	-	14	30 - 70
Rayners Kop R33	1	7	2	-	10	30 - 60
S. of Adelaide R38,39	1	11	4	-	16	30 - 60
Dikkop Vlakte R40	-	4	-	-	4	35 - 40
Helspoort R41	-	8	3	-	11	35 - 55
Krantz Drift (Commins 2063)	-	-	3	-	3	60
FOLIOLOSA.						
Graaff Reinet R29	-	-	10	6	16	65 - 85
nr. Pearston R34	-	-	2	-	2	60 - 70
Lake Mentz R36,37	-	-	9	7	16	60 - 80
Waterford R10	-	-	2	2	4	60 - 85
Wolwefontein R11	-	-	2	8	10	60 - 85
Baroe R12	-	-	1	-	1	65
Mt. Stewart R13	-	-	5	3	8	65 - 80
Steytlerville R14	-	-	9	6	15	55 - 80
ROBUSTA.						
Steytlerville R15	1	17	-	-	18	30 - 50
nr. Miller R8,9	-	14	1	-	15	35 - 55
Klaarstroom R27	-	1	-	-	1	40
Prince Albert R64	-	8	1	-	9	40 - 55
E. of Laingsburg R1	-	1	-	-	1	50
E. of Nelspoort R28	-	12	1	-	13	35 - 55
nr. Molteno Pass (Hall 2284)	-	-	7	1	8	60 - 75

Class interval 20°

Table 26. VARIATION IN ANGLE OF LEAF WITH STEM IN FIELD SPECIMENS OF FOLIOLOSA COMPLEX.

Locality.	Class range of measurement.				Total no. indiv.
	Curving upwards.	Following angle of leaf with stem.	Curving outwards.	Curving outwards & downwards.	
CONGESTA.					
N. of Cradock R31	-	4	2	-	6
Cradock R32	1	10	3	-	14
Rayners Kop R33	2	7	1	-	10
S. of Adelaide R38,39	1	7	8	-	16
Kikkop Vlakte R40	-	2	2	-	4
Helspoort R41	1	9	1	-	11
Krantz Drift (Commins 2063)	-	1	2	-	3
FOLIOLOSA.					
Graaff Reinet R29	-	4	12	-	16
Nr. Pearston R34	-	-	2	-	2
Lake Mentz R36,37	-	2	10	4	16
Waterford R10	-	1	3	-	4
Wolwefontein R11	-	2	8	-	10
Baroe R12	-	1	-	-	1
Mt. Stewart R13	-	-	8	-	8
Steytlerville R14	-	-	11	4	15
ROBUSTA.					
Steytlerville R15	-	7	11	-	18
nr. Miller R8,9	-	3	12	-	15
Klaarstroom R27	-	-	1	-	1
Prince Albert R64	-	1	8	-	9
E. of Laingsburg R1	-	1	-	-	1
E. of Nelspoort R28	-	3	10	-	13
nr. Molteno Pass (Hall 2284)	-	-	7	1	8

Table 27. VARIATION IN CURVATURE OF LEAF APEX IN FIELD SPECIMENS OF FOLIOLOSA COMPLEX.

congesta, however, the percentage of individuals in the patent-erect class for each sample of the entity robusta is considerably less.

Curvature of leaf apices. (See Table 27)

This was not dealt with by the early authors, but illustrations of Aloe foliolosa (Ker, 1811 and Salm Dyk, 1836-1863) show a tendency for the leaf apex to curve outwards. In Salm Dyk's illustration of Aloe congesta, the leaf apices follow the angle of the leaf with the stem, while in the illustration accompanying Hooker's account of Aloe deltoidea (1873), the leaf apices tend to curve outward.

In the introductory survey, it was shown that in the foliolosa complex, in the entities foliolosa and robusta, the leaf apex curved outward in the majority of individuals, while in congesta, it followed the angle of the leaf with the stem.

This pattern is found in all populations of foliolosa and robusta, with one exception, the Steytlerville robusta sample, where in approximately half of the individuals, the leaf apex followed the angle of the leaf with the stem. In four out of seven of the congesta population samples, a third to a half of the individuals have the leaf apices curving outwards.

It is a combination of the spiral angle, the angle of the leaf with the stem and the curvature of the leaf apices, which contributes to the appearance of the leafy shoot, and on a summation of these characters, there is a slight tendency for the entity foliolosa to be distinct from the entities congesta and robusta on the character of leaves which are more frequently patent and imbricate.

DIMENSIONS AND SHAPE OF LEAVES (See Figs. 23, 25, 25A and B)

Leaf length. (See Table 28)

The introductory survey showed that the longest leaves in the complex were found in the entity congesta, and the shortest leaves in the entity foliolosa, while the entity robusta had the majority of leaves intermediate in length.

In population samples of the entity congesta, the shortest leaves are found in plants from North of Cradock and Krantz Drift,

Locality	Class range of measurements.								Total no. indiv.	Range actual measurements.
	1.5	2	2.5	3	3.5	4	4.5			cm.
CONGESTA.										
N. of Cradock R31	-	-	-	5	2	-	-	-	7	2.6 - 3.5
Cradock R32	-	-	1	4	6	4	-	-	15	2.5 - 4.0
Rayners Kop R33	-	-	-	1	4	3	1	1	10	2.9 - 4.6
S. of Adelaide R38,39	-	-	-	7	4	2	2	-	15	2.7 - 4.4
Dikkop Vlakte R41	-	-	-	-	-	1	2	2	5	3.9 - 4.7
Helspoort R40	-	-	-	-	5	4	1	-	10	3.3 - 4.4
Krantz Drift (Commins 2063)	-	1	-	1	-	-	-	-	2	2.0 - 2.8
FOLIOLOSA.										
Graaff Reinet R29	-	6	12	1	-	-	-	-	19	1.9 - 3.0
nr. Pearston R34	-	2	-	-	-	-	-	-	2	1.7 - 2.0
Lake Mentz R36,37	6	4	4	-	-	-	-	-	14	1.4 - 2.4
Waterford R10	2	4	-	-	-	-	-	-	6	1.4 - 1.9
Wolwefontein R11	-	8	3	-	-	-	-	-	11	1.7 - 2.2
Baroe R12	-	-	1	-	-	-	-	-	1	2.2
Mt. Stewart R13	-	4	4	-	-	-	-	-	8	1.7 - 2.5
Steytlerville R14	-	21	12	-	-	-	-	-	33	1.6 - 2.5
ROBUSTA.										
Steytlerville R15	-	-	7	12	1	-	-	-	20	2.1 - 3.5
nr. Miller R8,9	-	-	-	7	6	5	-	-	18	2.6 - 3.9
Klaarstroom R27	-	-	-	-	-	2	-	-	2	4.0
Prince Albert R64	-	-	-	4	5	1	-	-	10	2.6 - 3.7
SE of Laingsburg R65	-	-	4	2	-	-	-	-	6	2.4 - 3.0
E. of Laingsburg R1	-	-	-	1	-	-	-	-	1	2.7
NW Matjesfontein R56	-	-	2	1	-	-	-	-	3	2.4 - 2.8
Nelspoort R28	-	-	-	2	7	5	-	-	14	2.6 - 3.9
Ft. Molteno Pass	-	1	5	-	-	-	-	-	6	1.8 - 2.3

Class interval 0.50 c.m.

Table 28. VARIATION IN LENGTH OF LEAF IN FIELD SPECIMENS OF FOLIOLOSA COMPLEX.

while in the other populations, half or more than half of the individuals have leaves exceeding 3.0 cm. in length.

For individuals of the entity robusta there is some variation in leaf length, the shortest leaves being found in plants from the foot of Molteno Pass, (majority range 2.0 - 2.5 cm), and the longest leaves in plants from Nelspoort, (majority range 3.0 - 4.0 cm), both localities near the known northern limits of distribution for this entity.

In the entity foliolosa, the longest leaves are found in plants from Graaff Reinet near the northern known limits of distribution, while the other population samples have half, or in most cases, nearly all individuals with leaves less than 2.0 cm long. The shortest leaves are found in individuals from the Waterford - Lake Mentz area, where there is an overlap in geographic distribution with the entity robusta.

The difference in leaf length between the entities congesta and foliolosa is thus considerable and may be judged a character of some significance in the separation of the two. That the entity robusta should have leaves of an intermediate length is of interest in view of the distribution pattern of the three members of this complex.

Leaf width at widest part and length-breadth ratio. (See Tables 29 and 30)

In his type description of Aloe foliolosa, Haworth (1804) described the leaves as "very short, rounded and ovate", and Salm Dyk (1836 - 1863) in his account of Aloe congesta considered his new species to be quite distinct from A. foliolosa on the grounds of, amongst other things, "less orbiculate leaves". Baker (1896) in his key to the genus Apicra, separated A. foliolosa and A. congesta on the character of "leaves deltoid" for A. foliolosa and "leaves lanceolate-deltoid" for A. congesta.

The introductory survey showed that for the entity foliolosa, the majority range for the length-breadth ratio was 1.25 - 1.50, while for the entities congesta and robusta it was 1.50 - 2.00. In individual population samples of the entity congesta, the majority of specimens do have a length-breadth ratio 1.50 - 2.00, and this is also the case for robusta population

Locality	Class range of measurements								Total no. indiv.	Range actual measurements.
	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75		cm.
CONGESTA.										
N. of Cradock R31	-	-	-	6	-	1	-	-	7	1.55 - 2.10
Cradock R32	-	-	2	8	2	3	-	-	15	1.40 - 2.10
Rayners Kop R33	-	-	-	-	4	5	1	-	10	1.85 - 2.35
S. of Adelaide R38,39	-	-	-	3	7	3	1	1	15	1.70 - 2.75
Dikkop Vlakte R40	-	-	-	-	-	1	2	1	5	2.18 - 2.80
Helspoort R41	-	-	-	3	3	2	2	-	10	1.65 - 2.43
Krantz Drift (Commins 2063)	-	-	1	-	1	-	-	-	2	1.38 - 1.91
FOLIOLOSA.										
Graaff Reinet R29	-	-	9	7	3	-	-	-	19	1.30 - 1.88
nr. Pearston R34	-	-	2	-	-	-	-	-	2	1.28 - 1.40
Lake Mentz R36,37	2	4	5	1	-	2	-	-	14	0.92 - 2.07
Waterford R10	1	-	4	1	-	-	-	-	6	1.00 - 1.56
Wolvefontein R11	-	2	7	2	-	-	-	-	11	1.20 - 1.57
Baroe R12	-	-	-	1	-	-	-	-	1	1.60
Mt. Stewart R13	-	2	5	1	-	-	-	-	8	1.10 - 1.60
Steytlerville R14	-	17	12	3	1	-	-	-	33	1.13 - 1.80
ROBUSTA.										
Steytlerville R15	-	-	7	8	5	-	-	-	20	1.27 - 2.00
nr. Miller R8,9	-	-	2	2	9	4	1	-	18	1.50 - 2.40
Klaarstroom R27	-	-	-	-	1	1	-	-	2	1.80 - 2.10
Prince Albert R64	-	-	2	2	5	-	1	-	10	1.40 - 2.40
SE of Laingsburg R65	-	-	-	1	5	-	-	-	6	1.70 - 1.90
E. of Laingsburg R1	-	-	1	-	-	-	-	-	1	1.40
NW Matjesfontein R56	-	-	2	1	-	-	-	-	3	1.40 - 1.55
Nelsport R28	-	-	-	5	7	2	-	-	14	1.55 - 2.05
Ft. Molteno Pass (Hall 2284)	-	1	5	-	-	-	-	-	6	1.00 - 1.50

Class interval 0.25 cm.

Table 29. VARIATION IN GREATEST WIDTH OF LEAF IN FIELD SPECIMENS OF FOLIOLOSA COMPLEX

samples, with the exception of that from S.E. of Laingsburg, where two thirds of the samples have a lower length-breadth ratio.

Of the foliolosa populations, about half of the samples from the Waterford-Lake Mentz area (which was also associated with the shortest leaves in the entity), have a length-breadth ratio of 1.00 - 1.25. For the great majority of individuals of other populations, the length-breadth ratio is 1.25 - 1.50, with the exception of samples from Mt. Stewart and Steytlerville where 50% and 42% respectively, of individuals have a length-breadth ratio of more than 1.50.

A scatter diagram (Fig. 26) of leaf length plotted against leaf width at the widest part for all three entities shows the tendency towards leaves with a lower length-breadth ratio in the entity foliolosa, but this difference between foliolosa and the entities congesta and robusta is by no means clear cut.

Position of widest part of leaf in relation to longitudinal halfway mark. (See Table 31).

In the introductory survey, it was shown that for the entity foliolosa, the majority of individuals had the widest part of the leaf 0 - 0.25 cm below the longitudinal halfway mark, while for robusta and congesta it was 0.25 - 0.50 cm below in most cases.

The above holds true for all save three plants in individual population samples of foliolosa.

In some of the congesta samples however, notably those from Krantz Drift, south of Adelaide and Cradock the widest part of the leaf is nearer the longitudinal halfway mark in a fair number of plants. This is also the case in several robusta population samples.

Mucro length. (See Table 32)

The introductory survey showed the majority range for mucro length to be 0.50 - 0.10 cm for all three entities of the foliolosa complex. There is little difference in the variation patterns for the different population samples, save that in the robusta samples from Prince Albert and S.E. of Laingsburg, the majority of individuals have a mucro length of less than 0.05 cm.

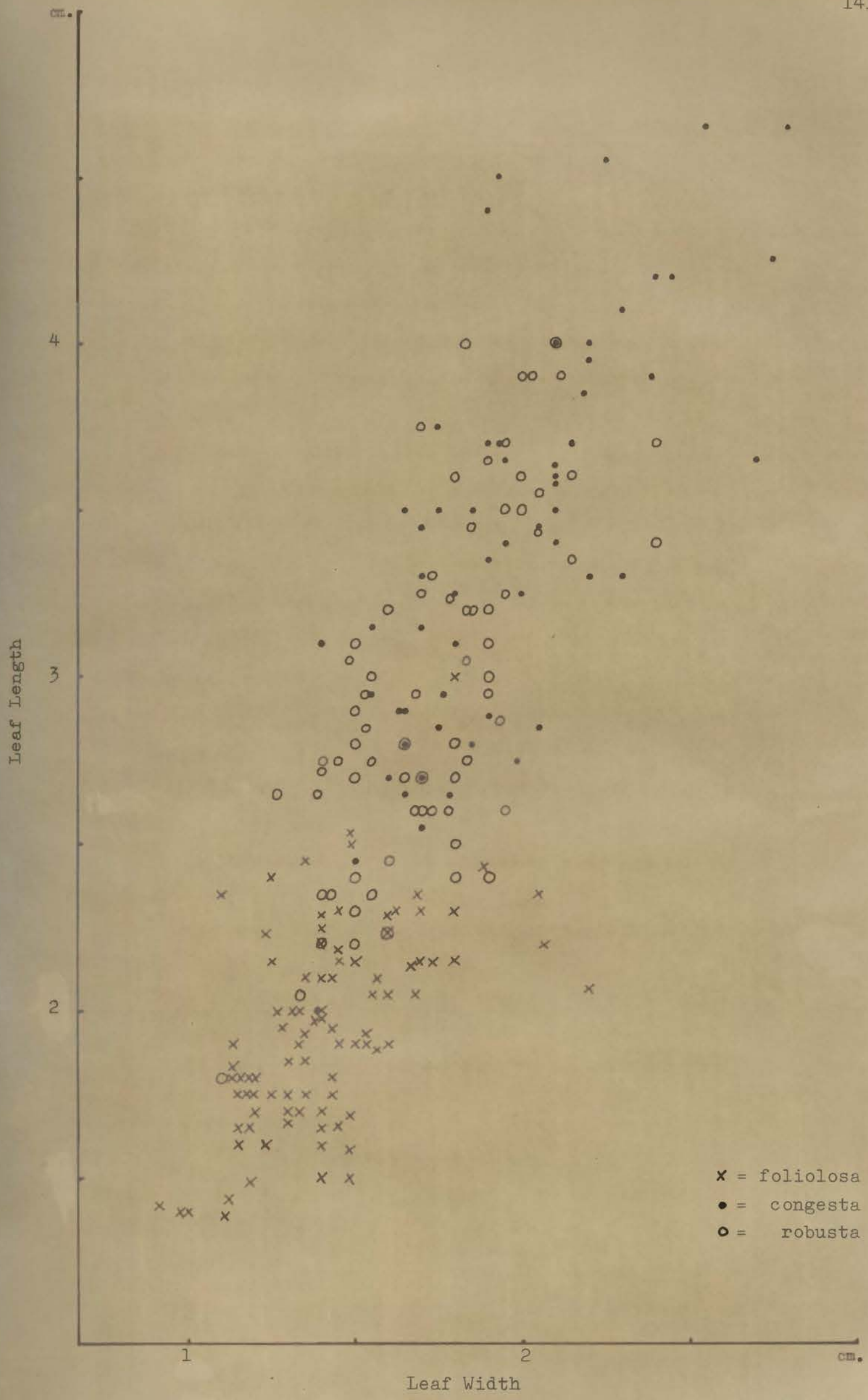


Fig.26. Variation in length and greatest width of leaf, (excluding the sheathing base) in the foliolosa complex.

Locality.	Class range of measurements.					Total no. indiv.	Range actual measurements.	
	Above 0		Below midlength 0	.25	.50			cm.
CONGESTA.								
N. of Cradock R31	-	-	1	6	-	7	.2	- .5 bel
Cradock R32	-	-	8	7	-	7	.1	- .5 bel
Rayners Kop R33	-	-	2	7	1	10	.1	- .7 bel
S. of Adelaide R38,39	-	-	11	4	-	15	.1	- .3 bel
Dikkop Vlakte R40	-	-	-	3	2	5	.3	- .7 bel
Helspoort R41	-	-	-	8	2	10	.3	- .6 bel
Krantz Drift (Commins 2063)	1	-	1	-	-	2	.1	ab- .2 bel
FOLIOLOSA.								
Graaff Reinet R29	-	-	18	1	-	19	.1	- .4 bel
nr. Pearston R34	-	-	2	-	-	2	.1	- .2 bel
Lake Mentz R36,37	1	7	6	-	-	14	.1	ab- .2 bel
Waterford R10	-	-	6	-	-	6	.1	- .2 Bel
Wolwefontein R11	-	4	7	-	-	11	0	- .2 bel
Baroe R12	-	1	-	-	-	1	0	
Mt. Stewart R13	-	1	7	-	-	8	0	- .2 bel
Steytlerville R14	1	8	22	2	-	33	.1	ab- .3 bel
ROBUSTA.								
Steytlerville R15	-	-	8	12	-	20	.1	- .5 bel
nr. Miller R8,9	-	-	7	11	-	18	.1	- .5 bel
Klaarstroom R27	-	-	-	2	-	2		- .4 bel
Prince Albert R64	1	-	3	6	-	10	.2	ab- .5 bel
S.E. of Laingsburg R65	1	1	2	2	-	6	.1	ab- .4 bel
E. of Laingsburg R1	-	-	-	1	-	1		- .3 bel
NW. Matjesfontein R56	1	-	1	1	-	3	.1	ab- .3 bel
Nelspoort R28	-	-	1	11	2	14	.2	- .7 bel
Ft. of Molteno Pass	-	2	4	-	-	6	0	- .2 bel

Class interval 0.25 cm.

Table 30. VARIATION IN POSITION OF WIDEST PART OF LEAF IN RELATION TO MIDLENGTH OF LEAF IN FIELD SPECIMENS OF FOLIOLOSA COMPLEX.

*(ab = above the midlength, bel = below the midlength).

Locality.	Class range of measurements. 1.25	1.50	1.75	2.00	2.25		Total no. indiv.	Range actual measurements.
CONGESTA.								
N. of Cradock R31	-	1	3	2	1	-	7	1.50 - 2.03
Cradock R32	-	-	7	5	3	-	15	1.51 - 2.21
Rayners Kop R33	-	1	4	4	-	1	10	1.39 - 2.33
S. of Adelaide R38,39	-	4	9	2	-	-	15	1.35 - 1.81
Dikkop Vlakte R40	-	-	2	3	-	-	5	1.66 - 1.82
Helspoort R41	-	2	1	4	2	1	10	1.40 - 2.32
Krantz Drift (Commins 2063)	-	2	-	-	-	-	2	1.46
FOLIOLOSA.								
Graaff Reinet R29	-	14	5	-	-	-	19	1.25 - 1.67
nr. Pearston R34	1	-	1	-	-	-	2	1.18 - 1.53
Lake Mentz R36,37	7	6	1	-	-	-	14	1.06 - 1.55
Waterford R10	4	2	-	-	-	-	6	1.02 - 1.40
Wolwefontein R11	1	9	1	-	-	-	11	1.12 - 1.56
Baroe R12	-	1	-	-	-	-	1	1.39
Mt. Stewart R13	1	3	2	1	1	-	8	1.19 - 2.12
Steytlerville R14	3	16	12	2	-	-	33	1.18 - 1.92
ROBUSTA.								
Steytlerville R15	-	4	10	5	1	-	20	1.33 - 2.09
nr. Miller R8,9	1	2	8	6	1	-	18	1.27 - 2.07
Klaarstroom R27	-	-	-	1	1	-	2	1.91 - 2.22
Prince Albert R64	-	-	3	6	1	-	10	1.54 - 2.06
SE of Laingsburg R65	-	4	2	-	-	-	6	1.26 - 1.59
E. of Laingsburg R1	-	-	-	1	-	-	1	1.92
NW Matjesfontein R56	-	-	2	1	-	-	3	1.60 - 1.77
E. of Nelspoort R28	-	-	5	8	1	-	14	1.51 - 2.21
Ft. Molteno Pass (Hall 2284)	-	1	5	-	-	-	6	1.47 - 1.57

Class interval 0.25

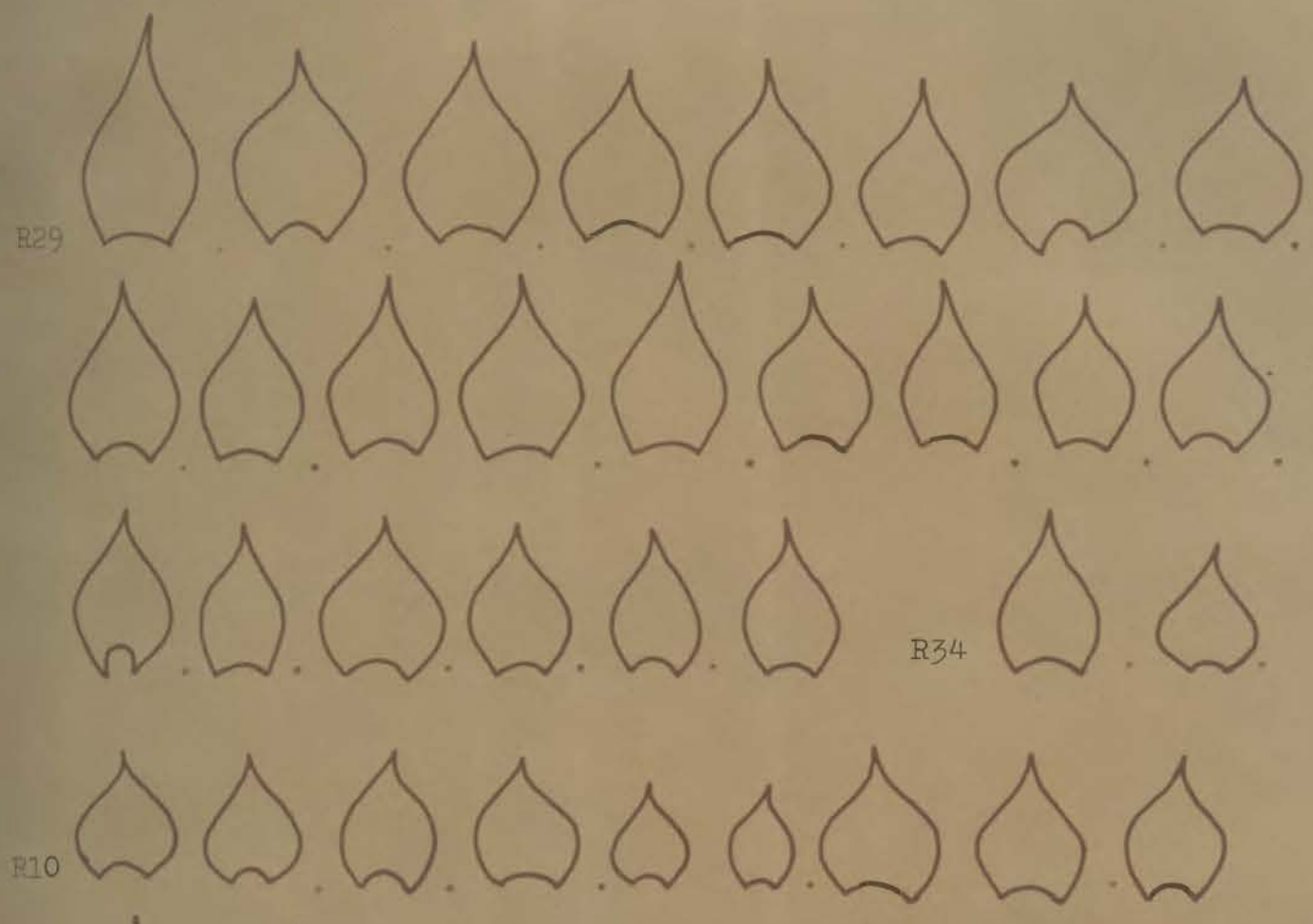
Table 31. VARIATION IN LENGTH-BREADTH RATIO IN FIELD SPECIMENS OF FOLIOLOSA COMPLEX.

Locality.	Class range of measurements.				Total no. indiv.	Range actual measurements
	.05	.10	.15			cm
CONGESTA.						
N. of Cradock R31	-	3	4	-	7	.08 - .13
Cradock R32	1	13	1	-	15	.05 - .13
Rayners Kop R33	1	8	1	-	10	.05 - .11
S. of Adelaide R38,39	1	14	-	-	15	.05 - .10
Dikkop Vlakte R40	1	1	2	-	4	.05 - .13
Helspoort R41	-	10	-	-	10	.05 - .10
Krantz Drift (Commins 2063)	1	1	-	-	2	.05 - .06
FOLIOLOSA.						
Graaff Reinet R29	-	13	6	-	19	.06 - .15
nr. Pearston R34	-	2	-	-	2	.07 - .10
Lake Mentz R36,37	2	9	3	-	14	.05 - .14
Waterford R10	2	3	1	-	6	.05 - .11
Wolwefontein R11	-	8	3	-	11	.06 - .12
Baroe R12	-	1	-	-	1	.09
Mt. Stewart R13	-	5	3	-	8	.07 - .13
Steytlerville R14	5	20	8	-	33	.04 - .12
ROBUSTA.						
Steytlerville R15	1	9	9	1	20	.05 - .18
nr. Miller R8	2	11	5	-	18	.04 - .15
Klaarstroom R27	-	2	-	-	2	.10
Prince Albert R64	8	2	-	-	10	.03 - .06
S.E. of Laingsburg R65	5	1	-	-	6	.03 - .06
E. of Laingsburg R1	1	-	-	-	1	.05
NW Matjesfontein R56	3	-	-	-	3	.05
E. of Nelspoort R28	-	5	7	2	14	.09 - .20
Ft. of Molteno Pass (Hall 2284)	1	5	-	-	6	.04 - .10

Class interval 0.05 c.m.

Table 32. VARIATION IN MUCRO LENGTH IN FIELD SPECIMENS OF FOLIOLOSA COMPLEX.

Fig.23. Variation in leaf shape in population samples of the entity foliolosa. (Only the fleshy part of the leaf base is shown. The dots indicate the number of leaves shown for each plant.)



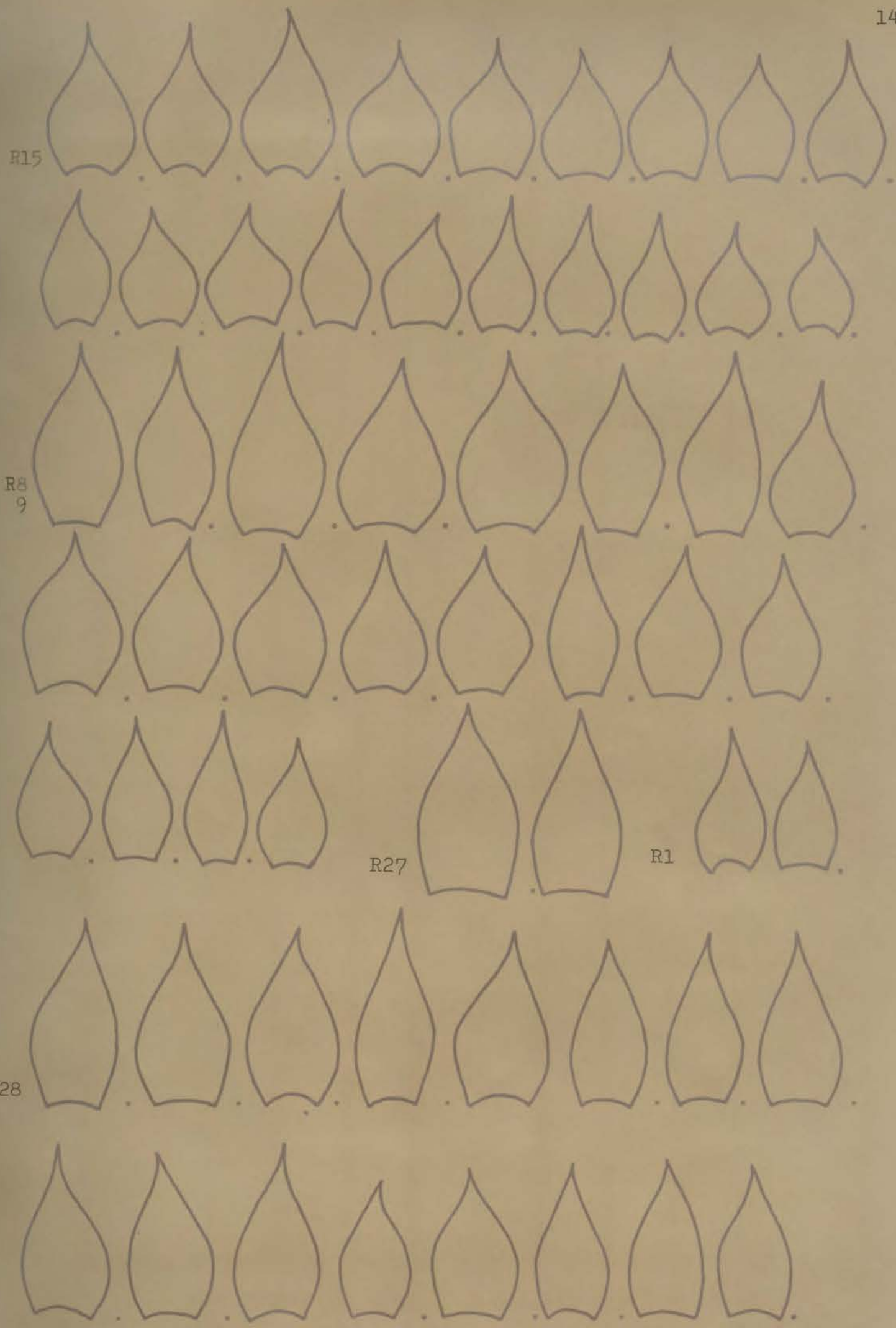


Fig.24. Variation in leaf shape in population samples of the entity robusta. (Only the fleshy part of the leaf base is shown. The dots indicate the number of leaves shown for each plant.)

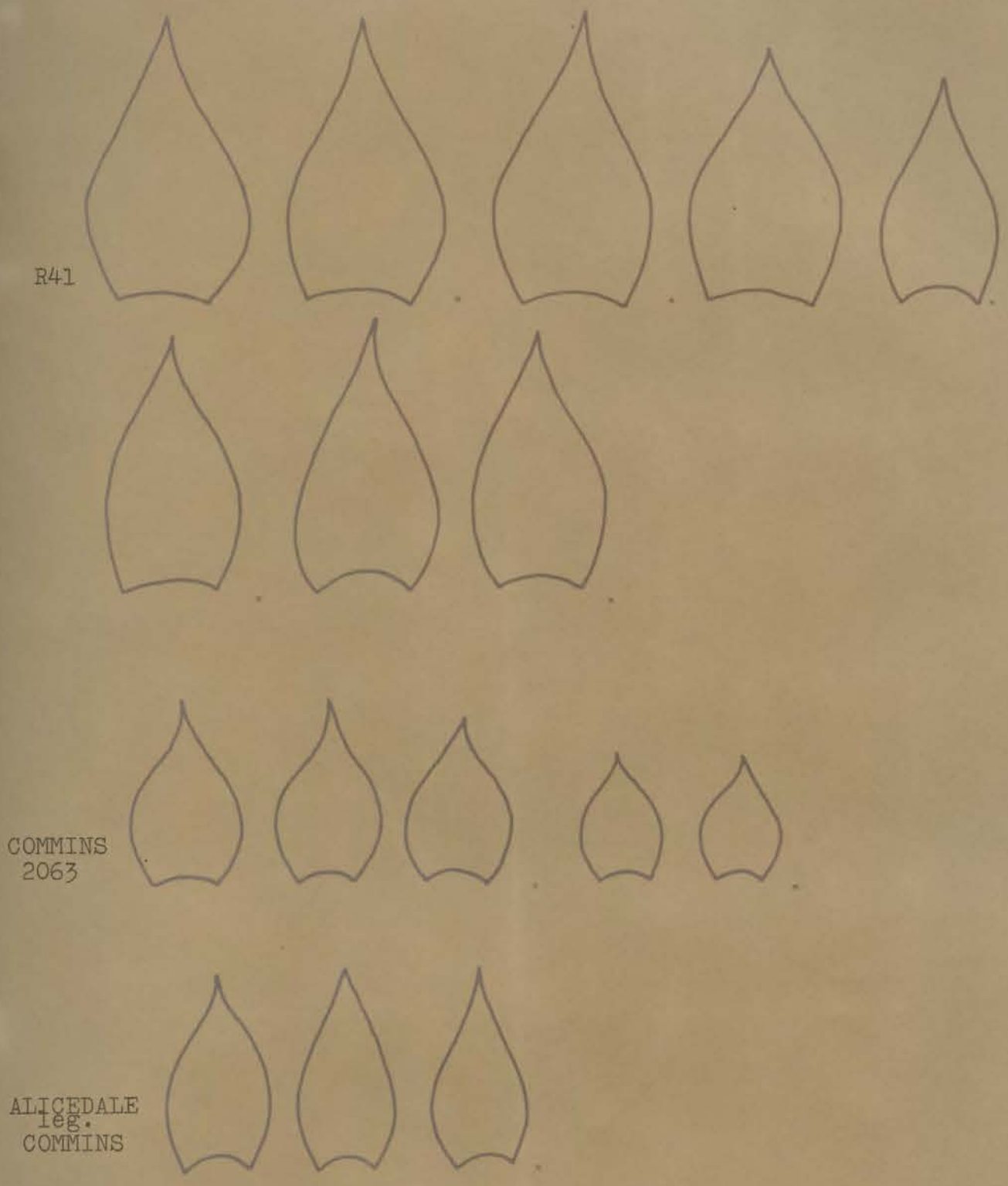


Fig.25A. Variation in leaf shape in population samples of the entity congesta. (Only the fleshy part of the leaf base is shown. The dots indicate the number of leaves shown for each plant.)

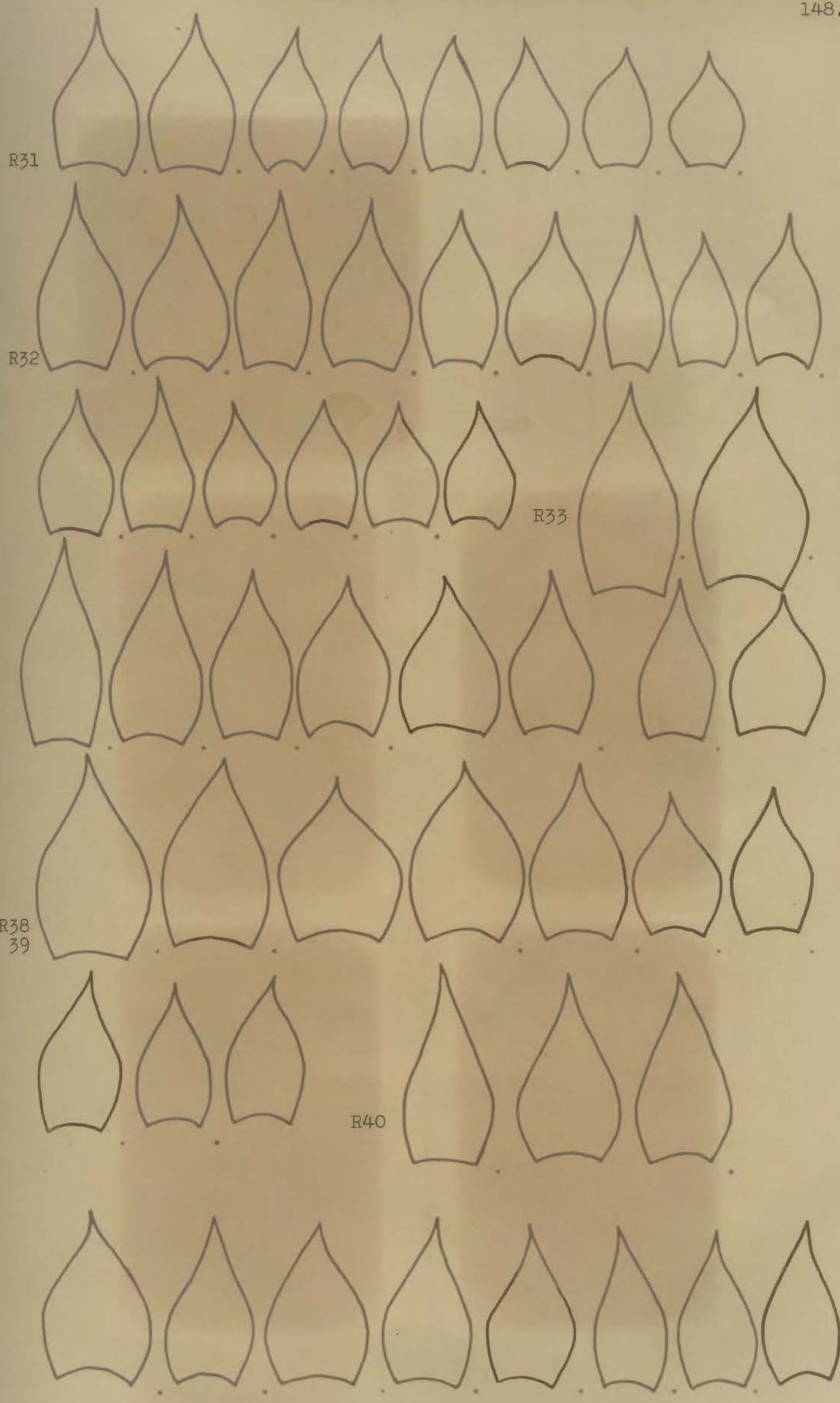


Fig. 25B. Variation in leaf shape in population samples of the entity congesta cont.

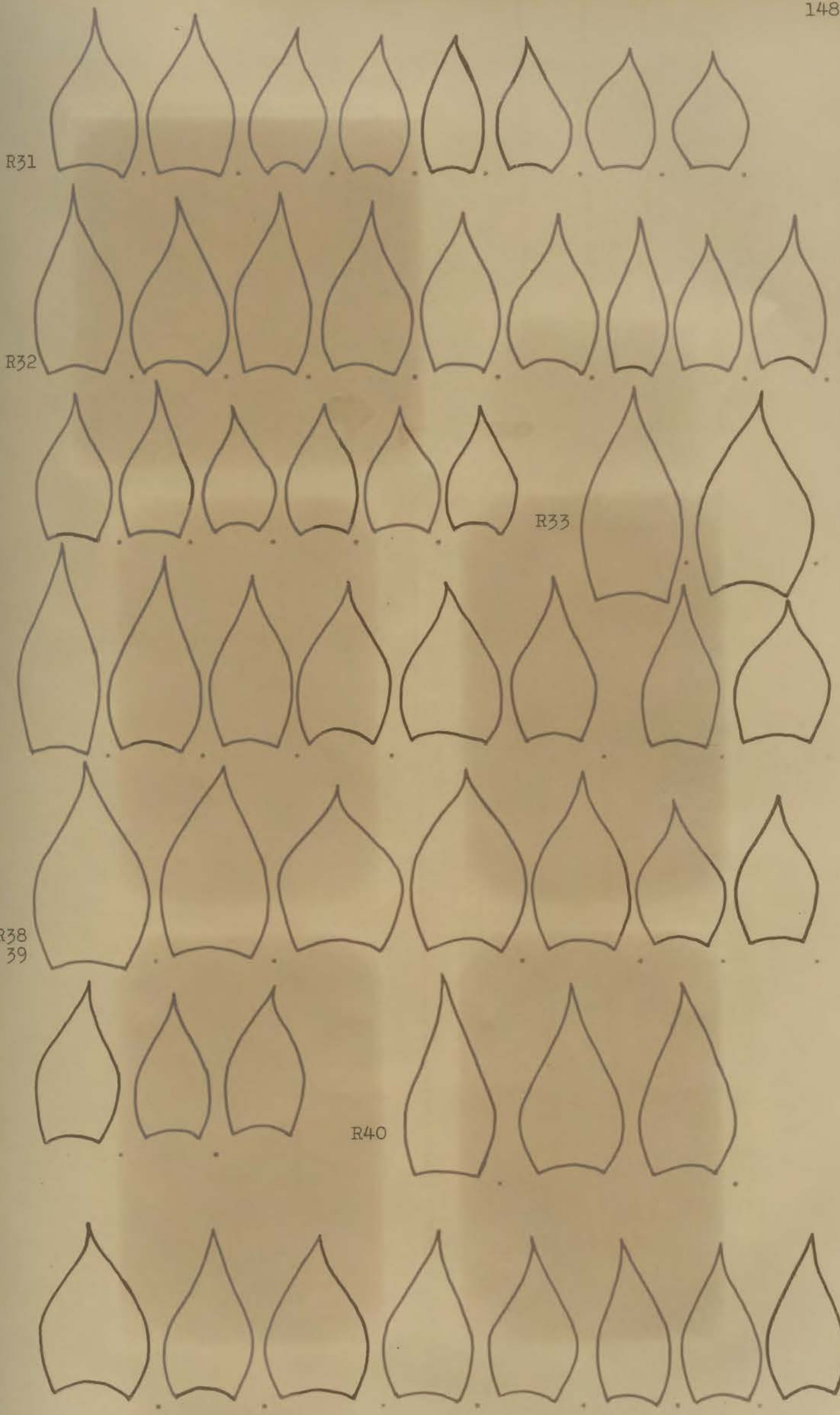


Fig. 25B. Variation in leaf shape in population samples of the entity congesta cont.

THE ENTITY ROBUSTA

Habit of a plant from Klaarstroom, R27(X $\frac{1}{3}$): thick bases of old peduncles visible.

A X $\frac{3}{4}$

B X 1

C X 1

D X $\frac{3}{4}$

Leafy shoots: leaves with maculae in A; vein lines in A, B and C; stout peduncle base in D, and whitish margins and keels in all four shoots. (Scales approximate).

PLATE 15.

THE ENTITY FOLIOLOSA

Habit of a plant from Mount Stewart R13, with very patent, imbricate leaves. (X ½).

C(X 1¼)

A(X 1¼)

D(X 1)

B(X 1)

Variation in appearance of leafy shoots: whitish margins and keels in A, prominent marginal tubercles in B, C and D.
(Scales approximate).

PLATE 16.

THE ENTITY CONGESTA.

Habit of a plant from S. of Adelaide, R38 (X ½): old peduncles are narrower at the base than those seen in the photographs of the entity robusta.

Leafy shoots (X1). Note concolorous margins and keels in both, and elongate, very slightly raised shiny patches in specimen on the left. (Scale approximate).

PLATE 17.

Summary

The entity foliolosa tends to differ from the entities congesta and robusta in that the spiral angle is more frequently greater than 30°, the leaves are always patent erect, the leaf length very rarely exceeds 2.0 cm and the length-breadth ratio is generally 1.50 cm or less. It has in common with the entity robusta a tendency for the leaf apex to curve outwards more frequently than observed in the entity congesta.

The entity robusta has greater number of individuals with leaves less than 2.5 cm long than has the entity congesta, where only 2 individuals examined had a leaf length of 2.5 cm or less.

Thus, although the differences in vegetative character between the entities foliolosa and congesta are considerable, the entity robusta, by being of an intermediate character, precludes their recognition as distinct species on the grounds of vegetative characters.

The species A. congesta and its synonyms were originally distinguished from the species A. foliolosa on vegetative characters of the short just described at some length.

LEAF ANATOMY (See Appendix Tables 5 and 6)

Unfortunately the anatomy of the leaves was investigated a considerable time after the plants were collected. As a result the number of leaves examined was small, especially in the case of the entity foliolosa, which like robusta, did not grow well under cultivation at Kirstenbosch.

In the accompanying tables, except for the entity foliolosa, the observations for each plant are, however, still listed according to locality.

Number of bundle caps per cm. from dorsal and ventral sides of leaf. (See Table 33)

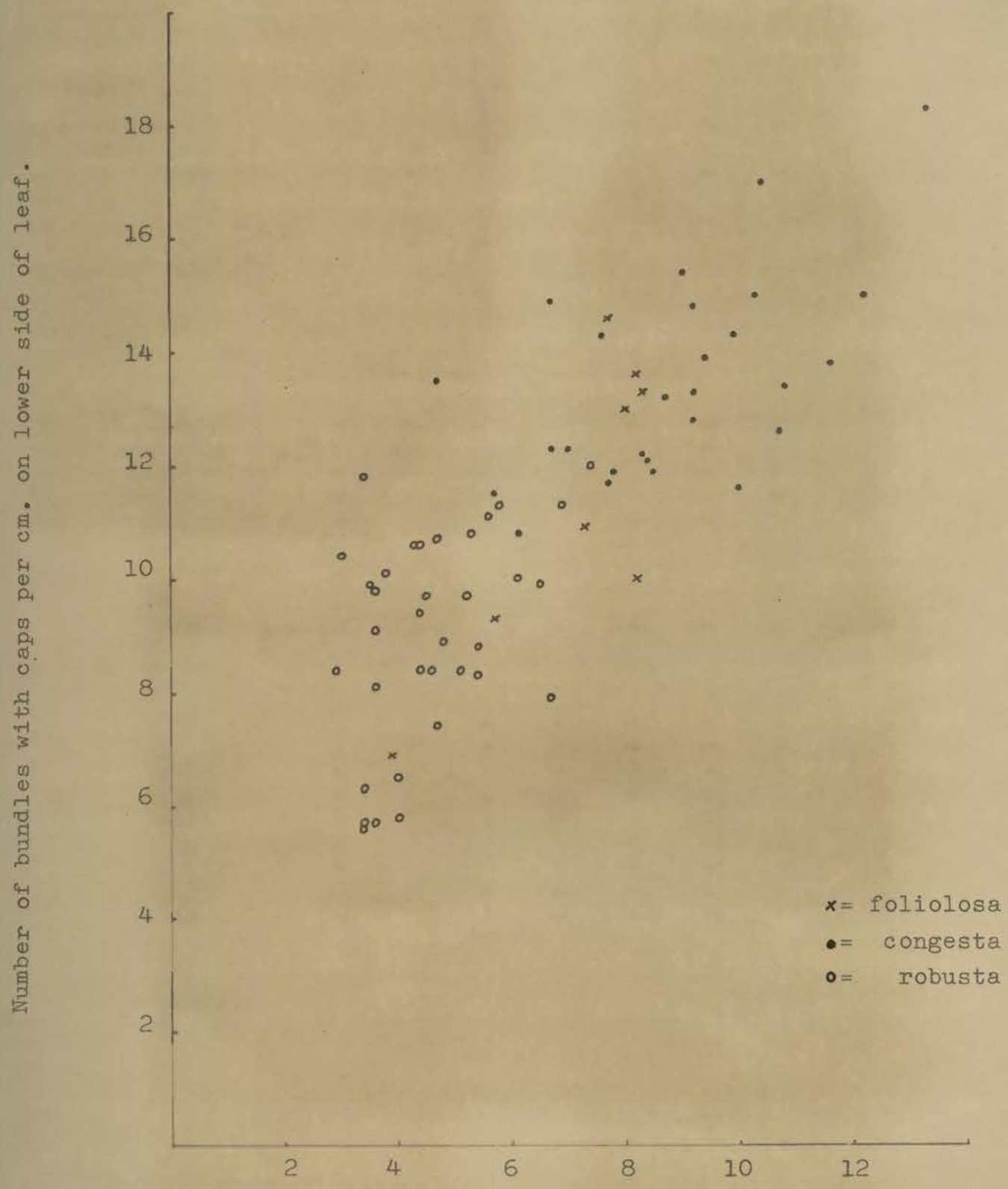
Although the samples are small, it can be seen that for the entity robusta as a whole, the number of bundles with caps per cm. on both upper and lower sides is generally less than for the entity congesta, with an intermediate number of bundle caps in the few

Locality	Class range of numbers							Total no. indiv.	Range actual values.
	FROM LOWER SIDE OF LEAF								
	3	6	9	12	15	18			Bundle caps per cm.
CONGESTA.									
Cradock R32	-	-	-	2	8	3	1	14	10.8 - 18.3
S. of Adelaide R38,39	-	-	-	4	3	-	-	7	11.5 - 14.3
Dikkop Vlakte R40	-	-	-	-	2	-	-	2	13.8 - 15.0
Helspoort R41	-	-	-	-	2	-	-	2	12.3 - 12.8
Nr. Alicedale Com.	-	-	-	-	2	-	-	2	13.4 - 12.6
FOLIOLOSA.									
Miscell. Localities	-	-	2	3	4	-	-	9	6.9 - 14.6
ROBUSTA.									
Steytlerville R15	-	-	-	5	-	-	-	5	9.9 - 11.8
nr. Miller R8	-	-	3	-	-	-	-	3	8.1 - 8.9
Klaarstroom R27	-	-	1	1	-	-	-	2	8.4 - 9.9
Prince Albert R64	-	-	4	4	-	-	-	8	7.4 - 10.7
nr. Whitehill 0	-	-	2	1	-	-	-	3	6.3 - 9.1
S.E. of Lainsburg R65	-	4	1	-	-	-	-	5	5.6 - 6.5
E. of Laingsburg R1	-	-	-	1	-	-	-	1	10.1
Nelspoort R28	-	-	1	1	-	-	-	2	9.4 - 8.3
Molteno Pass Hall 2284	-	-	-	6	-	-	-	6	10.0 - 12.0
	FROM UPPER SIDE OF LEAF								
CONGESTA.									
Cradock R32	-	-	9	4	1	-	-	14	6.1 - 13.3
S. of Adelaide R38,39	-	2	2	3	-	-	-	7	4.7 - 10
Dikkop Vlakte R40	-	-	-	1	1	-	-	2	11.6 - 12.2
Helspoort R41	-	-	1	1	-	-	-	2	7.0 - 9.2
Nr. Alicedale Com.	-	-	-	2	-	-	-	2	10.7 - 10.8
FOLIOLOSA.									
Miscell. Localities	-	2	6	-	-	-	-	8	3.9 - 8.3
ROBUSTA.									
Steytlerville R15	1	4	-	-	-	-	-	5	3.0 - 5.3
nr. Miller R8	1	2	-	-	-	-	-	3	2.9 - 4.8
Klaarstroom R27	-	1	1	-	-	-	-	2	5.1 - 6.5
Prince Albert R64	-	8	-	-	-	-	-	8	3.6 - 5.4
nr. Whitehill 0	-	2	1	-	-	-	-	3	3.4 - 6.7
S.e.of Laingsburg R65	-	5	-	-	-	-	-	5	3.4 - 4.0
E.of Laingsburg R1	-	1	-	-	-	-	-	1	3.8
Nelspoort R28	-	2	-	-	-	-	-	2	4.4 - 5.4
Molteno Pass Hall 2284	-	3	3	-	-	-	-	6	4.4 - 7.4

Class interval 3 bundles.

Table 33. VARIATION IN NUMBER OF BUNDLE CAPS PER CM. AS SEEN IN TRANSVERSE SECTION FROM LOWER & UPPER SIDE OF LEAF IN THE FOLIOLOSA COMPLEX.

Fig.27. Variation in number of vascular bundles with caps per cm. on upper and lower sides of leaves, (as seen in transverse section half way along the length), in the foliolosa complex.



foliolosa specimens examined. This is shown in a scatter diagram, (Fig. 27), in which the number of bundles with caps per centimetre on the lower side of the leaf is plotted against the corresponding number for the upper side.

Although the number of bundle caps from the upper and lower sides of the leaves cannot be used as a taxonomic criterion, the fact that there does tend to be a difference in bundle cap number in the entities congesta and robusta, helps to justify their recognition as distinct entities. This was not apparent in the survey of external vegetative characters.

Percentage lignification of bundle caps (See Table 34).

In the introductory survey, it was shown that in leaves sectioned a determined distance from the apex, (which depended upon leaf length), 50% of the foliolosa sample had all the bundle cap cells unlignified, and 50% had partial lignification of these cells. Of the congesta sample, 30% had all bundle cap cells unlignified, and 70% had partial lignification, while in the robusta sample all individuals had partial, but not complete lignification of the bundle cap cells.

In a second survey, the percentage lignification of all bundle caps from the ventral side of the leaf, half way along it, was estimated. This was done by estimating the percentage lignification for each bundle cap, totalling this value for all bundle caps and dividing by the actual number of bundle caps. Reference to the Appendix, Table 6, shows the differences in this value for more than one leaf from a plant to be small, with a few exceptions. The percentage lignification of each bundle cap was obtained by counting the number of cells constituting the bundle cap and expressing the number of bundle cap cells which were lignified as a percentage of this.

No attempt was made to determine the effect of water supply on lignification of bundle caps, but included in this survey were two rooted specimens of the entity foliolosa which had received very little water for over six months, and the percentage lignification of their bundle caps was 13 and 25% respectively.

Locality	Class range of measurements					Actual no. indiv.	Range actual measurements
	20	40	60	80			%
CONGESTA.							
Cradock R32	1	2	1	3	5	12	6 - 97
S. of Adelaide R38,39	2	1	2	2	-	7	1 - 77
Dikkop Vlakte R40	1	1	-	-	1	3	0 - 94
Helspoort R41	-	-	-	2	2	4	77 - 88
Nr. Alicedale (Commins 2063)	1	-	1	-	1	3	14 - 90
FOLIOLOSA.							
Miscell. Localities	5	2	1	2	-	10	0 - 75
ROBUSTA.							
Steytlerville R15	2	-	1	2	2	7	4 - 94
Miller R8	-	-	-	-	5	5	82 - 100
Klaarstroom R27	-	-	-	1	1	2	78 - 86
Prince Albert R64	-	-	-	-	8	8	87 - 100
SE of Laingsburg R65	-	-	-	3	-	3	69 - 79
Whitehill R57	-	-	-	1	1	2	77 - 90
Molteno Pass (Hall 2284)	-	-	-	1	4	5	76 - 93

Class interval 20%

Table 34 PERCENTAGE LIGNIFICATION OF BUNDLE CAPS HALF WAY ALONG LEAF FROM VENTRAL SIDE OF LEAF IN FOLIOLOSA COMPLEX.

From Table 34 it can be seen that there is a noticeable tendency for the entity robusta to differ from the entities congesta and foliolosa in the larger number of individuals with a greater percentage lignification of the bundle caps. Again, although this distinction is by no means absolute, it is indicative of a difference between the entity robusta and the other two entities.

Area of largest bundle cap in transverse section from ventral side of leaf. (See Table 35)

The size of the bundle caps also tends to vary in the three entities, and this is represented by measuring the area of the largest bundle cap from the ventral side as seen in transverse section halfway along the leaf. This area was calculated very approximately by multiplying together the widths of the bundle cap at right angles and parallel to the epidermis.

The smallest bundle caps are found in the small foliolosa sample, the largest in the entity robusta, with bundle caps of the entity congesta intermediate in size. Apart from the Molteno Pass robusta sample the overlap of bundle cap size in the entities congesta and robusta is very slight.

Size of bundle caps is thus another anatomical character indicative of a difference between the entities congesta and robusta.

Thickness of fibre-sclereidwall from largest bundle cap of ventral side of leaf. (See Table 36).

With the variation in the percentage lignification of the bundle cap cells, there is a variation in the thickness of the fibre-sclereid walls as seen in transverse section. These measurements were taken from the bundle caps for which the areas were calculated.

The thickest sclereid walls are also found in the entity robusta, and again, apart from the Molteno Pass robusta sample, the overlap of the robusta measurements with those of the two other entities is slight.

A scatter diagram, (Fig. 28), of the area of the largest bundle cap from the ventral side of the leaf, taken halfway along the leaf, plotted against the thickness of its thickest sclereid wall does tend to separate the entity robusta from the entities

Locality	Class range of measurements									Total no. indiv.	Range actual measurements
	1	2	3	4	5	6	7	8			sq. micrometer units.
CONGESTA.											
Cradock R32	2	9	-	-	-	-	-	-	-	11	1.0 - 1.9
S. of Adelaide R38, 39	3	4	-	-	-	-	-	-	-	7	0.9 - 1.3
Dikkop Vlakte R40	-	2	1	-	-	-	-	-	-	3	1.8 - 2.3
Helspoort R41	-	3	1	-	-	-	-	-	-	4	1.2 - 2.4
Nr. Alicedale Commins	2	1	-	-	-	-	-	-	-	3	1.0 - 1.8
FOLIOLOSA.											
Miscell. Localities	9	1	-	-	-	-	-	-	-	10	0.6 - 1.1
ROBUSTA.											
Steytlerville R15	-	-	3	1	1	2	-	-	-	7	2.6 - 6.0
Miller R8	-	-	1	-	1	-	-	2	1	5	3.0 - 8.6
Klaarstroom R27	-	-	-	-	-	-	1	1	-	2	6.4 - 7.2
Prince Albert R64	-	1	-	1	2	2	1	1	-	8	1.7 - 7.7
S.E. Laingsburg R65	-	-	3	-	-	-	-	-	-	3	2.2 - 2.9
Whitehall R57	-	-	-	1	-	-	1	-	-	2	3.2 - 7.0
Molteno Pass (Hall 2284)	1	4	-	-	-	-	-	-	-	5	0.9 - 1.8

Class interval 1 sq. unit
(1 unit = 130 μ)

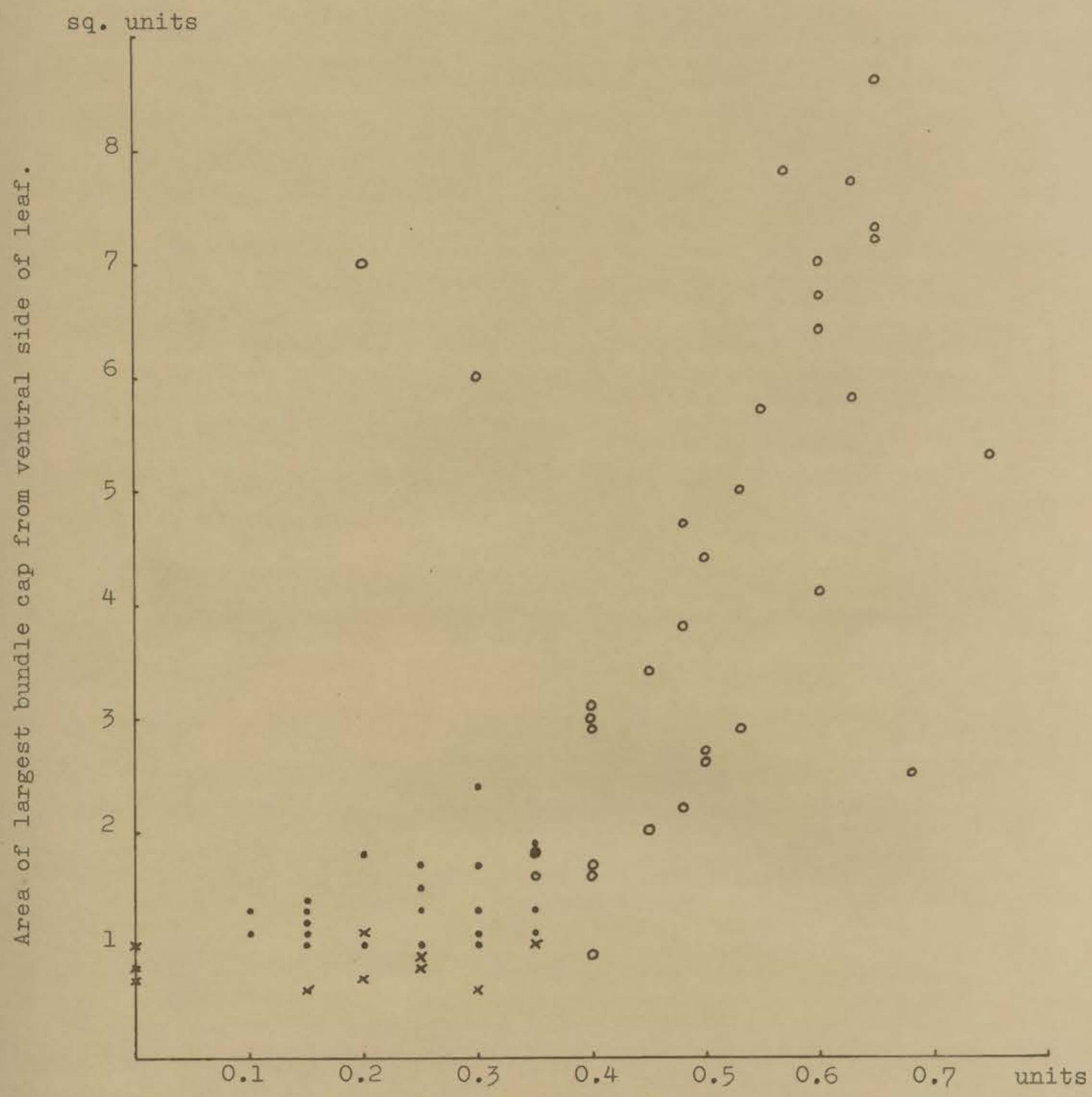
Table 35 AREA IN SQ. UNITS OF LARGEST BUNDLE CAP FROM UNDERSIDE OF LEAF IN FOLIOLOSA COMPLEX.

Locality	Class range of measurements.								Total no. indiv.	Range actual measurements.
	.1	.2	.3	.4	.5	.6	.7			
CONGESTA.										
Cradock R32	-	2	6	4	-	-	-	-	12	.15 - .35
S. of Adelaide R38,39	2	4	1	-	-	-	-	-	7	.10 - .25
Dikkop Vlakte R40	-	1	-	1	-	-	-	-	2	.20 - .35
Helspoort R41	-	-	3	1	-	-	-	-	4	.25 - .35
Nr. Alicedale (Commins 2063)	-	1	2	-	-	-	-	-	3	.20 - .30
FOLIOLOSA.										
Miscell. Localities.	-	3	2	2	-	-	-	-	7	.15 - .35
ROBUSTA.										
Steytlerville R15	-	-	1	1	4	-	-	1	7	.30 - .75
Miller R8	-	-	-	1	-	2	2	-	5	.40 - .65
Klaarstroom R27	-	-	-	-	-	1	1	-	2	.60 - .65
Prince Albert R64	-	-	-	1	2	3	2	-	8	.40 - .63
S.E. of Laingsburg R65	-	-	-	-	1	1	1	-	3	.48 - .68
Whitehill R57	-	1	-	1	-	-	-	-	2	.20 - .40
Molteno Pass (Hall 2284)	-	-	-	4	1	-	-	-	5	.35 - .40

Class interval 0.1 unit
(1 unit = 35μ)

Table 36 THICKNESS, MEASURED IN MICROMETER UNITS OF SCLEREID WALL FROM LARGEST BUNDLE CAP FROM UNDERSIDE OF LEAF IN FOLIOLOSA COMPLEX.

Fig.28. Variation in area of largest bundle cap and thickness of thickest sclereid wall from same cap from ventral side of leaf, (as seen in transverse section halfway along the leaf length), in the foliolosa complex. (1 unit =



(x = foliolosa, • = congesta, o = robusta)

foliolosa and congesta, but this separation is not complete.

Summary

Thus it can be seen that, bearing in mind the small size of some of the samples, the entity robusta tends to differ from the congesta and foliolosa on the grounds of fewer bundle caps per leaf, and greater size and degree of lignification of these caps. As in the case of the vegetative characters, however, these differences are not absolute. As has been mentioned earlier, the bundle cap cells may show up externally as faint dark lines, and this is more frequently the case in the entity robusta than in the other two entities.

LEAF COLOUR AND ORNAMENTATION.

A note on the dimensions of the tubercles of the margins and keels is included. In Table 37, the whole range of measurements is included in the class allocations. For example, if the height of the tubercles of one leaf ranged from 0.05 mm to 0.30 mm, then a point would be allocated to each of the three classes: <0.10 mm, 0.10 - 0.20 mm and 0.20 - 0.30 mm.

Height of tubercles of margins and keels (See Table 37)

In the samplesfor all three entities, the majority of specimens have tubercles less than 0.10 mm in height. It is of interest to note, however, that only 8% and 7% respectively of the congesta and robusta samples have tubercles more than 0.10 mm high, while 38% of the foliolosa sample have tubercles 0.10 - 0.20 mm high. This is particularly noticeable in foliolosa populations from Steytlerville, Mt. Stewart and the Waterford-Lake Mentz area.

Diameter of tubercles of margins and keels. (See Table 37)

The broadest tubercles tend to be found in the entity foliolosa. The entity congesta has 19% of the sample with tubercles less than 0.10 mm in diameter, while only 8% and 3% respectively of the robusta and foliolosa samples have tubercles less than 0.10 mm wide.

Leaf colour and ornamentation of ventral side of leaf. (See Table 38)

This was dealt with in the introductory survey of the genus as a whole, but a table showing variations in these characters

Locality.	Class range of measurements.					Total no. indiv.	Range actual measurements.
	DIAMETER OF TUBERCLES.						
	.1	.2	.3	.4			mm.
CONGESTA.							
N. of Cradock R31	2	7	4	-	-	13	.05 - .25
Cradock R32	3	9	7	-	-	19	.10 - .30
Rayners Kop R33	-	4	8	-	-	12	.20 - .25
S. of Adelaide R38,39	7	8	2	-	-	17	.10 - .25
Dikkop Vlakte R40	2	5	2	-	-	9	.10 - .25
Helspoort R41	4	9	7	-	-	20	.10 - .25
Krantz Drift (Commins 2063)	-	2	1	-	-	3	.15 - .25
FOLIOLOSA.							
Graaff Reinet R29	-	5	15	2	1	23	.15 - .45
Pearston R34	-	-	2	-	-	2	.25 - .30
Lake Mentz R36,37	-	6	12	-	-	18	.15 - .30
Waterford R10	1	6	7	1	-	15	.10 - .35
Wolwefontein R11	-	6	9	-	-	15	.15 - .30
Baroe R12	1	1	1	-	-	3	.10 - .25
Mt. Stewart R13	-	5	6	-	-	11	.15 - .30
Steytlerville R14	1	9	14	-	-	24	.15 - .30
ROBUSTA.							
Steytlerville R15	1	16	17	-	-	34	.10 - .30
Miller R8,9	1	6	5	-	-	12	.10 - .30
Klaarstroom R27	-	1	2	-	-	3	.20 - .25
E. of Laingsburg R1	-	1	-	-	-	1	.20
Nelspoort R28	4	11	13	1	-	28	.10 - .35
	HEIGHT OF TUBERCLES.						
CONGESTA.							
N. of Cradock R31	7	1	-	-	-	8	.03 - .15
Cradock R32	15	2	-	-	-	17	.04 - .15
Rayners Kop R33	10	-	-	-	-	10	.04 - .10
S. of Adelaide R38,39	13	1	-	-	-	14	.04 - .15
Dikkop Vlakte R40	5	-	-	-	-	5	.05 - .08
Helspoort R41	10	-	-	-	-	10	.02 - .10
Krantz Drift (Commins 2063)	2	1	-	-	-	3	.05 - .13
FOLIOLOSA.							
Graaff Reinet R29	14	3	-	-	-	17	.05 - .15
Pearston R34	2	1	-	-	-	3	.05 - .13
Lake Mentz R36,37	10	7	-	-	-	17	.05 - .20
Waterford R10	4	4	1	-	-	9	.06 - .25
Wolwefontein R11	9	3	-	-	-	12	.05 - .15
Baroe R12	1	1	-	-	-	2	.08 - .13
Mt. Stewart R13	5	4	-	-	-	9	.08 - .15
Steytlerville R14	12	8	-	-	-	20	.05 - .15
ROBUSTA.							
Steytlerville R15	19	3	-	-	-	22	.03 - .15
Miller R8,9	14	1	-	-	-	15	.02 - .15
Klaarstroom R27	2	-	-	-	-	2	.05
E. of Laingsburg R1	1	-	-	-	-	1	.05
Nelspoort R28	16	-	-	-	-	16	.03 - .10

Class interval 0.10 mm.

Table 37 VARIATION IN DIMENSIONS OF TUBERCLES OF MARGINS AND KEELS IN FOLIOLOSA COMPLEX.

Locality	Total no. indiv.	Leaves with a greyish tone.	Margins + keels concolorous.	Margins + keels paler.	Margins + keels whitish.	Darker bundle cap lines on undersurface of leaf.	Leaves with whitish flat or slightly raised flecks on underside.	Leaves with longit.elongated slightly raised patches on underside.
		no. indivs.	no. indivs.	no. indivs.	no. indivs.	no. indivs.	no. indivs,	no. indivs.
CONGESTA.								
N. of Cradock R31	7	-	3	4	-	-	-	-
Cradock R32	15	-	10	2	2	2	-	2
Rayners Kop R33	10	-	9	1	-	2	-	2
S. of Adelaide R38,39	14	-	11	2	1	5	-	3
Dikkop Vlakte R40	5	-	4	1	-	4	-	4
Helspoort R41	10	-	9	1	-	2	-	2
Krantz Drift (Commins 2063)	2	-	1	1	-	-	-	-
FOLIOLOSA.								
Graaff Reinet R29	15	-	5	7	3	-	-	-
nr. Pearston R34	2	-	-	1	1	1	-	-
Lake Mentz R36,37	10	-	4	3	3	-	-	-
Waterford R10	6	-	2	3	1	1	-	1
Wolwefontein R11	7	-	-	7	-	-	-	-
Mt. Stewart R13	8	-	5	2	1	-	-	-
Steytlerville	31	-	8	20	3	5	-	-
ROBUSTA.								
Steytlerville R15	20	6	-	3	17	10	13	1
nr. Miller R8,9	14	5	-	4	10	7	4	1
Klaarstroom R27	3	3	-	-	3	3	-	-
Prince Albert R64	6	4	-	2	4	6	2	-
S.E. Laingsburg R65	6	6	-	-	6	6	-	-
E. of Laingsburg R1	1	1	-	1	-	1	1	-
Nelspoort R28	14	7	3	3	8	7	-	-
Molteno Pass (Hall 2284)	6	4	-	3	3	2	-	-

Table 38 VARIATION IN COLOUR AND ORNAMENTATION OF LEAVES IN FIELD SPECIMENS OF FOLIOLOSA COMPLEX.

in the different populations is included here.

Noteworthy characteristics are the greyish overtones to the leaves found throughout populations of the entity robusta, which together with a tendency for most of the individuals to have whitish margins and keels, helps in the recognition of populations of this entity in the field. Also, darker bundle cap lines are found in more individuals of the entity robusta than in the other two entities.

The fact that some individuals of the entity congesta have slightly raised, elongated concolourous patches on the ventral side of some leaves, and some plants of the entity robusta have whitish flecks, which may be very slightly raised, has already been mentioned.

Summary

It can be seen that leaf ornamentation and colour, although showing variations in the different entities, are not characters which can be used as taxonomic criteria, although they may aid in identification of field populations.

INFLORESCENCE CHARACTERS (See Plate 18.)

Measurements made of herbarium specimens, where the shrinkage due to dessication is not critical, are included in this part of the survey, and they are given in separate tables, also according to locality.

Length of peduncle and raceme. (See Tables 39 and 40)

In the introductory survey of the genus as a whole, the shortest peduncles were found to occur in the entity robusta, the length of these being 5 - 15 cm. in the majority of cases. In the entity foliolosa, taken as a whole, the majority of specimens had peduncles 10 - 20 cm. long, while the longest peduncles were found in the entity congesta, with 15 - 25 cm. the length for most individuals.

Individual field population samples conform to this pattern. In the congesta populations it is of interest to note that the peduncles of the southern populations, from Dikkop Vlakte and Helspoort tend to be shorter than the peduncles of the northern populations, from Cradock and South of Adelaide. In the robusta

Locality.	Class range of measurements. 5	10	15	20	25	30		Total no. indiv.	Range actual measurements. cm.
FIELD SPECIMENS.									
CONGESTA.									
Cradock R32	-	-	-	3	5	6	-	14	16 - 30
S. Adelaide R38,39	-	-	-	8	14	6	1	29	16.-31
Dikkop Vlakte R40	-	-	2	4	1	-	-	7	14 - 25
Helspoort R41	-	1	3	7	3	-	-	14	6 - 23
FOLIOLOSA.									
Graaff Reinet R60	-	1	9	14	7	-	-	31	9 - 23
Mt. Stewart R52a	-	-	2	1	-	-	-	3	15 - 19
Baroe R12	-	-	-	1	-	-	-	1	18
Wolwefontein R11	-	-	-	1	-	1	-	2	19 - 28
Springbok Vlakte Nbg	-	-	1	1	-	-	-	2	14 - 17
Steytlerville R52b	-	-	8	6	3	-	-	17	11 - 23
ROBUSTA.									
Steyterville R43	2	10	3	-	-	-	-	15	5 - 14
Miller R45	-	6	1	-	-	-	-	7	6 - 11
Prince Albert R64	-	2	15	6	1	-	-	24	10 - 21
E. Laingsburg R1	-	-	2	-	-	-	-	2	13 - 14
Whitehill O	-	1	5	3	-	-	-	9	10 - 18
E. Nelspoort R42	-	2	6	2	1	-	-	11	8 - 22
Molteno Pass H2284	-	4	7	3	-	-	-	14	7 - 16
HERBARIUM SPECIMENS.									
CONGESTA.									
Cradock	-	1	-	-	-	-	-	1	9
Rayners Kop	-	-	-	1	-	-	-	1	17
Mortimer	-	-	-	-	1	-	-	1	22
Helspoort	-	-	1	2	1	-	-	4	12 - 21
Alicedale	-	-	-	-	1	-	-	1	22
Brakkloof	-	-	-	1	-	-	-	1	18
FOLIOLOSA.									
Addo Bush	-	-	1	-	-	-	-	1	14
Koega Kammas Kloof	-	-	-	1	-	-	-	1	20
Swartkops Sundays	-	-	-	1	-	-	-	1	16
Kleinpoort	-	-	-	2	1	-	-	3	18 - 21
Steytlerville	-	1	-	-	-	-	-	1	10
Waterford	-	-	1	1	-	-	-	2	13 - 20
Kruidfontein	-	-	-	1	-	-	-	1	18
Graaff Reinet	-	-	2	-	-	-	-	2	13 - 14
E. Laingsburg (?)	-	1	-	-	-	-	-	1	10
ROBUSTA.									
Lake Mentz.	-	1	-	-	-	-	-	1	9
Mt. Stewart	-	2	-	-	-	-	-	2	10
Steytlerville	-	2	-	-	-	-	-	2	6 - 9
Miller	-	-	1	-	-	-	-	1	12
Willowmore	-	1	-	-	-	-	-	1	9
Prince Albert	-	-	1	-	-	-	-	1	12
Whitehill	-	2	1	-	-	-	-	3	8 - 15
Matjesfontein	-	-	1	-	-	-	-	1	15
Beaufort West	-	1	1	1	-	-	-	3	10 - 16

Class Interval 5.0 cm.

Table 39 VARIATION IN LENGTH OF PEDUNCLE IN FOLIOLOSA COMPLEX.

Locality	Class range of measurements. 5	10	15	20	25	30		Total no. Indiv.	Range actual measurements. cm.
FIELD SPECIMENS.									
CONGESTA.									
Cradock R32	-	-	4	8	1	-	-	15	12 - 25
S. Adelaide R38,39	-	1	10	10	6	-	-	27	10 - 25
Dikkop Vlakte R40	-	-	4	2	-	-	-	6	11 - 20
Helspoort R41	-	-	9	4	-	-	-	13	12 - 19
FOLIOLOSA.									
Graaff Reinet R60	-	3	12	12	1	-	-	28	12 - 19
Mt. Stewart R52b	-	2	-	-	-	-	-	2	6 - 8
Wolwefontain R11	-	-	2	1	-	-	-	3	12 - 17
Steytlerville R52a	-	1	7	1	-	-	-	9	10 - 18
ROBUSTA.									
Steytlerville R43	-	7	7	1	1	-	-	15	6 - 21
Miller R45	-	2	5	-	-	-	-	7	5 - 13
Prince Albert R64	1	4	14	4	-	2	1	26	5 - 33
E. Laingsburg R1	0	-	2	-	-	-	-	2	11 - 13
Whitehill 0	-	1	1	6	1	-	-	9	10 - 23
E. Nelspoort R42	-	4	3	4	-	-	-	11	8 - 20
Molteno Pass H2284	-	5	8	1	-	-	-	14	
HERBARIUM SPECIMENS.									
CONGESTA.									
Cradock	-	1	-	-	-	-	-	1	8
Rayners Kop	-	-	1	-	-	-	-	1	11
Mortimer	-	-	-	1	-	-	-	1	18
Helspoort	-	-	3	-	-	-	-	3	12 - 15
Alicedale	-	-	-	1	-	-	-	1	20
Brakkloof	-	-	-	1	-	-	-	1	18
FOLIOLOSA.									
Kleinpoort	-	-	1	2	-	-	-	3	12 - 19
Steytlerville	-	-	1	-	-	-	-	1	11
Waterford	-	-	1	-	-	-	-	1	12
Graaff Reinet	-	-	1	-	-	-	-	1	11
E. Laingsburg (?)	-	-	1	-	-	-	-	1	12
ROBUSTA.									
Lake Mentz	-	-	1	-	-	-	-	1	11
Mt. Stewart	-	2	-	-	-	-	-	2	8 - 10
Steytlerville	-	1	-	-	-	-	-	1	9
Miller	-	-	1	-	-	-	-	1	15
Willowmore	-	-	1	-	-	-	-	1	11
Prince Albert	-	-	-	-	1	-	-	1	
Whitehill	-	2	1	-	-	-	-	3	7 - 11
Matjesfontein	-	1	-	-	-	-	-	11	9
Beaufort West	-	1	1	1	-	-	-	3	8 - 17

Class Interval 5 cm.

Table 40. VARIATION IN LENGTH OF RACEME IN FOLIOLOSA COMPLEX.

populations, those in the eastern part of the distribution range, from Steytlerville and Miller, tend to have the shortest peduncles.

In the introductory survey, it was seen that, although both the entities foliolosa and robusta had the majority of specimens with racemes 10 - 15 cm. long, only 12% of the foliolosa sample, compared with 30% of the robusta sample, had racemes of 10 cm. or less in length. The longest racemes were found in the entity congesta, where 10 - 20 cm. was the length in most cases. In individual field populations, there are no marked differences in raceme length which might be correlated with distribution.

Thus, although peduncle and raceme length cannot be considered significant taxonomic characters, the differences in peduncle and raceme length in the entities robusta and congesta may be considered as a further indication of a difference between them, while the lengths of the peduncle and raceme in the entity foliolosa are of an intermediate nature.

Number of sterile bracts (See Table 41)

It can be seen that this character varies between different populations of the same entity, and, apart from the slightly greater number of congesta specimens with fewer bracts per peduncle, is not indicative of any difference between the three entities.

Branching of inflorescence (See Table 42)

The introductory survey showed that the greatest number of branched inflorescences were found in the entity congesta, where 33% of the total sample had branched inflorescences, and 41% had one or more unexpanded raceme buds in the axils of the sterile bracts. In the entity foliolosa, taken as a whole, 6% of individuals had branched inflorescences, and 3% undeveloped raceme buds. No plants of the entity robusta had branched peduncles, but 8% had unexpanded raceme buds.

In field populations of the entity congesta, the greatest number of branched inflorescences is found in the Southern populations from Helspoort and Dikkop Vlakte, where over half the samples have branched inflorescences, and the rest unexpanded raceme buds in the sterile bract axils.

Locality.	Class Range of measurement. 2	4	6	8	Total no. indiv.	Range actual number.
FIELD SPECIMENS.						
CONGESTA.						
Cradock R32	- -	12	2	-	14	5 - 7
S. Adelaide R38,39	11 13	5	1	-	30	2 - 7
Dikkop Vlakte R40	3 4	-	-	-	7	2 - 3
Helspoort R41	3 8	3	-	-	14	2 - 5
FOLIOLOSA.						
Graaff Reinet R60	- 13	15	3	-	31	3 - 7
Mt. Stewart R52b	- 1	-	1	-	2	4 - 8
Baroe R12	1 -	-	-	-	1	2
Wolwefontein R11	- -	2	-	-	2	5 - 6
Springbok Vlakte Nbg	- -	1	1	-	2	5 - 7
Steytlerville R52a	- 5	9	2	1	17	3 - 10
ROBUSTA.						
Steytlerville R43	1 4	7	3	-	15	2 - 7
Miller R45	- 1	6	-	-	7	4 - 5
Prince Albert	- 10	11	3	0	24	3 - 8
E. Laingsburg R1	- 2	-	-	-	2	3 - 4
Whitehill 0	1 7	1	-	-	9	2 - 5
E. Nelspoort R42	1 6	2	1	1	11	2 - 9
Molteno Pass H2284	5 11	-	-	-	16	2 - 4
HERBARIUM SPECIMENS.						
CONGESTA.						
Cradock	- -	1	-	-	1	5
Mortimer	- 1	-	-	-	1	4
Helspoort	1 2	1	-	-	4	1 - 5
Alicedale	1 -	-	-	-	1	2
Brakkloof	1 -	-	-	-	1	2
FOLIOLOSA.						
Addo Bush	- -	1	-	-	1	5
Koega Kammas Kloof	- 1	-	-	-	1	3
Swartkops Sundays	- 1	-	-	-	1	4
Kleinpoort	- 1	1	1	-	3	4 - 7
Steytlerville	- -	1	-	-	1	5
Waterford	- 1	1	-	-	2	3 - 5
Kruidfontein	- 1	-	-	-	1	4
Graaff Reinet	- 1	1	-	-	2	3 - 5
E. Laingsburg (?)	- 1	-	-	-	1	4
ROBUSTA.						
Lake Mentz	- 1	-	-	-	1	4
Mt. Stewart	1 1	-	-	-	2	2 - 4
Steytlerville	- 2	-	-	-	2	4
Miller	- 1	-	-	-	1	3
Willowmore	- -	-	1	-	1	8
Prince Albert	- -	1	-	-	1	5
Whitehill	- 3	-	-	-	3	3 - 4
Matjesfontein	- -	1	-	-	1	5
Beaufort West	- -	3	-	-	3	5

Class Interval 2 bracts.

Table 41 VARIATION IN NUMBER OF STERILE BRACTS PER PEDUNCLE IN FOLIOLOSA COMPLEX.

Locality.	Individuals with one or more branches to inflorescence.	Individuals with unexpanded raceme buds in axils of sterile bracts.	Total no. Indiv.
CONGESTA.			
Field Pops.			
Cradock R32	0	5	14
S. Adelaide R38,39	7	14	30
Dikkop Vlakte R40	4	3	7
Helspoort R41	8	6	14
Herbarium Specimens.			
Helspoort	2	0	3
Alicedale	1	0	1
FOLIOLOSA.			
Field Pops.			
Graaff Reinet R60	2	0	31
Mt. Stewart R52b	0	0	3
Baroe R12	1	0	1
Wolwe fontein R11	0	0	2
Springbok Vlakte Nbg	0	0	2
Steytlerville R52a	0	1	18
Herbarium Specimens.			
Addo Bush	0	0	1
Swartkops Sundays River	0	0	1
Koega Kammas Kloof	0	0	1
Kleinpoort	1	1	3
Steytlerville	0	0	1
Waterford	0	0	2
Kruidfontein	1	0	2
Graaff Reinet	0	0	2
E. Laingsburg	0	0	1
ROBUSTA.			
Field Pops.			
Molteno Pass H2284	0	0	14
Nelspoort R42	0	0	11
Whitehill0	0	2	9
E. Laingsburg R1	0	0	2
Prince Albert R64	0	5	24
Miller R45	0	0	7
Steytlerville R43	0	0	15
Herbarium Specimens.			
Beaufort West	0	0	3
Matjesfontein	0	0	1
Whitehill	0	0	3
Prince Albert	0	0	1
Willowmore	0	0	1
Miller	0	0	1
Mt. Stewart	0	0	2
Steytlerville	0	0	2
Lake Mentz	0	0	1

Table 42 VARIATION IN BRANCHING OF INFLORESCENCES IN FOLIOLOSA COMPLEX.

Although these characters are not confined to the entity congesta, the high percentage of branched inflorescences and unexpanded raceme buds found in this entity are strongly indicative of a difference between it and the entities foliolosa and robusta.

Thickness of peduncle (See Table 43 and Appendix Table 7)

The very stout bases of old dried peduncles was a character of use in identifying populations of the entity robusta in the field*. (In the Appendix Table 7, the leaf length for each plant is shown, and also the width of old peduncle bases of previous years. If more than one old base was present on a single plant, then an average of the widths was taken).

In the introductory survey, it was seen that for complete flowering inflorescences, the thickest peduncle bases were found in the entity robusta, where in the majority of specimens they were 0.45 - 0.75 cm. wide. The entity foliolosa, with the majority of peduncles 0.30 - 0.45 cm. wide, had the thinnest peduncle bases, while those of the entity congesta, being 0.30 - 0.60 cm. wide in the majority of cases, were intermediate in size.

With some slight local variations the above pattern is observed in field populations.

The greatest width of the peduncle below the raceme was also shown in the introduction also to occur in the entity robusta, this being 0.30 - 0.45 cm, in the majority of cases, while for the majority of the more slender peduncles of the entities congesta and foliolosa, it was 0.15 - 0.30 cm.

Field populations of the entity foliolosa agree with the above, but the two Southern congesta populations tend to have a fair proportion of peduncles which are broader below the first pedicel.

In the robusta populations, peduncles with broad bases tend to be correspondingly broad below the first pedicel.

Three scatter diagrams have been constructed showing variation in peduncle size. The first, (Fig. 29) showing the width of old peduncle bases plotted against leaf length, resolves the foliolosa complex into its three components more clearly than the preceding scatter diagrams, but they are by no means sharply delimited.

---

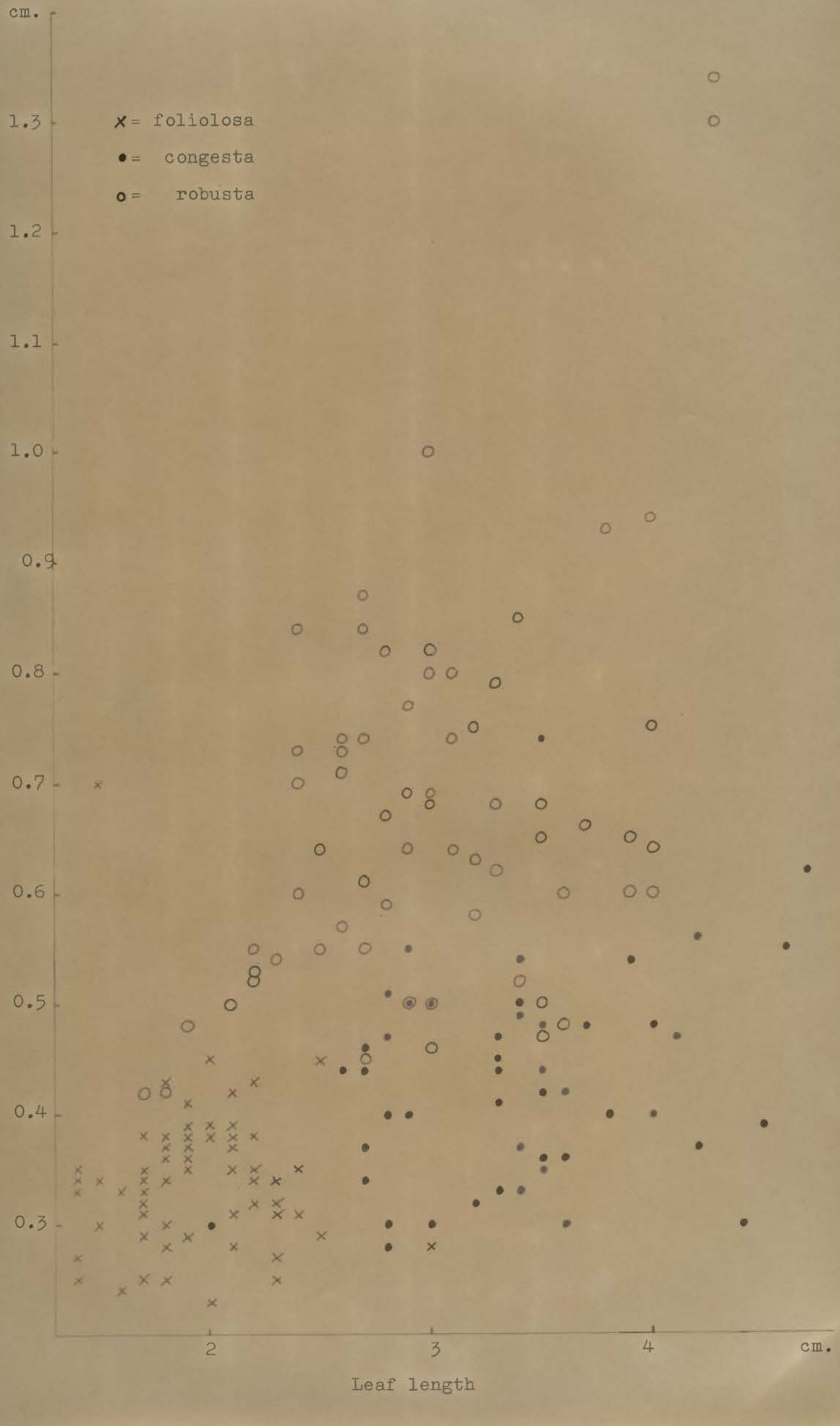
* Hence the author's choice of the epithet "robusta" for this entity.

Locality.	Class range of measurements. .15	.30	.45	.60	.75	.90	1.05	Total no. indiv.	Range actual measurements. cm
WIDTH PEDUNCLE BASE.									
CONGESTA.									
Cradock R32	-	-	1	9	4	-	-	14	0.41 - 0.75
S.of Adelaide R38,39	-	-	15	12	2	-	-	29	0.37 - 0.65
Dikkop Vlakte R40	-	-	-	4	2	1	-	7	0.50 - 0.80
Helspoort R41	-	-	6	4	3	1	-	14	0.32 - 0.77
FOLIOLOSA.									
Graaff Reinet R60	-	3	26	1	-	-	-	30	0.28 - 0.48
Mt. Stewart R52b	-	-	3	-	-	-	-	3	0.32 - 0.42
Baroe R12	-	-	-	1	-	-	-	1	0.50
Wolwefontein R11	-	-	2	-	-	-	-	2	0.38 - 0.40
Springbok Vlakte Nbg	-	1	-	1	-	-	-	2	0.26 - 0.47
Steytlerville R52a	-	3	12	2	-	-	-	17	0.26 - 0.48
ROBUSTA.									
Steytlerville R43	-	-	-	6	8	1	-	15	0.50 - 0.82
nr. Miller R45	-	-	-	3	2	-	-	5	0.47 - 0.66
Prince Albert R64	-	-	-	3	10	5	3	24	0.57 - 1.10
E. of Laingsburg R1	-	-	-	1	1	-	-	2	0.57 - 0.61
Whitehill O	-	-	-	-	4	2	2	9	0.64 - 1.10
E. of Nelspoort R42	-	-	1	6	4	-	-	11	0.42 - 0.68
Ft. Molteno Pass (Hall 2284)	-	-	-	3	-	-	-	3	0.50 - 0.58
WIDTH PEDUNCLE BELOW RACEME.									
CONGESTA.									
Cradock R32	-	11	3	-	-	-	-	14	0.23 - 0.40
S. of Adelaide R38,39	-	24	4	-	-	-	-	28	0.23 - 0.42
Dikkop Vlakte R40	-	3	4	-	-	-	-	7	0.20 - 0.38
Helspoort R41	-	9	5	-	-	-	-	14	0.24 - 0.37
FOLIOLOSA.									
Graaff Reinet R60	2	29	-	-	-	-	-	31	0.15 - 0.29
Mt. Stewart R52b	-	3	-	-	-	-	-	3	0.21 - 0.30
Baroe R12	-	1	-	-	-	-	-	1	0.30
Wolwefontein R11	-	2	1	-	-	-	-	3	0.25 - 0.35
Springbok Vlakte Nbg	-	2	-	-	-	-	-	2	0.16 - 0.23
Steytlerville R52a	-	17	-	-	-	-	-	17	0.20 - 0.30
ROBUSTA.									
Steytlerville R43	-	5	13	2	-	-	-	20	0.28 - 0.50
nr. Miller R45	-	2	1	-	-	-	-	2	0.29 - 0.38
Prince Albert R64	-	-	6	10	5	-	-	21	0.35 - 0.73
E. of Laingsburg R1	-	-	2	-	-	-	-	2	0.40
Whitehill O	-	-	1	6	2	-	-	9	0.44 - 0.66
E.of Nelspoort R42	-	1	8	-	-	-	-	9	0.30 - 0.45
Ft.of Molteno Pass (Hall 2284)	-	6	7	1	-	-	-	14	0.29 - 0.46

Class interval 0.15 cm.

Table 43 VARIATION IN THICKNESS OF PEDUNCLE IN FIELD SPECIMENS OF THE FOLIOLOSA COMPLEX.

Fig.29. Variation in width of old dried peduncles and leaf length in the foliolosa complex.



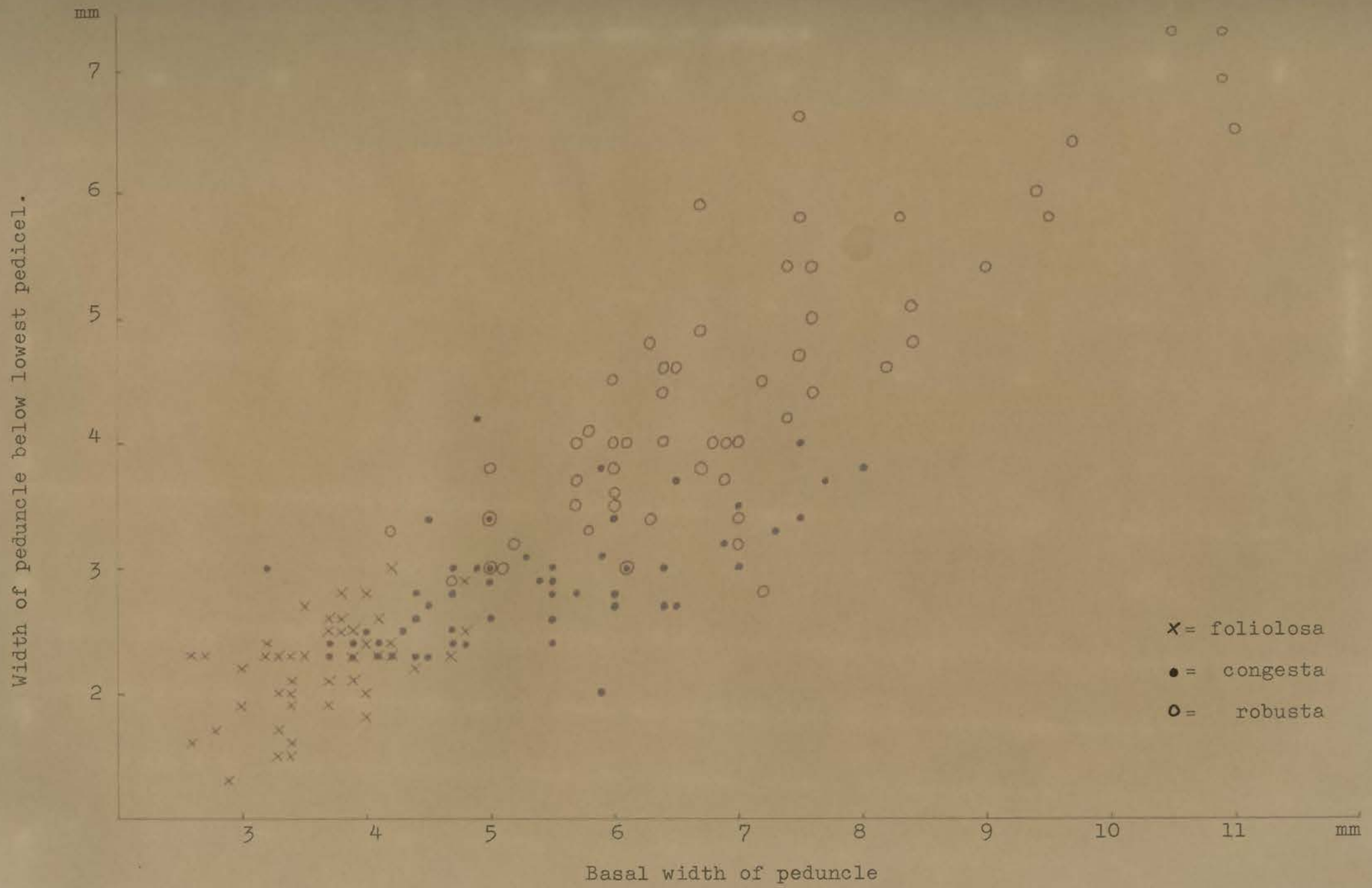
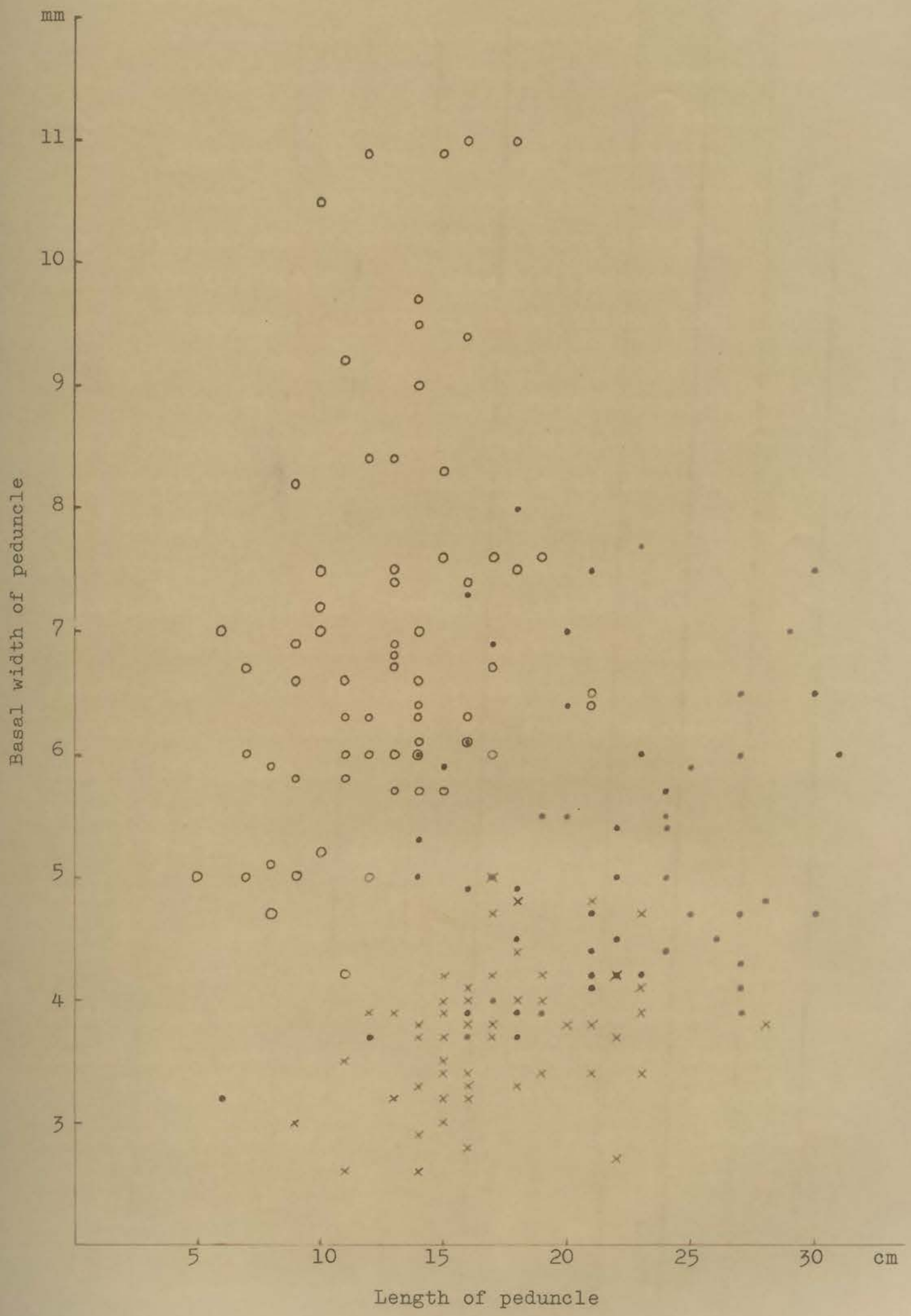


Fig.30. Variation in width of peduncle at base and below lowest pedicel in the foliolosa complex.

Fig.31. Variation in length and basal width of the peduncle in the foliolosa complex (× = foliolosa, • = congesta, o = robusta).



The second scatter diagram (Fig. 31) of peduncle length plotted against width of peduncle base shows a fairly good separation between the entities robusta and foliolosa, with the entity congesta intermediate, but closer in the combination of these characters to the entity foliolosa.

The last of these scatter diagrams (Fig. 30), of diameter of peduncle base plotted against diameter below raceme again shows the entities robusta and foliolosa to be at opposite ends of the variation pattern with the entity congesta intermediate.

Thickness of peduncle, both at the base and below the first pedicel is thus another character which differs in the three entities but this difference is by no means absolute.

Length of lowest sterile bract (See Tables 44A and 44B)

The introductory survey showed that the longest sterile bracts occurred in the entity robusta, where they were 1.0 - 1.4 cm. long in the majority of specimens. The shortest sterile bracts were found in the entity foliolosa where 48% of the sample had bracts 0.6 - 0.8 cm. long and 34% had bracts 0.8 - 1.0 cm. long, while the entity congesta was intermediate, with the lowest sterile bracts 0.8 - 1.0 cm. long in the majority of specimens.

Individual populations of the entity congesta follow the above pattern. In the foliolosa populations, the basal fertile bracts of the Graaff Reinet sample tend to be shorter than those from Mt. Stewart and Steytlerville, localities at the opposite end of the geographic pattern of distribution for the entity foliolosa.

In robusta populations, the length of the lowest sterile bract is very variable, the shortest basal sterile bracts being found in specimens from Molteno Pass.

A scatter diagram, (Fig. 32), of length of lowest sterile bract plotted against the diameter of the peduncle base, illustrates the pattern of variation in a combination of these characters.

The length of the basal sterile bract is thus another character by which the entity robusta tends to differ from the entities foliolosa and congesta, and again this difference is not absolute.

Locality.	Class range of measurements.									Total no. individuals.	Range actual measurements.
	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0			cm.
CONGESTA.											
Cradock R32	-	-	1	-	-	-	-	-	-	1	0.88
S. Adelaide R38.39	-	3	7	-	1	-	-	-	-	11	0.72 - 1.27
Dikkop Vlakte R40	-	1	5	-	-	-	-	-	-	6	0.76 - 1.00
Helspoort R41	-	4	6	3	-	-	-	-	-	13	0.75 - 1.20
Krantz Drift	-	-	1	-	-	-	-	-	-	1	0.82
FOLIOLOSA.											
Graaff Reinet R60	4	19	6	-	-	-	-	-	-	29	0.56 - 0.90
Mt. Stewart R52b	-	1	3	1	-	-	-	-	-	5	0.70 - 1.20
Springbok Vlakte Nbg	-	2	-	-	-	-	-	-	-	2	0.71 - 0.75
Steytlerville R52a	-	5	8	4	1	-	-	-	-	18	0.70 - 1.25
ROBUSTA.											
Steytlerville R43	-	-	2	5	5	2	1	-	-	15	1.00 - 1.70
Miller R45	-	-	-	1	2	2	2	-	-	7	1.10 - 1.70
Prince Albert R64	-	-	-	9	8	6	-	1	-	24	1.10 - 1.85
E. Laingsburg R1	-	-	-	2	-	-	-	-	-	2	1.05 - 1.14
Whitehill 0	-	-	-	1	1	3	2	1	1	9	1.20 - 2.15
E. Nelspoort R42	-	-	-	2	4	3	-	2	-	11	1.15 - 2.00
Molteno Pass H2284	-	4	5	5	2	-	-	-	-	16	0.75

Class interval 012 cm.

Table 44A VARIATION IN LENGTH OF BASAL STERILE BRACT IN FIELD SPECIMENS OF THE FOLIOLOSA COMPLEX.

Locality.	Class range of measurements.						Total no. indiv.	Range actual measurements.
	0.8	1.0	1.2	1.4	1.6			cm.
CONGESTA.								
Helspoort.	1	2	-	-	-	-	3	0.70 - 0.95
FOLIOLOSA.								
Koega Kammas Kloof	-	1	-	-	-	-	1	0.90
Swartkops Sundays	-	1	-	-	-	-	1	1.00
Kleinpoort	-	2	-	1	-	-	3	0.90 - 1.30
Steytlerville	-	-	1	-	-	-	1	1.05
Waterford	-	1	-	-	-	-	1	1.00
Kruidfontein	2	-	-	-	-	-	2	0.75
Graaff Reinet	1	-	-	-	-	-	1	0.70
E. Laingsburg	2	1	-	-	-	-	3	0.70 - 0.95
ROBUSTA.								
Lake Mentz	-	-	-	1	-	-	1	1.40
Steytlerville	-	-	1	-	-	-	1	1.10
Miller	-	1	-	-	-	-	1	1.00
Willowmore	-	-	-	-	-	1	1	1.80
Prince Albert	-	-	1	-	-	-	1	1.10
Whitehill	-	-	-	2	1	-	3	1.30 - 1.45
Matjesfontein	-	1	-	-	-	-	1	1.00
Beaufort West	-	2	1	-	-	-	3	0.90 - 1.15

Class interval 0.2 cm.

Table 44B VARIATION IN LENGTH OF BASAL STERILE BRACTS IN HERBARIUM SPECIMENS OF FOLIOLOSA COMPLEX.

Basal width of lowest sterile bract (See Table 45)

In the introductory survey, it was seen that the entity foliolosa had the narrowest bases to the lowest sterile bracts, this measurement being 0.15 - 0.45 cm. in the majority of specimens. In both the entities congesta and robusta, the majority of individuals had bract bases of 0.45 - 0.60 cm. but 37% of the robusta sample, compared with 24% of congesta sample, had wider bract bases. Thus the basal width of the lowest sterile bract corresponds to some extent with the basal width of the peduncle.

For the most part, individual populations of the entity congesta conform to this pattern. In the foliolosa populations, however, it is of interest to note that the basal width of the lowest sterile bract tends to be greater in specimens from Graaff Reinet than in specimens from Steytlerville, while the width of the peduncle base for both populations is the same in the majority of individuals. In the robusta populations, the width of the basal sterile bracts corresponds well with the width of the peduncle bases.

Locality	Class range of measurements. .30	.45	.60	.75	.90	1.05	1.20	Total no. indiv.	Range actual measurements. cm.
FIELD SPECIMENS.									
CONGESTA.									
Cradock R32	-	-	1	-	-	-	-	1	0.50
S.of Adelaide R38,39	-	2	6	2	-	-	-	10	0.30 - 0.75
Dikkop Vlakte R40	-	-	3	3	-	-	-	6	0.45 - 0.75
Helspoort R41	-	5	5	3	-	-	-	13	0.35 - 0.70
Krantz Drift (Commins 2063)	-	-	1	-	-	-	-	1	0.60
FOLIOLOSA.									
Graaff Reinet R60	7	20	3	-	-	-	-	30	0.20 - 0.55
Mt. Stewart R52b	1	4	-	-	-	-	-	5	0.15 - 0.45
Springbok Vlakte Nbg	1	1	-	-	-	-	-	2	0.24 - 0.35
Steytlerville R52a	17	2	1	-	-	-	-	20	0.20 - 0.50
ROBUSTA.									
Steytlerville R43	-	1	10	3	1	-	-	15	0.30 - 0.90
nr. Miller R45	-	-	7	-	-	-	-	7	0.45 - 0.60
Prince Albert R64	-	2	7	10	5	-	-	24	0.30 - 0.90
E. of Laingsburg R1	-	-	2	-	-	-	-	2	0.52 - 0.60
Whitehill 0	-	-	-	4	4	1	-	9	0.70 - 0.95
E. of Nelspoort R42	-	1	7	1	1	-	-	11	0.45 - 1.30
Ft. of Molteno Pass (Hall 2284)	-	3	9	3	-	-	-	15	0.40 - 0.68
HERBARIUM SPECIMENS.									
CONGESTA.									
Helspoort	-	2	1	-	-	-	-	3	0.40 - 0.47
FOLIOLOSA.									
Koega Kammas Kloof	1	-	-	-	-	-	-	1	0.30
Swartkops Sundays	1	-	-	-	-	-	-	1	0.24
Kleinpoort	2	1	-	-	-	-	-	3	0.22 - 0.42
Steytlerville	1	-	-	-	-	-	-	1	0.20
Waterford	-	-	1	-	-	-	-	1	0.60
Kruidfontein	1	-	-	-	-	-	-	1	0.30
E. of Laingsburg	2	1	-	-	-	-	-	3	0.30 - 0.36
ROBUSTA.									
Lake Mentz	-	-	-	1	-	-	-	1	0.62
Steytlerville	-	1	-	-	-	-	-	1	0.40
Miller	-	-	1	-	-	-	-	1	0.50
Willowmore	-	-	1	-	-	-	-	1	0.60
Prince Albert	-	1	-	-	-	-	-	1	0.35
Whitehill	-	1	2	-	-	-	-	3	0.40 - 0.60
Matjesfontein	1	-	-	-	-	-	-	1	0.30
Beaufort West	1	2	-	-	-	-	-	3	0.30 - 0.35

Class interval 0.15 cm.

Table 45 VARIATION IN WIDTH OF BASES OF LOWEST STERILE BRACTS IN FOLIOLOSA COMPLEX.

Locality.	Class range of measurements. 0.1	0.2	0.3	0.4	0.5		Total no. indiv.	Range actual measurements. cm.
FIELD SPECIMENS.								
CONGESTA.								
Cradock R32	-	-	1	-	-	-	1	0.27
S.of Adelaide R38,39	-	8	2	-	-	-	10	0.14 - 0.28
Dikkop Vlakte R40	-	-	4	1	1	-	6	0.23 - 0.46
Helspoort R41	-	2	4	1	2	-	9	0.17 - 0.48
Krantz Drift (Commins 2063)	-	-	-	1	-	-	1	0.30 - 0.40
FOLIOLOSA.								
Graaff Reinet R60	1	19	9	-	-	-	29	0.09 - 0.30
Mt. Stewart R52b	-	5	-	-	-	-	5	0.13 - 0.15
Springbok Vlakte Nbg	-	1	-	-	-	-	1	0.13
Steytlerville R52a	4	14	-	-	-	-	18	0.08 - 0.20
ROBUSTA.								
Steytlerville R43	-	2	8	5	-	-	15	0.20 - 0.40
Nr. Miller R45	-	-	2	3	2	-	7	0.23 - 0.50
Prince Albert R64	-	6	13	5	-	-	24	0.17 - 0.40
E.of Laingsburg R1	-	-	2	-	-	-	2	0.23 - 0.30
Whitehill O	-	1	4	4	-	-	9	0.20 - 0.37
E. of Nelspoort R42	-	3	3	3	1	1	11	0.20 - 0.52
Ft. of Molteno Pass (Hall 2284)	-	3	12	-	-	-	15	0.17 - 0.30
HERBARIUM SPECIMENS.								
CONGESTA.								
Helspoort	-	1	1	1	-	-	3	0.20 - 0.33
FOLIOLOSA.								
Koega Kammas Kloof	1	-	-	-	-	-	1	0.10
Swartkops Sundays	1	-	-	-	-	-	1	0.10
Kleinpoort	2	1	-	-	-	-	3	0.10 - 0.20
Steytlerville	1	-	-	-	-	-	1	0.10
Waterford	-	-	-	1	-	-	1	0.36
Kruidfontein	2	-	-	-	-	-	2	0.08 - 0.10
E. of Laingsburg	2	1	-	-	-	-	3	0.10 - 0.12
ROBUSTA.								
Lake Mentz	-	-	-	-	1	-	1	0.50
Steytlerville	-	1	-	-	-	-	1	0.20
Miller	-	-	1	-	-	-	1	0.30
Willowmore	-	-	1	-	-	-	1	0.30
Prince Albert	-	1	-	-	-	-	1	0.20
Whitehill	-	2	1	-	-	-	3	0.20 - 0.30
Matjesfontein	-	-	1	-	-	-	1	0.28
Beaufort West	-	2	1	-	-	-	3	0.20 - 0.28

Class interval 0.1 cm.

Table 46 VARIATION IN MIDDLE WIDTH OF BASAL STERILE BRACTS IN FOLIOLOSA COMPLEX.

Locality.	Class range of measurements. 3	5	7	9	11		Total no. indiv.	Range actual measurements.
			FIELD SPECIMENS.					
CONGESTA.								
Cradock R32	-	1	-	-	-	-	1	3.26
S.of Adelaide R38,39	1	4	4	1	0	-	10	2.76 - 7.47
Dikkop Vlakte R40	5	1	-	-	-	-	6	2.17 - 3.91
Helspoort R41	4	4	1	-	-	-	9	1.91 - 5.29
Krantz Drift	1	-	-	-	-	-	1	2.48
FOLIOLOSA.								
Graaff Reinet R60	4	20	4	1	-	-	29	2.38 - 7.22
Mt. Stewart R52	-	-	4	1	-	-	5	5.38 - 8.57
Baroe R12	-	-	-	-	-	1	1	12.80
Springbok Vlakte Nbg	-	-	1	-	-	-	1	5.46
Steytlerville	-	2	6	6	3	1	18	4.41 -12.50
ROBUSTA.								
Steytlerville R43	1	12	2	-	-	-	15	2.50 - 6.50
Nr. Miller R45	1	4	2	-	-	-	7	2.80 - 5.65
Prince Albert R64	-	9	12	3	-	-	24	3.15 - 8.52
E.of Laingsburg R1	-	2	-	-	-	-	2	4.56 - 3.80
Whitehill 0	-	3	5	1	-	-	9	4.56 - 3.80
E. of Nelspoort R42	1	5	3	2	-	-	12	2.69 - 8.00
Ft. of Molteno Pass (Hall 2284)	4	5	2	1	-	-	12	2.50 - 7.06
			HERBARIUM SPECIMENS.					
CONGESTA.								
Helspoort	2	1	-	-	-	-	3	2.50 - 4.25
FOLIOLOSA.								
Koega Kammas Kloof	-	-	-	1	-	-	1	9.00
Swartkops Sundays	-	-	-	-	1	-	1	10.00
Kleinpoort	-	1	1	-	-	1	3	4.50 -13.00
Steytlerville	-	-	-	-	1	-	1	10.50
Waterford	1	-	-	-	-	-	1	2.77
Kruidfontein	-	-	-	1	1	-	2	7.50 - 9.37
E. of Laingsburg	-	-	2	-	1	-	3	6.60 - 9.50
ROBUSTA.								
Lake Mentz	1	-	-	-	-	-	1	2.80
Steytlerville	-	-	1	-	-	-	1	5.50
Miller	-	1	-	-	-	-	1	3.33
Willowmore	-	-	1	-	-	-	1	6.00
Prince Albert	-	-	1	-	-	-	1	5.50
Whitehill	-	1	2	-	-	-	3	4.63 - 6.75
Matjesfontein	-	1	-	-	-	-	1	3.57
Beaufort West	-	3	-	-	-	-	3	4.10 - 4.75

Class interval 2.0

Table 47 VARIATION IN LENGTH - BREADTH RATIO OF BASAL STERILE BRACTS IN FOLIOLOSA COMPLEX.

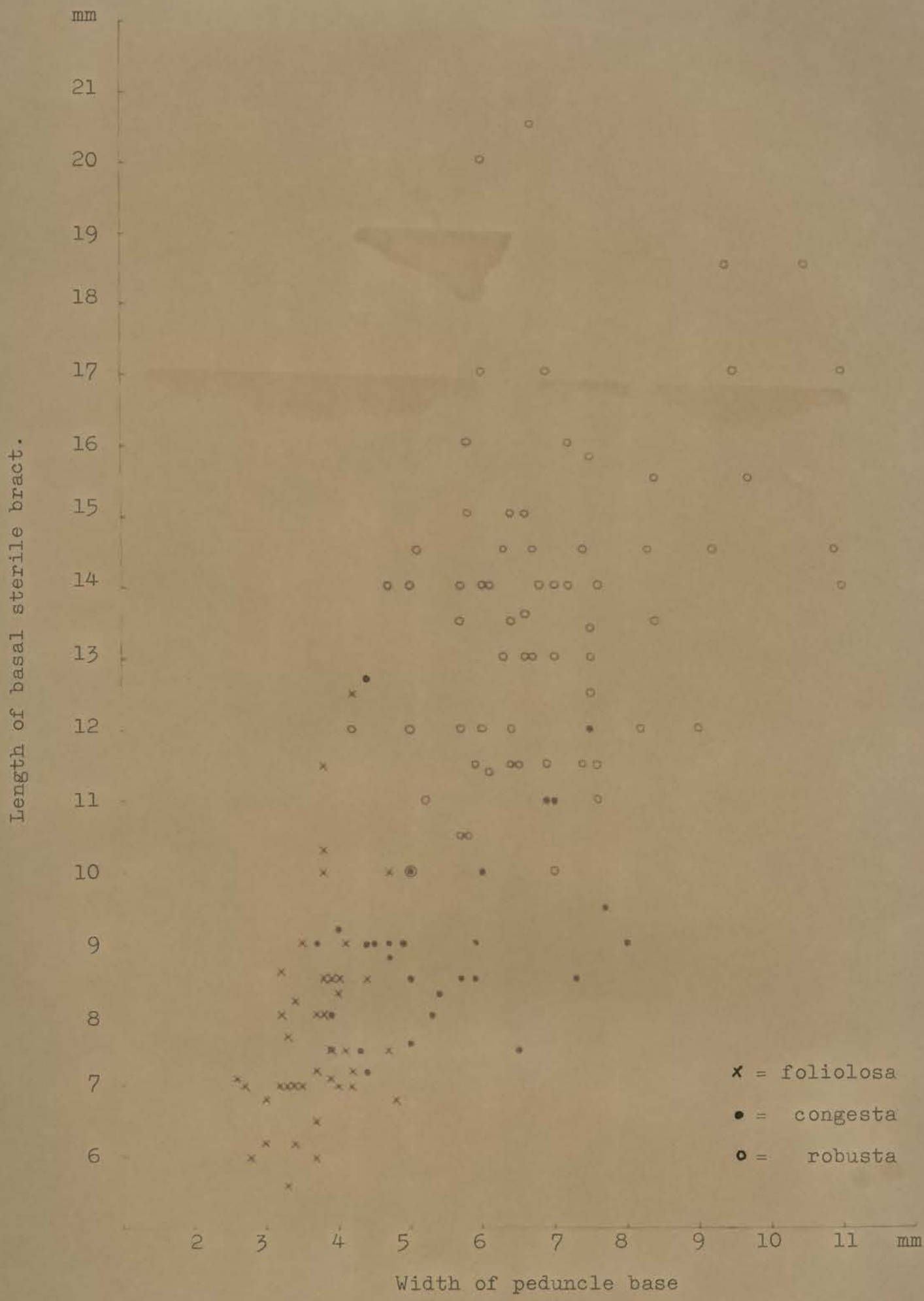


Fig.32. Variation in length of basal sterile bract and width of peduncle base in the foliolosa complex.

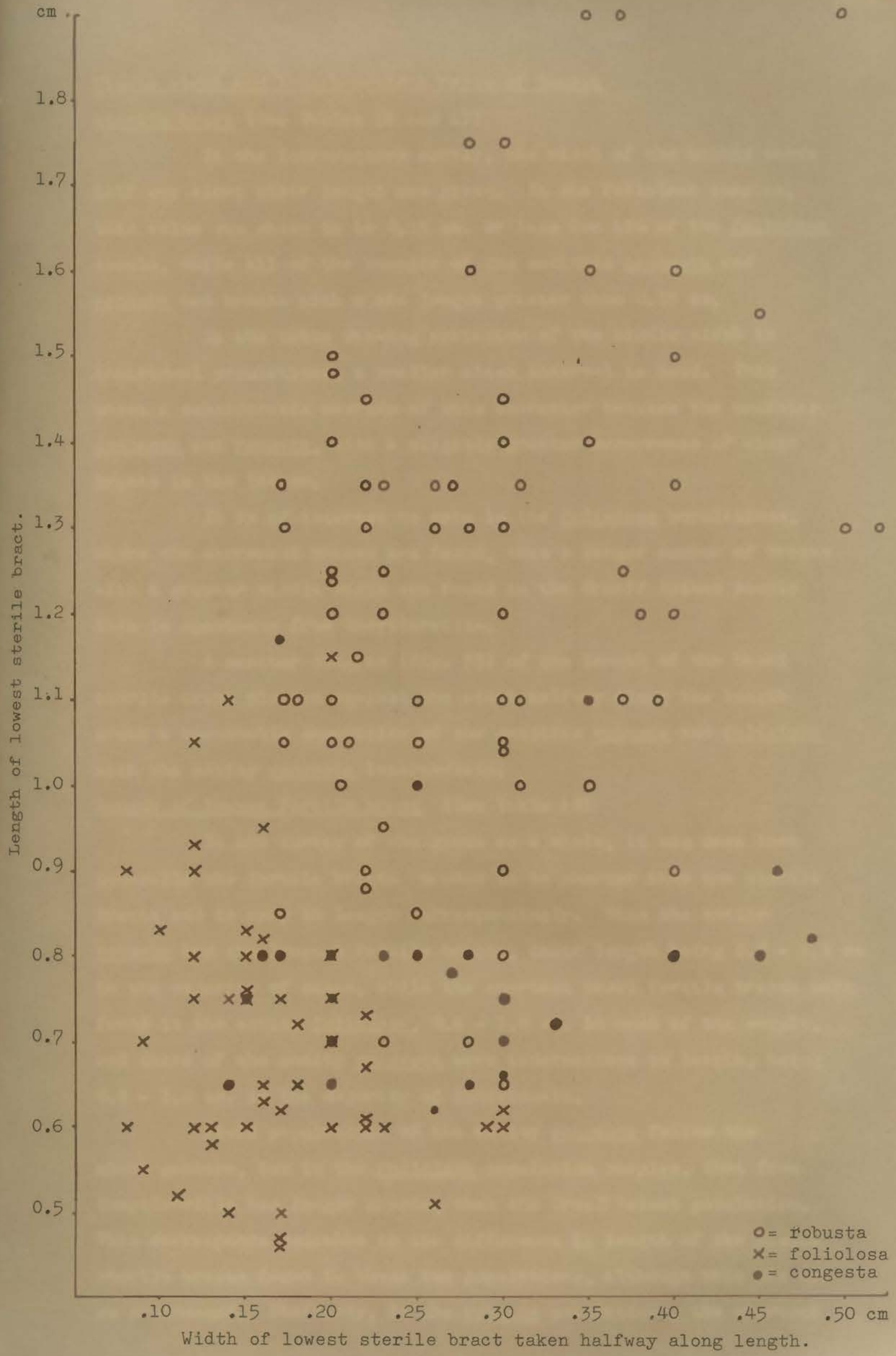


Fig.33. Variation in length and middle width of lowest sterile bract in the foliolosa complex.

Middle width and length-breadth ratio of lowest sterile bract (See Tables 46 and 47)

In the introductory survey, the width of the bracts taken half way along their length was given. In the foliolosa complex, this value was shown to be 0.15 cm. or less for 45% of the foliolosa sample, while all of the samples of the entities congesta and robusta had bracts with a mid length greater than 0.15 cm.

In the table showing variation of the middle width in individual populations, a smaller class interval is used. This shows a considerable overlap of this character between the entities congesta and robusta, with a slightly greater occurrence of wider bracts in the latter.

It is of interest to note in the foliolosa populations, where the narrowest bracts are found, that a larger number of bracts with a greater middle width are found in the Graaff Reinet sample than in specimens from Steytlerville.

A scatter diagram (Fig. 33) of the length of the basal sterile bract plotted against the width halfway along the length shows a reasonable separation of the entities robusta and foliolosa with the entity congesta intermediate.

Length of lowest fertile bract (See Table 48)

In the survey of the genus as a whole, it was seen that generally the fertile bracts tended to be shorter than the sterile bracts and to vary in length correspondingly. Thus the entity robusta had the longest fertile bracts, their length being 0.8 - 1.2 cm in the majority of cases, while the shortest basal fertile bracts were found in the entity foliolosa, 0.6 - 1.0 cm. in most of the sample, and those of the entity congesta were intermediate in length, being 0.8 - 1.0 cm. in the majority of individuals.

Field populations of the entity congesta follow the above pattern, but in the foliolosa population samples, that from Steytlerville has longer bracts, than the Graaff Reinet population. This corresponds somewhat to the difference in length of the lowest sterile bracts found in these two populations, although this was not as pronounced. Similarly, in the robusta populations, the shortest

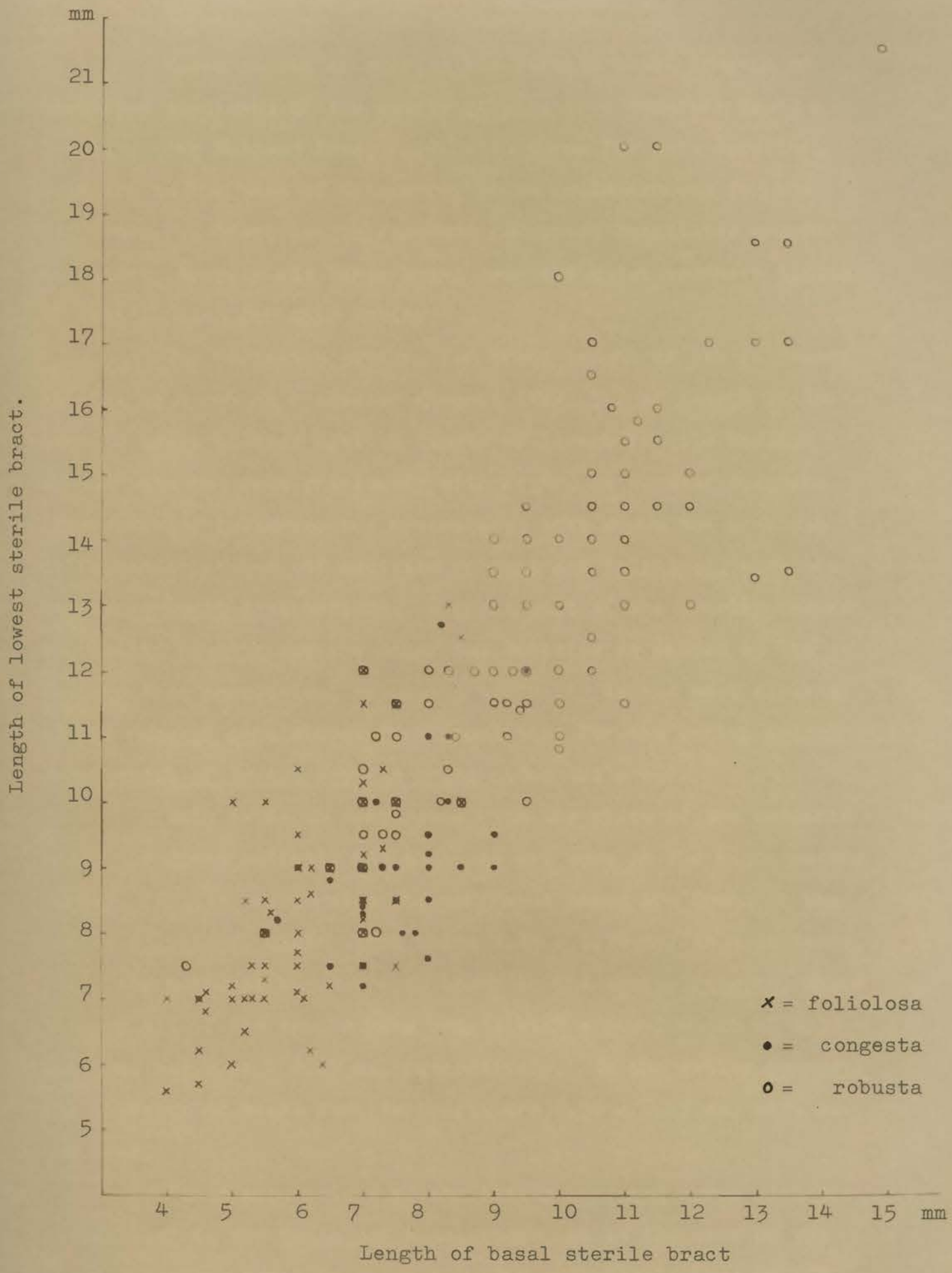


Fig.34. Variation in length of basal sterile and fertile bracts in the foliolosa complex.

basal fertile bracts are found in plants from the foot of Molteno Pass.

Measurements of sterile and fertile bract lengths of herbarium specimens of the entity robusta from Beaufort West, a locality near Molteno Pass, agree with those for this locality. Both are to the West of Nelspoort, which could account for the difference in bract length recorded for these localities and for Nelspoort, despite all three being near the known northern limits of distribution for this entity.

The variation pattern for bract length in the foliolosa complex is shown in a scatter diagram (Fig. 34) of length of lowest sterile bract plotted against length of lowest fertile bract. As has been the case previously with regard to scatter diagrams incorporating inflorescence characters, this shows the greatest differences between the entities robusta and foliolosa, with the entity congesta intermediate. A great part of the overlap between the entity robusta and the other two entities is caused by the Molteno Pass population, which geographically is the most distant of all robusta populations from localities for the entity foliolosa.

Basal width of lowest fertile bract (See Table 49)

This tends to correspond with the width of the peduncle below the first pedicel, and thus, as was seen in the introductory survey, fertile bracts with the narrowest bases are found in the entity foliolosa, their width being 0.15 - 0.30 cm. in most cases, while the broadest based bracts occur in the entity robusta, where 34% and 51% of the sample have bracts with a basal width of 0.30 - 0.45 cm. and 0.45 - 0.60 cm. respectively. In the entity congesta the majority of basal fertile bracts are 0.30 - 0.45 cm. wide at the base.

Field populations of the entity congesta agree with the above, but, in the foliolosa populations, as in the case of the sterile bracts, there is a tendency for individuals from Graaff Reinet to have broader bases to the fertile bracts than those from Steytlerville.

In robusta populations, fertile bracts with the narrowest bases are found in specimens from Nelspoort and Molteno Pass. In

Locality	Class Range of Measurements							Total no. Indiv.	Range actual measurements.
	0.4	0.6	0.8	1.0	1.2	1.4			cm.
FIELD SPECIMENS.									
CONGESTA.									
Cradock R32	-	-	1	-	-	-	-	1	0.65
S. Adelaide R38,39	-	4	14	2	-	-	-	20	0.50 - 0.90
Dikkop Vlakte R40	-	-	3	3	-	-	-	6	0.70 - 0.90
Helspoort R41	-	1	10	3	-	-	-	14	0.55 - 0.95
Krantz Drift	-	1	-	-	-	-	-	1	0.57
FOLIOLOSA.									
Graaff Reinet R60	2	23	8	-	-	-	-	33	0.40 - 0.75
Mt. Stewart R52b	-	2	5	-	-	-	-	7	0.53 - 0.73
Baroe R12	-	-	-	1	-	-	-	1	0.90
Wolwefontein R11	-	1	2	-	-	-	-	3	0.57 - 0.70
Springbok Vlakte Nbg	-	1	1	-	-	-	-	2	0.46 - 0.75
Steytlerville R52a	-	6	14	1	-	-	-	21	0.50 - 0.85
ROBUSTA.									
Steytlerville R43	-	-	2	7	6	-	-	15	0.70 - 1.10
Miller R45	-	-	-	1	5	1	-	7	1.00 - 1.30
Prince Albert R64	-	-	3	8	11	2	-	24	0.75 - 1.35
E. Laingsburg R1	-	-	-	2	-	-	-	2	0.83 - 0.94
Whitehill 0	-	-	-	1	4	3	1	9	1.00 - 1.50
E. Nelspoort R42	-	-	-	2	9	-	-	11	0.95 - 1.2
Molteno Pass H2284	-	2	10	3	-	-	-	15	0.43 - 1.0
HERBARIUM SPECIMENS.									
CONGESTA.									
Cradock	-	-	1	-	-	-	-	1	0.63
Mortimer	-	1	-	-	-	-	-	1	0.50
Helspoort	-	2	3	-	-	-	-	5	0.50 - 0.80
Brakkloof	-	1	-	-	-	-	-	1	0.60
FOLIOLOSA.									
Addo Bush	-	1	-	-	-	-	-	1	0.45
Koega Kammas Kloof	-	1	-	-	-	-	-	1	0.60
Swartkops Sundays	-	1	-	-	-	-	-	1	0.50
Kleinpoort	-	-	1	2	-	-	-	3	0.70 - 0.85
Steytlerville	-	-	1	-	-	-	-	1	0.73
Waterford	-	-	1	-	-	-	-	1	0.75
Kruidfontein	-	1	-	-	-	-	-	1	0.60
Graaff Reinet	-	1	1	-	-	-	-	2	0.50 - 0.63
E. Laingsburg (?)	-	3	-	-	-	-	-	3	0.55 - 0.60
ROBUSTA.									
Lake Mentz	-	-	-	1	-	-	-	1	0.90
Steytlerville	-	-	2	-	-	-	-	2	0.70 - 0.75
Miller	-	-	-	1	-	-	-	1	0.82
Willowmore	-	-	-	1	-	-	-	1	1.00
Prince Albert	-	-	-	1	-	-	-	1	0.92
Whitehill	-	-	-	1	1	1	-	3	1.00 - 1.35
Matjesfontein	-	-	1	-	-	-	-	1	0.75
Beaufort West	-	-	2	1	-	-	-	3	0.70 - 1.00

Class interval 0.2 c.m.

Table 48 VARIATION IN LENGTH OF BASAL FERTILE BRACT IN FOLIOLOSA COMPLEX.

Locality.	Class range of measurements					Total no. indiv.	Range actual measurements.
	0.30	0.45	0.60	0.75			cm.
FIELD SPECIMENS.							
CONGESTA.							
Cradock R32	-	1	-	-	-	1	0.45
S.of Adelaide R38,39	-	18	1	-	-	19	0.34 - 0.47
Dikkop Vlakte R40	-	4	2	-	-	6	0.35 - 0.58
Helspoort R41	-	13	1	-	-	14	0.34 - 0.46
Krantz Drift (Commins 2063)	-	1	-	-	-	1	0.45
FOLIOLOSA.							
Graaff Reinet R60	19	14	-	-	-	33	0.22 - 0.45
Mt. Stewart R52b	6	-	-	-	-	6	0.28 - 0.30
Wolwefontein R11	1	-	-	-	-	1	0.22
Springbok Vlakte Nbg	2	-	-	-	-	2	0.22 - 0.30
Steytlerville R52a	20	1	-	-	-	21	0.20 - 0.40
ROBUSTA.							
Steytlerville R43	-	1	12	2	-	15	0.45 - 0.65
nr. Miller R45	-	2	5	-	-	7	0.45 - 0.55
Prince Albert R64	-	4	16	4	-	24	0.40 - 0.75
E. of Laingsburg R1	-	1	1	-	-	2	0.45 - 0.47
Whitehill 0	-	-	2	6	1	9	0.57 - 0.80
E. of Nelspoort R42	-	7	3	1	-	11	0.40 - 0.62
Ft. of Molteno Pass (Hall 2289)	-	8	8	-	-	16	0.35 - 0.55
HERBARIUM SPECIMENS.							
CONGESTA.							
Cradock	1	-	-	-	-	1	0.28
Mortimer	-	1	-	-	-	1	0.34
Helspoort	2	3	-	-	-	5	0.30 - 0.40
Brakkloof	-	1	-	-	-	1	0.33
FOLIOLOSA.							
Addo Bush	1	-	-	-	-	1	0.20
Koega Kammas Kloof	1	-	-	-	-	1	0.20
Swartkops Sundays	1	-	-	-	-	1	0.18
Kleinpoort	3	-	-	-	-	3	0.20 - 0.24
Steytlerville	1	-	-	-	-	1	0.26 -
Waterford	1	-	-	-	-	1	0.23
Kruidfontein	1	-	-	-	-	1	0.30
Graaff Reinet	2	-	-	-	-	2	0.22 - 0.28
E. of Laingsburg	3	-	-	-	-	3	0.25 - 0.30
ROBUSTA.							
Lake Mentz	-	1	-	-	-	1	0.40
Steytlerville	-	1	1	-	-	2	0.40 - 0.55
Miller	-	-	1	-	-	1	0.48
Willowmore	-	1	-	-	-	1	0.44
Prince Albert	-	1	-	-	-	1	0.40
Whitehill	-	3	-	-	-	3	0.40 - 0.43
Matjesfontein	-	1	-	-	-	1	0.40
Beaufort West	1	2	-	-	-	3	0.30 - 0.40

Class interval 0.15 cm

Table 49 VARIATION IN WIDTH OF BASE OF LOWEST FERTILE BRACT IN FOLIOLOSA COMPLEX.

Locality.	Class range of measurements.				Total no. indiv.	Range actual measurements.
	0.1	0.2	0.3			cm.
MELD SPECIMENS.						
CONGESTA.						
Cradock R32	-	1	-	-	1	0.16
S.of Adelaide R38,39	-	16	3	-	19	0.11 - 0.28
Dikkop Vlakte R40	-	-	4	2	6	0.25 - 0.40
Helspoort R41	-	2	6	2	10	0.20 - 0.35
Krantz Drift (Commins.2063)	-	-	1	-	1	0.30
FOLIOLOSA.						
Graaff Reinet R60	3	29	1	-	33	0.06 - 0.22
Mt. Stewart R52b	3	3	-	-	6	0.10 - 0.15
Wolwefontein R11	-	1	-	-	1	0.13
Sprinbok Vlakte Nbg	-	1	-	-	1	0.11
Steytlerville R52a	17	4	-	-	21	0.06 - 0.17
ROBUSTA.						
Steytlerville R43	-	-	9	6	15	0.25 - 0.40
nr. Miller R45	-	-	4	3	7	0.25 - 0.35
Prince Albert R64	-	14	8	2	24	0.17 - 0.37
E.of Laingsburg R1	-	-	2	-	2	0.25
Whitehill O	-	1	8	-	9	0.17 - 0.30
E. of Nelspoort R42	-	-	10	1	11	0.23 - 0.33
Ft. of Molteno Pass (Hall 2284)	-	7	9	-	16	0.14 - 0.28
HERBARIUM SPECIMENS.						
CONGESTA.						
Cradock	-	1	-	-	1	0.20
Mortimer	-	-	1	-	1	0.23
Brakkloof	-	-	1	-	1	0.23
Helspoort	-	3	2	-	5	0.16 - 0.28
FOLIOLOSA.						
Addo Bush	1	-	-	-	1	0.08
Koega Kammas Kloof	1	-	-	-	1	0.06
Swartkops Sundays	1	-	-	-	1	0.08
Kleinpoort	2	1	-	-	3	0.08 - 0.14
Steytlerville	1	-	-	-	1	0.10
Waterford	1	-	-	-	1	0.08
Kruidfontein	1	-	-	-	1	0.10
Graaff Reinet	2	-	-	-	2	0.10
E. of Laingsburg	1	2	-	-	3	0.10 - 0.14
ROBUSTA.						
Lake Mentz	-	1	-	-	1	0.20
Steytlerville	-	-	2	-	2	0.23 - 0.28
Miller	-	-	1	-	1	0.30
Willowmore	-	-	1	-	1	0.24
Prince Albert	-	1	-	-	1	0.20
Whitehill	-	1	2	-	3	0.16 - 0.30
Matjesfontein	-	-	1	-	1	0.26
Beaufort West	-	2	1	-	3	0.20 - 0.28

Class interval 0.1 cm.

Table 50 VARIATION IN MIDDLE WIDTH OF BASAL FERTILE BRACTS IN FOLIOLOSA COMPLEX.

Locality.	Class range of measurements. 3	5	7	9	11		Total no. indiv.	Range actual measurements.
FIELD SPECIMENS.								
CONGESTA.								
Cradock R32	-	1	-	-	-	-	1	4.06
S.of Adelaide R38,39	2	12	5	-	-	-	19	2.73 - 6.82
Dikkop Vlakte R40	4	2	-	-	-	-	6	2.12 - 3.60
Helspoort R41	4	6	-	-	-	-	10	2.17 - 4.15
Krantz Drift (Commins2063)	1	-	-	-	-	-	1	1.90
FOLIOLOSA.								
Graaff Reinet R60	6	23	3	1	-	-	33	2.50 - 7.50
Mt. Stewart R52	-	1	5	-	-	-	6	4.13 - 7.00
Wolwefontein R11	-	1	-	-	-	-	1	4.38
Springbok Vlakte Nbg	-	1	-	-	-	-	1	4.18
Steytlerville R52	-	4	9	4	3	1	21	4.12 -11.67
ROBUSTA.								
Steytlerville R43	7	8	-	-	-	-	15	2.43 - 3.75
Miller R45	-	7	-	-	-	-	7	3.28 - 4.80
Prince Albert R64	1	14	8	1	-	-	24	2.28 - 7.06
E.of Laingsburg R1	-	2	-	-	-	-	2	3.32 - 3.76
Whitehill 0	-	6	3	-	-	-	9	3.57 - 6.00
Nelspoort R42	-	10	1	-	-	-	11	3.18 - 5.21
Molteno Pass (Hall 2284)	5	7	4	-	-	-	16	1.95 - 6.42
HERBARIUM SPECIMENS.								
CONGESTA.								
Cradock	-	1	-	-	-	-	1	3.15
Mortimer	1	-	-	-	-	-	1	2.17
Helspoort	3	2	-	-	-	-	5	2.00 - 4.37
Brakkloof	1	-	-	-	-	-	1	2.61
FOLIOLOSA.								
Addo Bush	-	-	1	-	-	-	1	5.62
Koega Kammas Kloof	-	-	-	-	1	-	1	10.00
Swartkops Sundays	-	-	1	-	-	-	1	6.25
Kleinpoort	-	-	2	-	1	-	3	6.07 -10.37
Steytlerville	-	-	-	1	-	-	1	7.30
Waterford	-	-	-	-	1	-	1	9.38
Kruidfontein	-	-	1	-	-	-	1	6.00
Graaff Reinet	-	1	1	-	-	-	2	6.30 - 5.00
E.of Laingsburg	-	2	1	-	-	-	3	4.29 - 5.50
ROBUSTA.								
Lake Mentz	-	1	-	-	-	-	1	4.50
Steytlerville	1	1	-	-	-	-	2	2.68 - 3.04
Miller	-	-	1	-	-	-	1	6.73
Willowmore	-	1	-	-	-	-	1	4.17
Prince Albert	-	1	-	-	-	-	1	4.60
Whitehill	-	2	1	-	-	-	3	3.50 - 6.25
Matjesfontein	1	-	-	-	-	-	1	2.88
Beaufort West	1	2	-	-	-	-	3	2.68 - 5.00

Class interval 2.0

Table 51 VARIATION IN LENGTH-BREADTH RATIO OF BASAL FERTILE BRACTS IN FOLIOLOSA COMPLEX.

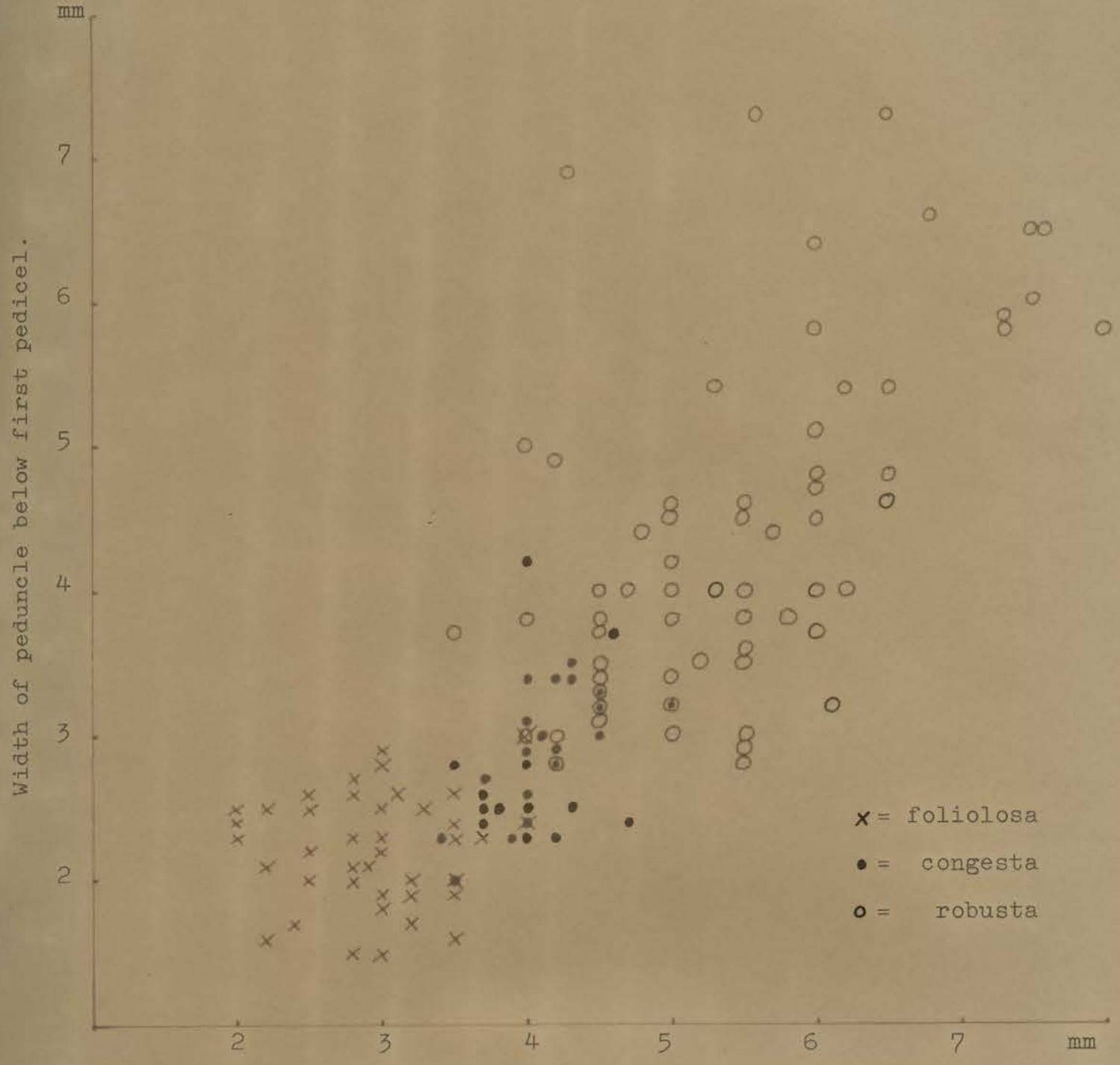


Fig.35. Showing variation in width of peduncle below raceme and basal width of lowest fertile bract in the foliolosa complex.

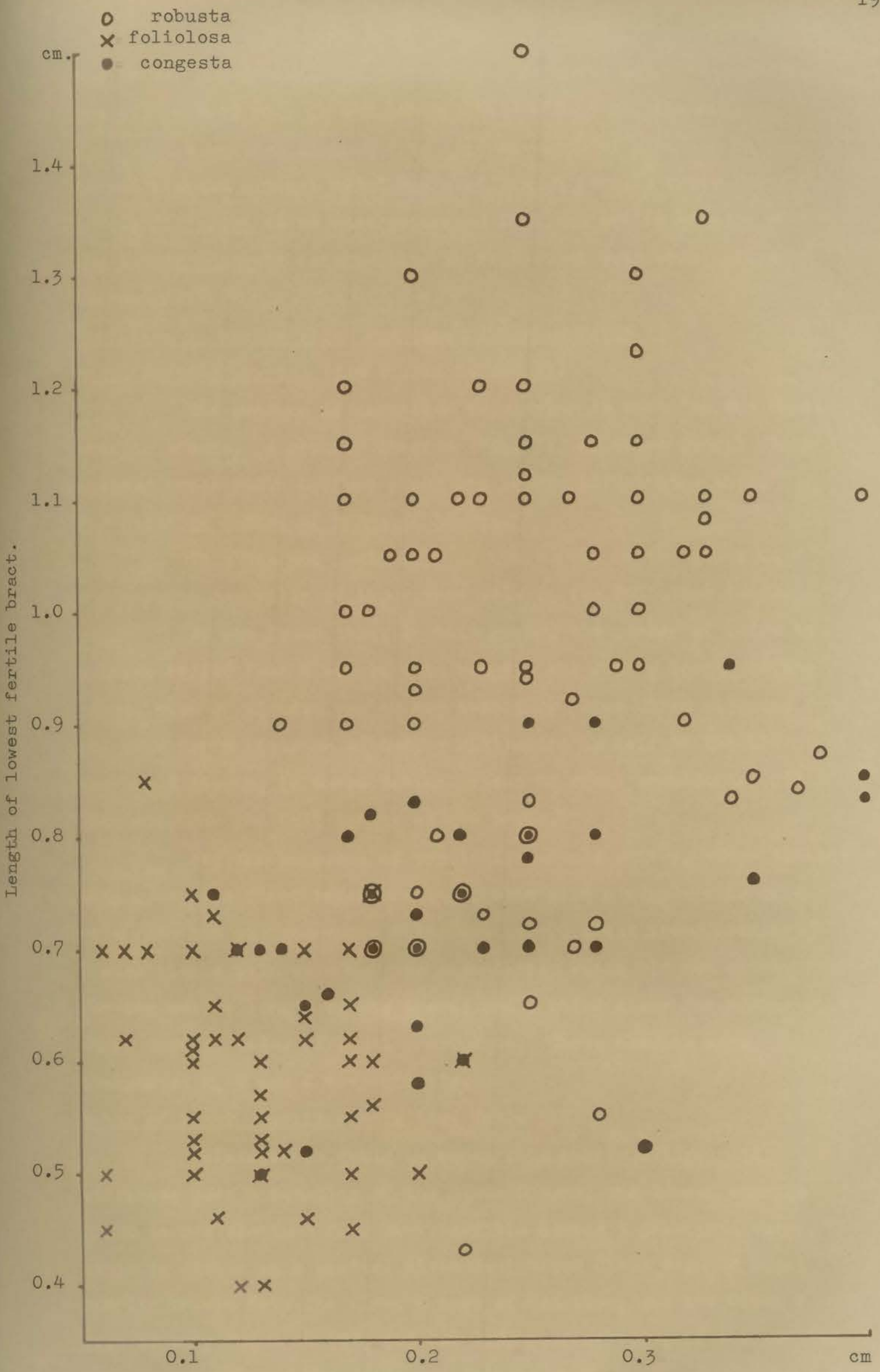


Fig.36. Variation in length, and width halfway along length of lowest fertile bract in the foliolosa complex.

the former population, the width of the peduncle below the raceme was 0.30 - 0.45 cm., in the latter, 0.15 - 0.45 cm. for most specimens.

A scatter diagram (Fig. 35) of width of peduncle below raceme plotted against basal width of lowest fertile bract shows the entity foliolosa to be most separated from the entity robusta with the entity congesta intermediate in respect of this combination of characters.

Variation in middle width and length-breadth ratio in basal fertile bracts. (See Tables 50 and 51)

The pattern of variation is similar to that for the basal sterile bracts. A scatter diagram (Fig. 36) of bract length plotted against bract width halfway along the length illustrates this.

Variation in number of veins in bracts.

This was not dealt with in the survey of the genus as a whole as it is really of importance only in the foliolosa complex.

It was found that, in this group, the number of veins in a bract varied from a single vein running the entire length of the bract, with or without one or two secondary veins which extended from the base for a distance of only a millimetre to half or two thirds of the bract length, to three central veins of equal prominence, all extending for the full length of the bract.

For the purposes of population sample survey, three classes were used, the first incorporating bracts with a single vein or a main vein and one secondary vein; the second class incorporating bracts with a main vein and two secondaries which did not extend for the entire length of the bract; and a third class for bracts with three central veins of equal prominence. These classes were designated A, B and C respectively.

Veins of basal sterile bracts (See Table 52)

Reference to Table 52 shows that nearly all robusta specimens have a venation of the Class C type, the lowest sterile bract in one specimen from Steytlerville having 5 prominent veins, (this is placed in a special class designated Class D). No basal sterile bracts have the Class A type of venation, and the Class B type is only found in 17%, 10% and 27%, respectively, of the samples from Prince Albert, Whitehill and Molteno Pass.

Locality.	D	C	B	A	No. in sample.
CONGESTA.					
Cradock R32	-	-	2	-	2
S. of Adelaide R38,39	-	-	5	1	6
Dikkop Vlakte R40	-	2	4	-	6
Nelspoort R41	-	-	9	1	10
Krantz Drift (Commins 2063)	-	-	1	-	1
FOLIOLOSA.					
Graaff Reinet R10	-	2	19	11	32
Mt. Stewart R52	-	1	3	1	5
Wolwefontein R11	-	-	1	-	1
Springbok Vlakte Nbg	-	1	1	-	2
Steytlerville R52	-	2	10	3	15
ROBUSTA.					
Steytlerville R43	1	14	-	-	15
nr. Miller R45	-	7	-	-	7
Prince Albert R64	-	23	5	-	28
E. of Laingsburg R1	-	2	-	-	2
Whitehill O	-	9	1	-	10
E. of Nelspoort	-	11	-	-	11
Ft. of Molteno Pass (Hall 2284)	-	11	4	-	15

TABLE 52 Variation in veins of lowest sterile bract in Field Specimens of Foliolosa Complex.

In foliolosa and congesta population samples, the majority of basal sterile bracts have venation of the Class B type, the Class C type only being found in 8% of the congesta sample and 11% of the foliolosa sample. It is of interest to note in the foliolosa samples, that Class A venation is found in 34% of specimens from Graaff Reinet, compared with 20% of the Steytlerville sample.

Veins of fertile bracts (See Table 53)

The type of venation found in bracts from the base middle and top of the raceme was noted.

Basal fertile bracts

All populations of the entity robusta have Class C venation, in the great majority of specimens, with two exceptions. In the Molteno Pass population, 45% of the basal fertile bracts have Class B venation, while in specimens from Prince Albert, Class B venation is found in 30%, and Class A in 25% of the sample.

In congesta populations, the basal fertile bracts have a venation of Class A or Class B type, while the majority of specimens in the foliolosa populations have Class A venation.

Middle fertile bracts.

With the exception of one congesta specimen all bracts from the middle of racemes of foliolosa and congesta samples have Class A venation.

In the robusta populations, all individuals from Steytlerville and Miller, and 56% of the Whitehill sample still have bracts with Class C venation. Class B venation is found in 73% of the Molteno Pass sample, while the majority of individuals from Prince Albert have Class B or Class A venation, and Class A venation is found in 70% of the Nelspoort sample.

Apical fertile bracts

All bracts from the apices of racemes of the entities congesta and foliolosa have Class A venation, and this now applies to the majority of robusta specimens, with a few exceptions. In the Steytlerville population 75% of the bracts still have Class C venation, but the remainder have the Class A type. Mention must be made of the three specimens from East of Laingsburg, the apical

Locality.	Class range of variation in veins of bracts.									No. in sample.
	BASE OF RACEME.			MIDDLE OF RACEME.			TOP OF RACEME.			
	C	B	A	C	B	A	C	B	A	
<u>CONGESTA.</u>										
Cradock R32	-	1	1	-	-	2	-	-	2	2
S.of Adelaide R38,39	-	6	8	-	-	14	-	-	14	14
Dikkop Vlakte R40	-	3	2	-	-	5	-	-	5	5
Helspoort R41	-	5	5	-	1	9	-	-	10	10
Krantz Drift (Commins 2063)	-	-	1	-	-	1	-	-	1	1
<u>FOLIOLOSA.</u>										
Graff Reinet R60	-	8	23	-	-	31	-	-	31	31
Mt. Stewart R52	-	1	5	-	-	6	-	-	6	6
Wolwefontein R11	-	-	1	-	-	1	-	-	1	1
Springbok Vlakte Nbg	-	-	1	-	-	1	-	-	1	1
Steytlerville R52	-	2	13	-	-	15	-	-	15	15
<u>ROBUSTA.</u>										
Steytlerville R43	12	-	-	12	-	-	8	-	4	12
nr. Miller R45	7	-	-	7	-	-	-	-	-	7
Prince Albert R64	11	7	6	2	9	13	2	-	22	24
E. of Laingsburg R1	3	-	-	-	3	-	-	3	-	3
Whitehill 0	7	1	1	5	3	1	-	2	7	9
E. of Nelspoort R42	9	1	-	-	3	7	-	-	10	10
Ft. of Molteno Pass (Hall 2284)	5	5	1	-	8	3	-	-	11	11

Table 53 Variation in veins of Fertile Bracts in Field Populations of the Foliolosa Complex.

bracts of which all have Class B venation.

The very high incidence of basal sterile and fertile bracts with three central veins in the entity robusta, compared with the very low incidence of such veins in the basal sterile bracts of the entities congesta and foliolosa, and their complete absence in the basal fertile bracts of these two entities is a further indication of a difference between them and the entity robusta.

Pedicel length (See Tables 54A, B, C and D)

In the tables showing variation in pedicel length in the foliolosa complex, a class interval of 0.05 cm., smaller than that of the introductory survey, is used to show more clearly the extreme shortness of the pedicels in the robusta entity.

In the introductory survey, it was shown that the shortest basal flowering pedicels occur in the entity robusta, where none of the specimens were found to be more than 0.2 cm. long. In both the entities congesta and foliolosa these pedicels ranged from less than 0.2 cm. to 0.4 cm. in length.

In individual populations of the entity robusta, the shortest basal pedicels are found in specimens from Nelspoort, where over half the sample have sessile flowers. It is of interest to note a pedicel length of 0.18 cm. recorded from the same population. The longest pedicels are found in plants from Molteno Pass, which locality, like Nelspoort, is at the northern end of the distribution range for this entity.

In the congesta and foliolosa populations, all pedicels, with the exception of four specimens, exceed 0.1 cm. in length. Thus the overlap with measurements for the entity robusta is quite small.

A scatter diagram (Fig. 37) of length of lowest flowering pedicel plotted against length of lowest fertile bract gives a good separation of the entities robusta from congesta and foliolosa, with the exception of an overlap due to individuals from Molteno Pass.

In the entity robusta, all pedicels from the middle of flowering racemes are found to be less than 0.05 cm. long, with

Locality.	Class range of measurements.									Total no. indiv.	Range actual measurements.
	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35			cm.
CONGESTA.											
Cradock R32	-	-	-	-	2	3	2	-	-	8	0.17 - 0.40
S. of Adelaide R38,39	-	-	-	2	4	5	1	1	-	13	0.14 - 0.35
Dikkop Vlakte R40	-	-	1	1	2	-	-	-	-	4	0.08 - 0.20
Helspoort R41	-	-	2	1	1	2	-	-	-	6	0.07 - 0.25
FOILOLOSA.											
Graaff Reinet R60	-	-	-	1	10	5	4	1	-	21	0.14 - 0.34
Mt. Stewart R52b	-	-	-	1	1	-	-	-	1	3	0.15 - 0.38
Baroe R12	-	-	-	-	-	-	-	1	-	1	0.32
Wolwefontein R11	-	-	-	-	-	1	2	-	-	3	0.23 - 0.30
Springbok Vlakte Nbg	-	-	-	1	1	-	-	-	-	2	0.14 - 0.19
Steytlerville R52a	-	-	1	4	3	3	4	-	-	15	0.09 - 0.30
ROBUSTA.											
Steytlerville R43	2	5	2	-	-	-	-	-	-	9	0.00 - 0.08
Nr. Miller R45	-	5	2	-	-	-	-	-	-	7	0.02 - 0.09
Prince Albert R64	4	11	3	-	-	-	-	-	-	18	0.00 - 0.07
E. of Laingsburg R1	2	-	-	-	-	-	-	-	-	2	0.00
Whitehill O	1	4	3	1	-	-	-	-	-	9	0.00 - 0.13
E. of Nelspoort R42	6	3	1	-	1	-	-	-	-	11	0.00 - 0.18
Ft. of Molteno Pass (Hall 2284)	1	-	3	2	-	-	-	-	-	6	0.00 - 0.13

Class interval 0.05 cm.

Table 54A VARIATION IN LENGTH OF BASAL FLOWERING PEDICEL IN FIELD SPECIMENS OF FOLIOLOSA COMPLEX.

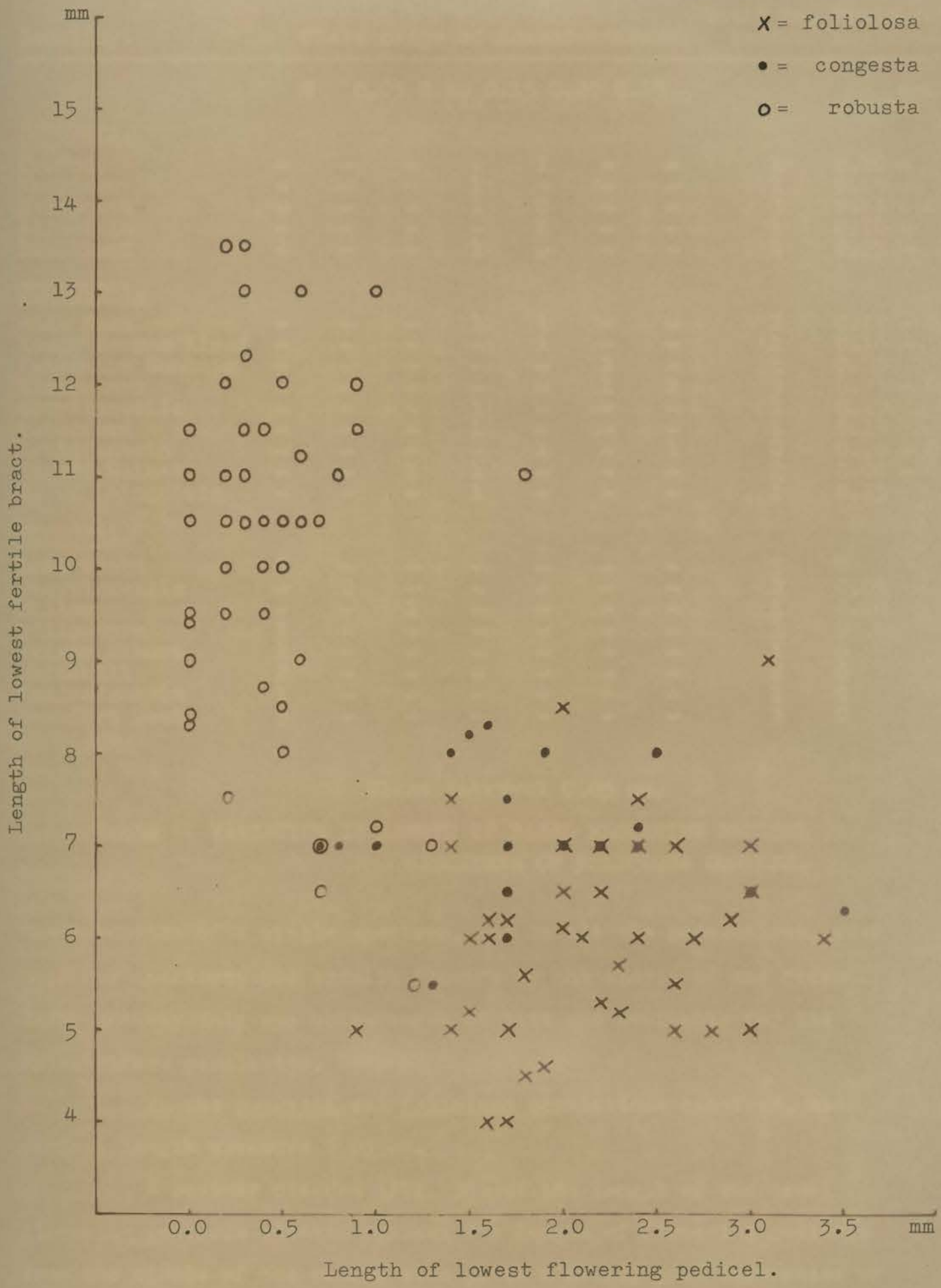


Fig.37. Variation in length of lowest fertile bract and length of lowest flowering pedicel in the foliolosa complex.

Locality.	Class range of measurements.							Total no. indiv.	Range actual measurements.
	0	0.05	0.10	0.15	0.20	0.25			cm.
CONGESTA.									
Cradock	-	-	-	-	1	-	-	1	0.16 -
Mortimer	-	-	-	1	-	-	-	1	0.14 -
Helspoort	-	-	-	1	2	-	-	3	0.14 - 0.18
Alicedale	-	-	-	-	1	-	-	1	0.18 -
Brakkloof	-	-	-	1	-	-	-	1	0.15 -
FOLIOLOSA.									
Addo Bush	-	-	-	1	1	-	-	2	0.14 - 0.18
Koega Kammas Kloof	-	-	-	-	1	-	-	1	0.18 -
Swartkops Sundays	-	-	-	-	-	1	-	1	0.25
Kleinpoort	-	-	-	-	-	1	2	3	0.23 - 0.28
Steytlerville	-	-	-	1	-	-	-	1	0.15
Waterford	-	-	-	1	-	-	-	1	0.15
Kruidfontein	-	-	-	-	1	-	1	2	0.20 - 0.29
Graaff Reinet	-	-	1	1	-	-	-	2	0.08 - 0.14
E. of Laingsburg	-	-	-	1	-	-	-	1	0.15
ROBUSTA.									
Lake mentz	1	-	-	-	-	-	-	1	0.00
Steytlerville	-	2	-	-	-	-	-	2	0.05
Miller	-	-	1	-	-	-	-	1	0.08
Willowmore	1	-	-	-	-	-	-	1	0.00
Prince Albert	1	-	-	-	-	-	-	1	0.00
Whitehill	2	-	-	-	-	-	-	2	0.00
Matjesfontein	1	-	-	-	-	-	-	1	0.00
Beaufort West	3	-	-	-	-	-	-	3	0.00

Class interval 0.05 cm.

Table 54BVARIATION IN LENGTH OF BASAL FLOWERING PEDICEL IN HERBARIUM SPECIMENS OF FOLIOLOSA COMPLEX.

the exception of a single specimen, and in all the populations, over half the specimens had sessile flowers by the middle of the raceme. Unfortunately only one measurement of this was available for the Molteno Pass population.

In the congesta and foliolosa populations examined, mid pedicel length exceeded 0.05 cm.

A scatter diagram (Fig. 38) of the length of the basal flowering pedicels plotted against the length of flowering pedicels from the middle of the raceme also gives a fairly good separation of the entity robusta from the entities congesta and foliolosa. Pedicel length in the two latter entities is very similar.

In general, herbarium specimens agree with the above observations. It is of interest to note the shortness of the pedicels of the few specimens of the entity robusta from Beaufort West in

Locality.	Class range of measurements. 0	.05	.10	.15	.20	.25	.30		Total no. indiv.	Range actual measurements cm.
FIELD SPECIMENS.										
CONGESTA.										
Cradock R32	-	-	-	2	5	3	-	-	10	0.14 - 0.24
S. of Adelaide R38,39	-	-	4	4	4	-	1	-	13	0.09 - 0.28
Dikkop Vlakte R40	-	-	1	4	-	-	-	-	5	0.10 - 0.14
Helspoort R41	-	-	8	4	1	-	-	-	13	0.06 - 0.17
FOLIOLOSA.										
Graaff Reinet R60	-	-	2	8	12	3	-	-	25	0.08 - 0.23
Mt. Stewart R52b	-	-	1	1	-	-	-	1	3	0.10 - 0.32
Baroe R12	-	-	-	-	-	1	-	-	1	0.25
Wolwefontein R11	-	-	-	-	2	1	-	-	3	0.18 - 0.25
Springbok Vlakte Nbg	-	-	1	1	-	-	-	-	2	0.09 - 0.14
Steytlerville R52a	-	-	5	4	8	2	-	-	19	0.08 - 0.24
ROBUSTA.										
Steytlerville R43	9	6	-	-	-	-	-	-	15	0.00 - 0.05
nr. Miller R45	6	1	-	-	-	-	-	-	7	0.00 - 0.02
Prince Albert R64	15	7	-	-	-	-	-	-	22	0.00 - 0.04
E. of Laingsburg R1	2	-	-	-	-	-	-	-	2	0.00
Whitehill 0	5	3	1	-	-	-	-	-	9	0.00 - 0.07
E. of Nelspoort R42	7	4	-	-	-	-	-	-	11	0.00 - 0.03
Ft. of Molteno Pass	-	1	-	-	-	-	-	-	1	0.05
HERBARIUM SPECIMENS.										
CONGESTA.										
Rayners Kop	-	-	1	-	-	-	-	-	1	0.09
Mortimer	-	-	1	-	-	-	-	-	1	0.09
Helspoort	-	-	2	2	-	-	-	-	4	0.09 - 0.15
Alicedale	-	-	1	-	-	-	-	-	1	0.05 - 0.10
FOLIOLOSA.										
Addo Bush	-	-	1	-	-	-	-	-	1	0.07
Koega Kammas Kloof	-	-	-	1	-	-	-	-	1	0.15
Kleinpoort	-	-	-	1	2	-	-	-	3	0.15 - 0.20
Waterford	-	-	1	-	-	-	-	-	1	0.10
Kruidfontein	-	-	-	1	-	-	-	-	1	0.15
E. of Langsburg	-	-	1	-	-	-	-	-	1	0.07
ROBUSTA.										
Lake Mentz	1	-	-	-	-	-	-	-	1	0.00
Steytlerville	-	2	-	-	-	-	-	-	2	0.02 - 0.03
Miller	-	1	-	-	-	-	-	-	1	0.04
Willowmore	1	-	-	-	-	-	-	-	1	0.00
Prince Albert	1	-	-	-	-	-	-	-	1	0.00
Whitehill	2	-	-	-	-	-	-	-	2	0.00
Matjesfontein	1	-	-	-	-	-	-	-	1	0.00
Beaufort West	3	-	-	-	-	-	-	-	3	0.00

Class interval 0.05 cm.

Table 54C VARIATION IN LENGTH OF FLOWERING PEDICEL FROM MIDDLE OF RACEME IN FOLIOLOSA COMPLEX.

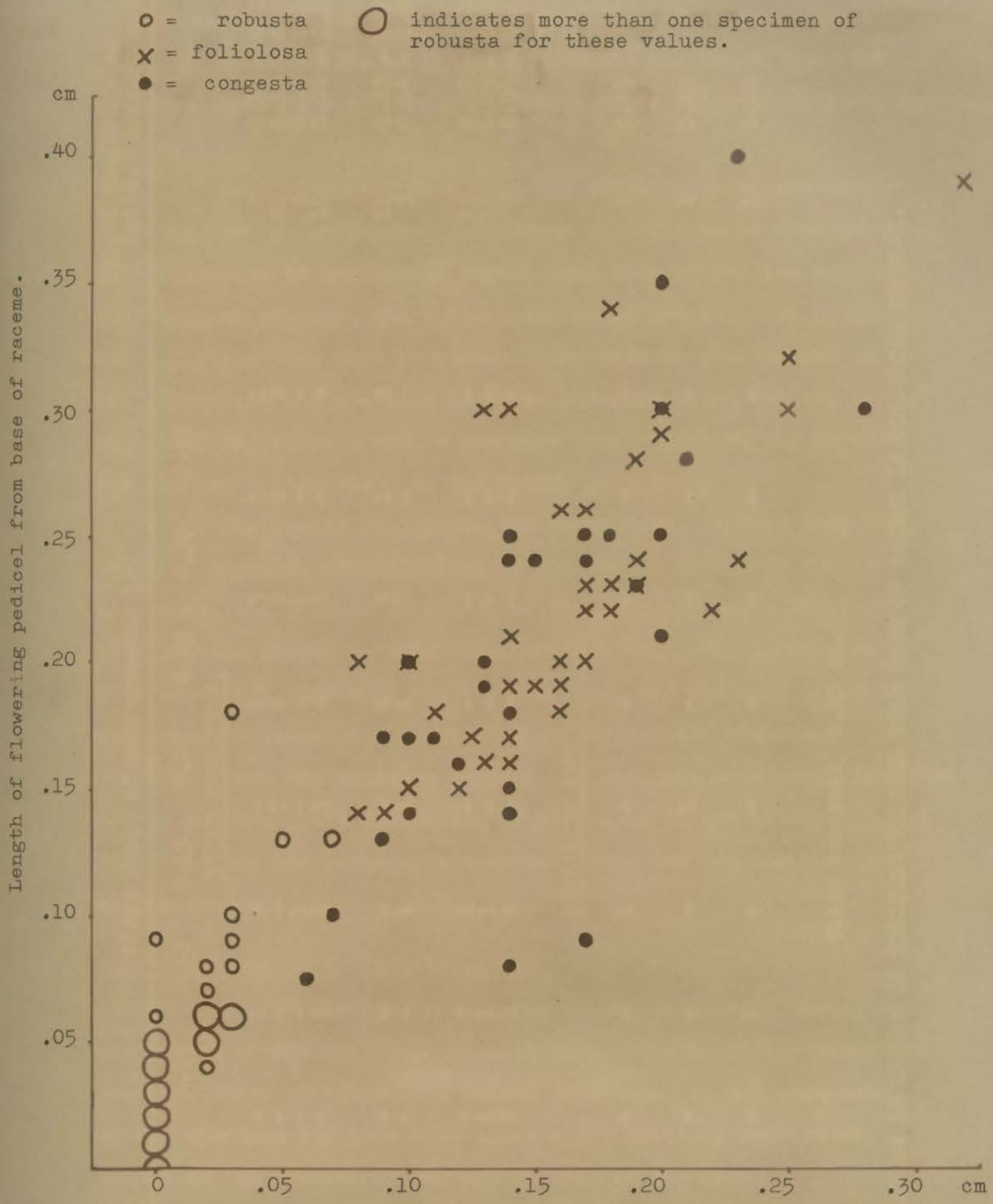


Fig.38. Variation in length of flowering pedicels from the base and the middle of racemes in the foliolosa complex.

Locality.	Class range of measurements							Total no. indiv.	Range actual measurements.
	0.05	0.10	0.15	0.20	0.25	0.30	0.35		cm.
FIELD SPECIMENS.									
CONGESTA.									
Cradock R32	-	1	-	-	2	3	1	1	8	0.10 - 0.36
S. of Adelaide R38,39	-	-	-	7	6	3	2	2	20	0.18 - 0.38
Dikkop Vlakte R40	-	-	1	-	-	2	-	-	3	0.14 - 0.30
Helspoort R41	-	5	1	3	-	1	-	-	10	0.06 - 0.28
FOLIOLOSA.									
Graaff Reinet R60	-	-	-	-	6	3	1	2	12	0.22 - 0.37
Steytlerville R52a	-	-	1	1	1	2	-	-	5	0.14 - 0.28
ROBUSTA.									
Steytlerville R43	7	7	1	-	-	-	-	-	15	0.02 - 0.14
Prince Albert R64	6	4	1	-	-	-	-	-	11	0.03 - 0.12
Ft. of Molteno Pass (Hall 2284)	3	2	4	-	-	-	-	-	9	0.04 - 0.15
HERBARIUM SPECIMENS.									
CONGESTA.									
Rayners Kop	-	-	1	-	-	-	-	-	1	0.15
FOLIOLOSA.									
Waterford	-	-	-	1	-	-	-	-	1	0.20
ROBUSTA.									
Whitehill	-	1	-	-	-	-	-	-	1	0.10

Class interval 0.05 cm.

Table 54D VARIATION IN LENGTH OF FRUITING PEDICEL FROM BASE OF RACEME IN FOLIOLOSA COMPLEX.

comparison with those from the nearby Molteno Pass locality.

Measurements of fruiting pedicels are fewer, but also show the above pedicel elongation which takes place after fertilisation.

Summary

Apart from the fact that all populations of the entity congesta have a far greater percentage of individuals with branched inflorescences or unexpanded raceme buds than either the entities foliolosa or robusta, the inflorescences of the entities congesta and foliolosa have much in common. The only noteworthy points of difference are the somewhat narrower peduncle bases and the larger number of individuals with a narrower basal width in the fertile and sterile bracts found in the entity foliolosa.

The entity robusta on the other hand, differs from the entities congesta and foliolosa in the larger number of shorter peduncles, the greater thickness of the peduncle below the first pedicel, the longer fertile and sterile bracts, the larger number of bracts with more than one central vein, and the very great numbers of racemes with sessile or almost sessile flowers.

Both the entities robusta and congesta have stout peduncle bases, but the great flattening of old bases in the entity robusta is not typical in congesta. Although these differences between robusta and the other two entities are marked, they are not completely discontinuous.

PERIANTH CHARACTERS (See Plate 18).

In the introductory survey of the genus as a whole, the components of the foliolosa complex were shown to differ somewhat from the other entities with smooth perianths, in the possession of the broadest and most open lobes and a perianth tube which tended to be broader in the middle than at the base.

In the following account of the variation of perianth characters within the foliolosa complex, the variation patterns for each population are represented by more compact histograms, for the differences in dimensions between the entities are, with few exceptions, slight.

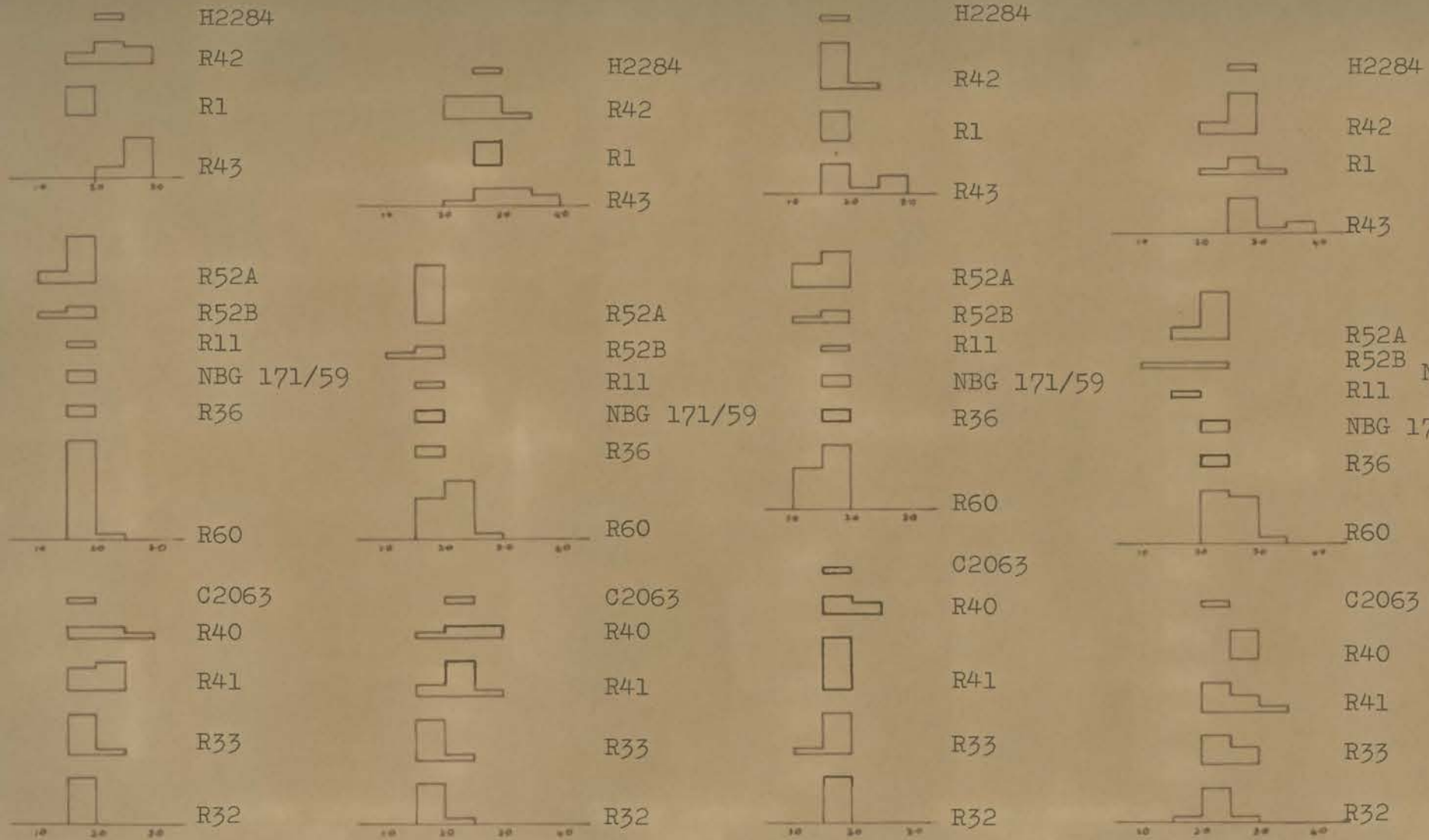
Length of perianth lobes. (See Fig. 39)

In general inner and outer perianth lobes tend to be

ROBUSTA

FOLIOLOSA

CONGESTA



LOCALITY

H2284	Nr. Molteno Pass
R42	E. of Nelspoort
R1	E. of Laingsburg
R43	Steytlerville
R52A	Steytlerville
R52B	Mt. Stewart
R11	Wolvefontein
NBG 171/59	Springbok Vlakte
R36	Lake Mentz
R60	Graaf Reinet
C2063	Krantz Drift
R40	Dikkop Vlakte
R41	Helspoort
R33	Rayners Kop
R32	Cradock

Fig. 39. Variation in dimensions of perianth lobes in the foliolosa complex.

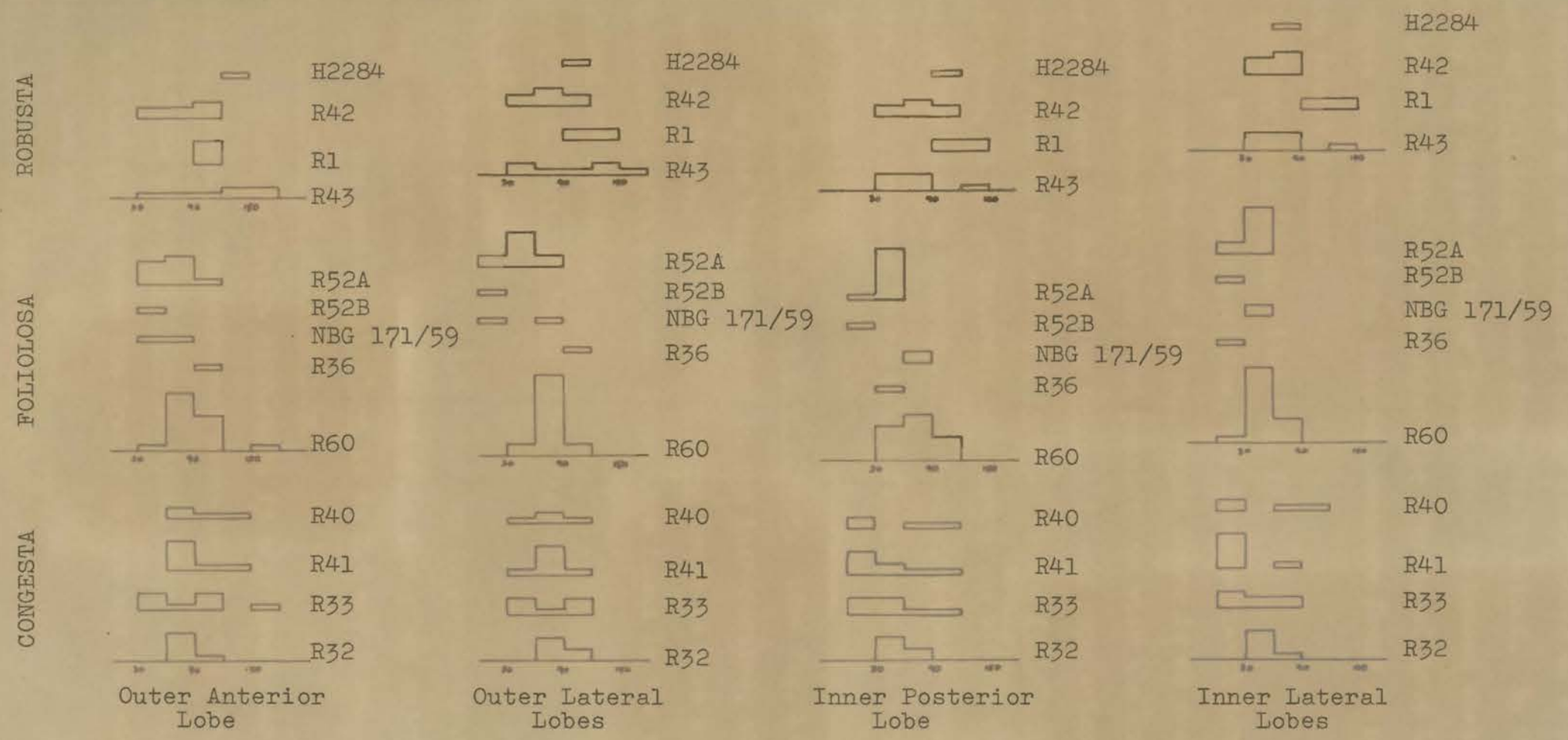


Fig.40. Variation in position of lobes in open flowers of the foliolosa complex.

of the same length in the congesta and foliolosa samples, with the exception of the slightly longer inner lobes of a large number of foliolosa specimens from Graaff Reinet. In the entity robusta, the length of inner lobes tends to exceed that of the outer lobes. There is a considerable overlap of lobe length in all three entities but the longest lobes are found in populations of the entity robusta.

Width of perianth lobes. (See Fig. 39)

In all three entities, the inner perianth lobes tend to be broader than the outer lobes. Again there is an overlap of measurements for all three, but populations with the narrowest lobes are found in the entity foliolosa, and populations with the broadest lobes in the entity robusta. In the foliolosa populations, it is of interest to compare the widths of the inner lobes of the samples from Graaff Reinet with those from Steytlerville, in view of differences in certain inflorescence characters between the two populations.

Position of the lobes in the open flower. (See Fig. 40)

As has been mentioned in the introduction, these characters are very variable. The entity robusta tends to have a larger number of individuals with more open lobes than found in the entities foliolosa and congesta.

Dimensions of perianth tube. (See Fig. 41)

Length of tube.

This varies from 5.0 - 9.0 mm in populations of the entities congesta and robusta, while in the great majority of specimens of the entity foliolosa it is 7.0 - 9.0 mm.

Diameter of neck of perianth tube

There is little difference in this character in the three entities, although the narrowest necks are found in population samples of the entity foliolosa. Again there is a slight difference in this dimension between the Graaff Reinet and Steytlerville foliolosa samples.

Middle and basal diameters of perianth tube.

There is little difference between the three entities with regard to these dimensions. There is again a slight difference

A(X $1\frac{1}{4}$)

C(X $\frac{1}{2}$)

B(X $1\frac{1}{3}$)

D(X $1\frac{1}{4}$)

A and B: Portions of inflorescences from specimens of the entity foliolosa. The lobes in B are not as open as in A.

C and D: Portions of inflorescences from specimens of the entity congesta.

E(X $1\frac{1}{5}$)

E: Part of inflorescence of a specimen of the entity robusta.

PLATE 18.

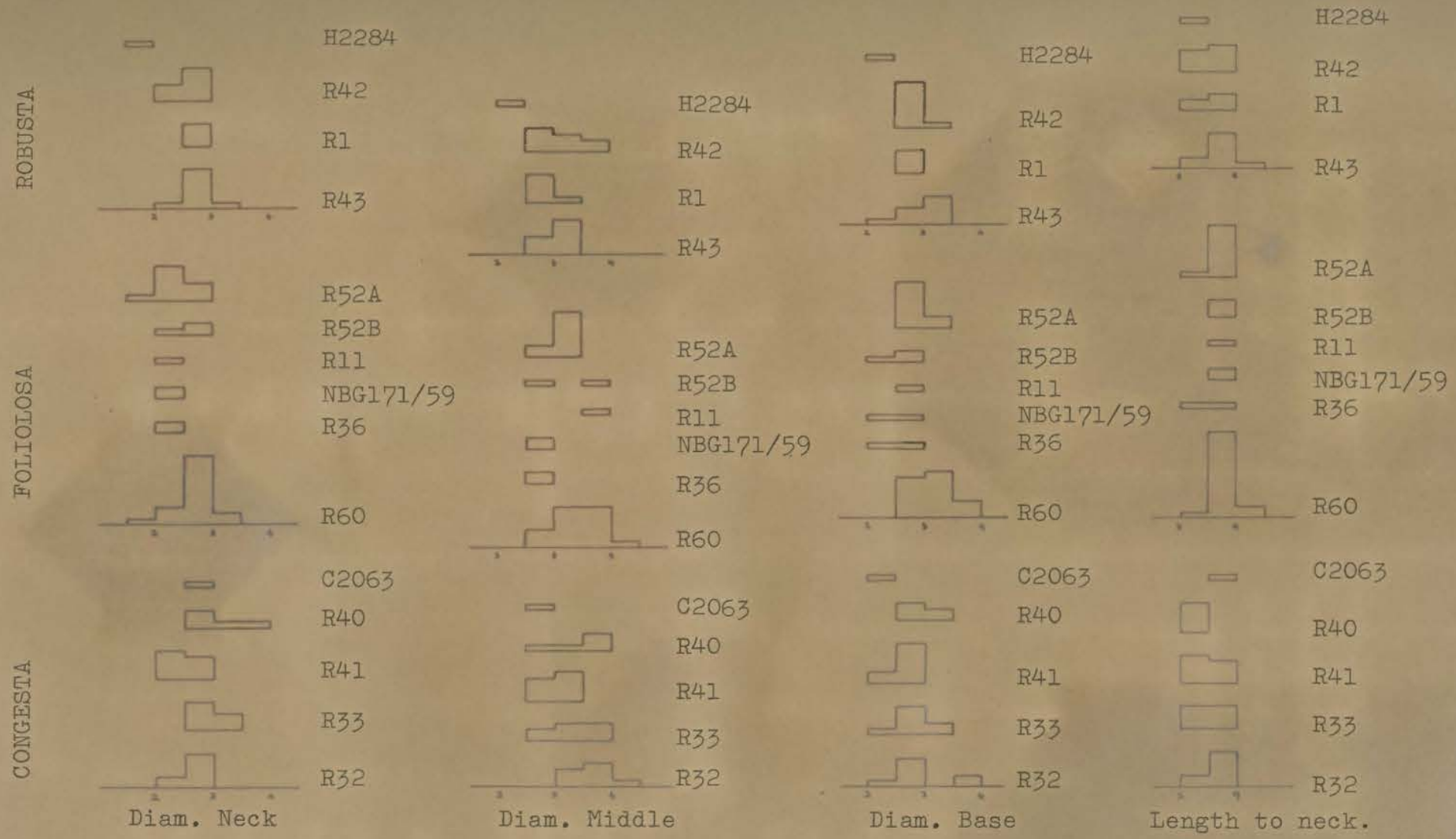


Fig.41. Variation in dimensions of perianth tube in the foliolosa complex.

Difference between diameters of middle and neck of perianth tube

Difference between diameters of base and middle of perianth tube

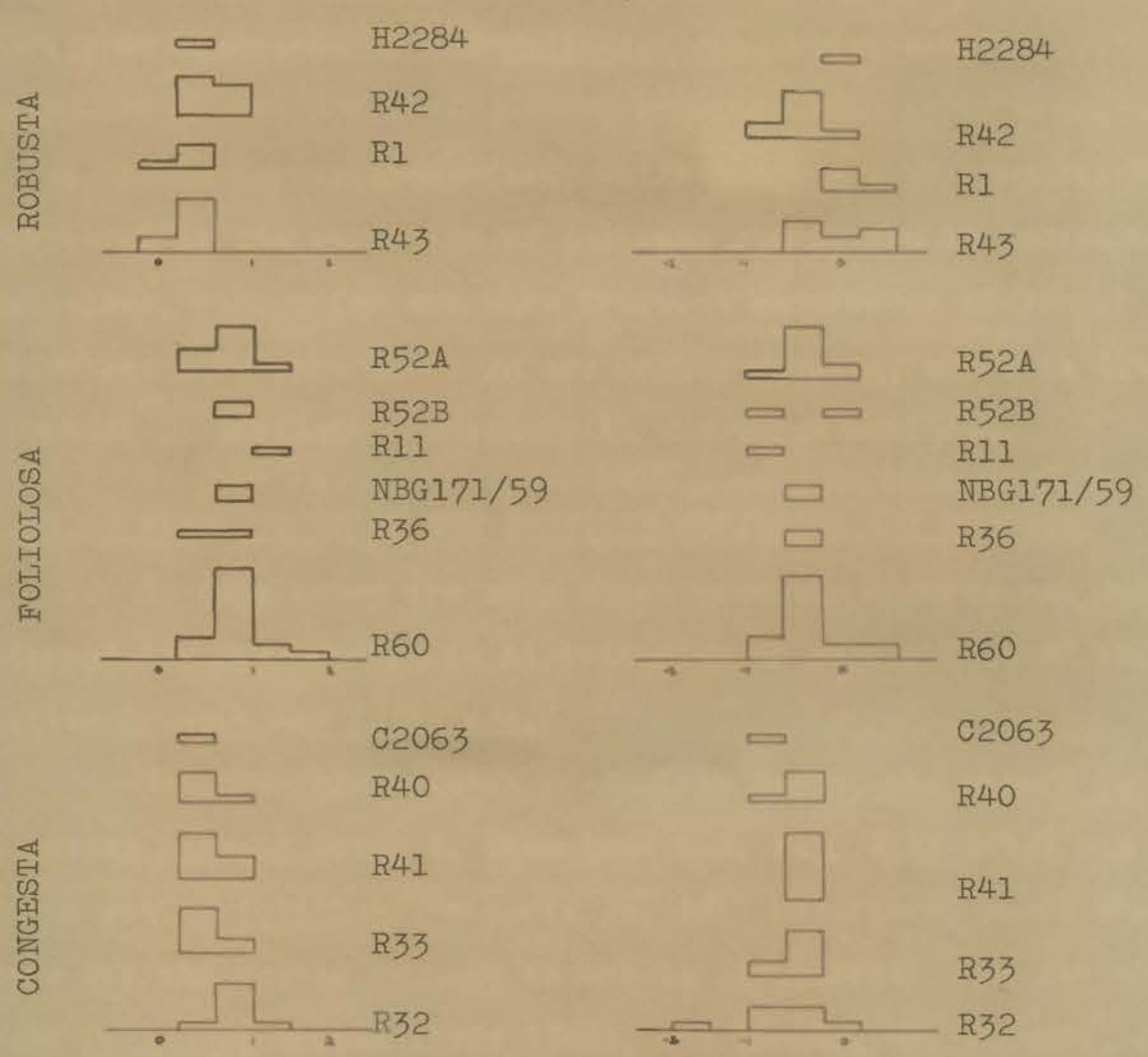


Fig.42. Variation in the shape of the perianth tube in the foliolosa complex.

in the diameter of the base of the perianth tube between the majority of specimens of the entity foliolosa from Graaff Reinet and those from Steytlerville.

Difference between diameter of base and diameter of middle of perianth. (See Fig. 42)

In all three entities, the middle diameter of the perianth tube is in most cases equal to, or up to 0.5 mm greater than the basal diameter. In only five instances was the basal diameter greater than the middle diameter.

Difference between diameter of middle and diameter of neck of perianth. (See Fig. 42)

Again there is little difference in this character in the three entities, the greatest difference between the diameters of the middle and the neck of the perianth being found in the majority of specimens of the foliolosa population samples.

Summary

This survey shows that, while there may be some slight differences in the variation of perianth characters in individual populations, except for the more frequent occurrance of longer broader and more open lobes in the entity robusta, there is little difference in perianth characters in the three entities.

MIXED POPULATIONS OF THE ENTITIES FOLIOLOSA AND ROBUSTA.

To date there are only three probable records and one confirmed one for overlap in distribution of populations of the entities robusta and foliolosa.

The probable records are: Lake Mentz, the record for the entity robusta being S. Schonland s.n. Aug. 1921 (PRE) and for the entity foliolosa, Roberts 36, 37; Waterford, where the record for the entity robusta is Acocks 11995 (PRE), and for the entity foliolosa Acocks 11997 (PRE), and lastly, Mt. Stewart, where the record for the entity robusta is Compton 20323 (NBG) and for the entity foliolosa, Roberts 13 and 52B.

The confirmed locality where these two entities have been found growing together, is at Steytlerville and has been described previously.

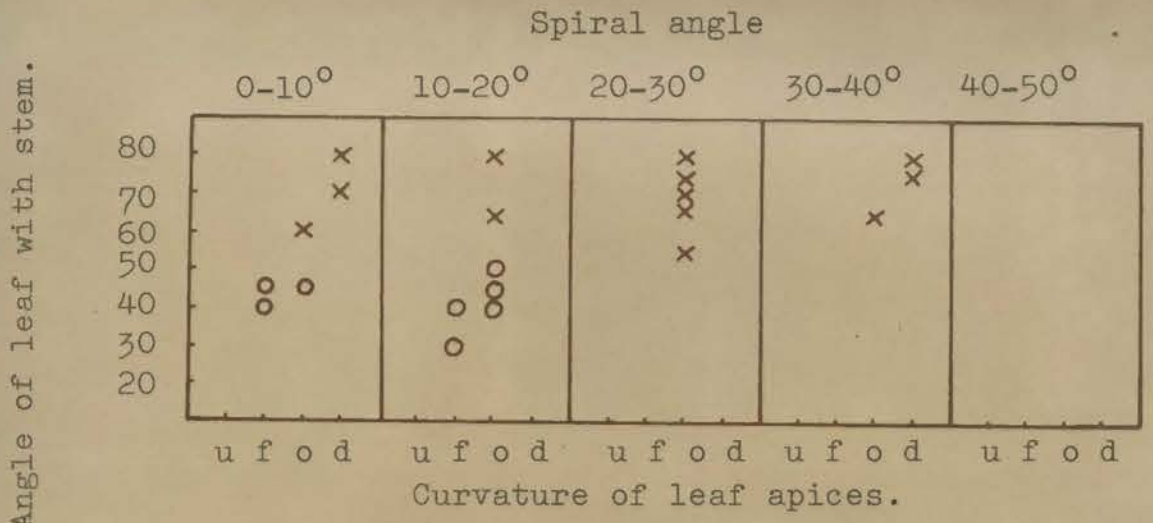
There are no known records of overlap of populations of the entities foliolosa and congesta or of the entities robusta and congesta.

Scatter diagrams incorporating vegetative and inflorescence characters of the mixed Steytlerville population have been compiled. (See Figs. 43 and 44). These show that the two entities are distinguishable at this locality, but more so by inflorescence characters than by vegetative ones. In the case of the scatter diagrams involving inflorescence characters, apart from that showing length of lowest fertile bract plotted against length of lowest sterile bract (Fig. 44F) the overlap of values for each entity is none or very slight. Separation is most wide in the diagrams of length of peduncle plotted against basal width of peduncle, (Fig. 44A) and length of pedicel from base of flowering raceme plotted against length of lowest fertile bract, (Fig. 44G). In the case of the vegetative characters the overlap of values for the two entities is more, but in no case are they completely intermingled.

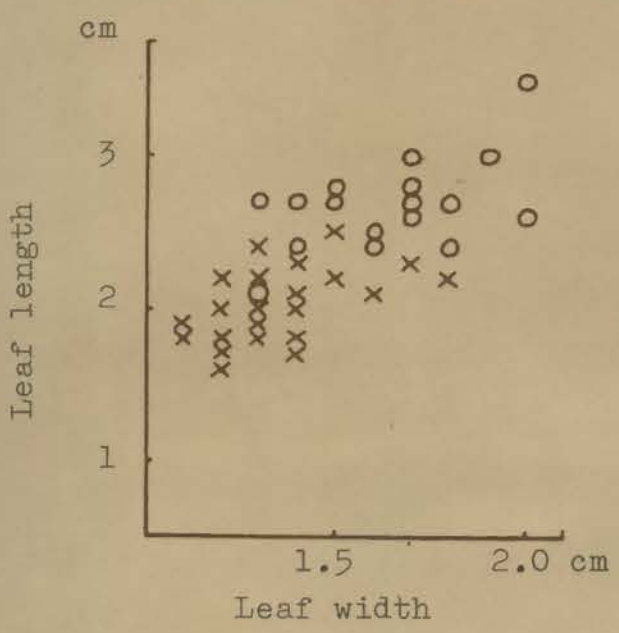
Entity	Collector	Date	Condition at time of collecting
ROBUSTA	Dyer 4022 (PRE)	Aug. 1939	Flowering
	Roberts 15	Oct. 1959	No buds or flowers
	Roberts 43	Jul. 1960	Flowering
	Roberts Obs.	Oct-Nov.1960	No buds or flowers
FOLIOLOSA	Paterson 40 (BOL)	Nov. 1911	Flowering
	Roberts 14	Oct. 1959	Buds and flowers
	Roberts 43A	Jul. 1960	No buds or flowers
	Roberts 52A	Oct-Nov.1960	Buds and flowers

Table 55: FLOWERING TIMES OF THE ENTITIES FOLIOLOSA AND ROBUSTA IN A MIXED POPULATION FROM STEYTLERVILLE.

As can be seen from Table 55, flowering times for the two entities tend to differ, which lessens the chance of hybridisation. In view of the morphological similarity of the chromosome complements of the entities, one would expect the possibility of hybridisation with vigorous off-spring. If hybridisation has indeed taken place

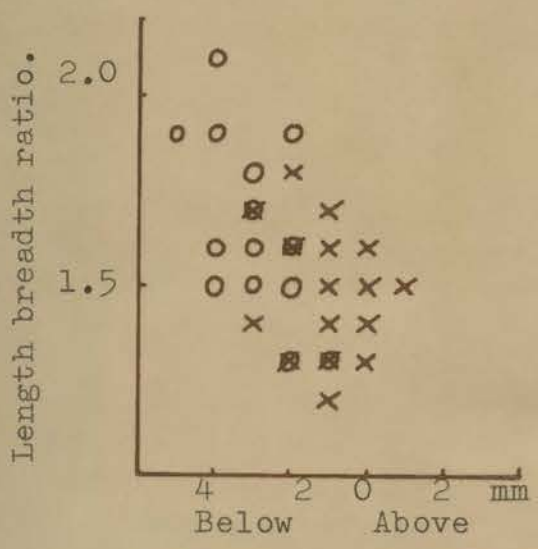


A. APPEARANCE OF LEAFY SHOOT INCORPORATING SPIRAL ANGLE, ANGLE OF LEAF WITH STEM AND TREND OF LEAF APICES.

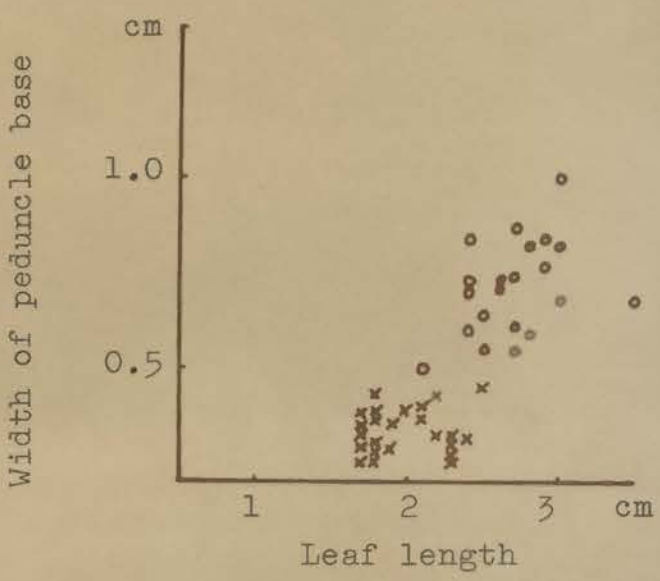


B. LENGTH AND WIDTH OF LEAF

Plants of the two entities growing next to one another in this mixed population. The entity robusta is on the left.

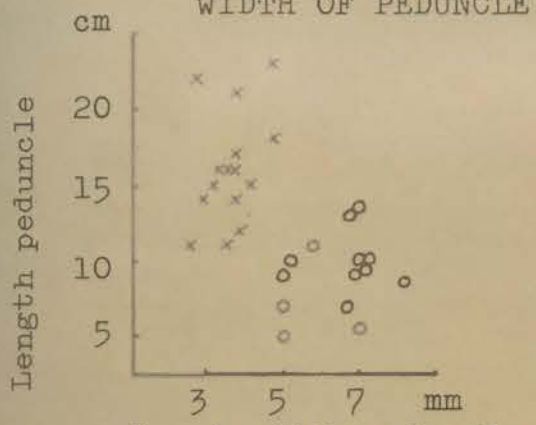


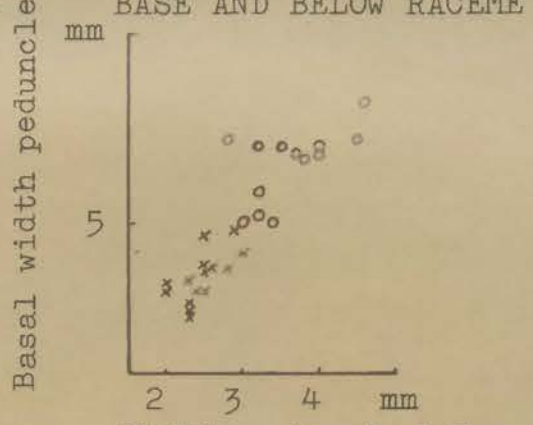
D. LENGTH BREADTH RATIO AND DISTANCE OF WIDEST PART OF LEAF FROM MID LENGTH.

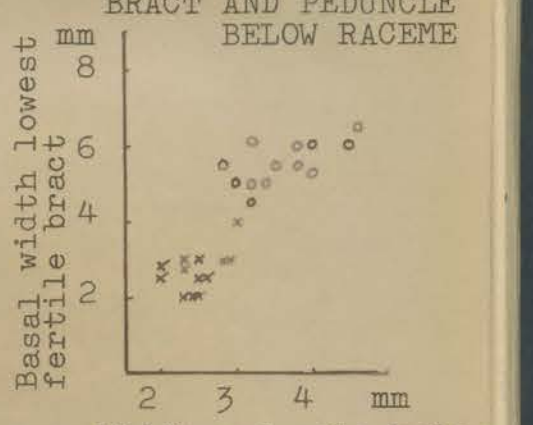


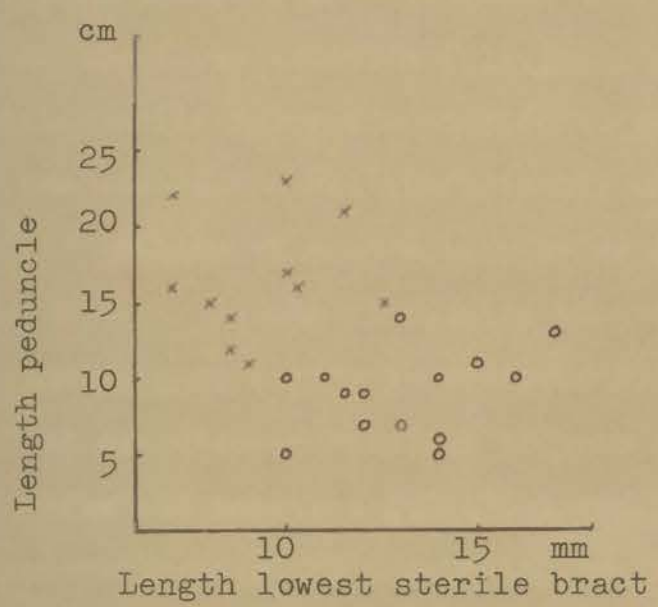
E. BASAL WIDTH OF OLD DRIED PEDUNCLES AND LEAF LENGTH.

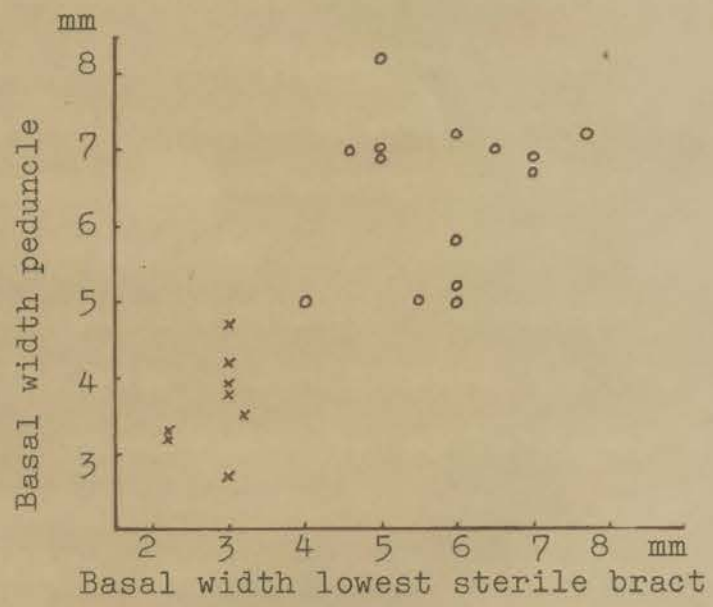
Fig.43. Showing variation in vegetative characters of a mixed population of the entities foliolosa (R14) and robusta (R15 from Steytlerville. (o = robusta, x = foliolosa).



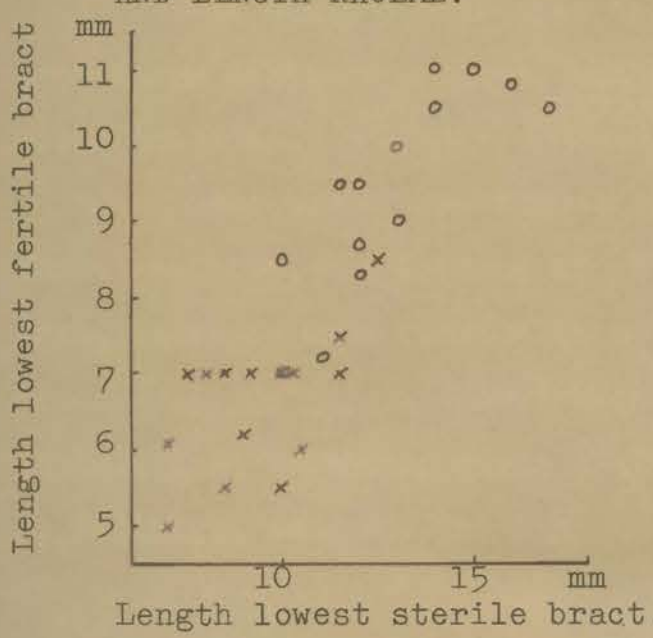






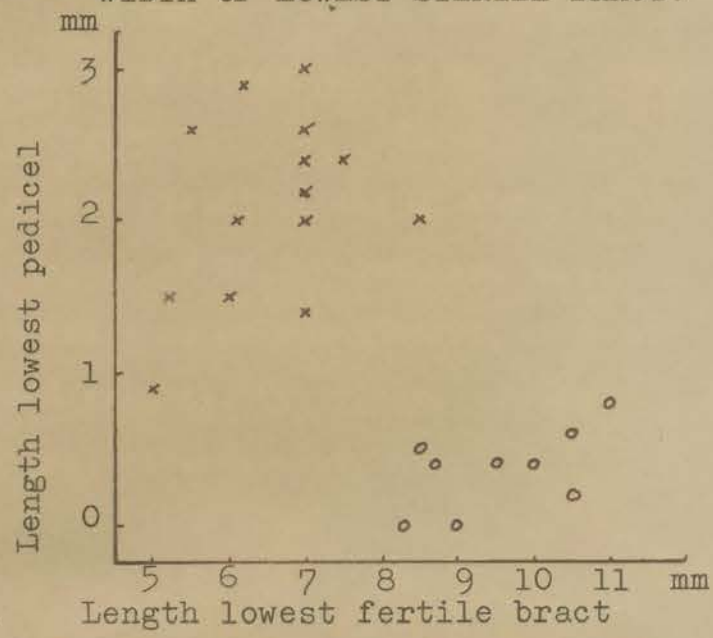


D. LENGTH LOWEST STERILE BRACT AND LENGTH RACEME.



F. LENGTHS OF LOWEST STERILE AND FERTILE BRACTS

E. BASAL WIDTH PEDUNCLE AND BASAL WIDTH OF LOWEST STERILE BRACT.



G. LENGTH OF LOWEST PEDICEL AND LOWEST FERTILE BRACT.

Fig.44. Showing variation in inflorescence characters of a mixed population of the entities foliolosa (R14) and robusta (R15) from Steytlerville. (o = robusta, x = foliolosa).

then the off-spring have reverted back to parental types, for the two entities in this mixed population are still recognisably distinct.

CONCLUSION.

It is felt that the foregoing detailed survey of populations of the foliolosa complex does justify the recognition of the three entities foliolosa, congesta and robusta, but shows that while there are many features characteristic of each, these characters are not sufficiently discontinuous to warrant the recognition of each entity as separate species.

As the discussion on geographic distribution has shown, the robusta entity is confined to the drier western karoid areas and experiences rainfall of both the summer and winter patterns, while the entities foliolosa and congesta occur in the more easterly marginal (according to Acock's classification), karoid areas, with a summer rainfall pattern.

It would appear that the foliolosa complex is diverging into three distinct species, but that this divergence is by no means complete.

Because of the almost disjunct distributions of the three entities, and because of the degree of differentiation in each, it seems most reasonable to treat them as sub-species, namely; A. foliolosa (Haw.) Uitewaal sub. sp. foliolosa, A. foliolosa subsp. congesta (Salm Dyk) Roberts comb. nov. and A. foliolosa sub. sp. robusta Roberts subsp. nov.

THE ENTITIES SMUTSIANA, HALLII, BULLULATA AND RUGOSA

The fact that the remaining entities with smooth perianthe tubes are dealt with together, does not at the outset imply a relationship between them. Compared with the A.foliolosa complex, they have in common a tendency for the perianth lobes to be slightly smaller and less open and for the perianth tube to be broader at the base than at the middle in most cases. Further, all have epidermal cells with markedly convex outer walls.

The introductory survey has shown that the entities hallii and bullulata have in common a tendency for the spiral angle to be low, the leaf apices to curve upward, and to be of a keeled marginate nature. There is a considerable similarity in their inflorescences, and in both, the perianth lobes tend to develop a chrome yellow colour found in no other entities with smooth perianths. Together with the entity rugosa they are the only entities in which tubercles have been found on the leaves of plants found in the field.

In the past, there has been little confusion over the identification of the entity bullulata (referable to Astroloba bullulata (Jacq.) Uitew) and the entity rugosa (formerly Astroloba aspera (Haw.) Uitew), these being recognised as distinct species by all authors except Baker (1881, 1896-1897) who considered bullulata a variety of a species, "Apicra pentagona Willd," and von Poellnitz (1930) who described a new species, Apicra egregia, from what appear to have been undoubtedly specimens of bullulata.

There has, however, been considerable confusion over the identity of specimens belonging to the entities hallii and smutsiana as construed by the present author. In the past, the epithets "pentagona" and "spirella" have been applied to both entities, but it is impossible to determine the true identity of the species originally described as "A.pentagona" and "A.spirella", and the present author has been forced to abandon these epithets and to construe anew the taxonomic concepts of the components of these two species.

Mention has been made of a suspected hybrid between members

of the entities rugosa and smutsiana which was found in the Ladismith-Barrydale Karoo, and it is for this reason, in addition to the tuberculate nature of the leaves, that the entity rugosa is included in this survey.

An account of the distribution of all four entities has already been given, and examination of the accompanying tables shows that the four populations of the entity smutsiana come from both the Little Karoo and the northern foothills of the Swartberg, while there are only two samples for hallii, one from the northern foothills of the Swartberg, the other from the Great Karoo. There are also only two localities for the entity bullulata,one from near Matjesfontein, the other from the eastern Tanqua Karoo. For the entity rugosa, a number of samples were collected in the Montagu Karoo, and one from the Ladismith-Barrydale Karoo.

The putative hybrid between members of the entities rugosa and smutsiana is included in the following population variation tables under the name "Hybrid R4." In this instance, although only one such plant was found, measurements of leaf arrangement etc., for several shoots are given in each table. This hybrid was found amongst plants of the smutsiana population referred to as Ladismith-Barrydale II, R3.

VEGETATIVE FEATURES (See Plates 19, 20, 21, 22, 23).

In the tables showing variation in appearance of the leafy shoot, the Montagu Karoo specimens of the entity rugosa are given together as a single sample, in the other tables, individual localities are given. The Rietvlei locality for the entity rugosa from the Montagu Karoo must not be confused with the Rietvlei localities for the entities halii and smutsiana in the northern fotthills of the Swartberg.

Leaf arrangement (See Table 56)

It was on this character that the early authors separated the various species they described belonging to what are now recognised as the entities hallii and smutsiana.

The introductory survey showed the entities hallii, bullulata and rugosa to have the majority of individuals with the smallest spiral angle, (0 - 10°), in the whole genus. Only 13% of the total samples of the entities bullulata and hallii has a spiral angle of more than 10°.

Locality.	Class range of measurements.					Total no. indiv.	Range actual measurements.
	SPIRAL ANGLE. Class interval 10°						
	0°	10°	20°	30°			°
HYBRID R4	-	-	3	-	-	3	11 - 15
SMUTSIANA.							
L'smith-B'dale I R5	-	5	6	6	1	18	3 - 40
L'smith-B'dale II R3	-	2	3	2	2	9	8 - 36
Rooinek Pass R51	-	1	3	7	3	14	2 - 33
nr. Rietvlei R49	-	-	4	-	1	5	11 - 33
HALLII.							
nr. Rietvlei R48	1	6	1	-	-	8	0 - 15
Koup R26	2	12	2	-	-	16	0 - 16
BULLULATA.							
N. Matjesfontein R25	1	7	-	1	-	9	0 - 21
Ceres-S'land R24	-	13	2	-	-	15	1 - 20
RUGOSA.							
nr. Montagu R17-23,50a	1	13	4	2	-	20	0 - 25
L'smith-B'dale R2	-	-	2	-	-	2	14 - 20
	ANGLE OF LEAF WITH STEM. Class interval 20°						
	Erect.	30°	Sub-erect.	50°	Patent erect.		°
HYBRID R4	-		3		-	3	40 - 45
SMUTSIANA.							
L'smith-B'dale I R5	-		16		2	18	35 - 60
L'smith-B'dale II R3	-		9		-	9	40 - 50
Rooinek Pass R51	-		12		2	14	40 - 60
nr. Rietvlei R49	1		1		3	5	30 - 55
HALLII.							
nr. Rietvlei R48	-		7		1	8	40 - 55
Koup R26	6		10		-	16	20 - 50
BULLULATA.							
N. Matjesfontein R25	-		9		-	9	35 - 50
Ceres-S'land R24	-		14		1	15	40 - 55
RUGOSA.							
nr. Montagu R17-23,50a	-		19		1	20	40 - 60
L'smith-B'dale R2	-		2		-	2	40 - 50
	CURVATURE OF LEAF APICES. *						
	us	u	f	o			
HYBRID R4	-	-	-	3		3	o
SMUTSIANA.							
L'smith-B'dale I R5	-	-	7	11		18	f - o
L'smith-B'dale II R3	-	-	-	9		9	o
Rooinek Pass R51	-	-	8	6		14	f - o
nr. Rietvlei R49	-	-	1	4		5	f - o
HALLII.							
nr. Rietvlei R48	-	7	1	-		8	u - f
Koup R26	-	14	2	-		16	u - f
BULLULATA.							
N. Matjesfontein R25	10	5	-	-		15	us - u
Ceres-S'land R24	9	-	-	-		9	us
RUGOSA.							
nr. Montagu R17-23,50a	-	-	4	16		20	o - f
L'smith-B'dale R2	-	-	-	2		2	o

TABLE 56 **Variation in appearance of leafy shoot in field specimens of "smutsiana," "hallii", "bullulata" and "rugosa", and the putative hybrid between members of "rugosa" and "smutsiana".** *(See page 212).

In the samples of the entity smutsiana, excluding those from the Ladismith-Barrydale Karoo, where no populations of hallii have to date been found, the spiral angle is 10 - 30° in the majority of specimens.

In the samples of the entity rugosa, the great majority of the specimens from the Montagu Karoo have a spiral angle of 0 - 10°, while for the two specimens and the suspected hybrid from the Ladismith Karoo the spiral angle is 10 - 20°.

Angle of leaf with stem (See Table 56)

In all four entities this is 30 - 50°, that is sub-erect, in the majority of specimens. This applies to individual population samples with the exception of the population of the entity smutsiana from Rietvlei, in the northern foothills of the Swartberg, where 60% of the small sample have patent-erect leaves.

It is of interest to note that 38% of the sample of the entity hallii from Koup, in the Great Karoo, have erect leaves. Out of all the other population samples this is the case only in a single specimen of the entity smutsiana from Rietvlei.

Leaf apices (See Table 56)

Here the entity bullulata is unique in that the leaf apices curve upward and slightly to one side in all individuals examined, except for 33% of the sample from Matjesfontein where they only curve upward. The latter is the case in all save 13% of samples of the entity hallii, where the apices follow the angle of the leaf with the stem.

In the population samples of the entity smutsiana from Ladismith-Barrydale I and Rooinek Pass, the apices follow the angle of the leaf with the stem or curve outwards, while in the two remaining populations, in the majority of rugosa specimens, and in the suspected hybrid between members of the entities rugosa and smutsiana, the leaf apices curve outward in the great majority of plants.

The appearance of leafy shoots of all four entities is shown in a diagram incorporating all three of the above characters (See fig. 45).

It is the fact that the leaf apices curve upwards, and upwards and sideways in the majority of specimens of the entities

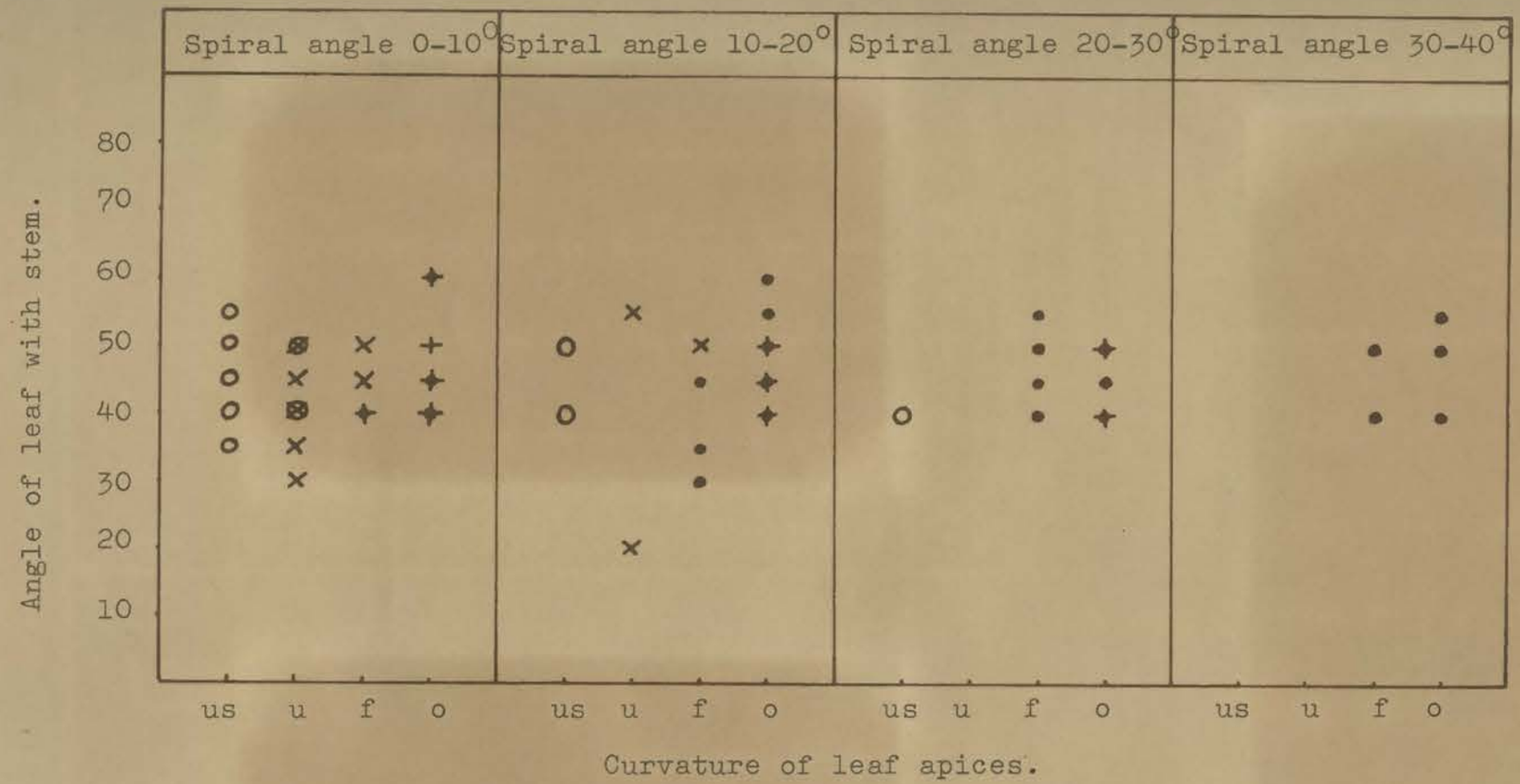


Fig.45. Variation in appearance of leafy shoot, incorporating the spiral angle, angle of the leaf with the stem, and curvature of leaf apices, in the entities smutsiana (•), hallii (x), bullulata (o), and rugosa (+). (us = apices curving upwards and to one side, u = apices curving upward, f = apices following the angle of the leaf with the stem, o = apices curving outward).

Leaves of, from left to right, the entities bullulata, hallii and smutsiana, seen from the upper side. Keeled marginate apices are seen in the leaves of bullulata and hallii, the apex of the entity smutsiana is true marginate. (X1½).

A (X 1)

B (X 1¼)

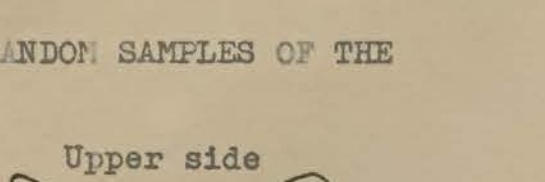
Leafy shoots of the entity rugosa. A: from Pietersfontein, R19, B: from Dobbelaar's Kloof R22. (Scales approximate).

PLATE 19.

hallii and bullulata, which tends to distinguish these two from the entities rugosa and smutsiana. The distinction is rendered absolute by the presence of keeled-marginate apices in the entities bullulata and hallii as opposed to true marginate apices in the entities smutsiana and rugosa. As previously mentioned, keeled-marginate apices have been found in some or all the leaves of all plants of the entities hallii and bullulata so far examined. In dried specimens, however, this character is not always obvious. Also in specimens of the entities hallii and bullulata the leaf apex is often somewhat "shouldered" below the mucro, as opposed to the acute acuminate condition always found in the other entities.

BULLULATA			HALLII		
Leaf length	Distance from apex at which x is measured	Width x	Leaf length	Distance from apex at which x is measured	Width x
cm.	cm.	cm.	cm.	cm.	cm.
4.2	0.9	0.96	4.8	1.0	0.75
4.0	0.8	0.82	4.4	0.9	0.65
3.9	0.8	1.04	4.2	0.9	0.64
3.5	0.7	1.02	4.1	0.9	0.79
3.3	0.7	1.13	4.0	0.8	0.69
3.3	0.7	0.95	4.0	0.8	0.60
3.3	0.7	0.77	3.9	0.8	0.88
3.1	0.7	0.85	3.9	0.8	0.74
3.0	0.6	0.91	3.9	0.8	0.64
3.0	0.6	0.82	3.9	0.8	0.58
3.0	0.6	0.81	3.8	0.8	0.65
2.9	0.6	0.80	3.6	0.8	0.62
2.9	0.6	0.76	3.5	0.7	0.59
2.7	0.6	0.92	3.5	0.7	0.56
2.7	0.6	0.79	3.4	0.7	0.57
2.5	0.5	0.80	3.2	0.7	0.61
2.5	0.5	0.63	3.2	0.7	0.57
2.3	0.5	0.58	3.1	0.7	0.58
2.1	0.5	0.70	3.1	0.7	0.56
			3.1	0.7	0.47
1.8	0.4	0.50	3.0	0.6	0.40
			2.9	0.6	0.60
			2.9	0.6	0.58
			2.9	0.6	0.39
			2.8	0.6	0.56

Table 57 SHOWING VARIATION IN WIDTH x IN RANDOM SAMPLES OF THE ENTITIES HALLII AND BULLULATA.



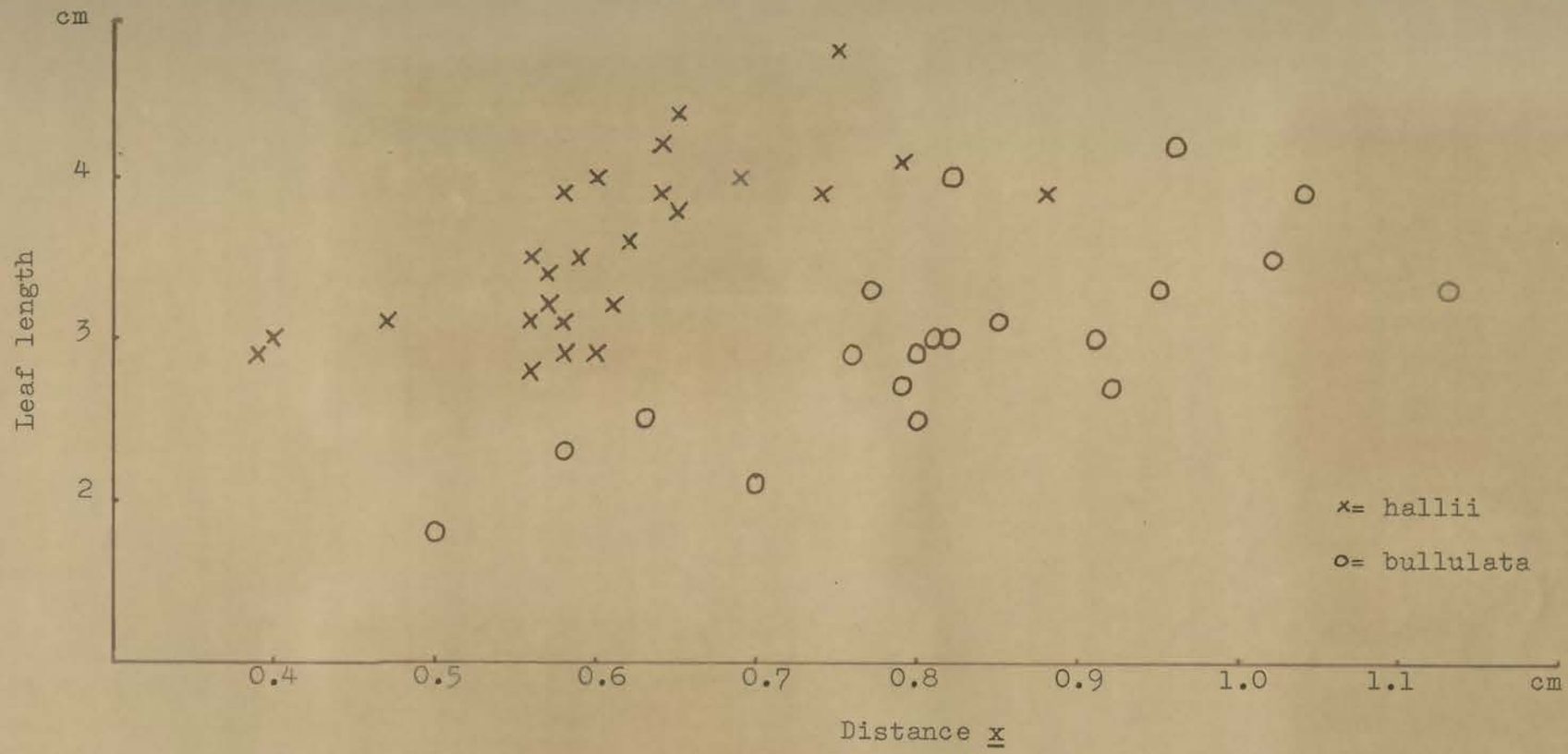


Fig.46. Variation in leaf length and the distance x between the keel and the leaf margin furthest from it at a distance from the leaf apex, which is approximately one fifth of the length of the leaf, in the entities hallii and bullulata.

The leaf apex of the entity bullulata is also in general broader than that of the entity hallii, as is shown by measuring the distance between the keel and the leaf margin furthest from it, at a set distance from the apex, which is approximately one fifth of the length of the leaf. This is shown in Table 57, where the distance from keel to leaf margin is, for the sake of brevity referred to as x, and in a scatter diagram (Fig.46) where leaf length is plotted against the value of this measurement. The scatter diagram gives a fairly good, if not an absolute separation between the two entities.

Leaf length (See Table 58 and figs. 49, 50, 47 and 48)

The longest leaves amongst the four entities tend to be found in the majority of specimens of the entities hallii and bullulata. Of the plants of the entity hallii, only 18%, (all from the Rietvlei locality), have leaves less than 30 cm. in length. In the entity bullulata, 29% of the plants examined have leaves less than 3.0 cm. in length.

Leaf length is quite variable in population samples of the entity smutsiana, being shortest (1.5 - 2.5 cm.) in the Rietvlei plants, and longest, (2.0 - 4.0 cm.), in plants from Adams Kraal in the Little Karoo, where no plants of the entity hallii have yet been found. Leaves are generally of an intermediate length in the other Little Karoo smutsiana samples.

In samples of the entity rugosa leaves vary from 1.5 - 2.5 cm. in length, while the leaves of the putative hybrid between members of this entity and the entity smutsiana are 2.0 cm. long.

Leaf width at widest part and length-breadth ratio (See Tables 59 and 60).

In the past, the terms lanceolate acuminate, ovate acuminate, ovate acute, and lanceolate deltoid have been used to describe the leaves of plants belonging to what are now recognised as the entities hallii and smutsiana.

The leaves with the highest length-breadth ratio are found in the entity hallii, this being less than 2.00 in only 19% of the specimens examined.

Locality	Class range of measurements.										Total no. indiv.	Range actual measurements.
	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5			cm.
HYBRID R4	-	2	-	-	-	-	-	-	-	-	2	2.0
SMUTSIANA.												
Adams Kraal R63	-	-	1	2	1	2	-	-	-	-	6	2.3 - 3.9
L'smith-B'dale I R5	-	-	11	9	3	-	-	-	-	-	23	2.1 - 3.1
L'smith-B'dale II R3	-	6	11	5	-	-	-	-	-	-	22	1.8 - 2.7
Rooinek Pass R51	-	-	6	5	3	-	-	-	-	-	14	2.1 - 3.1
nr. Rietvlei R49	-	3	2	-	-	-	-	-	-	-	5	1.8 - 2.2
HALLII.												
nr. Rietvlei R48	-	-	-	3	5	2	6	-	-	1	17	2.7 - 5.8
Koup R26	-	-	-	-	9	-	-	-	-	-	9	3.1 - 3.5
BULLULATA.												
N. Matjesfontein R25	-	-	3	1	9	2	-	-	-	-	15	2.3 - 4.0
Ceres-S'land R24	-	-	-	3	4	2	-	-	-	-	9	2.8 - 4.0
RUGOSA.												
Pietersfontein R19+20	-	5	5	-	-	-	-	-	-	-	10	1.7 - 2.5
Upper Baden R17	1	5	1	-	-	-	-	-	-	-	7	1.4 - 2.2
Baden Rd R18	-	3	4	-	-	-	-	-	-	-	7	1.7 - 2.2
nr. Montagu R23	-	8	2	-	-	-	-	-	-	-	10	1.6 - 2.2
Rietvlei R50a	-	2	2	-	-	-	-	-	-	-	4	2.0 - 2.4
Dobbelaars Kloof I R21	-	3	4	-	-	-	-	-	-	-	7	1.8 - 2.3
Dobbelaars Kloof II R22	-	4	3	-	-	-	-	-	-	-	7	1.6 - 2.2
L'smith-B'dale R2	-	5	-	-	-	-	-	-	-	-	5	1.7 - 2.0

Class interval 0.5 cm.

TABLE 58 Variation in length of leaf in field specimens of 'smutsiana', 'hallii', 'bullulata' and 'rugosa'. and the putative "smutsiana" X "rugosa" hybrid.

Locality.	Class range of measurements.								Total no. indiv.	Range actual measurements.
	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75		cm.
HYBRID R4	-	-	2	-	-	-	-	-	2	1.3 - 1.5
SMUTSIANA.										
nr. Adams Kraal R63	-	-	2	2	2	-	-	-	6	1.3 - 1.9
L'smith-B'dale I R5	-	3	12	5	3	-	-	-	23	1.2 - 1.9
L'smith-B'dale II R3	1	1	11	6	3	-	-	-	22	1.0 - 2.0
Rooinek Pass R51	-	2	7	4	1	-	-	-	14	1.2 - 1.9
Rietvlei R49	1	1	3	-	-	-	-	-	5	1.0 - 1.4
HALLII.										
Rietvlei R48	-	-	4	5	-	-	-	-	9	1.4 - 1.7
Koup R26	-	-	3	5	8	1	-	-	17	1.3 - 2.0
BALLULATA.										
N. Matjesfontein R25	-	-	5	1	4	2	3	-	15	1.3 - 2.3
Ceres-S'land R24	-	-	-	1	3	2	2	1	9	1.6 - 2.6
RUGOSA.										
Pietersfontein R19+20	-	1	7	2	-	-	-	-	10	1.1 - 1.7
Upper Baden R17	-	-	5	1	1	-	-	-	7	1.3 - 1.8
Baden Rd R18	-	1	3	3	-	-	-	-	7	1.2 - 1.7
nr. Montagu R23	-	1	5	4	-	-	-	-	10	1.2 - 1.7
Rietvlei R50a	-	1	2	1	-	-	-	-	4	1.2 - 1.6
Dobbelaars Kloof I R21	-	1	5	1	-	-	-	-	7	1.2 - 1.6
Dobbelaars Kloof II R22	-	1	6	-	-	-	-	-	7	1.1 - 1.5
L'smith-B'dale R2	-	-	5	-	-	-	-	-	5	1.4 - 1.5

Class interval

TABLE 59 Variation in greatest width of leaf in field specimens of "smutsiana", "hallii", "bullulata" "rugosa" and the putative hybrid "smutsiana" X "rugosa".

Locality.	Class range of measurements										Total no. indiv.	Range actual measurements.
	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00			cm.
HYBRID R4	-	-	1	1	-	-	-	-	-	-	2	1.30 - 1.53
SMUTSIANA.												
nr. Adams Kraal R63	-	-	-	2	2	1	1	-	-	-	6	1.53 - 2.31
L'smith-B'dale I R5	-	-	3	9	6	4	1	-	-	-	23	1.32 - 2.30
L'smith-B'dale II R3	-	2	9	8	2	1	-	-	-	-	22	1.14 - 2.11
Rooinek Pass R51	-	-	1	5	5	3	-	-	-	-	14	1.46 - 2.23
Riwtvlei R49	-	-	2	2	1	-	-	-	-	-	5	1.48 - 2.00
HALLII.												
nr. Rietvlei R48	-	-	-	-	1	6	2	-	-	-	9	1.91 - 2.48
Koup R26	-	-	-	2	2	7	4	1	-	1	17	1.72 - 3.14
BULLULATA.												
N. Matjesfontein R25	-	-	4	4	1	-	-	-	-	-	9	1.38 - 1.90
Ceres-S'land R24	-	-	1	10	1	2	-	1	-	-	15	1.42 - 2.72
RUGOSA.												
Pietersfontein R19+20	-	1	4	5	-	-	-	-	-	-	10	1.24 - 1.69
Upper Baden R17	-	3	3	1	-	-	-	-	-	-	7	1.06 - 1.69
Baden Rd R18	1	2	2	2	-	-	-	-	-	-	7	1.00 - 1.69
nr. Montagu R23	-	3	5	2	-	-	-	-	-	-	10	1.06 - 1.67
Rietvlei R50a	-	-	3	-	1	-	-	-	-	-	4	1.43 - 1.83
Dobbelaars Kloof I R21	-	-	5	1	1	-	-	-	-	-	7	1.44 - 1.77
Dobbelaars Kloof II R22	-	1	3	3	-	-	-	-	-	-	7	1.23 - 1.57
L'smith-B'dale R2	-	2	3	-	-	-	-	-	-	-	5	1.20 - 1.43

Class interval 0.25 cm.

TABLE 60 Variation in length-breadth ratio in field specimens of 'smutsiana', "hallii", "bullulata" "rugosa" and the putative "smutsiana" X "rugosa" hybrid.

Locality.	Class range of measurements.								Total no. indiv.	Range actual measurements.
	0	0	.25	.50	.75	1.00	1.25			cm.
POSITION OF WIDEST PART OF LEAF Class interval 0.25 cm.										
HYBRID R4	-	-	2	-	-	-	-	-	2	.1bel - .2bel
SMUTSIANA.										
nr. Adams Kraal R63	-	-	3	2	1	-	-	-	6	.1bel - .6bel
L'smith-B'dale I R5	-	-	13	9	1	-	-	-	23	1.bel - .6bel
L'smith-B'dale II R3	-	4	16	2	-	-	-	-	22	0 - .3bel
Rooinek Pass R51	-	-	7	6	1	-	-	-	14	.1bel - .6bel
Rietvlei R49	-	1	4	-	-	-	-	-	5	0 - .2bel
HALLII.										
Rietvlei R48	-	-	-	7	2	-	-	-	9	.3bel - .6bel
Koup R26	-	-	1	7	5	3	-	1	17	.2bel -1.3bel
BULLULATA.										
N. Matjesfontein R25	-	-	6	3	-	-	-	-	9	.1bel - .4bel
Ceres-S'land R24	-	1	3	10	1	-	-	-	15	0 - .6bel
RUGOSA.										
Pietersfontein R19+20	-	5	5	-	-	-	-	-	10	0 - .1bel
Upper Baden R17	3	2	2	-	-	-	-	-	7	.1 ab - .1bel
Baden Rd R18	3	3	1	-	-	-	-	-	7	.1 ab - .1bel
nr. Montagu R23	4	3	2	1	-	-	-	-	10	.2 ab - .3bel
Rietvlei R50a	-	2	2	-	-	-	-	-	4	0 - .1bel
Dobbelaars Kloof I R21	-	2	5	-	-	-	-	-	7	0 - .2bel
Dobbelaars Kloof II R22	1	4	2	-	-	-	-	-	7	.2 ab - .1bel
L'smith-B'dale R2	-	2	3	-	-	-	-	-	5	0 - .2bel

*(ab = above the midlength, bel = below the midlength)

LENGTH OF MUCRO. Class interval 0.05 cm						
	.05	.10	.15			cm.
HYBRID R4	-	2	-	-	2	.07 -
SMUTSIANA.						
nr. Adams Kraal R63	3	3	-	-	6	.04 - .09
L'smith-B'dale I R5	4	16	3	-	23	.03 - .13
L'smith-B'dale II R3	2	19	1	-	22	.05 - .12
Rooinek Pass R51	3	11	-	-	14	.05 - .09
Rietvlei R49	1	4	-	-	5	.05 - .08
HALLII.						
Rietvlei R48	-	5	4	-	9	.08 - .13
Koup R26	1	7	8	-	16	.05 - .15
BULLULATA.						
N. Matjesfontein R25	1	7	1	-	9	.03 - .11
Ceres S'land R24	-	10	3	1	14	.06 - .20
RUGOSA.						
Pietersfontein R19+20	5	5	-	-	10	.05 - .10
Upper Baden R17	2	5	-	-	7	.05 - .06
Baden Rd R18	3	4	-	-	7	.04 - .07
nr. Montagu R23	6	3	-	-	9	.04 - .08
Rietvlei R50a	3	1	-	-	4	.05 - .06
Dobberlaars Kloof I R21	4	3	-	-	7	.04 - .07
Dobbelaars Kloof II R22	4	3	-	-	7	.04 - .08
L'smith - B'dale R2	4	1	-	-	5	.04 - .06

TABLE 61 Variation in position of widest part of the leaf in relation to mid length, & in length of mucro in field specimens of "smutsiana", "hallii", "bullulata" & "rugosa", and the putative "smutsiana" X "rugosa" hybrid.

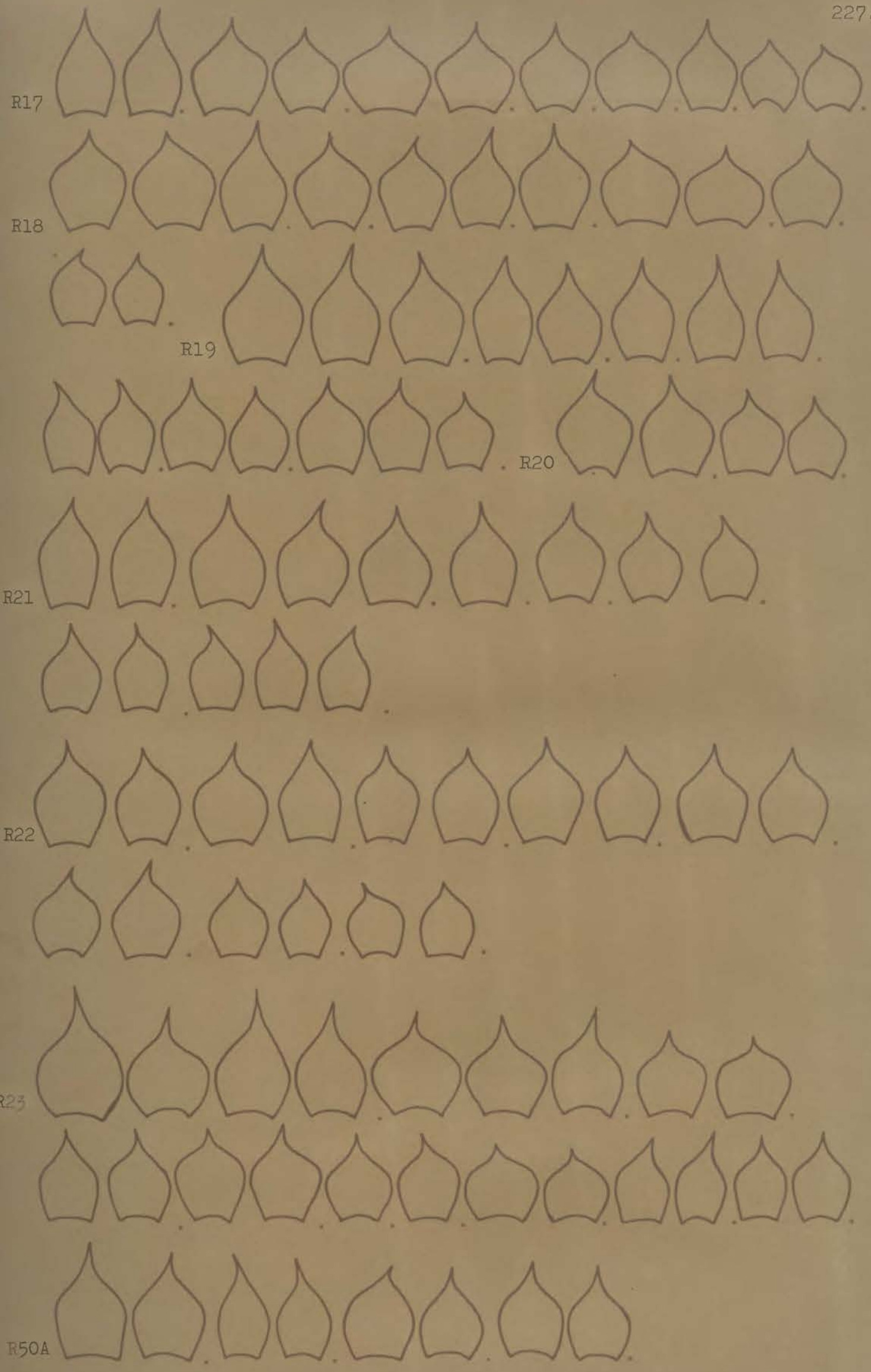


Fig.48. Variation in leaf shape in population samples of the entity rugosa. (Sheathing part of base not shown, the dots indicate the number of leaves shown for each plant.)

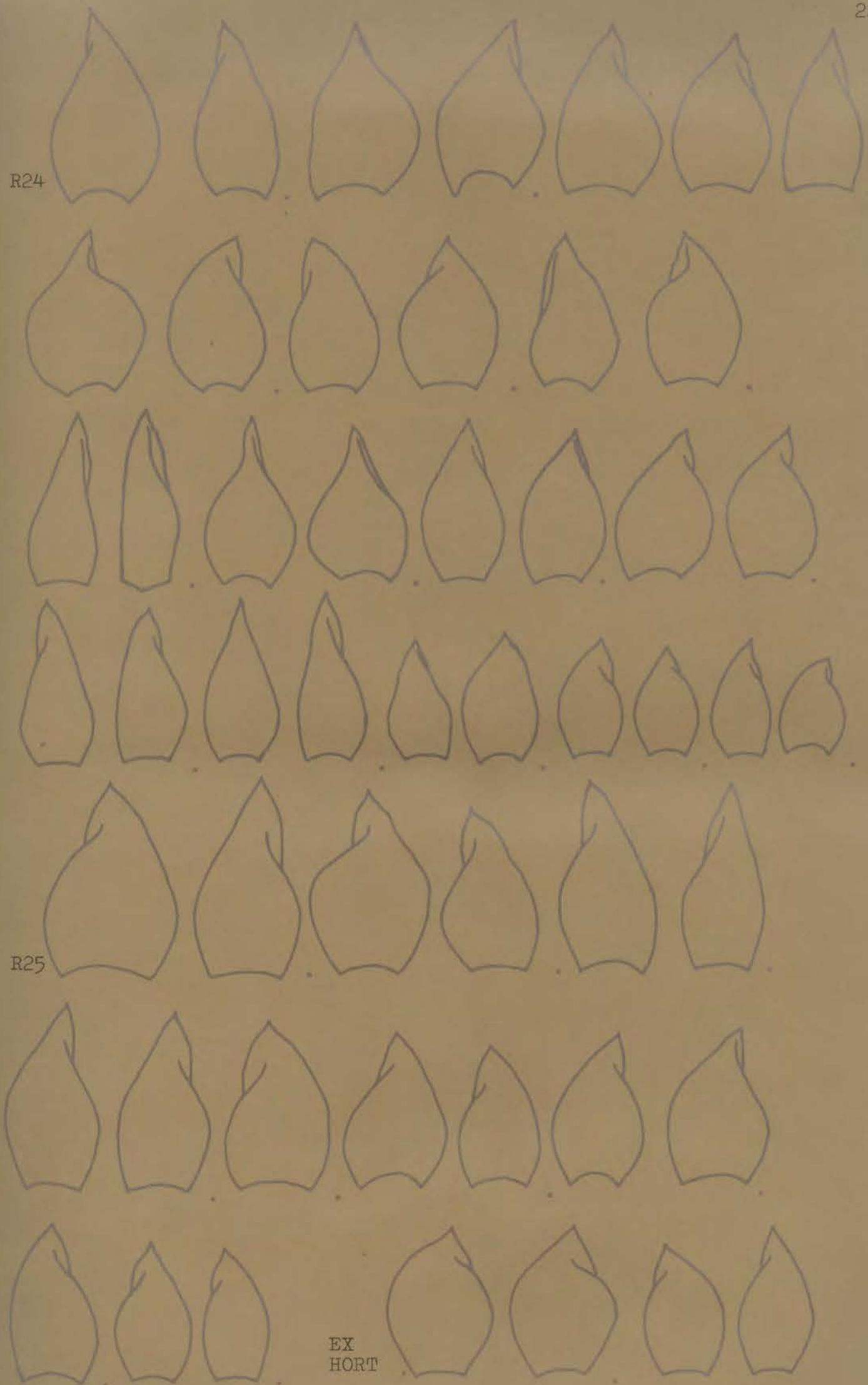


Fig.47. Variation in leaf shape in population samples of the entity bullulata. (Sheathing part of base not shown, the dots indicate the number of leaves shown for each plant.)

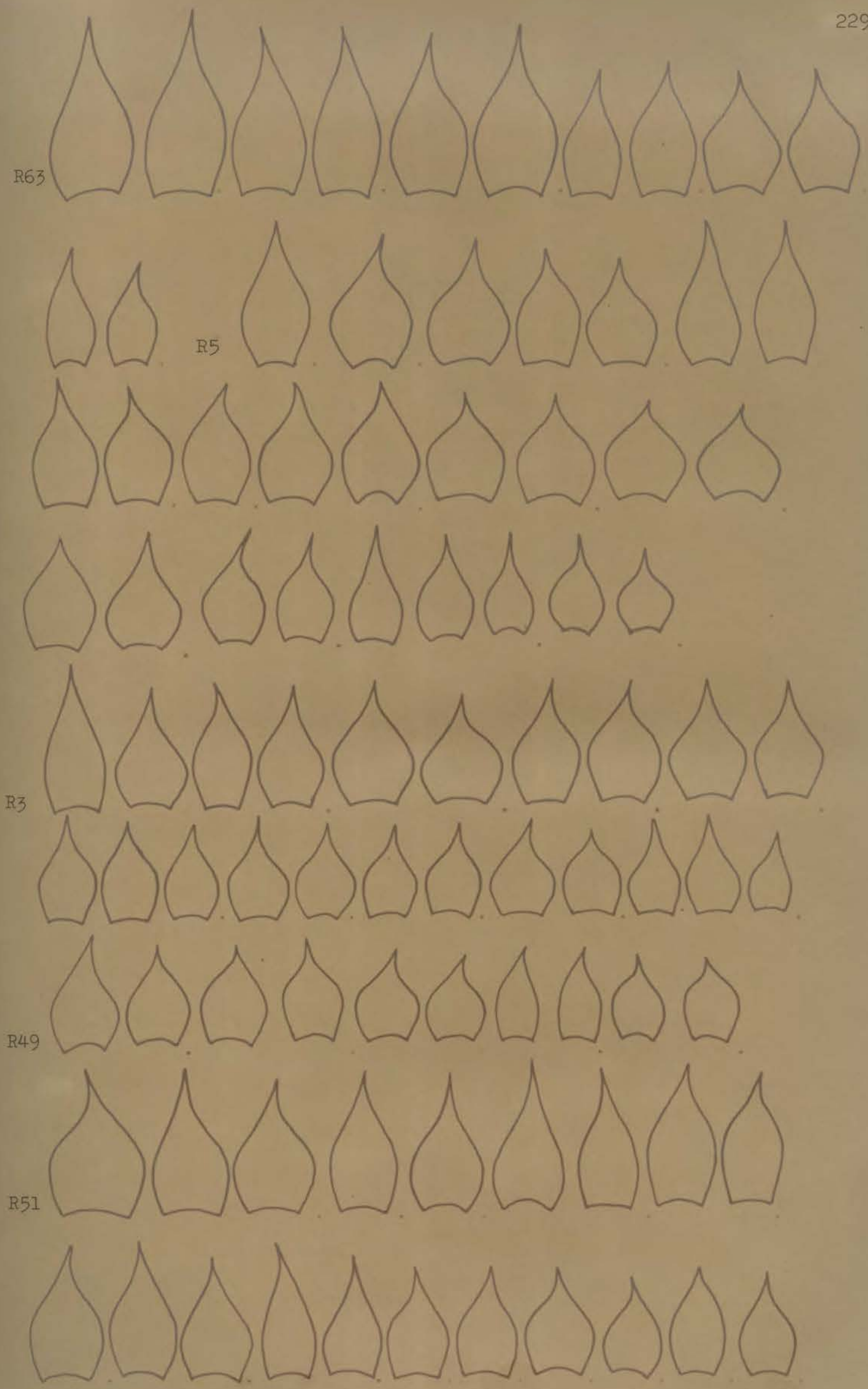


Fig.49. Variation in leaf shape in population samples of the entity smutsiana. (Sheathing part of base not shown, the dots indicate the number of leaves shown for each plant).

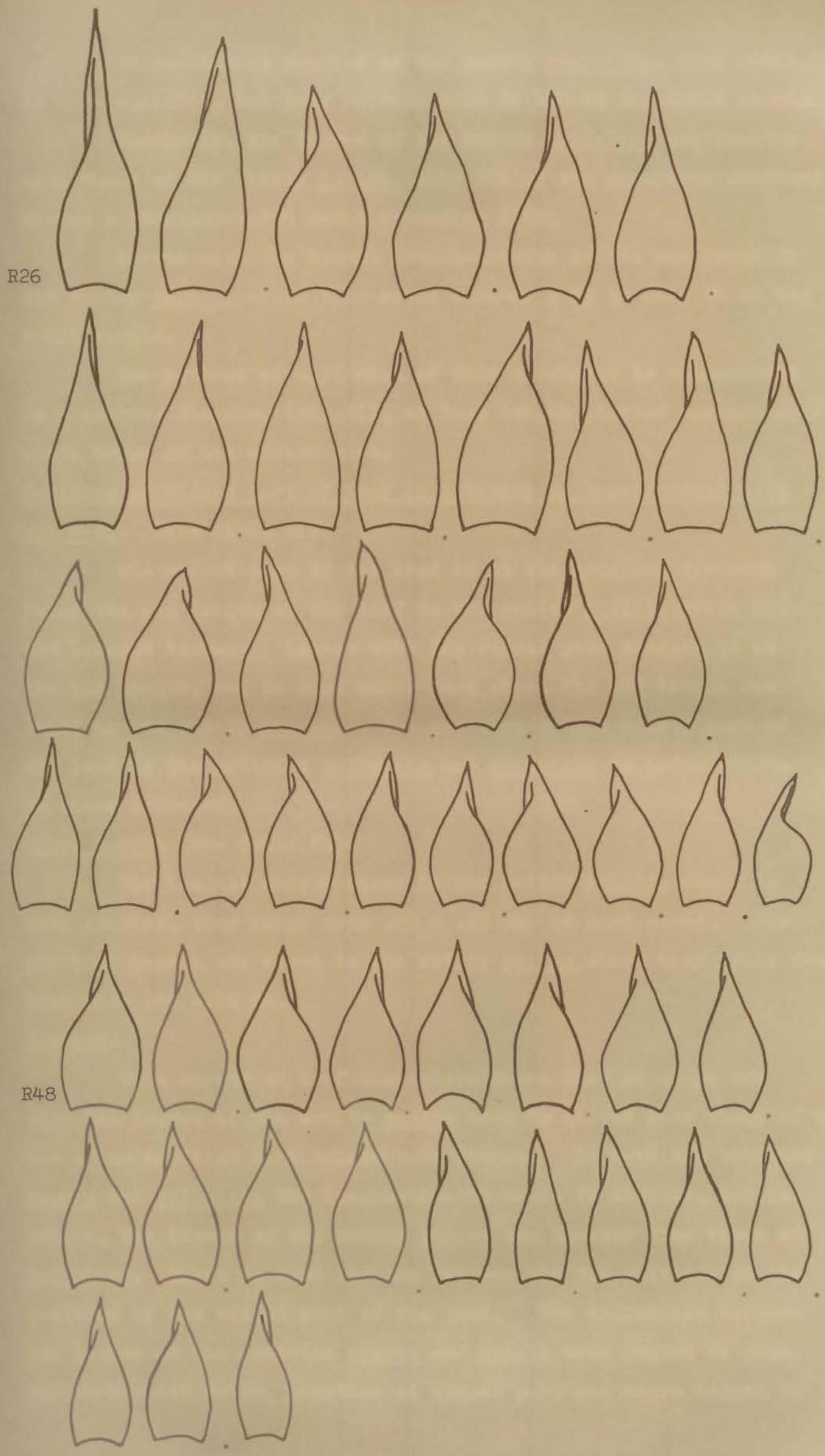


Fig.50. Variation in leaf shape in population samples of the entity hallii. (Sheathing part of base not shown, the dots indicate the number of leaves shown for each plant.)

In population samples of the entity smutsiana, this ratio is more variable, but only exceeds 2.00 in 16% of the total sample.

Similarly, the leaves of the entity bullulata are broader than those of the entity hallii, only 12% of the specimens examined having a length-breadth ratio exceeding 2.00.

Leaves with the lowest length-breadth ratios are found in the entity rugosa, where this ratio exceeds 1·75 in only 4% of the total sample.

The pattern of variation of this character is illustrated in a scatter diagram, (Fig.51), of leaf length plotted against leaf width taken at the widest part.

Position of widest part of leaf in relation to longitudinal half way mark. (See Table 61).

The widest part of the leaf is at the greatest distance below the mid length of the leaf in the entity hallii, which has the longest leaves. Leaves with the widest part nearest or at the mid length, and in some cases just above the mid length are found in the entity rugosa. The position of the widest part of the leaf in the entities bullulata and smutsiana is intermediate to these extremes.

Mucro length (See Table 61).

The longest mucros occur in the entity hallii, where in both samples, they range from .05 - .15 cm. in most cases. The shortest mucros are found in the entity rugosa,where they range from less than .05 -.10 cm.

Summary.

This survey of leaf dimensions shows that in shape and size the leaves of the entity rugosa tend to differ from those of the two other entities with tuberculate leaves. In both the entities rugosa and bullulata the length-breadth ratio is similar, but in length, the leaves of the entity rugosa are shorter than those of bullulata. There is some overlap between the two entities in the position of the widest part of the leaf. The difference between the leaves of the entities rugosa and hallii with regard to size, length-breadth ratio, position of widest part and mucro length is

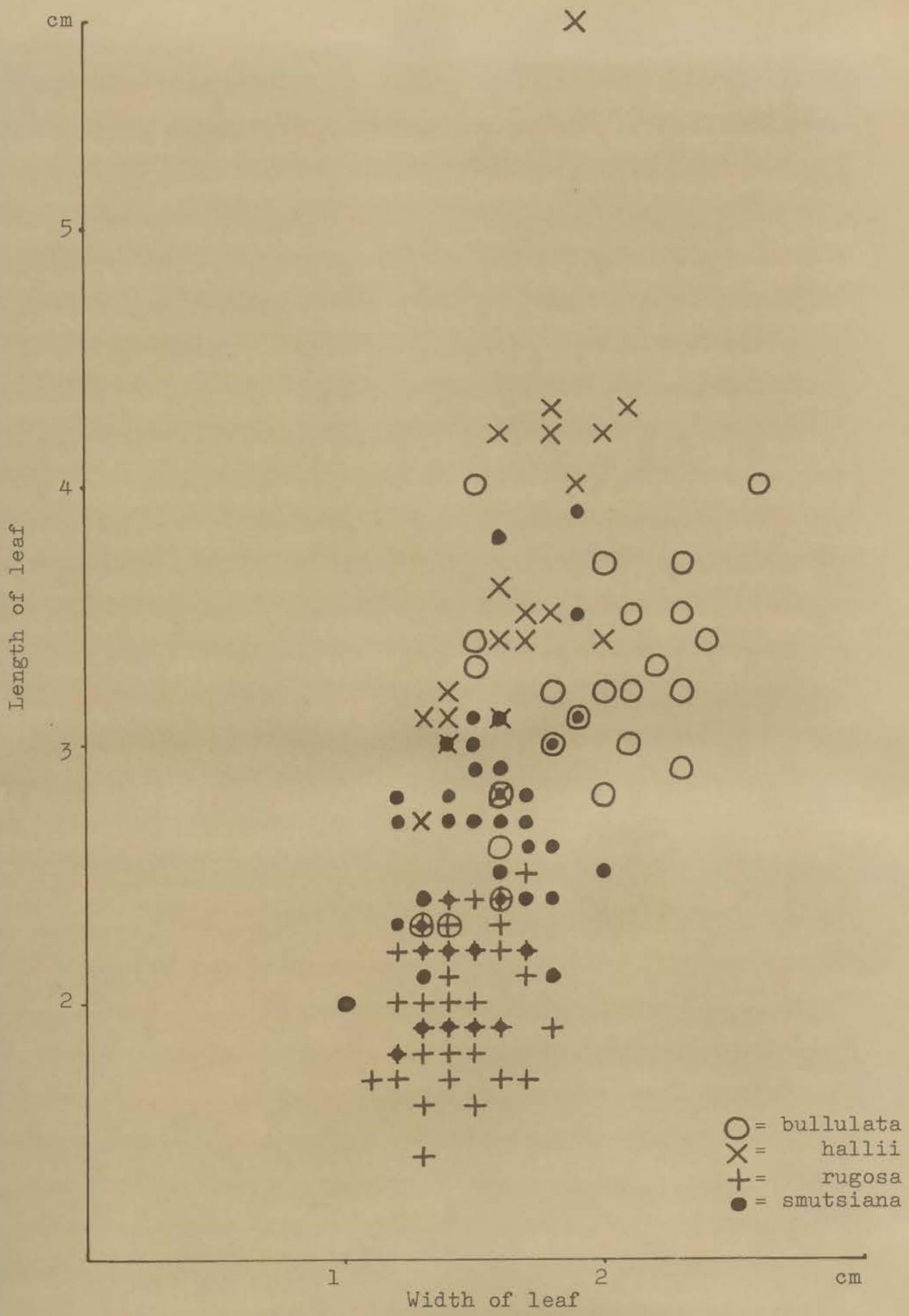


Fig.51. Variation in length and width of leaf at the widest part excluding the basal sheath in the entities smutsiana, hallii, bullulata and rugosa.

much more marked.

The entities hallii and bullulata have leaves similar in size but differing in shape, in that in the entity hallii, the length-breadth ratio is generally greate and the leaf apex narrower than in bullulata. As mentioned before, both have keeled marginate apices in common.

The entity smutsiana has, on the whole, shorter leaves than the entities hallii and bullulata, but in length-breadth ratio and in position of the widest part of the leaf it is intermediate between the two. It does however, lack keeled marginate apices.

From this it can be seen that, with regard to leaf shape, there is only one character of primary taxonomic significance, and that is the keeled marginate leaf apex found in the entities hallii and bullulata. Although there is an overlap of the characters leaf length and length breadth ratio between the four entities, the fact that they do tend to differ in each, is indicative of a difference between these entities.

The leaves of the putative hybrid between members of the entities smutsiana and rugosa are intermediate in the above characters to those of the parent entities.

LEAF ANATOMY.

This is only of significance in separating the entities bullulata and hallii. The bundle caps of the entity hallii are completely lignified for the entire length of the leaf, while in the entity bullulata they are completely unlignified towards the leaf apex, and, by the mid length of the leaf are lignified partially in only a few specimens. This is considered a character of some importance in the separation of these two entities.

A further feature of interest and to date only observed in leaves of the entity rugosa is that the outer walls of the lower epidermal cells from the upper half of the leaf are very frequently papillate (See Fig 8A). The epidermal cells of the putative hybrid between members of this entity and the entity smutsiana also

also exhibit this character. (See Fig. 7D1).

LEAF ORNAMENTATION.

Leaf Ornamentation excluding margins and keel.

As was mentioned in the introductory survey, fine, darker green bundle cap lines are visible towards the leaf apices in all specimens of the entity hallii and in the great majority of leaves examined of the entity smutsiana. These lines, the tendency for the leaf apices to have a reddish tinge and the similarity in the colour of the leaves have probably been responsible in the past, for part of the confusion over identification of these two entities, which have both, at various times been referred to as A.pentagona.

However, as has been mentioned, no specimens of the entity smutsiana with tuberculate or spotted leaf under-surfaces, have been found in the field. Under cultivation, a few specimens of this entity did develop a few whitish spots on the under surface of the leaf, but these were never raised. It was also mentioned in the introduction that 8 of the 50 specimens examined of the entity smutsiana had some leaves with elongated very slightly raised patches, such as were found in a few members of A.foliolosa complex.

The differences between the ornamentation of the exposed part of the ventral side of the leaves in the entities hallii and bullulata are shown in Table 62. The fact that darker vein lines are always present in the entity hallii, and have never been observed in the entity bullulata is another character considered of primary taxonomic significance in the separation of the two. In both entities, the degree of tuberculation on the leaves of any one plant is irregular, but when the tubercles are numerous they tend to be arranged in transverse groups in the entity bullulata and in longitudinal series along the vein lines in the entity hallii. This character and the fact some plants of the entity hallii lack any maculae or tubercles, or have only maculae, features not observed in the entity bullulata, are further indicative of a difference between these two entities.

It should be mentioned that what appear to be large tubercles

Table 62. VARIATION IN ORNAMENTATION OF VENTRAL SIDE OF LEAF IN FIELD SPECIMENS OF THE ENTITIES HALLII AND BULLULATA.

	Plants with no spots or tubercles	Plants with white spots on some or all leaves	Plants with tubercles on some leaves	Plants with tubercles on all leaves	Bundle cap lines present	Tubercles arranged in transverse rows	Tubercles along veins lines	No.of plants examined
HALLII								
Rietvlei R48	1	3	5	-	9	-	5	9
Koup R26	2	7	7	-	16	-	6	16
BULLULATA								
Ceres-S'land R24	-	-	4	11	-	7	-	15
Matjesfontein R25	-	-	2	9	-	8	-	11

Table 63. VARIATION IN DEGREE OF TUBERCULATION OF VENTRAL SIDE OF LEAF IN FIELD SPECIMENS OF THE ENTITY RUGOSA AND THE PUTATIVE HYBRID BETWEEN MEMBERS OF THE ENTITIES SMUTSIANA AND RUGOSA.

Locality	No. of tubercles per 4 mm.sq.				Height of tubercles in mm.				Total no. plants
	5	15	25		0.1	0.2	0.3		
Pietersfontein R19 & R20	-	-	3	7	-	6	4	-	10
Upper Baden R17	-	-	2	5	-	3	4	1	7
Baden Rd. R18	-	-	1	6	-	5	5	-	7
nr Montagu R23	-	-	4	6	-	7	5	-	10
Riet Vlei R50A	-	-	4	-	-	2	2	-	4
Dobbelaars Kloof R21	3	3	2	-	6	4	-	-	8
Dobbelaars Kloof R22	3	3	1	-	6	4	-	-	7
L'smith-B'dale R2	-	-	4	-	-	2	3	-	5
HYBRID R4	1	1	-	-	-	1	1	-	2

Table 64 VARIATION IN HEIGHT OF TUBERCLES OF MARGINS AND KEELS IN FIELD SPECIMENS OF THE ENTITIES HALLII, BULLULATA, SMUTSIANA AND RUGOSA. Class interval 0.05 mm.

Locality	Class range of measurements.							Total no. indiv.	Range actual measurements.
	.05	.10	.15	.20	.25	.30			mm.
HYBRID R4	-	1	-	-	-	-	-	1	.10
SMUTSIANA									
L'smith - B'dale I R5	13	12	1	-	-	-	-	20	.05-.15
L'smith - B'dale II R3	7	7	1	1	-	-	-	10	.05-.20
Rooinek Pass R51	8	7	1	-	-	-	-	14	.05-.15
Rietvlei R49	3	-	-	-	-	-	-	3	.05
HALLII									
Rietvlei R48	1	7	6	5	1	-	-	9	.05-.25
Koup R26	1	9	10	5	1	-	-	15	.05-.25
BULLULATA									
Ceres - S'land R24	1	4	10	3	2	-	-	15	.05-.25
Matjesfontein R25	-	4	7	3	2	2	1	11	.10-.35
RUGOSA									
Pietersfontein R19,20	-	4	5	4	-	-	-	10	.10-.20
Upper Baden R17	-	4	5	4	2	-	-	7	.10-.25
Baden Rd R18	-	2	4	-	-	-	-	5	.10-.15
nr Montagu R23	-	3	6	1	-	-	-	9	.10-.20
Ri et Vlei R50A	-	2	-	-	1	-	-	3	.10-.25
Dobbelaar's Kloof R21	3	6	-	-	-	-	-	7	.05-.10
Dobbelaar's Kloof R22	1	7	3	-	-	-	-	7	.05-.15
L'smith-B'dale R2	-	3	5	1	-	-	-	5	.10-.20

Table 65 VARIATION IN HEIGHT OF TUBERCLES FROM LOWER SIDE OF LEAF IN FIELD SPECIMENS OF THE ENTITIES HALLII AND BULLULATA. Class interval 0.10 mm.

Locality	Class range of measurements.				Total no. indiv.	Range actual measurements.
	.10	.20	.30			
HALLII						
Rietvlei R48	5	-	-	-	5	.05-.10
Koup R26	6	4	2	-	6	.05-.25
BULLULATA						
Ceres-S'land R24	4	9	8	3	15	.10-.35
Matjesfontein	3	5	5	3	11	.10-.35

in the entity bullulata, with a diameter of from one to two millimetres, are seen under a lens to consist of a large mound topped by a number of very fine protuberances, so that these large tubercles are actually an aggregation of confluent smaller tubercles. It is only where the tubercles are few that they are not arranged in any particular order on the under side of the leaf.

Tubercles from the ventral side of the leaf are much more prominent in the entity bullulata than in the entity hallii. (See Table 6.).

In the entity rugosa, where the degree of tuberculation is the same for all the leaves on any one plant, unlike the condition in the entities hallii and bullulata, the Dobbelaars Kloof populations have the least amount of tuberculation. This is shown in Tables 63 and 64. It is seen that the under sides of the leaves of the putative hybrid have very few tubercles compared with the leaves of plants of the entity rugosa from the same area.

(N.B. The tables showing variation in height of tubercles in field populations of these entities have been compiled in the same way as those for the A. foliolasa complex).

Tubercles of margins and keels. (See Table 64).

These are least prominent in the entity smutsiana. In the entities hallii and bullulata the height of these tubercles is on the whole similar. In the population samples of the entity rugosa, the least raised tubercles on the margins and keels are again found in specimens from the Dobbelaars Kloof localities.

Summary.

In these four entities, leaf ornamentation is a character of taxonomic significance. The fact that the degree of tuberculation is more even and regular on all the leaves of a single plant tends to distinguish the entity rugosa from the entities hallii and bullulata. These two in turn are distinguished by the nature of the tuberculation and by the darker vein lines in the entity hallii. The total absence of tuberculate or maculate leaves in field

THE ENTITY BULLULATA

A(X 1)

B(X 1)

C(X $\frac{5}{6}$)

D(X 2)

A and B: leafy shoots; in A tubercles few, some leaves without tubercles; in B tubercles more numerous, compound nature of tubercle apparent. C and D: lower sides of leaves, tubercles when numerous arranged roughly in transverse rows. In some specimens the leaf apices are seen to curve upward and to one side. (Scales approximate).

PLATE 20.

THE ENTITY HALLII.

A X 1

C (X 1½)

B X 1

Leafy shoots: keeled marginate apices visible in some leaves of all specimens; darker bundle cap lines very apparent. In B tubercles present corresponding to the bundle cap lines. (Scales approximate).

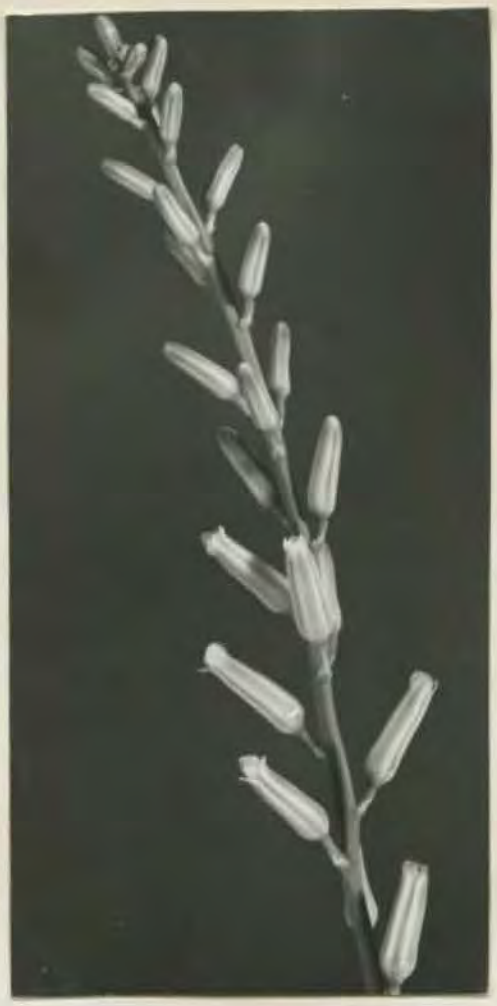
PLATE 21.

THE ENTITY SMUTSIANA.

Leafy shoots (X 1 approx.). All leaves with true marginate apices darker bundle cap lines seen in some leaves.

PLATE 22.

A.



B.

C.

Inflorescences of: A, the entity rugosa; B, the putative hybrid between the entities rugosa and smutsiana; C, the entity smutsiana. (X 1 approx.)

Leafy shoots of, from left to right: the entity rugosa, the putative hybrid between the entities rugosa and smutsiana; the entity smutsiana. (X ¾ approx.)

PLATE 23.

populations of the entity smutsiana indicates a difference between this entity and the entity hallii.

INFLORESCENCE CHARACTERS (See Plate 24).

In this part of the survey, herbarium material is also included.

In field populations of the entities smutsiana and bullulata, flowering material was only available from the Ladismith-Barrydale Karoo and Matjesfontein, respectively.

Length of peduncle and raceme. (See Tables 66, 67 and 68).

Peduncle length is somewhat variable in all four entities. The longest peduncles are found in speciments of the entity hallii from Koup, the shortest peduncles in plants of the entity smutsiana from the Ladismith-Barrydale II locality. Apart from the latter, the majority of the peduncles of the population samples exceed 15 cm. in length.

In the putative hybrid between members of the entities rugosa and smutsiana, which was found at the Ladismith-Barrydale II locality, most peduncles are 20 - 25 cm. long.

Raceme length is also variable, the shortest racemes occurring in sample populations of the entity rugosa. In the Montagu Karoo a number of racemes were found to be stunted due to insect parasites. In these the pedicels tended to become thickened.

Number of sterile bracts (See Tables 69A and B).

In the entities bullulata, hallii and smutsiana there is little difference in the number of sterile bracts, which is variable. In the entity rugosa however, the number of sterile bracts per peduncle is smaller, although there is an overlap with the other three entities. In 27% of the field samples of the entity rugosa, only 2 sterile bracts per peduncle are found.

The range of variation in the number of sterile bracts in the putative hybrid incorporates the numbers found in both the entities rugosa and smutsiana.

Branching of inflorescence. (See Table 70)

Apart from a single spedimen of the entity smutsiana, where

Locality.	Class range of measurements.									Total no. indiv.	Range actual measurements.
	5	10	15	20	25	30	35	40			cm.
HYBRID R4	-	-	-	1	4	1	-	-	-	6	16
SMUTSIANA.											
L'smith-B'dale I R5,62b	-	-	4	9	3	2	-	-	-	18	12 - 28
L'smith-B'dale II R3,62a	-	3	7	5	3	2	-	-	-	20	8 - 29
HALLII.											
Rietvlei R52	-	-	-	1	1	5	3	-	-	10	19 - 32
Koup R54	-	1	4	10	6	1	2	-	-	24	8 - 31
BULLULATA.											
Matjesfontein R55	-	-	1	4	1	3	-	-	-	9	14 - 30
RUGOSA.											
Pietersfontein R19+20	-	-	4	2	2	2	-	-	-	10	12 - 29
Baden-Baden R17,18,59	-	-	1	3	8	3	3	-	-	18	14 - 34
nr. Montagu R23	-	-	-	1	4	1	1	-	-	7	18 - 31
"Montagu Dist." Nbg	-	-	-	-	3	1	-	-	1	5	21 - 43
Dobbelaars Kloof R21,22	-	-	1	1	4	3	-	-	-	9	13 - 26
L'smith-B'dale R2	-	-	1	2	3	1	-	-	-	7	14 - 27

Class interval 5.0 cm.

Table 66 VARIATION IN LENGTH OF PEDUNCLE IN FIELD SPECIMENS OF "SMUTSIANA", "HALLII", "BULLULATA", "RUGOSA" AND THE PUTATIVE "SMUTSIANA" x "RUGOSA" HYBRID.

Locality.	Class range of measurements.									Total no. indiv.	Range actual measurements.
	5	10	15	20	25	30	35	40			cm.
HYBRID R4	-	1	3	1	1	-	-	-	-	6	7 - 21
SMUTSIANA.											
L'smith-B'dale I R5,62b	-	3	7	7	1	-	-	-	-	18	8 - 23
L'smith-B'dale II R3,62a	-	3	8	7	1	-	-	-	-	19	8 - 25
HALLII.											
Rietvlei R52	-	-	2	3	5	-	-	-	-	10	13 - 24
Koup R54	-	-	5	10	6	1	2	-	-	24	12 - 32
BULLULATA.											
Matjesfontein R55	-	-	2	1	3	3	-	-	-	9	11 - 29
RUGOSA.											
Pietersfontein R19+20	1	7	1	-	-	1	-	-	-	10	5 - 27
Baden-Baden R17,18,59	-	4	6	6	1	-	-	-	-	17	9 - 22
nr. Montagu R23	-	3	1	1	-	1	-	-	-	6	6 - 27
"Montagu Dist." Nbg	-	-	3	2	-	-	-	-	-	5	11 - 16
Dobbelaars Kloof R21,22	1	1	5	1	-	-	-	-	-	8	5 - 16
L'smith-B'dale R2	-	2	3	1	-	-	-	-	-	6	9 - 17

Class interval 5.0 cm.

Table 67 VARIATION IN LENGTH OF RACEME IN FIELD SPECIMENS OF 'SMUTSIANA', 'HALLII', 'BULLULATA', 'RUGOSA' AND THE PUTATIVE 'SMUTSIANA' x 'RUGOSA' HYBRID.

Locality.	Class range of measurements. 10	15	20	25		Total no. indiv.	Range actual measurements. cm.
			LENGTH PEDUNCLE.				
HALLII.							
Prince Albert	1	-	-	-	-	1	9
BULLULATA.							
Verlaten Kloof	-	-	1	-	-	1	18
Ceres Karoo	-	-	1	-	-	1	19
Laingsb'g-L'smith	-	1	2	-	-	3	15 - 18
RUGOSA.							
Graaff Reinet	-	1	1	-	-	2	9+ - 17+
Bonnievale	-	-	1	-	-	1	17
Barrydale	-	1	2	-	-	3	15 - 18
Muiskraal	-	-	1	-	-	1	18
Laingsb'g-L'smith	-	1	-	1	-	2	13 - 26
Ladismith	-	-	2	-	-	2	16
			LENGTH RACEME.				
HALLII.							
Prince Albert	1	-	-	-	-	1	8
BULLULATA.							
Verlaten Kloof	-	-	-	-	1	1	26
Ceres Karoo	-	-	1	-	-	1	17
Laingsb'g-L'smith	-	2	-	-	1	3	11 - 26
RUGOSA.							
Graaff Reinet	-	-	1	1	-	2	17 - 24
Bonnievale	-	-	1	-	-	1	19
Barrydale	3	-	-	-	-	3	6 - 8
Muiskraal	1	-	-	-	-	1	9
Laingsb'g-L'smith	-	1	-	-	-	1	11
Ladismith	1	-	-	-	-	1	7

Class interval 5.0 cm.

TABLE 68 VARIATION IN LENGTH OF RACEME AND PEDUNCLE IN HERBARIUM SPECIMENS OF 'HALLII', 'BULLULATA' AND 'RUGOSA'.

Locality.	Number of bracts.							Total no. indiv.	Range actual no. bracts.
	2	4	6	8	10	12			
HYBRID R4	2	2	1	1	-	-	-	6	2 - 7
SMUTSIANA.									
L'smith-B'dale R5,62b I	1	3	12	2	-	-	-	18	2 - 7
L'smith-B'dale R3,62a II	-	9	8	3	1	-	-	21	3 - 10
HALLII.									
Rietvlei R52	-	-	7	2	1	-	-	10	5 - 9
Koup R54	-	6	10	5	2	-	1	24	3 - 14
BULLULATA.									
Matjesfontein R55	-	2	4	3	-	-	-	9	3 - 7
RUGOSA.									
Pietersfontein R19+20	2	8	-	-	-	-	-	10	2 - 4
Baden-Baden R17,18,59	6	13	-	-	-	-	-	19	2 - 4
nr. Montagu R23	2	5	-	-	-	-	-	7	2 - 4
"Montagu Dist" Nbg	1	4	-	-	-	-	-	5	2 - 4
Dobbelaars Kloof R21,22	2	7	-	-	-	-	-	9	2 - 4
L'smith-B'dale R2	1	7	-	-	-	-	-	8	2 - 4

Class interval 2 bracts.

Table 69A VARIATION IN NUMBER OF STERILE BRACTS PER PEDUNCLE IN FIELD SPECIMENS OF 'SMUTSIANA', 'HALLII', 'BULLULATA', 'RUGOSA' + THE PUTATIVE 'SMUTSIANA x RUGOSA' HYBRID.

Locality.	Number of bracts.							Total no. indiv.	Range actual no. bracts.
	2	4	6	8	10	12			
HALLII.									
Prince Albert Nbg 141/28 (BOL)	-	1	-	-	-	-	-	1	4
BULLULATA.									
Verlaten Kloof Nbg 258/55(NBG)	-	-	1	-	-	-	-	1	5
Ceres Karoo No. 27635(BOL)	-	1	-	-	-	-	-	1	3
Laingsb'g-L'smith 9363(BOL)	-	1	1	-	-	-	-	2	4 - 6
RUGOSA.									
Graaff Reinet (?) 4202 in herb Marloth (PRE)	-	1	1	-	-	-	-	2	4 - 5
Bonnievale v.d. Merwe 226(BOL)	1	-	-	-	-	-	-	1	2
Barrydale, Nbg 2154/26 (BOL)	1	2	-	-	-	-	-	3	2 - 3
Muiskraal Nbg 2306/27 (BOL)	-	2	-	-	-	-	-	2	3
Laingsb'g-L'smith Pillans 857(BOL)	1	-	1	-	-	-	-	2	2 - 5
Ladismith No. 27638 (BOL)	2	-	-	-	-	-	-	2	2

Class interval 2 bracts.

Table 69B VARIATION IN NUMBER OF STERILE BRACTS PER PEDUNCLE IN HERBARIUM SPECIMENS OF "SMUTSIANA", "HALLII", "BULLULATA" & "RUGOSA"

Locality.	Individuals with one or more branches to inflorescence	Individuals with unexpanded infl. buds in axils of sterile bracts.	Total no. indiv.
HYBRID R4	0	0	6
SMUTSIANA.			
L'smith-B'dale I R5,62b	0	0	18
L'smith-B'dale II R3,62a	0	1	21
HALLII.			
nr. Rietvlei R52	0	2	10
Koup R54	1	10	24
BULLULATA.			
Matjesfontein R55	0	2	9
RUGOSA.			
Pietersfontein R19+20	0	0	10
Baden-Baden R17,18,59	0	0	19
nr. Montagu R23	0	0	7
"Montagu Dist." Nbg	0	0	5
Dobbelaars Kloof R21,22	0	0	9
L'smith-B'dale R2	0	0	7

Table 70. VARIATION IN DEGREE OF BRANCHING OF INFLORESCENCES IN FIELD SPECIMENS OF 'SMUTSIANA', 'HALLII', 'BULLULATA' AND 'RUGOSA', + THE PUTATIVE 'SMUTSIANA' X 'RUGOSA' HYBRID.

an unexpanded raceme bud was found in the axil of a sterile bract, branched inflorescences or undeveloped raceme buds were found only in the entities bullulata and hallii. It is of interest to note the higher incidence of unexpanded raceme buds found in the axils of the Koup sample of the entity hallii, compared with that in specimens of this entity from Rietvlei.

Thickness of peduncle (See Table 71).

Peduncles with the stoutest bases are found in the entities hallii and bullulata. In the population samples of these, the broadest peduncle bases are found in specimens of the entity hallii from Koup, where in 42% of the sample, the width of the peduncle base exceeds 0.6 cm.

Peduncle bases in the entities rugosa and smutsiana tend to be narrower, but this difference is by no means absolute.

Locality.	Class range of measurements.					Total no. indiv.	Range actual measurements.
DIAMETER PEDUNCLE BASE. Class interval 0.15 cm.							
	.30	.45	.60	.75			cm.
HYBRID R4	3	4	-	-	-	7	0.25 - 0.38
SMUTSIANA.							
L'smith-B'dale I R5,62b	5	12	-	-	-	17	0.22 - 0.38
L'smith-B'dale II R3,62a	10	10	-	-	-	20	0.23 - 0.42
HALLII.							
Rietvlei R52	-	3	7	-	-	10	0.39 - 0.57
Koup R54	-	1	13	7	3	24	0.45 - 0.90
BULLULATA.							
Matjesfontein R55	-	1	8	-	-	9	0.44 - 0.56
RUGOSA.							
Pietersfontein R19,20	9	1	-	-	-	10	0.23 - 0.40
Baden-Baden R17,18,59	8	9	-	-	-	17	0.22 - 0.41
nr. Montagu R23	7	-	-	-	-	7	0.25 - 0.30
"Montagu Dist." Nbg	3	2	-	-	-	5	0.28 - 0.37
Dobbelaars Kloof R21,22	6	3	-	-	-	9	0.25 - 0.40
L'smith-B'dale R2	4	3	-	-	-	7	0.27 - 0.40
DIAMETER PEDUNCLE BELOW RACEME. Class interval 0.10 cm.							
	.10	.20	.30	.40			cm.
HYBRID R4	-	4	2	-	-	7	0.15 - 0.25
SMUTSIANA.							
L'smith-B'daleIR5,62b	-	15	6	-	-	21	0.11 - 0.24
L'smith-B'dale II R3,62a	-	16	2	-	-	18	0.12 - 0.27
HALLII.							
Rietvlei R52	-	3	6	1	-	10	0.17 - 0.31
Koup R54	-	-	9	14	1	24	0.28 - 0.44
BULLULATA.							
Matjesfontein R55	-	-	7	2	-	9	0.24 - 0.33
RUGOSA.							
Pietersfontein R19,20	-	5	5	-	-	10	0.18 - 0.25
Baden, Baden R17,18,59	-	14	3	-	-	17	0.14 - 0.26
nr. Montagu R23	-	4	3	-	-	7	0.19 - 0.27
"Montagu Dist." Nbg	-	5	-	-	-	5	0.14 - 0.20
Dobbelaars Kloof R21,22	-	5	4	-	-	9	0.15 - 0.28
L'smith-B'dale R2	-	6	1	-	-	7	0.16 - 0.23

Table 71 VARIATION IN BROADNESS OF PEDUNCLE IN FIELD SPECIMENS OF 'SMUTSIANA', 'HALLII', 'BULLULATA', 'RUGOSA', + THE PUTATIVE 'SMUTSIANA' X 'RUGOSA' HYBRID.

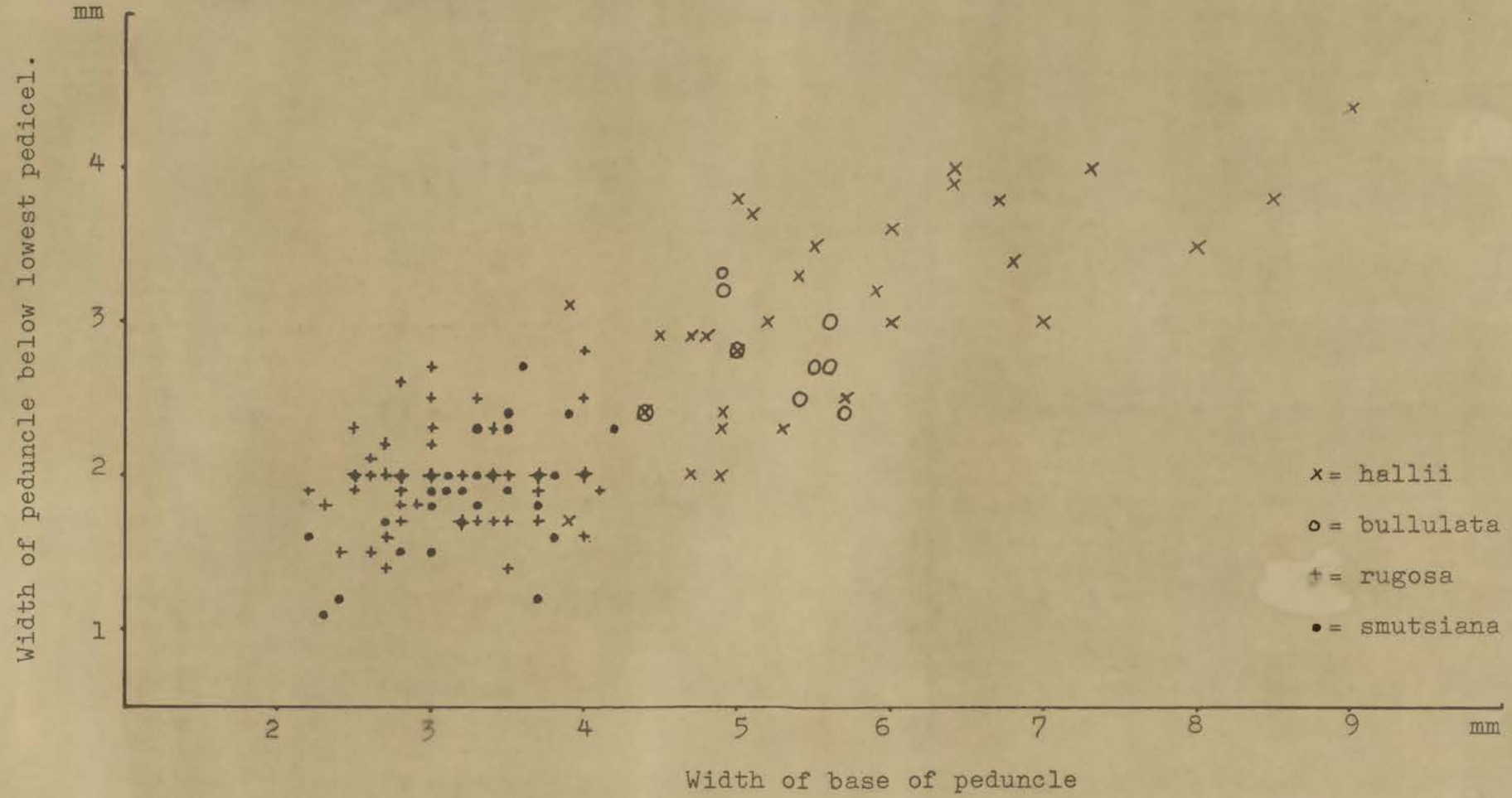


Fig.52. Variation in thickness of peduncle in the entities smutsiana, hallii, bullulata and rugosa.

A similar pattern of variation is observed for the width of the peduncle below the first pedicel.

A scatter diagram, (Fig.52), of the diameter of the base of the peduncle plotted against the diameter of the peduncle below the first pedicel gives a fairly good, but by no means complete, separation of the entities smutsiana and rugosa from the entities hallii and bullulata.

Dimensions of basal sterile bract. (See Tables 72 and 73).

There is considerable overlap in the length of the lowest sterile bract between the four entities. The shortest bracts are found in population samples of the entity rugosa. The length of the basal sterile bract of the putative hybrid between this entity and the entity smutsiana is very variable.

The width of the base of the lowest sterile bract is similar in all four entities, with the exception of specimens of the entity hallii from Koup, where the bases of the sterile bracts are broader, agreeing with the broader peduncle base observed in specimens of this sample.

Although there is an overlap in the length-breadth ratio of the basal sterile bract between all four entities, a majority of specimens with the highest ratios is found in the entity smutsiana, while the lowest ratios are found in the majority of specimens of the entities rugosa and bullulata.

The length-breadth ratio of the basal ste ile bracts of the putative hybrid is very variable.

Dimensions of basal fertile bract. (See Tables 74 and 75)

There is little difference in the length of the lowest fertile bract between the four entities. A larger number of longer bracts tends to be found in the entities hallii and bullulata, and a greater number of shorter bracts is found in the entity rugosa.

Differences with regard to the basal width and the length-breadth ratio are also slight, the greatest number of bracts with a length-breadth ratio exceeding 5.0 being found in the entity smutsiana. Again this ratio is very variable in the putative hybrid between members of the entities smutsiana and rugosa.

Locality.	Class range of measurements.						Total no. indiv.	Range actual measurements.
BRACT LENGTH. Class interval 0.2 cm.	0.4	0.6	0.8	1.0	1.2			cm.
Field Specimens.								
HYBRID R4	-	1	-	1	-	1	3	0.48 - 1.40
SMUTSIANA.								
L'smith-B'dale I R5 62b	-	4	9	2	1	-	16	0.55 - 1.05
L'smith-B'dale II R3 62a	-	9	8	3	-	-	20	0.42 - 0.90
HALLII.								
Rietvlei R52	-	1	9	-	-	-	10	0.60 - 0.80
Koup R54	-	8	12	3	-	-	23	0.43 - 0.93
BULLULATA.								
Matjesfontein R55	-	5	4	-	-	-	9	0.55 - 0.73
RUGOSA.								
Pietersfontein R19+20	-	-	-	-	-	-	-	-
Baden-Baden R17,18,59	1	7	-	-	-	-	8	0.40 - 0.55
"Montagu Dist" Nbg	-	3	1	-	-	-	4	0.47 - 0.65
Dobbelaars Kloof R21,22	-	1	-	-	-	-	1	0.48
L'smith-B'dale R2	-	8	1	-	-	-	9	0.45 - 0.80
Herbarium Specimens.								
BULLULATA.								
Verlaten Kloof	-	-	1	-	-	-	1	0.70
Ceres Karoo	-	1	-	-	-	-	1	0.42
Laingsb'g-L'smith	-	2	1	-	-	-	3	0.55 - 0.70
RUGOSA.								
Graaff Reinet	-	-	1	-	-	-	1	0.80
Laingsb'g-L'smith	-	-	1	-	-	-	1	0.75
Ladismith	-	1	-	-	-	-	1	0.48

	BASAL WIDTH OF BRACT. Class interval 0.1 cm.					
Field Specimens.	0.2	0.3	0.4			
HYBRID R4	-	3	-	-	3	0.23 - 0.30
SMUTSIANA.						
L'smith-B'dale I R5,62b	2	13	1	-	16	0.18 - 0.32
L'smith-B'dale II R3,62a	4	15	1	-	20	0.15 - 0.37
HALLII						
Rietvlei R52	1	7	2	-	10	0.19 - 0.40
Koup R54	-	9	9	4	23	0.22 - 0.47
BULLULATA.						
Matjesfontein R55	-	7	2	-	9	0.26 - 0.40
RUGOSA.						
Baden-Baden R17,18,59	1	6	1	-	8	0.18 - 0.36
"Montagu Dist" Ng.	1	3	-	-	4	0.20 - 0.27
Dobbelaars Kloof R21,22	-	1	-	-	1	0.28
L'smith-B'dale R2	-	6	2	-	8	0.24 - 0.35
Herbarium Specimens.						
RUGOSA.						
Graaff Reinet	-	1	-	-	1	0.25
Bonnievale	-	-	-	-	-	-
Laingsb'g-L'smith	1	-	-	-	1	0.20
Ladismith	-	1	-	-	1	0.23

TABLE 72 Variation in length and width of base in lowest Sterile bract in field and herbarium specimens of "smutsiana', 'halli', 'bullulata', 'rugosa' and the putative "smutsiana x 'rugosa" hybrid.

Locality.	Class range of measurements.					Total no. indiv.	Range actual measurements.
MIDDLE WIDTH OF BRACT. Class interval 0.05 cm.							
	.05	.10	.15	.20			cm.
Field Specimens.							
HYBRID R4	1	2	-	-	-	3	0.05 - 0.10
SMUTSIANA.							
L'smith-B'dale I R5,62b	-	10	6	-	-	16	0.06 - 0.15
L'smith-B'dale II R3,62a	1	13	6	-	-	20	0.05 - 0.15
HALLII.							
Rietvlei R52	-	3	5	-	-	8	0.10 - 0.14
Koup R54	-	4	7	3	1	15	0.08 - 0.22
BULLULATA.							
Matjesfontein R55	-	2	2	3	2	9	0.08 - 0.23
RUGOSA.							
Baden-Baden R17,18,59	-	4	3	-	1	8	0.06 - 0.23
"Montagu Dist". Nbg	-	1	3	-	-	4	0.08 - 0.12
Dobbelaars Kloof R21,22	-	1	-	-	-	1	0.10
L'smith-B'dale R2	-	-	5	3	-	8	0.11 - 0.16
Herbarium Specimens.							
RUGOSA.							
Graaff Reinet	-	1	-	-	-	1	0.06
~~Bonnievale~~	-	-	-	-	-	--	-
Laingsb'g-L'smith	-	-	1	-	-	1	0.13
Ladismith	-	-	1	-	-	1	0.12

Locality.	Class range of measurements.							Total no. indiv.	Range actual measurements.
LENGTH-BREADTH RATIO OF BRACT. Class interval 0.20 cm.									
	3	5	7	9	11	13			
Field Specimens.									
HYBRID R4	-	-	1	-	-	1	-	3	4.8 - 28.00
SMUTSIANA.									
L'smith-B'dale I R5,62b	-	1	7	6	1	-	1	16	4.83 - 15.00
L'smith-B'dale II R3,62a	1	4	7	5	-	2	1	20	3.00 - 14.66
HALLII.									
Rietvlei R52	-	2	3	3	-	-	-	8	4.42 - 8.00
Koup	1	6	6	2	-	-	-	15	2.88 - 8.12
BULLULATA.									
Matjesfontein R55	-	7	1	-	1	-	-	9	3.09 - 9.13
RUGOSA.									
Baden-Baden R17,18,59	1	6	-	-	1	-	-	8	1.82 - 9.16
"Montagu dist". Nbg	-	2	2	-	-	-	-	4	4.33 - 5.87
Dobbelaars Kloof R21,22	-	1	-	-	-	-	-	1	4.80
L'smith-B'dale R2	-	7	1	-	-	-	-	8	3.50 - 5.06
Herbarium Specimens.									
RUGOSA.									
Graaff Reinet	-	-	-	-	-	1	-	1	13.0
Laingsb'g-L'smith	-	-	1	-	-	-	-	1	5.76
Ladismith	-	1	-	-	-	-	-	1	4.00

Table 73 Variation in width of basal sterile bract taken half way along the length, and in the length-breadth ratio in field and herbarium specimens of 'smutsiana', 'hallii', 'bullulata', 'rugosa' + the putative 'rugosa' x 'smutsiana' hybrid.

Locality.	Class range of measurements.						Total no. indiv.	Range Actual measurements.
BRACT LENGTH. Class interval 0.10 cm.								
	0.3	0.4	0.5	0.6	0.7			cm.
Field Specimens.								
HYBRID R4	-	1	-	-	1	1	3	0.38 - 0.76
SMUTSIANA.								
L'smith-B'dale I R5,62b	2	8	3	3	-	-	16	0.29 - 0.58
L'smith-B'dale II R3,62a	3	7	5	4	-	-	19	0.30 - 0.60
HALLII.								
Rietvlei R52	1	3	6	-	-	-	10	0.30 - 0.48
Koup R54	2	5	13	4	-	-	24	0.30 - 0.54
BULLULATA.								
Matjesfontein R55	-	3	6	-	-	-	9	0.35 - 0.48
RUGOSA.								
Pietersfontein R19+20	3	6	1	-	-	-	10	0.23 - 0.50
Baden-Baden R17,18,59	7	10	2	-	-	-	19	0.30 - 0.45
nr. Montagu R23	1	5	1	-	-	-	7	0.28 - 0.50
"Montagu Dist." Nbg	-	5	-	-	-	-	5	0.32 - 0.40
Dobbelaars Kloof R21,22	1	5	3	-	-	-	9	0.30 - 0.49
L'smith-B'dale R2	1	5	3	-	-	-	9	0.30 - 0.45
Herbarium Specimens.								
HALLII.								
Prince Albert	1	-	-	-	-	-	1	0.30
BULLULATA.								
Verlaten Kloof	-	-	-	1	-	-	1	0.53
Ceres Karoo	-	1	-	-	-	-	1	0.37
Laingsb'g-L'smith	-	3	-	-	-	-	3	0.35 - 0.38
RUGOSA.								
Graaff Reinet	-	-	1	-	-	-	1	0.48
Bonnievale	-	-	1	-	-	-	1	0.50
Barrydale Nbg	-	1	-	-	-	-	1	0.35
Muiskraal Nbg	-	1	-	-	-	-	1	0.40
Laingsb'g-L'smith	-	-	1	-	-	-	1	0.45
Ladismith	-	1	-	-	-	-	1	0.35

BASAL WIDTH OF BRACT. Class interval 0.10 cm.						
Field Specimens.	0.2	0.3	0.4			cm.
HYBRID R4	2	1	-	-	3	0.19 - 0.25
SMUTSIANA.						
L'smith-B'dale I R5,62b	4	15	-	-	19	0.17 - 0.30
L'smith-B'dale II R3,62a	8	7	1	-	16	0.14 - 0.34
HALLII.						
nr. Rietvlei R52	4	6	-	-	10	0.19 - 0.26
Koup R54	4	17	2	-	23	0.20 - 0.40
BULLULATA.						
Matjesfontein R55	2	7	-	-	9	0.20 - 0.30
RUGOSA.						
Baden-Baden R17,18,59	4	6	-	-	10	0.20 - 0.25
"Montagu Dist." Nbg	2	3	-	-	5	0.20 - 0.30
Dobbelaars Kloof R21,22	-	1	-	-	1	0.23
L'smith-B'dale R2	-	8	-	-	8	0.22 - 0.30
Herbarium Specimens.						
Prince Albert Nbg	1	-	-	-	1	0.15
RUGOSA.						
Graaff Reinet	-	1	-	-	1	0.23
Bonnievale	-	1	-	-	1	0.23
Barrydale Nbg	-	1	-	-	1	0.25
Muiskraal Nbg	-	1	-	-	1	0.26
Laingsb'g-L'smith	-	1	-	-	1	0.23
Ladismith	-	1	-	-	1	0.25

TABLE 74 **Variation in length and width of base in lowest** fertile **bract in field and herbarium specimens of "smutsiana", "hallii", bullulata, rugosa + the** putative **smutsiana x rugosa hybrid.**

Locality.	Class range of measurements.			Total no. indiv.	Range actual measurements.
MIDDLE WIDTH OF BRACT. Class interval 0.05 cm.					
	.10	.15			cm.
Field Specimens.					
HYBRID R4	3	-	-	3	0.07 - 0.10
SMUTSIANA.					
L'smith-B'dale I R5,62b	15	1	-	16	0.07 - 0.11
L'smith-B'dale II R3,62a	15	4	-	19	0.06 - 0.13
HALLII.					
Rietvlei R52	5	4	-	9	0.07 - 0.13
Koup R54	11	4	-	15	0.08 - 0.12
BULLULATA.					
Matjesfontein R55	3	5	1	9	0.08 - 0.16
RUGOSA.					
Baden-Baden R17,18,59	7	3	-	10	0.07 - 0.12
"Montagu Dist". Nbg	2	3	-	5	0.08 - 0.13
Dobbelaars Kloof R21,22	1	-	-	1	0.09
L'smith-B'dale R2	1	6	1	7	0.10 - 0.17
Herbarium Specimens.					
RUGOSA.					
Graaff Reinet (?)	1	-	-	1	0.07
Bonnievale	1	-	-	1	0.08
Barrydale Nbg	1	-	-	1	0.09
Muiskraal Nbg	1	-	-	1	0.08
Laingsb'g-L'smith	1	-	-	1	0.08
Ladismith	-	1	-	1	0.13

Locality.	Class range of measurements.					Total no. indiv.	Range actual measurements.
LENGTH-BREADTH RATIO OF BRACT. Class interval 2.0 cm.							
	3	5	7	9			
Field Specimens.							
HYBRID R4	-	1	-	-	2	3	3.45 - 11.00
SMUTSIANA.							
L'smith-B'dale I R5,62b	2	8	5	1	-	16	2.90 - 7.28
L'smith-B'dale II R3,62a	3	8	6	1	1	19	2.31 - 10.00
HALLII.							
nr. Rietvlei R52	-	7	1	-	-	8	3.30 - 5.14
Koup R54	3	8	4	-	-	15	2.50 - 6.62
BULLULATA.							
Matjesfontein R55	5	2	2	-	-	9	2.69 - 6.00
RUGOSA.							
Baden-Baden R17,18,59	2	7	1	-	-	10	2.50 - 5.71
"Montagu Dist." Nbg	1	4	-	-	-	5	2.46 - 4.12
Dobbelaars Kloof R21,22	-	1	-	-	-	1	3.66
L'smith-B'dale R2	3	5	-	-	-	8	2.17 - 3.46
Herbarium Specimens.							
RUGOSA.							
Graaff Reinet (?)	-	-	1	-	-	1	6.85
Bonnievale	-	-	1	-	-	1	6.25
Barrydale Nbg	-	1	-	-	-	1	3.88
Muiskraal Nbg	-	1	-	-	-	1	5.00
Laingsb'g-L'smith	-	-	1	-	-	1	5.62
Ladismith	1	-	-	-	-	1	2.69

TABLE 75 Variation in width of basal fertile bract taken half way along the length and in the length-breadth ratio in field and herbarium specimens of "smutsiana", "hallii" "bullulata", "rugosa" + the putative "rugosa" x "smutsiana" hybrid.

Locality.	Class range of measurements. 0.2	0.3	0.4	0.5	0.6	0.7	0.8	Total no. indiv.	Range actual measurements. cm.
FIELD SPECIMENS.									
HYBRID R4	-	1	3	3	-	-	-	7	0.28 - 0.50
SMUTSIANA.									
L'smith-B'dale I R5,62b	1	7	8	-	-	-	-	16	0.15 - 0.40
L'smith-B'dale II R3,62a	2	8	8	3	-	-	-	21	0.14 - 0.48
HALLII.									
nr. Rietvlei R52	-	-	2	3	2	3	-	10	0.35 - 0.69
Koup R54	-	-	5	12	3	2	1	23	0.35 - 0.75
BULLULATA.									
Matjesfontein R55	-	-	1	4	4	-	-	9	0.37 - 0.53
RUGOSA.									
Pietersfontein R19+20	-	-	2	1	2	1	4	10	0.32 - 0.80
Baden-Baden R17,18,59	-	-	2	5	4	4	3	18	0.40 - 0.80
nr. Montagu R23	-	-	1	1	3	2	-	7	0.35 - 0.75
"Montagu Dist." Nbg	-	-	-	2	-	-	-	2	0.45 - 0.80
Dobbelaars Kloof R21,22	-	1	-	2	3	-	1	2	9	0.30 - 0.90
L'smith-B'dale R2	-	-	3	3	-	-	-	-	6	0.35 - 0.49
HERBARIUM SPECIMENS.									
HALLII.									
Prince Albert Nbg	-	-	1	-	-	-	-	-	1	0.33
BULLULATA.									
Verlaten Kloof Nbg	-	-	-	1	-	-	-	-	1	0.45
Ceres Karoo	-	-	1	-	-	-	-	-	1	0.38
Laingsb'g-L'smith	-	1	1	-	-	-	-	-	2	0.30 - 0.38
RUGOSA.									
Graaff Reinet (?)	-	-	-	1	1	-	-	-	2	0.42 - 0.54
Bonnievale	-	-	-	-	-	-	1	-	1	0.73
Barrydale Nbg	1	1	-	1	-	-	-	-	3	0.20 - 0.46
Muiskraal Nbg.	-	1	-	-	-	-	-	-	1	0.27
Laingsb'g-L'smith	-	-	-	1	1	-	1	-	3	0.50 - 0.74
Ladismith	-	-	-	1	-	-	-	-	1	0.47

Class interval 0.10 cm.

Table 76A VARIATION IN FLOWERING PEDICEL FROM BASE OF RACEME IN FIELD SPECIMENS AND HERBARIUM SPECIMENS OF "SMUTSIANA", "HALLII", "BULLULATA", "RUGOSA" + THE PUTATIVE SMUTSIANA" x "RUGOSA" HYBRID.

Locality.	Class range of measurements.										Total no. indiv.	Range actual measurements.
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9			cm.
FIELD SPECIMENS.												
HYBRID R4	-	2	3	1	-	-	-	-	-	-	6	0.18 - 0.40
SMUTSIANA.												
L'smith-B'dale I R5,62B	1	6	10	1	-	-	-	-	-	-	18	0.09 - 0.35
L'smith-B'dale II R3,62a	-	4	12	4	-	1	-	-	-	-	21	0.13 - 0.60
HALLII.												
nr. Rietvlei R52	-	-	-	6	3	-	-	-	-	-	9	0.34 - 0.50
Koup R54	-	-	2	13	6	3	-	-	-	-	24	0.28 - 0.59
BULLULATA.												
Matjesfontein R55	-	-	2	3	4	-	-	-	-	-	9	0.30 - 0.47
RUGOSA.												
Pietersfontein R19+20	-	-	1	1	3	1	1	1	-	-	8	0.30 - 0.72
Baden-Baden R17,18,59	-	-	1	5	6	3	-	-	-	1	15	0.30 - 0.92
nr. Montagu R23	-	-	-	3	2	-	-	-	-	-	5	0.35 - 0.49
"Montagu Dist." Nbg	-	-	1	3	1	-	-	-	-	-	5	0.30 - 0.57
Dobbelaars Kloof R21,22	-	-	-	-	2	2	2	-	-	-	6	0.45 - 0.68
L'smith-Bdale R2	-	-	2	4	-	-	-	-	-	-	6	0.28 - 0.40
HERBARIUM SPECIMENS.												
HALLII.												
Prince Albert Nbg.141/28(BOL)	-	-	1	-	-	-	-	-	-	-	1	0.24
BULLULATA.												
Ceres KarooNo. 27635(BOL)	-	-	1	-	-	-	-	-	-	-	1	0.29
RUGOSA. (PRE)												
Graaff Reinet (?) 4202 herb.Marloth	-	-	1	1	-	-	-	-	-	-	2	0.28 - 0.37
Bonnievale v.d. Merwe 226(BOL)	-	-	-	-	-	1	-	-	-	-	1	0.58
Barrydale Nbg.2154/26(BOL)	-	1	1	1	-	-	-	-	-	-	3	0.18 - 0.39
Muiskraal Nbg.2306/27(BOL)	-	1	-	-	-	-	-	-	-	-	1	0.20
Laingsb'g-L'smith Pillans 857(BOL)	-	-	1	1	-	-	-	-	-	-	2	0.30 - 0.39
Ladismith No. 27638(BOL)	-	-	-	2	-	-	-	-	-	-	2	0.38 - 0.39

Class interval 0.10 cm.

Table 76B VARIATION IN FLOWERING PEDICEL LENGTH FROM MIDDLE OF RACEME IN FIELD SPECIMENS AND HERBARIUM SPECIMENS OF PUTATIVE "SMUTSIANA", "HALLII", "BULLULATA", "RUGOSA" + THE "SMUTSIANA" x "RUGOSA" HYBRID.

Locality.	Class range of measurements. .3	.4	.5	.6	.7	.8		Total no. indiv.	Range actual measurements. cm.
FIELD SPECIMENS.									
HYBRID R4	-	-	-	-	-	-	-		
SMUTSIANA.									
L'smith-B'dale I R5,62b	2	3	-	-	-	-	-	5	0.24 - 0.40
L'smith-B'dale II R3,62a	3	2	1	-	-	-	-	6	0.25 - 0.43
HALLII.									
Koup R54	-	-	3	1	-	-	-	4	0.41 - 0.53
BULLULATA.									
Matjesfontein R55	-	1	1	-	-	-	-	2	0.39 - 0.42
RUGOSA.									
Baden-Baden R17,18,59	-	-	-	-	-	-	1	1	0.89
"Montagu Dist." Nbg.	-	-	-	2	-	-	-	2	0.52 - 0.55
HERBARIUM SPECIMENS.									
RUGOSA.									
Muiskraal Nbg	-	-	-	1	-	-	-	1	0.53
Ladismith	-	-	-	1	-	-	-	1	0.53

Class interval 0.10 cm

LENGTH

Table 76C VARIATION IN FRUITING PEDICEL/ FROM BASE OF RACEME IN FIELD POPULATIONS AND HERBARIUM SPECIMENS OF 'SMUTSIANA', 'HALLII', 'BULLULATA', 'RUGOSA' + THE PUTATIVE 'SMUTSIANA' x 'RUGOSA' HYBRID.

Pedicel length. (See Tables 76 A, B and C).

In the tables showing variation of this character in field population samples of these entities, the class interval used is 0.1 cm., compared with that of 0.2 cm. in the introductory survey.

There is an overlap of flowering pedicel length between the entities but the shortest basal flowering pedicels, 0.2 - 0.4 cm. in length in most cases, are found in the entity smutsiana. The majority of pedicels in the three other entities are longer. Pedicel length in the entity rugosa, and to a lesser extent in the entity hallii, is very variable.

By the middle of the raceme, most flowering pedicels in the samples of the entity smutsiana are 0.2 - 0.3 cm. in length while there are only a small number of specimens with pedicels less than 0.3 cm. long in the three other entities.

The putative hybrid tends to have pedicels of a length intermediate between that of the entities rugosa and smutsiana.

A scatter diagram of the length of the lowest flowering pedicel plotted against the width of the peduncle base (Fig.53) shows some separation of the entities rugosa and smutsiana from the entities hallii and bullulata, while a second scatter diagram (Fig.54) of the length of the lowest fertile bract plotted against the length of the lowest flowering pedicel shows a very slight tendency for the entities rugosa, bullulata and hallii to be distinct from the entity smutsiana in a combination of these characters.

Summary

The considerable overlap of inflorescence characters between all four entities precludes their being of any great taxonomic significance. The slight differences that are present do however indicate differences between the entities, which are more completely expressed in other characters.

All inflorescence characters of the entities hallii and bullulata apart from the greater frequency of axillary raceme buds in the former, are very similar.

The entity rugosa differs slightly from these two in the possession of more slender peduncles with fewer sterile bracts, which have no axilarry branches or undeveloped axillary r ceme buds, and a slight tendency towards shorter basal fertile bracts and longer pedicels.

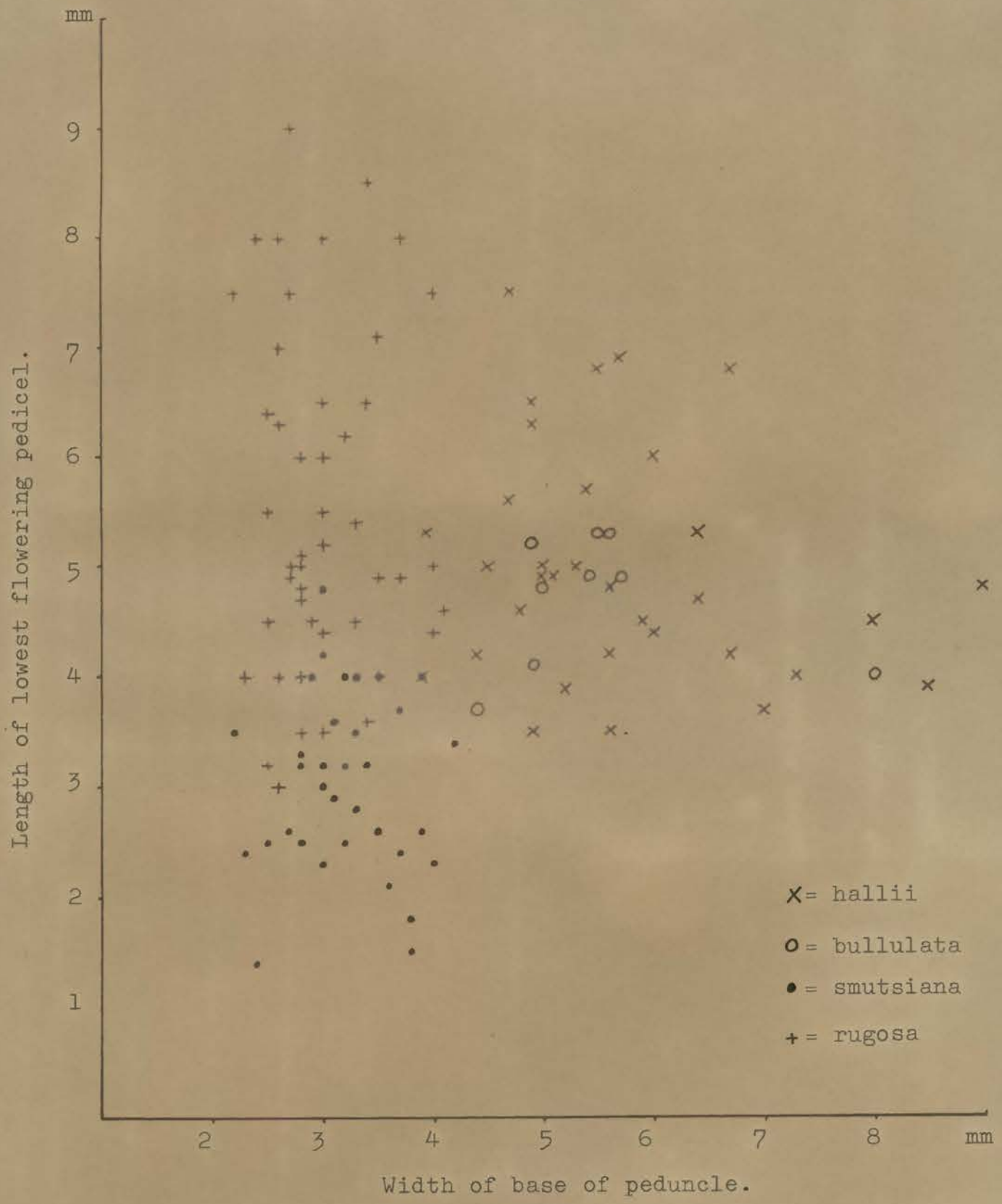


Fig.53. Variation in width of base of peduncle and length of lowest flowering pedicel in the entities smutsiana, hallii, bullulata and rugosa.

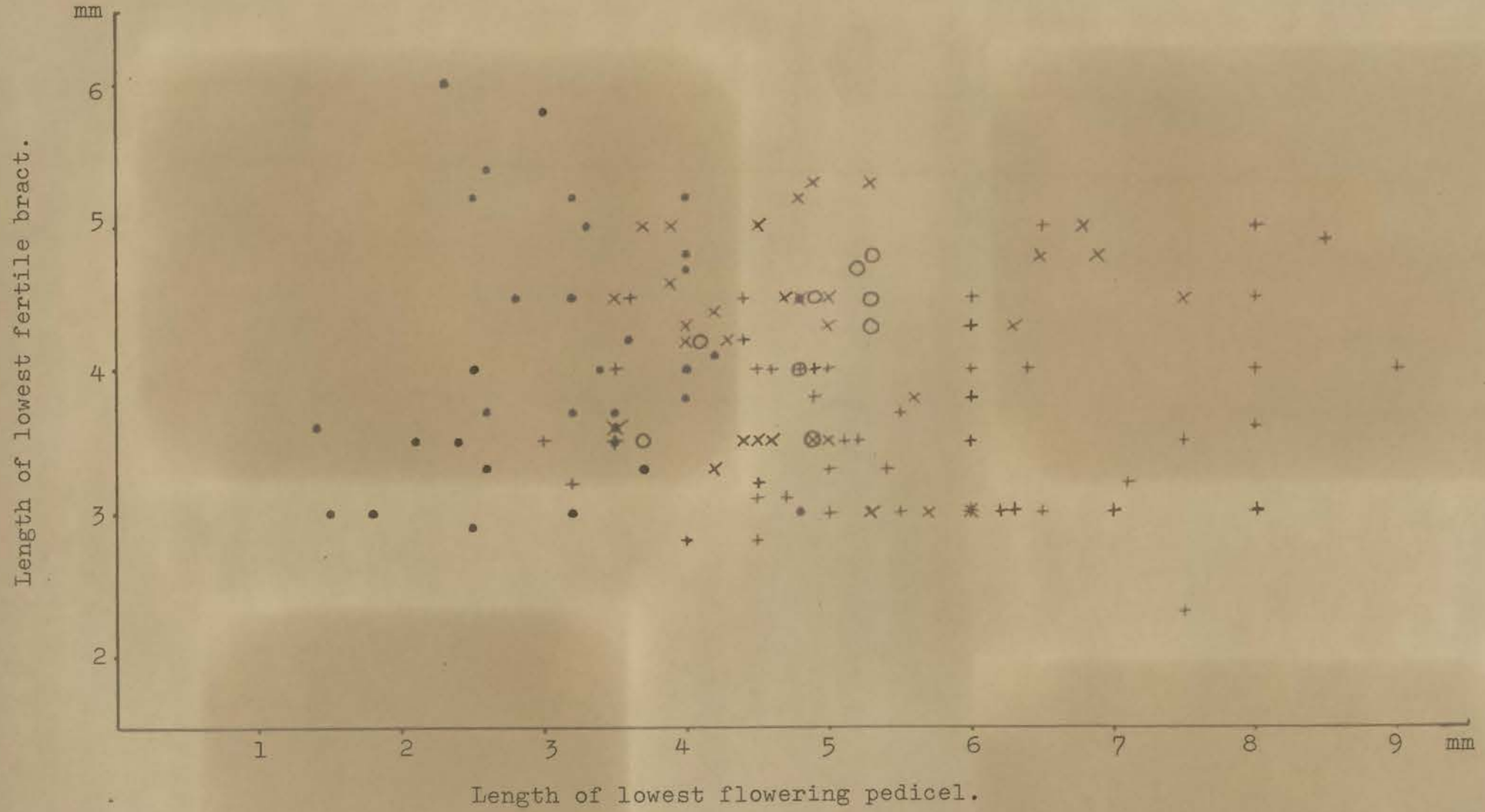


Fig.54. Variation of lowest fertile bract and length of lowest flowering pedicel in the entities smutsiana (•), hallii (×), bullulata (o), and rugosa (+).

Portion of an inflorescence of a specimen of the entity bullulata. (X $1\frac{1}{10}$).

Portion of an inflorescence of a specimen of the entity smutsiana. (X $1\frac{2}{10}$).

Portion of an inflorescence of a specimen of the entity hallii. (X $1\frac{1}{10}$).

Capsules from an inflorescence of the entity hallii.

PLATE 24.

The entity smutsiana also differs from the entity hallii in the frequency of undeveloped raceme buds, but in other respects its inflorescences differ little from those of this entity and the entity bullulata, save for peduncles which tend to be thinner, and lowest fertile bracts and pedicels which tend to be shorter.

The inflorescence characters of the putative hybrid between members of the entities smutsiana and rugosa are in general intermediate between those of these two entities.

PERIANTH CHARACTERS (See Plate 24.)

Variation in perianth characters is again shown in a series of histograms. Measurements for perianths of rugosa from the Montagu karoo area are shown as from a single locality.

Position of lobes in open flower. (See Fig.55)

This is very similar in the entities smutsiana, hallii, bullulata, and the putative hybrid between members of the entities smutsiana and rugosa.

The perianths of the entity rugosa differ from the other entities in that in most perianths, the outer lateral lobes and all the inner lobes are at an angle of 30° or less.

Length of perianth lobes. (See Fig.55)

Here the differences between the entities are slight, the lobes of the entity smutsiana tending to be shorter than those of the entities hallii and bullulata, whilst those of the entity rugosa are more variable.

Lobe length in the putative hybrid is similar to that found in the entity rugosa.

Width of perianth lobes. (See Fig.55)

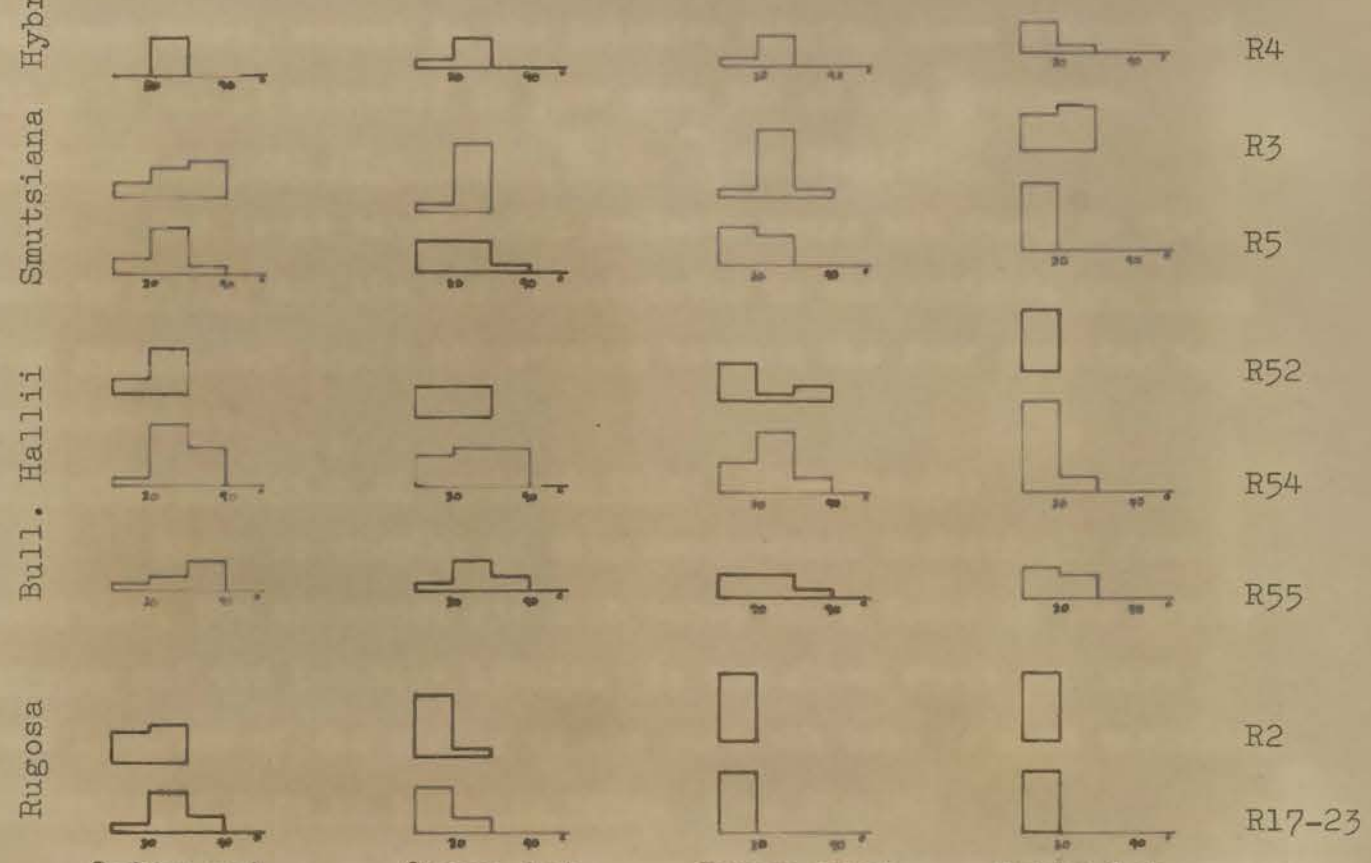
In this character too the lobes of all four entities are very similar. The inner perianth lobes tend to be slightly broader than the outer ones.

The narrowest lobes occur in the entity smutsiana, the broadest in the Rietvlei speciment of the entity hallii.

Length of perianth. (See Fig.56)

Perianth length is somewhat variable, ranging from 7 - 11 mm.

POSITION OF LOBES IN OPEN FLOWER



DIMENSIONS OF PERIANTH LOBES

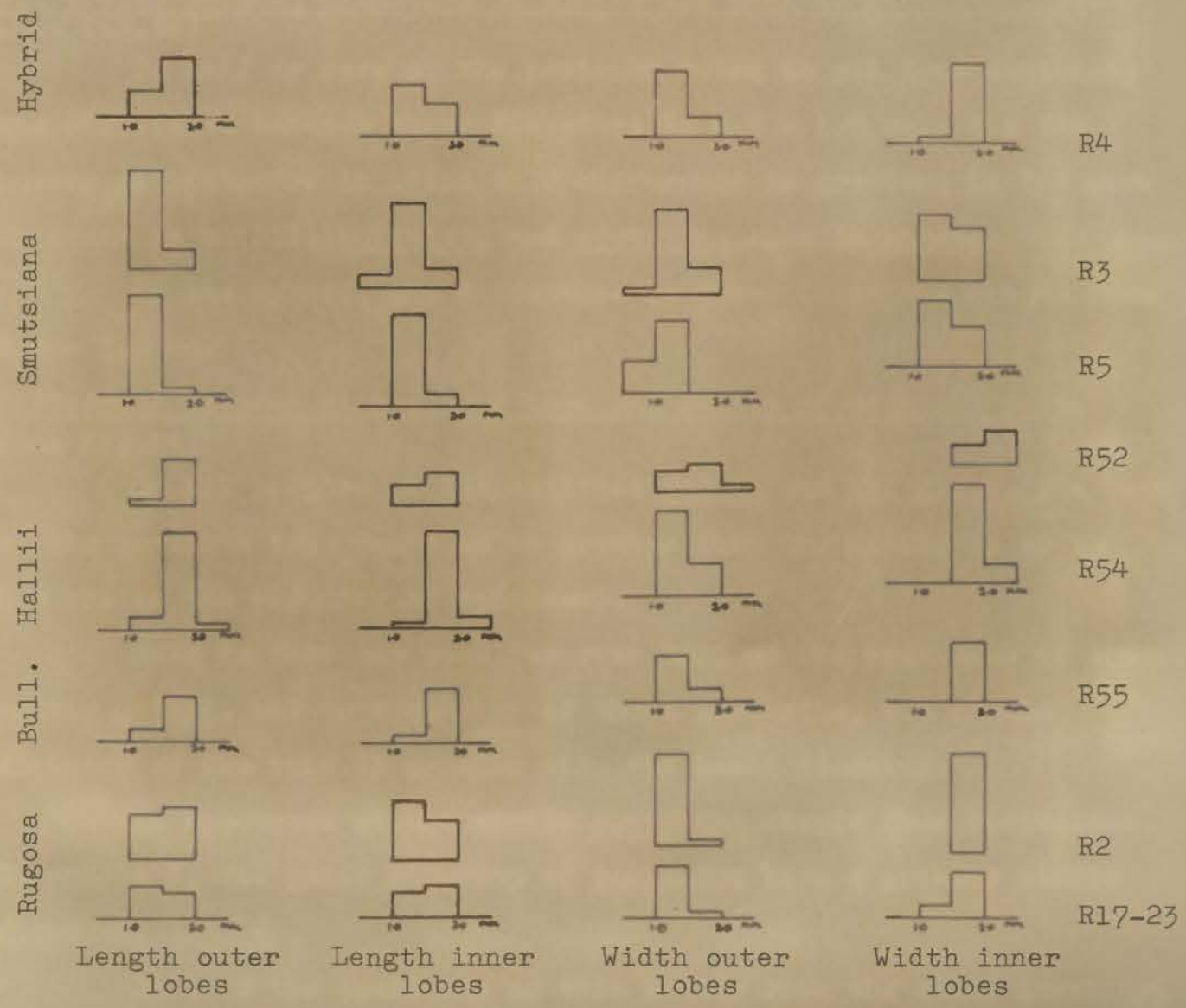


Fig. 55. Variation in position and dimensions of lobes in open flower in the entities smutsiana, hallii, bullulata, rugosa, and the putative smutsiana x rugosa hybrid.

in most cases, except in the putative hybrid, where a length of 11 - 13 mm. is recorded in just over 50% of the specimens.

Diameter of neck of perianth tube. (See Fig.56)

The least constricted perianth necks are found in the entity hallii and the most constricted in the entities smutsiana and rugosa, but again the overlap between the four entities is considerable.

Diameter of middle of perianth tube. (See.Fig.56)

There is overlap of this measurement between all four entities, the narrowest perianth tubes being found in the entity rugosa and the putative hybrid. In the other three entities the diameter of the middle of the perianth tube is more variable.

Diameter of base of perianth tube. (See Fig.56)

There is an overlap between the entities in this character too, but the broadest perianth bases are found in the entities bullulata and hallii and the narrowest in the entity smutsiana.

Difference between diameters of middle and neck of perianth tube. (See Fig.56)

In half or more of the perianth tubes in all four entities, the difference between these diameters is 0.5 - 1.0 mm., but the number of instances in which this difference is greater, is far more frequent in hallii, bullulata and smutsiana than in rugosa.

In the hybrid, the difference in these diameters ranges from 0.5 - 1.0 mm.

Difference between diameter of base and middle of perianth tube. (See Fig.56)

In all samples of the entities rugosa and bullulata, the base of the perianth tube tends to be greater than the middle by up to 0.5 mm. in the majority of specimens.

This is also the case for over half of the specimens of the entity hallii, but in a quarter of these perianths, the middle diameter of the tube is greater than the basal diameter.

In specimens of the entity smutsiana sample from Ladismith-Barrydale I, the great majority of perianths have a greater middle diameter.

In half the specimens of this entity from the other locality, however, there is no difference between the basal and mid diameter

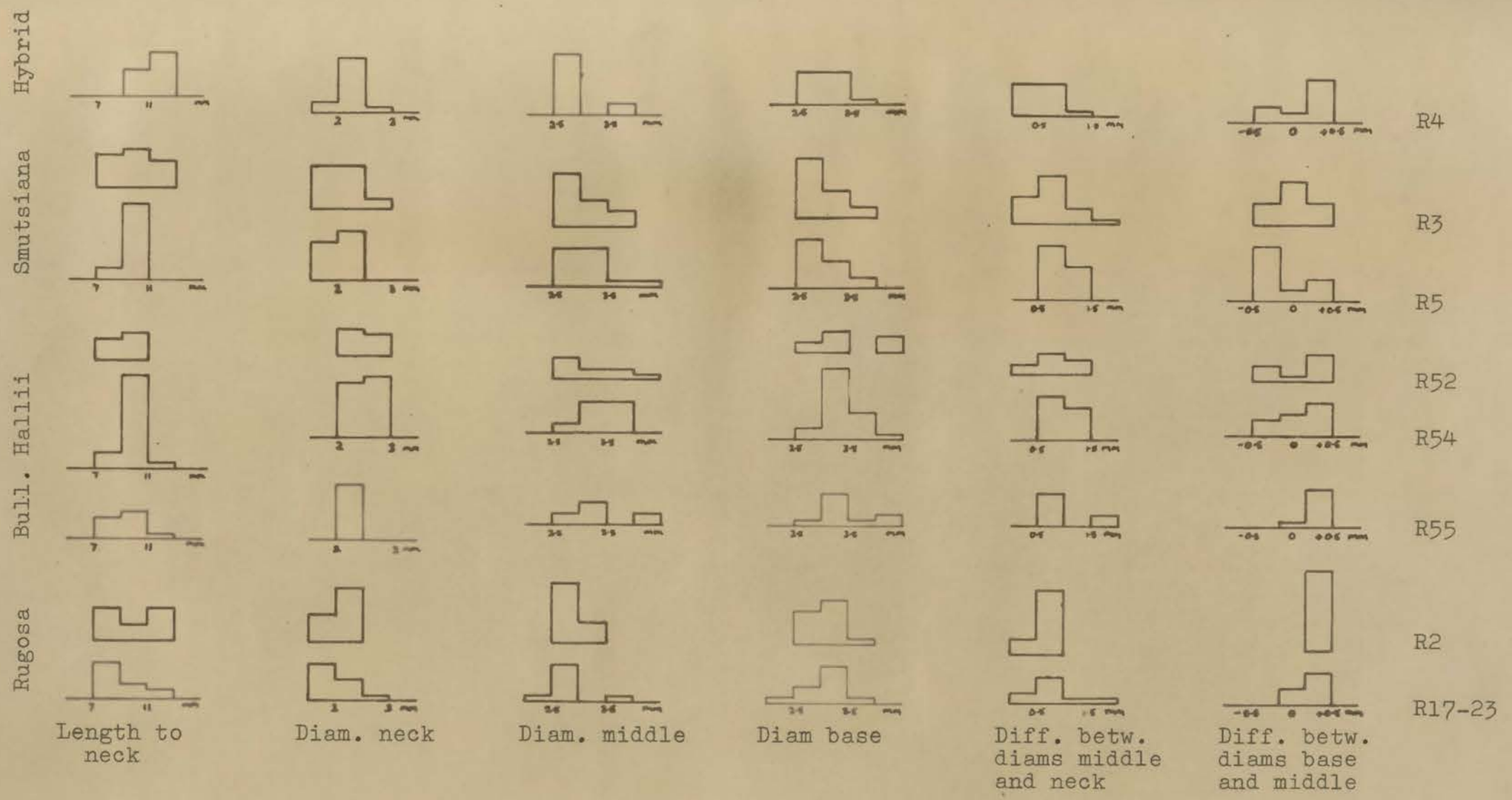


Fig.56. Variation in dimensions and shape of perianth tube in the entities smutsiana, hallii, bullulata, rugosa, and the putative hybrid between rugosa and smutsiana.

of the perianth tubes, while equal numbers of the rest have the middle diameter greater than or less than the basal diameter.

In the hybrid, the shape of the perianth tube ranges from the basal diameter being less than to greater than the mid diameter, but in the majority of cases, the basal diameter is greater.

Summary

From the foregoing it is seen that the perianths of the entities bullulata and hallii are almost identical.

The entity smutsiana tends to differ slightly from the other three entities in the possession of slightly narrower inner lobes, and in the fact that the middle diameter of the perianth tube is more frequently equal to or greater than that of the base.

The entity rugosa differs from the other three entities in the fact that the outer lateral and all of the inner perianth lobes are least open. The narrowest neck and middle diameters in perianth tubes tend to be found in the entity rugosa, and this makes the fact that the basal diameter is greater than the middle diameter more pronounced than in the entities hallii and bullulata, although the basal diameter is similar in all three entities.

Colour of perianth

This has been already dealt with in the introduction, and the fact has been mentioned that in the entity rugosa the outer tepals of the perianth tube may be very slightly inflated. This was not observed in flowers of the putative hybrid between members of the entities rugosa and smutsiana. It may well be that certain authors in the past, who mentioned perianths "spongey at the angles" in connection with species other than A. herrei and A. spiralis, were, in fact, referring either to specimens of the entity rugosa with leaves with few tubercles, or to hybrids between the entities rugosa and smutsiana in which the outer tepals were slightly inflated on either side of the midrib.

CONCLUSION

In conclusion, it would appear that the similarity between the entities hallii and bullulata is closer than between these

entities and other members of the genus. Their floral and inflorescence characters are extremely similar, apart from the fact that in both the perianth lobes are frequently bright or pale yellow - which is not found in any other entities with smooth perianths in the genus.

Vegetatively, they have in common a low spiral angle (0 - 10° in the majority of individuals), a tendency for the leaf apices to curve upward, and, which must be considered the most distinguishing feature, keeled marginate apices, present in some or all the leaves of any one plant.

Points of difference between the two entities which are not absolute are : the tendency for the leaf apices of the entity bullulata to curve upward and sideways, and the fact that the length-breadth ratio is greater in the entity hallii than in the entity bullulata, and the leaf apex narrower. This last character gave fairly good separation in a scatter diagram (See Fig.50). The fact that all plants of the entity bullulata have some leaves with tubercles, while some plants of the entity hallii do not, is another difference of secondary importance, as is the tendency for the tubercles of the entity bullulata to be grouped in approximate transverse rows on the leaf under-surface, and to be somewhat more prominent than those of the entity hallii, where the tubercles are arranged in longitudinal series in nearly all cases.

A point of absolute difference between the two are the presence of fine lines towards the apex on the underside of some or all of the leaves in any one plant of the entity hallii; these lines have never been observed in the entity bullulata. A second point of absolute difference is the fact that in all the plants of the entity hallii examined, the bundle caps were lignified for the entire length of the leaf, while in the entity bullulata, in the plants examined, the bundle caps were only completely lignified at the base of the leaf, and completely unlignified at the apex.

It is on these two characters that the recognition of the entities hallii and bullulata as two separate, but similar, species, is justified in the present author's opinion. They are consequently termed Astroloba hallii Roberts sp. nov. and Astroloba bullulata (Jacq.) Uitew.

The differences between these two and the third entity of the genus with tuberculate leaves is very marked. In the entity rugosa, the leaf apices are true marginate and curve outwards in most plants, the majority of leaves are much smaller and broader, and the distribution of the tubercles on the exposed part of the ventral side of the leaf is more regular and denser, even in the specimens from Dobbelaars Kloof. It is the nature of the leaf apex, the degree of tuberculation and to a lesser extent, the size and shape of the leaves which are the characters separating, at specific level, the entity rugosa from the two other tuberculate entities of the genus.

The differences in inflorescence and floral characters between the entities rugosa and these two are not as marked. In the entities rugosa, the peduncles tend to be more slender, the sterile bracts fewer, and, to a lesser extent, the lowest fertile bracts shorter. In floral characters, the entity rugosa tends to be distinguished by the very slight angle at which the outer lateral and all inner lobes lie open, (30° or less), and the fact that the neck and middle diameters of the perianth are less than in A. hallii and A. bullulata, giving the whole flower a more slender appearance. In the entity rugosa, the perianth lobes may have a faint yellowish tinge, but are never bright yellow. The slight inflation on either side of the midribs of the outer tepals found in some flowers of the entity rugosa has never been observed in the other two.

On the grounds of vegetative characters then, the entity rugosa is considered a distinct species, and is referred to as Astroloba rugosa Roberts sp. nov., formerly known incorrectly as Astroloba aspera (Haw.) Uitew.

The fact that the entity smutsiana and A. hallii both have almost identical leaf colour, and darker longitudinal striations on the underside of the leaf towards the apex has been mentioned.

However, on the grounds that keeled marginate apices are never present in the entity smutsiana it seems reasonable, in the opinion of the present author, to consider this as a species distinct from A. hallii. In a genus where the facies of the components are as similar as they are in Astroloba, any character such as this,

which shows a complete discontinuity, must be considered of taxonomic significance. Further, while populations of A. hallii and the entity smutsiana occur in close proximity in the northern foothills of the Swartberg, they still remain distinct.

Other characters by which the entity smutsiana tends to differ from A. hallii, but not absolutely, are : a greater variability in the spiral angle, a greater tendency for the leaf apices to curve outwards, and shorter leaves which tend to be slightly broader, and are never tuberculate in the field.

There is a good deal of similarity in the inflorescences of the entity smutsiana and A. hallii, but in the former, the peduncles tend to be more slender and the pedicels shorter. The perianth of the entity smutsiana differs slightly from that of A. hallii in that the mid diameter is greater than the basal diameter in a large number of cases. The perianth lobes of the entity smutsiana are generally white or cream and rarely have a yellowish tinge.

Accordinly this entity is referred to as Astroloba smutsiana Roberts sp. nov.

The putative hybrid is in every way intermediate in character between its suggested progenitors. Although cytological evidence has not yet been obtained, and the hybrid has not been artificially recreated, the evidence with regard to its occurrence in the field, its morphology and the anatomy of the epidermal cells of the leaf, indicates most convincingly that it is a naturally occurring hybrid between the species A. rugosa and A. smutsiana.