A STUDY OF THE GENERA *JUSTICIA* L. AND *SIPHONOGLOSSA* OERST. (ACANTHACEAE) IN SOUTHERN AFRICA.

By

KATHLEEN LEONORE IMMELMAN

Submitted in partial fulfilment of the requirements for the degree of DOCTOR OF PHILOSOPHY in the Department of Botany, Faculty of Science, University of Natal, Pietermaritzburg,

1987

Pietermaritzburg

1987

PREFACE

The studies described in this thesis were carried out in the department of Botany, University of Natal, Pietermaritzburg, under the supervision of Dr. F. Getliffe Norris.

I hereby declare that this thesis, submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy, is the result of my own investigation, except where the work of others is acknowledged.

This thesis has not been submitted in any form to another University.

K Immelman

KATHLEEN LEONORE IMMELMAN

1987

Great are the works of the Lord,

Studied by all who have pleasure in them.

Psalm 111:2 (Revised Standard Version)

ACKNOWLEDGEMENTS

I would like to express my thanks to my supervisor, Dr F Getliffe Norris of the Department of Botany, University of Natal, for her helpful comments and constant interest.

Thanks are also due to the other members of my Research Committee, Prof. OM Hilliard and Prof. RM Pienaar.

The helpful comments and friendship of Dr K Balkwill are much appreciated.

Special thanks to those members of the Botanical Research Institute, Pretoria, who have given my help and advice with various aspects of this research. I would especially like to thank Mrs S Perold not only for her excellent SEM photographs but also for her cheerful and helpful attitude throughout.

I wish to thank the Department of Botany, University of Natal, Pietermaritzburg for the use of their facilities, especially for phytochemical work and photography.

Thanks are also due to the Botanical Research Institute, Pretoria, for the use of their facilities, especially the SEM and Herbarium, and their excellent libarary.

I would like to thank the curators of the following herbaria for loan material:

Albany Museum Herbarium, Grahamstown

Bolus Herbarium, University of Cape Town, Cape Town

Botanical Museum, University of Copenhagen

Botanical Museum and Herbarium, Copenhagen

Botanical Research Unit, Stellenboch

Botanical Research Unit, Durban

Botanischer Garten und Botanisches Museum, Berlin

British Museum, London

Institut für Systematische Botanik der Universitat Zürich, Zürich

McGregor Museum, Kimberley

Muséum National d'Histoire Naturelle, Paris

Natal University Herbarium, Pietermaritzburg

National Botanic Gardens Herbarium, Kirstenbosch, Cape Town

National Herbarium of Victoria, Victoria, Australia

National Parks Herbarium, Skukuza

Royal Botanic Garden, Edinburg

Royal Botanic Gardens, Kew

Swedish Museum of Natural History, Stockholm

SWA Herbarium, Windhoek.

Finally, I wish to thank my typist, Miss J H Schnehage, for her typing of the manuscript.

ABSTRACT

A comprehensive revision of the genus Justicia L. and the closely related genera Siphonoglossa Oersted and Aulojusticia Lindau in southern Africa was undertaken as part of the Flora of Southern Africa project. Taxonomic characters re-examined include traditional morphological features and novel characters such as SEM studies of pollen, seed and indumentum morphology, as well as chromatographic work on floral pigments.

Traditional morphological features examined included habit, the size and shape of leaves, the corolla, anthers and capsules.

Inflorescence features were thoroughly re-examined. Pollen morphology was found to be diverse, with three types of grain present in the genus. The number of colpi was either two or three and there were major differences in the appearance of the sexine. Pollen and inflorescence type were found to correlate. On the basis of this, a natural infrageneric classification was proposed.

The seeds showed a number of testa patterns: smooth, papillate, reticulate or with long scales. These types in many cases also correlated with the proposed infra-generic classification. The indumentum of leaves, stems and bracts was examined for each taxon, and in many cases proved valuable foridentification of the taxon. The floral pigments were analysed using by 2D paper chromatography but, except in one species, did not prove useful in species or sectional delimitation.

As a result of these studies, Justicia in southern Africa was divided into eight sections containing 22 species with six subspecies. One species and two subspecies were new and there is one new record for the region. These new taxa and a number of nomenclatural changes were published by Immelman (1986).

The genus Aulojusticia was reassessed and is here regarded as a synonym of Siphonoglossa. Siphonoglossa, therefore, is considered here to include three species and one subspecies in the southern African region.

The species and subspecific taxa recognised in this revision are:

Justicia

1. J. glabra Koenig ex Roxb. - N. Botswana, N. Transvaal and Zululand; also in tropical Africa.

2. J. campylostemon (Nees) T. Anders. - from N.E. Transvaal to E. Cape.

3. J. bolusii C.B. Cl. - restricted to the E. Cape and the Transkei.

4. J. betonica L. - from N. Namibia and N.E. Botswana, through the Transvaal to the E. Cape; also in tropical Africa and India.

5. J. montis-salinarum A. Meeuse - restricted to the Soutpansberg (N. Transvaal).

6. J. flava (Vahl) Vahl - from E. Botswana through the Transvaal and Natal to the Transkei, also widespread in Africa.

7. J. kirkiana T. Anders. - a common species in Africa, occurring in the region covered only from two localities in N. Botswana.

8. J. petiolaris (Nees) T. Anders. -

   (a) subsp. petiolaris from E. Transvaal to the Transkei

   (b) subsp. bowiei (C.B. Cl.) Immelman stat. nov. restricted to the E. Cape

   (c) subsp. incerta (C.B. Cl.) Immelman stat. nov. from the Transvaal and Zululand.

9. J. protracta (Nees) T. Anders. -

   (a) subsp. protracta from the Transvaal to the S. Cape

   (b) subsp. rhodesiana (S. Moore) Immelman stat. nov. from Namibia, W. Botswana and the N. and E. Transvaal.

10. J. parvibracteata Immelman sp. nov. - from the N. Cape, with one record from the N. Transvaal.

11. J. dinteri S. Moore - N. Namibia, N.E. Botswana and W. Transvaal.

12. J. odora (Forssk.) Vahl - N. Namibia, N. and E. Botswana, the Transvaal and Natal, also in tropical Africal.

13. J. capensis Thunb. - N. Natal and also, disjunctly, the Transkei and E. and S. Cape.

14. J. cuneata Vahl -

   (a) subsp. cuneata which is restricted to the E. Cape

   (b) subsp. latifolia (Nees) Immelman from Namaqualand, W. Karoo and E. Cape

(c) subsp. hoerleiniana (P.G. Mey.) Immelman stat. nov. from S. Namibia.

15. J. orchioides L. f. -

(a) subsp. orchioides restricted to the E. Cape

(b) subsp. glabrata Immelman subsp. nov. from the S. and E. Cape, E. Karoo, O.F.S., and S.W. Transvaal.

16. J. thymifolia (Nees) C.B. Cl. - restricted to the N. Cape.

17. J. guerkeana Schinz - mainly in S. Namibia.

18. J. platysepala (S. Moore) P.G. Mey. - mainly in N. Namibia.

19. J. minima A. Meeuse - endemic to the Waterberg (Transvaal).

20. J. anagalloides (Nees) T. Anders. - Transvaal to Natal.

21. J. crassiradix Burkill & Clarke (new record for southern Africa) - one record from the E. Caprivi.

22. J. anselliana (Nees) T. Anders. - N. Namibia, N. and E. Botswana and the Transvaal.

Siphonoglossa

1. S. leptantha (Nees) Immelman -

(a) subsp. leptantha - from Natal to the E. Cape

(b) subsp. late-ovata - (C.B.Cl.) Immelman comb. nov. ined. from the E. to the S. Cape.

2. S. nkandlaensis Immelman sp.nov. ined. - Central Natal.

3. S. linifolia (Lindau) C.B. Cl. (= Aulojusticia linifolia Lindau) - endemic to the Barberton area (Transvaal).

A formal taxonomic revision including keys to genera, sections and species has been included.

CONTENTS

CHAPTER 1

INTRODUCTION

The genus *Justicia* was established by Linnaeus in his Species Plantarum (1753), with eleven species. Subsequently, numerous other species were described by him and later authors. Nees (1847) restricted the genus to a few species and transferred the remainder to *Adhatoda* Nees. Bentham (1876) and Lindau (1894) considerably enlarged the boundaries of the genus again, including many previously separate genera in *Justicia sensu lato*.

The genus comprises between 300 (Airy Shaw 1973) and 600 species (Graham, pers. comm.) distributed through Africa, North and South America, Asia and Australia, with the majority of species occurring in the tropics and subtropics. *Siphonoglossa*, a probably closely related genus of some 10 species, occurs in North and Central America, the West Indies and South Africa. *Aulojusticia* is a monospecific genus found only in the Transvaal.

Since the treatment of Lindau (1894) there has been no comprehensive treatment of *Justicia* for the whole of southern Africa. C.B. Clarke (1900, 1912) did revise the species from tropical Africa and part of southern Africa and P.G. Meyer (1968) revised those from Namibia. Hilsenbeck (1983) presented a dissertation on *Siphonoglossa*.

A comprehensive revision of all relevant taxa was therefore deemed necessary for the Flora of Southern Africa project, i.e. the Flora of the subcontinent south of the Cunene and Limpopo Rivers, including Botswana.

Generic and infrageneric limits appeared to be unclear, but it was necessary that species limits be clarified before attempting any classification at the generic or infrageneric level. This was done for the genera in southern Africa.

Traditional morphological characters were re-examined and a number of new characters were assessed. These latter include S.E.M. studies of pollen, seed and indumentum, and a chromatographic study of corolla pigments.

The study was based on material from major South African herbaria and a number of overseas herbaria. Living material was gathered on field excursions and formed the basis for experimental work (See Chapter 3).

CHAPTER 2

TAXONOMIC HISTORY

2.1 ACANTHACEAE: ITS SUBFAMILIES AND TRIBES

The term 'Acanthi' was first adopted by B. de Jussieu in 1759, and later taken up by A.L. de Jussieu (1789), who divided the family in two. The first group comprised six genera, that had four stamens; the second two genera, including Justicia, with two stamens. Endlicher (1839) divided the family into three tribes: Thunbergieae, Nelsonieae and Echmatacanthieae.

It was Nees von Esenbeck, however, who gave the first comprehensive account of the family in De Candolle's Prodromus (1847). He divided it into two subfamilies, Anechmatacanthi and Echmatacanthi, on the basis of whether or not the seeds were subtended by hard funicular outgrowths (retinacula), which he called jaculators. Anechmatanthi, which lacked retinacula, comprised two tribes: Thunbergieae and Nelsonieae, the former including Mendoncia Vandelli with its unusual drupaceous fruit. Echmatacanthi, where retinacula were present, consisted of eleven tribes, and comprised the bulk of the genera of the Acanthaceae Juss.

T. Anderson (1867), in his treatment of the African Acanthaceae, recognised three "suborders" (subfamilies): Thunbergideae with the single genus Thunbergia, Ruellideae with two tribes Nelsonieae and Ruellieae, and Acanthideae with four tribes, one of which was Justiceae. These subfamilies he defined on characters of the calyx, the retinaculum (jaculator) and the aestivation of the corolla. As Mendoncia does not occur in Africa, it was not dealt with by him.

Bentham (1886) recognised five tribes, preferring to divide Nées' Echmatacanthi into three: Ruellieae, Acantheae and Justicieae.

Lindau (1894) placed these three under a single subfamily Acanthoideae once more and for the first time separated Mendoncioideae from Thunbergioideae. He also recognised Nelsonioideae, thus dividing Acanthaceae into four subfamilies in all, a division that was accepted by most authors for the next sixty years. Lindau divided Acanthoideae, which included Justicia, into two taxa (rank not specified) on the basis of the corolla aestivation. The corolla had either convolvulate aestivation or was ascending-imbricate or with the upper lip lacking (e.g. Crossandra Salisb.).

There was no question of splitting the family into smaller families during this period except in the case of Van Tieghem (1907) and Lindau's system was used by most authors to the present time, e.g. Leonard (1958) and Melchior (1964).

Van Tieghem (1907) proposed, but did not actually describe, a family Thunbergiaceae, in which he placed those plants lacking a retinaculum, and divided Acanthaceae s.s. into two subfamilies, Acanthoideae (without cystoliths) and Justicioideae (with cystoliths). His position was thus essentially similar to that of Nees, who divided Acanthaceae (s.l.) in two on the basis of the presence or absence of the retinaculum, the main difference being the rank at which the groups were recognised.

C.B. Clarke (1912), in dealing with the South African Acanthaceae, maintained it as a single, broadly-defined family, dividing it into four tribes: Thunbergieae, Ruellieae, Acanthieae and Justiceae. These he defined on a wide variety of characters, making use of the lobing and aestivation of the corolla, as well as characters of the anthers, capsules, seeds, and others. Justiceae was subdivided into four subtribes of which the fourth (Eu-Justiceae) was by far the largest and which was in turn divided into four groups of unspecified rank, as follows:

Monothecieae - anthers one-celled, placenta not elastic: Ruttya.

Typicae - anthers two-celled, placentae not elastic, flower not enclosed by two opposite bracts: Justicia, Monechma, Siphonoglossa, Adhatoda, Rhinacanthus Nees, Ecbolium Kurz, Isoglossa Oerst.

Hypoesteae - placentae not elastic, various floral characters also used: Peristrophe Nees, Hypoestes R. Br.

Solutae - placentae elastic: Macrorungia C.B. Cl., Dicliptera Juss.

Van Tiegham's division of the Acanthaceae into separate families was not widely accepted, and it was only in 1953 that Bremekamp first seriously challenged the prevailing broad concept of the family. In his paper of that year he states, "In some of my previous papers on the Acanthaceae ... I have found occasion to expound my, gradually changed, ideas on the subdivision of the family, but hitherto the latter was accepted by me in customary delimitation. However, further study of some of the groups that up to now were, as a rule, included in the family and comparison with representatives of related families have convinced me that this delimitation cannot be regarded as adequate." He agreed here with Van Tieghem that Thunbergioideae, Mendoncioideae and Nelsonioideae should be excluded. However, he prefered not to include these three in a single family. The first two he considered should respectively form the families Thunbergiaceae Bremek. and Mendonciaceae (Lindau) Bremek., while Nelsonioideae he placed as a tribe of the Scrophulariaceae close to the Rhinatheae. Thunbergiaceae and Mendonciaceae were described and Bremekamp also provided a diagnosis of his narrower concept of Acanthaceae. Though he placed Nelsonioideae in the

Table 1: Subdivision of Acanthaceae sensu Bremekamp

ACANTHOIDEAE	RUELLIOIDEAE
shoots never articulated	shoots always articulated
cystoliths always absent	cystoliths always present
always with four stamens	with two or four stamens
anthers always monothecous	anthers not described
pollen usually colpate	pollen colporate or porate
(5 tribes)	(7 tribes)

Table 2: Subdivision of *Justiceae* by Bremekamp

RHYTIGLOSSINAE	ODONTONEMINAE	JUSTICIINAE
corolla without rugula	corolla without rugula	corolla with rugula
4 stamens or 2 stamens and 2 staminodes	2 stamens, no staminodes	2 stamens or 2 stamens and 2 staminodes
anthers bithecous with thecae at same height, rarely monothecous	anthers bithecous with thecae at different heights	anthers bithecous with thecae at different heights
pollen with colpoid streaks	2-porous, lenticular pollen, exine pattern not specified	pollen prolate, bilateral or occasionally trigonous, pores situated in a trema area

Scrophulariceae, he suggested that eventually it and the Rhinantheae, and perhaps the genus Hiernia (Scrophulariaceae) might need to be segregated as a family separate from Scrophulariaceae, forming three tribes respectively of a new family. No formal decision was taken, however, on this proposal, either in this or subsequent publications of Bremekamp (but see Sreemadhaven, below). In this and in his paper of 1965, Bremekamp gave a detailed defence of his decisions.

Acanthaceae sensu Bremekamp was a more easily definable family, characterised by a bilocular ovary, each locule of the capsule having either two superposed ovules or two (rarely four) longitudinal rows of ovules; a loculicidal, explosively dehiscing capsule whose dissipiment (placenta) splits into two halves; and flattened, exalbuminous seeds supported by retinacula.

The Acanthaceae s.s. (which is equivalent to Lindau's Acanthoideae) he divided into two subfamilies, but along different lines from Lindau, taking no account of the aestivation of the corolla. The characteristics used are set out in Table 1.

After briefly discussing each of the other tribes, Bremekamp concluded with the Justiceae. This he divided into three subtribes, the Odontonemineae, the Rhytiglossinae and the Justiciinae. The delimitation is summarised in Table 2. The pollen of the tribe he divided into three main types, and stated that one or other of these three types occurs in "typical representatives" of each of the subtribes. Justicioinae, he stated, had pollen "prolate and dorsiventrally flattened with a pore in the middle of a 'trema area' (paracolpoid ridge) studded with circular 'insulae' (areolae).

Sreemadhaven (1977) described the following families: Acanthaceae Juss. emend. Sreem. (Type genus Acanthus L.), Justiciaceae (Van Tieghem) Sreem. (Type genus Justicia L.), Meyeniaceae Sreem. (Type genus Meyenia Nees), Nelsoniaceae (Nees) Sreem. (Type genus Nelsonia R.Br.) and Tomandersiaceae Sreem. (Type genus Tomandersia Baill.). This does not appear to have been taken up in recent work on the family.

The Acanthaceae s.l. thus appear to divide naturally into four or five groups, and this has been recognised since the time of Lindau. The segregation of Thunbergioideae and Mendoncioideae as separate families has been accepted by such as Bremekamp (1953), Raj (1961), Mohan Ram & Wadhi (1964) and Cronquist (1981). Others such as Grant (1955), Leonard (1958), Melchior (1964), Heine (1966), Benoist (1967), Takhatajan (1969), Long (1970), Hutchinson (1973), Sporne (1974), Dahlgren (1975) and Dyer (1975) regarded the taxa as subfamilies of Acanthaceae. Retief, in her thesis on Thunbergia in southern Africa (1977), also came to the conclusion that the genus is best retained in the Acanthaceae.

It is evident, however, that the rank of these four to five groups is controversial. Detailed studies of individual genera must first be done to form a firm basis of discussion of relationships, evolutionary trends and classification of the family, and this is so far lacking, especially from the tropics where the family is most abundant. The schemes that have been proposed to classify *Justicia* and some related genera are presented in the following chapter.

TABLE 3: SUMMARY OF THE CLASSIFICATION OF ACANTHACEAE BY NEES (1847) P.P.

ACANTHACEAE

- TRIBE ERANTHEMAE
  - *JUSTICIA*
- TRIBE GENDARUSSAE
  - *MONECHMA*
  - *ADHATODA*

SECTIONS:	*ADHATODA*	*AMBLYANTHUS*	*TYLOGLOSSA*
INCLUDING SPP. OF:	*JUSTICIA*	*ADHATODA*	*JUSTICIA*
			SIPHONOGLOSSA
			MONECHMA
			BELOPERONE
			DIANTHERA

TABLE 4: SUMMARY OF PART OF THE CLASSIFICATION OF THE ACANTHACEAE BY ANDERSON (1860)

ACANTHACEAE

TRIBE JUSTICEAE

SUBTRIBE EU-JUSTICEAE

JUSTICIA

SECTIONS:	*BETONICA*	*ROSTELLARIA*	*GENDARUSSA*	*MONECHMA*	*RAPHIDOSPORA*
INCLUDING SPP. OF:	*JUSTICIA*	*JUSTICIA* & *SIPHONOGLOSSA*	*JUSTICIA* & *MONECHMA*	*MONECHMA*	*JUSTICIA*

TABLE 5: SUMMARY OF PART OF THE CLASSIFICATION OF THE ACANTHACEAE BY BENTHAM (1876)

ACANTHACEAE

TRIBE JUSTICIEAE

SUBTRIBE EU-JUSTICIEAE

	SIPHONOGLOSSA	ADHATODA	JUSTICIA
INCLUDING SPECIES OF:	S. AFR. & AMERICAN SPP. OF SIPHONOGLOSSA	6 SPP. FROM INDIA, AFRICA & S. AMERICA	SPP. INCLUDED NOT USUALLY SPECIFIED, BUT SEE UNDER SECTIONS

SECTIONS:	HEMICHORISTE	ADHATODOIDES	BETONICA	GENDARUSSA
INCLUDING SPECIES OF:	INDIAN SPP.	10 S. AMERICAN SPECIES	10 OLD WORLD SPP.	24 OLD WORLD SPP. & A FEW S. AMERICAN SPP.

SECTIONS:	ROSTELLARIA	HARNIERIA	MONECHMA	AMPHISCOPIA
INCLUDING SPECIES OF:	25 OLD WORLD SPP.	JUSTICIA HETEROCARPA	2-3 AFRICAN SPP.	ALL AMERICAN SPP.

SECTIONS:	ANISOSTACHYA	RAPHIDOSPORA	SAROTHECA
INCLUDING SPECIES OF:	5 SPP. FROM AFRICA & MADAGASCAR	14 OLD WORLD SPP.	2-3 S. AMERICAN & MEXICAN SPP.

TABLE 6: SUMMARY OF PART OF THE CLASSIFICATIONS OF THE ACANTHACEAE BY LINDAU (1896)

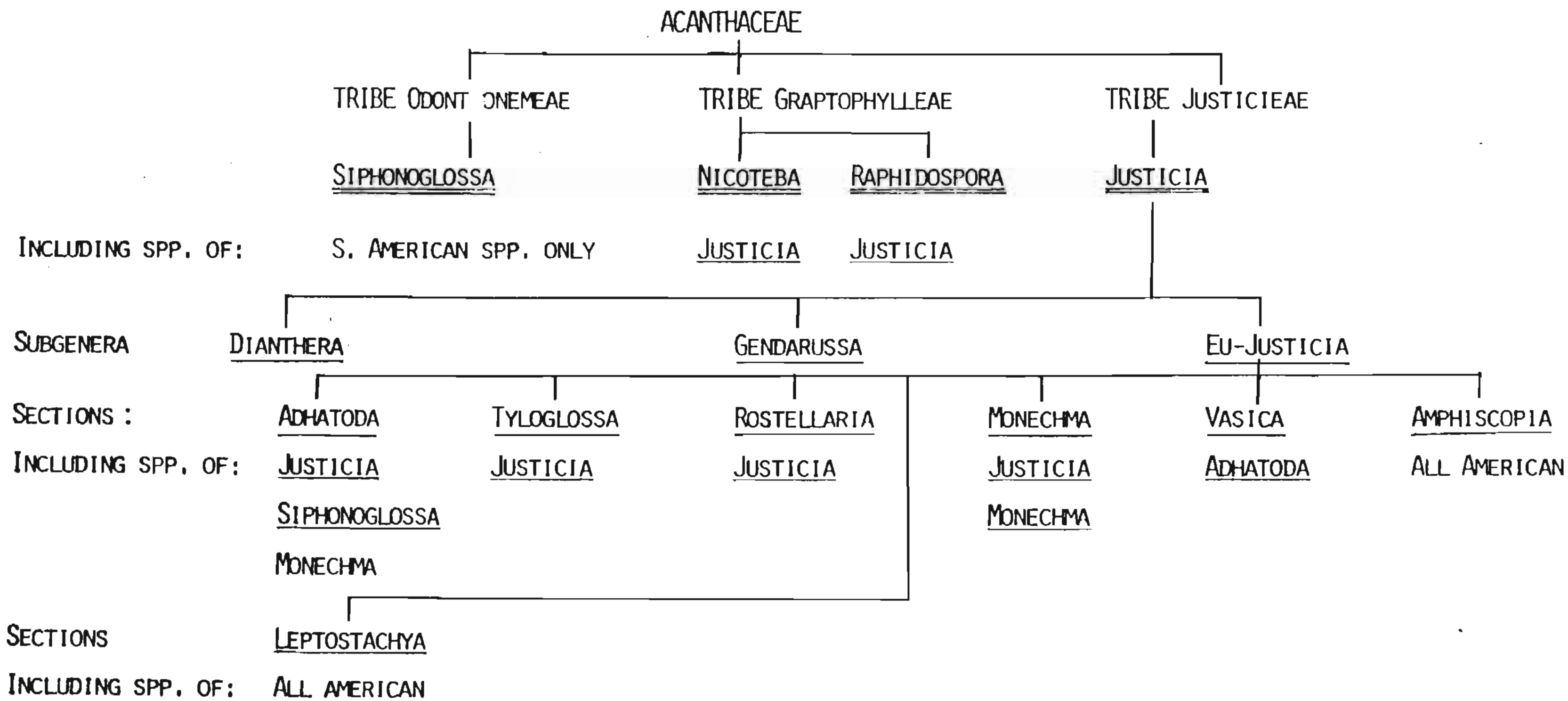


TABLE 7: SUMMARY OF PART OF THE CLASSICICATION OF THE ACANTHACEAE BY CLARKE (1900, 1912)

- ACANTHACEAE
  - TRIBE JUSTICIEAE
    - SUBTRIBE EU-JUSTICIEAE
      - SERIES TYPICAE
        - *ADHATODA*
        - *MONECHMA*
        - *SIPHONOGLOSSA*
        - *JUSTICIA*
          - SECTIONS:
            - *BETONICA* — INCLUDING SPP. OF: *JUSTICIA*
            - *ROSTELLULARIA* — INCLUDING SPP. OF: *JUSTICIA*
            - *CALOPHANOIDES* — INCLUDING SPP. OF: *JUSTICIA*
            - *GENDARUSSA* — INCLUDING SPP. OF: *JUSTICIA*
            - *ANSELLIA* — INCLUDING SPP. OF: *JUSTICIA*

2.2 JUSTICIA AND SIPHONOGLOSSA

Since the genus Justicia was described by Linnaeus in 1737, it has received attention from a number of workers, and its history is complicated and confusing. In part this is because Justicia as defined by Linnaeus comprised a number of disparate elements. In his Species Plantarum (1753) he included 11 species, only four of which still remain in the genus and one of these four (J. adhatoda L.) is also removed by many authors as Adhatoda zeylanica Medicus. The following taxa were placed under Justicia by Linnaeus:

J. adhatoda L. .... (Adhatoda zeylanica Medicus)

J. ecbolium L. .... (Ecbolium Kurz. or E. viride (Forssk.) Alton p.p., depending on which authority is followed)

J. betonica L.

J. hyssopifolia L.

J. procumbens L.

J. repens L. .... (Rungia repens (L.) Nees)

J. chinensis L. .... (Dicliptera chinensis (L.) Juss.)

J. echioides L. .... (Andrographis echioides (L.) Nees or Indoneesiella echioides (L.) Sreem., depending on which authority is followed)

J. sexangularis L .... (Dicliptera sexangularis (L.) Juss.

J. nasuta L. .... (Rhinacanthus nasutus (L.) Kurz.)

J. purpurea .... (present identity not established)

It is apparent that species from five, and perhaps six, other genera have been included in Justicia. In later publications Linnaeus described the following species:

J. bivalvis L. .... (Dicliptera bivalvis (L.) Juss.)

J. charthaginensis L. ...... (possibly Beloperone violacea Planch & Linden)

J. fastuosa L. .... (Hypoestes fastuosa (L.) R. Br.)

J. gangetica L. .... (Asystasia gangetica (L.) Anders.)

J. infindibuliformis L. .... (Crossandra infinidibuliformis (L.) Nees)

J. pectinata L. .... (Rungia pectinata Nees, according to Nees in DC., Prodr. 11: 470 (1847) or J. pectinata L. according to Roxburgh in Fl.Ind. 1: 134 (1820))

J. scorpioides L. .... (Henrya scorpioides (L.) Happ)

J. picta L. .... (Graptophyllum pictum (L.) Griffith)

Six other genera were therefore placed within the circumscription of Justicia if Beloperone Nees can be regarded as a separate genus. When the generic description given by Linnaeus in his Genera Plantarum (1754) is examined, it can be seen that any Acanthaceous genus with a retinaculum and a two-lipped corolla could be accommodated within his concept of Justicia. The following is translated from Linnaeus, Genera Plantarum, ed. 5 (1754) - bracketed comments are by the present author:

26. Justicia Houst. A.A. Adhatoda Tourn. 79.

Calyx: monophyllous, small, 5-partite, acute, erect, narrow.

Corolla: petals one (presumably 5 united). Tube gibbous. Limb gaping. Upper lip oblong, emarginate. Lower lip of the same length (as the upper lip), reflexed, trifid.

Stamens: 2, subulate, hidden below upper lip. Anthers erect, bifid at base.

Pistil: ovary turbinate. Style filiform, as long as and close to anthers. Stigma simple.

Fruit: capsules oblong, obtuse, base narrow, bilocular, dissipiment opposite valves, claw (?) dehiscing elastically.

Seeds: subrotund.

Obs.: upper lip of corolla differently positioned (presumably referring to the resupinate corolla of Dicliptera).

Since the time of Linnaeus, much work has been done on the group, and many new genera described, creating a problem of typification of Justicia. Britton (1918) proposed J. adhatoda L. as the lectotype of the genus, but gave no reasons for so doing. Hitchcock & Green (1929) lectotypified Justicia by J. hyssopifolia L., but gave no reasons for their choice either. Both lectotypfications appear to have been arbitrary. If J. adhatoda is accepted as lectotype and, as is sometimes done, Adhatoda is accepted as genus separate from Justicia, only c. 10 species out of 300-600 will remain in Justicia s.s. The remainder must either be included in other genera or new genera must be described to accommodate them. However the genus is lectotypified, probable nomenclatural stability must be considered. Stearn (1971) comments "The definition of the genus Justicia L. and the typification of its name provide interlocked problems of taxonomy and nomenclature for which every possible solution is certain to cause nomenclatural disturbance". McNeill et al. (1987) discussed the lectotypification of Justicia and did not come to a decision as to how it should be lectotypified. Instead, they proposed 1935 as a starting date for all lectotypifications in order to avoid discrepencies between Britton (1918) and Hitchcock & Green (1929). This would avoid the problem of lectotypifying Justicia until the genus is better known throughout its range.

At the opposite extreme from Linnaeus' very wide concept of Justicia was that of Nees who, in 1847, gave the first comprehensive account of the genus, under the name Adhatoda (See Table 3). He preferred to divide Justicia s.l. into a number of smaller segregate genera, with only nine species remaining in his Justicia. There were also a further three species placed under "species dubiae" and five under "species incertae sedis et non cruende". He placed the genus Justicia in his tribe Eranthemae, defining it as having two stamens with locules at equal heights, both locules being muticous, and the capsule with two tuberculate seeds. Of the names placed in the genus, seven are synonyms of Ecbolium linneum Kurtz (according to Index Kewensis 1) while the other two are Madagascan species whose present identity is unknown, as there has been no recent treatment of the Acanthaceae of Madagascar. Nees' concept of Justicia, like that of Linnaeus, therefore included some very disparate elements, if the two Madagascan species are actually Justicia.

The majority of species now placed in Justicia, Nees placed in Adhatoda in the tribe Gendarussae, in a different tribe to his Justicia. Justicia he divided into three sections. Monechma Hochst. he kept separate, and also placed in tribe Gendarussae, with two-seeded capsules being considered diagnostic of the genus. Adhatoda contained those species with two stamens having the locules at different heights, and four-seeded capsules (Table 3).

1. sect. Adhatoda - inflorescence spicate, bracts and bracteoles reticulate-veined.

2. sect. Amblyanthus - inflorescence of pedunculate axillary cymes.

3. sect. Tyloglossa - inflorescence of sessile axillary clusters

that may be confluent into a terminal spike, or with axillary or terminal spikes; anther locules on a dilated connective, oblique, lower locule spurred or mucronate.

This last section he further subdivided on characters of the inflorescence and capsule without naming formal categories.

T. Anderson (1864) described members of his tribe Justicieae as having the corolla two-lipped, and the fertile stamens two, with the locules approximately one above the other. This was divided into subtribes, with Justicia being in subtribe Eu-Justicieae (Table 4). The characters used were as follows:

Subtribe Eu-Justicieae - Corolla tube not elongate, straight, lower lip trifid with central lobe longer than side lobes, upper lip shortly bifid; stamens two.

Justicia - upper lip concave, not hooded, lower lip convex, rugose; stamens bilocular, lower locule spurred.

1. sect. Betonica - inflorescence an axillary or terminal spike, bracts imbricate.

2. sect. Rostellaria - inflorescence a terminal spike or flowers axillary and subsolitary, bracts ciliate.

3. sect. Gendarussa - flowers few, axillary, pendunculate, or solitary, bracts minute.

4. sect. Monechma - inflorescence an axillary spike; capsules two-seeded by abortion.

5. sect. Raphidospora - inflorescence a lax panicle.

These delimitations result in disparate elements being placed together in sect. Rostellaria (Nees) T. Anders. and sect. Raphidospora where such different species as J. hyssopifolia, J. cuneata, J. orchioides, J. anagalloides and J. odora are found.

Bentham (1876) stated that he considered Nees had described too many genera and, accordingly, widened the concept of Justicia to include many of Nees' genera (see Table 5). Many of them he maintained at lower rank as sections, e.g. sect. Monechma. However, he did keep as separate genera Siphonoglossa, Beloperone, Adhatoda, Dianthera Klotzsch and Jacobinia Nees, all of which are probably closely related to Justicia. His concept of Justicia is similar to that of Anderson (1864), whom he quoted, excluding only those species with muticous anthers.

All the above genera Bentham placed in his tribe Justicieae, subtribe Eu-Justicieae, which he defined as having the corolla two-lipped or subequally four-lobed, with four ovules in the capsule. In Siphonoglossa and Justicia, the lower anther locule was spurred or shortly mucronate, while in Adhatoda both anther locules were muticous and the calyx was campanulate.

Justicia he divided into 11 sections as follows:

1. sect. Hemichoriste - flowers subsessile, often fascicled, in long spikes; bracts herbaceous or narrow.

2. sect. Adhatodoides - flowers solitary in leaf axils; bracts usually herbaceous; anthers usually spurred.

3. sect. Betonica - flowers subsessile, spicate, bracts orbicular-ovate, membranous or conspicously veined or laxly imbricate.

4. sect. Gendarussa - flowers subsessile, fascicled in leaf axils or in interrupted spikes; bracts small and narrow; calyx five-lobed, lobes slightly unequal.

5. sect. Rostellaria - flowers in dense apical spikes, sessile, solitary or fasicled in leaf axils; bracts narrow, usually ciliate or white-margined.

6. sect. Harnieria - flowers in axillary fascicles; capsules clearly dimorphic, either normal or indehiscent, one-seeded, with six longitudinal wings.

7. sect. Monechma - flowers in dense axillary spikes; bracts orbicular, subimbricate; calyx five-lobed, lobes subequal or upper smaller; capsule small, subglobose above the stipe, often two-seeded by abortion; seeds smooth.

8. sect. Amphiscopia - flowers in terminal or axillary spikes, spikes usually penduncŭlate; bracts membranous, orbicular, without cilia; calyx five-lobed, upper lobe often smaller; capsule narrower than in sect. Monechma, two- to four-seeded; seeds smooth or tuberculate.

9. sect. Anisostachya - flowers in axillary spikes or pedunculate branching apical inflorescences, peduncles sometimes branching; bracts orbicular-ovate, membranous or conspicuously veined, often oblique in secondary spikes; upper lobe of calyx short or absent; capsule two- to four-seeded.

10. sect. Raphidospora - flowers usually pedicellate, in lax axillary penduncŭlate spikes or in large panicles; bracts small; seeds usually echinate-hispid.

11. sect. Sarotheca - flowers in lax panicles, laxer than in

Gendarussa; bracts small; flower tube usually broad at base with limb short, otherwise as usual for Justicia.

Lindau (1894) also included Monechma as a section of Justicia, and added the bulk of Adhatoda, also as a section. Siphonoglossa he separated widely from Justicia, placing it in his tribe Odontonemeae (margocolpus of pollen entire), while most of Justicia was placed in Justicieae (pollen areolate). However, he stated that the South African species of Siphonoglossa would fit with difficulty into his Siphonoglossa, and the three species he cited were all from America or the West Indies. The South African S. leptantha he placed under Justicia as J. leptantha. Those species with entire margocolpi and short corollas were removed to other genera: those species with lax axillary "panicles" and small bracts being placed in the genus Gendarussa Nees, while those with large bracts and terminal "spikes" comprise the genus Nicoteba Lindau, both in the tribe Graptophylleae. Lindau's Justicia he placed in tribe Justicieae, and divided into three subgenera, the third subgenus being further subdivided into seven sections (See Table 6). The characters he used were as follows:

1. sect. Adhatoda - flowers one to three, scattered in leaf axils, pedicellate.

2. sect. Tyloglossa - inflorescence dense, in leaf axils.

3. sect. Rostellaria - flowers in large lax spikes or racemes; bracts small and not imbricate.

4. sect. Monechma - flowers in large dense usually axillary spikes or racemes; bracts usuallly imbricate, usually rounded and ciliate on the margins.

5. sect. Vasica - flowers in large dense spikes or racemes; bracts large and imbricate, not ciliate on margins; upper lip large and hooded.

6. sect. Amphiscopia - as for sect. Vasica, but upper lip small, tube therefore longer and narrower.

7. sect. Leptostachya - flowers in dense racemes on slender peduncles, small.

C.B. Clarke's system in Flora Capensis (1912) is essentially that of T. Anderson (Table 7). However, he separated Adhatoda, Monechma and Siphonoglossa from Justicia, and made separate sections for those species having "spicate" and those with "solitary" flowers. The above genera are all placed in his tribe Justicieae, subtribe Eu-Justicieae. Unlike Lindau, he did not remove those species with pollen having entire margocolpi from Justicia, but included them as sections Betonica (cf. Nicoteba

Lindau) and Gendarussa Nees (cf. Rostellaria Lindau). His genera and sections he defined as follows:

Adhatoda - anther locules at slightly different heights, shortly tailed.

Siphonoglossa - one anther locule below the other, distinctly tailed; corolla tube slender, much longer than limb (lips).

Monechma - one anther locule below the other, distinctly tailed; corolla tube not much longer than limb (lips); two-seeded, seeds smooth and usually shining.

Justicia - one anther cell below the other, distinctly tailed except in two species; corolla tube not much longer than limb (lips); seeds usually four, rough or tubercular.

1. sect. Betonica - inflorescence a strobilate spike; bracts ovate and often four-ranked; sepals usually five; pollen hardly tuberculed.

2. sect. Rostellularia - inflorescence a terminal non-strobilate spike, may be interrupted at base; bracts narrower than in former section; flowers 1-3 per bract.

3. sect. Calophanoides - inflorescence of sessile axillary clustered or solitary flowers, upper clusters hardly confluent.

4. sect. Gendarussa - inflorescence a terminal panicle, or terminal cymes running into a terminal pseudo-panicle; bracts small and subulate.

5. sect. Ansellia Burkill & Clarke - inflorescence of slender axillary spikes with distant solitary flowers.

This broad concept of Justicia lasted unchallenged until 1948, when Bremekamp argued for the rejection of the wide delimitation of the genus adopted by Bentham and Lindau. He considered the small genera recognised by Nees as being more natural. Stearn (1971) criticized Bremekamp's proposals as he apparently covered very few species, mainly those of Java, and stressed that the genus needed to be studied over its whole range if one were to define "relatively homogenous groups". Long (1970) also criticised Bremekamp for apparently over-stressing minor pollen characters, the value of which is often disputed.

Siphonoglossa has received the attention of Henrickson and Hilsenbeck (1979), who reviwed the genus and published some new taxa and combinations. They considered Siphonoglossa to consist of two sections: sect. Pentaloba with 5 sepals, leafy bracteoles, the upper corolla lip emarginate and the fertile part of the capsule ovoid and glabrous; and sect. Siphonoglossa with 4 sepals, bracteoles reduced and subulate, the upper corolla lip rounded and not emarginate and the fertile part of the capsule ellipsoidal and usually pubescent. They tentatively included the South African species in the typical section. They also transfer the genus from tribe Odontonemeae to tribe Justicieae.

Hilsenbeck (1983), in his thesis on Siphonoglossa (of which I have seen only the abstract) removes sect. Pentaloba to Justicia, removes also "... other taxa placed in Siphonoglossa ... it is proposed that they too be excluded from the genus for various reasons". It is uncertain what taxa are meant. He also adds other charcaters to strengthen the thesis that Siphonoglossa sensu lato should be divided into at least two sections. In sect. Pentaloba has a base chromosome number of x = 14 and produces flavonol O-glycosides of quercetin and isorhamnetin. In sect. Siphonoglossa (Siphonoglossa sensu stricto) x = 11 and the species elaborate only apigenin-based C-glycosylflavones.

In Justicia and allied genera, the difficulty lies mainly in recognising and defining natural groups. Many specialisations, e.g. a long corolla tube such as is found in Siphonoglossa, a reduced number of seeds in the capsule, such as is seen in Monechma and a number of species of Justicia and various pollen and anther characters, may have arisen more than once. Only a thorough knowledge of the species, coupled with the examination of more characters, can provide the necessary evidence to distinguish true relationship from the effects of parallelism or convergence.

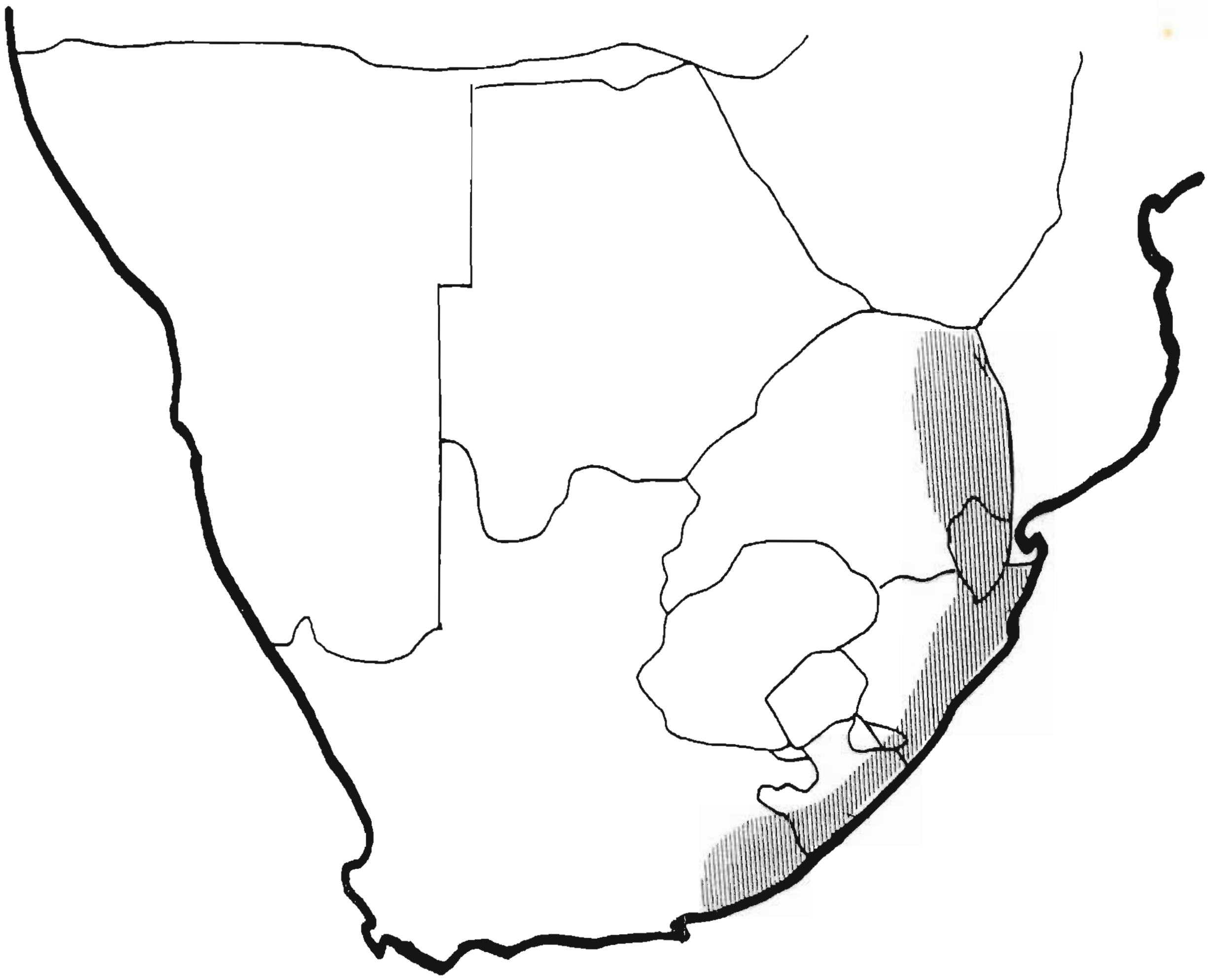
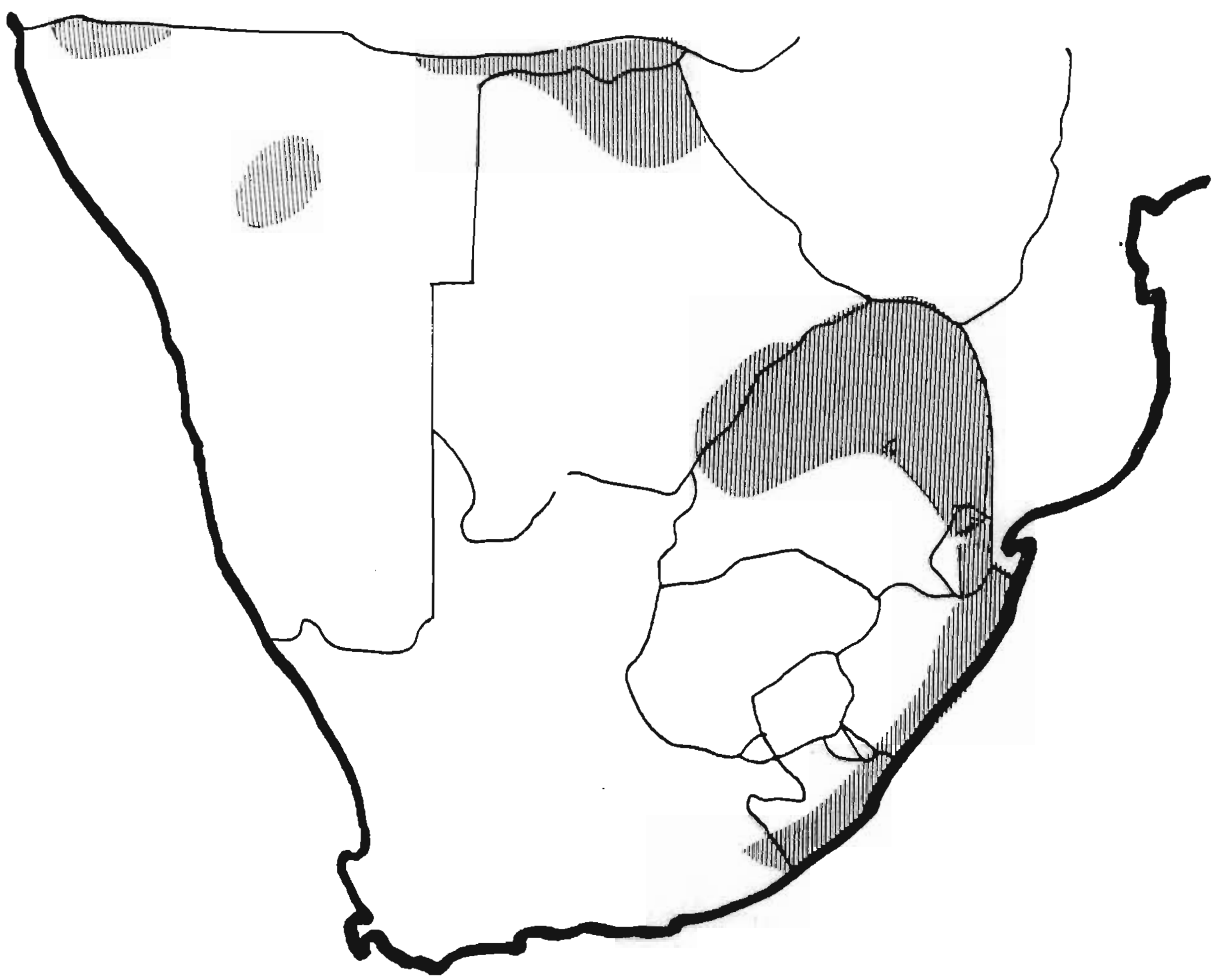


Figure 1.1   Distribution of J. campylostemon



CHAPTER 3

TAXONOMIC EVIDENCE

3.1 HABIT, DISTRIBUTION AND HABITAT

HABIT

Most of the species of Justicia and Siphonoglossa are soft sub-shrubs variously described on herbarium sheets as herbs, shrubs or shrublets. There are also three annual species, J. kirkiana, J. dinteri and J. anselliana, each from a separate section of the genus, and each apparently independently derived specialisations from the more usual perennial habit. J. platysepala and J. guerkeana are definitely shrubs, but soft-stemmed; J. orchioides, J. cuneata and J. thymifolia are rigid, thick-stemmed shrubs. Occasional specimens of J. cuneata and J. orchioides also show a tendency for the stems to become spinescent. These latter five are all species of arid areas, and all except J. cuneata are placed in the same section of the genus. The other definitely shrubby species is J. bolusii, which occurs in dense coastal forest. It has very straight erect branches (virgate), and sends up suckers from the underground base of the stem.

Both shrubs and herbs may root at the nodes. The most extreme example of this is the little grassland herb, J. anagalloides, where the whole plant is prostrate, and each node has roots, an inflorescence and a pair of erect leaves. None of the southern African species of Justicia are hydrophytes, epiphytes or lianes, nor are any large shrubs or trees.

DISTRIBUTION

The Acanthaceae are predominantly tropical, with the majority of species occurring in four centres of distribution: Indomalaysia, tropical Africa, Brazil and central America, (Airy Shaw, 1973). However, the family also occurs in more temperate areas such as the Mediterranean, northern America, Australia and southern Africa. This same trend is observed in Justicia. C.B. Clarke (1900) recorded 80 species of Justicia for tropical Africa and 25 in the Flora Capensis area (1912). As both Flora treatments were written by the same author, the species concepts should be equivalent. Although the number of species cannot be accepted as absolute values, their proportion to each other will give a rough estimate of the relative numbers of tropical and temperate African species, i.e. 3:1.

The southern African species fall into two major categories - those which have a predominantly tropical distribution and extend south into southern Africa and those which are endemic to southern Africa.

Those with a tropical element (16 taxa) may occur in southern Africa merely as a single record (J. crassiradix in the Caprivi), or may have a more widespread distribution in either a predominantly eastern direction or in a crescent-shaped northern distribution.

Six of the 16 taxa have a predominantly eastern distribution pattern, occurring from the N.E. Transvaal, through Swaziland and Natal to the Transkei, and sometimes as far south as the Eastern Cape (e.g. J. campylostemon)(Figure 1:1) or even Mossel Bay in the southern Cape (J. capensis). The other 10 taxa have a crescent - shaped northern - type distribution, occurring from Namibia through northern Botswana to the northern Transvaal (e.g. J. betonica) (figure 1:2). These taxa may occur in only part of that range, and may also occur further south than the northern Transvaal.

The remaining 12 taxa of Justicia are endemic to southern Africa, many with very restricted distributions. Two (J. cuneata subsp. hoerleiniana and J. guerkeana) are confined to southern Namibia, two (J. thymifolia and J. parvibracteata) to the northern Cape, and two to the mountain ranges of the Transvaal (J. montis-salinarum in the Soutpansberg and J. minima in the Waterberg). Four taxa are restricted to the Eastern Cape (J. orchioides subspp. orchioides and glabrata, J. petiolaris subsp. bowiei and J. bolusii), and two to the Namaqualand-Karoo-Eastern Cape area (J. cuneata subspp. cuneata and latifolia).

No Justicia species have been found from the South Western Cape, in the sandy central Botswana area, or in the high regions of the Drakensberg.

Both J. orchioides and J. cuneata are endemic to the semi-arid central area of southern Africa. J. cuneat is basically found in the western half of the Karoo and Namaqualand (winter rainfall), while J. orchioides occurs in the east (summer rainfall (figure 2:1). Their distributions overlap in the southern part of the range (Port Elizabeth area), where rain may fall at any time of the year, and both these species have separate subspecies in this area.

Two species considered closely related, which have restricted distributions, are J. guerkeana and J. platysepala (figure 2:2). Here again the division seems to be related to rainfall patterns. The former species occurs in the northern half of Namibia (rainfall above 200 mm p.a.) and the latter in the south (rainfall below 200 mm p.a.), with the dividing line being at about Windhoek. This pattern has been seen in two closely related species of Forsskaolea (Urticaceae), and here also the dividing line was at approximately 23°S (Merxmüller & Roessler, 1980). Munday (1980) has shown a similar pattern in the two subspecies

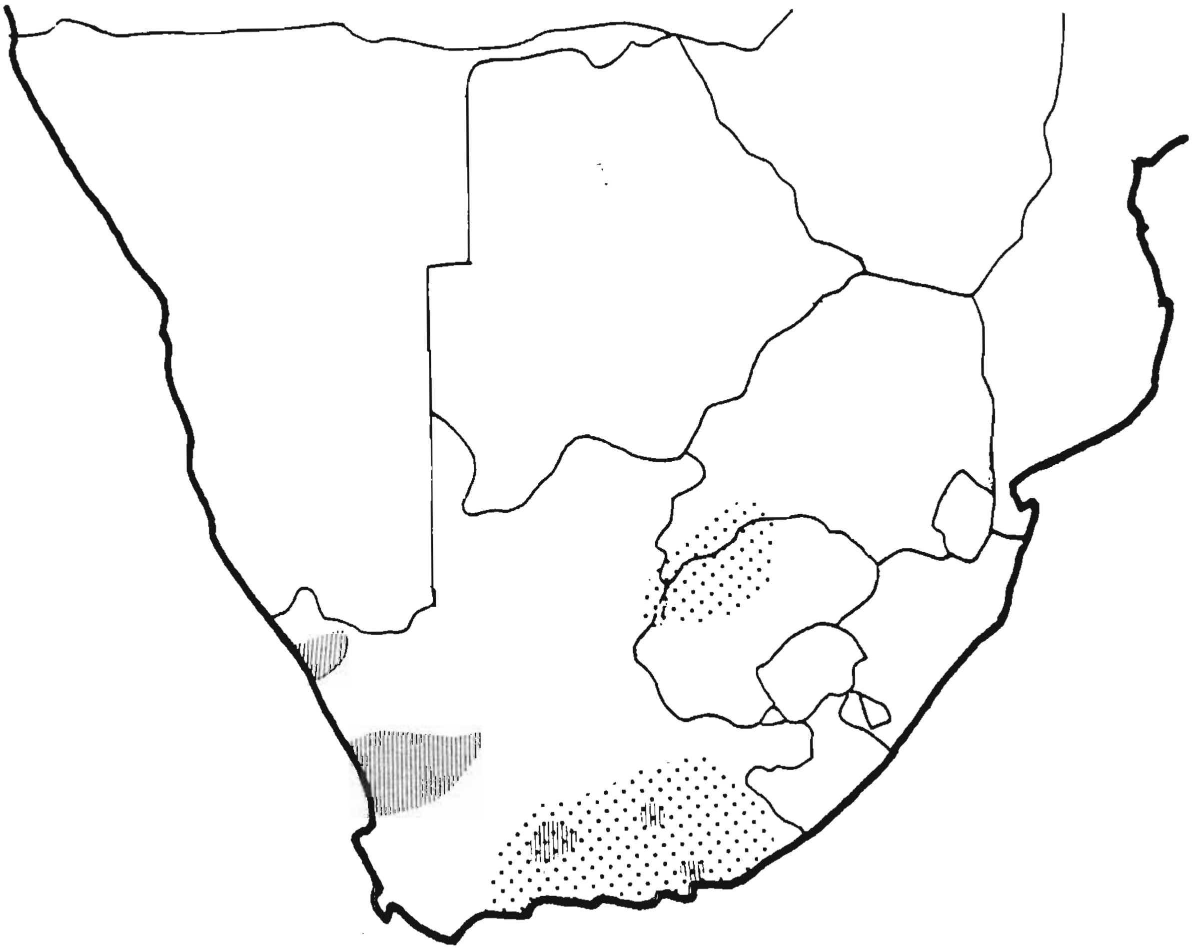


Figure 2.1 Distribution of J. orchioides ∴ J. cuneata

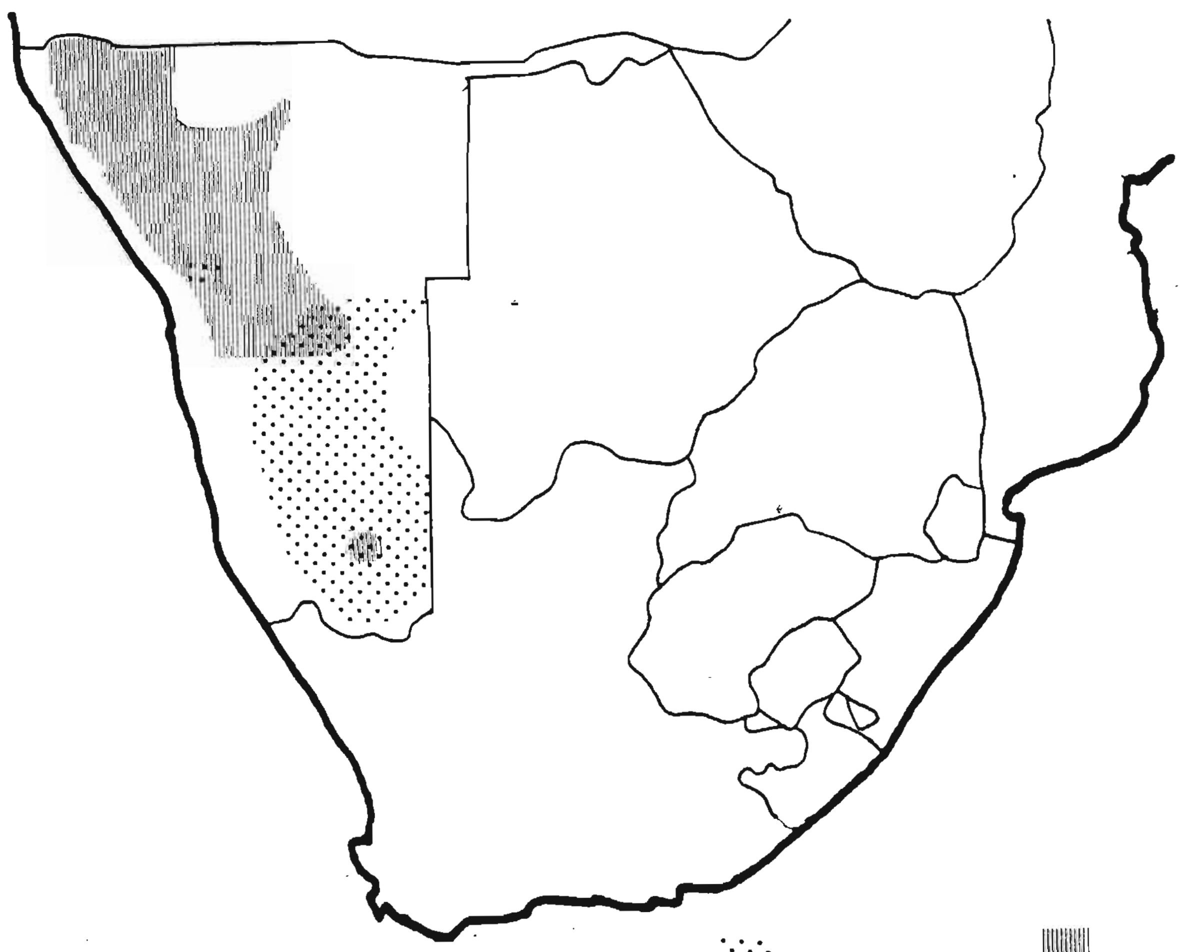


Figure 2.2 Distribution of J. guerkeana ∴ J. platysepala

of *Monechma genistifolium*, with subsp. *genistifolium* in the north and subsp. *australe* in the south of Namibia.

The species *J. bolusii*, one of the Eastern Cape endemics, has no near relatives in southern Africa, but appears to be most closely related to tropical species such as *J. cordata* (Nees) T. Anders. *J. bolusii* and *J. cordata* are very similar in appearance, both have a throat pouch in the corolla, a clavate capsule and a similar inflorescence, in addition to the unusual smooth seeds. *J. cordata* is a common species in tropical Africa and may be locally dominant in grassveld and open woodland. Its habit is very variable, from prostrate to stoloniferous, a virgate shrub (like *J. bolusii*) or a dense thicket up to 3m high. *J. bolusii*, on the other hand, is rare and is restricted to a few forests in the Eastern Cape. It is seldom collected though it is one of the largest species in the genus in southern Africa. It is here surmised that the section to which *J. bolusii* and *J. cordata* belong was once more widely distributed in Africa, and that *J. bolusii* is a relic of this distribution.

Two other taxa present problems of interpretation of distribution. One is *J. petiolaris* subsp. *incerta* from northern Natal, central Transvaal and the central Kruger National Park also. It is not known why it should have such an unusual distribution, apparently not linked with any ecological factors. Another taxon with a puzzling distribution is *J. capensis*, which is found in northern Natal and in the Eastern Cape. The intervening area is relatively well-collected. *J. capensis* is one of the more conspicuous species of the genus with its medium-sized, bright mauve flowers, but no specimen of the species has been found in either the Transkei or most of Natal.

HABITAT

The range of habitats ocupied by *Justicia* species is wide: from forest undergrowth (*J. petiolaris* subsp. *petiolaris*, *J. campylostemon*) to the driest parts of the Namib (*J. cuneata* subsp. *hoerleiniana*), and from widespread on roadsides and overgrazed fields (*J. protracta* subsp. *protracta*, *J. anagalloides*) to highly specialised habitats in a single mountain range (*J. minima*). The altitude occupied ranges from sea level (*J. bolusii*, *J. protracta* subsp. *protracta*) to the Witwatersrand at 1800 m elevation (*J. anagalloides*), but not into the Drakensberg. (Further details on habitat are given for each species under the descriptions of the species).

It is probable that *Justicia* first evolved in a tropical climate and has since spread into cooler and especially dryer areas, with concomitant specialisations. In support of this hypothesis are observations that, within southern African *Justicia* at least, three pairs of taxa include one member that shows reduction or specialisation, and is associated with the drier habitat. The taxa of each pair are almost certainly closely related. These are J. protracta/J. dinteri (at least in part), J. protracta/J. parvibracteata and J. cuneata subsp. cuneata/subsp. hoerleiniana. J. dinteri is an annual and regularly has dimorphic capsules, J. parvibracteata is smaller than J. protracta, with the bract reduced, and J. cuneata subsp. hoerleiniana has dense anvil-shaped hairs with broad heads that appear to be a xeromorphic modification (see Ch. 3.3, and Figure 7: 10-13).

The genus Monechma (Munday, 1980) has radiated even more than Justicia into the dry areas of the subcontinent. Fifteen of the 19 species recognized by Munday occur in areas where the mean annual rainfall is below 125 mm, and the distribution of the genus is centred on the southern half on Namibia and adjoining Cape Province. Nine species are restricted to Namibia. Munday considers advanced characters, associated with aridity, to be:

1. the two-seeded capsule

2. the annual habit

3. T-shaped or erect hairs are advanced over anvil-shaped hairs.

In Justicia, a two-seeded capsule like that of Monechma is found in J. cuneata, J. guerkeana and J. platysepala, species which all occur in dry areas. The seeds themselves, though, are rough, and are clearly not like those of Monechma. J. bolusii, which grows in coastal forests of the Eastern Cape, also has a reduced number of seeds so that this character is not necessarily associated with an arid habitat. In this case large seeds are probably associated with the larger food reserves necessary for a seedling germinating under low-light conditions. The annual habit is found in three species, of which two (J. anselliana and J. dinteri) are species of semi-arid areas. The hairs of Justicia, however, present a more complex situation than in Monechma. Here T-shaped hairs are not found, and anvil-shaped hairs with well developed "anvil" heads are rare. The relationships of hair types to ecology is discussed in the chapter on indumentum (Ch. 3.3).

3.2 LEAVES

Surveys of vegetative characters, including leaves, preceded the delimitation and description of the species and subspecies in the two genera studied. In most cases leaf characters proved to be very plastic within a taxon, and to relate more to the habitat of the population than to the taxon to which it belonged. Their value for identifying of taxa was not high except in isolated cases, while for classifying into higher taxa they were not used at all.

METHODS AND MATERIALS

The leaves of a large number of herbarium specimens were examined, and size (length and width), texture and shape were recorded, as well as petiole length. The indumentum of the leaves was also examined (see Ch. 3.3). A number of populations of some species were cultivated and changes in leaves noted.

RESULTS AND DISCUSSION

The leaves of *Justicia* and *Siphonoglossa* are typical of the Acanthaceae, being opposite, decussate, entire and exstipulate. In one case however (*J. betonica*), the leaves may be very slightly toothed, with broad, shallow teeth.

A. Leaf size and shape: variation and possible ecological significance

In at least one species (*J. glabra* Koen. ex Roxb.) the shape of the leaves is characteristic. The subspecies of *J. petiolaris* (Nees) T. Anders. are distinguished partially on leaf size. In general, however, the shape and size of the leaves is too variable to be of more than secondary value, and more constant characters exist for identification.

The size range of the leaves, and their shape, appears to depend on the habitat. One of the most variable species is probably *J. betonica*, where the leaves are broadly ovate to narrowly lanceolate, to nearly linear (figure 3: 2). Linear leaves occur in nearly all the specimens from the Barberton area, but are also found elsewhere. It was at first considered possible that the these plants might be recognised as a separate subspecies, but the fact that there is no clear-cut discontinuity between broad- and narrow-leaved specimens, mitigated against recognition of a separate taxon. It was also noted that the leaf width in *J. betonica* was correlated with bract width. C.B. Clarke (1912) recorded five species in his sect. *Justicia* (sect. *Justicia*), basing them largely on leaf size and leaf and bract width but, for the reasons given above, only one (*J. betonica*) is recognised in this revision,

FIGURE 3

Variation in leaves of three taxa of *Justicia* (X1).

(All specimens are housed in PRE)

1-5. *J. protracta* subsp. *protracta*

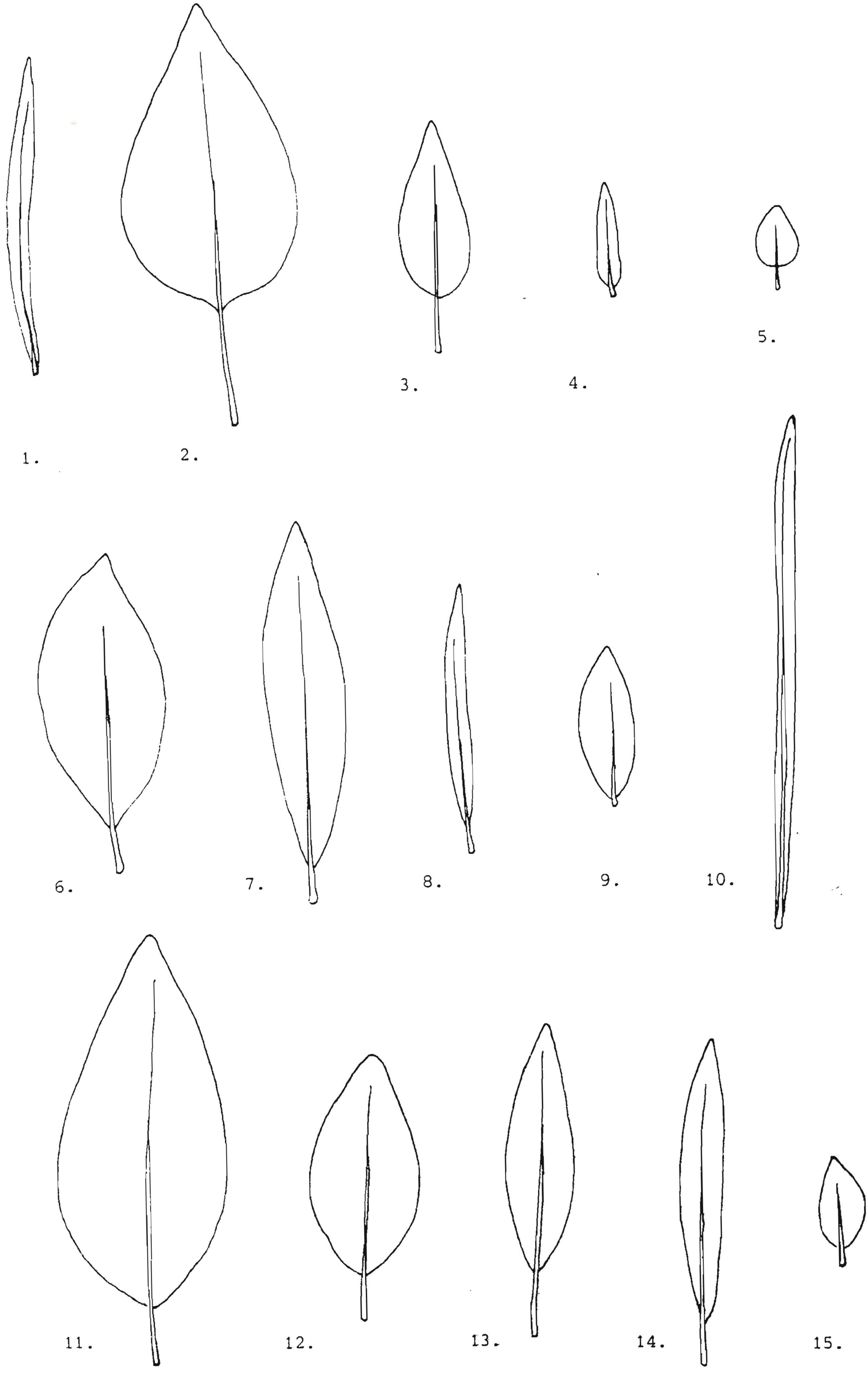
1. Killick & Strey 2513
2. Pott Leendertz 5691
3. Junod 4450
4. Meeuse 9315
5. Wylie 21947

6-10. *J. betonica*

6. Balkwill 258
7. Hutchinson 2437
8. Mogg 1340
9. Balkwill 750
10. Kluge 2279 B

11-15. *J. flava*

11. Leach & Noel 55
12. Van Dam s.n. (Tvl. Mus. 12002)
13. Mogg 15403
14. Collett 516
15. Rogers 21505


1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.

with the other four being reduced to synonomy (J. betonicoides Burkill & Clarke, J. cheiranthifolia Nees, J. variegata (Nees) C.B. Clarke and J. trinervia Vahl).

Leaves of J. flava and J. protracta subsp. protracta are also very variable (figure 3: 1 and 3 respectively). These two taxa occupy a wide range of habitats and have a correspondingly wide variety of leaf shapes and sizes depending on the population. Populations of J. protracta subsp. protracta from moist, shady areas have large, thin-textured leaves, while in exposed situations such as roadsides, the leaves are smaller and narrower. A population of this subspecies was found growing near the sea shore, where the plants had small, rounded, semi-succulent leaves, but living material of this population was unfortunately not available and so it was not possible to ascertain whether these differences in leaf size, shape and texture would remain constant under cultivation.

Specimens of a number of populations of both J. flava and J. protracta subsp. protracta were grown under the same conditions at the Botanical Research Institute nursery (Pretoria) for several seasons, and it was found that the differences in leaf size and shape between populations remained more or less constant. It can therefore be assumed that in these taxa the differences are genetically fixed. The three subspecies of J. petiolaris, which are at least partially definable on leaf size, were also grown for a number of years in the nursery and the differences found to remain constant.

Differences in leaf size range between species as well as between populations appears to also be correlated with the habitat of those species. Taxa found in the undergrowth of forests, such as J. campylostemon (Nees) T. Anders., J. glabra and J. petiolaris subsp. petiolaris, have large, thin, broadly-ovate leaves with long petioles (Figures 4:1,2 and 5:2 respectively). Those species of Justicia which occur in arid or semi-arid areas, on the other hand, show one of two types of leaf, which correspond with two different adaptive strategies to the prevailing arid conditions. J. dinteri and J. anselliana (Figures 5:6 and 6:8 respectively) are annuals which grow rapidly when there is sufficient moisture and die off in the dry season. Both occur in semi-arid areas, extending from northern Namibia through northern Botswana into the Transvaal. They are soft herbs, and their leaves are large relative to the plant size. The other adaptive strategy is represented by species which are perennial shrubs with reduced leaves, often sclerophyllous and more or less sessile. The most extreme examples of this are J. cuneata (Figure 6:1) and J. orchioides (Figure 6:2), where the sessile sclerophyllous leaves are distinctive of the species. A similar correlation between arid habitat and small leaf size was noted by Munday

(1980) in her study of Monechma, a genus characteristically occurring in arid areas of the subcontinent. She recorded that most of the species of the genus had leaves less than 25 mm long or, if longer, then only 15-20 mm broad.

B. Venation

Most species of Justicia and Siphonoglossa have a midrib with the veins coming off at an acute angle along its length. In two species however (J. thymifolia and J. guerkeana, Figures 6:3 and 6:4 respectively), the leaves are three-veined from the base. This character, together with pubescence and distribution, is very important in distinguishing J. guerkeana from the morphologically very similar J. platysepala (Figure 6:5).

C. Stomata

Stomata in Justicia, as in nearly all the Ancanthaceae, are caryophyllaceous (diacytic) (Paliwal 1966; Inamdar, 1970; Ahmad, 1974). In J. montis-salinarum they were found to be sunken, something that was not noted in any other species of the genus in southern Africa.

There is too much evidence of parallelism for the leaves to be used with confidence as indicators of relationships. As discussed in Chapter 3.1, Justicia is probably a tropical genus, and many unrelated groups have radiated into the more arid areas of southern Africa. Similar adaptations of the leaves have followed. Reduction in leaf size has been noted in such unrelated species as J. orchioides (Figure 6:2), J. cuneata (Figure 6:1) and J. parvibracteata (Figure 5:5), each of these species being in a different section of the genus, as well as in Monechma. The reduction is clearly correlated with arid habitat, rather than indicating a relationship between the species.

If it can be accepted that radiation in Justicia has taken place from the moist areas of the tropics into the semi-arid areas of southern Africa, then the following characters would be advanced in the genus:

a) annual habit

b) small sessile leaves

c) leaves sclerophyllous

d) sunken stomata

e) loss of hairs on leaves, or hairs short (puberulous) with heavy ornamentation (See Ch. 3.3 for discussion of indumentum).

FIGURE 4

Leaves of species and subspecies of *Justicia* and *Siphonoglossa*

(Average leaf taken, X 1. Number in brackets is the species number in text)

1 (1). *J. glabra* (Lambrecht 93)

2 (2). *J. campylostemon* (Strey 8389)

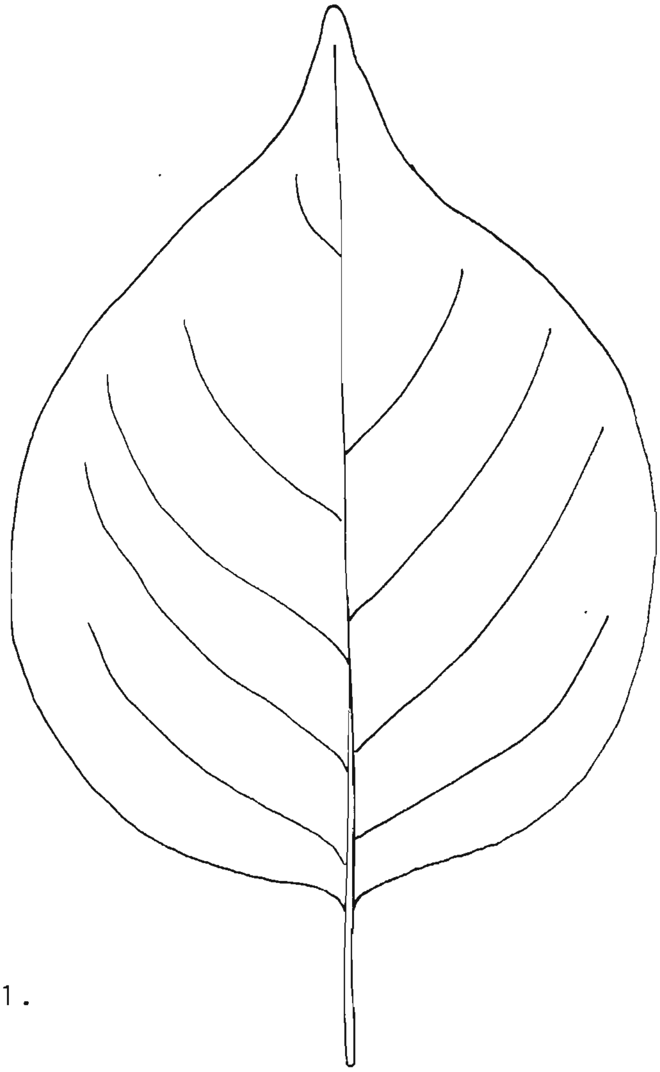
3 (3). *J. bolusii* (Immelman 373)

4 (4). *J. betonica* (De Winter & Leistner 5288)

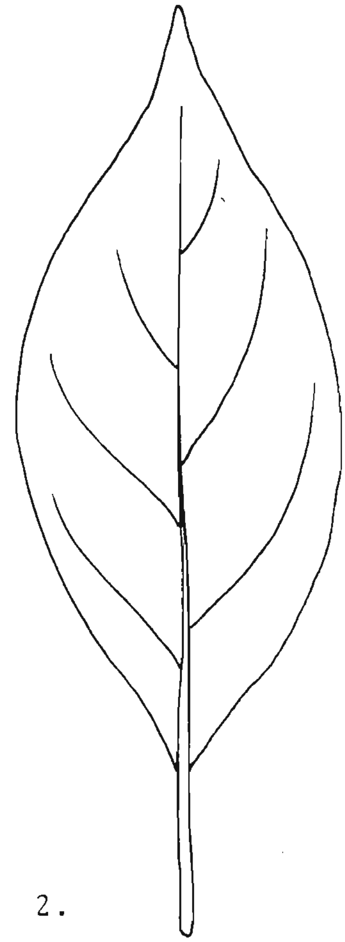
5 (5). *J. montis-salinarum* (Van Wyk 5536)

6 (6). *J. flava* (Thode A1753)

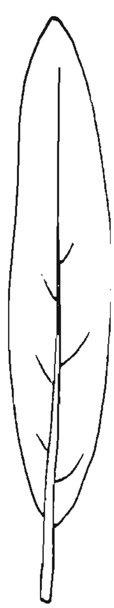
Species No. 9 a & b (*J. protracta* subspp. *protracta* and subsp. *rhodesiana*) are not included because of the great variability of the former. See Fig. 3.



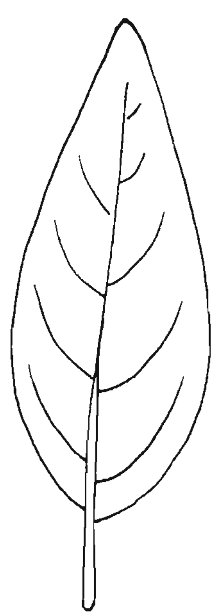
1.



2.

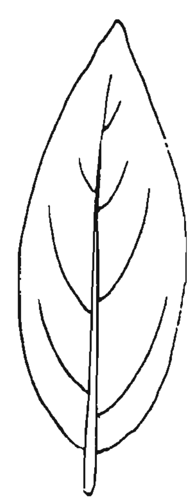


3.



4.

5.



6.

FIGURE 5

Leaves of species and subspecies of _Justicia_ and _Siphonoglossa_

(Average leaf taken, X 1. Number in brackets is the species number in text)

1 (7). _J. kirkiana_ (Vahmeijer & Steenkamp 3167)

2 (8a). _J. petiolaris_ subsp. _petiolaris_ (McMurtry 1532)

3 (8b). _J. petiolaris_ subsp. _bowiei_ (Immelman 363)

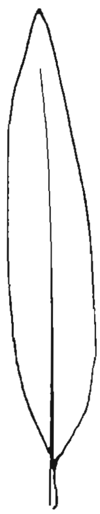
4 (8c). _J. petiolaris_ subsp. _incerta_ (Galpin 507 M)

5 (10). _J. parvibracteata_ (Esterhuysen 2354)

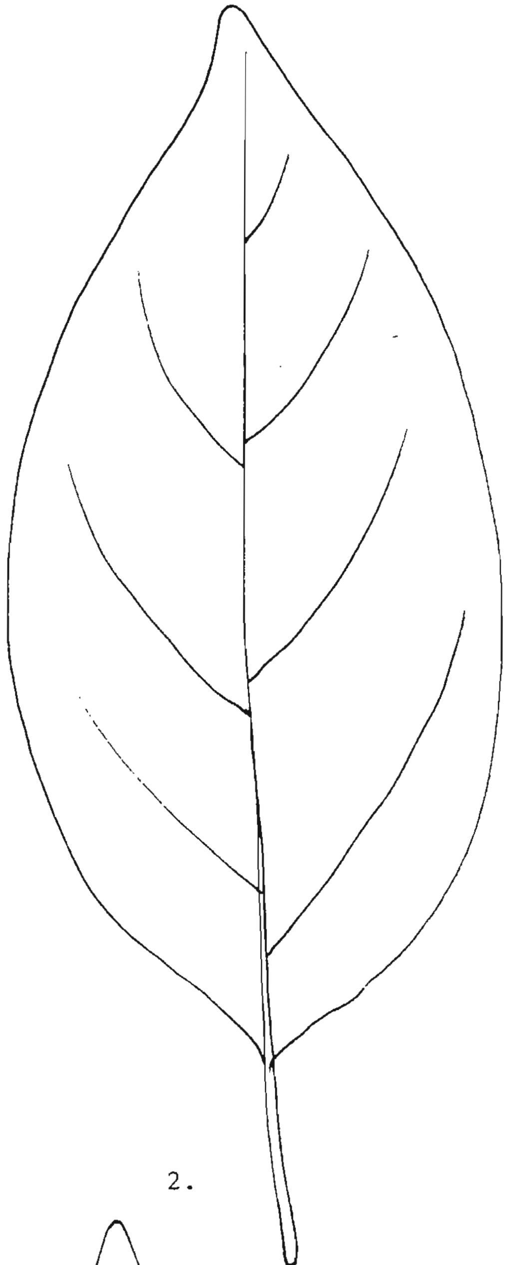
6 (11). _J. dinteri_ (De Winter & Leistner 5434)

7 (12). _J. odora_ (Leistner 3466)

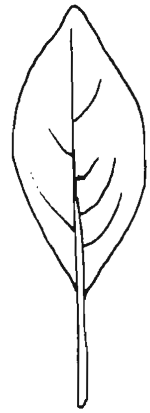
8 (13). _J. capensis_ (Immelman 180)



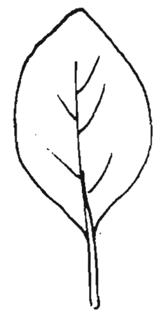
1.



2.

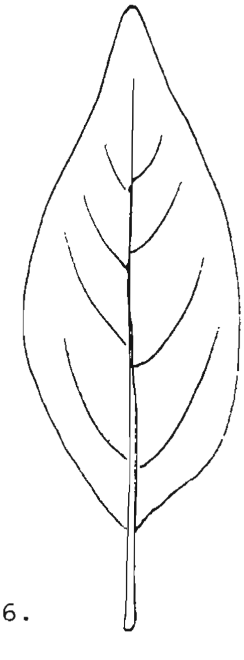


3.

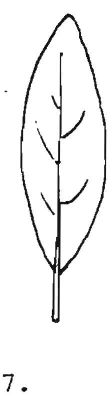


4.

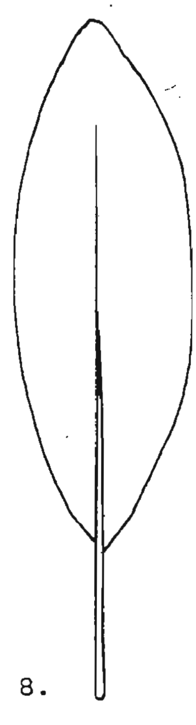
5.



6.



7.



8.

FIGURE 6

Leaves of species and subspecies of *Justicia* and *Siphonoglossa*

(Average leaf taken, X 1. Number in brackets is the species number in text)

1 (14 a, b, c). *J. cuneata* (3 subspp.)(Bayliss BRI.B 569)

2 (15 a, b). *J. orchioides* (2 subspp.)(Acocks 189)

3 (16). *J. thymifolia* (Bryant 1092)

4 (17). *J. guerkeana* (Merxmuller & Giess 1235)

5 (18). *J. platysepala* (Immelman 444)

6 (19). *J. mimima* (Van Wyk 5536)

7 (20). *J. anagalloides* (Balsinhas 2893)

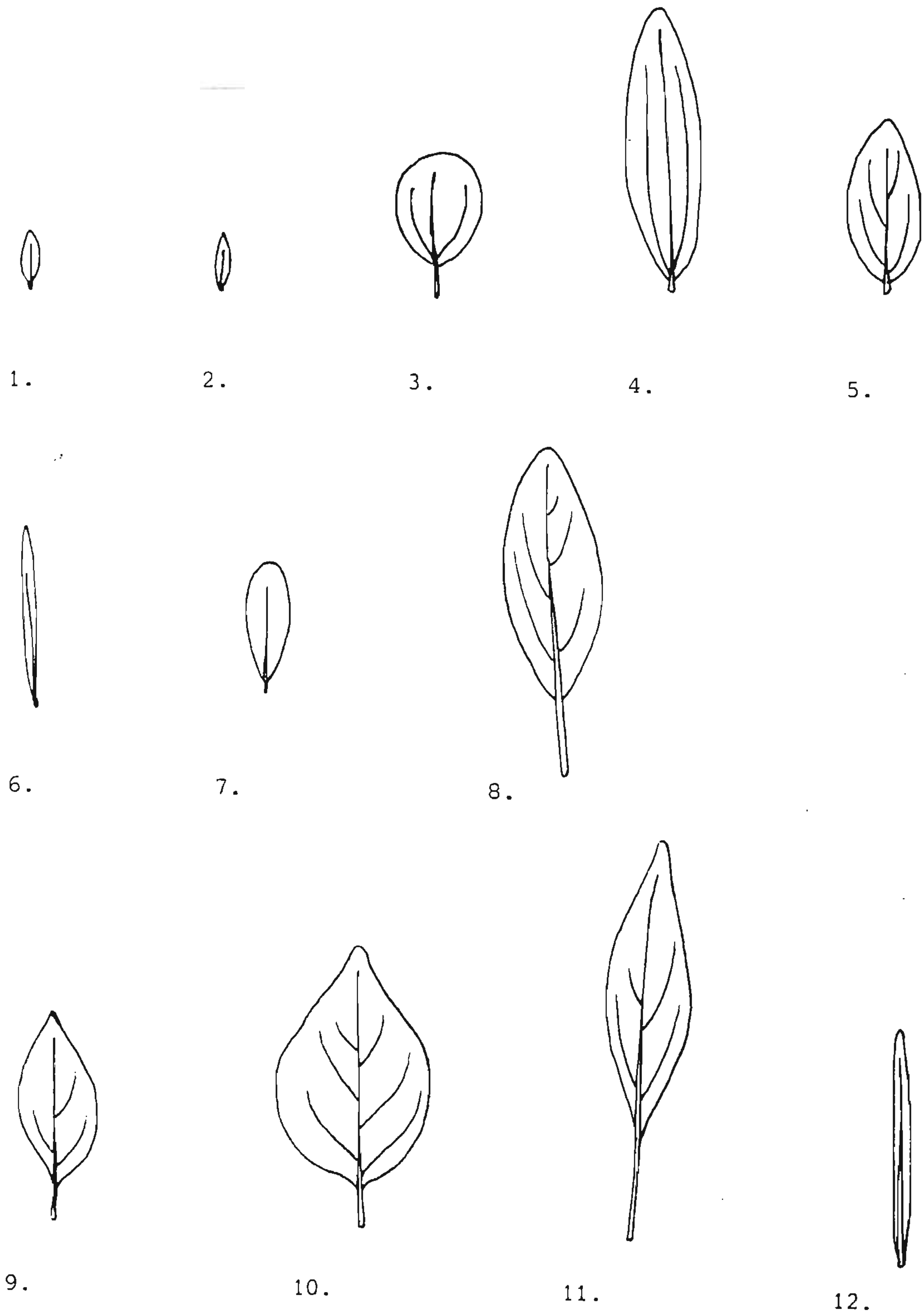
8 (22). *J. anselliana* (Codd 6593)

9 (1a). *Siphonoglossa leptantha* subsp. *leptantha* (Acocks 13639)

10 (1b). *S. leptantha* subsp. *late-ovata* (Botha 2245)

11 (2). *S. nkandlaensis* (Venter 3486)

12 (3). *S. linifolia* (Clarke 38)


1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

3.3 INDUMENTUM

Studies of the indumentum have been included in many significant taxonomic studies of the Acanthaceae over the past two decades.

Probably the most detailed of the studies done of indumentum in the family as a whole were those of Ahmad (1974 a, b, 1978) who argued, on the basis of hair types present, for the retention of Mendoniciaceae, Nelsonioideae and Thunbergiaceae in the Acanthaceae. He examined 109 species in 39 genera, and found that both Thunbergiaceae and Nelsonioideae have panduriform sessile glands, which were not present either in Scrophulariaceae or in the rest of the Acanthaceae. Mendonciaceae had sessile glandular hairs similar to the rest of the Acanthaceae. Stalked glands, he stated, were rare, and were seen in only nine of the 109 species. Eglandular hairs were found in some species of each of the four subfamilies/families, but Ahmad stated that they differ widely from species to species, and claimed they are either species- or genus-specific.

De (1967) gave an account of, amongst other things, the hairs of the Acanthaceae. Hers was a very restricted view of the family, based on ten species from the Acanthaceae, only one of which was a member of the Justicieae (Beleperone guttata). This account included descriptions of the eglandular hairs, which she found to be two- to seven-celled, and the glandular hairs, which had two- to four-celled shafts and heads with one to seventeen cells. She did not see the anvil-shaped hairs described in Munday (1980).

Munday (1980) examined in detail the southern African species of Monechma (Justicieae), describing the various types of trichome present in the genus. These, she stated, were important in identifying species, and were used extensively for this purpose in the key. Many of the same hair types occur in Justicia, and the terminology proposed by Munday has been largely followed in this study, though with fewer categories recognised.

In the present study, the indumentum was examined, and the variety of hair types classified and assessed for taxonomic and ecological significance.

METHODS

Material was selected from one specimen of each taxon recognised for examination under the SEM. Where fresh material was available this was critical-point dried as described below. This is preferable to using dried material as the hairs, especially glandular hairs, are not collapsed and their structure can be more accurately observed.

The upper and lower surface of leaf, outer and inner surface of calyx as well as the outer surface of the bract and the leaf base/petiole junction were scanned. Approximately 2X3 mm3 of leaf tissue (and also of the bracts where these were large) were removed from herbarium sheets. These were mounted directly onto 15 mm diameter aluminium stubs with double-sided 3M Scotchtape and glow-discharge-coated with c. 400 A° of metallic gold in an Eiko sputter coater. They were then viewed directly in an MSM 4 Hitachi-Akashi (desk top model) SEM at kv 15, and photographed using a Mamiya 6X7 camera and Ilford FP 4 125 ASA film. The film was developed in Microdol X.

Where fresh material was available, it was dehydrated in 2,2-dimethoxypropane (DMP) fixed in FAA, and critical-point dried in a Balzer's Union critical-point drier using liquid carbon dioxide. It was then mounted, viewed and photographed as described above.

Hair types were defined and named according to the terminology used by Munday (1980). Presence or absence of the different types was recorded for the different organs mentioned above (see Table 8). Plates were prepared illustrating the range of hair types seen (see figures 7 and 8).

RESULTS

Hair types

Two basic types have been found - eglandular (Table 8, type A; and Figure 7) and glandular (Table 8, types B and C; and Figure 8).

1. EGLANDULAR TRICHOMES

Eglandular hairs are of various lengths and consist of two to many cells variously arranged, these being with or without ornamentation.

A. Straight (long or short) or anvil-shaped hairs (Figure 7: 1, 2, 4 - 13)

In some species, e.g. *J. parvibracteata* Immelman, the hairs have only two cells. In other species where additional cells are present, they may be one to many and are narrower than the basal cell. The cells may be set at an angle to each other, so that the hair is appressed to the surface of the leaf or other organ. The basal cell is thicker, often not ornamented, and set into the epidermis. It may be surrounded by a ring of swollen epidermal cells (e.g. *J. protracta* - Figure 7:6). The cell above it is broadly cylindrical. Where the hair is anvil-shaped, it is usually this second cell which is set at an angle to the basal cell. The terminal cell is usually pointed but in *J. cuneata* subsp. *hoerleiniana* it is swollen, with one end rounded and the other pointed (Figure 7:10, 11). This may or may not be ornamented (Figures 7:12 and 13 respectively). Rarely, a branched hair may be encountered, as in J. capensis (Figure 7:5).

The cells of the upper tiers are usually ornamented, except in those hairs found on the inside of the calyx lobes. The ornamentation is striate to papillose, but these types intergrade and so no attempt has been made to draw a distinction between them. The area on either side of the joint between two cells is smooth and non-ornamented except for a ring of vertical striations. In J. glabra, in addition to the short layer of eglandular hairs, there is a distinct upper layer of longer hairs, also eglandular. This is not here considered a specific hair type, though it is characteristic of this one species. (Figure 7:3).

2. GLANDULAR TRICHOMES

B. Peltate glands (Figure 8:5, 6, 11)

A solitary basal cell is present, and is set as a wedge into the epidermis. The head is broad and flattened, and is probably four-celled. No sections were cut to confirm this, but the head is marked with two lines at right angles (probably cell walls, Figure 8:5, 6). The top of the head is sometimes marked with a faint ring where the lines cross. In J. anagalloides (Figure 8:11) each cell of the head has a single papilla on the outer edge, and this is unique for this species among the species of Justicia seen in this study.

C. Shafted glands (Figure 8:1-4, 7-10)

The basal cell of shafted glands is similar to that of the peltate glands.

The shaft may be of various lengths and numbers of cells, and is not ornamented. It may become very long due, largely, to increase in the length of the cells.

Below the head there is always a collar cell, which is shortly cylindrical and narrower than the rest of the shaft.

The glandular heads are of various types, and are often species-specific. The head is often longitudinally faintly striate (cell walls). It may be the same width as the shaft and longer than wide (Figure 8:7) or much wider than the shaft and wider than long (pin-shaped glands) (Figure 8:1).

The number of cells in the head is uncertain, as no sections have been cut, but accounts in the literature refer to there being from 1 - 17 cells.

DISCUSSION

TAXONOMIC IMPORTANCE OF INDUMENTUM QUALITY IN JUSTICIA

A wide range of indumentum types has been found in *Justicia*, both glandular and eglandular. The use of these in delimiting the Acanthaceae or deciding how to place it among other families of the Tubiflorae is likely to be limited. For instance, Visser (1981) shows an electron micrograph of an anvil-shaped hair in *Alectra* (Scrophulariaceae) of the same kind, and ornamented in the same way, as seen here in *Justicia* and *Siphonoglossa*, and also observed in *Monechma* by Munday (1980).

Within the Acanthaceae s.l., certain specialised aspects may prove more rewarding, e.g. the panduriform glands of Thunbergiaceae and Nelsonioideae (Ahmad 1974 a, 1975) or the hair bases of the Mendonciaceae (Rizzini 1949) if these prove constant in these groups.

Within *Justicia* itself, and the related genera *Siphonoglossa* and *Monechma*, the delimitation of sections on the basis of hair types present, or of indumentum as a whole, does not at this stage appear possible. Munday (1980) did not attempt to divide *Monechma* into sections, but did use indumentum extensively in defining and distinguishing species. Some of the hair types she found in *Monechma* are very rare or absent altogether from those species of *Justicia* and *Siphonoglossa* seen in this study. These types are glandular papillae with the tip not wider than the shaft, T-shaped eglandular trichomes, flattened uniseriate eglandular trichomes, and dendroid trichomes. However, as none of these were present in all species of *Monechma*, they cannot be used to distinguish it as a genus from *Justicia*.

At species and subspecies level, however, the trichomes in *Justicia* supply many useful characters, and are sometimes characteristic of individual species. Many species or subspecies, such as *J. parvibracteata*, are puberulous, with short, dense indumentum when seen under the dissecting microscope. *J. cuneata* subsp. *hoerleiniana* has broad-headed, anvil-shaped hairs unlike any of the other southern African species in the genus. In *J. glabra*, the eglandular hairs are in two distinct layers, one layer being much longer than the other. Both *J. kirkiana* (Figure 7:3) and *J. dinteri* (Figure 7:4) have very long-shafted glands on the bracts, which give the bracts a cottony appearance.

Many subspecies or closely related pairs of species are most easily distinguished by means of the difference in indumentum, and in some cases this may be the only difference. One instance of this is *J. orchioides* subsp. *orchioides* which has stiff opaque white hairs as opposed to subsp. *glabrata* which either has papillae or is glabrous. *J. cuneata* subsp. *cuneata* is glabrous except on the stems and inside of the calyx lobes, while subsp.

latifolia is densely puberulous on all parts. The third subspecies, subsp. *hoerleiniana*, is also distinguished by means of the indumentum type, as it has a dense covering of broad-headed anvil-shaped hairs. *J. protracta* subsp. *protracta* has long to medium-length multicellular hairs, while in subsp. *rhodesiana* the whole plant is densely puberulous with short, two-celled hairs. These two types of hair are essentially the same, being of type A, but differ consistently in length and number of cells.

In the above cases, the pubescence is the only reliable means of distinguishing the taxa (although there is also geographical separation) and they are therefore recognised only at subspecific rank. There are, however, two cases among the southern African species of *Justicia* where pubescence is the most easily-used character, but where differences in other characters also exist, making it appear reasonable to maintain the taxa at specific rank. *J. platysepala* has leaves with sparse to dense pubescence, while the probably closely related *J. guerkeana* is completely glabrous. In *J. guerkeana* the leaves are also three-veined from the base and there is a difference in distribution. *J. parvibracteata* is considered to be closely related to *J. protracta*. However, as well as the densely puberulous indumentum, which is the same as found in *J. protracta* subsp. *rhodesiana*, the bract is reduced, and the whole plant is smaller and less floriferous than is found in either subspecies of *J. protracta*. In the key, though, the puberulous indumentum provides the easiest means of distinguishing the species from *J. protracta* subsp. *protracta*.

ADAPTIVE IMPORTANCE

Some interesting species-specific patterns were found within *Justicia* which may relate to ecology. A number of probably closely related pairs of species/subspecies are found where one occurs in more arid environment that the other, and where corresponding changes in pubescence are also encountered. (See Chapter 3)

In some cases the indumentum is reduced or even lacking (except for the sessile glands)(see Table 8). Thus *J. orchioides* subsp. *glabrata* from the Karoo is glabrous, one of the few such species of *Justicia* in southern Africa.

Some species from arid or semi-arid areas show a well-developed pubescence, e.g. *J. cuneata* subsp. *hoerleiniana* (Namibian coast) and *J. guerkeana* (southern Namibia). *J. dinteri* and *J. anselliana*, which are pubescent, may also occur in arid areas (Namibia, Botswana and the N. Transvaal), but as they are annuals they escape the worst effects of aridity, and so are not considered here.

Some species have, most noticeably, an dense indumentum in which the hairs are shorter and more heavily ornamented than species in moister areas. J. cuneata subsp. cuneata (W. Karoo), J. protracta subsp. rhodesiana (Namibia, Botswana, N. Transvaal, Zimbabwe), J. parvibracteata (N. Cape) and J. montis-salinarum (Soutpansberg) have all parts minutely puberulous. This can easily be seen under a dissecting microscope. When the hairs are examined under the SEM, they are seen to be reduced to two cells, with the upper cell at an angle to the basal cell, and both cells are strongly ornamented. These papillae are noticeably denser and more projecting than in other species of the genus.

Johnson: 240 (1975), after reviewing the evidence for the presence and density of pubescence in areas of different moisture stress, concludes that "It thus seems clear that ecogeographic relationships of pubescence must involve factors in addition of moisture". It is even possible, he suggests, that the presence of hairs increases the rate of transpiration, and that their function may rather be to act as a light shield in areas of intense radiation. Uphof (1962) makes a similar suggestion, though he stresses that experimental proof is lacking. The bent shape and heavier ornamentation of hairs of some species would seem to add to the effectiveness of such hairs as light shields. Uphof states, "According to Boumert (1907) and to Staudermann (1924: 160), the faculty to function as a screen against the light would depend on the presence of a large number of light-dispersing centres. The latter may be present in the form of knobs on the cell-wall or on the cuticle only or in that of more or less sharp bends in the hairs."

This is a possible explanation for the predominance of short dense pubescence, with bent hairs having heavy ornamentation, in many of those species of Justicia occuring in arid or semi-arid areas. Monechma was found by Munday (1980) to have many species with puberulous leaves, especially those occuring in the southern part of Namibia. This is not always the case however, and in Justicia also there are exceptions, as in J. orchioides subsp. glabrata mentioned above.

In Justicia, three taxa have dense to moderately dense long pubescence. Two of these (J. dinteri and J. anselliana) are annuals, and so, as stated earlier, probably escape the full effects of aridity. Their seeds only germinate after there has been sufficient rain. The third species is J. cuneata subsp. hoerleiniana, a woody shrub from the Namib. Here the hairs are long and dense, but it is possible that the swollen heads of the hairs are even more effective in preventing excessive radiation from reaching the leaf surface than are the adaptations discussed above. This type of indumentum is unique in Justicia, and J. cuneata subsp. hoerleiniana occurs in the most arid environment of any species of the genus.

Indumentum characters, therefore, have proved taxonomically useful in many instances and have an important role in adaptations to aridity.

Table 8: Indumentum types in taxa of Justicia and Siphonoglossa

	Lf. base	Lf. lamina	Bract	Calyx (outer)	Calyx (inner)
J. glabra	A B C	A B	A	-	A C
J. campylostemon	A B C	C	A B	A B	C
J. bolusii	A B	-	-	-	-
J. betonica	B C	B	B C	A	A C
J. montis-salinarum	A B	A	A B	A B	A B
J. flava	A B C	A B	A B C	A - C	A B C
J. kirkiana	A B C	A B C	A B C	A B C	A B C
J. petiolaris subspp.	B C	B C	B C	A B C	A B C
J. minima	A B	A B	A B	A B	A B
J. protracta s. protracta	A B C	A B	A C	A B	A C
s. rhodesiana	A C	A C	A C	A	A C
J. parvibracteata	A C	A C	A C	A	A C
J. dinteri	A C	A C	A C	A C	A C
J. capensis	A B C	A B C	A B C	A B C	A B C
J. cuneata s. cuneata	A B	B	A B	-	A C
s. glabrata	A	A	A	?	A C
s. hoerleiniana	A	A	A	A	?
J. odora	A B	B	B	A	A B
J. orchioides s. orchioides	A C	-	A	A	A
s. latifolia	A	A	A	A	A
J. thymifolia	A	A	A	A	A ?B
J. platysepala	A	A	A	A	A B
J. guerkeana	A B C	A B ?C	A B	A B	A B
J. anselliana	A	A	A	A	A B
J. anagalloides	A B	A B	A B	A B	A C
S. leptantha, subspp.	A B C	A B C	A B C	A B C	A C
S. nkandlaensis					
S. linifolia					

Key to indumentum types: A = Eglandular hairs
B = Sessile glands
C = Stalked glands

FIGURE 7: INDUMENTUM OF *JUSTICIA* SPECIES: EGLANDULAR TRICHOMES (TYPE A)

1. *J. cuneata* subsp. *latifolia*
2. *J. cuneata* subsp. *latifolia*
3. *J. kirkiana*
4. *J. dinteri*
5. *J. capensis*
6. *J. protracta* subsp. *protracta*
7. *J. capensis*
8. *J. guerkeana*
9. *J. cuneata* subsp. *cuneata*
10. *J. cuneata* subsp. *hoerleiniana*
11. *J. cuneata* subsp. *hoerleiniana*
12. *J. cuneata* subsp. *hoerleiniana*
13. *J. cuneata* subsp. *hoerleiniana*
14. *J. glabra*
15. *J. minima*

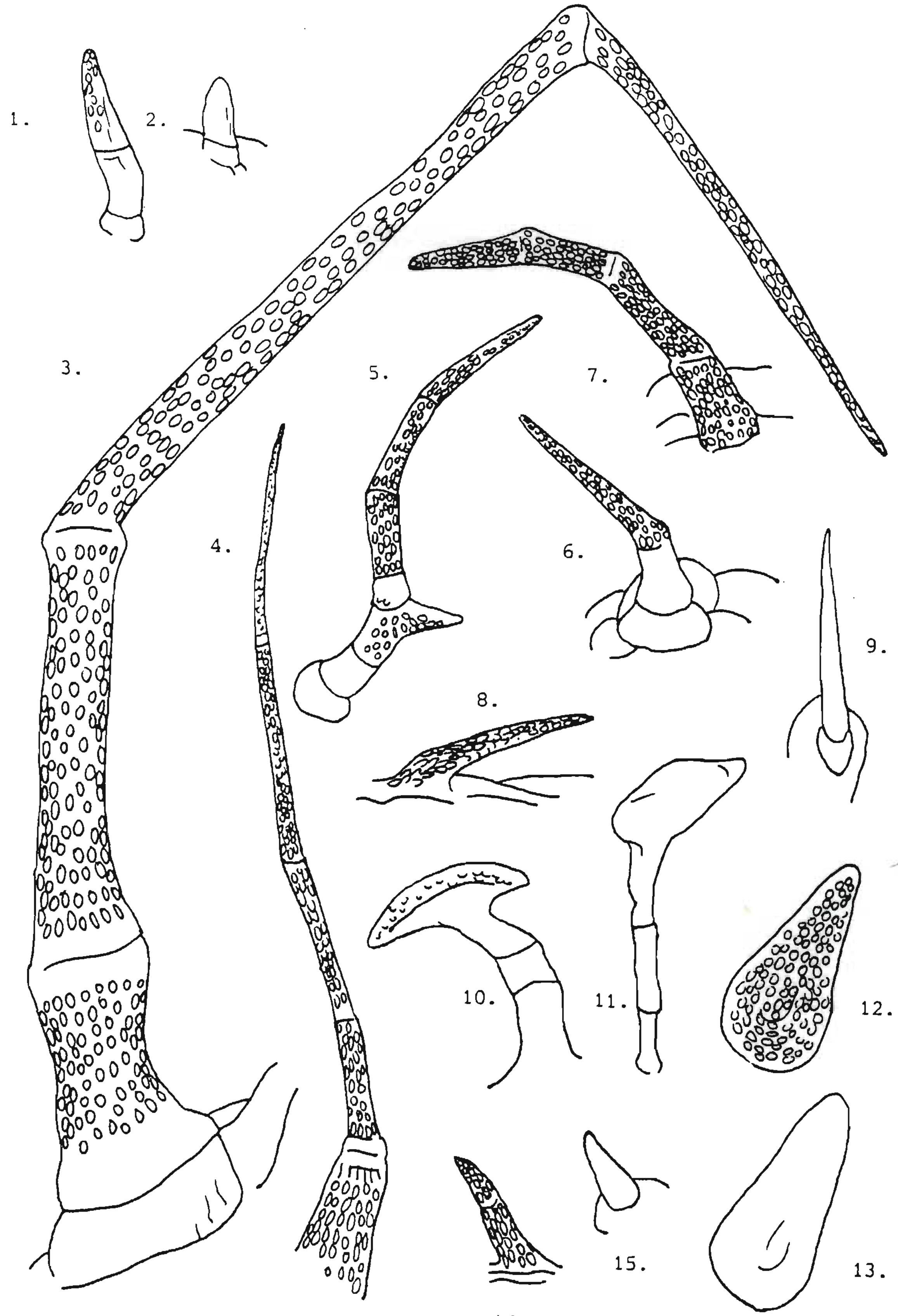
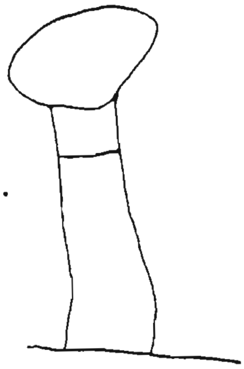

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.

FIGURE 8 - INDUMENTUM OF *JUSTICIA* SPECIES: GLANDULAR TRICHOMES

1. *J. glabra* - type C
2. *J. campylostemon* - type C
3. *J. betonica* - type C
4. *J. betonica* - type C
5. *J. flava* - type B
6. *J. flava* - type B
7. *J. petiolaris* - type C
8. *J. flava* - type C
9. *J. flava* - type C
10. *J. protracta* - type C
11. *J. anagalloides* - type B

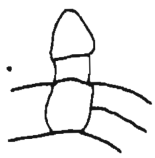
1.



2.

3.

4.

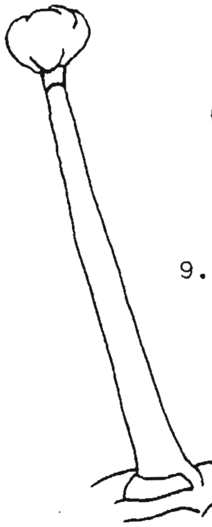


5.

6.

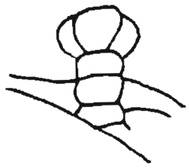
7.

8.

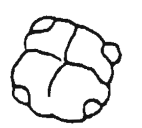


9.

10.



11.



3.4 INFLORESCENCE AND BRACTS

Various studies in the Acanthaceae have confirmed the value of inflorescence characters in identification of species. The ancestral inflorescence in the family is believed to be a dichasial cyme of bracteate flowers with paired bracteoles (Bremekamp, 1944). Nevertheless it was necessary to review inflorescence structure in all the southern African species of Justicia and Siphonoglossa before assessing the taxonomic value of this character.

Baden (1981 a) revised the genus Macrorungia (Justicieae sensu Clarke, 1912) and considered the length of the spike to be important in distinguishing the species. He did not discuss whether the inflorescence was a true spike or not. The presence of bracts and bracteoles subtending each flower was noted. In his studies (1981 b) on Anisotes, he interpreted the many varied inflorescence types in this genus as derived from an "hypothetical ancestral thyrse".

Balkwill & Getliffe Norris (1985) in their study of Hypoestes, and Manning & Getliffe Norris (1985) in their revision of Duvernoia and Adhatoda, followed Bremekamp's hypothesis.

In Justicia itself, limited attention was given in earlier accounts to inflorescence structure, and C.B. Clarke (1912), though he based his five sections of Justicia mainly on characters of inflorescence and bracts, described the appearance rather than the structure of the inflorescence. The inadequate terminology makes his key difficult to use: for instance he described the inflorescences as being "spikes" or "solitary axillary flowers". Because this does not adequately describe inflorescence structure it also makes it difficult to fit newly described species into his sections. However, when his use of the terms is understood, the key works well, and his sections are by and large natural.

METHODS

The inflorescence of each species of Justicia and Siphonoglossa was rehydrated in boiling water and dissected, and the number and position of flowers and bracts was noted, as well as the relative sizes of the bracts. Where fresh material was available, this was dissected in preference to dried, as it was easier to handle. Diagrams were prepared (see Figure 9) for each type of inflorescence or synflorescence.

RESULTS AND DISCUSSION

Investigations into the inflorescences of Justicia and Siphonoglossa in southern Africa support the theory that the basic inflorescence type of the Acanthaceae is a dichasial cyme.

The wide variety of inflorescences met with in these genera can all be derived from this basic unit (Figure 9:1). It is considered probable that the inflorescence as seen in J. campylostemon (Figure 9.1) and J. glabra is the primitive state for the genus Justicia, with a branching "racemose" arrangement of dichasial cymes having numerous flowers each subtended by two bracteoles. A pair of bracts (2° bracts) subtends each branch of the cyme. The flowers may be sessile or pedicellate, and the cymes are pedunculate with an elongated axis. There are two cymes at each node on the axis. In other sections of the genus there is a progressive reduction in the number of flowers per cyme and in the length of pedicels or peduncles or both. One cyme of the pair may be lost from each node, the 2° and 3° bracts may be reduced or entirely lost, and the cymes may be secondarily aggregated into a terminal, spike-like synflorescence. The axis of this synflorescence may also be somewhat condensed.

Reduction in number of flowers

This has taken place progressively, as can be seen in (Figure 9), the extreme state being that of J. orchioides (Figure 9:5) where the entire cyme is reduced to a single pedunculate flower with two bracteoles.

The most common condition is a cyme consisting of three to five sessile flowers, the cyme itself being sessile or subsessile in the leaf axil (Figure 9:3, deliberately drawn more lax than is actually the case). This condition is seen in such species as J. protracta and J. capensis. The number of flowers in the inflorescence as a whole may then be secondarily increased by aggregation of these cymes at the ends of branches, concomitant with reduction of the subtending primary bracts to form a spike-like, terminal synflorescence.

This state is found in, for instance, J. petiolaris subsp. petiolaris, (Figure 9:4), while its other two subspecies, subspp. incerta and bowiei, show an intermediate condition. The transition between scattered axillary cymes and a dense terminal synflorescence can clearly be seen in these two subspecies, where the apex of the "spike" is dense, with crowded cymes and reduced subtending bracts, whereas towards the base the cymes are more clearly separated and are subtended by large leaflike bracts.

Some species appear to have true terminal spikes, e.g. J. betonica and J. montis-salinarum. However, it is also probable that the apparent spike, is as in the above case, is the result of reduction in number of flowers in the cymes together with condensation of the terminal nodes. This is borne out by the fact that, under the ideal conditions of cultivation, plants of J. betonica may produce a few two to three-flowered cymes at the lower nodes of the inflorescence instead of single flowers, thus indicating that the apparently solitary axillary flowers are actually much-reduced sessile cymes.

Reduction in number of inflorescences at each node

In most species, even those that have undergone great reduction in the number of flowers and the length of the peduncles, there are two cymes at each node, one on either side of the floral axis. Each is subtended by a primary bract (often reduced) However, in some species, one cyme of each pair has been lost. In at least one species, J. anagalloides, the single-cyme state can be seen to be derived. Normally plants of this species have a single pedunculate lax cyme per node but, in cultivation, they often produce a second cyme on the opposite side of the axis. Specimens showing this condition have been preserved at PRE (Immelman 610). The other southern African species in its section, J. anselliana, regularly produces two cymes per node.

Reduction in size or number of bracts

In Justicia the trend is for the bracts to be reduced in number and size. This is seen within the sections rather than between the sections, and cannot be used to establish relative levels of advancement of the sections themselves. For instance, in sect. Gendarussa the 2° and 3° bracts are reduced, though the pollen and inflorescence are primitive.

In all cases the inflorescence is situated in the axil of a leaf (primary bract) which, when the inflorescences are modified or reduced, may be itself reduced or differ in colour or shape from the normal leaves. In at least some species the bracts may take over the function of display from the flowers. In sect. Justicia the inflorescences are aggregated into terminal synflorescences. In section Gendarussa, J. betonica has both primary and 2° bracts large, imbricate and pale in colour with conspicuous dark green veining. The other species in the section, J. montis-salinarum, has the bracts so reduced that the terminal synflorescence looks superficially like a terminal spike. In J. betonica, the bracts are far more conspicuous than the small white flowers. In sect. Rostellularia (Reichb.f.) C.B. Cl., which also has a terminal synfloresence of aggregated reduced cymes, the bracts are reduced in size and not conspicously coloured but the flowers are large and brightly coloured, being either yellow or mauve-blue.

In sect. Orchioides Immelman it is possible to see a similar trend. Here there are two species with large conspicous bracts and medium sized white flowers (J. guerkeana and J. platysepala). The bracts are broad, with pale membranous margins and apiculate, often recurved apices. The other two species in the section, J. orchioides and J. thymifolia have inconspicuous small bracts, but J. thymifolia has large flowers, which at 20 - 30 mm long are the longest in the genus in southern Africa. J. orchoides, however, has both small bracts and medium sized flowers, the flowers being 4 - 10 mm long.

The general trend, however, in the genus, is towards reduction of the bracts. In some species, e.g. J. protracta, the 3° bracts may be reduced to minute triangles of tissue at the base of each flower, and this is also the case in all three species of Siphonoglossa, which, on other grounds, could be considered to be derived from some species of the section to which J. protracta belongs (sect. Harnieria (Solms-Laub.) Hook. f.). Another species which is probably derived from J. protracta, and which shows a further stage in reduction of the bracts, is J. parvibracteata. Here both the 2° and 3° bracts are reduced to minute triangles of tissue.

In some cases one of the orders of bracts may be entirely missing, as in J. cuneata and J. orchioides. In this case it is not certain whether the remaining bracts are 2° or 3°.

Taxonomic value of bracts

A number of species (here all included in J. betonica) were distinguished by C.B. Clarke (1912) on the basis of (among other characters) bract width. However, this varies greatly, forming a continuous range. It seems to correlate approximately with leaf width, which is also highly variable, and is possibly determined by the same genetic or ecological factors. Nevertheless, there are cases where characters of the bracts are very useful in identifying species. J. betonica has imbricate bracts (at least when the inflorescence is young) and the bracts are veined with dark green unlike those of any other species in the region. J. platysepala and J. guerkeana have ovate 2° bracts with membranous margins and apiculate recurved apices. In sect. Rostellularia all the bracts are lanceolate or oblanceolate, usually acute, and glandular-pubescent. In sect. Harnieria the 2° bracts are similar to the leaves in shape, but reduced in size.

In contrast to the findings of Munday (1980) in Monechma, the pubescence of the bracts is not generally useful in Justicia and Siphonoglossa for identification of species. There are three species where this could be of use however: J. glabra, which has a double layer of eglandular hairs on bracts and petioles, and J. kirkiana and J. dinteri where there are long-shafted glands on the bracts as well as other parts of the plant.

Figure 9

Diagrams of inflorescence types in species of *Justicia* in southern Africa.

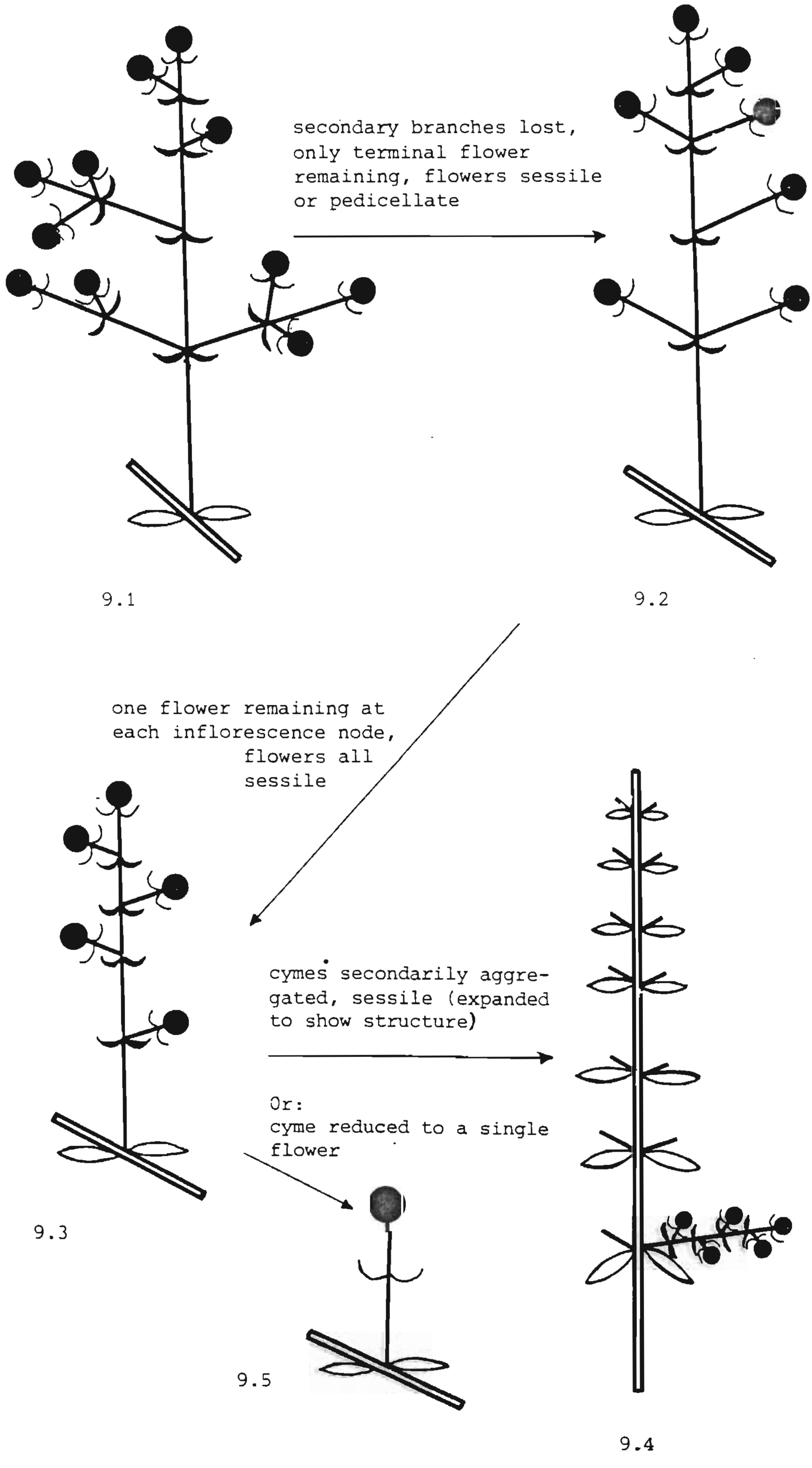
9.1 *J. campylostemon*

9.2 *J. bolusii*

9.3 *J. protracta*

9.4 *J. petiolaris* subsp. *petiolaris*

9.5 *J. cuneata*


secondary branches lost, only terminal flower remaining, flowers sessile or pedicellate
9.1
9.2
one flower remaining at each inflorescence node, flowers all sessile
cymes secondarily aggregated, sessile (expanded to show structure)
Or:
cyme reduced to a single flower
9.3
9.5
9.4

3.5 FLOWERS

Various flower characters have been used in distingushing tribes, genera, sections and species in the Justicieae. Anderson (1867) used a number of flower characters in distinguishing his subtribe Eu-Justicieae, as well as Justicia. In delimiting sections, Bentham (1876) used, among others, characters of the anther and calyx. Lindau (1895) did not make much use of flower characters, though anthers were important in delimiting the three subgenera of Justicia, and he did use the presence or absence of a hooded upper lip of the corolla to distinguish between Justicia sect. Vasica and Justicia sect. Amphiscopia. C.B. Clarke (1912) used the anthers, corolla length and proportions of corolla tube to lip to distinguish a number of genera in subtribe Justicieae.

More recently, Baden considered a number of characters of calyx and corolla important in distinguishing species in Macrorungia (1981 a) and Anisotes (1981 b). Hansen (1985) also used the calyx and corolla to distinguish a number of the species of Isoglossa in S.E. Asia. Balkwill & Getliffe Norris (1985) pointed out that the resupination of the corolla has long been considered characteristic of Hypoestes, Peristrophe and Dicliptera, and considered the shape of the "lower" lip to be species-specific in Hypoestes. In one species (H. aristata (Vahl) Roem. & Schult.) a new variety was described on the basis of corolla colour. Manning & Getliffe Norris (1985), in their reappraisal of the genera Adhatoda and Duvernoia, pointed out the clear differences in calyx lobing between the two genera. The shape and venation of the upper lip of the corolla, and details of the palate on the lower lip, were studied and, in some cases (e.g. A. maculata) the palate and venation were considered species-specific.

METHODS AND MATERIALS

Specimens of Justicia and Siphonoglossa from all major and a number of minor herbaria in southern Africa were borrowed, and the following flower characters noted (on the dry flowers):

1. shape of tube and lips

2. length and ratio of tube and lower lips, and width of tube (in Siphonoglossa only). The total length of the corolla was also measured, taken from the base of the tube to the apex of the upper lip.

3. flower colour and markings

4. shape of anther locules, including spurs at the base of the lower locule.

5. pubescence on calyx and number of calyx lobes.

Material of at least one species of each section of _Justicia_, and of _Siphonoglossa leptantha_ subsp. _leptantha_, was grown from cuttings or seeds of known provenance in the greenhouse at Botanical Research Institute, Pretoria, and the movements of the anthers at anthesis noted.

RESULTS AND DISCUSSION

Shape of the tube and lips

Some species had a short broad tube with the upper lip hooded and the lower lip reflexed at an angle of greater than 90°, i.e. _J. cuneata_, _J. campylostemon_ (Figure 23) and _J. bolusii_ (Figure 24). All of these species occur in different sections of the genus, and it is possible that the hooded flower has arisen independently in these sections, as well as in other genera of the Acanthaceae, e.g. _Adhatoda_ and _Duvernoia_. It is also possible that a hooded upper lip is ancestral in _Justicia_, or in the Justiciineae, to which _Justicia_, _Siphonoglossa_, _Adhatoda_ and _Duvernoia_ all belong.

Within the sections of _Justicia_ there are different shapes of upper lip found, e.g. _J. glabra_ and _J. campylostemon_. In _J. campylostemon_ the flowers are hooded, but _J. glabra_ has shortly tubular flowers with a relatively straight upper lip. This difference in flower shape is also important in distinguishing _J. cuneata_, with hooded flowers, from _J. orchioides_, which has a more tubular, non-hooded flower. These two species have been much mixed in herbaria, due to the unreliable characters that were used to separate them by Clarke (1912).

The long-tubed type of flower, like the hooded flower, has probably also arisen independently in different genera. _J. thymifolia_ has a very long, tubular flower, but is not placed in _Siphonoglossa_, which also has long-tubed flowers, because its anthers are those of a _Justicia_ and the margocolpi of its pollen are entire, a condition not found in _Siphonoglossa_. In _Siphonoglossa_ the anther locules are elongated and mucronate, while in _J. thymifolia_ they are broadly ovate and the lower locule is spurred.

Flower length

In the southern African species of _Justicia_, flower length ranges from 3 mm (_J. anselliana_) to 33 mm (_J. thymifolia_), and in _Siphonoglossa_ from 13 mm to 45 mm. The total length of the flowers is often useful in distinguishing between species. In _J. cuneata_ the flowers, as well as having a different shape, are longer than those of _J. orchioides_, being 11-15 mm long rather than the 7-10 mm of _J. orchioides_.

Tube: lip ratio and tube width

S. leptantha has two subspecies with distinctive ranges correlated with a difference in tube dimensions. The south-western element, S. leptantha subsp. late-ovata has a shorter

lip: tube ratio ((0,3) 0,6-1,2) and a broader tube (1,5-2 mm) while the typical subspecies has a lip: tube ratio of 0,2-0,5 and a relatively narrow corolla tube (0,5-1,5 mm). S. leptantha subsp. late-ovata was originally described as a variety of Justicia pulegioides C.B. Cl. (= J. protracta) because of its short tube and relatively long lower lip. However, the anthers as described under (4) below, are characteristic of Siphonoglossa.

Flower colour and markings

Within southern Africa, the following flower colours and markings occur:

Sects. Gendarussa, Bolusia Immelman, Minima Immelman, Orchioides and Ansellia - cream or white, usually with reddish markings on the palate.

Sect. Harnieria - usually cream-white with reddish markings, but J. protracta subsp. protracta occasionally has light pink flowers with darker markings, J. capensis is always deep mauve, and J. odora is yellow. Siphonoglossa, which is here considered closely related to Justicia sect. Harnieria, also has cream-white flowers.

Sect. Rostellularia - the species have either yellow or mauve-blue to sky-blue flowers.

Flower markings are not used to distinguish species, but are nevertheless of interest. On the upper lip there may be a delicate pattern of darker veins. On the lower lip the usual pattern is of a mauve or reddish herringbone pattern of raised ridges on the palate. In J. flava, with yellow flowers, the lower lip has instead a dark brownish line along the centre of each lobe. One species of Siphonoglossa, S. linifolia, also has three broad, dark pink blotches on the lower lip, one along the centre of each lobe. The biological significance of the markings has not been determined, but they are probably guides for the honey bees, solitary bees and large wasps that have been observed gathering nectar from the various species.

Anthers

The anthers are of great importance in delimiting Justicia and distinguishing it from Siphonoglossa. In Siphonoglossa the anther thecae are elongated and relatively narrow, with pointed bases, and the anthers do not reflex as the flower ages. In Justicia, on the other hand, the thecae are broadly ovate, the lower theca nearly always has a long whitish spur, and the anthers are hercogamous, i.e. they reflex out of the way of the stigma as the flower ages. (Manning & Getliffe Norris, 1985; Immelman, 1984a, 1985). The flower in all species of Justicia in southern Africa is protandrous, with the filaments arching under the lower lip and the anthers adpressed just in front of the stigma. The style is held in place within a rugula. When the pollen has been shed, the filaments curve outwards and slightly downwards, removing the anthers from the vicinity of the stigma. This movement was not seen in Siphonoglossa.

All species seen of the two genera had spurred anthers, but J. campylostemon is an occasional exception, as a few specimens have been seen where the anthers are not spurred, but only mucronate. However, as this is variable within the species and other characters are typical for Justicia, it is not considered necessary to reconsider the generic position of the species.

Within each of the two genera, the anthers do not vary greatly, and so have not been used to distinguish sections and species.

Calyx

The calyx in all Justicia and Siphonoglossa species was deeply divided, with narrowly lanceolate, acute lobes. In all species except J. minima there were five lobes, but in this species there were only four, the adaxial (upper) lobe being absent. This character has been used in the key to species of Justicia. The pubescence of the calyx is in some cases species-specific, and is discussed in Ch. 5.

3.6 POLLEN

One of the first Angiosperm families to be investigated palynologically was the Acanthaceae, and it is also one of the families showing the most diversity in the characters of its pollen. The first person to look at Acanthaceous pollen was probably Bauer (1790-1840), who sketched pollen grains of Thunbergia alata, amongst others. It was Lindau in Engler & Prantl, though (1894) who first attempted to use the pollen in classifying the family.

A number of the studies of pollen in the Acanthaceae have been wide-ranging, taking a few representatives of selected genera. Bhaduri (1944) studied 30 species in 22 genera, covering the whole family. These included three species of Justicia, one of Dianthera and one of Adhatoda. The colpi he called "germinal furrows" and the colpoid streaks "harmemogathi". The three species of Justicia seen (J. gendarussa, J. betonica and J. procumbens) were all three-colporate, with entire margocolpi. He also mentioned the presence of "giant grains" in these three species, but did not describe them. In his discussion of phylogeny, which he deduced from these results, Bhauduri derived Justicia and Dianthera independantly from Dicliptera, while Adhatoda is kept as a separate genus not closely related to either.

The survey by Bhoj Raj (1961) was more comprehensive than the preceding, with an examination of 260 species in 103 genera, as well as 14 species of the Pedaliaceae. He made much use of the various characters of the sporoderm, and the presence or absence of the various layers. Twelve species of Justicia (two of which are now placed in Monechma), one of Adhatoda and one of Gendarussa were considered by him. The Justicia species were from Asia, the Canary Islands, South America and East Africa, and Bhoj Raj saw species with two and three colpi, and with areolate or entire margocolpi. He did not make any suggestion as to phylogeny.

Bremekamp (1965) split Acanthaceae into two subfamilies, Acanthoideae and Ruellioideae, on the basis of a number of characters, including pollen (See Table 6). The first, he considered, had mainly colpate pollen, while the Ruellioideae (which included Justicia) had colpate or porate grains. His tribe Justicieae he divided into three sutribes, also basing this on a number of characters. These subtribes were Odontoneminae, Rhytiglossinae and Justicinae (see Ch. 2.1 for more detailed discussion). The "typical representatives" of the subtribe Justiciinae have, according to Bremekamp, prolate, dorsiventrally flattened pollen, with the pore in the middle of a trema area which is studded with circular "insulae" (areolae).

Anima De (1968), in one of a series of papers on aspects of the

Acanthaceae, also looked at the pollen. However, only 22 species were selected from the whole of the family, of which three were in the Justicieae and none of these in Justicia itself. Despite this, she placed Justicia and Gendarussa in a separate subfamily (which she called a suborder) from Beloperone and Dianthera.

Petriella (1968) conducted a similar study on the Acanthaceae of the Argentine, including seven species of Justicia and one of Jacobinia. He came to the conclusion that it was possible to separate the various genera on pollen characters, and gave a key. All the Justicia species he reported as having two colpi while pollen of Siphonoglossa in the Argentine is apparently three-colporate with an entire margocolpus: quite different from the pollen of what in South Africa is called Siphonoglossa.

It is evident from these studies that broad surveys are inadequate and that detailed studies of all the species in a genus are needed before palynology can be used in the taxonomy of the family. The results of palynological investigations also need to be combined with work on other aspects of a genus and not used in isolation. In the last five or six years a number of such studies have been carried out.

Munday (1980) studied all the southern African species of Monechma. She found the pollen to be uniform in its grosser features, being lenticular, two-colporate, areolate and in the "medium" size range (25-50 um long). She suggested that characters of use in separating species might be found in the outline (shape) or size of the grains, in the nature of the colpus, and in the number, size and arrangement of the areolae, but specified that such an investigation would necessitate a larger sample than she was able to examine.

Baden (1981a), in revising Macrorungia, likewise found little variation within the genus. The pollen was two-porate, with or without an indication of colpi. The sexine was reticulate, and the trema area had four rows of areolae.

In Baden's revision of Anisotes (1981b) he found that "the pollen morphology is considered of high taxonomic importance at both inter- and infra-generic level. The size, the numbers of the pores and the morphology of the trema area can be used in specific delimination." He gave a key to species based on pollen characters and used pollen to characterise his monospecific section Tetrapori, comprising the one species with tetraporate pollen. Pollen was also used by him to distinguish sect. Macrophylli (two-porate) from sect. Spiciflori (three-porate).

Balkwill & Getliffe Norris (1984), in revising Hypoestes, also investigated the pollen of the genus. It was found to be essentially similar to that of J. campylostemon and J. glabra, both in appearance and size, being three-colporate with entire margocolpi, and also in the "medium" size range, i.e. 40-53 um long.

Manning & Getliffe Norris (1985) re-evaluated both the generic limits and the value of various taxonomic characters (including pollen) in Duvernoia and Adhatoda. Some species of Justicia were included. Duvernoia was found to have consistently two-colporate pollen with entire margocolpi. Adhatoda though, had two different pollen types: the southern African and two tropical African species had three-colporate pollen with entire margocolpi, while three tropical species investigated had two-colporate, areolate pollen. These three species are also distinguished by having pedunculate, strobilate inflorescences with large imbricate bracts and showy flowers. They did not suggest that the genus be divided along these lines, however.

In this study all southern African species and subspecies of Justicia and Siphonoglossa have been investigated, the pollen viewed under the SEM, and the results used in conjunction with other characters to suggest a possible division of the genus into sections.

METHODS AND MATERIALS

Material was obtained from three sources: herbarium sheets, fresh material grown in the greenhouse at Botanical Research Institute, Pretoria, and material preserved in alcohol (gathered in the field). No differences were observed in pollen taken from each of these sources when it was viewed.

Fresh material of two of the species, J. flava and J. protracta subsp. protracta, was also acetolysed (following Erdtman, 1971, as quoted by Taylor, Hollingsworth & Bigelow, 1974) before being mounted and viewed. The acetolysed material was then compared with that of the same species mounted directly onto stubs, but no significant difference was found between the two treatments. This is similar to the results found by Munday (1980), who found little difference between the results obtained in acetolysed and non-acetolysed material in Monechma, except that acetolysed material tended to lose its "stopples" and had a high proportion of damaged grains. Material was therefore viewed without pre-treatment.

From one to four specimens of each species and subspecies of Justicia and Siphonoglossa in southern Africa was examined. The flowers were first softened by boiling to prevent the anthers shattering when they were removed from the flowers. The anthers were then macerated onto 15 mm aluminium stubs covered with double-sided sticky tape and as much of the debris removed as possible. Thin tape was used, as the thicker 3M Scotch tape used in viewing seeds proved unsuitable, the pollen grains sinking partially into the thicker gum and becoming difficult to photograph well.

After air-drying, the mounted material was glow discharge-coated with c. 400 A° of metallic gold in an Eiko sputter coater. The specimens were then viewed in an MSM 4 Hitachi-Akashi (desk top model) SEM at kv 15. Selected views were photographed of the profile (face), side and amb (polar) faces of the pollen grains of each taxon, using a Mamiya 6 x 7 camera and Ilford FP4 125 ASA film. The film was developed in Microdol X. Stubs were stored in perspex boxes with silica gel to keep them dust- and moisture-free, and were re-viewed later if the photographs already taken proved unsuitable.

Contact prints were made from the negatives and pasted onto large cardboard sheets for easy selection of photographs later. The size of the pollen grains was originally calculated from these photographs, but checked in three taxa (J. protracta subsp. protracta, J. capensis and J. anagalloides) against measurements taken from slides measured with a Kontron Image analyser. The results proved to differ by a factor of nearly two, and so pollen of each taxon of the two genera was re-measured with the Image Analyser. These measurements have been used here in preference to those calculated from SEM photographs.

It may be valuable to measure pollen by two methods and compare the results, to avoid the possibility of error in the machine. The method of measurement may also need to be taken into account when comparing sizes of pollen from different genera, revised by different workers using different means of measurement, and different preparative methods.

An attempt was also made to establish the nature of the "stopples" seen in the pollen of all species, by staining with ruthenium red for intine. Unfortunately the whole grain appeared pink under the microscope, and so it was not possible to draw any conclusions from this.

RESULTS

1) Shape

The pollen of both genera was found to be basically prolate, with some species (e.g. J. orchioides, J. thymfolia) showing a slight median constriction (pl. 2: 12).

2) Sexine pattern

The sexine pattern was lophate over most of the grain with smooth areas (margocolpi) on either side of the colpi. These margocolpi were ornamented either with an entire band of lophate sexine (paracolpoid ridge)(Figure 10.1) or this band was broken up into areolae, i.e. circular areas of lophate sexine (Figure 10.2). The areolae were in 1 or 2 rows (Justicia) (pl. 1: 6; pl. 2: 4, 7,

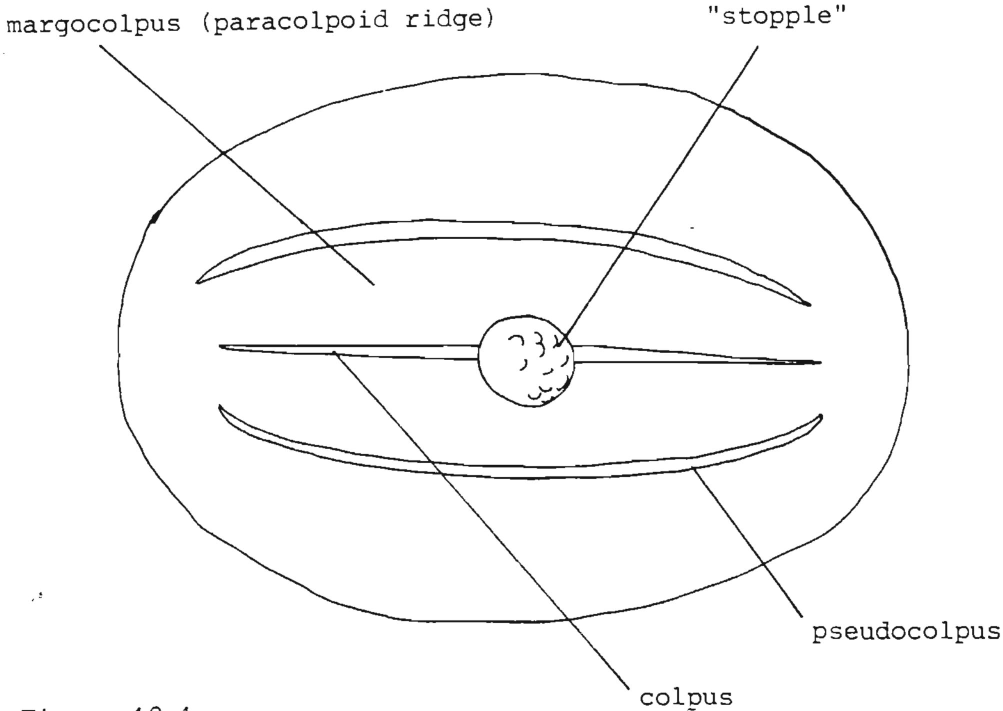


Figure 10.1

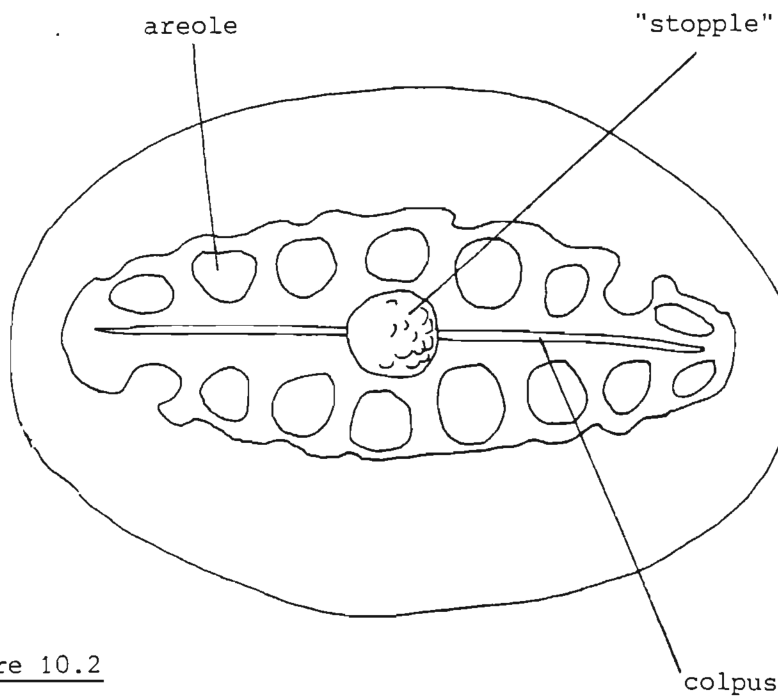


Figure 10.2

Diagrams of pollen types in *Justicia* and *Siphonoglossa*

10.1 Margocolpus entire

10.2 Pollen areolate

10) or sometimes up to 3 rows (Siphonoglossa). The outer row was frequently partially merged with the main area of lophate sexine. In the case of pollen with entire paracolpoid ridges, the colpoid streak (which lies between the paracolpoid ridge and the main area of lophate sexine) would sometimes continue to the poles. This, however, may be variable (see also Balkwill & Getliffe Norris, 1984), and has not been used in the classification. The colpoid streaks may actually join at the poles; see for instance J. campylostemon and J. glabra among the three-colporate species (pl. 1: 4).

3) Pores

There were either two (pl. 2) or three (pl. 1) pores, each within an elongate colpus running to near each pole. Two species however, J. anselliana and J. anagalloides, showed no colpi at all (pl. 2: 7). An intermediate stage was seen in one of the tropical species, J. elegantula S. Moore, where the colpi were present but short. There was a granular stopple present projecting from each pore. (pl. 2: 2,3).

4) Length

The length of the pollen grains (taken between the poles) covered a wide range within the two genera. In Justicia it varied from 22 um (J. anselliana) to 77 um (J. petiolaris) and in Siphonoglossa from 58 (S. leptantha) to 90 um (S. linifolia). The pollen in the genera is therefore small, medium or large according to the categories in Erdtman (1952).

5) Abnormal grains

These are seen occasionally in both genera, and take the form of a triangular grain with a trilete colpus (pl. 2:15) It is presumed that these are what Bhaduri (1944) called "giant grains".

DESCRIPTION OF POLLEN OF SPECIES (number in brackets is the mean length, n=20):

Justicia

J. anagalloides: two-porate, areolate, one row areolae, length 28 (31,1) 36 um (Hafstrom & Acocks 1390) (pl. 2: 7, 8).

J. anselliana: two porate, areolate, one row areolae, length 22 (31,3) 29 um (De Winter 2518) (pl. 2: 9).

J. betonica: three-colporate, margocolpus entire, length 36 (46) 58 um (Strey 8161) (pl. 1: 1, 2, 3)

J. bolusii: three-colporate, margocolpus entire, length 34 (46) 58 um (Immelman 376)

J. campylostemon: three-colporate, margocolpus entire, length 45 (49,8) 53 um (McClean 126)

J. capensis: two-colporate, areolate, one row areolae, length 48 (51,2) 60 um (Acocks 20100) (pl. 2: 4, 5, 6)

J. crassiradix: two-porate, areolate, one row areolae, length unknown (Killick & Leistner 3417)

J. cuneata (all 3 subspp.): two-colporate, areolate, 1-2 rows areolae, length (subspp. cuneata & longebracteata only) 45 (50,9) 61 um (subsp. cuneata: Esterhuysen 5550; subsp. longebracteata: Dahlstrand and 3157; subsp. hoerleiniana: Dinter 60401)

J. dinteri: two-colporate, areolate, 1-2 rows areolae, length 32 (37,2) 43 um (Edwards 04338, Smith 1339)

J. flava: three-colporate, areolate, one row areolae, length 42 (52,3) 58 um (Werdemann & Oberdieck 1744) (pl. 1: 9, 10)

J. glabra: three-colporate, margocolpus entire, length 41 (43,4) 50 um (Smith 1700, 2734). (pl. 1, 4,5)

J. guerkeana: two-colporate, margocolpus entire, length 35 (39,3) 45 um (Barnard 122) (pl. 2: 1, 2, 3)

J. kirkiana: three-colporate, areolate, one row areolae, length 47 (54,2) 61 um (Muir 1090, Drummond 5329: both tropical African specimens) (pl. 1: 6,8)

J. minima: three-colporate, areolate, 2 rows areolae, length 30 (33,3) 39 um (Immelman 145)

J. montis-salinarum: three-colporate, margocolpus entire, length 37 (41,8) 45 um (Van Wyk 5536)

J. odora: two-colporate, areolate, one row areolae, length 37 (41,8) 45 um (H. & E. Wanntorp 414)

J. orchioides (both subspp.) two-colporate, margocolpus entire, length 30 (39,6) 49 um (subsp. orchioides: Hafstrom & Acocks H 905; subsp. glabrata: Muir 1100)

J. petiolaris (all 3 subspp.): three-colporate, areolate, one row areolae, length 56 (67) 77 um (subsp. petiolaris: McMurtry 1532; subsp. incerta: Meeuse 9100; subsp. bowiei: Marriott 3) (pl. 1: 7)

J. parvibracteata: two-colporate, areolate, 1-2 rows areolae, length 35 (37,9) 42 um (Leistner 1402, 1657)

J. platysepala: two-colporate, margocolpus entire, length 32 (37,4) 44 um (Giess, Volk & Bleissner 5863) (pl. 2: 12)

J. protracta (both subspp.): two-colporate, areolate, 1-2 rows areolae, length 30 (41,9) 48 um (subsp. protracta: Hall 4563; subsp. rhodesiana: Germishuizen 974)

J. thymfolia: two-colporate, margocolpus entire, length 53 (60,6) 68 um (Oliver, Toelken & Venter 61)

Siphonoglossa

S. leptantha (both subspp.): two-colporate, areolate, 2-3 rows areolae, length 58 (64,4) 77 um (subsp. leptantha: Galpin 7752, 10856; subsp. late-ovata: Fourcade 3724) (pl. 2: 10, 11, 13)

S. linifolia: two-colporate, areolate, 2-3 rows areolae, length 74 (83,4) 90 um (Meeuse 10093)

S. nkandlaensis: two-colporate, areolate, 3 rows areolae, length 71 (79,4) 88 um (Wells 2495)

TAXONOMIC VALUE

Number of pores and gross configuration of the sexine is constant, and have been useful both in delimiting Justicia and Siphonoglossa and in delimiting sections in Justicia. Size, while used in the key (below), has not been used to reach taxonomic decisions, as there is a large range in pollen sizes in each sample, even when measurements are taken from a single flower. Keys using pollen sizes must therefore be used with caution, and need to be based on a number of pollen samples.

In Siphonoglossa, the south African species have 2-3 rows of areolae, while in Justicia there are 1-2 rows, or an entire margocolpus. The South American species of Siphonoglossa, according to Petriella (1968) however, have an entire margocolpus. These also have three colpi, not two as in the South African species and, as the type species of the genus is from South America, there may be justification for splitting the genus and giving a different generic name to the South African species. More work is needed on the genus as a whole. At present, however, it is proposed to retain the name Siphonoglossa for the South African species, as different pollen types have been accepted in other genera of Acanthaceae, e.g. Anisotes (Baden 1981a), Macrorungia (Baden 1981b) and Adhatoda (Manning & Getliffe Norris 1985).

For the same reason, though five different types of pollen have been found in Justicia within southern Africa, it is not proposed here to split the genus, but rather to recognise sections, using pollen characters as one of the main criteria.

KEY TO POLLEN OF GENERA

Pollen longer than 58 um, with 2-3 rows areolae .... Siphonoglossa

Pollen usually shorter than 58 um or, if longer, then with 1 row of areolae or margocolpus entire .... Justicia

KEY TO POLLEN OF SECTIONS OF JUSTICIA IN SOUTHERN AFRICA

1a Pollen 2-porate or 2-colporate 2

1b Pollen 3-colporate 4

2a Pollen with entire marcocolpus .... sect. Orchioides

2b Pollen areolate 3

3a Pollen usually 2-porate (in southern African species), 22-36 um long .... sect. Ansellia

3b Pollen 2-colporate, 34-60 um long .... sect. Harnieria

4a Pollen with entire margocolpus ....sects. Gendarussa, Bolusia and Justicia

4b Pollen areolate 5

5a Pollen shorter than 40 um .... sect. Minima

5b Pollen longer than 40 um .... sect. Rostellularia

PLATE 1: **Pollen of *Justicia* species --- 3-colporate**

Margocolpi entire:

1. *J. betonica*, face. Scale bar = 5 um

2. *J. betonica*, side. Scale bar = 5 um

3. *J. betonica*, amb. Scale bar = 5 um

4. *J. glabra*, amb showing pseudocolpi continuous at poles. Scale bar = 10 um

5. *J. glabra*, surface detail of seed. Scale bar = 5 um

Marcocolpi areolate:

6. *J. kirkiana*, face. Scale bar = 10 um

7. *J. petiolaris* subsp. *incerta*, side. Scale bar = 10 um

8. *J. kirkiana*, amb. Scale bar = 10 um

9. *J. flava*, surface detail showing areolae. Scale bar = 2 um

10. *J. flava*, surface detail showing main surface area. Scale bar = 2 um

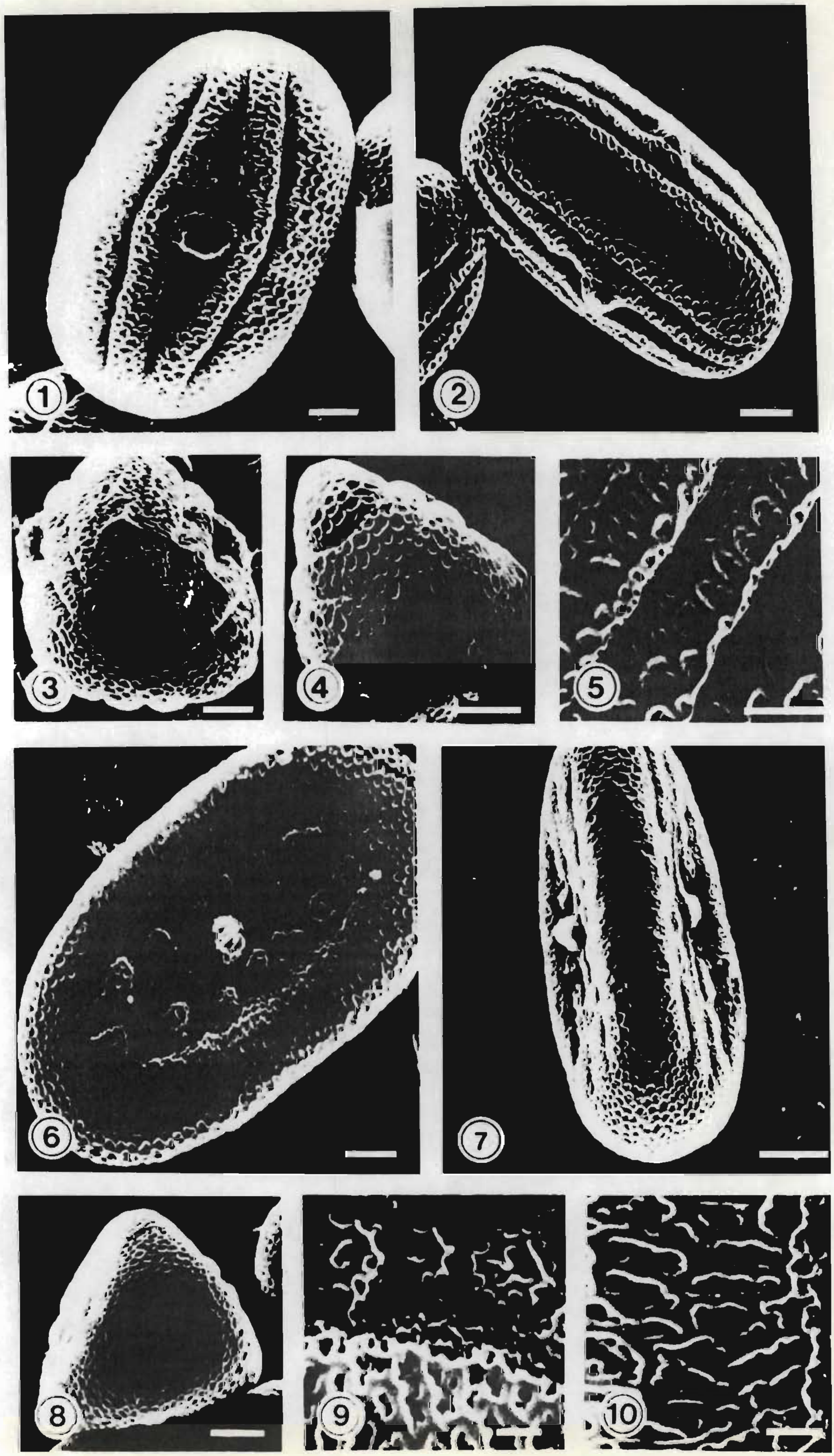

1
2
3
4
5
6
7
8
9
10

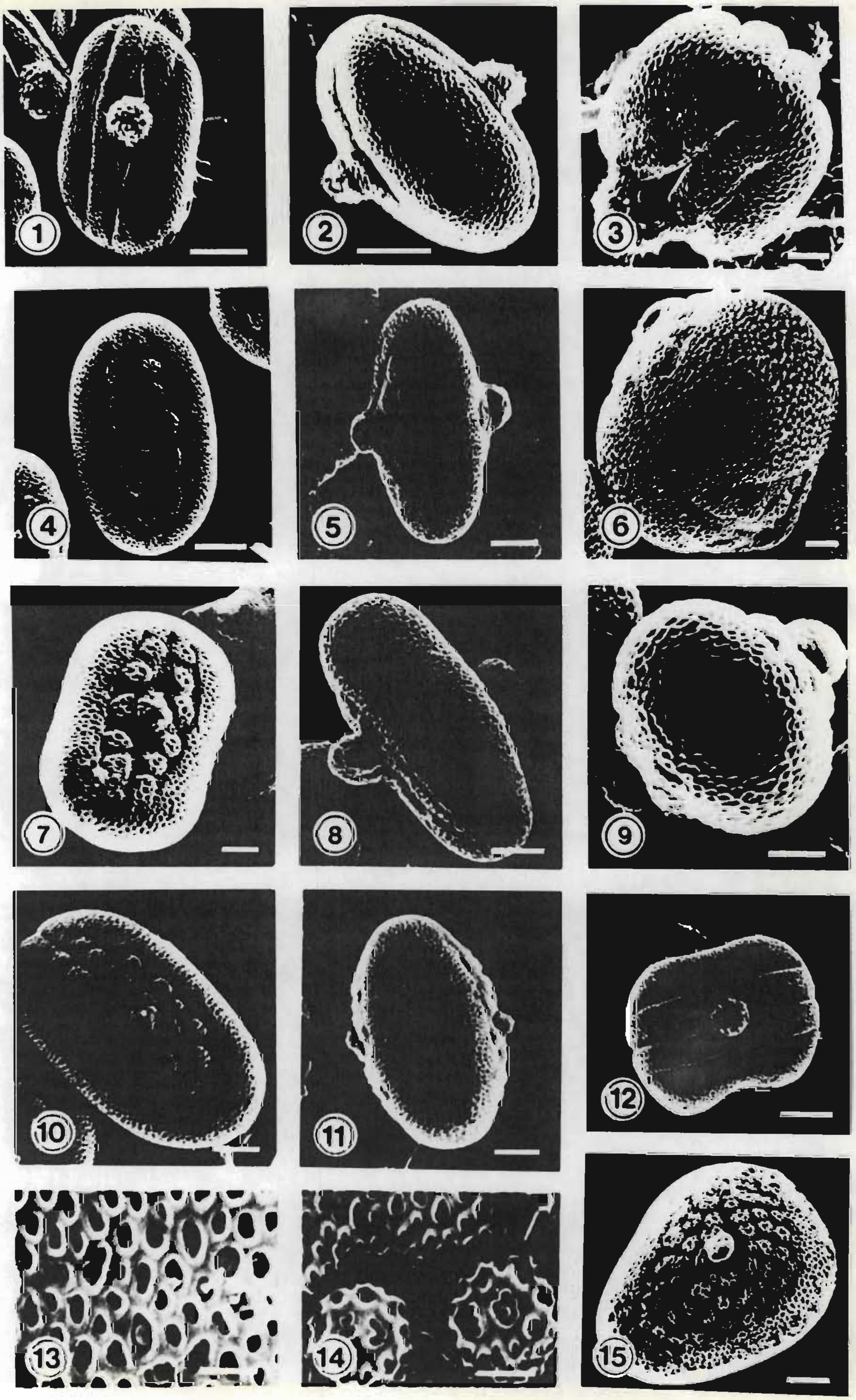
PLATE 2: **Pollen of _Justicia_ and _Siphonoglossa_ --- 2-colporate or 2-porate**

Margocolpi entire:

1. _J. guerkeana_, face. Scale bar = 10 um
2. _J. guerkeana_, side. Scale bar = 10 um
3. _J. guerkeana_, amb. Scale bar = 5 um

Margocolpi areolate:

4. _J. capensis_, face. Scale bar = 10 um
5. _J. capensis_, side. Scale bar = 10 um
6. _J. capensis_, amb. Scale bar = 5 um
7. _J. anagalliodes_, face. Scale bar = 5 um
8. _J. anagalliodes_, side. Scale bar = 5 um
9. _J. anselliana_ subsp. _leptantha_, face. Scale bar = 5 um
10. _Siphonoglossa leptantha_ subsp. _leptantha_, face. Scale bar = 10 um
11. _S. leptantha_ subsp. _leptantha_, side. Scale bar = 10 um
12. _J. platysepala_, face. Scale bar = 10 um
13. _S. leptantha_ subsp. _leptantha_, surface detail showing main surface area. Scale bar = 2 um
14. _S. leptantha_ subsp. _leptantha_, surface detail showing areolae. Scale bar = 2 um
15. _S. leptantha_ subsp. _leptantha_, abnormal trilete grain. Scale bar = 5 um


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

3.7 CAPSULES

The importance of features of the capsule in the Acanthaceae has long been recognised. As early as 1847 Nees divided the family in two on the basis of presence or absence of the retinaculum (which he called a "jaculator"). This characteristic has been used by most subsequent authors (e.g. Anderson 1867) in their classification schemes, culminating in the division of the Acanthaceae s.l. into four taxa by Bremekamp (1953), partly on the basis of the retinaculum with three of these taxa being raised to the rank of family and the fourth removed to Scrophulariaceae.

Another characteristic of the fruit of Acanthaceae which has been much used in its classification is the presence of a drupe rather than a capsule in the Mendoncioideae. In earlier schemes Mendoncia was included with Thunbergia, but in 1894 Lindau separated it in a subfamily of its own. Bremekamp later described a separate family Mendonciaceae.

The prescence of placentas which rise elastically from the base of the fruit at maturity was used in delimiting a number of genera, e.g. Dicliptera (where the placenta is elastically rising) from Peristrophe and Hypoestes (where it is not). Baden (1981a) distinguished Macrorungia from the similar genus Anisotes on characters of the inflorescence, bracts, and on the fact that in the former the placentas are elastically rising.

Manning and Getliffe Norris (1985) considered the length of the stipe of the capsule to be of some value at generic level. In Duvernoia the stipe is long compared to that of Adhatoda. They noted that this character is variable in Justicia.

Shape of capsule has also been used. Munday (1980) considered a clavate capsule characteristic of Monechma, as it was constant in the genus, being correlated with the two-seeded condition. Some Justicia species (also two-seeded) had this type of capsule, but in most cases it could be used to distinguish the two genera.

MATERIALS AND METHODS

Capsules from a number of herbarium specimens were examined, and pubescence, size and texture (hard and woody or thin and papery) as well as number of seeds was noted. A number of species were also grown in the shadehouse at Botanical Research Institute, Pretoria, and information from these used to supplement the used of dried material.

RESULTS AND DISCUSSION

The capsule of Justicia is basically clavate-apiculate, with a short or long stipe and a rounded or cylindrical fertile portion. The stipe is laterally flattened and woody. The fertile portion contains four, two or one seed(s), each subtended by a hook-shaped retinaculum arising from the septum and attached to the base of the seed. This is thought to be the funicle of the seed.

The texture of the fruit varies from woody and thick (sect. Bolusia, sect. Orchioides, J. cuneata) or papery and thin (sect. Ansellia). Intermediate between these two extremes are the capsules of, for example sect. Gendarussa and most species of sect. Harnieria. The outer surface of the capsule may be pubescent, puberulous or glabrous; a character which may vary within the species.

The opening mechanism of the fruit is also of interest. The capsule has a pyramidal, acute, approximately woody apex. In the ripe capsule, and often in the unripe as well if the plant is dried, this apex splits in half and the two halves of the capsule spring apart violently, forming an angle of up to 180°.

Atypical capsules

J. bolusii has one or sometimes two smooth seeds in a clavate capsule. In this respect it would seem to belong to Monechma, but other characters make it seem likely that this is a parallel adaptation. For a more detailed discussion, see Ch. 3.8.

J. guerkeana also has a clavate, Monechma-type capsule. Specimens grown in the nursery at Botanical Research Institute, Pretoria, produced profuse numbers of capsules, but it is of interest to note that these, even when ripe, did not open.

Dimorphic capsules were seen in sect. Harnieria - regularly in J. dinteri and only once in J. protracta subsp. protracta. They were also occasionally seen in Siphonoglossa leptantha subsp. leptantha. Specimens of J. protracta and S. leptantha showing this condition are preserved in PRE (Immelman s.n. - 630291 in PRE); Balkwill 649) and at NU (Balkwill 217, 649). In this case, as well as the normal four-seeded capsule, a smaller, one-seeded, non-opening (indehiscent) capsule was produced, with four irregularly serrate wings (See Figure 32: 6). The seed does not differ from those in the normal capsules except in being larger (pl. 9:1-6). Siphonoglossa is in many other respects like species of Justicia sect. Harnieria, e.g. in flower, inflorescence and pollen, and the possesion in common of a specialised type of capsule is strong evidence of a close relationship between these two taxa.

3.8 SEEDS

Munday (1980) found that, although all seeds had a smooth testa, there was variation in size, shape and colour of seeds of Monechma. A longitudinal ridge was characteristic of one species (M. desertorum (Engl.) C.B.Cl) and mottled colouring of another (M. spartioides (T. Anders.) C.B.Cl.).

Baden (1981a), investigating Macrorungia, stated that all species were four-seeded with a uniform testa, and considered the seeds of limited taxonomic importance. However he did not view them under the SEM. In his paper on Anisotes (1981b), he did not use the seeds in the classification, though he noted that the surface was "variable". More detail was given in the descriptions of some of the species, though he did not investigate the seeds of every species. The seeds often had a longitudinal ridge, and the texture was described as rugose, tuberculate, verrucose or smooth. In one species (A. guineensis Lindau) the seeds were glandular. This species was unusual in other ways also, including having 4-porate pollen, and was placed by Baden in a separate monospecific section.

Balkwill & Getliffe Norris (1985) used the fact that the seed surface in Hypoestes was asperous, tuberculate or smooth in their key to species.

Manning & Getliffe Norris (1985) found that there were no crystals in the seed testa of species of Duvernoia or Adhatoda, as there are in some species of Justicia.

Balkwill, Getliffe Norris & Schoonraad (1986) used the microsculpturing of the seed surface in their investigation of Peristrophe.

Apart from these studies, no SEM investigations of the seed surface of African Acanthaceous seeds is known, though considerable attention has been paid to embryology. In the present study, external morphology has been examined with a view to assessing the taxononomic potential of seed characters.

MATERIALS AND METHODS

Seeds of each species and subspecies were removed from herbarium sheets and mounted directly onto 15 mm aluminium stubs with double-sided 3M Scotchtape. Two to six seeds per taxon were viewed depending on the size of the seeds. Where fresh fruiting material was available from the nursery (Botanical Research Institute, Pretoria), seeds were also dehydrated, fixed and critical-point dried by the following method:

1. Specimens were dehydrated either in series of ascending

concentrations of alcohol or, more usually, in two changes of 2,2-Dimethoxypropane (DMP) for up two hours.

2. They were then transferred to 100% acetone for five minutes.

3. Critical point drying was done with liquid CO_2 evaporated off at 40° C and 80-90 atmospheres (critical point for CO_2 is at 31,3° C and 72,8 atmos.)

4. The dried specimens were stored in a desiccator with silica gel, or immediately mounted on aluminium stubs for coating.

All seeds were glow-discharge coated with metallic gold in an Eiko sputter coater. They were then viewed and photographed as described in the chapter on pollen. (Ch. 3.6). The whole seed was photographed at low magnification (in two sections where it was too large to fit into a single photograph at the minimum magnification) and at higher magnifications to show details of the testa.

RESULTS AND DISCUSSION

Critical-point drying

It was noted in many instances that material that had not been critical-point dried showed structures of the testa such as radial cell-walls, ornamentation of these walls, and crystals in the testa, better than fresh, critical-point dried material. This was due to the collapse of the outermost cell walls, which made it easier to see such structures. On the other hand, structures such as fine papillae were sometimes only visible when the material had been pre-treated before viewing. This was the case with J. anselliana (pl. 9: 7, 8; compare with pl. 9: 9, 10), and it was felt that critical-point drying would be a valuable procedure for those species which, like J. anselliana, had "amorphous" testas, as found in sects. Ansellia and Orchioides.

A number of different patterns of testa were observed, in many cases correlating with the proposed sections.

In sect. Ansellia, (pl. 9) J. crassiradix had the seed covered with a reticulate pattern of ridges and depressions on the sides while around the margin of the seeds the ridges form a roughly semicircular pattern (pl. 9:1, arrowed). The testa of the other two members of this section (J. anagalloides and J. anselliana (Nees) T. Anders.) however, showed no equivalent pattern (pl. 9: 4, 7, 9). At higher magnifications, all the seeds had rough testas, with no discernable pattern ("amorphous"), when they were viewed without having been critical-point dried (pl. 9: 2, 3, 5, 6, 8). However, when seed of J. anselliana was critical-point dried, each cell was found to have a small, centrally situated papilla (pl. 9:10). The papilla was longer than wide, with an acute or truncate apex. The whole seed was ellipsoidal to conical and, when critical-point dried, had a reticulate pattern with raised ridges and central depressions between them. (pl. 9:9). This is not equvalent to the reticulate pattern in sect. Harnieria, where the ridges correspond to cell walls, as the pattern is a larger relative to seed size than in that section (pl. 8:8).

The other section having "amorphous" testas is sect. Orchioides (pl. 4: 1-6). Four of the five species placed in this section were examined, but seeds of the fifth, J. thymifolia, were not available. Seeds of J. guerkeana were critical-point dried for viewing, as well as being viewed without pretreatment. In this case, unlike J. anselliana, the irregular pattern remained, and no papillae were seen.

The only species of sect. Bolusia, J. bolusii (pl. 4:7,9) had seeds which were almost smooth, being only very slightly rugose even at high magnifications (pl. 4:9). It compares well with Monechma mollissimum (Nees) P.G. Mey., which was also viewed for purposes of comparison (pl 4:8, 10). However, it was decided that, despite similarities in the seeds and capsules, J. bolusii should not be included in Monechma. Differences between them included inflorescence and pollen, and will be discussed in more detail below (see Ch. 4).

Many species showed a reticulate pattern, where the radial cell walls protruded slightly to form the pattern. However, if other characters are taken into consideration, these species are not necessarily related, and indeed there are many differences in detail in the reticulate pattern. J. capensis (pl. 8:7, 8, 9) and J. minima (pl. 6:1, 2, 3) had a simple reticulate pattern. J. campylostemon (pl. 3:6, 7, 8) had the radial walls ornamented with a double row of minute projections, which were more visible without critical-point drying.

The species of sect. Rostellularia (pl. 6:4-12) all had a reticulate pattern on the seed surface, with the reticulations in the yellow-flowered species (J. flava and J. kirkiana) radiating from a central "hub" like spokes of a wheel (pl. 6: 5, 6), giving the whole seed a segmented appearance. This was not present in any of the subspecies of the blue-flowered species, J. petiolaris. In addition, all the species of this section had one large or many small crystals visible as cubic or retangular projections below the surface of the outer wall (pl. 6:7-12). These crystals were scarcely visible in critical-point dried material, but were clearly seen when the material was viewed without pre-treatment. In some cases a deposit of small irregular specks of wax on the outer surface of the seed was seen (pl. 6:11).

Both J. betonica and J. montis-salinarum (sect. Justicia) had a pattern of short sinous ridges ("pretzels"). The testa was often drawn out into dentate structures (pl. 5:4, 5) with the individual cells showing on their surface (pl. 5:3). When broken off, these teeth were seen to be hollow (pl. 5:11).

The most complex pattern observed was that of J. glabra (sect. Gendarussa) which had seeds quite unlike any other Justicia (pl. 3:1-5). The testa was drawn out into numerous multicellular scales (pl. 3:2) with each cell of the scale producing a sharp retrorse barb (pl. 3:3, 4, 5). These scales were longest along the margin furthest from the point of attachment of the seed (pl.3:1, arrowed). They are probably a means of seed dispersal, analogous to the barbed scales on the fruit of Bidens pilosa (Asteraceae). J. campylostemon, though placed in the same section, had very different seeds. These were covered with irregular vermiculate ridges, each of which had a reticulate surface pattern. The pattern was the result of raised ridges, and along each margin of a ridge there was a row of small, blunt, tooth-like projections (pl. 3:6-8).

All southern African species of sect. Harnieria except J. capensis and J. cuneata had a single large rounded papilla in the centre of each cell (pl. 8: 1-4; pl. 9: 1-6) which was visible in material that had not been pre-treated before mounting. This unusual papilla was also found in the critical-point dried material of Siphonoglossa leptantha subsp. leptantha (pl. 8: 7, 8) although not visible in untreated seeds. Material of all Siphonoglossa species viewed without pre-treatment had an "amorphous" testa (pl. 8: 5, 6).

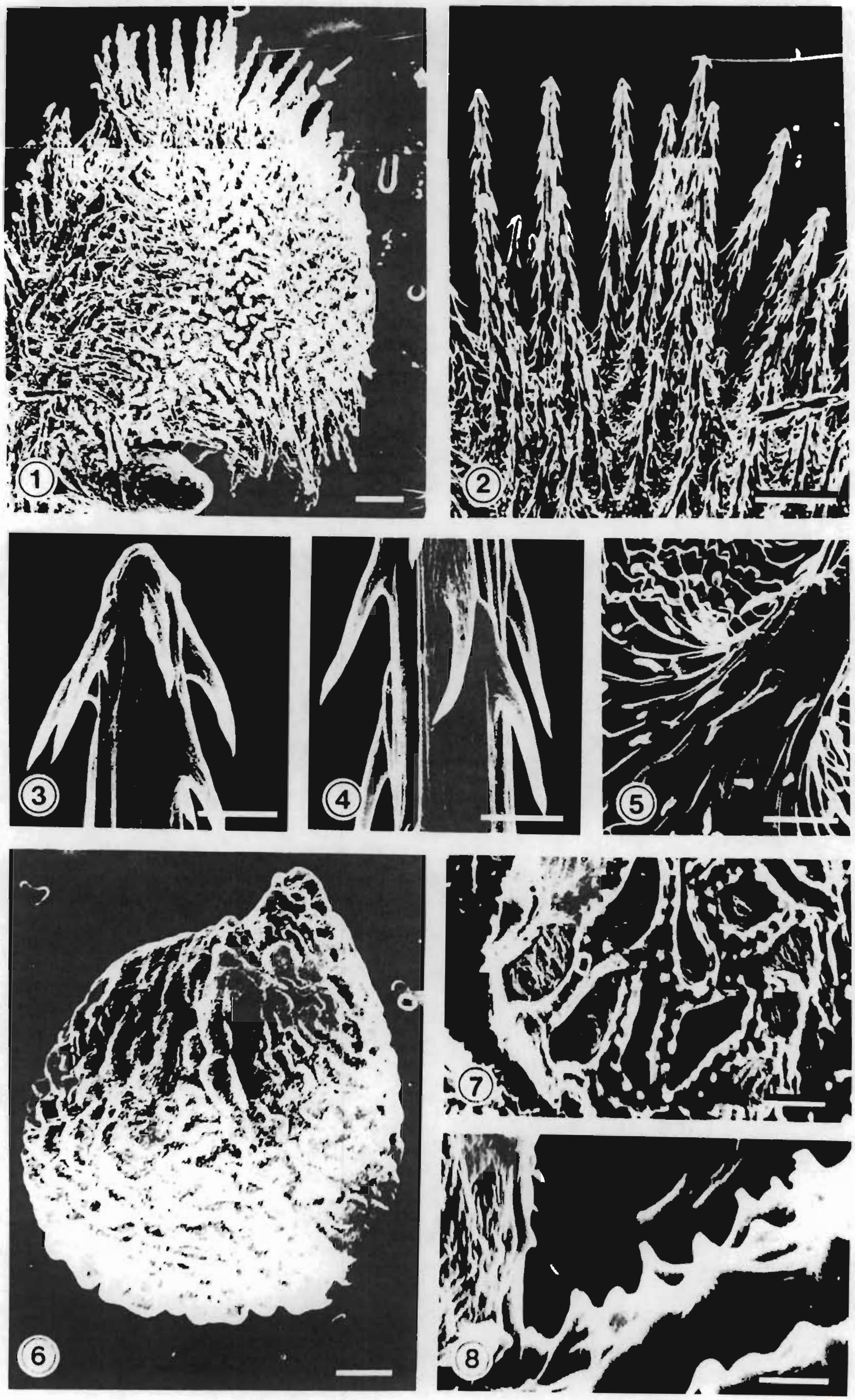
This unusual pattern is interesting in that it adds a further line of evidence to the theory that Justicia and Siphonoglossa are closely related, probably through Justicia sect. Harnieria. No other southern African species of Justicia had a papillate testa except J. anselliana of sect. Ansellia, which differs from both Siphonoglossa and Justicia sect. Harnieria in its inflorescence and pollen.

In J. dinteri, also of sect. Harnieria, two kinds of capsule are regularly produced (see Ch. 3.7) for futher discussion). The seeds from each type of capsule were compared, and the testa found to be essentially similar in both, though the seeds in the one-seeded capsules were larger (pl. 8:1, 3, 5 [four-seeded capsule]: pl. 8:2, 4, 6 [one-seeded capsule]).

Seed testa features were therefore considered of major importance in delimiting a number of the sections of Justicia, and are also suggestive of a relationship between Justicia sect. Harnieria and Siphonoglossa.

PLATE 3: **Seeds of *Justicia* sect. *Gendarussa***

1. *J. glabra*, whole seed (composite picture). Scale bar = 200 um
2. *J. glabra*, scales on seed (composite picture). Scale bar = 100um
3. *J. glabra*, apex of scale. Scale bar = 10 um
4. *J. glabra*, shaft of scale. Scale bar = 10 um
5. *J. glabra*, base of scale. Scale bar = 20um
6. *J. campylostemon*, whole seed (composite picture). Scale bar = 400 um
7. *J. campylostemon*, detail of seeds. Scale bar = 20um
8. *J. campylostemon*, detail of seeds. Scale bar = 5 um



1
2
3
4
5
6
7
8

PLATE 4: **Seeds of *Justicia* sects. *Orchioides* and *Bolusia*, and of *Monechma***

1. *J. orchioides*, whole seed. Scale bar = 200 um
2. *J. platysepala*, whole seed. Scale bar = 400 um
3. *J. guerkeana*, whole seed. Scale bar = 400 um
4. *J. orchioides*, detail of seed. Scale bar = 10 um
5. *J. guerkeana*, detail of seed. Scale bar = 10 um
6. *J. platysepala*, detail of seed. Scale bar = 15 um
7. *J. bolusii*, whole seed (composite plate). Scale bar = 400 um
8. *Monechma mollissimum*, whole seed. Scale bar = 200 um
9. *J. bolusii*, detail of seed. Scale bar = 10 um
10. *M. mollissimum*, detail of seed. Scale bar = 10 um

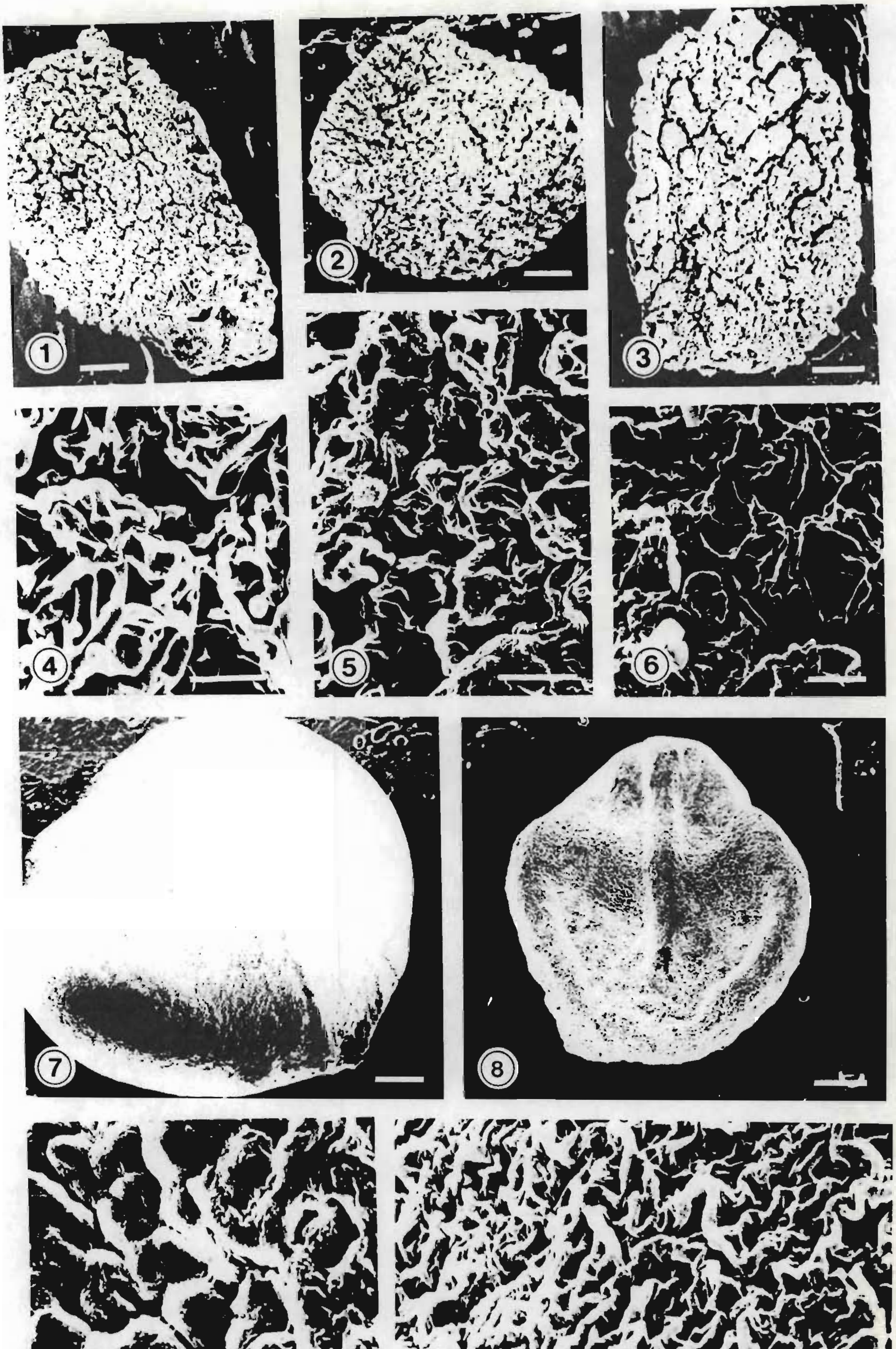

1
2
3
4
5
6
7
8
9
10

PLATE 5: **Seeds of *Justicia* sect. *Justicia***

1. *J. betonica*, whole seed. Scale bar = 400 um
2. *J. montis-salinarum*, whole seed. Scale bar = 200 um
3. *J. betonica*, detail of seed. Scale bar = 100um
4. *J. montis-salinarum*, detail of seed. Scale bar = 100um
5. *J. betonica*, detail of seed. Scale bar = 100um
6. *J. betonica*, detail of seed. Scale bar = 50 um
7. *J. montis-salinarum*, detail of seed showing broken-off papilla. Scale bar = 20um

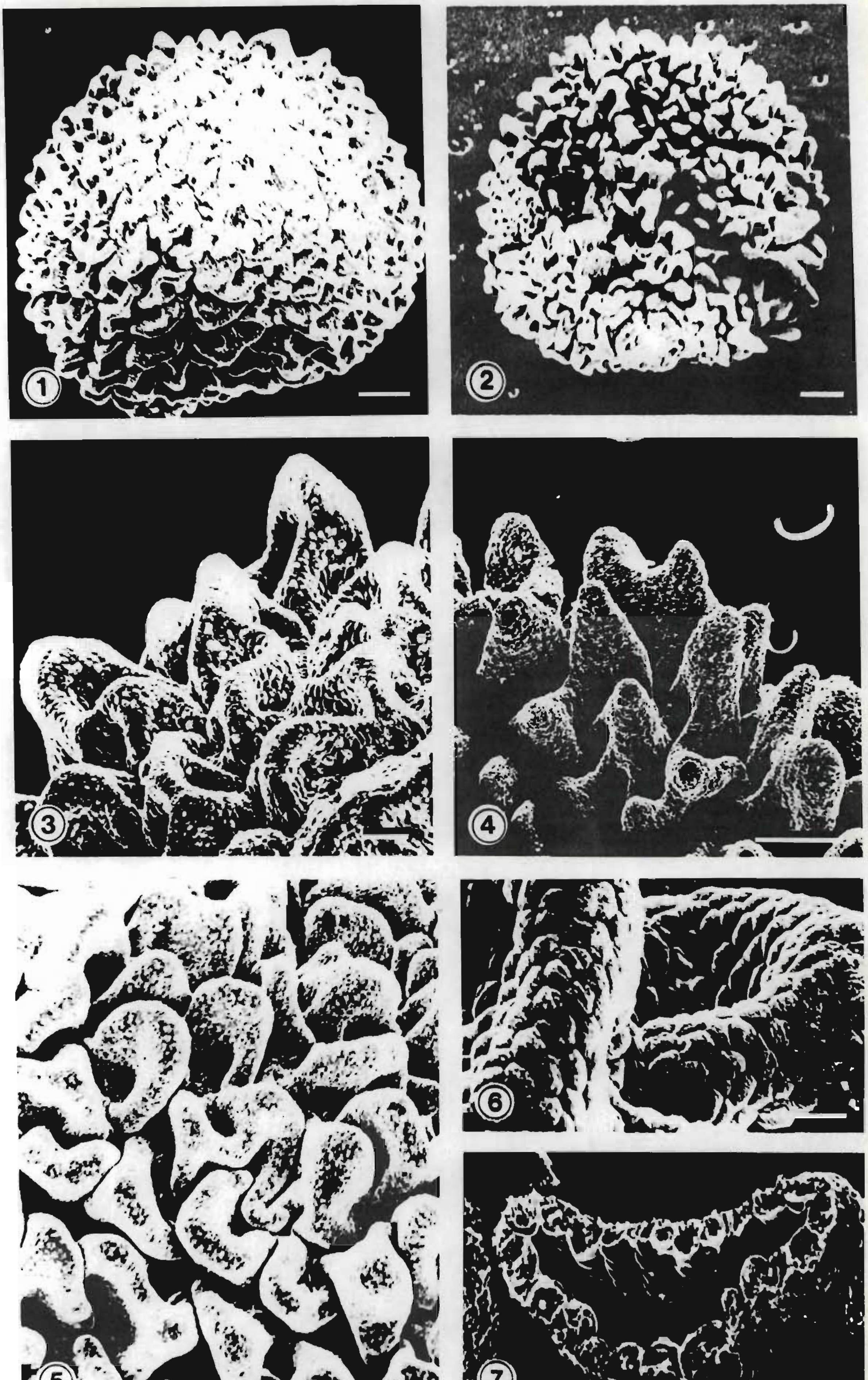

1
2
3
4
5
6
7

PLATE 6: **Seeds of *Justicia* sects. *Minima* and *Rostellularia***

Sect. *Minima*

1. *J. minima*, whole seed. Scale bar = 200 um

2. *J. minima*, detail of seed. Scale bar = 100um

3. *J. minima*, detail of seed. Scale bar = 10 um

Sect. *Rostellularia*

4. *J. petiolaris* subsp. *petiolaris*, whole seed. Scale bar = 400 um

5. *J. flava*, whole seed. Scale bar = 400 um

6. *J. kirkiana*, whole seed. Scale bar = 200 um

7. *J. petiolaris* subsp. *incerta*, detail of seed. Scale bar = 20um

8. *J. petiolaris* subsp. *petiolaris*, detail of seed. Scale bar = 2 um

9. *J. kirkiana*, detail of seed. Scale bar = 20um

10. *J. petiolaris* subsp. *incerta*, detail of seed. Scale bar = 5 um

11. *J. flava*, detail of seed. Scale bar = 5 um

12. *J. kirkiana*, detail of seed. Scale bar = 10 um

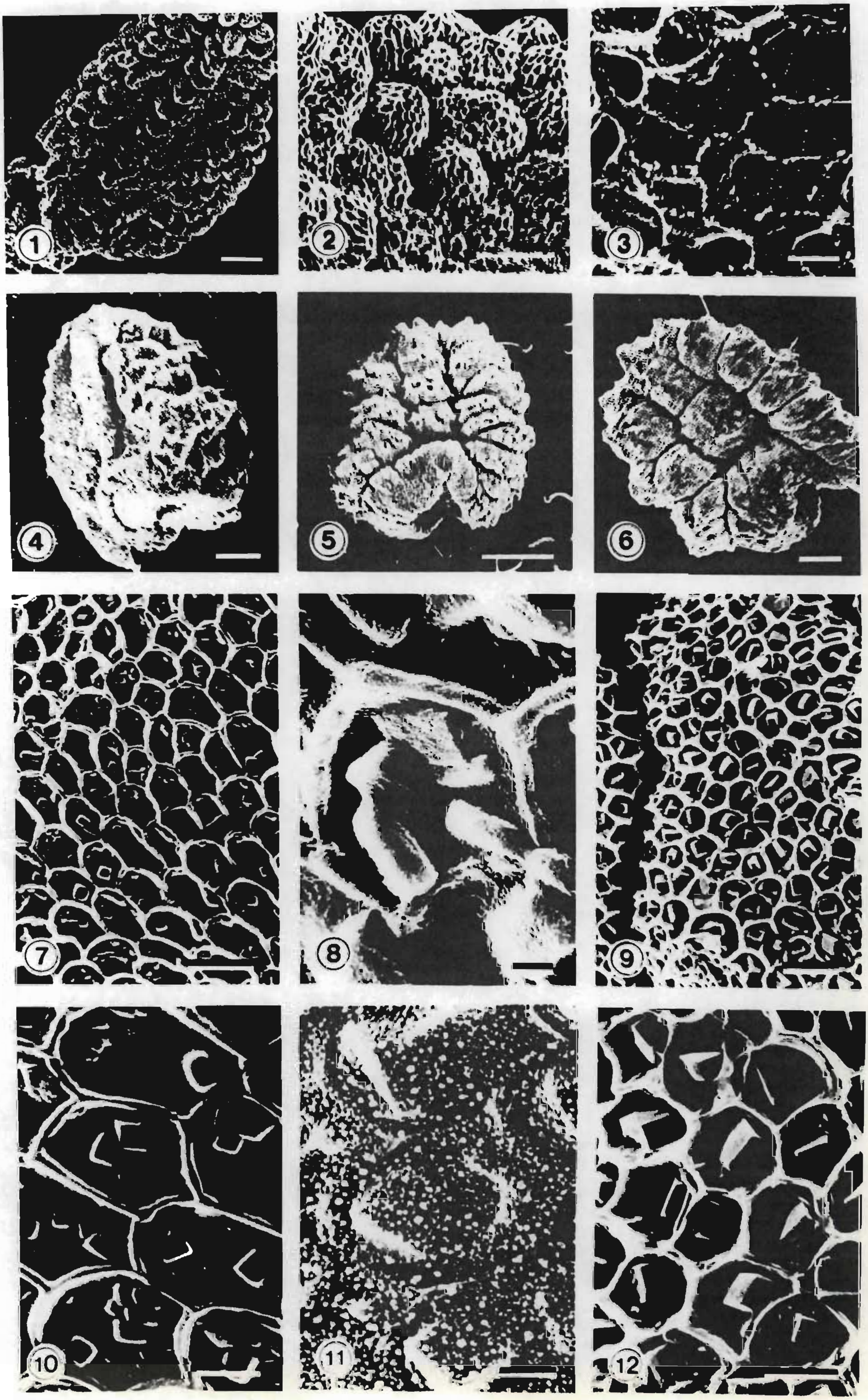

1
2
3
4
5
6
7
8
9
10
11
12

PLATE 7: **Seeds of _Justicia_ sect. _Harnieria_ and of _Siphonoglossa_**

1. _J. protracta_ subsp. _protracta_, whole seed. Scale bar = 400 um

2. _J. protracta_ subsp. _protracta_, detail of seed. Scale bar = 10 um

3. _J. parvibracteata_, whole seed. Scale bar = 200 um

4. _J. parvibracteata_, detail of seed. Scale bar = 5 um

5. _Siphonoglossa leptantha_ subsp. _leptantha_, whole seed. Scale bar = 200 um

6. _S. leptantha_ subsp. _leptantha_, detail of seed. Scale bar = 5 um.

7. _S. leptantha_ subsp. _leptantha_, detail of seed (critical-point dried). Scale bar = 10 um

8. _S. leptantha_ subsp. _leptantha_, detail of seed (critical-point dried). Scale bar = 10 um

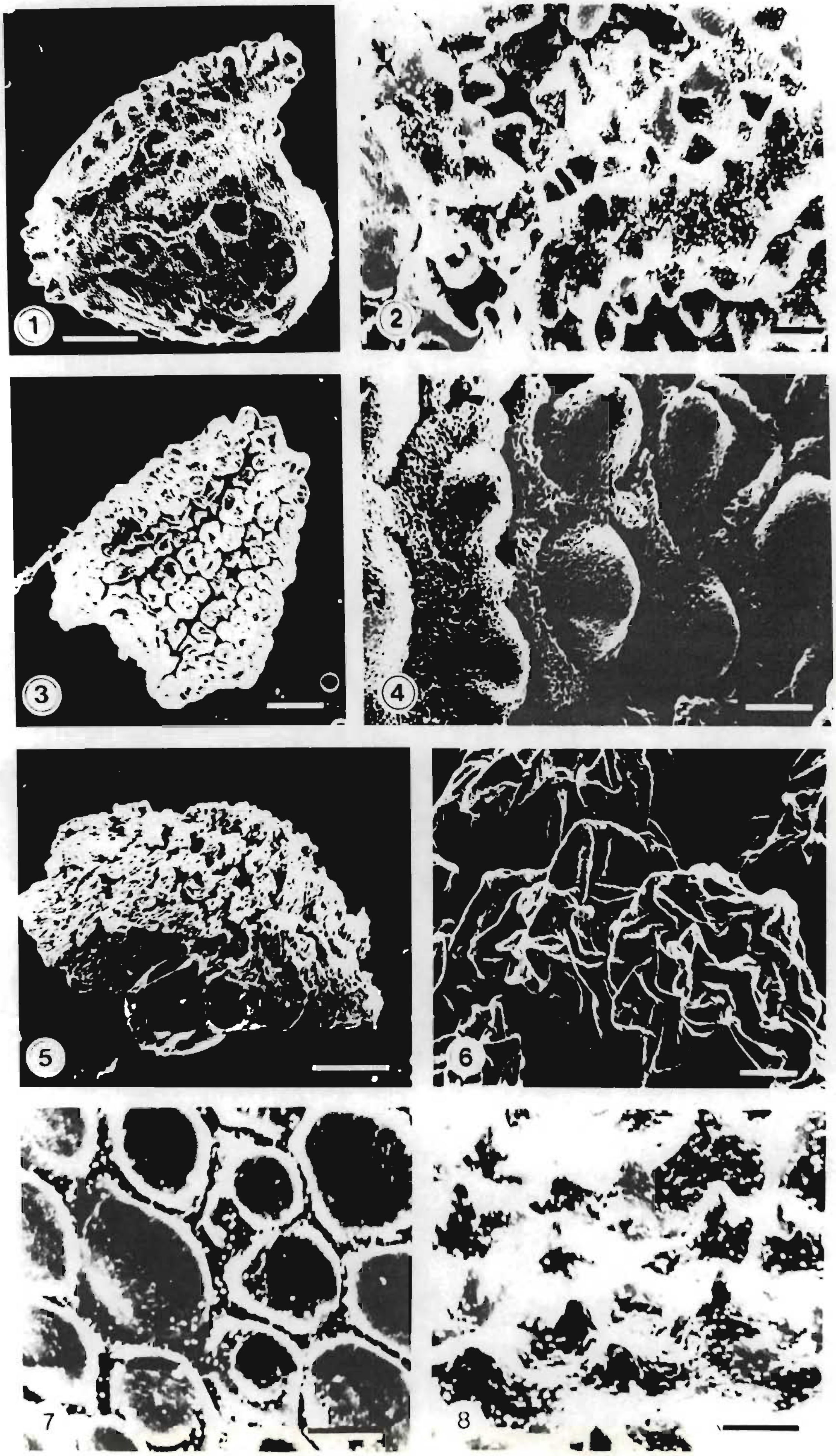

1
2
3
4
5
6
7
8

PLATE 8: **Seeds of *Justicia* sect. *Harnieria***

1. *J. dinteri*, whole seed from four-seeded capsule. Scale bar = 200 um

2. *J. dinteri*, whole seed from one-seeded capsule. Scale bar = 200 um

3. *J. dinteri*, detail of seed from four-seeded capsule. Scale bar = 20um

4. *J. dinteri*, detail of seed from one-seeded capsule. Scale bar = 25um

5. *J. dinteri*, detail of seed from four-seeded capsule. Scale bar = 5 um

6. *J. dinteri*, detail of seed from one-seeded capsule. Scale bar = 20um

7. *J. capensis*, whole seed. Scale bar = 400 um

8. *J. capensis*, detail of seed. Scale bar = 50 um

9. *J. capensis*, detail of seed. Scale bar = 10 um

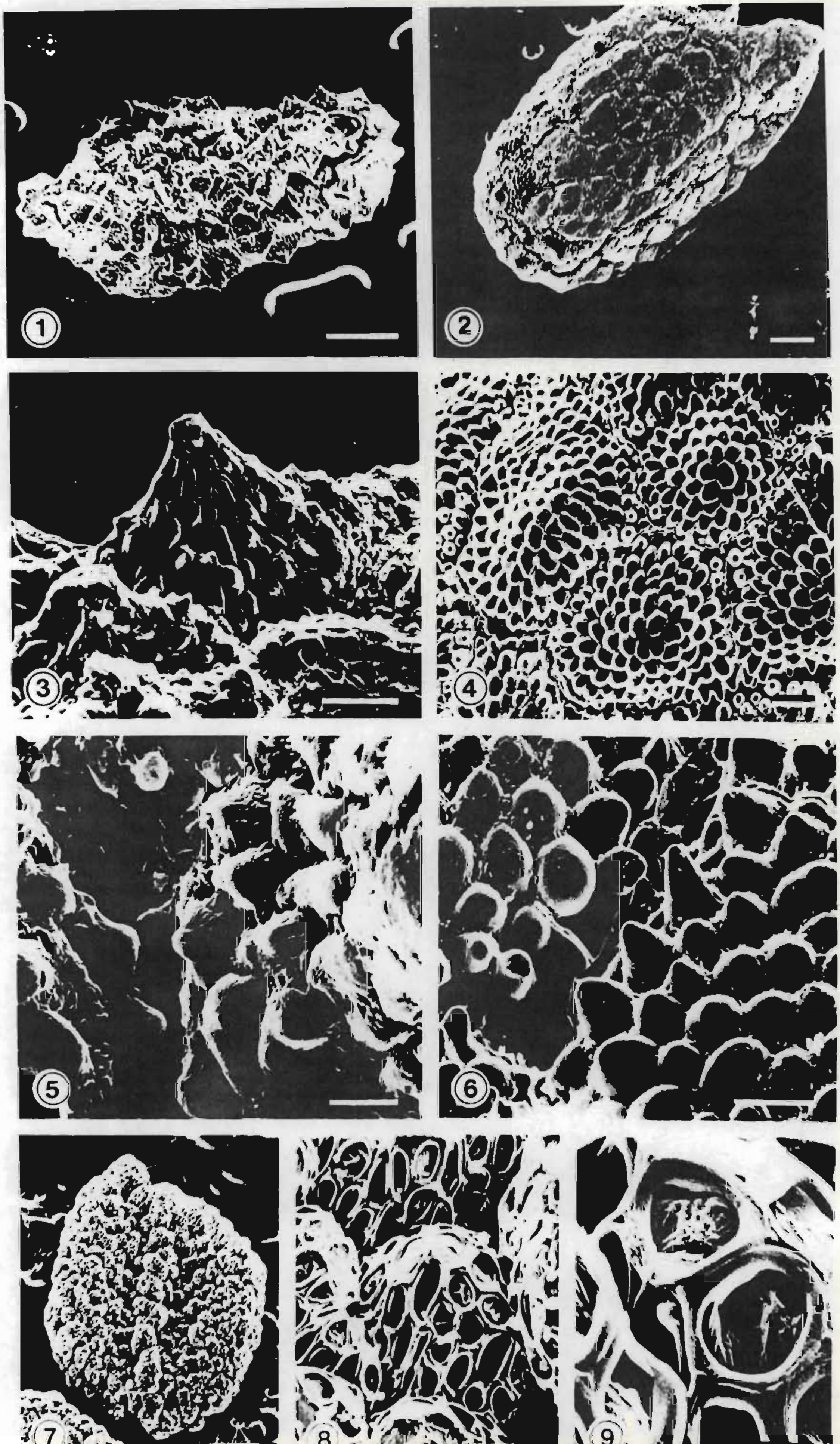
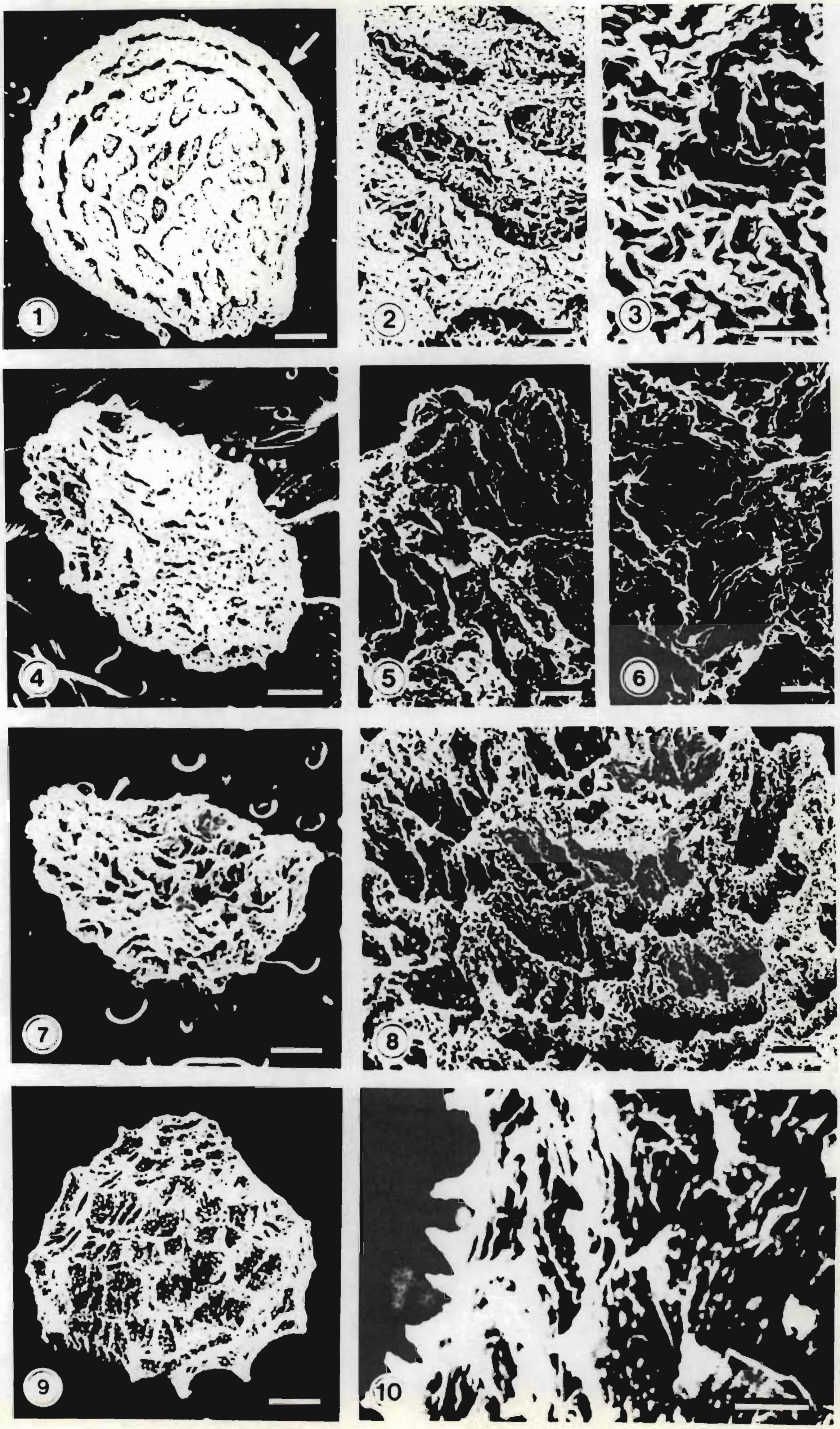

1
2
3
4
5
6
7
8
9

PLATE 9: **Seeds of *Justicia* sect. *Ansellia***

1. *J. crassiradix*, whole seed. Scale bar = 200 um
2. *J. crassiradix*, detail of seed. Scale bar = 30 um
3. *J. crassiradix*, detail of seed. Scale bar = 10 um
4. *J. anagalloides*, whole seed. Scale bar = 150 um
5. *J. anagalloides*, detail of seed. Scale bar = 50 um
6. *J. anagalloides*, detail of seed. Scale bar = 10 um
7. *J. anselliana*, whole seed. Scale bar = 150 um
8. *J. anselliana*, detail of seed. Scale bar = 50 um
9. *J. anselliana*, whole seed (critical-point dried). Scale bar = 200 um
10. *J. anselliana*, detail of critical-point dried seed. Scale bar = 10 um


1
2
3
4
5
6
7
8
9
10

3.9 PHYTOCHEMISTRY

METHODS AND MATERIALS

Materials

The initial survey was based on extracts from separate populations collected in the field and grown in the nursery at Botanical Research Institute, Pretoria. Later, bulk extracts combining the populations of each species were prepared. The following sections were represented: Gendarussa (two species, three subspecies), Minima (one species, initial collection only), Gendarussa (one species), Bolusia (one species), Ansellia (one species), Justicia (one species) and Harnieria (two species). The collections represented, with their provenance, are listed at the end of this chapter Sect. Orchioides was not represented, as the cuttings taken would not strike (four species collected), and sect. Minima could not be collected in bulk, as the plants died a few months after the initial collection was made.

Preparation of extracts

Floral material was chosen for the study of the phenolics as it was thus possible to ensure that homologous material was collected. Newly opened flowers were removed from the inflorescences with care, to ensure that calyx and bract material was not included. They were placed immediately into jars of 95% ethanol, and stored in a refrigerator until used.

Extraction was completed by heating the sample, in the original alcohol, over a waterbath at 100°C for $\pm$ five minutes. Anti-bumping granules (glass beads) were used to prevent boiling over.

The extract was then filtered through glass wool to remove the remains of the flowers, and concentrated in a watch glass in the draft of fume cupboard, or in a glass beaker placed on a heater at low heat, also in a fume cupboard. The concentrated extract was then stored in small, airtight bottles until used.

Preparation of chromatograms

Two-dimensional paper chromatograms were prepared on Whatman No. 1 sheets (45 X 57 cm) and developed in the first direction in BAW (16 - 18 hours), then in the second direction in 5% acetic acid (three - four hours). Rutin was used as a marker. BAW (Butanol-glacial acetic acid-water: 4:1:5 upper layer) was freshly prepared.

Attempts were also made to identify a conspicuous pink-red spot seen in the chromatogram of one poplation of J. flava. Bulk extracts were run in one dimension as streaks on Whatman No. 3

paper and the appropriate band isolated, eluted with 70% ethanol, and the elutant purified by repeating the preparative procedure.

The dried chromatograms were viewed under longwave UV light and the boundaries of the spots were marked in pencil. The solvent front was also marked. The spots were numbered for future reference.

The papers were then fumed with conc. NH4 before being viewed again, and any colour changes recorded. Some spots were not visible until this was done, and so the whole paper was fumed and not only the spots already marked. Spots of particular interest were noted.

Synthesis and presentation of results

The Rf value for each spot was calculated in BAW and 5% AA according to the following formula:

$$Rf = \frac{\text{Distance moved by spot} \times 100}{\text{Distance moved by front}}$$

"Distance moved by spot" was taken as the distance from the origin to the approximate centre of the spot. In spotting up the extracts an effort was made to keep the spot as small as possible, to ensure accurate Rf values and good separation. If the initial spot was too large the spots on the developed chromatogram were large and diffuse. They then tended to run into each other, and it was difficult to be sure of the exact centre of the spot when calculating Rf values.

RESULTS AND DISCUSSION

This pilot study was limited by the availability of material of all species and by the lack of opportunity to complete partial identifications of compounds. Comparisons of colour and Rf were used to estimate similarity but should be confirmed by co-chromatography and further identification.

Where there was more than one population of a species, the chromatograms revealed a common basic pattern with minor variations within a species. The exception was *J. flava* in which there was considerable variation. There was very limited overlap between species, even those within the same section.

The great variation encountered in *J. flava* may indicate that extracts stored in the refrigerator were unstable. Attemps to isolate the two conspicuous red spots from fresh extract were unsuccessful but they were possibly chalcones which, as pointed out by Harbourne (1972) are susceptible to isomerisation by acids to flavonones and oxidise slowly to aurones (bright yellow to bright orange-red). The elutants proved not to be anthocyanins and, on acid hydrolysis, yielded an aglycone which appeared as shiny yellow-green spots (possibly flavonones). Rf values of these aglycones are given in Table 10. These do not match any of the common flavonones referred to by Harbourne (1972).

The results are presented in the form of diagrams for each species, and will be discussed below under the section to which each species belongs.

Section Justicia

Only one population of J. betonica was available and its chromatographic pattern was extremely simple (Table 9; Figure 11). Two spots dark in UV turning yellow or greenish yellow on fuming are presumed to be flavone and flavonol glycosides respectively (Harborne, 1972: 54). The shiny blue spot is presumed to be an hydroxycinnanic acid (Harbourne, 1972: 41).

Section Rostellularia

Two species, J. petiolaris and J. flava were examined.

J. flava

Four poplations of J. flava (Table 10; Figure 12) exhibited very varied chromatograms, with those of extacts from the population at Natal University (fresh material) conspicuously more rich and different. In the other three chromatagrams there was a common core of two dark/greenish yellow spots and one spot which appeared blue only after fuming. In addition assorted lesser blue spots (presumed to be hydroxycinnamic acids) occurred. The fresh material collected at Natal University gardens yielded two vivid shiny pink spots. Attempts to identify this (see above) were not successful, but the compounds producing these spots are believed to be chalcones, which are unstable.

J. petiolaris

All three subspecies were included in the survey (Tables 11-13; Figures 13-15). A dark spot presumed to be a flavone glycoside and a deep blue hydroxycinnamic acid are common to all three subspecies. J. petiolaris subsp. bowiei (Figure 13) has a suite of three more spots which do not occur regularly in the other two subspecies. There appears, however, to be a basic similarity to support their recognition as one species.

There do not appear to be any spots in common between J. flava and J. petiolaris to form a marker for the section.

Section Harnieria

Two species, J. capensis and J. protracta, were available.

J. capensis

The four populations of J. capensis had very similar spot patterns (Figure 16; Table 14). The most conspicuous elements were three compounds that had a similar Rf in BAW but seperated in 5% acetic acid (Spots 1-3 in Table 14) and a blue spot (presumably a hydroxycinnammic acid) with a very high Rf in BAW and a low Rf in acetic acid (Spot 8 in Table 14). In addition two colourless to blue spots and a colourless to yellow spot were common in all. The remaining spots occurred once in the sect. J. capensis has an unusual disjunct distribution, occurring in Northern Natal and in the Eastern Cape. One of the populations studied for phenolics was from Ndumu, while the rest were from the Eastern Cape, and it was therefore of interest to note that they shared a common phenolic pattern. No morphological differences either were noted between collections from the two areas.

J. protracta

J. protracta subsp. protracta was represented by four populations and had a basic pattern of eleven compounds common to all (Figure 17; Table 15). None of these appeared to occur in J. capensis. Though J. protracta subsp. protracta is morphologically considerably more diverse than J. flava (sect. Rostellularia, above), its basic phenolic pattern appears to be for less diverse between the populations. One population (Jenkins s.n.) had all-pink flowers, but did not differ much in phenolics from the populations with the more usual white and mauve flowers.

Section Gendarussa

J. campylostemon, represented by two populations, had a characteristic chromotographic pattern of four dark spots turning yellow when fumed with NH4 (Table 16; Figure 19). This pattern was conspicuous for the absence of any hydroxycinnamic acids.

Section Bolusia

The only species placed in this section is J. bolusii, of which one population was available (Table 17; Figure 19). The most conspicuous elements of its chromatogram were a dark spot presumed to be a flavone and a bright blue hydroxycinnamic acid. This latter spot appeared to be similar to one in J. protracta. A third spot, a yellow suggesting flavonol glycoside, was also found in J. flava, J. campylostemon and J. minima.

J. bolusii had formerly been placed in the same section as J.

campylostemon, but in this thesis it is proposed to separate sect. Bolusia from sect. Gendarussa, basing this mainly on evidence of the seeds and inflorescence. The phenolic patterns of the two species appear to have only one spot in common.

In itself this is of little significance, taking into account the different patterns of species confidently placed together in other sections of the genus. However, had they shown similar phenolic patterns, it might have been necessary to re-appraise the already-existing evidence for their being separated.

Section Minima

The single representative of J. minima (Table 18; Figure 20) yielded an extract with seven compounds of which the most conspicuous was a dark spot presumed to be a flavone glycoside and which, on the basis of colour and Rf only, appears to be similar to a compound occurring in J. flava. As in all other chromatograms there were a number of blue spots that may be hydroxycinnamic acids.

Section Ansellia

Only one population of J. angalloides was available (Table 19; Figure 21). Ten compounds were seen, the most conspicuous being a dark/yellow compound (spot 1). A number of other dark/yellow or dark spots were seen as well as three bright blue or blue/bright blue, presumably hydroxycinnamic acids.

Siphonoglossa

S. leptantha subsp. leptantha (Table 20; Figure 22) had the most complex phenolic pattern of all the species studied, with a number of a dark spots fluorescing yellow and a large number presumed to be hydroxycinnamic acids. Three of the spots (colourless/yellow, spot 8; dark/green-yellow, spot 20; and blue/blue, spot 23) appear to be similar to spots on chromatograms of J. protracta. If they are indeed the same compounds, it reinforces the hypothesis that Siphonoglossa is closely related to Justicia sect. Harnieria. This, however, is speculative at this stage.

Table 9: Survey of phenolics in *J. betonica*

SPOT NO.	COLOUR		rf X100	
	UV	UV + NH3	BAW	5% AA
1	dark	dark yellow	40	68
2	shiny blue	shiny blue	54	70
3	dark	green-yellow	52	78

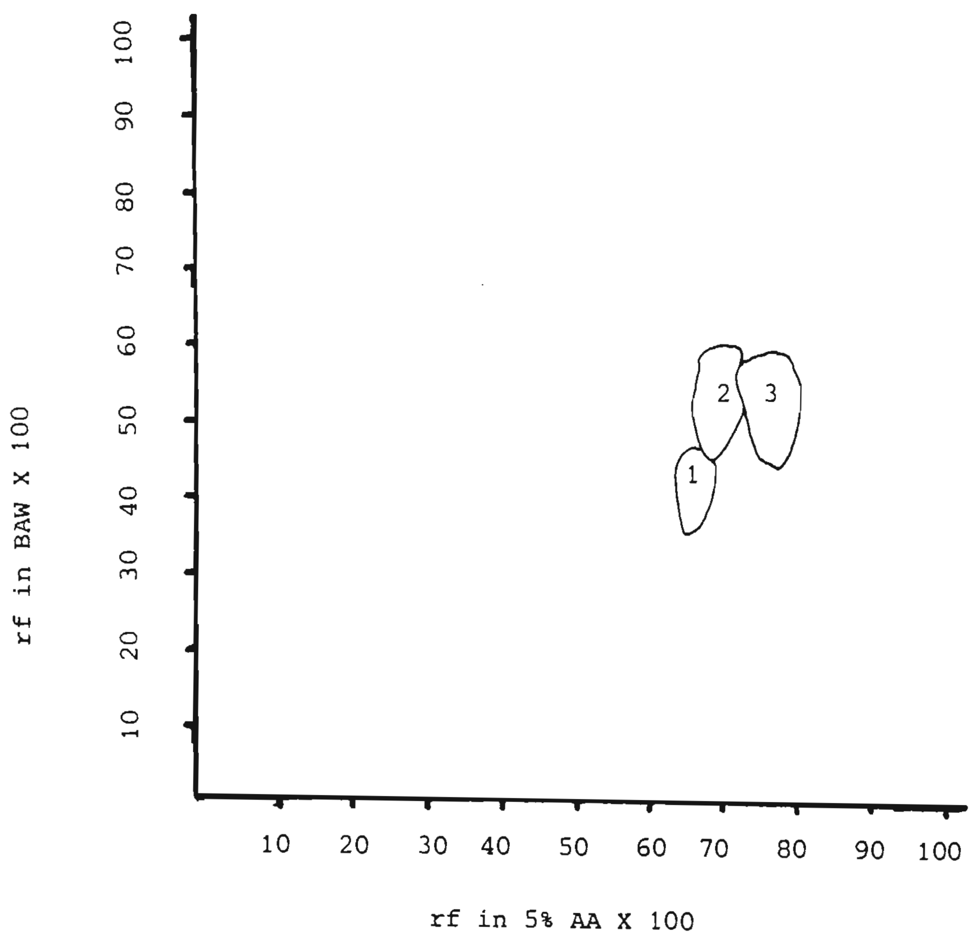


Figure 11. Diagram of phenolics in Justicia betonica

Only one population studied

Table 10: Survey of phenolics in _J. flava_

SPOT NO.	COLOUR		rf X100	
	UV	UV + NH3	BAW	5% AA
1	colourless	blue	79	13
2	colourless	colourless	76	54
3	colourless	pale yellow	51	41
4	colourless	bright yellow	35	49
5	dark	greenish yellow	11	37
6	dark	greenish yellow	56	34
7	dark	briht yellow	44	66
8	colourless	colourless	57	65
9	bright pink	bright pink	47	23
10	pinkish	pinkish	46	5
11	shiny blue	shiny blue	50	47
12	dark	buff	46	52
13	blue	blue	36	61
14	ice-white	shiny pale yellow	46	68
15	dark	dark	44	84
16	dark	deep violet	15	83
17	pink	pink	79	33

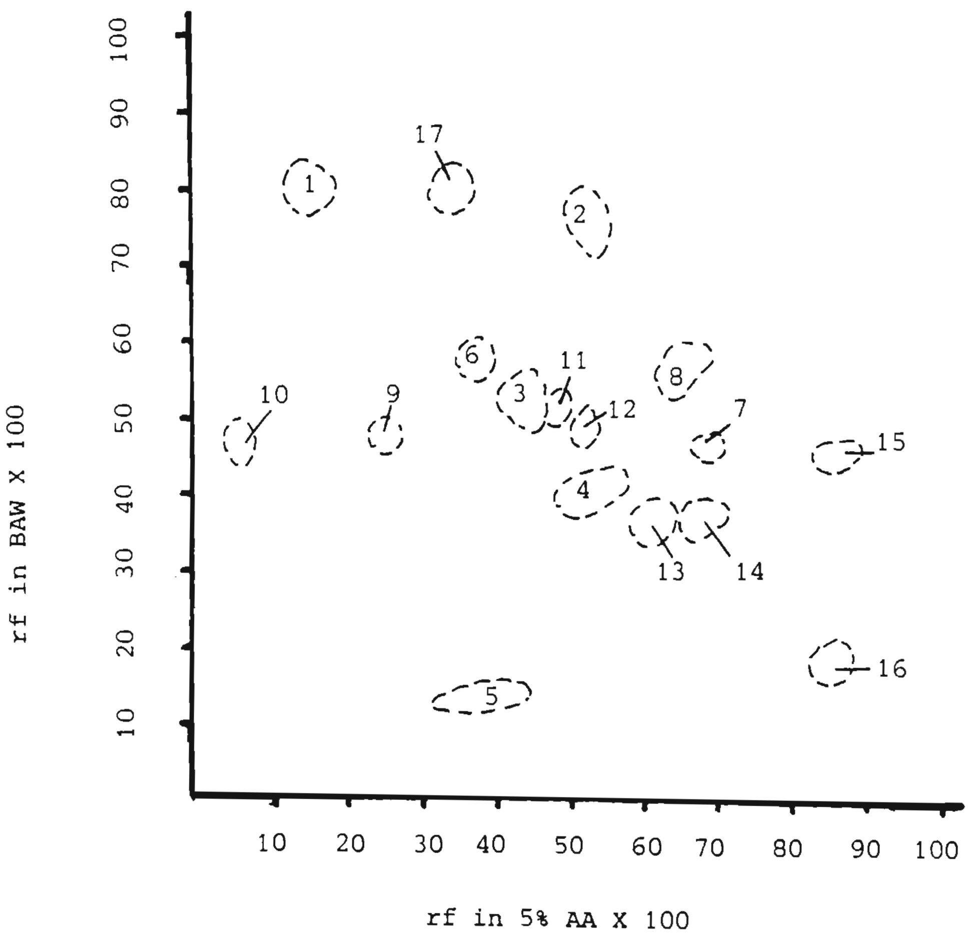


Figure 12. Composite diagram of phenolics in representative populations of *Justicia flava*

Solid lines — spots present in all populations studied

Dotted lines — spots present in some populations only

Table 11: Survey of phenolics in <u>J. petiolaris</u> subsp. <u>petiolaris</u>

SPOT NO.	COLOUR		rf X100	
	UV	UV + NH3	BAW	5% AA
1	colourless	bright blue	91	79
2	bright	bright greenish	81	73
3	colourless	pale yellow	79	84
4	colourless	colourless	59	65
5	blue	blue	15	88
6	colourless	colourless	81	47
7	colourless	blue	69	79
8	colourless	blue	92	48

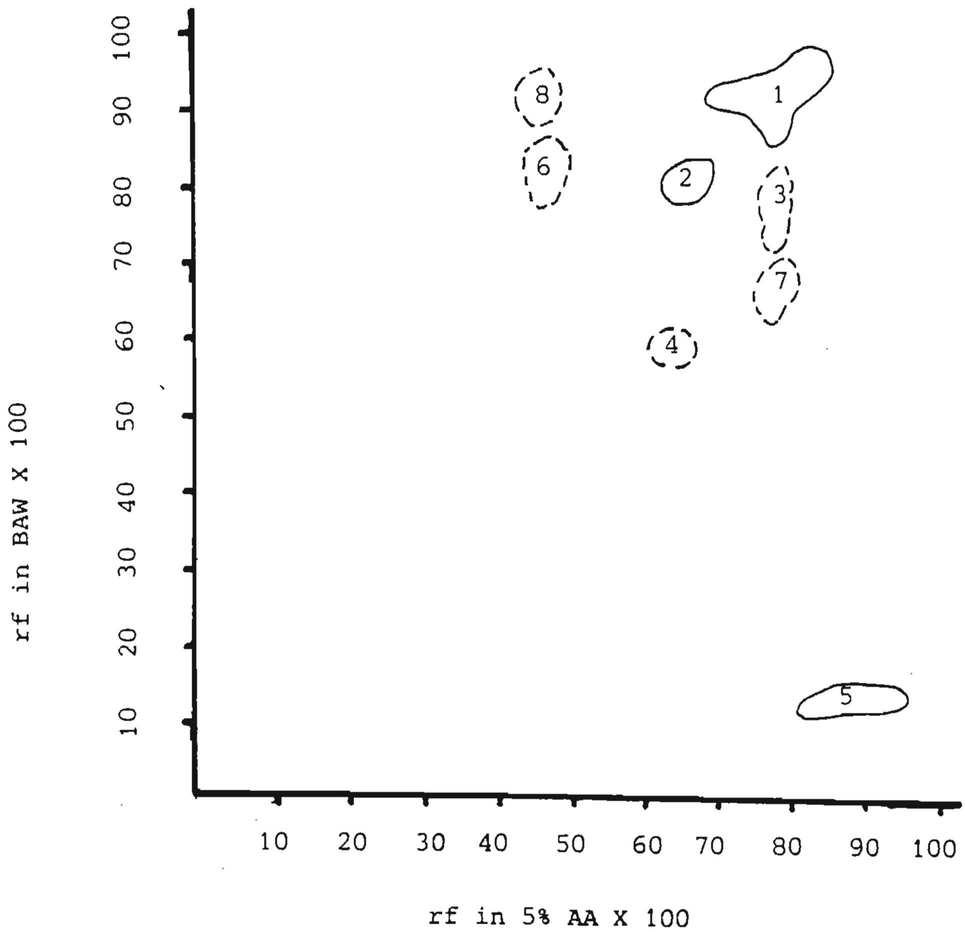


Figure 13. Composite diagram of phenolics in representative populations of Justicia petiolaris subsp. petiolaris

Solid lines — spots present in all populations studied

Dotted lines — spots present in some populations only

Table 12: Survey of phenolics in *J. petiolaris* subsp. *bowiei*

SPOT NO.	COLOUR		rf X100	
	UV	UV + NH3	BAW	5% AA
1	colourless	bright blue	88	81
2	bright	bright greenish	80	64
3	colourless	pale yellow	78	78
4	colourless	bluish	84	25
5	dark	yellow	44	63
6	colourless	colourless	52	55
7	colourless	colourless	51	66
8	blue	blue	7	87
9	colourless	colourless	79	45

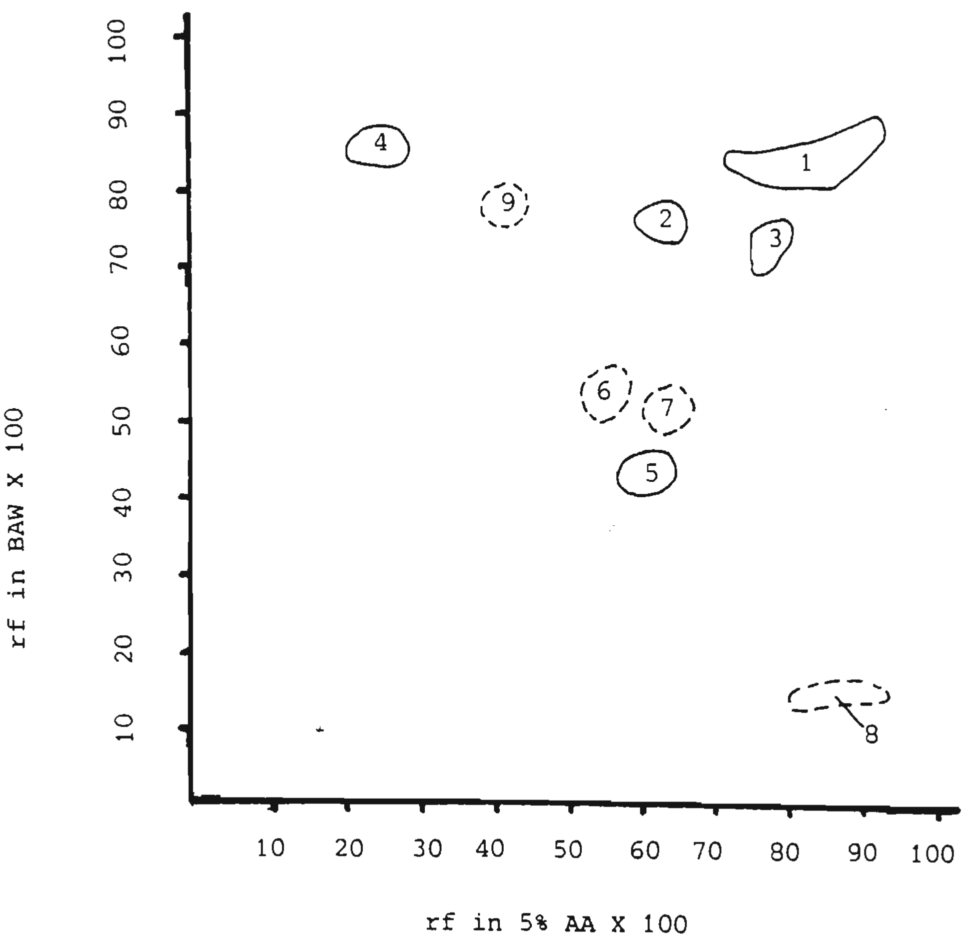


Figure 14. Composite diagram of phenolics in representative populations of <u>Justicia petiolaris</u> subsp. <u>bowiei</u>

Solid lines — spots present in all populations studied

Dotted lines — spots present in some populations only

Table 13: Survey of phenolics in <u>J. petiolaris</u> subsp. <u>incerta</u>

SPOT NO.	COLOUR		rf X100	
	UV	UV + NH3	BAW	5% AA
1	colourless	bright blue	90	79
2	bright	bright greenish	79	67
3	colourless	colourless	62	71

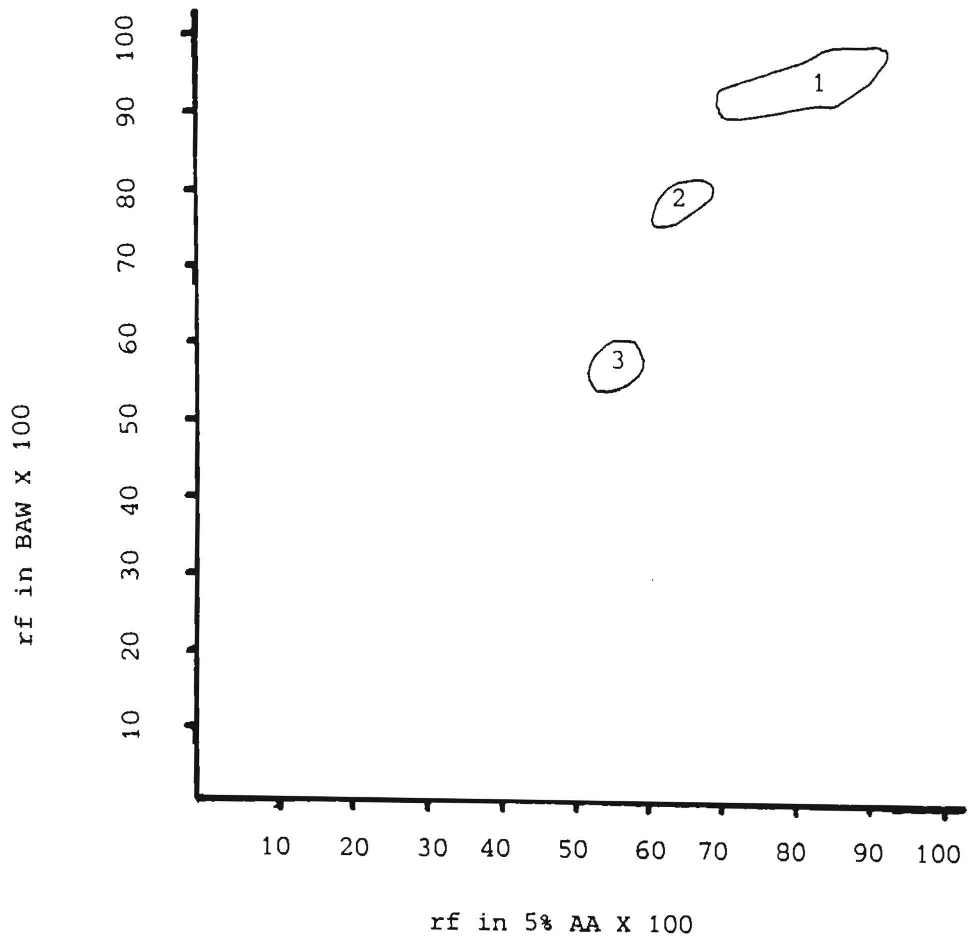


Figure 15. Diagram of phenolics in Justicia petiolaris subsp. incerta

Only one population studied

Table 14: Survey of phenolics in *J. capensis*

SPOT NO.	COLOUR		rf X100	
	UV	UV + NH3	BAW	5% AA
1	shiny	shiny	67	31
2	pale yellow	pale-yellow	68	0-25
3	colourless	blue	55	15
4	colourless	blue	35	39
5	colourless	yellow	27	25
6	dark	yellow	22	54
7	dark	green-yellow	27	77
8	blue	blue	88	20
9	colourless	blue	57	49
10	colourless	shiny blue	59	82
11	dark	yellow	31	26

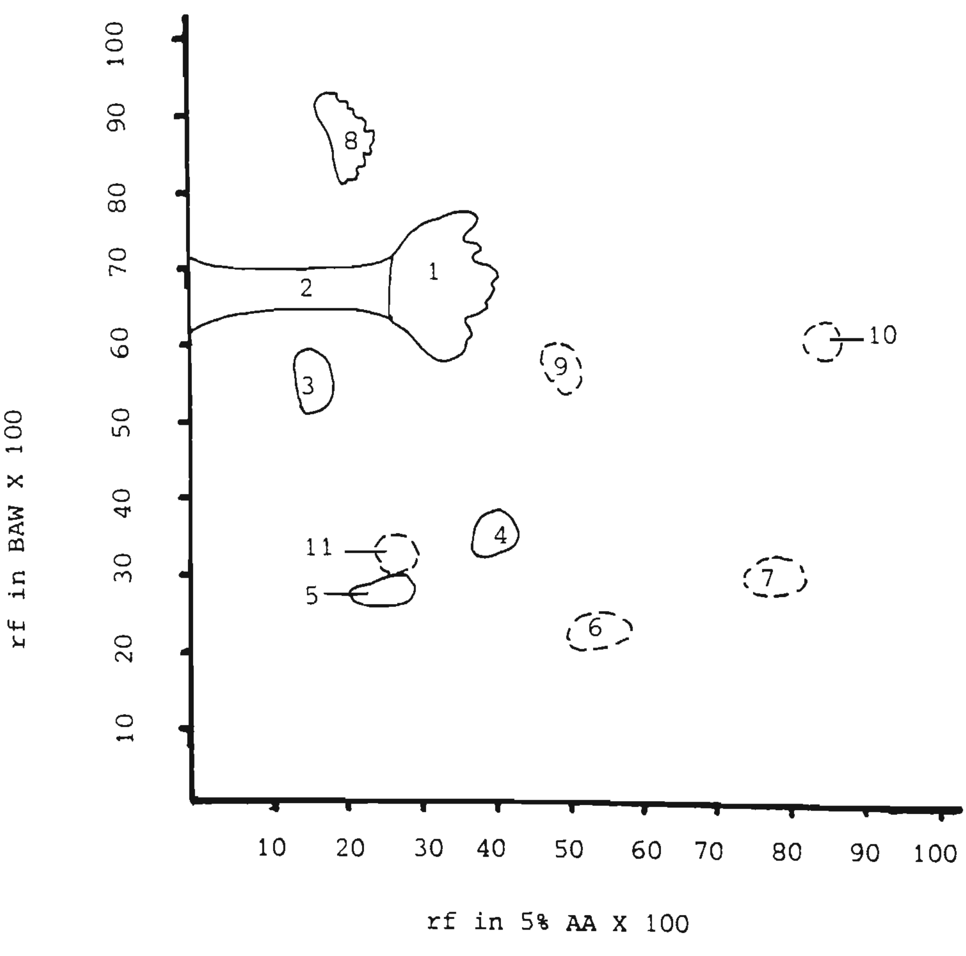


Figure 16. Composite diagram of phenolics in representative populations of Justicia capensis

Solid lines – spots present in all populations studied

Dotted lines – spots present in some populations only

Table 15: Survey of phenolics in <u>J. protracta</u>

SPOT NO.	COLOUR		rf X100	
	UV	UV + NH3	BAW	5% AA
1	dark	green-yellow	12	10
2	dark	green-yellow	35	9
3	dark	green-yellow	49	18
4	dark	bright yellow	15	33
5	dark	bright yellow	48	31
6	dark	bright yellow	62	45
7	dark	green-yellow	17	61
8	dark or colour-less	green-yellow	37	68
9	colourless	green-yellow	47	59
10	dark	green-yellow	57	62
11	blue or colour-less	blue	75	30
12	colourless	blue	76	56
13	blue or colour-less	blue	66	70
14	blue	blue	16	87
15	colourless	blue	85	70
16	blue	blue	71	78

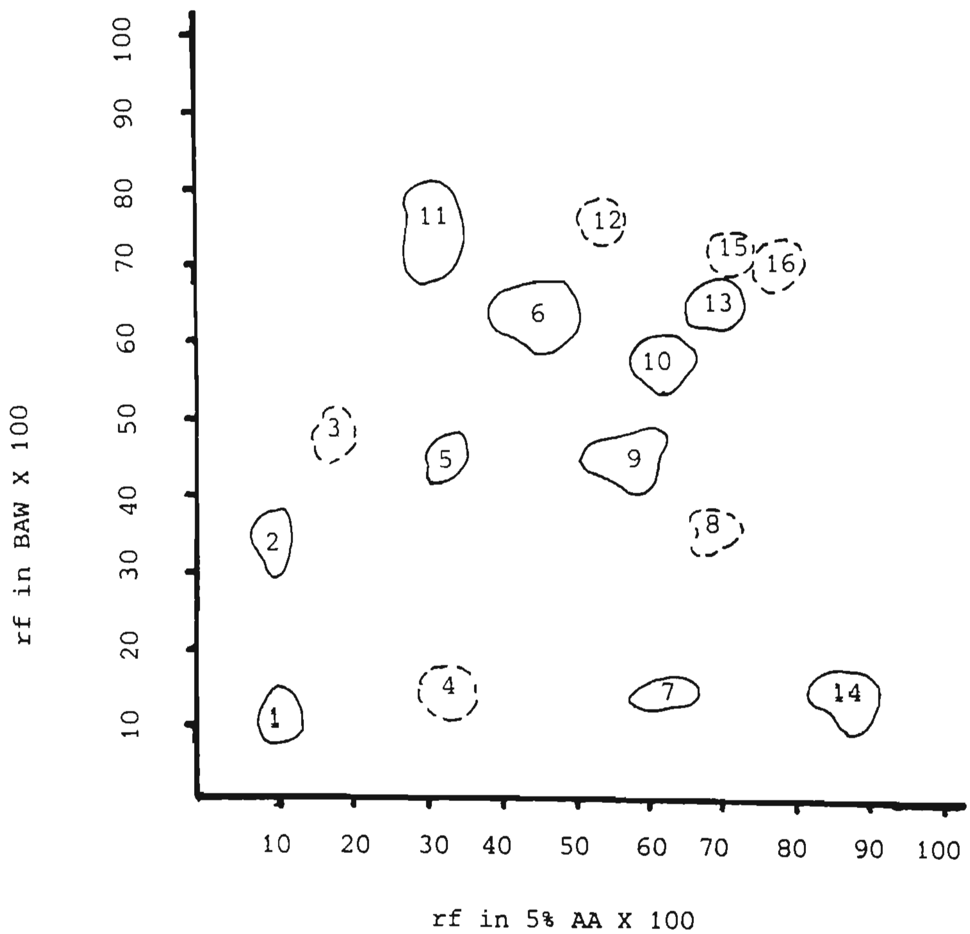


Figure 17. Composite diagram of phenolics in representative populations of <u>Justicia protracta</u> subsp. <u>protracta</u>

Solid lines — spots present in all populations studied

Dotted lines — spots present in some populations only

Table 16: Survey of phenolics in <u>J. campylostemon</u>

SPOT NO.	COLOUR		rf X100	
	UV	UV + NH3	BAW	5% AA
1	dark	yellow	62	17
2	dark	green-yellow	52	36
3	dark	dark-yellow	54	73
4	dark	dark	27	80

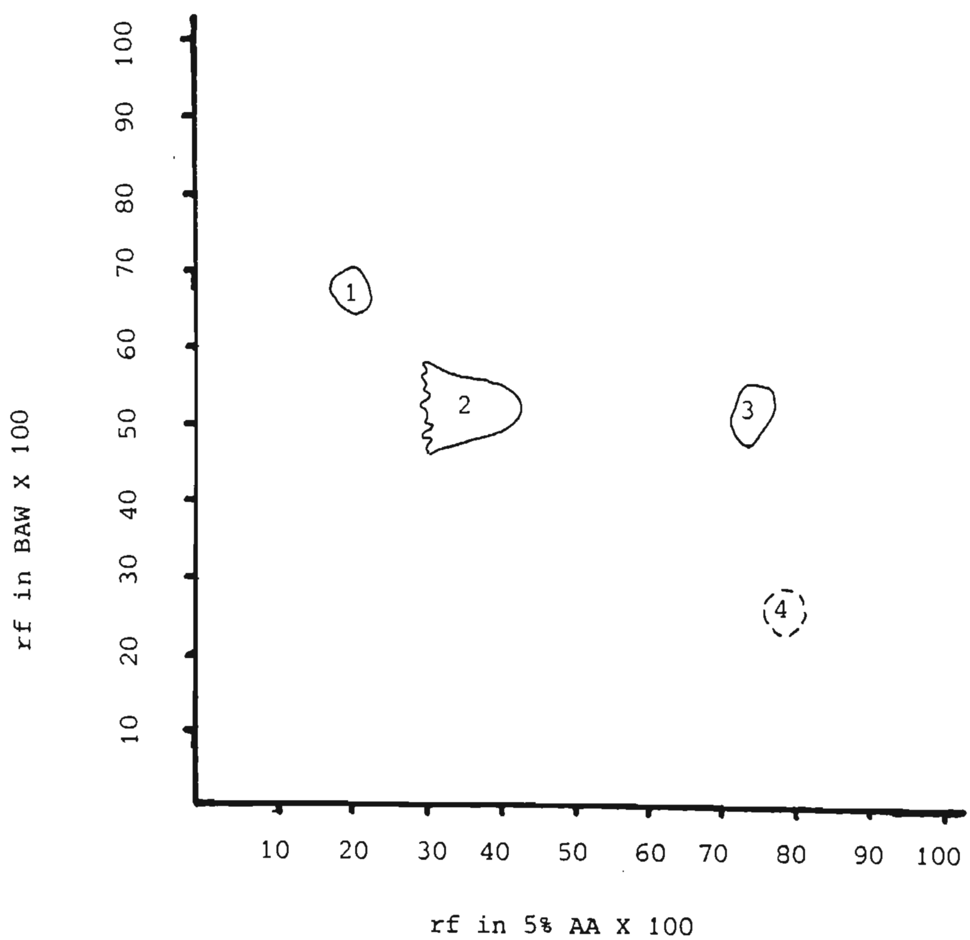


Figure 18. Composite diagram of phenolics in representative populations of _Justicia campylostemon_

Solid lines — spots present in all populations studied

Dotted lines — spots present in some populations only

Table 17: Survey of phenolics in <u>J. bolusii</u>

SPOT NO.	COLOUR		rf X100	
	UV	UV + NH3	BAW	5% AA
1	colourless	yellow	50-75	9
2	blue	purple	70-95	13
3	buff	buff	40-90	29
4	shiny blue	shiny blue	40-80	43
5	colourless	pale yellow	63	60
6	bright yellow	bright yellow	44	7
7	bright yellow	orange	28	6
8	dark	yellow	25	68
9	blue	blue	33	67
10	colourless	blue	41	78

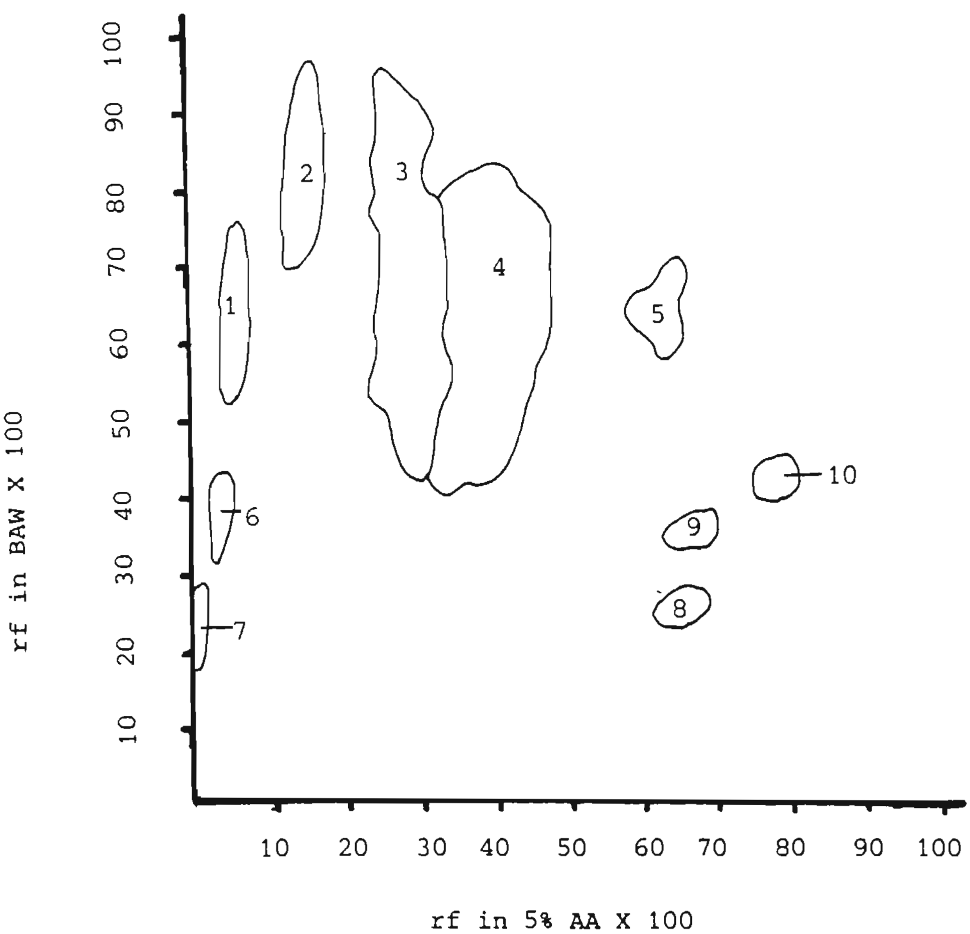


Figure 19. Diagram of phenolics in Justicia bolusii

Only one population studied

Table 18: Survey of phenolics in *J. minima*

SPOT NO.	COLOUR		rf X100	
	UV	UV + NH3	BAW	5% AA
1	colourless	pale yellow	87	9
2	dark	green-yellow	56	45
3	yellow	colourless	30	42
4	yellow	yellow	27	58
5	blue	blue	38	68
6	blue	blue	41	80
7	dark	yellow	33	83

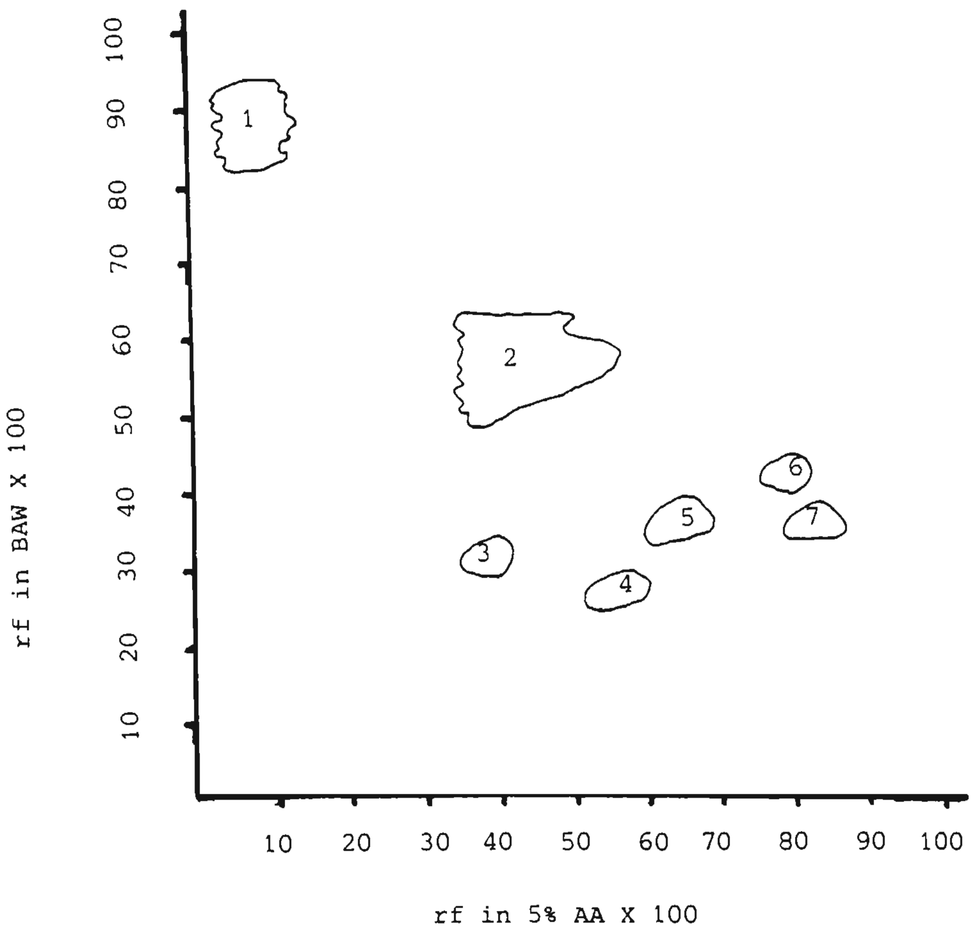


Figure 20. Diagram of phenolics in Justicia minima

Only one population studied

Table 19: Survey of phenolics in *J. anagalloides*

SPOT NO.	COLOUR		rf X100	
	UV	UV + NH3	BAW	5% AA
1	dark	dark yellow	76	33
2	dark	yellow	60	40
3	dark	dark	55	60
4	blue	colourless	50	64
5	blue	colourless	67	58
6	bright blue	bright blue	64	65
7	blue	colourless	60	73
8	colourless	bright blue	87	59
9	violet	violet	c.70	80
10	bright blue	bright blue	c.80	87

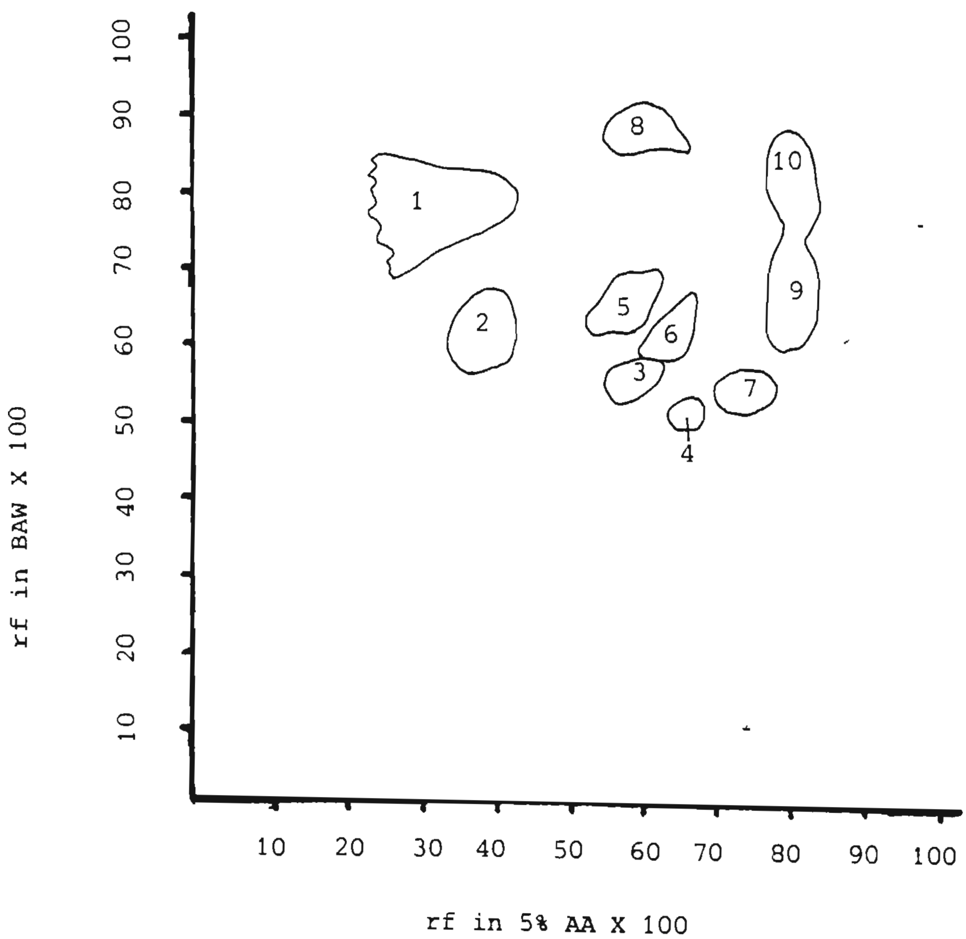


Figure 21. Diagram of phenolics in <u>Justicia anagalloides</u>

Only one population studied

Table 20: Survey of phenolics in *Siphonoglossa* subsp. *leptantha*

SPOT NO.	COLOUR		rf X100	
	UV	UV + NH3	BAW	5% AA
1	blue	bright greenish	17	53
2	dark	yellow	17	71
3	bright	bright greenish	34	73
4	dark	yellow	34	54
5	yellow	yellow	48	3
6	bright	bright violet	48	30
7	dark	dark yellow	48	48
8	blue	bright greenish	48	66
9	colourless	blue	48	82
10	yellow	yellow	58	2
11	dark	dark yellow	58	34
12	blue	bright greenish	58	65
13	dark	dark yellow	64	25
14	colourless	blue	64	60
15	colourless	blue	64	93
16	colourless	yellow	81	9
17	colourless	yellow	81	23
18	blue	blue	81	38
19	colourless	bright yellow	81	57
20	colourless	blue	81	75

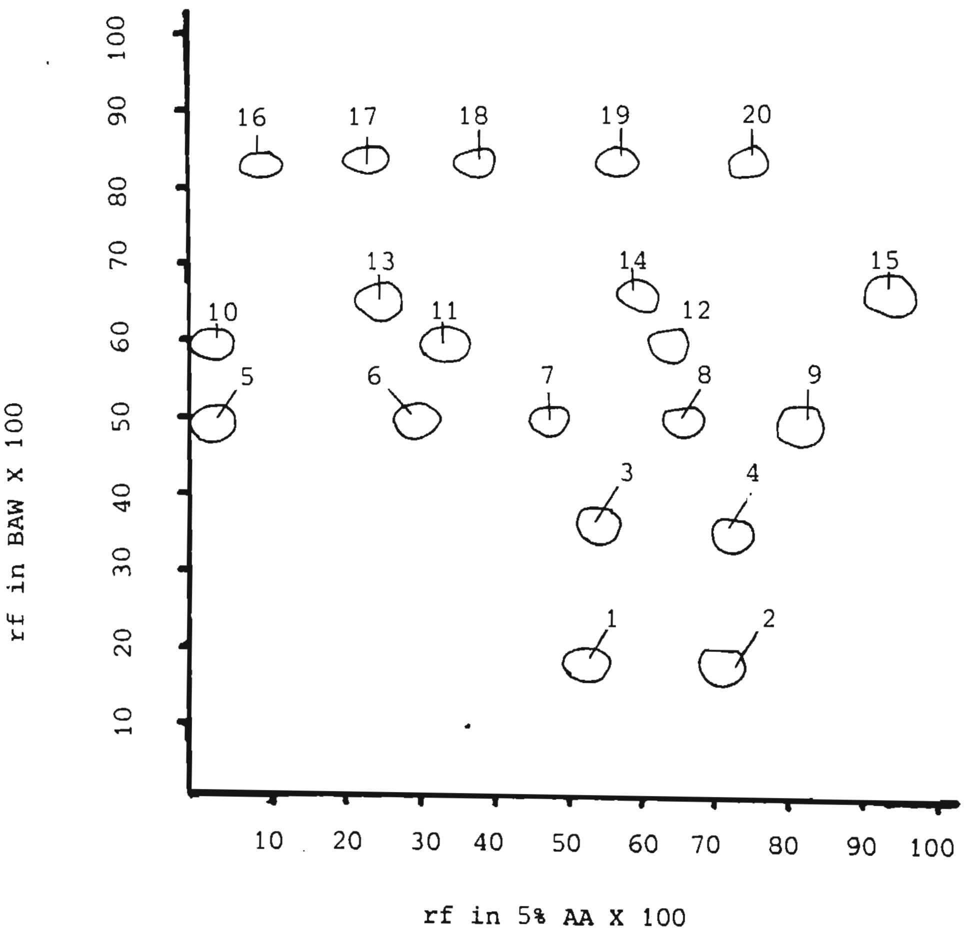


Figure 22. Diagram of phenolics in <u>Siphonoglossa leptantha</u> subsp. <u>leptantha</u>

Only one population studied

CHAPTER 4

SECTIONS OF JUSTICIA - EVALUATION OF TAXONOMIC EVIDENCE

The taxonomic evidence presented in Chapter 3 provided characters that were valuable in distinguishing species, but more striking correlations between inflorescence form, seed morphology and pollen were found. Largely on the basis of these three characters, the species studied were grouped into eight sections, some newly named.

The primitive inflorescence, as discussed in Ch. 3.4 is probably a dichasial cyme, which has been reduced to various degrees, and in some cases re-aggregated to form a more or less dense, always terminal synflorescence. This has been used extensively in the study in delimiting the sections of Justicia.

The pollen in the genus was found to be three- or two-colporate or two-porate, with entire (Figure 10:1) or areolate (Figure 10:2) margocolpi. The sexine is reticulate in all species, with a pseudo-colpus (colpoid streak) on either side of the colpus. The area between the colpus and the pseudocolpus is called the margocolpus, and may be either entire or divided into circular areolae (see Ch. 3.6). It was found that, in the southern African taxa at least, the inflorescence and pollen types were closely correlated and could be used to divide the genus into sections.

Seed surface, described simply as "rough" in earlier accounts of the genus, distinguishes it as a whole from Monechma. It is, however, very varied in the genus (see Ch. 3.8, for a full account), and under the SEM revealed a variety of useful characters.

In a number of cases seed surface also correlated with these divisions, which lent weight to their naturalness, as it was considered unlikely that a number of characters taken from three parts of the plant, viz. pollen, inflorescence and seeds, would have evolved in parallel. In some cases trends in flower, bracts, capsule and habit were also seen to correlate within the sections but these characters were given little weight by comparison with the three mentioned above. A key to and diagnoses of the sections is provided in Chapter 5.

The status of Siphonoglossa and Aulojusticia was re-examined and the light of evidence derived from this study, Aulojusticia is considered to be congeneric with Siphonoglossa.

The most primitive section in most respects was considered to be **sect. Gendarussa.** The inflorescence in both the southern African species is a lax, branching axillary cyme, and the pollen was three-colporate with entire margocolpi. The large, hard-walled capsules each contain four seeds. The seeds of the two species, however, differ greatly and, in J. glabra at least, may be considered highly advanced, as they are covered with barbed scales (pl. 3:1-5).

These sections were proposed on the basis of a study of southern African material only. However, as discussed in the Ch. 3.1 on distribution, Justicia is probably a tropical genus, with southern Africa being at the southern end of its distribution range. It was therefore considered of great importance to assess whether the apparent pattern seen in the southern African species also existed north of the borders. Seven tropical species were therefore selected from a number of the sections, their probable section being first assessed by examining the type of inflorescence present. The pollen of each was then viewed under the SEM and it was found that in nearly every case it was of the pollen type expected for the section in which they had provisionally been placed. In only one section (sect. Ansellia) was there a discrepency, where instead of the porate pollen expected, the pollen was shortly colporate, with the colpi being about half the length of the pollen grain.

From the three-colporate pollen with entire margocolpi and the laxly branching inflorescence of sect. Gendarussa, a number of lines of specialization can be traced. **Sect. Bolusia**, with one species, has retained the primitive pollen type, but the inflorescence has been reduced to an unbranched axillary cyme with about five sessile or shortly pedunculate flowers. This led to J. bolusii being placed in sect. Gendarussa when it was described by C.B. Clarke (1912) but, when the flowers, capsules and seeds were examined it could be seen that it was widely different from that section. The flowers have a pouched throat like that described for Monechma (Munday, 1980) and the capsules have one or two seeds. The seeds are smooth-surfaced, also as in Monechma. It was considered whether J. bolusii should therefore not be better placed in that genus than in Justicia, but the inflorescence and pollen are not those of a Monechma. Monechma usually has sessile cymes or single sessile or pedicellate flowers and has two-colporate areolate pollen. Monechma is here considered most closely related to sect. Harnieria, while J. bolusii is very similar to some East African species, e.g. J. cordata. The one or two smooth seeds and pouched corolla throat are considered to be a parallel adaptation in Monechma, rather than indicating relationship between it and J. bolusii. The pouched throat is also probably not homologous with that of Duvernoia which, on dissection, was seen to be a thickened solid swelling, rather than the hollow pouch of J. bolusii. Duvernoia also has the stamen filaments in channels in the upper lip, which is not the case in any Justicia species.

Sect. Orchioides and the section which follows (sect. Justicia) are of uncertain affinity and it would be necessary to examine tropical African species to be able to place them with any confidence. In the pollen of sect. Orchioides (four species) the number of colpi has been reduced to two, but each still has an entire margocolpus. The pollen often shows a slight equatorial constriction. The capsule is hard and woody, as in sects. Gendarussa and Bolusia, and there is usually only a single seed (rarely two). Pollen type and a single seed in the capsule together characterise the section. There is within the section a tendency to an increase in woodiness and to a reduction in the number of flowers in the cyme, the two trends progressing together, from e.g. J. guerkeana with numerous flowers in the cyme and rather softly shrubby stems, to J. orchioides, which has always solitary axillary flowers and is a hard-stemmed, sometimes spiny, shrublet. The bracts also tend towards reduction, being broad with green centres and white membranous margins in J. guerkeana and J. platysepala, but greatly reduced in J. orchioides and J. thymifolia.

Sect. Justicia consists of two species, the common and widespread J. betonica and the narrowly endemic J. montis-salinarum. The pollen is similar to that of sect. Gendarussa, but the inflorescence has been reduced to a single axillary flower. These flowers have been secondarily aggregated in J. betonica to form a dense, terminal "spike" with large, colourful, imbricate bracts, while in J. montis-salinarum the trend has been to further reduction. Here the bracts are small and subulate and the small flowers are sessile at each node, so that the inflorescence is a terminal spike or lax cyme. Although the two species placed in this section are very different superficially, they have the same pollen and inflorescence structure and an identical pattern in the seed testa. Since the similarity in inflorescence is not obvious at first and the pollen is of the primitive type, it would not be possible from these characters alone to postulate with confidence a relationship between two such dissimilar species. The seeds, however, have a sinuate surface unique in the genus and it was this which led to the decision to place the two species in the same section.

The section of Justicia with the most (six) species in southern Africa is **sect. Harnieria.** Both pollen and inflorescence are specialized with respect to the condition seen in sect. Gendarussa, the pollen being two-colporate and areolate and the inflorescence reduced to sessile axillary cymes with one to five flowers. The cymes are scattered in the leaf axils. The capsule is relatively small and thin-walled in some species, but larger and thick-walled in J. capensis and J. cuneata, and also shows trends towards specialization within the section. Usually it is four-seeded and cylindrical but in two species, J. dinteri and J. protracta there are one-seeded winged capsules present together with the normal capsules (see Ch. 3.8 on seeds). Seed surface varies greatly in the section, with J. capensis and J. cuneata again differing. All except these two in the section have papillate seeds, with a single papilla in the centre of each cell of the testa, but in J. capensis the seed testa is reticulate and in J. cuneata it is amorphous. These two species may need to be removed when the tropical African species are better known but, because they have the same pollen and the same or similar inflorescences as that section, they are temporarily placed in sect. Harnieria. In J. cuneata the inflorescence has been reduced to a single pedunculate flower, thus paralleling the trend also seen in sect. Gendarussa.

Sect. Rostullularia has three species and it and the following section, sect. Minima, have three-colporate, areolate pollen. The inflorescence of sect. Rostellularia is basically composed of sessile cymes, as in sect. Harnieria, but these are aggregated into a terminal compound "spike" with numerous flowers at each node. The flowers open sequentially so that the plant may remain in flower for some months. The capsules are relatively small and thin-walled with four seeds each. One of the major characteristics of the section is found in the seeds, which under the SEM are seen to have one to many cubic or rectangular crystals in each cell of the testa. This character is unique to the section. Bracts and bracteoles are somewhat reduced, often spatulate and glandular. The flowers are medium to large and either yellow or blue-mauve, but this may not prove important in the section when the tropical African species are examined.

Sect. Minima consists of only one species, the recently described J. minima Meeuse. It is a rare endemic from the Waterberg of the Transvaal and its affinities probably lie north of the border. It is not here considered closely related to any of the southern African species. Its pollen is similar to that of sect. Rostellularia, but its inflorescence is a terminal, unbranched, lax cyme and its calyx is four-lobed. The seed surface does not aid in placing it close to any other section as, although it is reticulate, this pattern is scattered in the genus, e.g. J. campylostemon (sect. Gendarussa) and J. capensis (sect. Harnieria) and therefore is not considered significant. The bracts are greatly reduced and the four-seeded capsule is small and thin-walled.

Two small herbaceous species, J. anselliana and J. anagalloides, are placed in **sect. Ansellia**. As in sect. Minima, they have elongated cymes, but these are axillary and not terminal and in J. anselliana are paired at each node. The calyx lobes are always five and not four. The capsules are thin-walled and four-seeded and are the smallest in the genus, as are the flowers and pollen. The bracts are reduced and subulate. The pollen is quite different from that of sect. Minima, being two-porate and areolate like that of sect. Harnieria. In are tropical African species there were short colpi present and it is considered probable that the porate condition seen in the two southern African species is derived from the colporate by gradual reduction of the colpus length.

CHAPTER 5

TAXONOMY OF *JUSTICIA*

Justicia L., Sp. Pl. 15 (1753); Roxburgh, Fl. Ind. 1: 115 (1820); Anderson in J. Linn. Soc., Bot. 7: 38 (1867); Hooker in Bentham & Hooker, Gen. 2: 1108 (1876); Clarke in Hooker, Fl. Brit. Ind. 4: 524 (1885); Trimen, Handbook Fl. Ceylon 3: 333 (1895); Lindau in Engler & Prantl, Natürl. Pflanzenf. 4,3b: 347 (1894); Clarke in Thiselton-Dyer, Fl. Trop. Afr. 5: 179 (1900), in Thiselton-Dyer, Fl. Cap. 5,1: 55 (1912); Andrews, Flower. Pl. Anglo-Egypt. Sudan 3: 177 (1956); Heine in Fl.W.Trop.Afr. 2: 426 (1963); Meyer in Fl. S.W.Afr. 130 (1968); Agnew, Upland Kenya Wild Flowers 601 (1974); Dyer, Gen. 1: 598 (1975); Compton, Fl. Swaziland 564 (1976). Type species uncertain: see page 7.

Gendarussa Nees in Wallich, Pl. Asiat. Rar. 3: 76, 105 (1832), in *Linnaea* 15: 366 (1841), partim.

Leptostachya Nees in Wallich, Pl. Asiat. Rar. 3: 76, 105 (1832), in DC., Prodr. 11: 376 (1847).

Raphidospora Nees in Wallich, Pl. Asiat. Rar. 3: 76, 105 (1832), in DC., Prodr. 11: 499 (1847); Lindau in Engler and Prantl, Natürl. Pflanzenf. 4,3b: 329 (1894).

Adhatoda Nees in DC., Prodr. 11: 384 (1847) p.p. excl. *A. leptantha*, *A. tubulosa*.

Nicoteba Lindau in Engler and Prantl, Natürl. Pflanzenf. 4,3b: 329 (1894).

Annual or perennial herbs or shrubs. *Leaves* opposite, simple, entire. *Inflorescence(s)* cymose, cymes pedunculate or sessile, lax or contracted, often approximated at ends of branches and then subtended by reduced floral leaves, or arranged in raceme-like compound cymes. *Bract* (0) 1, *bracteoles* 2, one or both may be reduced. *Calyx* 4- or 5-lobed to near base, with glandular and/or eglandular hairs. *Corolla* pilose outside, along rugula and at base of filaments inside, 2-lipped, with a short or long, cylindric or subcampanulate tube; upper lip very shortly two-lobed; lower lip deeply three-lobed, with a raised palate, palate with raised oblique ridges and a channel down the centre. *Stamens* 2, filaments attached to tube, arching inside upper lip with anthers adpressed to each other, later separating and becoming reflexed; anthers two-thecate with one theca above the other, lower theca with a well-defined whitish tail (this occasionally nearly absent in *J. campylostemon*). *Pollen* lenticular, two- or three-colporate or two-porate, sexine reticulate, forming a single or double row of raised areoles along a smooth area on either side of colpus, or with narrow to broad margocolpus on either side of colpus. *Ovary* two-locular with two ovules in each locule, some of which may abort; style lying inside a channel (rugula) in upper lip; stigma minutely two-lobed. Capsule cylindric or clavate, stipitate, hard or delicate in texture, four- or sometimes two- or one-seeded; seeds with testa usually rough, rarely smooth, without hygroscopic hairs, laterally compressed or subglobose.

In the area covered (South Africa, Botswana, Namibia, Swaziland, Transkei, Ciskei and Boputhatswana) 22 species and 6 subspecies are recognised. At least one species has been recorded from each of the major regions except the S.W. Cape, the Drakensberg and central Botswana. Many species are described as being heavily browsed, and the roots of J. odora are used by the Zulus to make scented beads.

The genus was named by Linnaeus after James Justice, a Scottish horticulturalist.

Justicia is a large and poorly known pantropical genus, from which numerous segregate genera at different times have been removed and often later recombined. The distribution of characters makes generic boundaries difficult to define. The sections have traditionally been defined on the basis of the inflorescence, and pollen and seed characters seem to bear this division out as being a natural one (Chapter 4). In the present study, eight sections are recognised.

5.1 KEY TO SECTIONS OF JUSTICIA

The synonomy of the sections is given below, together with a summary of those characters considered diagnostic and a key.

1a Pollen three-colporate; inflorescence of pedunculate lax axillary cymes, or sessile condensed cymes aggregated condensed into a terminal inflorescence 2

1b Pollen two-colporate or two-porate; inflorescence of axillary lax or condensed cymes 6

2a Pollen with entire margocolpi 3

2b Pollen areolate 5

3a Seeds one per capsule, smooth; inflorescence a simple axillary cyme; flowers with a pouched throat .... 6. sect. Bolusia

3b Seeds 4 per capsule, rough; inflorescence terminal or a compound axillary cyme; flowers without a pouched throat 4

4a Inflorescence terminal, an aggregate of sessile cymes, each usually reduced to a single flower; seed testa with shortly sinuate cells .... 8. sect. Justicia

4b Inflorescence axillary, a lax branching raceme-like compound cyme; seed testa either with long barbed scales or reticulate with each cell outlined by minute papillae .... 5. sect. Gendarussa

5a Calyx four-lobed; inflorescence a terminal elongated cyme; seeds without crystals in testa; flowers small and white .... 3. sect. Minima

5b Calyx five-lobed; inflorescence a terminal aggregate of sessile cymes; seeds with crystals in testa; flowers medium to large, yellow or blue .... 1. sect. Rostellularia

6a Pollen with entire margocolpi; shrubs, sometimes woody; cymes often reduced to a single axillary flower; bracts and leaves often reduced .... 7. sect. Orchioides

6b Pollen areolate; plants herbaceous or shrubby; inflorescence rarely reduced to a single flower 7

7a Pollen porate, small (22-36 um long); inflorescence an axillary elongate cyme; flowers white, small; herbaceous .... 2. sect. Ansellia

7b Pollen colporate, medium-sized (34-60 um long); inflorescence of axillary sessile cymes; flowers and habit various .... 4. sect. Harnieria

5.2 SYNOPSES OF SECTIONS OF JUSTICIA

1. **Sect. Rostellularia** (Reichb.f.) C.B. Cl. in Thiselton-Dyer, Fl. Trop. Afr. 5: 180 (1900), in Thiselton-Dyer, Fl.Cap. 5,1: 56 (1912) p.p. excl. J. spergulaefolia.

   Rostellularia Reichb. f., Handb. 190 (1837); Nees in DC., Prodr. 11: 386 (1847). Type species: R. procumbens (L.) Nees (lecto., Bremek.) (is synonymous with J. diffusa in Burkill & Clarke (1900)).

   Rostellaria Nees in Wallich, Pl. Asiat. rar. 3: 76, 100 (1832) non Gaertn. (1805) (Sapotaceae).

   Justicia sect. Rostellaria (Nees) T. Anders. in J. Linn. Soc., Bot. 7: 38 (1864); Hooker in Bentham & Hooker, Gen. Pl. 1109 (1876).

   Tyloglossa Hochst. in Flora 26: 72 (1843).

   Adhatoda sect. Tyloglossa (Hochst.) Nees in DC., Prodr. 11: 389 (1847) p.p. quoad J. flava, J. petiolaris, J. fasciata (only southern African names considered).

   Justicia sect. Tyloglossa (Hochst.) Lindau in Engler & Prantl, Nat. Pflanzenf. 4,3b: 349 (1894).

DIAGNOSTIC CHARACTERS

Inflorescence terminal, a dense or lax aggregate of sessile axillary cymes. Bract and bracteoles reduced, oblanceolate to obovate. Pollen three-colporate, areolate. Seeds four, rough, with crystals in testa.

A well-defined section. The inflorescence of J. petiolaris subspp. incerta and bowiei tends towards that of sect. Harnieria, but the pollen and seeds are quite different.

Species included: J. flava, J. kirkiana, J. petiolaris.

2. **Sect. Ansellia** Burkill & Clarke in Thiselton-Dyer Fl. Trop. Afr. 5: 183 (1900), in Thiselton-Dyer, Fl. Cap. 5,1: 57 (1912). Type species: None designated by Clarke. Lectotype: J. anselliana.

DIAGNOSTIC CHARACTERS

Inflorescence axillary, of elongated cymes on slender peduncles. Bract and bracteoles greatly reduced, subulate. Pollen two-porate, areolate. Seeds four, rough. Herbaceous, may be annual or creeping and rooting at the nodes.

This is also a well-defined section. Its inflorescence and flowers resemble those of sect. Minima, but the inflorescences are axillary not terminal, the calyx is five-lobed and the pollen is quite different.

Species included: J. anselliana, J. anagalloides, J. crassiradix.

3. **Sect. Minima** Immelman sect. nov. Type species: J. minima Meeuse.

DIAGNOSTIC CHARACTERS

Inflorescence a terminal, elongate, unbranched cyme. Bracts and bracteoles reduced and subulate. Calyx four-lobed. Pollen three-colporate, areolate. Seeds four, rough.

The section is distinguished from all others in southern Africa by the four-lobed calyx, the adaxial lobe being absent, and by the terminal elongated cymes.

Species included: J. minima.

4. **Sect. Harnieria** (Solms-Laubach) Hooker f. in Bentham & Hooker, Gen. Pl. 1109 (1876).

Harnieria Solms-Laub., Sitzungsber. Ges. Naturf. Freunde Berlin 1864: 21 (1864). Type species: Harnieria dimorphocarpa Solms-Laub.

Justicia sect. Calophanoides subsect. Harnieria (Solms-Laub.) Burkill & Clarke in Thiselton-Dyer, Fl. Trop. Afr. 5: 189 (1900).

Justicia sect. Calophanoides Burkill & Clarke in Thiselton-Dyer, Fl.Trop.Afr. 5: 181 (1900), in Thiselton-Dyer, Fl. Cap. 5,1: 56 (1912) p.p. excl. J. cuneata.

Calophanoides (C.B.Cl.) Ridley in Fl. Malay. Penins. 2: 592 (1923).

DIAGNOSTIC CHARACTERS

Inflorescence of scattered axillary cymes, or these reduced to a single flower. Bracts foliose but not enlarged, bracteoles reduced and subulate or absent. Pollen two-colporate, areolate. Seeds four, or only one in the dimorphic capsules of J. dinteri and (rarely) J. protracta.

This is possibly not a natural group, and J. capensis, J. cuneata and J. odora may not belong here. Characterised mainly by the pollen and inflorescence, but the species differ greatly in their seeds. In J. cuneata the inflorescence is reduced to a single pedunculate axillary flower. The seeds in J. dinteri, J. protracta and J. parvibracteata are papillate.

Species included: J. protracta, J. dinteri, J. parvibracteata, J. capensis, J. odora, J. cuneata.

5. **Sect. Gendarussa** (Nees) Hook.f. in Bentham & Hooker, Gen. Pl. 1109 (1876); Burkill & Clarke in Thiselton-Dyer, Fl. Trop. Afr. 5: 183 (1900) p.p., in Fl. Cap. 5,1: 57 (1912) p.p. excl. J. bolusii.

Gendarussa Nees in Wallich, Pl. Asiat. rar. 3: 76, 103 (1832). Type species: Gendarussa vulgaris Nees (lecto.)

Raphidospora Nees in Wallich, Pl. Asiat. rar. 3: 115 (1832), in DC., Prodr. 11: 499 (1847); Anderson in J. Linn. Soc., Bot. 7: 43 (1867); Lindau in Engler & Prantl, Natürl. Pflanzenf. 4, 3b: 329 (1894).

DIAGNOSTIC CHARACTERS

Inflorescence of axillary branching cymes. Bracts reduced, subulate. Pollen three-colporate, with entire margocolpi. Seeds four, reticulate or with long barbed scales.

The section is characterised by the pollen and inflorescence, both of which are considered to be the primitive state in the genus. The two species included, however, differ greatly in seeds.

Species included: J. campylostemon, J. glabra.

6. **Sect. Bolusia** Immelman, sect. nov. Type species: J. bolusii C.B. Cl.

DIAGNOSTIC CHARACTERS

Inflorescence of stout-peduncled axillary elongated cymes. Bracts and bracteoles reduced and subulate. Flowers hooded, with pouched throat. Pollen three-colporate, with entire margocolpi. Seeds one(two), smooth. Shrubby, with suckers from stems below ground.

J. bolusii had formerly been included in sect. Gendarussa, but differs in the single smooth seed, the pouched corolla throat and the unbranched inflorescence. It is therefore placed in a section of its own.

Species included: J. bolusii.

7. **Sect. Orchioides** Immelman sect. nov. Type species: J. orchioides L.f.

DIAGNOSTIC CHARACTERS

Inflorescence of scattered axillary cymes, these shortly pedunculate, may be reduced to a single pedunculate flower. Bracts and bracteoles reduced and subulate or large and lanceolate to broadly obovate with membranous margins and apiculate apex. Pollen two-colporate, with entire margocolpus. Seeds one(two), rough. Shrubby.

The pollen and the (usually) single seed are characteristic of the section. There is also a tendency within the section to an increase in woodiness, and to a reduced number of flowers in the cyme.

Species included: J. orchioides, J. platysepala, J. guerkeana, J. thymifolia.

8. **Sect. Justicia**

Justicia sect. Betonica, T.Anders. in J. Linn. Soc., Bot. 7: 38 (1864); Hooker in Bentham & Hooker, Gen. Pl. 1109 (1876); Burkill & Clarke in Thiselton-Dyer, Fl. Trop. Afr. 5: 180 (1900), in Thiselton-Dyer, Fl. Cap. 5,1: 56 (1912).

Nicoteba Lindau in Engler & Prantl, Natürl. Pflanzenfam. 4, 3b: 329 (1894).

DIAGNOSTIC CHARACTERS

Inflorescence a terminal spike-like aggregate of reduced axillary cymes. Bract and bracteoles reduced and subulate or large and green-veined. Pollen 3-colporate, with entire margocolpi. Seeds 4, rough.

Although the two species placed in this section are very different superficially, they have the same pollen and inflorescence structure, and an identical pattern in the seed testa. The section is distinguished from sect. Rostellularia in having pollen with entire margocolpi, though the inflorescences are similar in structure.

Species included: J. betonica, J. montis-salinarum.

5.3 KEY TO SPECIES AND SUBSPECIES OF *JUSTICIA*

Note: Corolla length is taken from base to tip of upper lip.

1a Bracts and bracteoles whitish with green veining; inflorescence a terminal strobilate spike-like aggregate of cymes, each cyme usually reduced to a single flower .... 4. *J. betonica*

1b Bracts and bracteoles without contrasting veining; inflorescence various but not strobilate 2

2a Inflorescence of sessile axillary cymes, either scattered or approximated at ends of branches 3

2b Inflorescence of long-pedunculate cymes, axillary or terminal, or flowers in axillary raceme like cymes 27

3a Cymes each reduced to a single pedunculate flower, with a pair of reduced subulate or triangular bracteoles; woody shrublets 4

3b Cymes two- or more-flowered or reduced to a single sessile flower; bracts usually broad, sometimes reduced; habit various 9

4a Corolla shorter than 10 mm 5

4b Corolla longer than 10 mm 6

5a Bracts, stem and inside of calyx with stiff, opaque, white hairs; Port Elizabeth district .... 15a. *J. orchioides* subsp. *orchioides*

5b Bracts, stem and inside of calyx glabrous or with short stout pyramidal papillae; widespread in Karoo, O.F.S., and S.W. Transvaal .... 15b. *J. orchioides* subsp. *glabrata*

6a Corolla 20-30 mm long; N. Cape .... 16. *J. thymifolia*

6b Corolla 10-21 mm long; Karoo, E. Cape and Namibia, rarely in N. Cape 7

7a Upper lip only slightly hooded 8

7b Upper lip deeply hooded 11

8a Bracts, stem and inside of calyx with stiff, opaque, white hairs; Port Elizabeth district .... 15a. *J. orchioides* subsp. *orchioides*

8b Bracts, stem and inside of calyx glabrous or with short stout pyramidal papillae; widespread in Karoo, O.F.S., and S.W. Transvaal .... 15b. J. orchioides subsp. glabrata

9a Stems and leaves puberulous with swollen hairs; in Namibia, rare .... 14c. J. cuneata subsp. hoerleiniana

9b Stems and leaves glabrous or, if puberulous, then hairs not swollen; widespread and common in drier areas of South Africa but not in Namibia 10

10a Vegetative parts densely and minutely puberulous, inside of calyx lobes glabrous; widespread .... 14b. J. cuneata subsp. latifolia

10b Plant glabrous except for long hairs on stems and inside of calyx lobes; Port Elizabeth district only .... 14a. J. cuneata subsp. cuneata

11a Cymes in axils of normal leaves, well separated 12

11b Cymes in axils of reduced, bract-like leaves, approximated .. towards ends of branches 23

12a Flowers blue 13

12b Flowers yellow, mauve or white 14

13a Corolla 11-20 mm long; E. Cape .... 8b. J. petiolaris subsp. bowiei

13b Corolla 8-13 mm long; Natal and Transvaal .... 8c. J. petiolaris subsp. incerta

14a Flowers bright yellow .... 12. J. odora

14b Flowers cream, white or mauve 15

15a Flowers mauve, palate often white 16

15b Flowers cream or white, sometimes striped with mauve 18

16a Annual; long cottony hairs on bracts and calyx; capsules dimorphic .... 11. J. dinteri

16b Perennial; glabrous or hairs short; only one type of capsule present 17

17a Leaves leathery in texture, usually slightly obovate; palate white without mauve stripes; capsule up to 19 mm long, hard .... 13. J. capensis

17b Leaves not leathery, very variable in shape but usually lanceolate to ovate; palate usually white with mauve stripes; capsule up to 10 mm long, delicate in texture .... 9a. J. protracta subsp. protracta

18a Annual; long cottony hairs on bracts and calyx; capsules dimorphic .... 11. J. dinteri

18b Perennial; bracts and calyx glabrous or with short hairs; only one type of capsule present 19

19a Capsule four-seeded; bracts and calyx without broad membranous margins; E. Botswana, Transvaal, Swaziland, Natal, Cape, Transkei, very rarely in Namibia 20

19b Capsule one- or two-seeded; bracts and calyx with relatively broad membranous margins; in Namibia only 22

20a Bract minute, subulate or triangular; N. Cape with one record from N. Transvaal .... 10. J. parvibracteata

20b Bract large and foliose; widespread but not in N. Cape ... 21

21a All parts densely and minutely puberulous with 2-celled hairs .... 9b. J. protracta subsp. rhodesiana

21b All parts with medium to long multicellular hairs .... 9a. J. protracta subsp. protracta

22a Leaves, at least when young, sparsely to densely pubescent, not three- to five-veined from base; Namibia, mainly north of Windhoek .... 17. J. platysepala

22b Leaves glabrous at all stages, three- to five-veined from base; Namibia, mainly south of Windhoek .... 18. J. guerkeana

23a Flowers yellow 24

23b Flowers blue to blue-mauve 25

24a Annual; bracts and calyx with long cottony hairs; N. Botswana .... 7. J. kirkiana

24b Perennial; bracts and calyx usually densely pubescent but hairs not long and cottony; E. Botswana, Transvaal, Swaziland, Natal, Transkei .... 6. J. flava

25a Leaves usually longer than 50 mm, 20-70 mm wide, apex slightly attenuate; cymes of terminal inflorescence densely crowded .... 8a. J. petiolaris subsp. petiolaris

25b Leaves usually shorter than 50 mm, 9-24 mm wide, apex obtuse or acute but never attenuate; cymes of terminal inflorescence well separated especially towards base of inflorescence ... 26

26a Corolla 11-20 mm long; E. Cape .... 8b. J. petiolaris subsp. bowiei

26b Corolla 8-13 mm long; Natal and Transvaal .... 8c J. petiolaris subsp. incerta

27a Inflorescence axillary 28

27b Inflorescence terminal 34

28a Inflorescence an elongate cyme with sessile flowers; flowers shorter than 8 mm; plants herbaceous, often prostrate 29

28b Inflorescence a lax or reduced raceme-like compound cyme with sessile or pedicellate flowers; flowers longer than 8 mm; plants suffruticose, erect 32

29a Annual; cymes usually two per node; corolla 3-5 mm long .... 22. J. anselliana

29b Perennial; cymes usually one per node or cymes branching laxly; corolla (5)6-8 mm long 30

30a Cymes branching laxly; erect shrub .... 1. J. glabra

30b Cymes with sessile flowers on the floral axis; prostrate 31

31a Plant with long scaley stolons; growing in marshy areas in northern Namibia .... 21. J. crassiradix

31b Plant with stems often prostrate and rooting but not forming long bare stolons; growing in grassveld in Transvaal, Swaziland and Natal .... 20. J. anagalloides

32a "Racemes" reduced and spike-like with 5-6 subsessile flowers crowded towards apex of a relatively stout peduncle; corolla throat with a small pouch; bracts and calyx densely pubescent; capsule one-seeded; seeds smooth .... 3. J. bolusii

32b "Racemes" usually laxly branching (except in depauperate specimens); flowers pedicellate or sessile; bracts and calyx glabrous or with a few hairs; capsule four-seeded; seeds rough 33

33a Flowers with upper lip not hooded; seeds with long barbed scales, N. Botswana, N. Transvaal and N. Zululand .... 1. J. glabra

33b Flowers with upper lip hooded; seeds without scales; widespread from N. Transvaal to Somerset West in the Cape Province .... 2. J. campylostemon

34a Calyx four-lobed; hairs, if present, long and multicellular; Waterberg (Transvaal) .... 19. J. minima

34b Calyx five-lobed; all parts sparsely to densely puberulous; Soutpansberg (Transvaal) .... 5. J. montis-salinarum

5.4 DESCRIPTION OF SPECIES AND SUBSPECIES OF JUSTICIA

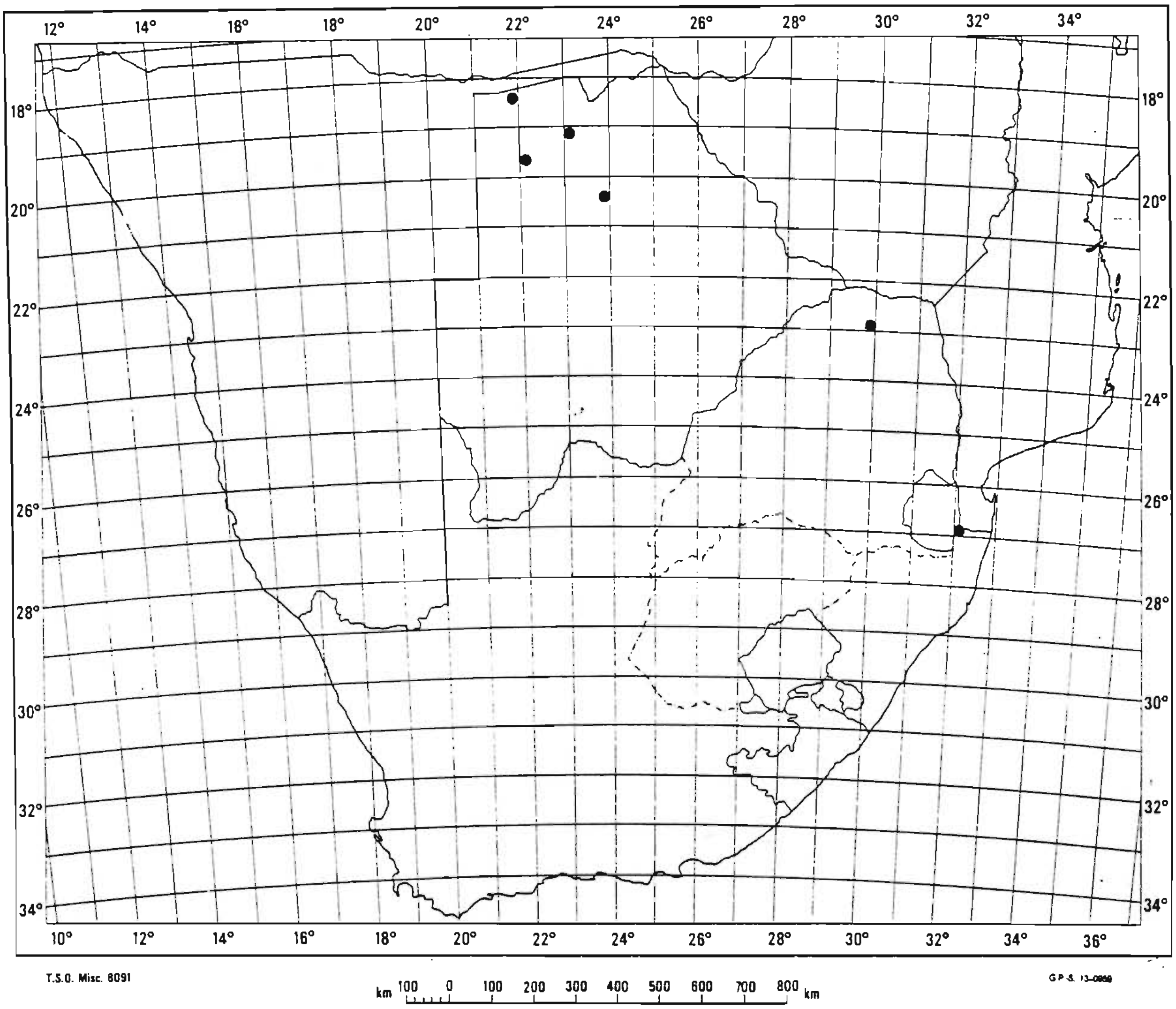
1. **Justicia glabra** Koenig ex Roxb. in Fl. Ind. 1: (1820); Anderson in J. Linn. Soc., 9: 516 (1867); Clarke in Hooker, Fl. Brit. Ind. 4: 535 (1885); Trimen, Handbook Fl. Ceylon 3: 336 (1895); Burkill & Clarke in Thiselton-Dyer, Fl. Trop. Afr. 5: 208 (1900); Andrews, Fl. Pl. Anglo-Egypt. Sudan 3: 179 (1956); Heine in Fl. W. Trop. Afr. 2: 418 (1963); Binns, First Checklist Herb. Fl. Malawi 14 (1968); Agnew, Upland Kenya Wild Flowers 604 (1974). Type: Coromandel, near Tanjore, Koenig s.n. (BM, holo!).

Raphidospora glabra Nees in Wallich, Pl. Asiat. Rar. 3: 115 (1830), in DC., Prodr. 11: 499 (1847).

Herb with woody rootstock and annual stems, 0,3-1,3 m high. Leaves pilose with hairs denser along margins, lanceolate to broadly ovate, 46-115 x 31-86 mm, apex attenuate, base cuneate to cordate; petiole slender, 6-56 mm long. Inflorescence of raceme-like compound cymes, axillary, branching, each branch subtended by a pair of minute subulate bracts, with 2-3 sessile or pedicellate flowers at end of each branch; peduncles and pedicels glandular. Bract 1, bracteoles 2, minute, lanceolate or subulate. Corolla with upper lip not hooded, 6-11 mm long, purplish brown or cream striped pink on palate. Capsule four-seeded, cylindrical, up to 13 mm long, with a long stipe. Seeds four, with testa produced into long, retorsely barbed scales. Pollen three-colporate 41-50 um long, sexine with entire margocolpus. (Figure 4.1, Map 1)

Widespread in tropical Africa and India; in the area under study it is found only in northern Botswana, the northern Transvaal and the extreme north of Natal, growing in riverine woodland.

The seeds of J. glabra have an unusual testa. In all the southern African species of Justicia the testa is either smooth or variously rugose, but the rugose pattern is formed by single cells. In J. glabra the testa is produced into numerous long multicellular structures (scales) (Plate 3: 1-5), with the individual cells forming retrose barbs on the surface of the scales. These are longer towards the apex of the seed (away from



Map 1. Recorded distribution of <u>J. glabra</u>

the point of attachment to the retinaculum). In J. campylostemon the testa is reticulate, without scales. The two species differ also in the flowers, those of J. glabra being smaller and not hooded.

Vouchers: Biegel, Muller & Gibbs Russell 5041: Lambrecht 93; Pooley 454 (NH, NU); Smith 1256, 1700, 2734; Tinley 772 (NU).

2. **Justicia campylostemon** (Nees) T. Anders.in J. Linn. Soc., Bot. 7: 44 (1868); Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 64 (1912); Gibson, Wild Fl. Natal (Coastal Region) pl. 99,6 (1975); Compton, Fl. Swaziland 564 (1976). Type: Natal, in shade at mouth of Umsikaba River (spec. 1 only), Drége s.n. (G-DC, lecto.; microfiche in PRE!). Figure 23.

Leptostachya campylostemon Nees in DC., Prodr. 11: 378 (1874).

Raphidospora campylostemon (Nees) Lindau in Engler & Prantl, Natürl. Pflanzenfam. 4,3b: 329 (1894).

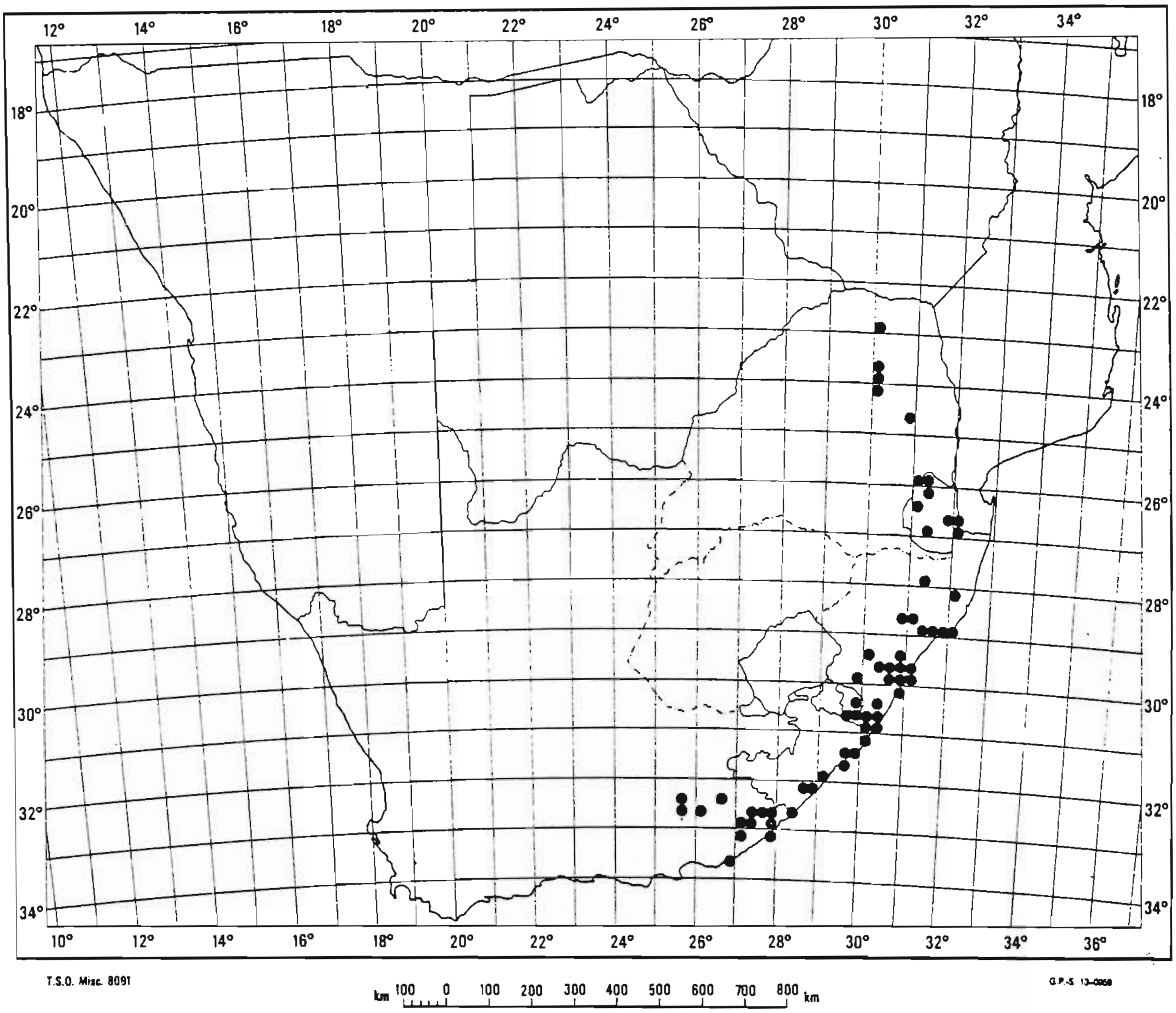
Shrub or shrublet, rarely scrambling, 0,3-3,0 (-7) m high. Leaves glabrous to sparsely pubescent, ovate to lanceolate, 20-190 x 13-84 mm, apex obtuse or usually broadly attenuate, base cuneate or slightly oblique, lamina glossy or slightly discolorous; petiole slender, 4-20 mm long. Inflorescence of raceme-like compound cymes, axillary, paired at nodes, branching, with each branch subtended by a pair of minute subulate bracts, 2-3 sessile or pedicellate flowers at the end of each branch. Bract 1, bracteoles 2, minute, subulate or lanceolate. Calyx glandular. Corolla with upper lip hooded, 9-18 mm long, white, cream or greenish with maroon speckles in throat. Anthers with lower theca sometimes nearly ecaudate. Capsule four-seeded, cylindrical, up to 20 mm long, with a long stipe. Seeds rugose, without long barbed scales. Pollen three-colporate, 45-53 um long, sexine with entire margocolpus.

The species has been recorded from the northern Transvaal, through Swaziland, Natal and the Transkei, as far south as Grahamstown and Somerset West in the Cape, growing in the undergrowth of forests. It has not been recorded outside the area studied.

Differences between this and J.glabra, the other species placed in sect. Gendarussa, are discussed under J.glabra (above).

Vouchers: Acocks 13309; Compton 29902 (NBG, PRE); Smook 1752; Strey 5829 (NH, NU, PRE); Van Wyk 5339.

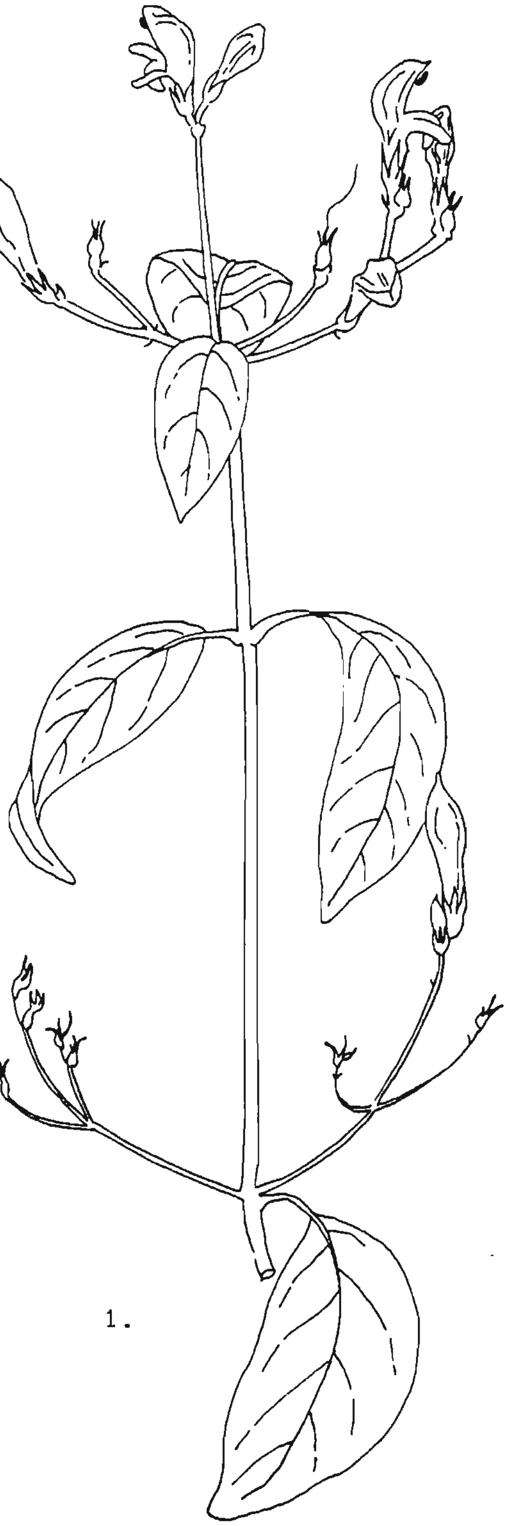
In Nees' description of J.glabra he cited Meyer, Zwei Pfl., giving in his synonomy Campylostemon campanulatus (nom.nud.). Three specimens are given under this name by Meyer, but Nees does not specify which of these he saw. Two specimens of Drége have



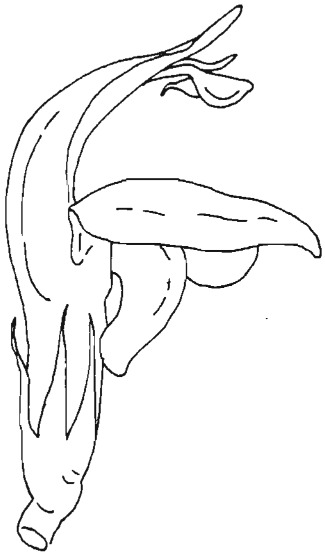
Map 2. Recorded distribution of J. campylostemon

FIGURE 23: **Justicia campylostemon**

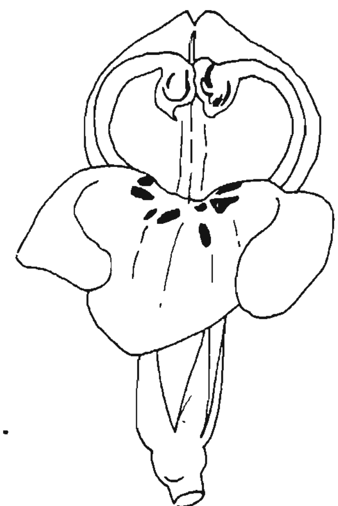
1. Habit, X1
2. Flower, side view, X6
3. Flower, front view, X6
4. Capsule, X6



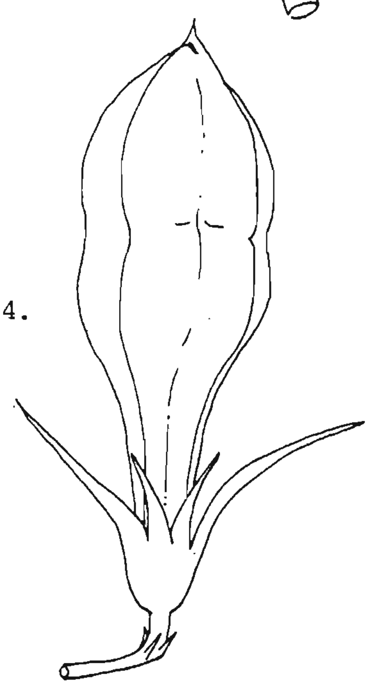
1.



2.



3.



4.

been seen in the present study: Natal, between the great waterfall and the Umsikaba River, narrow rocky ravine, by stream in shade of trees, Drêge (P!); and Natal in shade at mouth of Umsikaba River (Specimen 1 only), Drêge (G-DC, microfiche at PRE!). The latter specimen is annotated by Nees, and is therefore chosen as the lectotype.

3. **Justicia bolusii** C.B. Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 65 (1912). Type: Cape Province, margins of woods near Komgha, 1800 ft., Flanagan 608 (BOL!; GRA!; PRE, holo; SAM!). Figure 24.

Gendarussa hyssopifolia (L.) Nees partim excl. var. longebracteolata (=J.cuneata) in Linnaea 15: 368 (1841).

Adhatoda hyssopifolia (L.) Nees in DC., Prodr. 11: 392 (1847), p.p. excl. vars. longebractiolata (=J.cuneata) et uncinulata (=Monechma sp.)

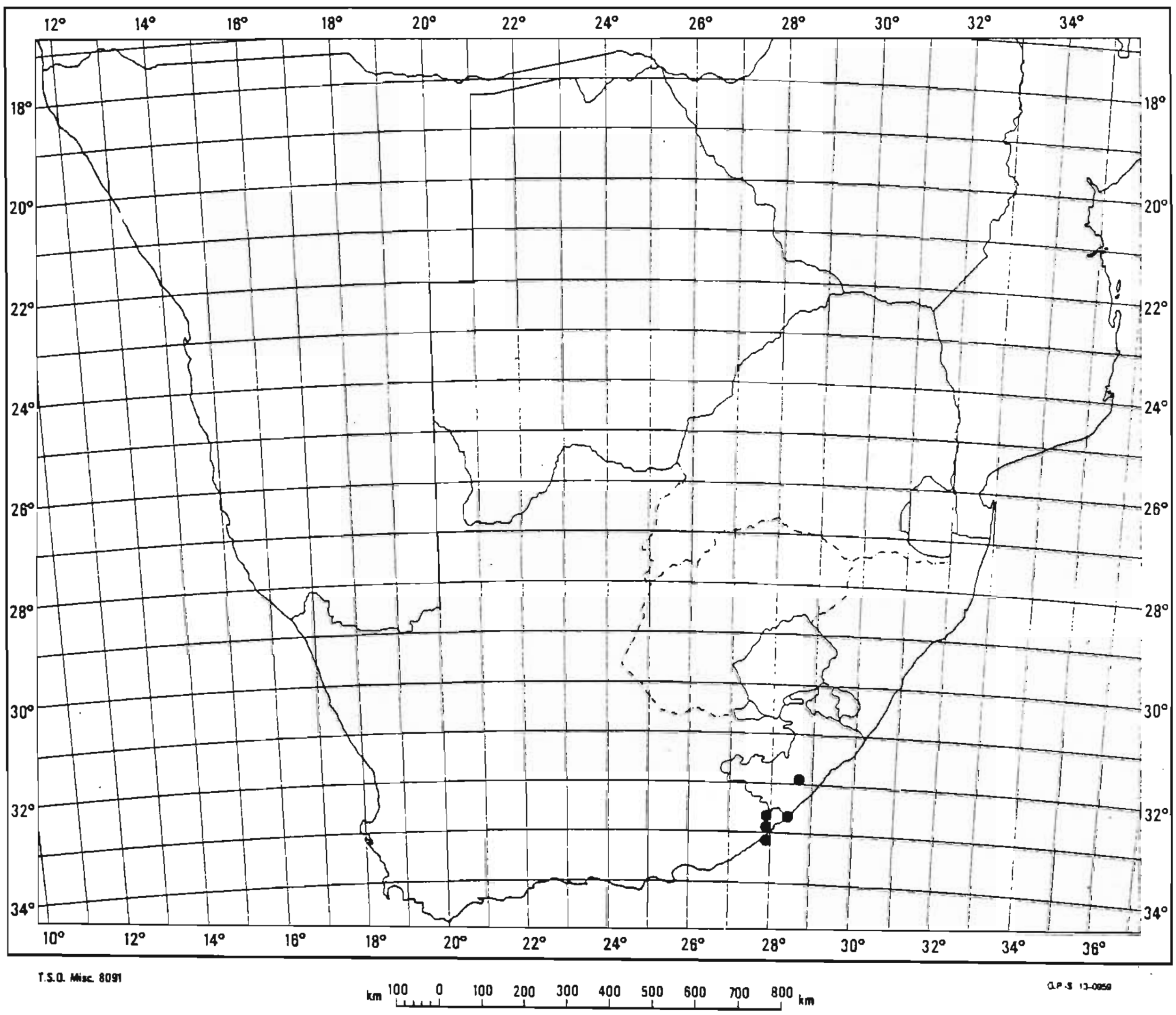
Shrub 0,5-1 m high, suckering from base of stem below ground. Leaves glabrous to pilose, ovate-oblong or sometimes ovate or obovate, 36-110 x 8-31 mm, apex obtuse to shallowly emarginate, base cuneate to decurrent; petiole 3-14 mm long. Inflorescence of stout-peduncled axillary cymes, flowers paired at lowest node, solitary along rest of inflorescence. Bract 1, with an empty bract on opposite side of axis, with glandular and non-glandular hairs; bracteoles 2, reduced, subulate to ovate, thick, 2 mm long. Penducles 1-2 per node, with 5-6 flowers crowded towards end, these sessile or shortly pedicellate. Calyx with glandular and eglandular hairs. Corolla with upper lip hooded, 11-15 mm long, lower lip reflexed, throat with a shallow pouch, white or cream, with or without mauve markings. Capsule one-seeded, clavate, up to 32 mm long, with long stipe, hard in texture, densely pubescent. Seeds 1-2, smooth. Pollen 3-colporate, 34-58 um long, sexine with entire margocolpus. (Figures 4: 3, 24; Map 3).

J. bolusii is found only in the Eastern Cape, growing in coastal forest, often at river mouths.

Vouchers: Immelman 376; Miller in PRE 5589; Pegler 1092; Rattray 1354 (NBG, PRE).

J. bolusii is characterised by the inflorescence, the one smooth seed and and the large hooded flowers with a pouched throat. All these characters except the last are also found in the tropical species J. cordata, and may also occur in other tropical species I have not seen. It is placed in sect. Bolusia.

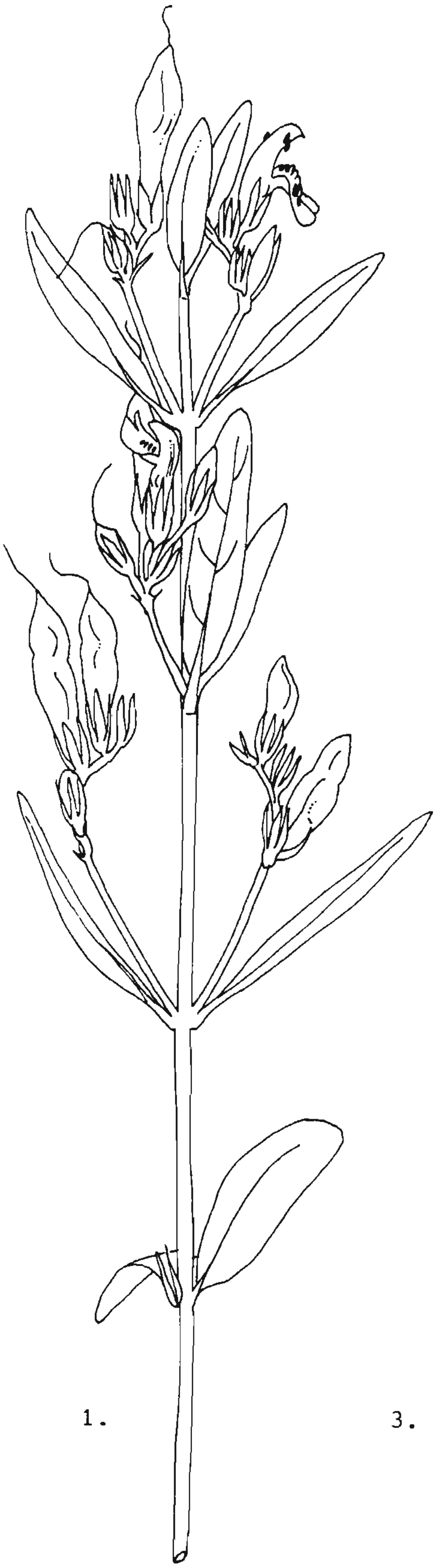
4. **Justicia betonica** L., Sp. Pl. 15 (1753); Anderson in J. Linn. Soc., Bot. 7: 38 (1867); Clarke in Hooker, Fl. Brit. Ind. 4: 525 (1885); Trimen, Handbook Fl. Ceylon 3: 333 (1895); Burkill & Clarke in Thiselton-Dyer, Fl. Trop. Afr. 5: 184 (1900), in



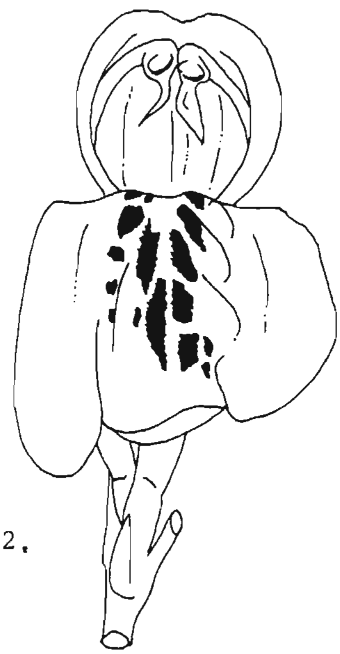
Map 3. Recorded distribution of J. bolusii

FIGURE 24: **Justicia bolusii**

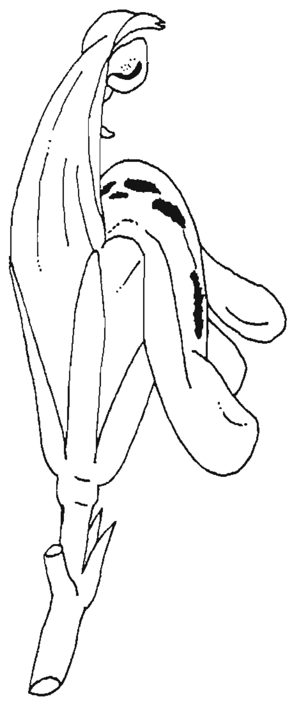
1. Habit, X1
2. Flower, front view, X6
3. Flower, side view, X6
4. Capsule, X6



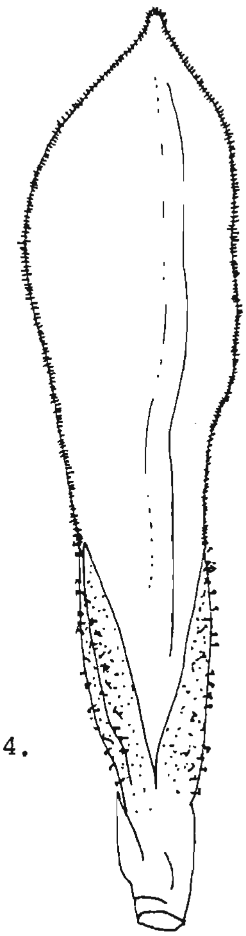
1.



2.



3.



4.

Thiselton-Dyer, Fl. Cap. 5,1: 57 (1912); Robert & Martineau, Rhod. Wild Flower. 80 (1953); Andrews, Fl. Pl. Anglo-Egypt. Sudan 3: 177 (1956); Heine in Fl. W. Trop. Afr. 2: 427 (1963); Binns, First Checklist Herb. Fl. Malawi 14 (1968); Meyer in Fl. S. W. Afr. 130 (1968); Agnew, Upland Kenya Wild Flowers 603, 606 (1974); Compton, Fl. Swaziland 563 (1976); Immelman in Bothalia 16,1: 40 (1986). Type: Ceylon, Hermann vol. 3, fol. 2 (BM, holo!; photo at PRE!).

Adhatoda betonica (L.) Nees in Wallich, Pl. Asiat. Rar. 3: 102 (1832), in DC., Prodr. 11: 385 (1847).

Nicoteba betonica (L.) Lindau in Engler & Prantl, Natürl. Pflanzenfam. 4,3b: 329 (1894).

Justicia trinervia Vahl, Enum. 1: 156 (1804); Burkill & Clarke in Thiselton-Dyer, Fl. Trop. Afr.: 185 (1900), in Fl. Cap. 5,1: 58 (1912); Andrews, Fl. Pl. Anglo-Egypt. Sudan 3: 156 (1956). Type: East India, Röttler s.n. (not found).

Dicliptera trinervia (Vahl) Juss. in Ann. Mus. Paris 9: 169 (1807).

Adhatoda trinervia (Vahl) Nees in Wallich, Pl. As. rar. 3: 103 (1832), in DC., Prodr. 11: 386 (1847).

Nicoteba trinervia (Vahl) Lindau in Engler & Prantl, Natürl. Pflanzenfam. 4,3b: 329 (1894).

Adhatoda variegata Nees in DC., Prodr. 11: 385 (1847). Holotype: Abyssinia, Sana district, dry hills near Dochli, Schimper 516 (G-DC; microfiche at PRE!).

Adhatoda variegata var. pallidior Nees in DC., Prodr. 11: 385 (1847). Holotype: Transvaal, Apies River, Burke 514 (K; photo at PRE!).

Justicia pallidior (Nees) C.B. Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 58 (1912).

Adhatoda lupulina Nees in DC., Prodr. 11: 385 (1847). Syntypes: Natal, Port Natal (Durban), Peddie s.n. (not found); no locality given, Harvey s.n. (not found); Natal, between the Umkomaas Rivier and Durban Bay, Drége s.n. (G-DC; microfiche at PRE!, P!).

Adhatoda cheiranthifolia Nees in DC., Prodr. 11: 387 (1847). Type: Transvaal, Magaliesberg, Burke s.n. (K; photo. at PRE!).

Justicia cheiranthifolia (Nees) C.B. Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 58 (1912); Robert & Martineau, Rhod. Wild Flower. 80 (1953); Van der Schijff, Checklist Vasc. Pl. Kruger Nat. Park 88 (1969); Compton, Fl. Swaziland 564 (1976).

<u>Justicia betonicoides</u> Burkill & Clarke in Thiselton-Dyer, Fl. Trop. Afr. 5: 184 (1900), in Thiselton-Dyer, Fl. Cap. 5,1: 58 (1912); Andrews, Fl. Pl. Anglo-Egypt. Sudan 3: 178 (1956); Binns, First Checklist Herb. Fl. Malawi 14 (1968); Van der Schijff, Checklist Vasc. Pl. Kruger Nat. Park 88 (1969); Agnew, Upland Kenya Wild Flowers 604 (1974); Compton, Fl. Swaziland 564 (1976). Syntypes: Sudan, Jur, Jur Ghattas, <u>Schweinfurth</u> 1423; French Equatorial Africa, Mittu (Mittou), <u>Schweinfurth</u> 2793; Gabon, Bongo, <u>Schweinfurth</u> 2543; Kenya, along Gilgil River, north of Lake Naivashu 6-7000 ft., <u>Scott-Elliot</u> 6647 (location unknown, not at K); Tanzania, Tanganyika Plateau, at Fort Hill, 3500-4000 ft., <u>Whyte</u> s.n. (none of these specimens located).

Perennial herb or soft shrublet, 0,13-1 m high. <u>Leaves</u> glabrous or with a short to long dense white pubescence, linear to broadly ovate, rarely slightly obovate, 16-130 x 1,5-43 mm, apex acuminate to obtuse, base obtuse to decurrent, margin flat or wavy; petiole 0-2(-42) mm long. <u>Inflorescence</u> terminal, an aggregate of sessile cymes usually reduced to a single flower each. <u>Bract</u> 1 below each flower, with one on opposite side of axis empty, <u>bracteoles</u> 2 per flower, strobilate, linear-lanceolate to ovate, 6-19 x 2-9 mm, apex acute, whitish with contrasting green veining, contrast may fade with age or bracts become suffused with purple, pubescence as for leaves. <u>Corolla</u> 7-14 mm long, cream to greenish white with mauve markings, or mauve. <u>Capsule</u> 4-seeded, cylindrical, glabrous to densely white-puberlous or pubescent, with a long stipe, hard, up to 20 mm long. <u>Pollen</u> 3-colporate, sexine 36-57 um long, with entire margocolpus (Figure 4: 4, 25; Map 4).

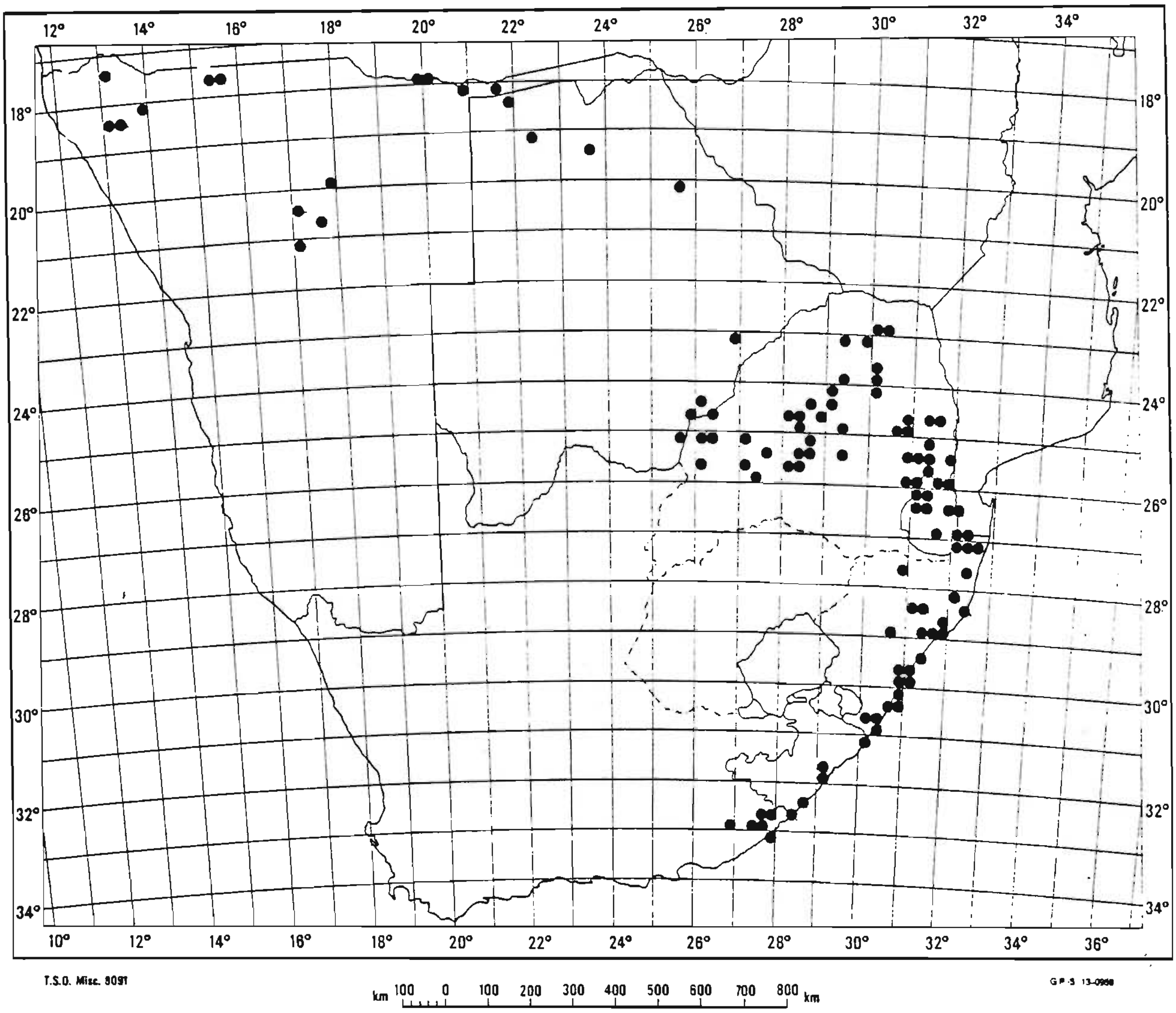
Widespread in tropical Africa and India, and was originally described from an Indian specimen. In southern Africa it is found in Namibia, N. Botswana, Transvaal, Swaziland, Natal, Transkei, and the Eastern Cape as far south as Fort Beaufort. It is one of the most common species in the genus, growing in grassveld, open bushveld or savanna, often in sandy or rocky soil and often along watercourses.

Vouchers: <u>Anderson</u> 4; <u>Curson</u> s.n.; <u>Goosens</u> 1712; <u>Hanson</u> 3493; <u>Kluge</u> 22793 (PRE, SAM).

This and the following species are in the typical section, sect. <u>Justicia</u>, which is the same as C.B. Clarke's sect. <u>Justicia</u> in Flora Capensis. Although the two species differ superficially, they have the same pollen and inflorescence, as well as an identical, pretzel-like pattern on the seed testa.

The leaf shape and size in <u>J. betonica</u> is very variable (Figure 3.2), but the species as a whole is easily distinguished by the lanceolate to ovate, reticulately coloured bracts.

<u>J. betonica</u> was originally described by Linnaeus, who cites three



Map 4. Recorded distribution of <u>J. betonica</u>

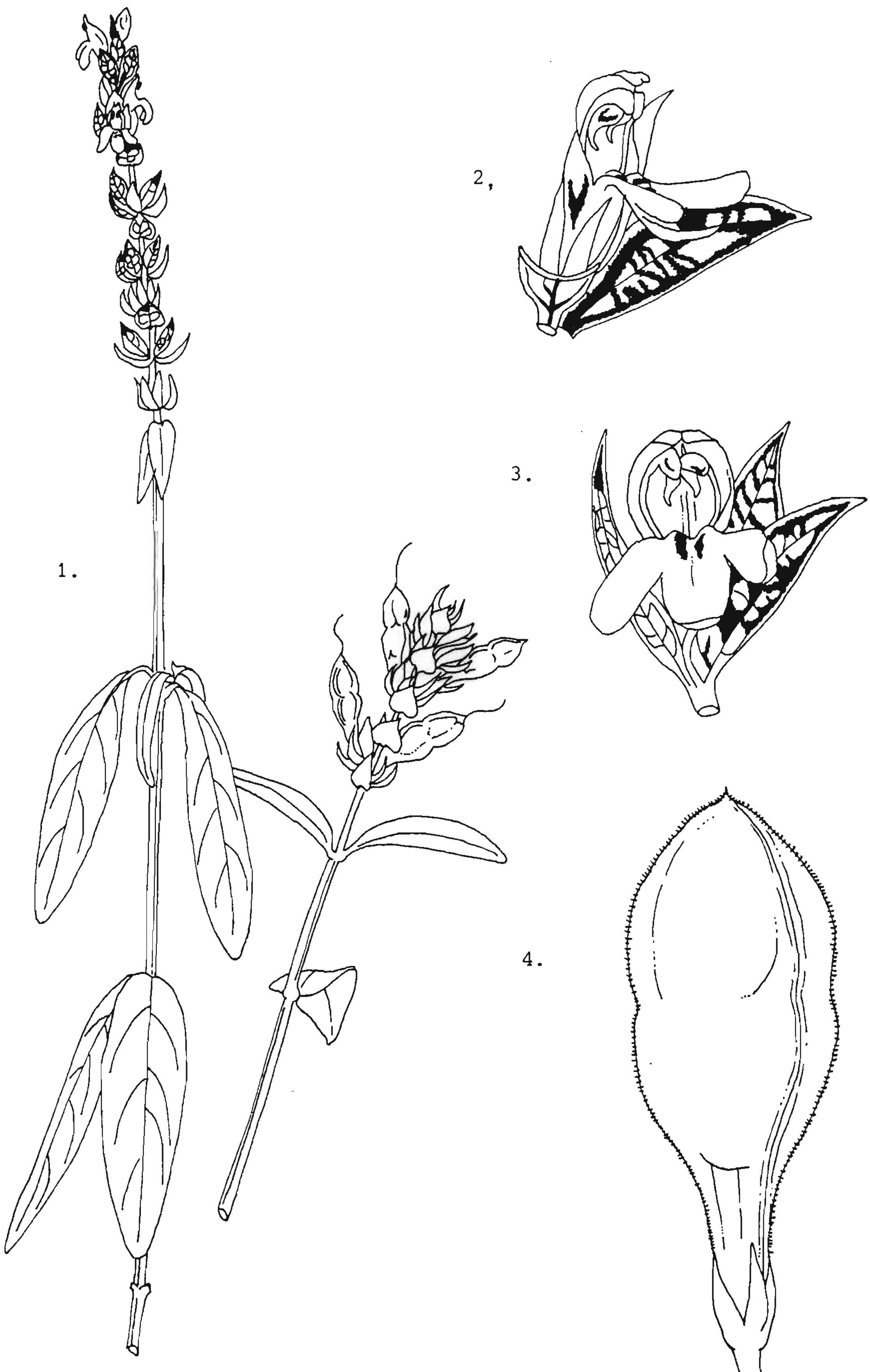
FIGURE 25: Justicia betonica

1. Habit, X1

2. Flower, 3/4 view, X6

3. Flower, front view, X6

4. Capsule, X6


1.
2,
3.
4.

publications in his protologue (1753). The specimens of Rheede and Bontius are unknown, if in fact specimens were ever made, but Flora Zeylanica is known to be based on specimens collected by Hermann. These are pasted into books and housed at BM. According to Savage, there are no specimens of J. betonica in LINN, but there is one in the Hermann collection (J. Linn. Soc. 24). As no Rheede or Bontius specimens are known to exist, the Hermann specimen is made the lectotype of J. betonica.

It is not certain here whether Nees: 386 (1847) intended A. trinervia var. A as a separate variety, or as the typical variety. The specimen he cites, Wallich 2446 a pars altera, fits the concept of J. betonica accepted in this study (K!; G-DC; microfiche in PRE!).

The type of A. variegata var. pallidior is almost certainly Burke 514 (K!) not Burchell 514 as given by Nees. Probably he misread the label on the specimen, mistaking "Burke" for "Burch".

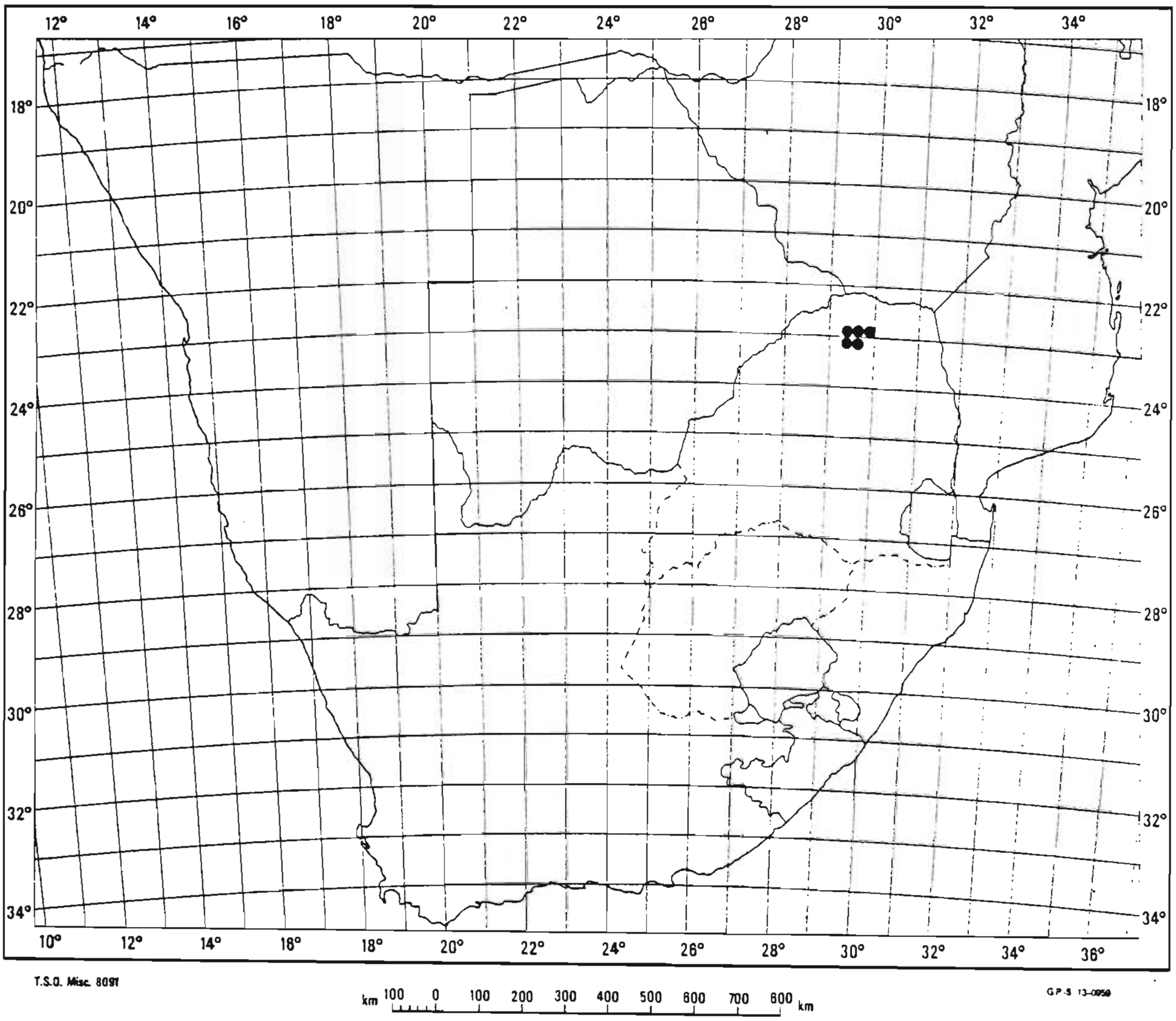
Nees does not specify which of the Drége specimens he saw under A. lupulina. Meyer cites four, one of which is at G-CD, and it is assumed that Nees would have seen at least this one. It was collected between the Umkomaas River and Natal Bay (Durban).

The type of A. cheiranthifolia is given by Nees as "Macalis Bay, "Burchell" but no such locality could be found, either on the maps or in the list of Burchell's collecting localities. In A. variegata var. pallidior a Burke specimen had been cited as "Burchell", and it is probable that the type of A. cheiranthifolia was also collected by Burke. This is supported by the finding of a Burke specimen at K from "Magaliesberg", which could easily have been misread as "Macalis Bay". The specimen fits Nees' description and belongs to J. betonica.

The types of J. trinervia and J. betonicoides have not been located. However, the descriptions are easily recognised as belonging to J. betonica with its imbricate pale-coloured bracts veined with green and the terminal inflorescences.

5. **Justicia montis-salinarum** A. Meeuse in Bothalia 7: 407 (1960). Syntypes: Transvaal, Soutpansberg, Vivo schoolgrounds, Mogg 24448 (J; PRE!); Soutpansberg, "Zoutpan 193", above cave, Obermeyer, Schweikerdt & Verdoorn 168 (PRE!); Transvaal, along road to Sandrivier bridge on Louis Trichardt-Mara-Vivo road, c. 1 mile from Dundee farm, south slopes of Soutpansberg range (southern entrance of Sandrivierspoort, about 4 miles north of main road bridge), Meeuse 10213 (PRE, holo!).

Densely-tufted shrublet, 0,2-0,4 m high. Leaves densely to sparsely puberulous, linear-lanceolate, c. 22 x 1,5 mm, apex acute, base tapering, often greyish, sessile. Inflorescence terminal, an aggregate of sessile cymes reduced to a single



Map 5. Recorded distribution of J. montis-salinarum

flower each. Bract 1 with one on opposite side of axis, bracteoles 2, puberulous, linear-lanceolate, 4-7 mm long, acute. Corolla 7-8 mm long, white marked with mauve. Capsule 4-seeded, clavate, c. 10 mm long. Pollen 3-colporate, 37-45 um long, sexine with entire margocolpus (Figure 4: 5; Map 5).

Voucher: Van Wyk 5536.

J. montis-salinarum is structurally similar to and probably derived from forms similar to, J. betonica, from which it differs in inflorescence, bracts and leaves. It is therefore placed in sect. Justicia with that species. It is endemic to the Soutpansberg.

6. **Justicia flava** (Vahl) Vahl, Symb. Bot. 2 1 5 (1791); Clarke in Hooker, Fl. Brit. Ind. 4: 531 (1885); Burkill & Clarke in Thiselton-Dyer, Fl. Trop. Afr. 5: 190 (1900), in Thiselton-Dyer, Fl. Cap. 5,1: 59 (1912); Andrews, Fl. Pl. Anglo-Egypt. Sudan 3: 179 (1956); Letty, Wild Flower. Transv. 316, pl. 158: 6 (1962); Heine in Fl. W. Trop. Afr. 2: 427 (1963); Binns, First Checklist Herb. Fl. Malawi 14 (1968); Van der Schijff, Checklist Vasc. Pl. Kruger Nat. Park 88 (1969); Agnew, Upland Kenya Wild Flowers 602, 604 (1974); Gibson, Wild Fl. Natal (Coastal Region) pl. 99,5 (1975); Compton, Fl. Swaziland 564 (1976); Wood et al. in Kew Bull. 38,3: 429 (1983); Immelman in Flower. Pl. Afr. 48,1 & 2: 1898 (1984). Type: (lecto. fide Wood et al., 1983) Forsskaol 394 (C, microfich No. 39.1.3-4 in PRE!).

Dianthera flava Vahl, Symb. Bot. 1: 5 (1790).

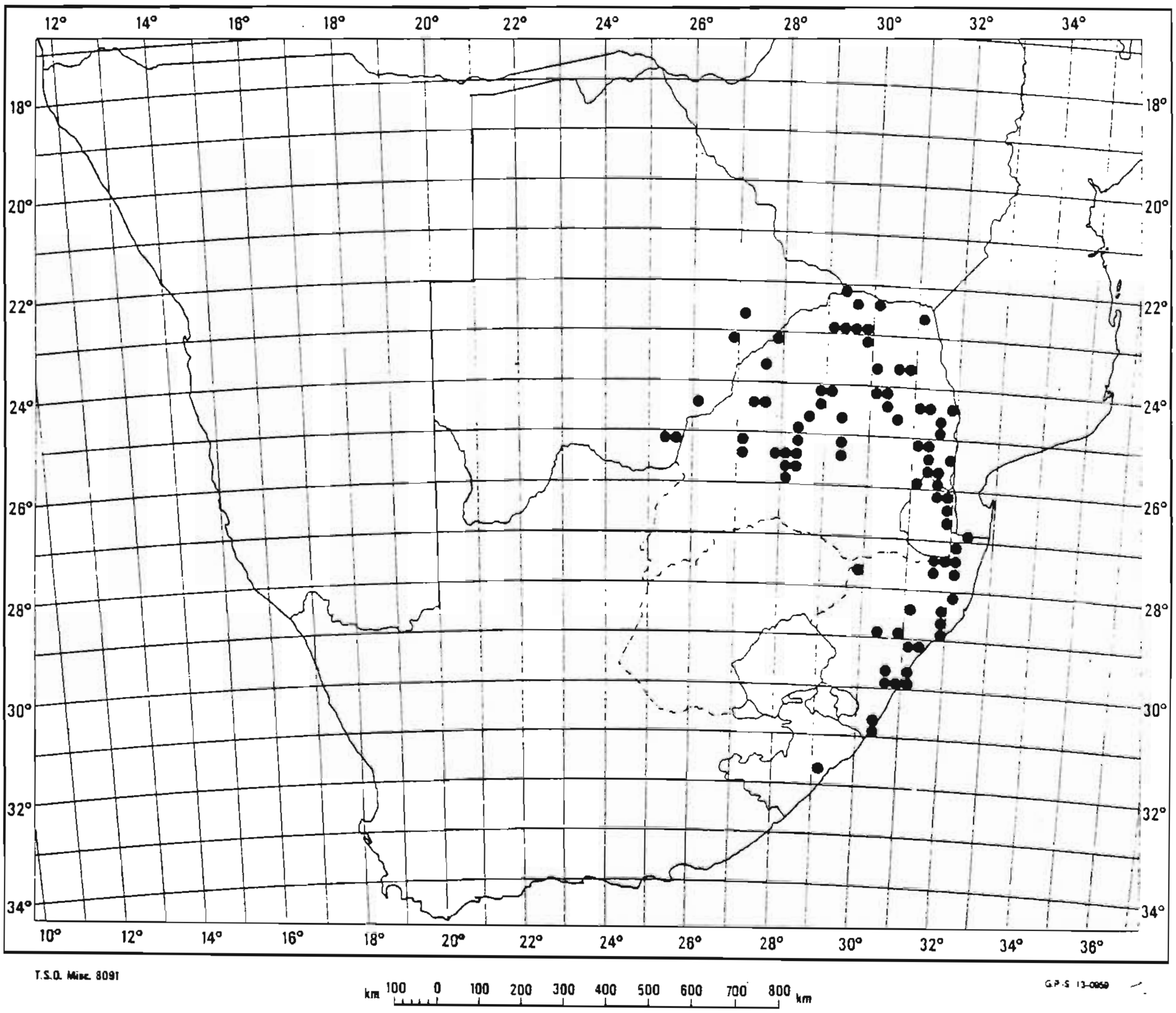
Dianthera americana var. flava (Vahl) Forssk., Fl. Egypt-Arab. 9 (1795).

Adhatoda flava (Forssk.) Nees in DC., Prodr. 11: 401 (1847).

Adhatoda fasciata Nees in DC., Prodr. 11: 402 (1847). Type: Natal, Umgeni, on hills, Drége s.n. (G-DC; microfiche at PRE!; P!).

Justicia fasciata (Nees) T. Anders. in J. Linn. Soc., Bot. 7: 39 (1864).

Perennial herb or shrublet, 0,1-1(-2) m high; stems herbaceous, may root at nodes. Leaves nearly glabrous to densely white-pilose especially on veins and margins, lanceolate to broadly ovate, 12-120x4-46 mm, apex obtuse to broadly acute, base cuneate to obtuse; petiole 1-25 mm long. Inflorescence terminal, a dense aggregate of sessile cymes in axils of reduced floral leaves. Bracts and bracteoles similar to floral leaves but smaller, always pubescent, narrowly lanceolate to oblanceolate, 7-14 mm long, apex acute or obtuse. Corolla 7-11 mm long, pale to greenish yellow with bright yellow lower lip, lower lip usually



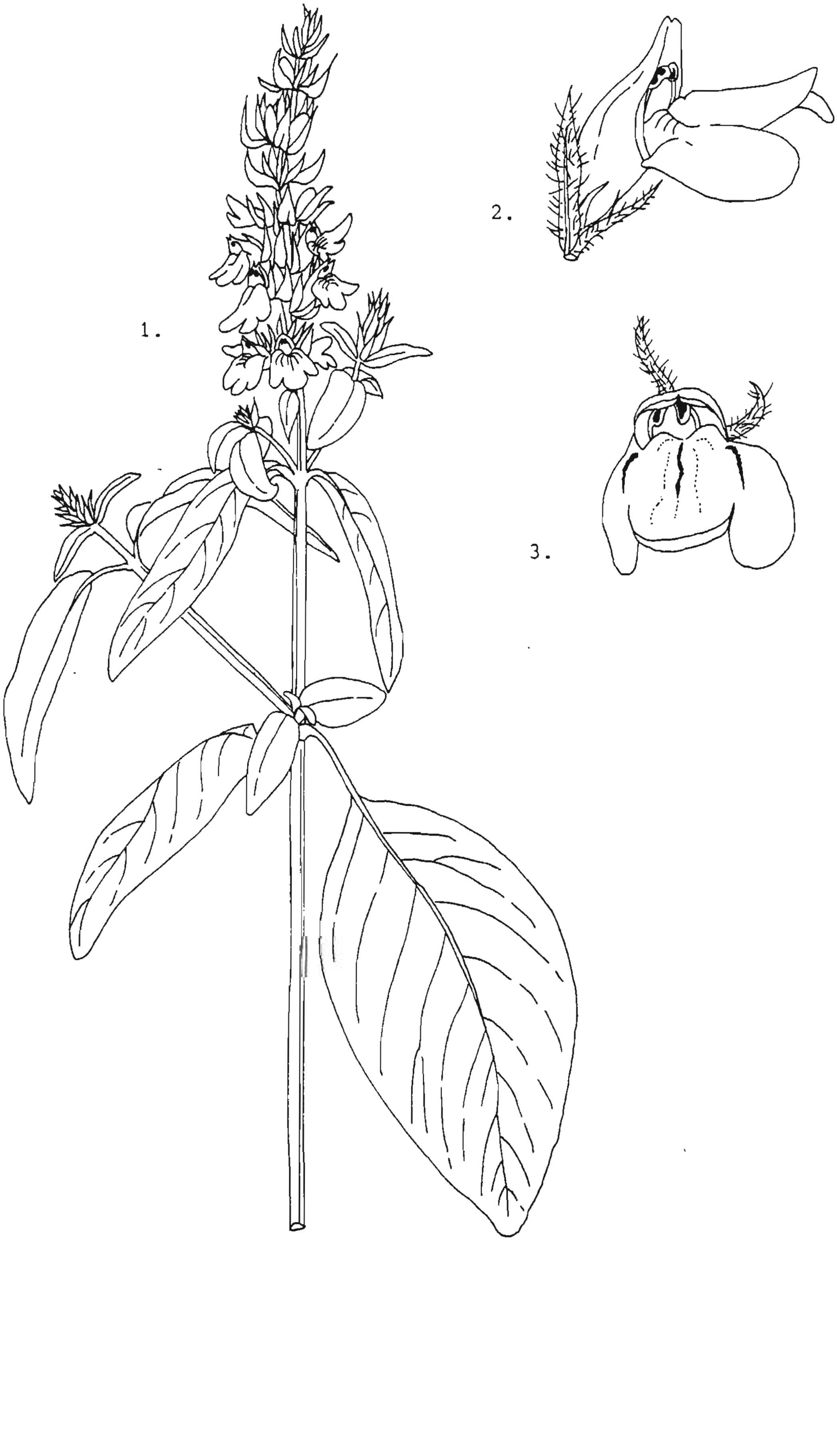
Map 6. Recorded distribution of J. flava

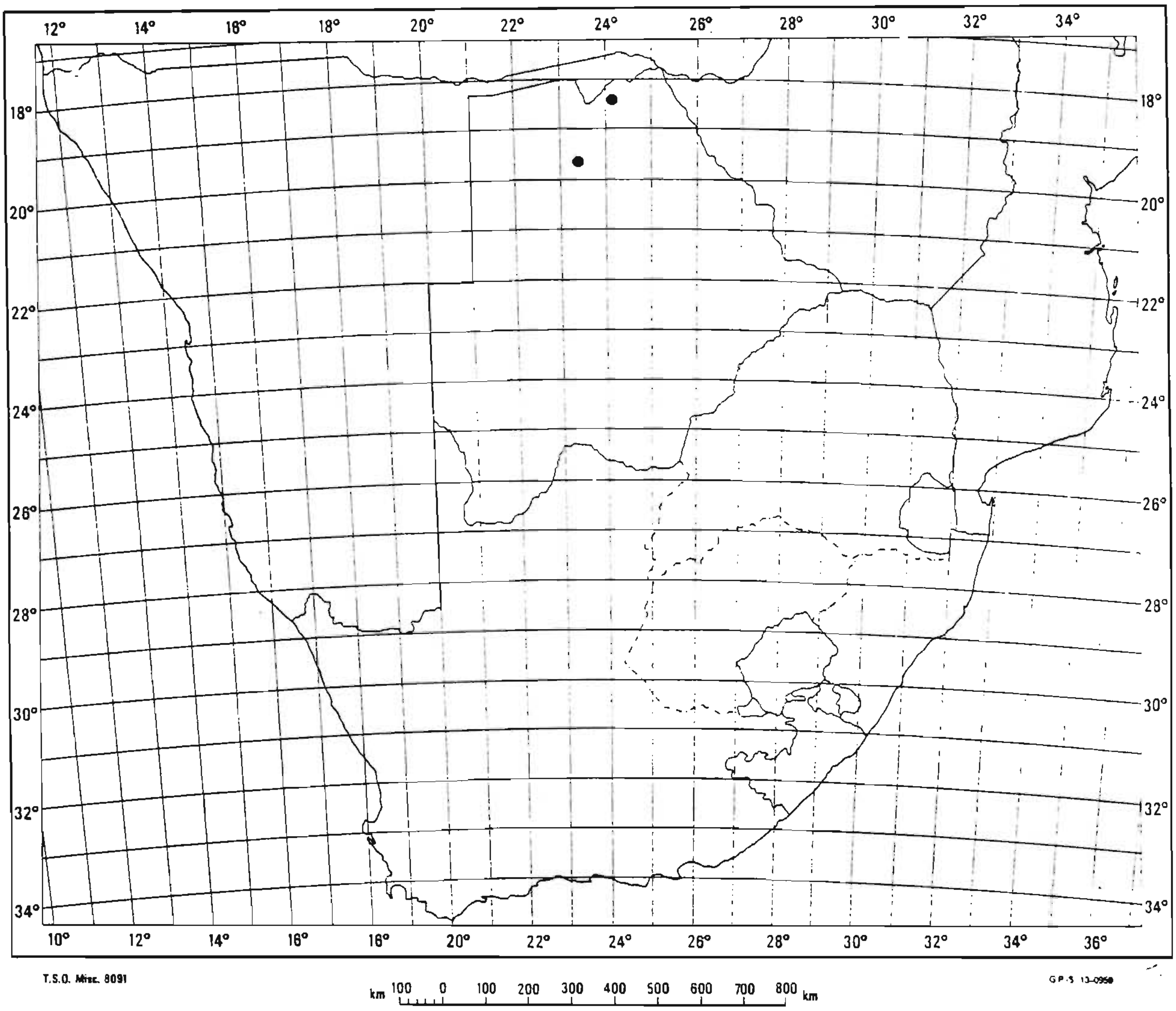
FIGURE 26: *Justicia flava*

1. Habit, X1

2. Flower, 3/4 view, X6

3. Flower, front view, X6


1.
2.
3.



Map 7. Recorded distribution of J. kirkiana

with a dark stripe down each lobe. Capsule four-seeded, delicate in texture, up to 9 mm long. Seeds rough, with one (-many) crystals per cell in testa. Pollen three-colporate, 42-58 um long, areolate (Figures 4: 6, 26; Map 6).

Widespread in tropical and southern Africa, originally described from Yemen. A common species, found in a number of veld types, as well as by roadsides and other disturbed habitats.

Vouchers: Clarke 545; Ihlenfeldt 2246; Peeters, Gericke & Burelli 639; Venter 1902; Zambatis 357.

J. flava is here made the type species of sect. Rostellularia (Hochst.) Immelman. This is the same as sect. Rostellularia sensu C.B. Clarke in Flora Capensis, excl. J. spergulaefolia.

7. **Justicia kirkiana** T. Anders. in J. Linn. Soc., Bot. 7: 39 (1864); Burkill & Clarke in Thiselton-Dyer, Fl. Trop. Afr. 5: 192 (1900); Binns, First Checklist Herb. Fl. Malawi 14 (1968). Holotype: Mozambique, Tete Hills, banks of Zambesi River, Kirk s.n. (K; photo at PRE!).

Slender erect annual herb 0,25-0,4 m high. Leaves few with long internodes, pilose, narrowly lanceolate, 18-62x 2-5 mm long. Inflorescence as for J. flava (above). Bracts and bracteoles with long cottony glandular hairs, narrowly oblanceolate, 7-11x1-2 mm. Corolla c. 7-8 mm long, yellow with a dark stripe on each lobe of the lower lip. Capsule four-seeded, delicate in texture, up to 7 mm long. Seeds and pollen as for J. flava (above), except pollen 47-61 um long (Figure 5: 1; Map 7).

J. kirkiana is a common tropical species. Within the area studied it is found only in northern Botswana.

Vouchers: Lambrecht 267; Smith 1714.

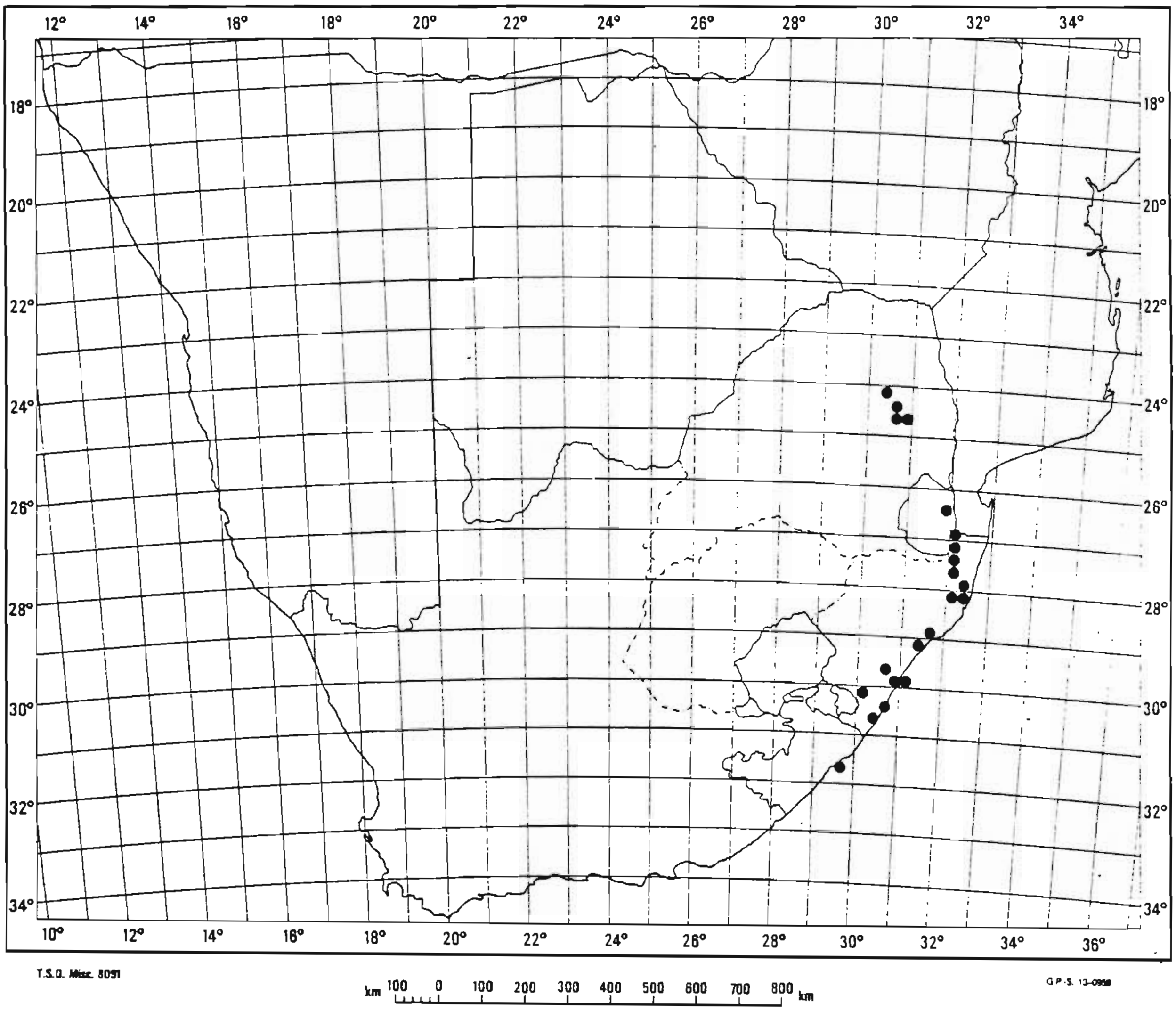
8. **Justicia petiolaris** (Nees) T. Anders. in J. Linn. Soc., Bot. 7: 39 (1864); Clarke in Thiselton-Dyer, Fl. Cap. 5: 59 (1912); Van der Schijff, Checklist Vasc. Pl. Kruger Nat. Park 88 (1969); Compton, Fl. Swaziland 565 (1976); Immelman in Flower. Pl. Afr. 48,1 & 2: Pl. 1897 (1984).

(a) subsp. **petiolaris**

Immelman in Bothalia 16,1: 40 1986.

Adhatoda petiolaris Nees in DC., Prodr. 11: 402 (1847). Syntypes: Natal, Umzimvubu River, wooded rocky shaded valley and ravine by river, below 1000 ft., Drége s.n. (K; photo. at PRE!; P!); Natal, Umgeni, on hills, 200 ft., Drége s.n. (P!).

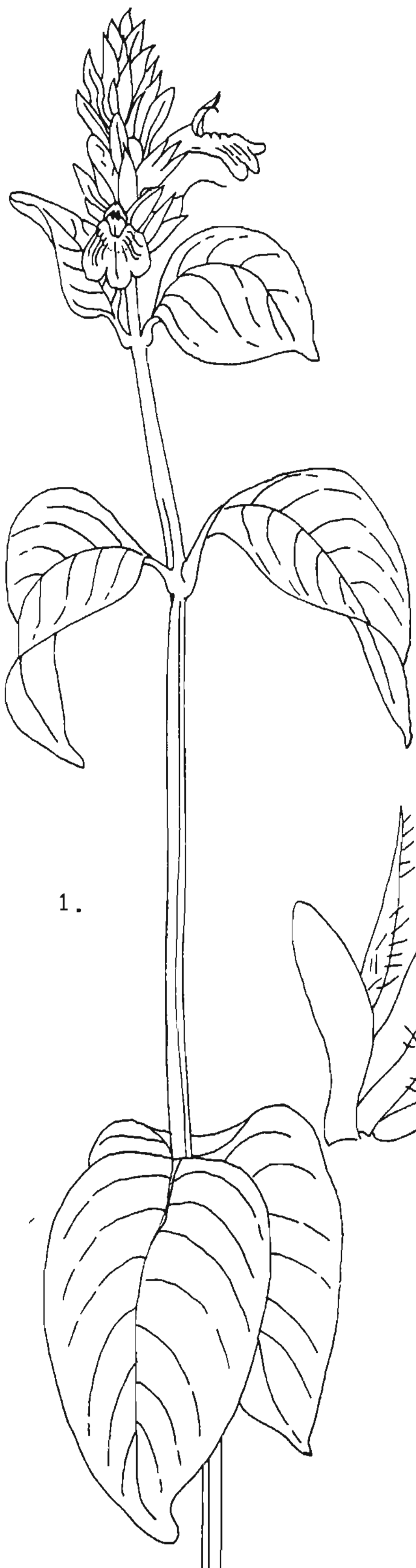
Perennial herb or soft shrublet, 0,24-1,3 m high, stems



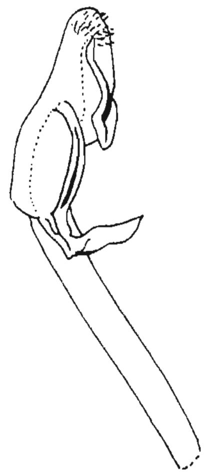
Map 8. Recorded distribution of J. petiolaris subsp. petiolaris

FIGURE 27: **Justicia petiolaris** subsp. **petiolaris**

1. Habit, X1
2. Flower, 3/4 view, X6
3. Flower, front view, X6
4. Anther, X12
5. Capsule, X6



1.



4.

2.

3.

frequently rooting at nodes. Leaves glabrous to pilose, ovate to lanceolate, 48-145x20-70 mm, apex shortly attenuate, base decurrent, margins rarely broadly and shallowly toothed; petiole 8-42 mm long. Inflorescence terminal, a dense aggregate of sessile cymes in axils of reduced floral leaves. Bracts and bracteoles sparsely to densely pubescent with long, often glandular hairs, spathulate or oblanceolate, 5-15 mm long, apex acute or obtuse. Corolla 11-18 mm long, blue-mauve to sky blue, often with a white palate which may be striped with mauve. Capsule four-seeded, glabrous, delicate in texture, up to 12 mm long. Seeds with numerous crystals per cell in testa. Pollen three-colporate, 56-77 um long, sexine areolate (Figures 5: 2, 27; Map 8).

Occurs as undergrowth in forest and on forest margins, sometimes becoming the dominant understory. It is found in Natal, Swaziland and the Transvaal, and has not been recorded outside this area. In the Eastern Cape it is replaced in similar habitats by subsp. bowiei.

Vouchers: Brenan 14191 (NBG, PRE); Buitendag 886 (NBG, PRE); Codd 9371; Strey 4671 (NH, PRE); Van Wyk 5517.

(b) subsp. **bowiei** (C.B. Cl.) Immelman in Bothalia 16,1: 40 (1986). Syntypes: Cape Province, near Kei Mouth, in woods, 300 ft., Flanagan 882 (BOL!; GRA!; PRE, lecto!; SAM!); Moist situations in George, Uitenhage and Albany divs., Bowie s.n. (K; photo. at PRE!); No locality given, Guthrie 4711 (BOL!).

J. bowiei C.B. Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 59 (1912).

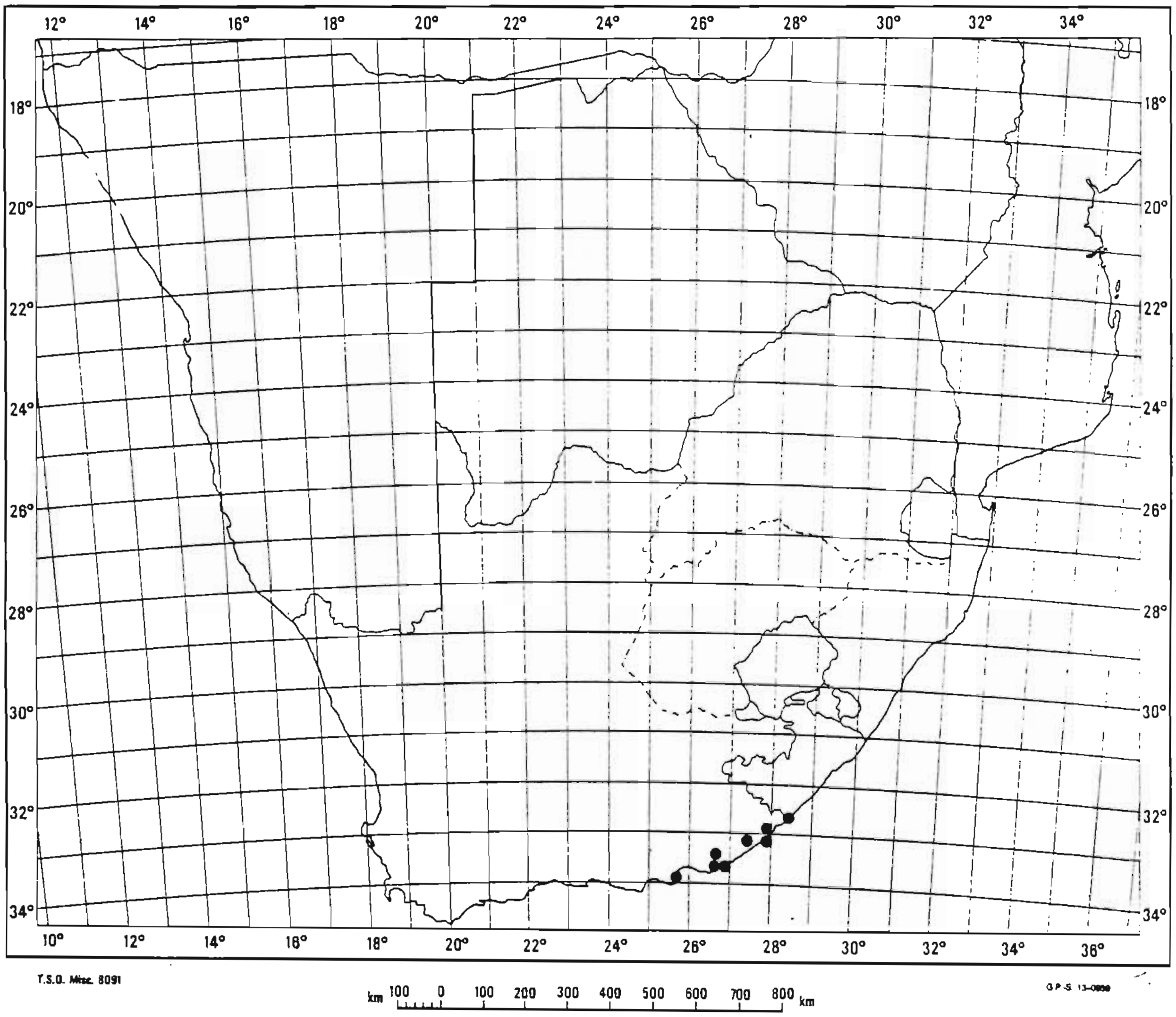
J. petiolaris subsp. B, Nees in DC., Prodr. 11: 402 (1847). Holotype: Cape Province, George, Uitenhage and Albany divs., no collector given (probably Bowie) (K; photo. at PRE!).

J. burchellii C.B. Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 59 (1912). Holotype: Cape Province, Bathurst region, between Rietfontein and the shore, Burchell 4107 (K; photo. at PRE!).

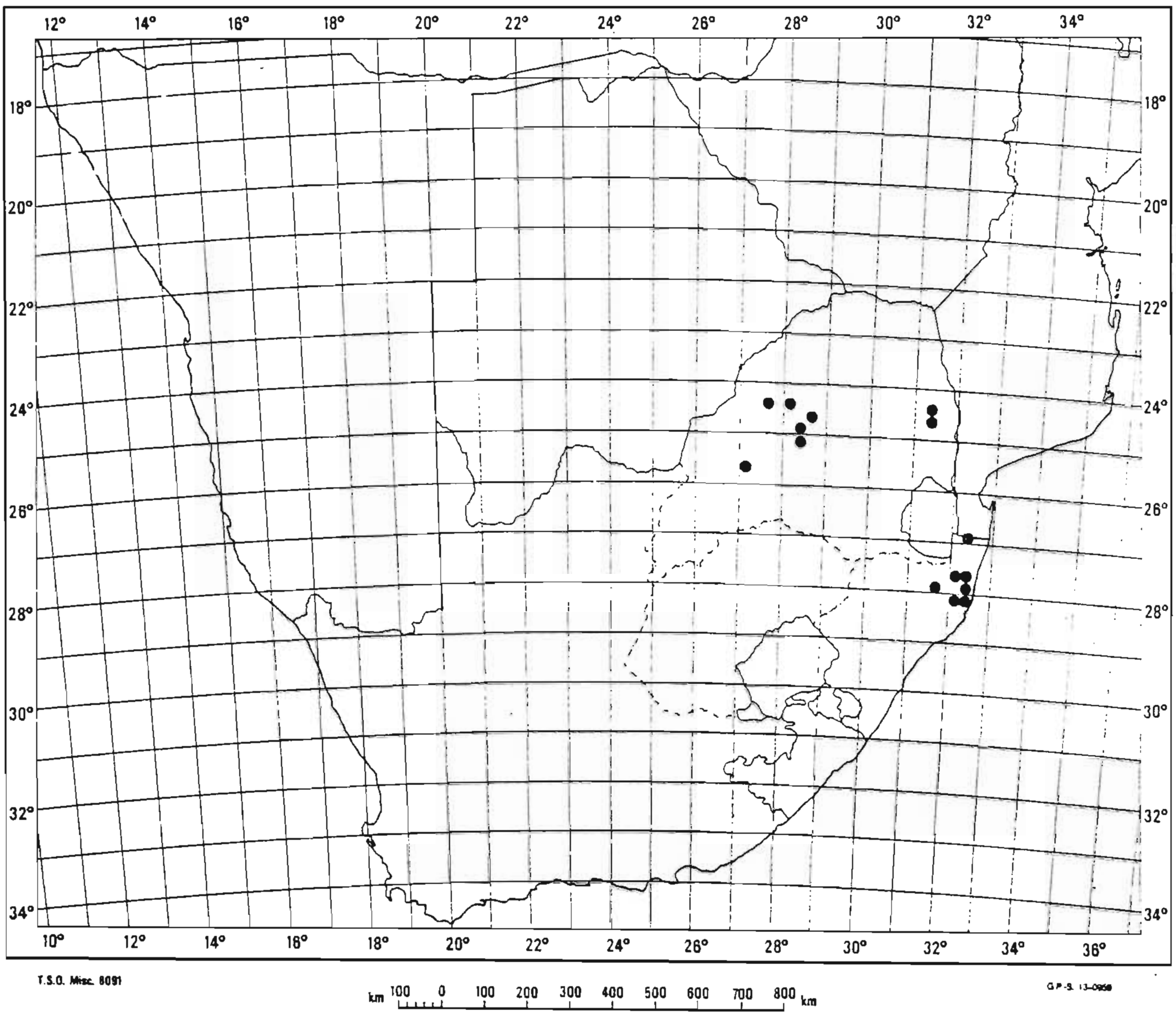
J. mutica C.B. Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 59 (1912). Holotype: Cape Province, wooded situations in Uitenhage and Albany divs., Bowie s.n. (K; photo. at PRE!).

Similar to subsp. petiolaris, from which it differs as follows: Leaves 19-50x10-24 mm, apices acute or obtuse but never acuminate; petiole 3-20 mm long. Inflorescence with cymes well separated, especially at base. Bracts and bracteoles with apex obtuse (Figure 5: 3; Map 9).

Restricted to the Eastern Cape and, like the typical subspecies, found as undergrowth in forest.



Map 9. Recorded distribution of J. petiolaris subsp. bowiei



Map 10. Recorded distribution of J. petiolaris subsp. incerta

Vouchers: Britten 425, 1429; Flanagan 882; Marriot 3 (NH, PRE); Schlechter 2689 (BOL, GRA, PRE).

(c) subsp. **incerta** (C.B. Cl.) Immelman in Bothalia 16,1: 40 (1986). Type: Transvaal, bushveld between Elandsrivier and Klippan, Rehmann 5058 (not found).

J. incerta C.B. Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 59 (1912); Meeuse in Flower. Pl. Afr. 31: pl. 1237 (1956); Letty, Wild Flower. Transv. 320, fig 12: 1 (1962).

Similar to subsp. petiolaris, from which it differs as follows: Plant 0,1-0,5 m high. Leaves ovate, 16-30 (-40)x9-22 mm, apex obtuse or occasionally broadly acute. Inflorescence with cymes well separated, expecially at base. Bracts and bracteoles narrowly obovate to spathulate, obtuse. Corolla 8-13 mm long. Capsule up to 10 mm long (Figure 5: 4; Map 10).

This subspecies grows in shade in bushveld, always in sandy soil. This occurs in the Transvaal and Zululand.

Vouchers: Codd 837, 9605; Meeuse 9100; Ward 4132; Werdemann & Oberdieck 1724.

Although the type of this subspecies has not been located, the description by C.B. Clarke in (1912) is that of a plant within the present author's concept of J. petiolaris. The locality is within that of subsp. incerta and outside that of the other two subspecies.

J. petiolaris, J. flava, and J. kirkiana, make up the sect. Rostellularia in southern Africa, and form a natural and well-defined section within the genus. The section is characterised by tricolporate, areolate pollen, cymes condensed at the stem apices, and crystals in the seed testa.

9. **Justicia protracta** (Nees) T. Anders. in J. Linn. Soc., Bot. 7: 41 (1864); Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 62 (1912); Wilman, Checklist Griq. West 222 (1946); Meyer in Fl. S. W. Afr. 130 (1968); Van der Schijff, Checklist Vasc. Pl. Kruger Nat. Park 88 (1969); Gibson, Wild Fl. Natal (Coastal Region) pl. 99,4 (1975); Compton, Fl. Swaziland 565 (1976).

(a)subsp. **protracta**

Immelman in Bothalia 16,1: 40 (1986). Syntypes: Cape Province, between shrubs in fields by Zwartkopsrivier, Ecklon 456 (BOL!; MEL!); Bosmansrivierhoogde Mountains, Ecklon s.n. (not found); Near Grahamstown, Ecklon s.n. (S!); Between Great Fish River and Ceded Territory, Ecklon s.n. (PRE!; S!).

Gendarussa protracta Nees partim excl. J. capensis Thunb., in Linnaea 15: 371 (1841).

Adhatoda protracta (Nees) Nees partim excl. syn. Thunb., in DC., Prodr. 11: 390 (1847).

G. mollis Hochst. in Flora 28: 71 (1845). Type: Natal, forest margins near Durban, Krauss 61 (BM!; K!).

G. protracta subsp. microphylla Nees var. strictior Nees in Linnaea 15: 372 (1841). Type: Cape Province, Konapshoogde, near Fort Beaufort, Ecklon s.n. (MEL!; S!).

Adhatoda protracta var. strictior (Nees) Nees in DC., Prodr. 11: 390 (1847).

Adhatoda rotundifolia Nees in DC., Prodr. 11: 391 (1847). Type: Natal, between Mtentu and Umzimkulu Rivers, Drége s.n. (P!; G-DC; microfiche in PRE!).

J. rotundifolia (Nees) T. Anders. in J. Linn. Soc., Bot. 7: 41 (1864); Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 63 (1912).

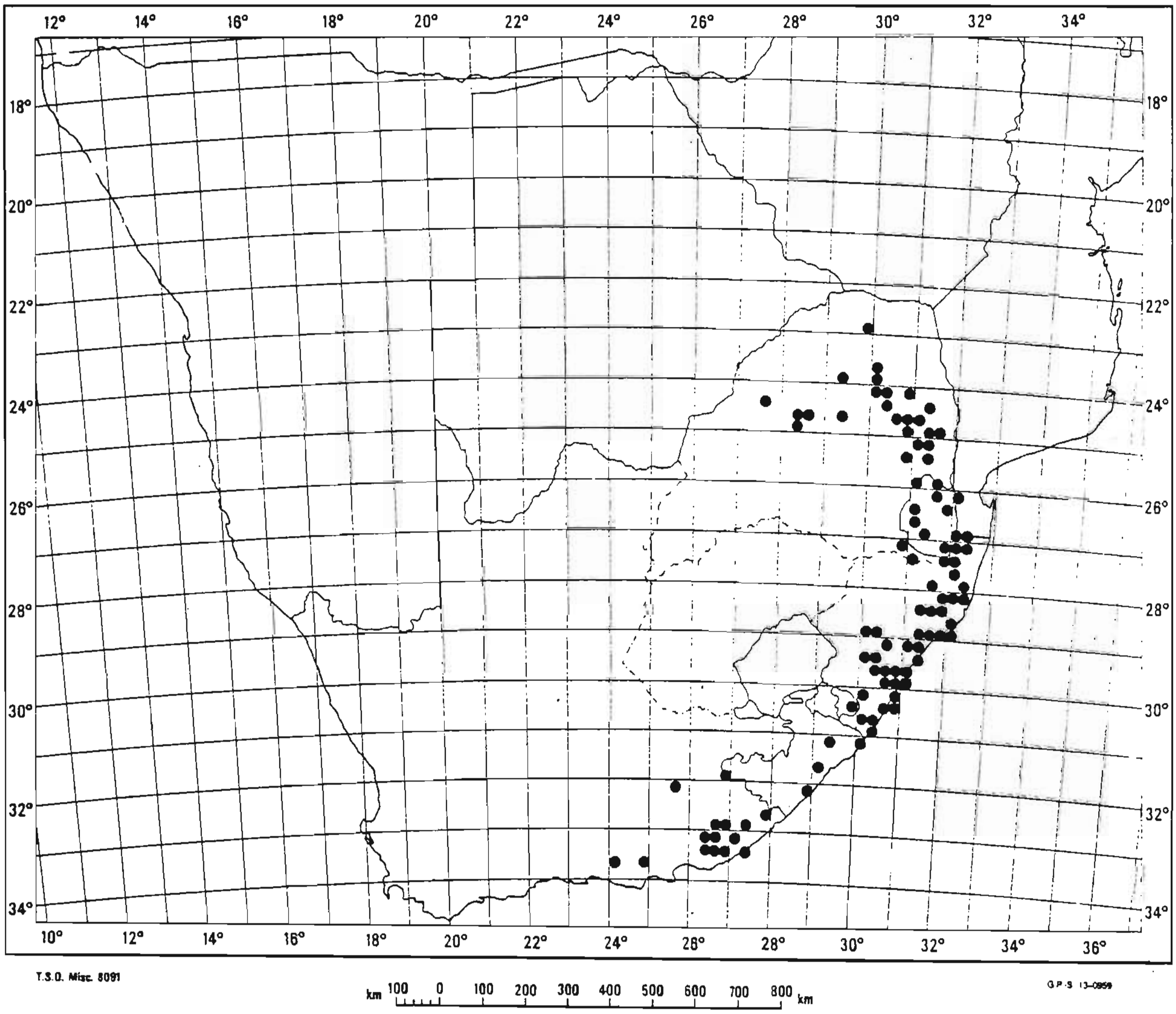
Adhatoda protracta var. convexa Nees in DC., Prodr. 11: 390 (1847). Type: Natal, between the Mtentu and Umzimkulu Rivers, Drége s.n. (G-DC; microfiche in PRE!).

J. kraussii C.B. Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 62 (1912); Van der Schijff, Checklist Vasc. Pl. Kruger Nat. Park 88 (1969). Type: Natal, between Mlazi River and Durban Bay, Krauss 61 (BM!; K; photo. at PRE!); Natal, Inanda, Wood 423 (not found); Zululand, Gerrard 1272 (BM!; K; photo. at PRE!).

J. kraussii var. florida C.B. Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 62 (1912). Type: Natal, Inanda, Wood 566 (BM!).

J. pulegioides C.B. Clarke partim excl. syn. Chaetacanthus persoonii, Fl. Cap. 5,1: 62 (1912); Wilman, Checklist Griq. West 222 (1946). Syntypes: Cape Province, Komgha, Flanagan 725 (NH!; GRA!; PRE!; SAM!); Natal, Durban Flats, Wood in Herb. Norm. Aust.-Afr. 1019 (BOL!; PRE!; SAM!); Natal, Inanda, Wood 718 (PRE!; NH!); Cape Province, Uitenhage, Ecklon & Zeyher 436; Cape Province, Komadagga, Burchell 3300 (also type of Gendarussa protracta subsp. microphylla Nees) (G-DC; microfiche in PRE!); Transvaal, Houtbosch Rand, Schlechter 3324; Pondoland, between St Johns River and Umsikaba River, Drége s.n.; Natal, Durban Bay, Krauss 304; Natal, Inanda, Wood 309; without localities: Peddie s.n.; Sanderson 433; Grant s.n.

Gendarussa prunellaefolia Hochst. in Flora 28: 71 (1845). Type: Natal, between Mlazi River and Durban Bay, Krauss 61 (BM!; K; photo. at PRE!).



Map 11. Recorded distribution of <u>J. protracta</u> subsp. <u>protracta</u>

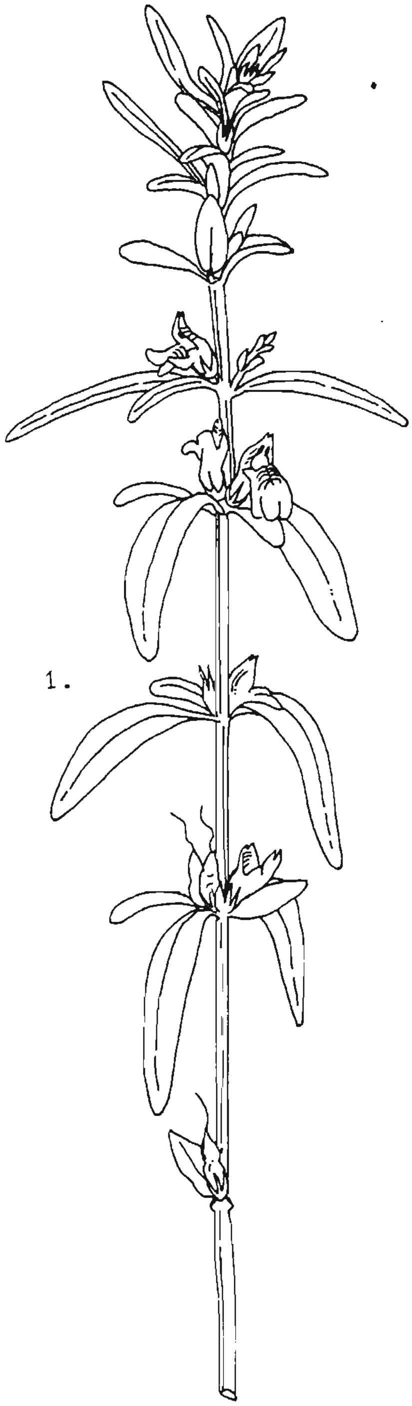
FIGURE 28: **Justicia protracta** subsp. **protracta**

1. Habit, X1

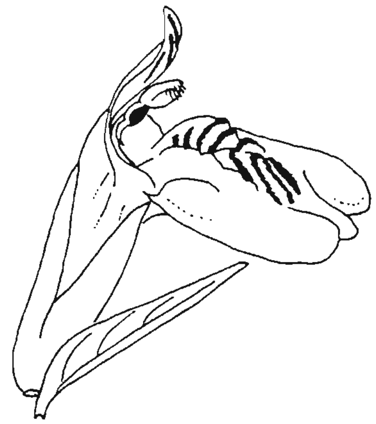
2. Flower, 3/4 view, X6

3. Flower, front view, X6

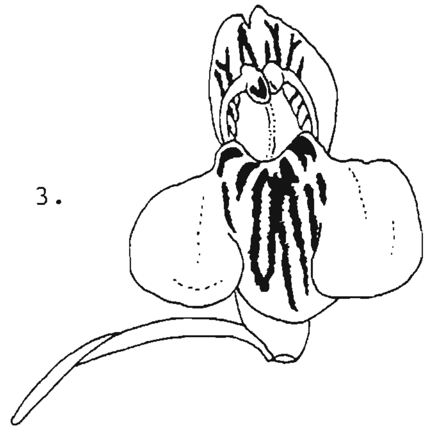
4. Capsule, X6



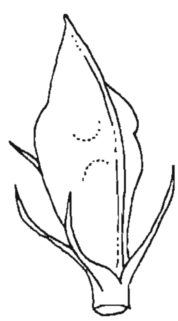
1.



2.



3.



4.

J. woodii C.B. Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 64 (1912). Type: Natal, Noodsberg, Wood 112 (K; photo. at PRE!).

Shrublet or perennial herb, 0,16-1(-2) m high. Leaves with short to long multicellular hairs, often glandular on margins, shape very variable, from narrowly lanceolate to broadly ovate, oblong or obovate, 5-70(-155)x2-45(-63) mm; petiole 0-32(-67) mm long. Inflorescence of scattered axillary sessile cymes. Bracts foliose, 2-13x1,5-8 mm, bracteoles 2 per flower, minute. Corolla 6-10(-13) mm long, usually white with or without mauve stripes on palate, occasionally mauve with darker stripes on a white palate. Capsule four-seeded, glabrous to pubescent, delicate, up to 10 mm long, very rarely with one-seeded capsules as in J. dinteri (below). Pollen two-colporate, 30-48 um long, sexine areolate (Figures 3: 1, 28; Map 11).

J. protracta is probably the most common of the southern African species, and is found throughout the eastern half of the country as far south as Port Elizabeth. In the northern Transvaal as well as in Namibia and Botswana, it is largely replaced by subsp. rhodesiana, though the transition is not a sudden one. The great range in pubescence and leaf size and shape has led to the description of numerous species and subspecies (See Figure 3.1), but examination of a larger number of specimens shows that these form a continuous range rather than discrete entities.

Vouchers; Meeuse 9197; Stirton 9817; Vahrmeijer 2385; Wells 2622 (GRA!, PRE!); Werdemann & Oberdieck 1785.

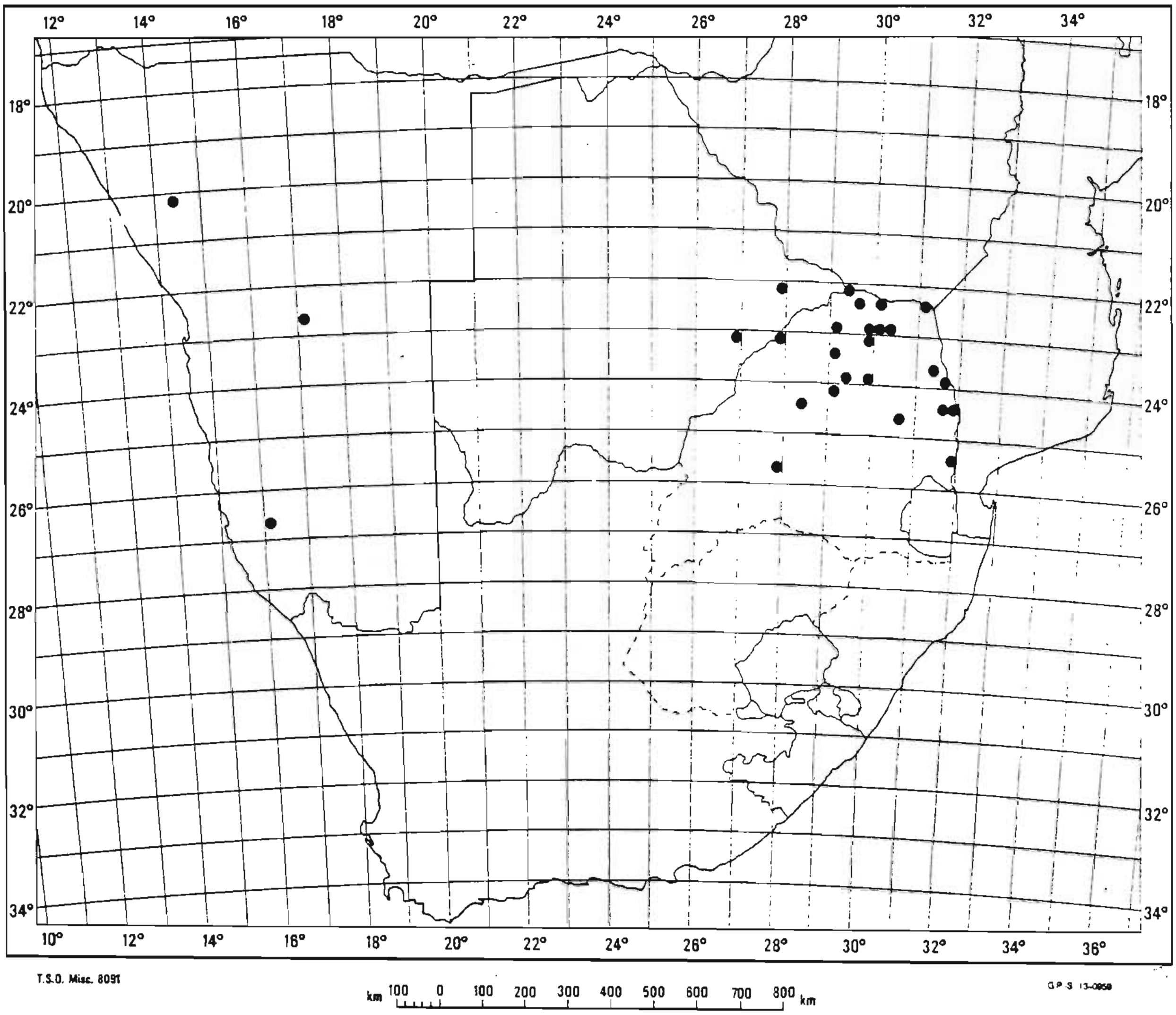
The species is placed in sect. Harnieria (Solms) C.B. Clarke, where, with J. dinteri and J. parvibracteata, it possibly could form a separate subsection within this rather poorly defined section.

C.B. Clarke placed G. mollis in the synonomy of J. kraussii, while its type is cited rather under J. pulegioides. However, both G. mollis and J. pulegioides are here placed in the synonomy of J. protracta subsp. protracta.

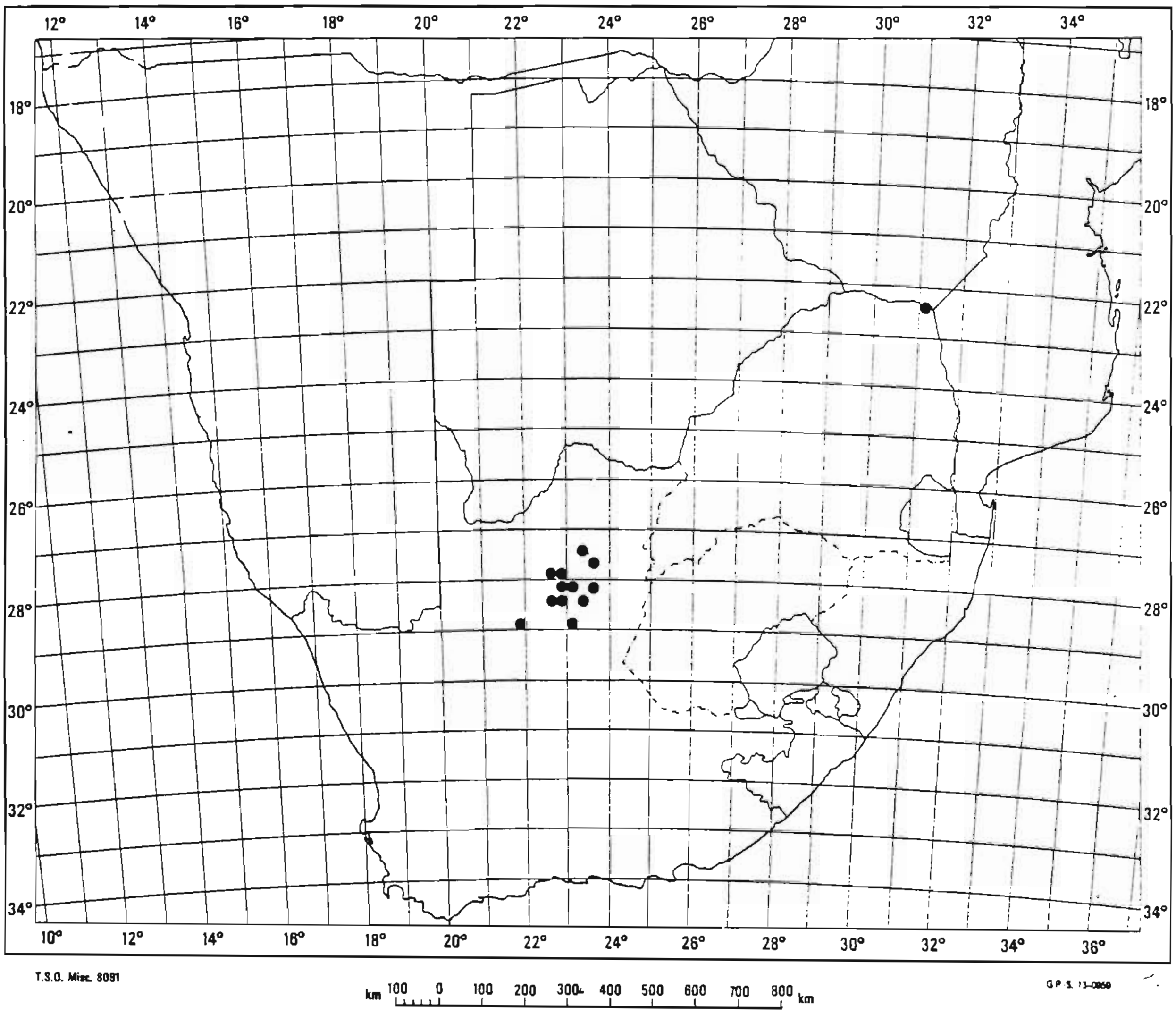
(b) subsp. **rhodesiana** (S. Moore) Immelman in Bothalia 16,1: 40 (1986). Syntypes: Botswana, Mahalapye, Rogers 6098 (BOL!; SAM!); Zimbabwe, Bulawayo, Rogers 5740 (BOL!; SAM!).

J. rhodesiana S. Moore in J. Bot., Lond. 51: 188 (1913).

Similar to subsp. protracta, from which it differs as follows: Leaves 7-31x3-14 mm; petiole 0-10 mm long. Bract 2,5-8,5x1-6 mm. Corolla never longer than 10 mm, white with mauve on palate only. All parts minutely and densely puberulous, with only occasional long hairs. (Map 12)



Map 12. Recorded distribution of J. protracta subsp. rhodesiana



Map 13. Recorded distribution of J. parvibracteata

The subspecies is found in Namibia, Botswana and the northern Transvaal, and occasionally further south, growing on rock outcrops, rocky slopes and in sandy places.

Vouchers: Germishuizen 969; Lightfoot 3 (SAM, WIND); Maguire 1502 (BOL, NBG); Rogers 19413 (BOL, NH, PRE); Taylor 3029 (NBG); Van Jaarsveld 1992 (NBG).

10. **Justicia parvibracteata** Immelman in Bothalia 16,1: 39 (1986).

Type: N. Cape, 11 miles NNW of Olifantshoek, in Toto Mnts., kloof, in rock crevices and under shrubs, Tölken and Schlieben 1176 (PRE, holo.!).

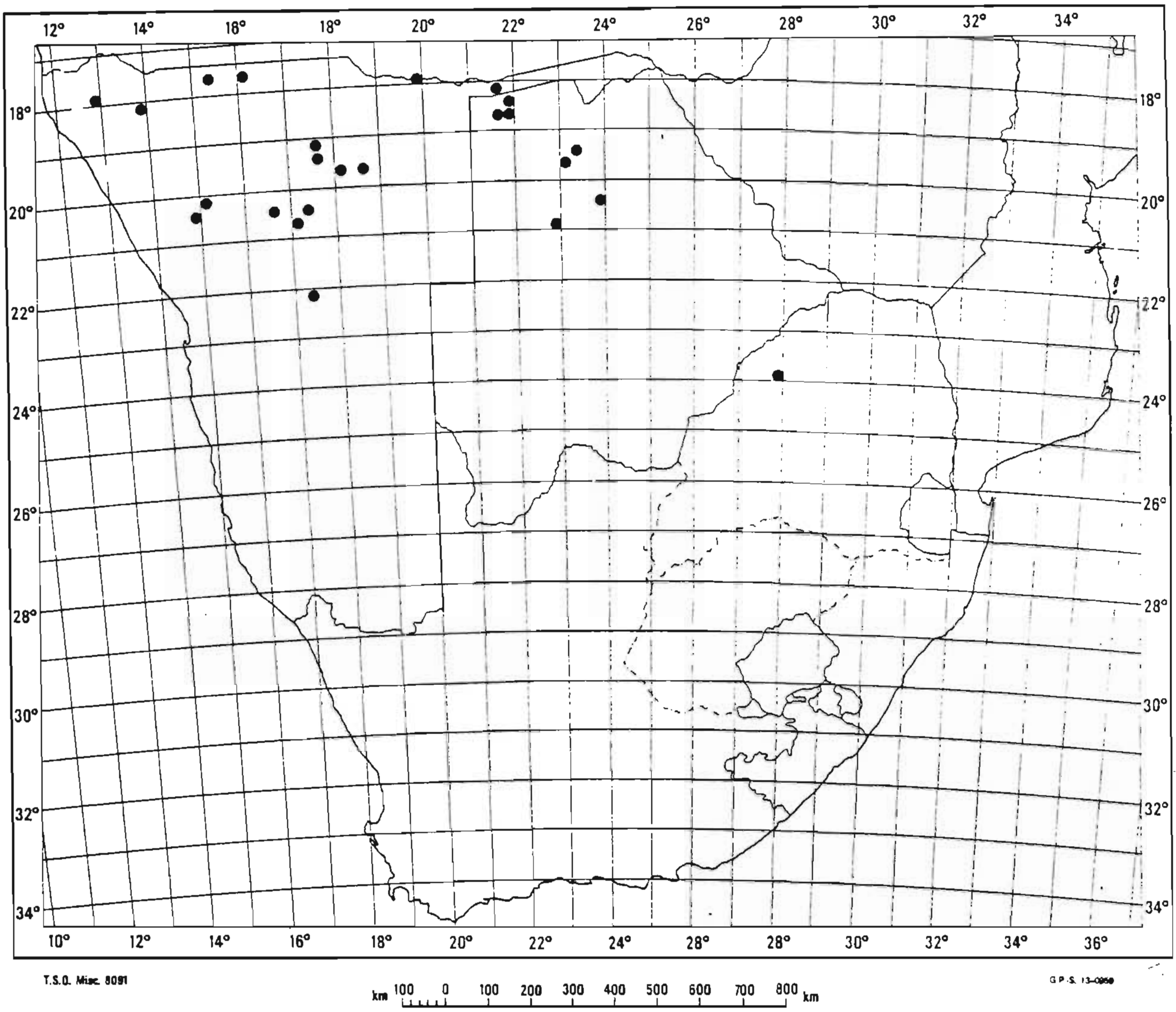
Shrublet or perennial herb, 0,12-0,5 m high, all parts minutely and densely puberulous. Leaves sometimes glandular on margins, narrowly to broadly lanceolate, apex broadly acute to obtuse, base cuneate; petiole slender, 0-6 mm long. Inflorescence of 1(-2) flowers per cyme, sessile, scattered in leaf axils. Bract and bracteoles reduced, subulate to triangular, c. 2x1 mm. Calyx of 5 subequal, narrowly lanceolate lobes. Corolla (4)5-8 mm long, white with mauve lines on palate. Capsule four-seeded, cylindrical, puberulous, delicate, up to 8 mm long. Pollen two-colporate, 35-42 um long, areolate (Figure 5:5; Map 13).

Similar to and presumably derived from J. protracta. This species is mainly restricted to the Northern Cape, with a single record from the northern Kruger National Park, and thus does not overlap with the distribution of J. protracta. It grows in rocky or sandy soil. The greatly reduced bract is characteristic.

Vouchers: Acocks 29471 (BOL, NBG, PRE); Esterhuysen 2354 (BOL, PRE); Leistner 1402 (KMG, PRE), 1657 (BOL, KMG, PRE); Van Rooyen 86 (KNP).

11. **Justicia dinteri** S. Moore in J. Bot., Lond. 57: 246 (1919); Meyer in Fl. S. W. Afr. 130 (1968). Type: Namibia, Otjitua, Dinter 87 (B!; NBG!).

Annual herb, sometimes rooting at lower nodes, (0,04-) 0,3-0,82 m high. Leaves always with at least some hairs, these longer on veins than on lamina, lamina narrowly lanceolate to ovate, (15-) 35-93x(7-)14-42 mm, apex acute to attenuate-obtuse, base cuneate; petiole slender, 3-31 mm long. Inflorescence of scattered, sessile, axillary cymes. Bract foliose, with long cottony hairs, 4-14x1,5-7,5 mm; bracteoles reduced and triangular. Calyx with hairs as for bracts. Corolla 5-7 mm long, pale to deep mauve or violet, palate often white with dark mauve lines or spots. Capsules dimorphic; normal capsule four-seeded, delicate, up to 7 mm long; intermixed with one-seeded capsules, these shorter than normal ones, with four serrated longitudinal wings, indehiscent. Pollen two-colporate, 32-43 um long, sexine areolate (Figure 5: 6; Map 14).



Map 14. Recorded distribution of J. dinteri

The presence of dimorphic capsules, as well as other characters, strongly argues a relationship between J. dinteri and J. protracta, as well as Siphonoglossa leptantha. In all three cases the dimorphism takes the same form. (See Ch. 3.8 on seeds).

J. dinteri occurs in northern Namibia, northern Botswana and the N.W. Transvaal. It grows in the shade of trees, usually either on rocky koppies or in riverine woodland.

Vouchers: De Winter & Leistner 5320 (WIND, PRE); De Winter & Marais 4906 (WIND, PRE); Meeuse & Strey 10457; Merxmüller & Giess 30045; Meyer 1166 (WIND, PRE).

12. **Justicia odora** (Forssk.) Vahl, Enum. 1: 164 (1804); Burkill & Clarke in Thiselton-Dyer, Fl. Trop. Afr. 5,1: 201 (1900), in Thiselton-Dyer, Fl. Cap. 5,1: 61 (1912); Andrews, Fl. Pl. Anglo-Egypt. Sudan 3: 180 (1956); Agnew, Upland Kenya Wild Flowers 604 (1974); Meyer in Fl. S. W. Afr. 130 (1968). Type: Yemen, Wadi Surdud, Kaejsaman, near mountains, Forsskal s.n. (C; microfiche in PRE!).

Dianthera odora Forssk., Fl. Aegypt.-Arab. 8 (1775).

Gendarussa odora (Forssk.) Presl, Bot. Bemerk. 95 (1844).

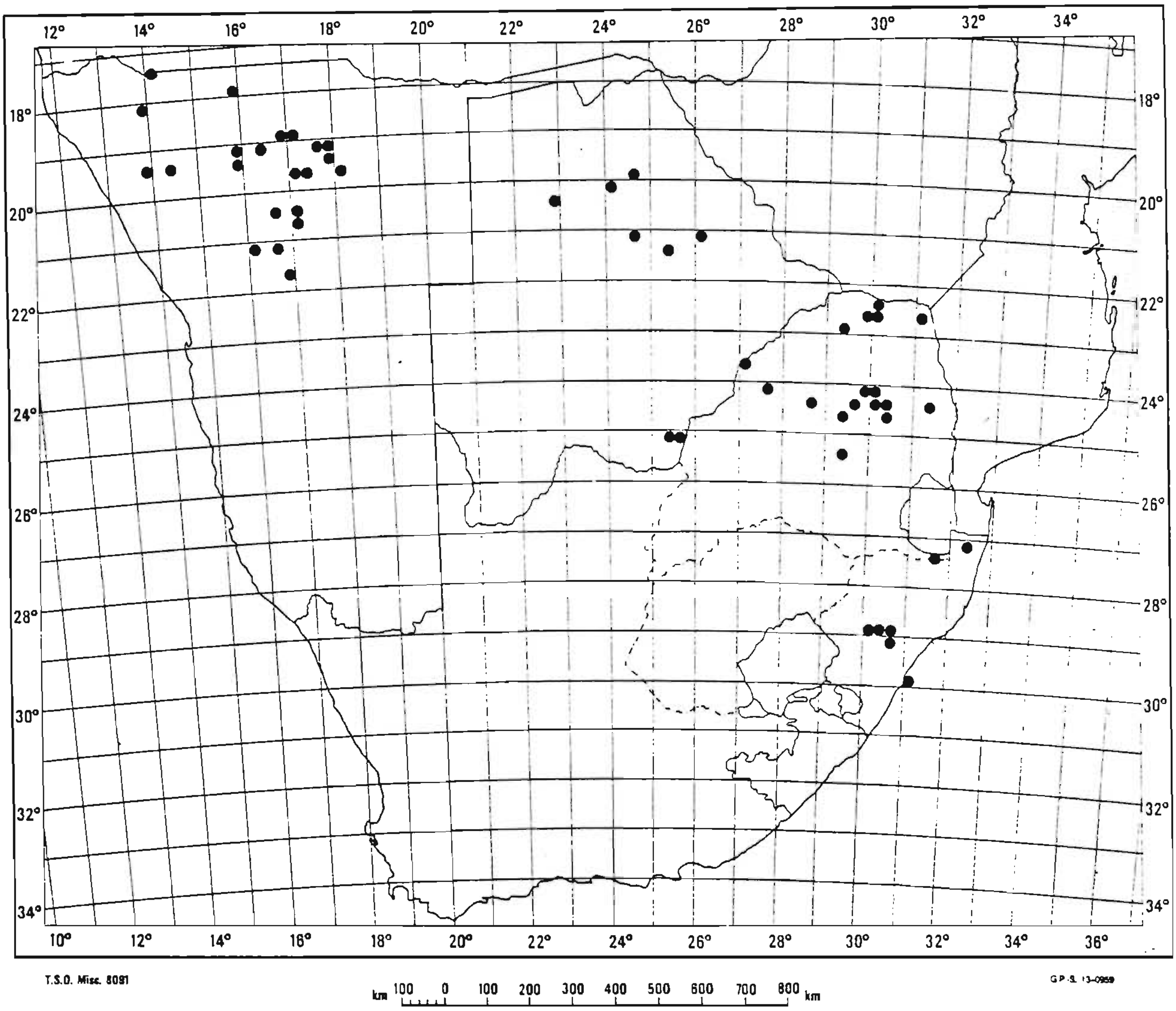
Adhatoda odora (Forssk.) Nees in DC., Prodr. 11: 399 (1847).

Justicia polymorpha Schinz in Verh. bot. Ver. Prov. Brandenb. 31: 203 (1890). Type: Namibia, S.E. Ondonga, Oshando, Schinz s.n. (Z!).

J. lycioides Schinz in Vjschr. naturf. Ges. Zürich 61: 440 (1916). Type: Namibia, between Ondonga and Ukuambi, Rautanen 785 (Z!).

Shrub or perennial herb, 0,2-1,5 m high. Leaves glabrous except for a few hairs on midrib and margins, often with long multicellular cilia on margins near petiole, ovate to obovate, 9-73(-65)x4-22(-70) mm, apex acute or obtuse, base cuneate; petiole 2-7(-65) mm long. Inflorescence of scattered axillary sessile cymes. Bract foliaceous, glabrous, 4-20x2-7 mm; bracteoles minute, subulate to triangular. Corolla 3-14 mm long, bright yellow, may be veined with red or purple inside tube. Capsule four-seeded, cylindrical, glabrous, hard in texture, up to 15 mm long. Pollen two-colporate, 37-45 um long, sexine areolate (figure 5: 7; Map 15).

Widespread in tropical Africa; within the Flora region it is found in Namibia, Botswana, the Transvaal and Natal. Like many of the other species of the genus, it is frequently, though not exclusively, found on calcareous soils.



Map 15. Recorded distribution of J. odora

Vouchers: De Winter & Leistner 5214 (PRE, WIND); Miller B/281; Rodin 9195 (PRE, WIND); Smith 2602; Wanntorp 414.

13. **Justicia capensis** Thunb., Prodr. 104 (1800), Fl. Cap. 2: 478 (1813); Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 60 (1912); Marloth, Fl. S. Afr. 3,2: 173, pl. 45:c (1932); Immelman in Flower. Pl. Afr. 48,3 & 4: pl. 1920 (1985). Type: Interior of the Cape of Good Hope, Thunberg s.n. partim spec. 1 only (UPS; microfiche in PRE!).

Gendarussa capensis (Thunb.) Nees in Linnaea 15: 336 (1841).

Adhatoda capensis (Thunb.) Nees in DC., Prodr. 11: 391 (1847).

G. capensis subsp. obovata Nees in Linnaea 15: 365 (1841). Type: S. Cape, Zwartkops River, amongst other shrubs in thickets, on hills around river, Ecklon 555 (BOL!; S!); Zwartkops River, at house of Paul Maré, Ecklon s.n. (BOL!; MEL!).

Adhatoda capensis subsp. obovata (Nees) Nees in DC., Prodr. 11: 391 (1847).

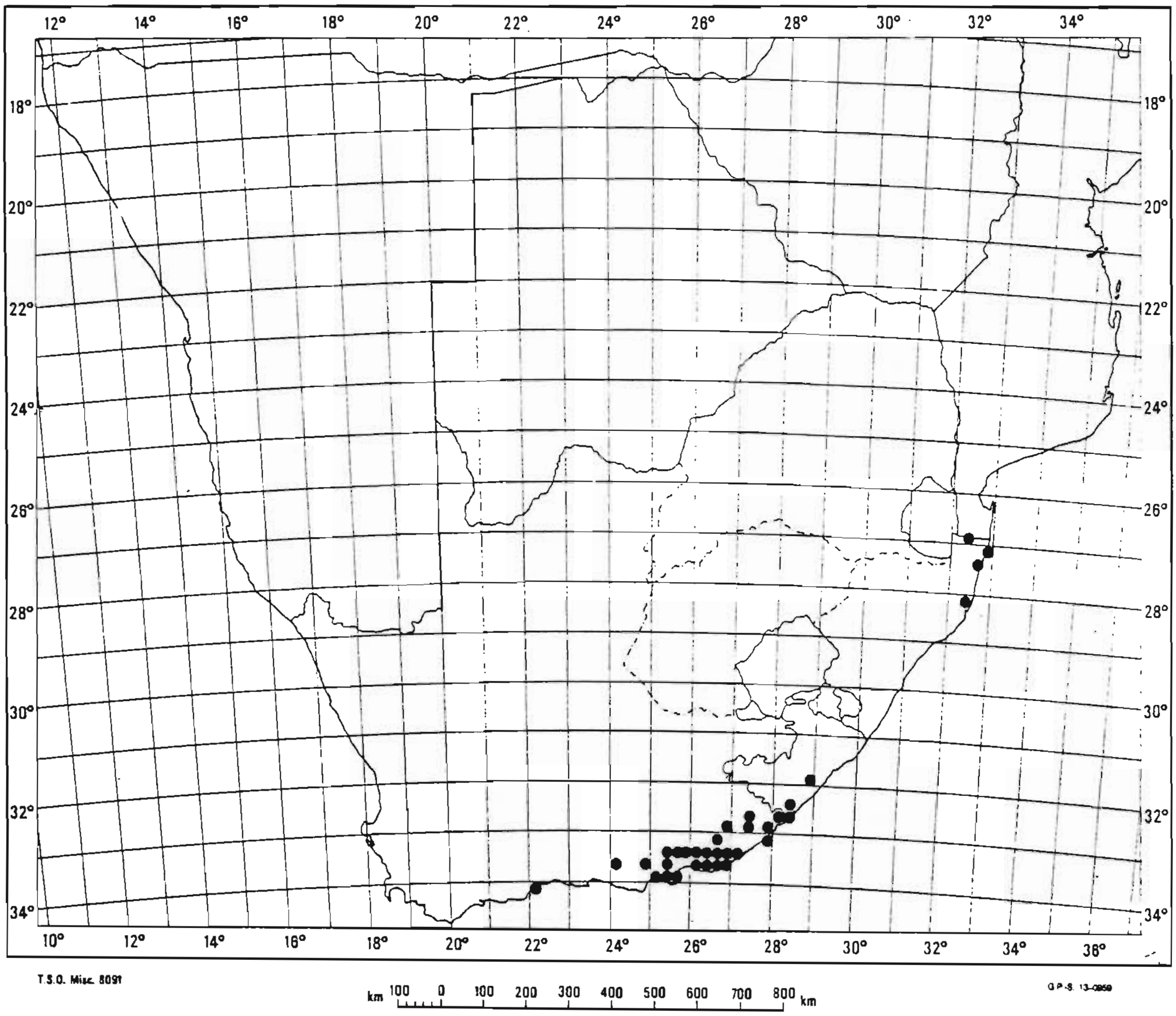
Adhatoda capensis subsp. A: presumably the typical subspecies. Subsp. A var. glabrescens Nees in DC., Prodr. 11: 391 (1847). Type: No locality given, Krebs s.n (G-DC; microfiche in PRE!).

Shrub or woody herb, sometimes scrambling, 0,2-2 m high. Leaves glossy and glabrous to densely velvet-haired, slightly obovate or occasionally ovate, 14-74(-125)x5-33 (-50) mm, apex obtuse, base cuneate, slightly fleshy in texture, dark green; petiole 1-16(-37) mm long. Inflorescence of scattered axillary sessile cymes. Bract foliaceous, glabrous to densly velvety, 4-17x3-9 mm; bracteoles minute, triangular. Corolla 9-15(-17) mm long, mauve with a white palate. Capsule four-seeded, cylindrical, glabrous or pubescent, hard in texture, up to 19 mm long. Pollen two-colporate, 48-60 um long, sexine areolate (Figures 5: 8, 29; Map 16).

J. capensis grows in the shade of trees and shrubs, often in sandy soil. It has a rather unusual distribution, as it is found in the eastern and southern Cape, as well as in northern Natal. There does not seem to be any morphological difference between the two groups. It is uncertain why there should be this disjunction, as the intervening area is well-collected, and J. capensis is also one of the more conspicuous species of the genus.

Vouchers: Dyer 5446 a, b; Galpin 5766; Immelman 181 A; Moll 4849 (NH, PRE); Taylor 3697 (NBG).

There are two specimens of Thunberg at UPS marked J. capensis, but only the first belongs to this species. The second is

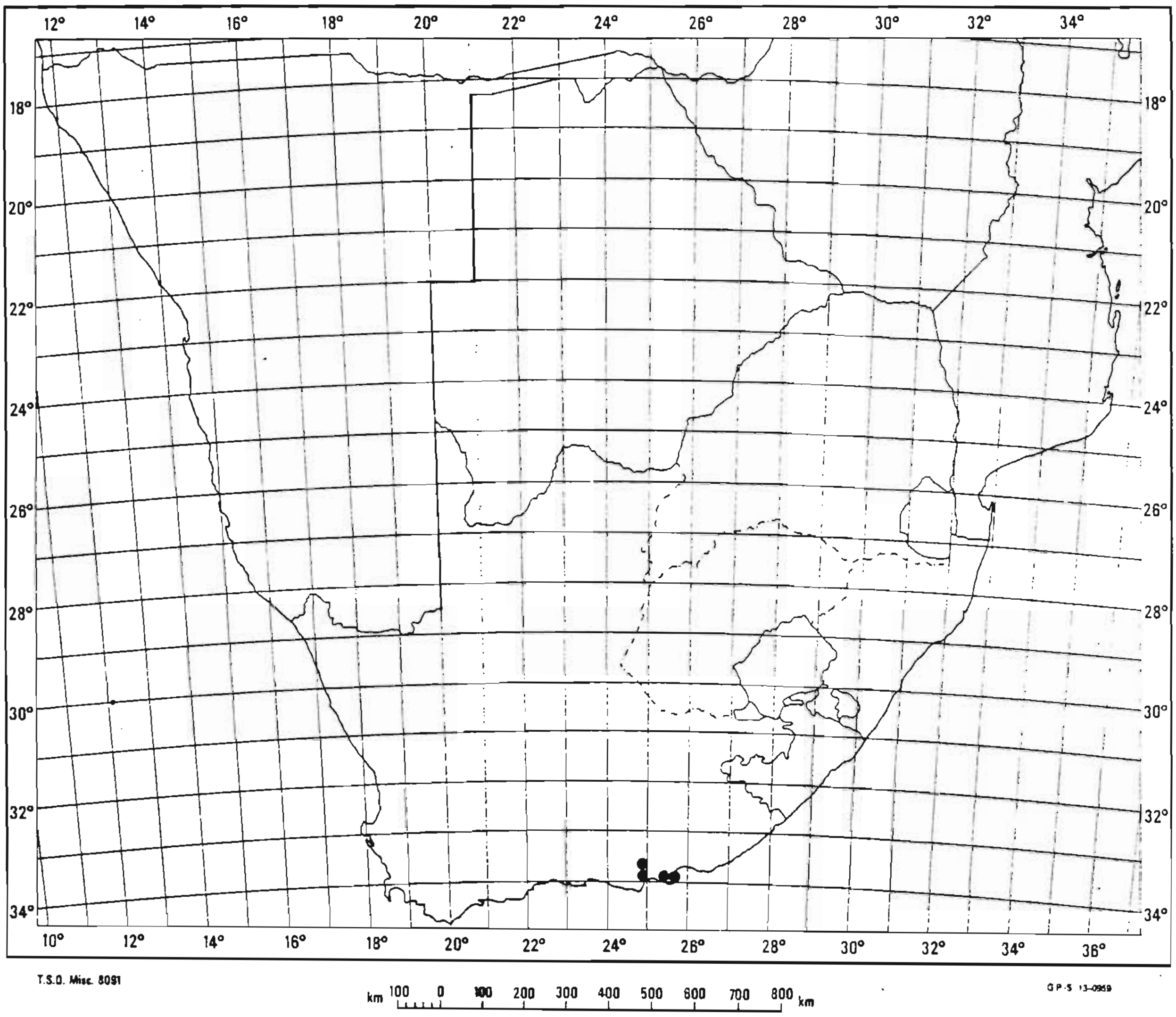


Map 16. Recorded distribution of J. capensis

FIGURE 29: **Justicia capensis**

1. Habit, X1
2. Flower, front view, X6
3. Flower, side view, X6
4. Capsule, X6


1.
2.
3.
4.



Map 17. Recorded distribution of J. cuneata subsp. cuneata

Sclerochiton odoratissima Hilliard, and is labelled as such. There is also a Thunberg specimen at G-DC (microfiche in PRE!) marked "J. capensis", but it belongs rather to J. protracta.

14. **Justicia cuneata** Vahl, Symb. bot. 2: 10 (1790-94), Enum. 1: 163 (1804); Anderson in J. Linn. Soc., Bot. 7: 41 (1874); Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 61 (1912); Meyer in Fl. S. W. Afr. 130 (1968) as J. orchioides; Le Roux & Schelpe, Namaqualand and Clanwilliam - S.A. Wild Flower Guide 1: 128 (1981) as J. orchioides. Type: Cap. bon. spei, Sparrman s.n. in herb Dahl (C!).

(a) subsp. **cuneata**

Immelman in Bothalia 16,1: 40 (1986).

Gendarussa cuneata (Vahl) Nees in Linnaea 15: 367 (1841).

Gendarussa hyssopifolia var. longebracteolata Nees in Linnaea 15: 368 (1841). Type: S. Cape, on the Karoolike hills, between the Coega and Zwartkops Rivers, Ecklon & Zeyher s.n. (BOL!; MEL!; S!).

G. cuneata var. hirtula Nees in Linnaea 15: 367 (1841). Type: S. Cape, between Krakakamma mountains and Van Staadens River, Ecklon & Zeyher s.n. (S!); Zwartkopsrivier, by house of Paul Maré, Ecklon & Zeyher s.n. (BOL!).

J. cuneata subsp. cuneata is similar to subsp. latifolia (following), but differs from it as follows: Leaves and outer surface of calyx glabrous, stems and inside of calyx with long hairs and sometimes also with glands (Figure 6:1; Map 17).

Restricted to the area around Port Elizabeth, where subsp. latifolia does not occur.

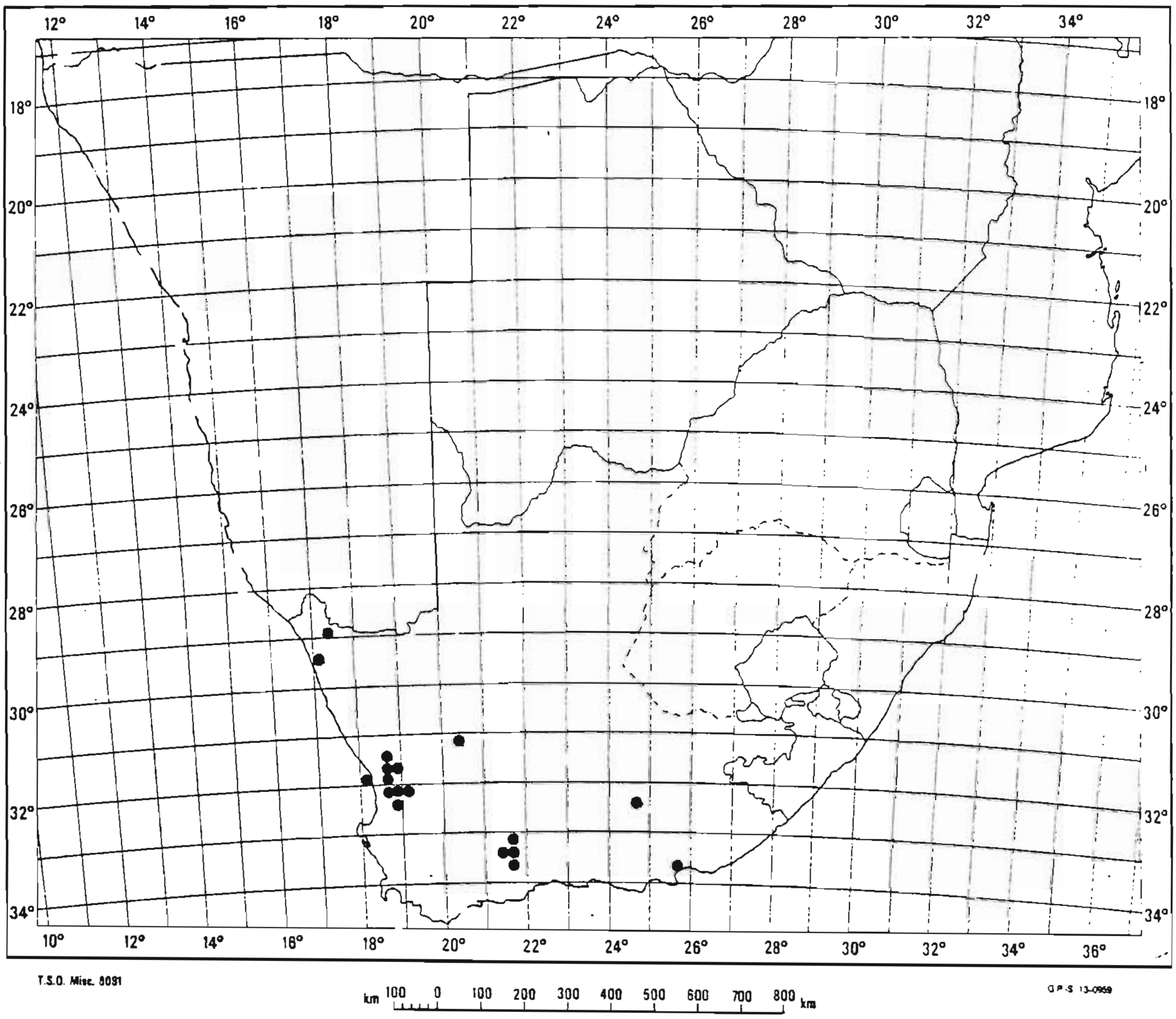
Vouchers: Bayliss 4876 (NBG); Dahlstrand 1575 (GRA), 5157; Fries, Norlindh & Weimarck 230; West 352 (BOL, GRA).

(b) subsp. **latifolia** (Nees) Immelman in Bothalia 16,1: 40 (1986). Syntypes: Cape Province, Kanaquasberg, Ecklon s.n. (BOL!); Clanwilliam, between Olifantsrivier and Brakfontein, Ecklon & Zeyher s.n. (S!; MEL!).

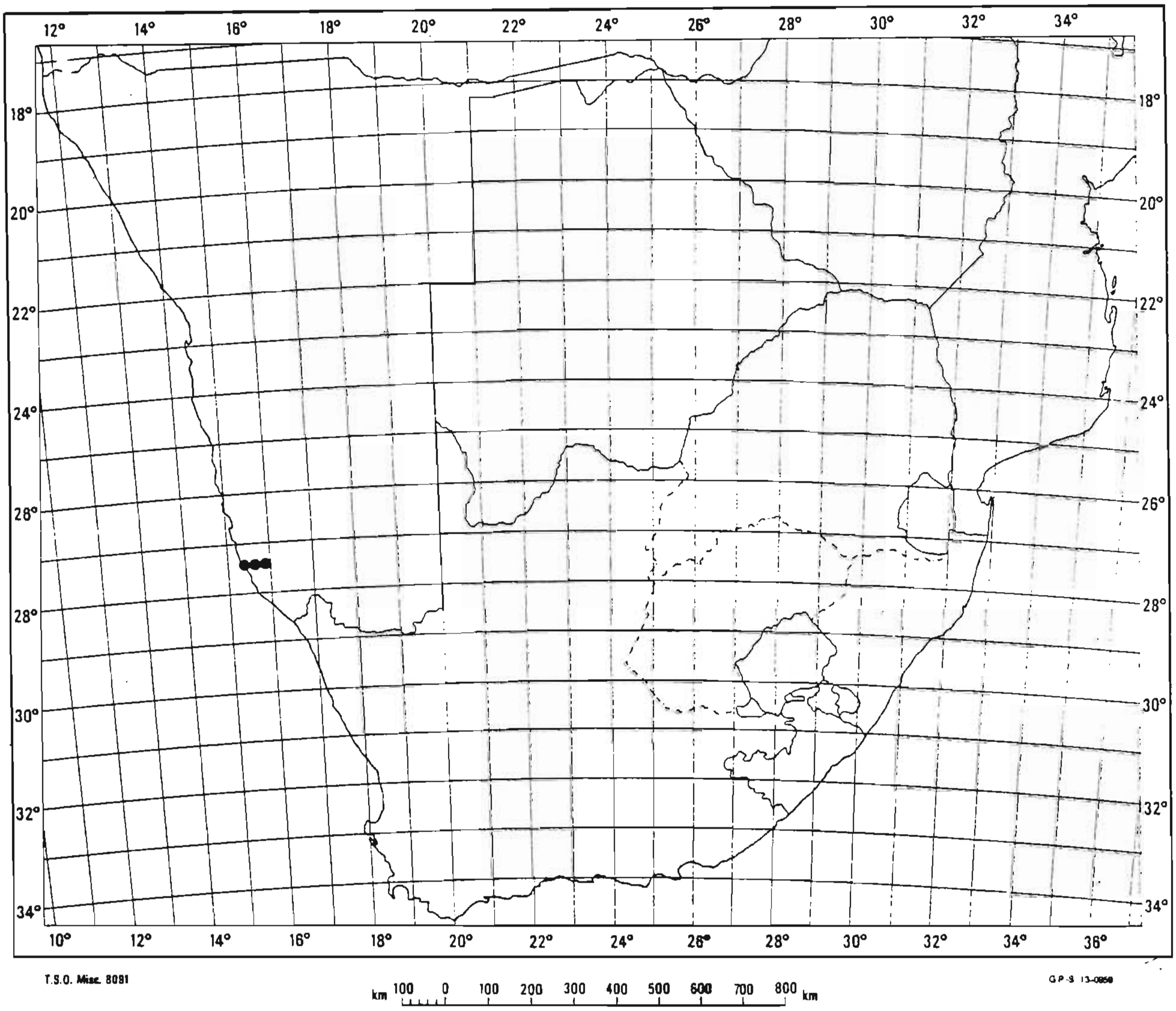
Gendarussa orchioides var. latifolia Nees in Linnaea 15: 369 (1841).

Adhatoda orchioides var. latifolia (Nees) Nees in DC., Prodr. 11: 393 (1847).

Gendarussa orchioides var. angustifolia Nees in Linnaea 15:



Map 18. Recorded distribution of J. cuneata subsp. latifolia



Map 19. Recorded distribution of J. cuneata subsp. hoerleiniana

369 (1841). Type: Cape Province, between Olifantsrivier and Brakfontein, Ecklon & Zeyher s.n. (S!).

Adhatoda orchioides var. angustifolia (Nees) Nees in DC., Prodr. 11: 393 (1847).

Compact twiggy shrub, 0,2-1,6 m high; stems thick, woody and sometimes becoming spinescent; bark grey, cracked and furrowed; young shoots woody or herbaceous. Leaves densely and minutely puberulous, obovate, 4-16x1,5-6 mm, apex obtuse, base cuneate, thick-textured; petiole short or absent. Inflorescence of cymes each reduced to a single pedunculate axillary flower. Peduncles stiff, 2,5-10 mm long. Bract absent, bracteoles 2, puberulous, broadly ovate, 1-4 mm long, often joined at base across peduncle. Corolla (10)11-17 mm long, hooded, white to cream with mauve markings. Capsule one-seeded, clavate, hard in texture, up to 19 mm long, shiny, glabrous. Pollen two-colporate, 45-61 um long, sexine areolate (Map 18).

The subspecies occurs in Namaqualand and the western Karoo as far east as Port Elizabeth. It is usually found in dry open sandveld, occasionally on shaley hillslopes.

Vouchers: Acocks 19385 (KMG; PRE); Esterhuizen 5550 (BOL, GRA, PRE); Leighton 1375; Leipoldt 3772 (BOL, PRE, SAM); Van Breda 4288.

(c) subsp. **hoerleiniana** (P.G. Mey.) Immelman in Bothalia 16,1: 40 (1986). Type: Namibia, Alicetal, Pomona (probably on the coastal plain in the Lüderitz district), Dinter 6401 (BOL!; PRE!).

Justicia hoerleiniana P.G. Mey. in Mitt. bot. StSamml. München. 2: 300 (1957, in Fl. S. W. Afr. 130 (1968).

Similar to subsp. latifolia, from which it differs as follows: Leaves up to 10 mm wide, broadly ovate to obovate;, base obtuse to broadly cuneate. Corolla 13-21 mm long. All parts densely covered with velvety, grey-white, swollen, anvil-shaped hairs, calyx also glandular (Map 19).

The subspecies is restricted to the area between the southern Namibia border and Lüderitz, where subsp. latifolia does not occur.

Vouchers: Dinter 3947, 3949 (SAM); Schager 15, s.n.

15. **Justicia orchioides** L.f., Suppl. 85 (1781); Anderson in J. Linn. Soc. Bot. 7: 42 (1867); Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 63 (1912); Wilman, Checklist Griq. West 221 (1946). Type: Cape of Good Hope, Thunberg s.n. (UPS; microfiche in PRE!).

(a) subsp. **orchioides**

Immelman in Bothalia 16,1: 39 (1986).

Gendarussa orchioides (L. f.) Nees in Linnaea 15: 369 (1841).

Gendarussa diosmophylla Nees in Linnaea 15: 370 (1841). Type: Cape Province, Zwartkops River, by house of Paul Maré, Ecklon & Zeyher s.n.(MEL!; S!).

Adhatoda diosmophylla (Nees) Nees in DC., Prodr. 11: 394 (1847).

Justicia diosmophylla (Nees) Lindau in Engler & Prantl, Natürl. Pflanzenfam. 4,3b: 349 (1894).

G. pygmaea Nees in Linnaea 15: 369 (1841). Type: S. Cape, Uitenhage, amongst shrubs in Karoo, between Coega and Zwartkops Rivers, Ecklon s.n. (MEL!).

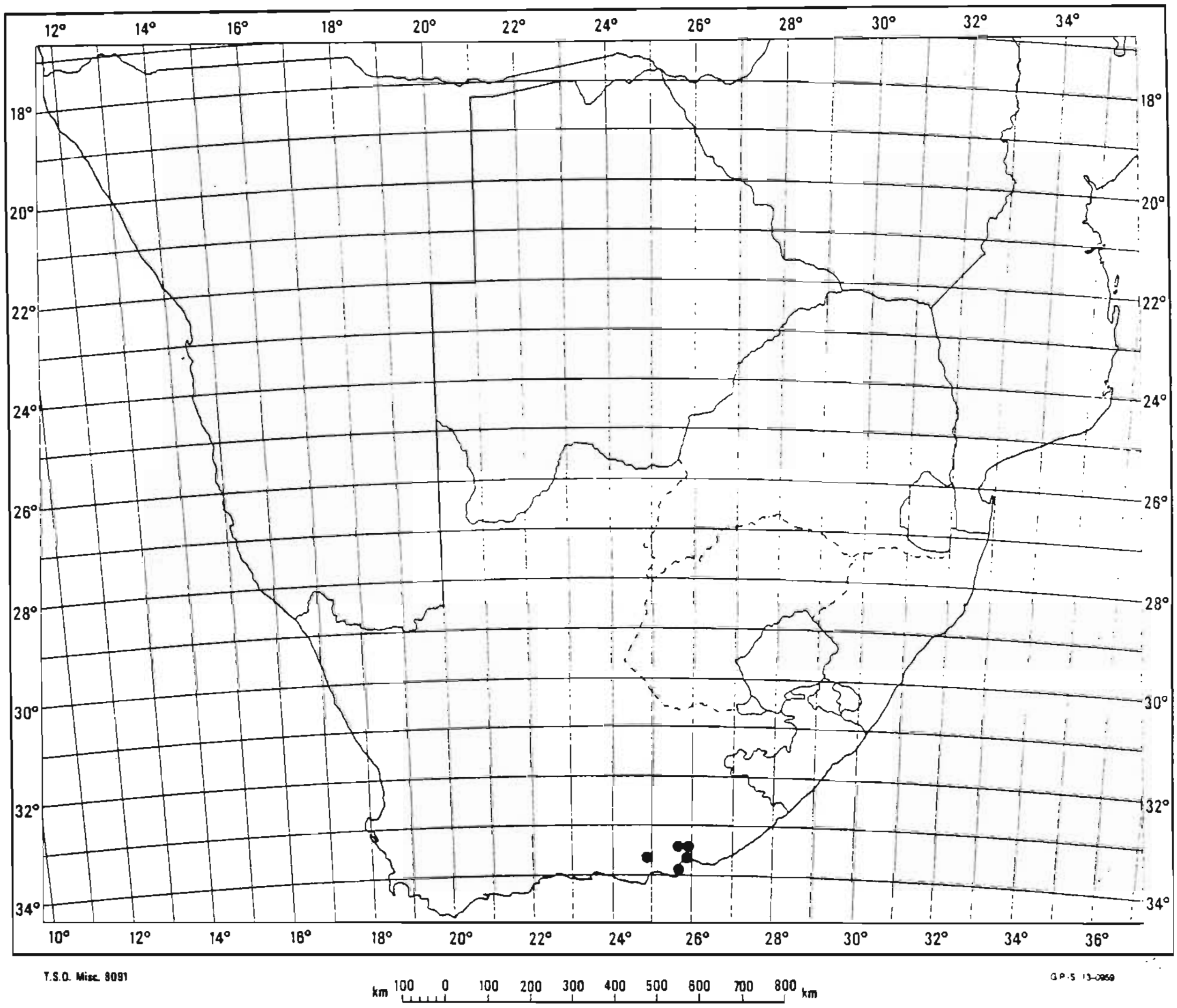
Adhatoda pygmaea (Nees) Nees in DC., Prodr. 11: 394 (1847).

Adhatoda pygmaea var. serpyllum Nees in DC., Prodr. 11: 394 (1847). Syntypes: No locality given, Mund; Maire s.n. (not found).

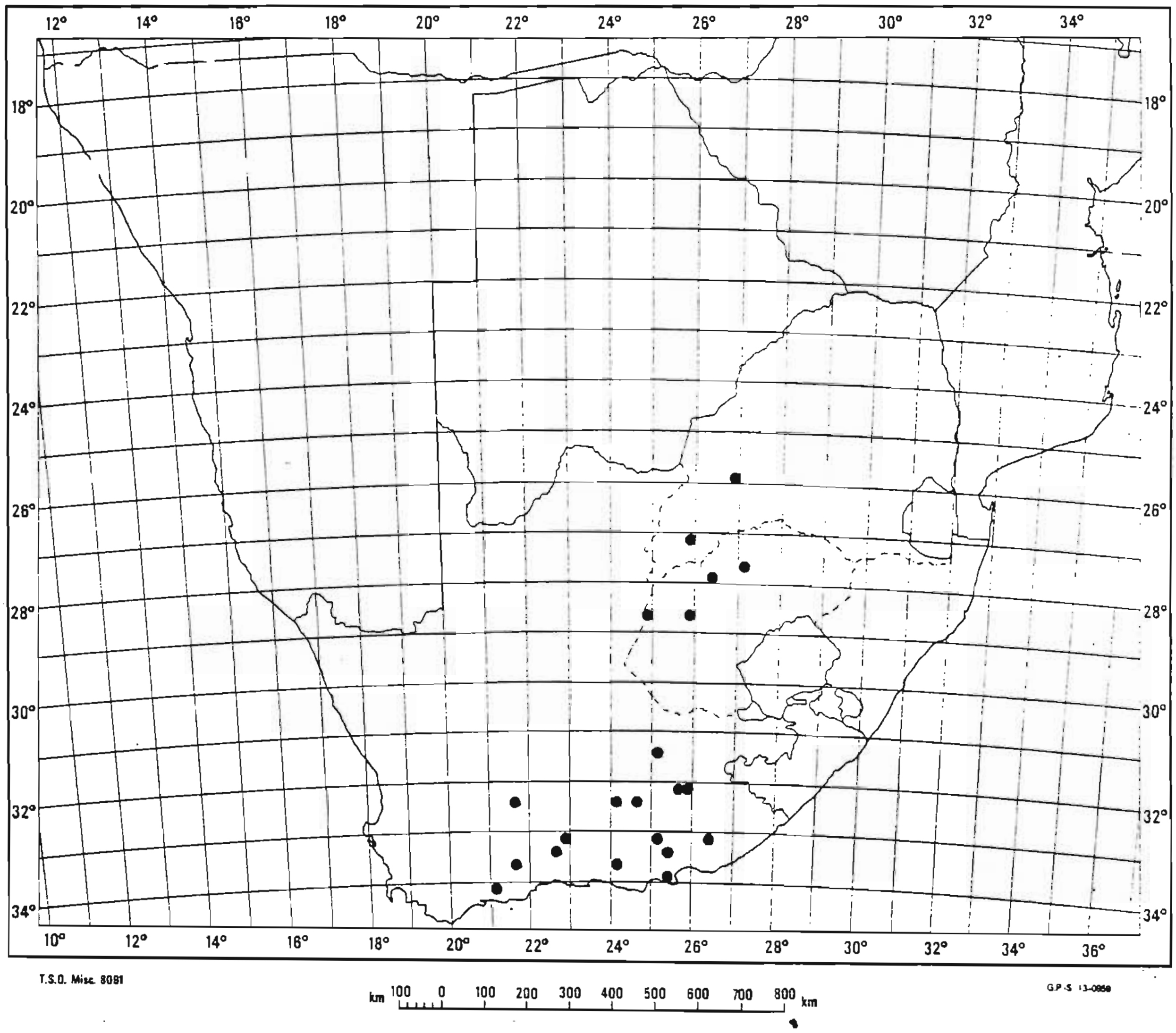
Woody shrublet, 0,14-0,6 m high, stems thick, gnarled, may become spinescent, with long white-opaque hairs; bark grey, cracked and furrowed; young branches sub-herbaceous. Leaves glabrous or with a few long white-opaque hairs, ovate to lanceolate, 3,5-13x1,5-7 mm, apex acute to obtuse, base cuneate, sessile, leathery, midrib prominent but side-veins not visible. Inflorescence of scattered cymes each reduced to a single peduculate axillary flower. Peduncle and pedicel stout, 1-10 mm long. Bract absent; bracteoles 2, with long, white-opaque hairs, triangular, 1-2 mm long, joined at base across peduncle. Calyx with hairs as for bracts on inner surface. Corolla 7-10 mm long, white with maroon markings. Capsule one- seeded, glabrous, hard in texture, up to 17 mm long. Pollen two-colporate, 30-49 um long, sexine with entire margocolpi (Figure 6: 2; map 20).

Vouchers: Acocks 14011, 14031; Liebenberg 3003; Louw 1969; Muir 1100 (BOL, PRE).

This, and J. thymifolia, were formerly placed in sect. Harnieria by C.B. Clarke; however they differ in pollen from the other species in that section. A separate section seems justified to accommodate these species, as well as J. guerkeana and J. platysepala. The first two species show a



Map 20. Recorded distribution of J. orchioides subsp. orchioides



Map 21. Recorded distribution of J. orchioides subsp. glabrata

tendency parallel to that of J. cuneata to a reduced number of flowers in the cyme, to increased woodiness and to smaller leaves.

The type of the species has been seen only on microfiche, which unfortunately does not show the hairs which are necessary to distinguish the subspecies. However, information received from UPS shows that the type of hair, at least on the right hand plant, is consistent with that of the Port Elizabeth subspecies, and this is accordingly made the typical subspecies.

(b) subsp. **glabrata** Immelman in Bothalia 16,1: 39 (1986).

Type: S. Cape, Grahamstown, between Piggots Bridge and Hounslow, roadside on dry clay soil, 400m, A. Jacot Guillarmod 6902 (PRE, holo.!; GRA!).

Similar to subsp. orchioides, from which it differs as follows: All parts glabrous or with short hairs or stout pyramidal papillae, without long white-opaque hairs (Map 21).

The subspecies is widespread in eastern part of Karoo as far north as the Orange Free State, and grows in open areas, often in calcareous soils.

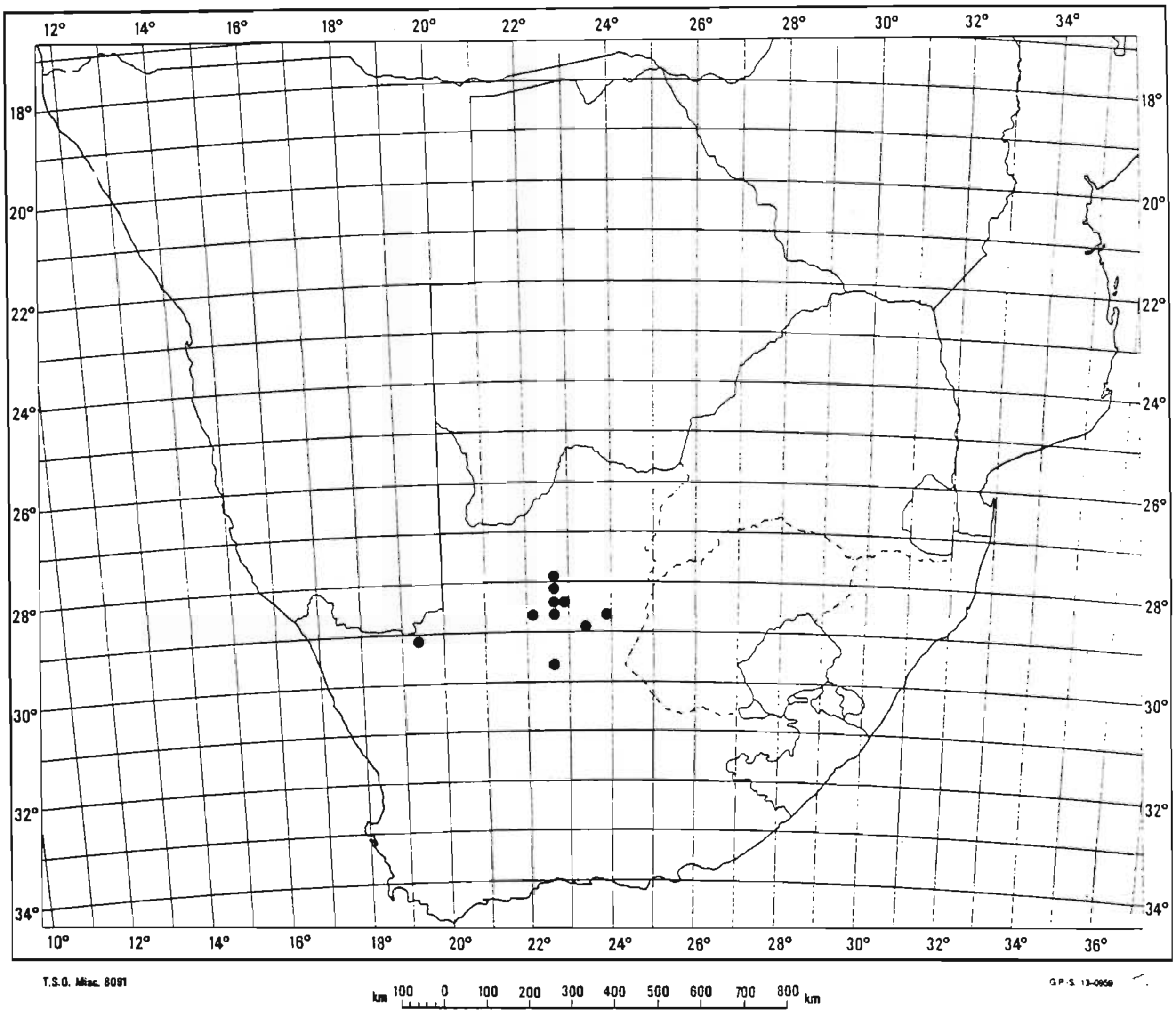
Vouchers: Acocks 14011, 14013; Liebenberg 3003; Louw 1969; Muir 1100 (BOL, PRE).

16. **Justicia thymifolia** (Nees) C.B. Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 64 (1912); Wilman, Checklist Griq. West 222 (1947). Syntypes: N. Cape, Orange River, Lichtenstein s.n. (B-W; microfiche in PRE!); N. Cape, Hay div., between Griquatown and Spuigslang, Burchell 1702 (K; photo. in PRE!).

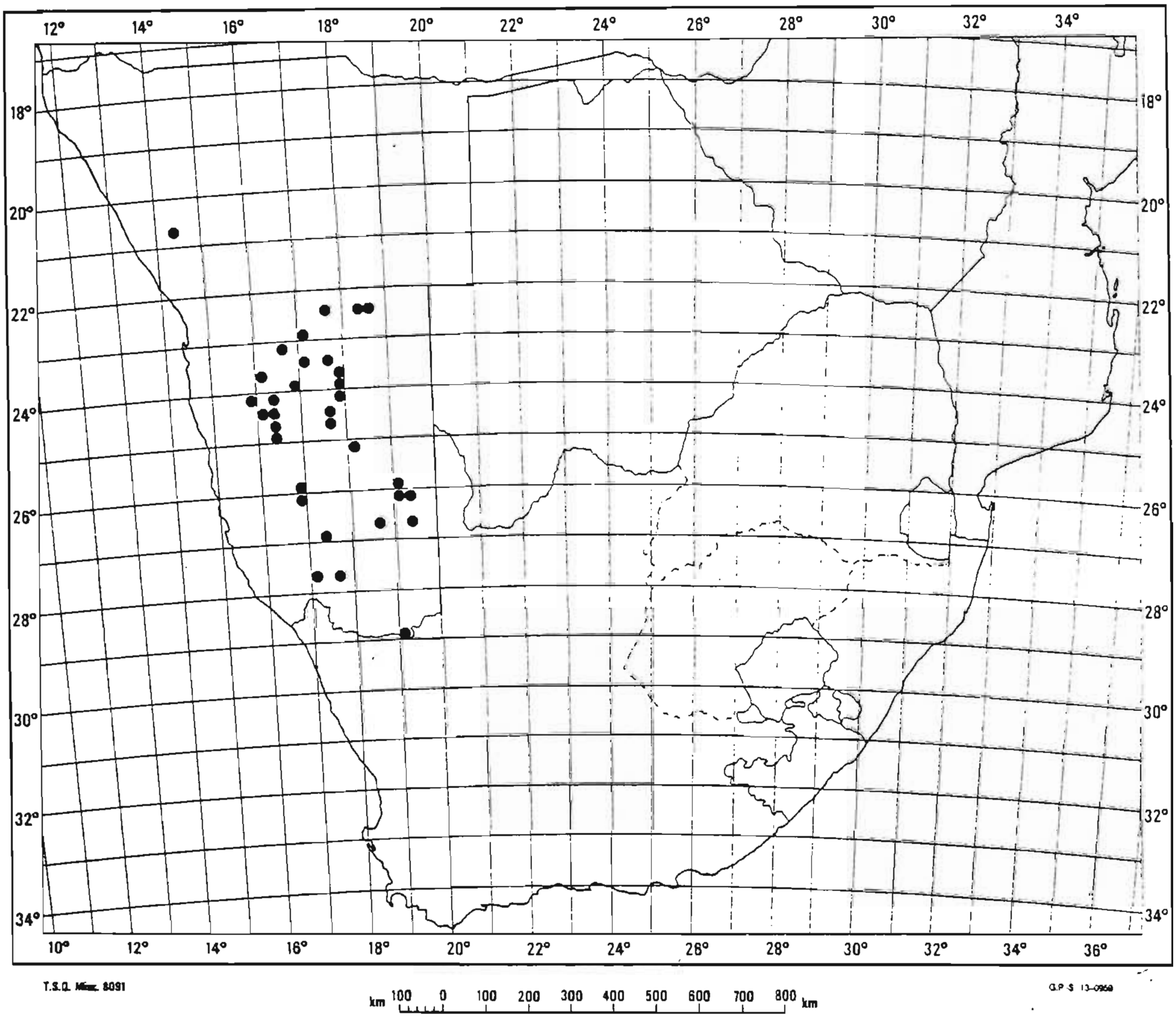
Adhatoda thymifolia Nees in DC., Prodr. 11: 392 (1847).

Woody shrub, 0,36-1,5 m high; branches often spinescent; bark yellow-green becoming grey and cracked. Leaves with short, sparse to moderately dense pubescence, broadly obovate to ovate, apex obtuse, base cuneate or sometimes truncate, leathery, often three-veined from the base, side veins usually visible; petiole broad, 1-3 mm long. Inflorescence of scattered cymes reduced to 1-2 shortly pedunculate axillary flowers. Bract and bracteoles reduced, lanceolate to triangular, 2-3,5 mm long. Corolla with a long cylindrical tube, 20-33 mm long, cream, may be brownish in throat, tube and back of lobes. Capsule with 1(-4) seeds, glabrous, clavate, up to 17 mm long. Pollen two-colporate, 53-68 um long, sexine with entire margocolpi (Figure 6: 3; Map 22).

This species is restricted to the Northern Cape and grows on rocky hillslopes. Like many species of Justicia, especially those



Map 22. Recorded distribution of <u>J. thymifolia</u>



Map 23. Recorded distribution of J. guerkeana

growing in arid areas, it makes a good browse. It has the longest corolla of the southern African species.

Vouchers: Acocks 14399; Bryant 1092, 1187; Leistner 1354 (KMG, NBG, PRE); Pole-Evans s.n. Flora of S.A. No. 29.

17. **Justicia guerkeana** Schinz in Verh. bot. Ver. Prov. Brandenb. 31: 201 (1890); Burkill & Clarke in Thiselton-Dyer, Fl. Trop. Afr. 5: 211 (1900); Meyer in Fl. S. W. Afr. 130 (1968). Type: Namibia, between Tiras and Rehoboth, Schinz s.n. (Z!).

J. leucocraspedota Lindau in Bot. Jb. 43: 357 (1909). Type: Namibia, Ausis, 1250m, Range 422 (not found).

Monechma clarkei Schinz in Vjschr. naturf. Ges. Zürich 61: 440 (1916). Syntypes: Namibia, Rehoboth, Fleck 538 (not found); Angabe, Kolbe s.n. (not found).

Shrub 0,3-2 m high; bark pale grey to yellowish. Leaves glabrous or with a few minute hairs on margin, ovate, oblong-ovate, narrowly lanceolate or obovate, 10-52x4-22 mm, apex acute or obtuse, base slightly cordate, 3- or 5-veined from the base, often yellowish; petiole up to 2 mm long. Inflorescence of scattered, axillary, many-flowered cymes. Bract and bracteoles subequal, broadly obovate to oblanceolate, 4,5-13x5-13 mm, apex truncate or acute, with a recurved apiculus, with broad membranous margins. Calyx lobes with apices recurved, with broad membranous margins. Corolla 8-12 mm long, white, palate with yellow and mauve markings. Capsule 1(-2) seeded, clavate, hard, dark-coloured, up to 13 mm long. Pollen two-colporate, 35-45 um long, with entire margocolpi (Figure 6: 4; Map 23).

J. guerkeana occurs mainly in the southern half of Namibia, growing in flat areas or riverbeds, usually in calcareous soils.

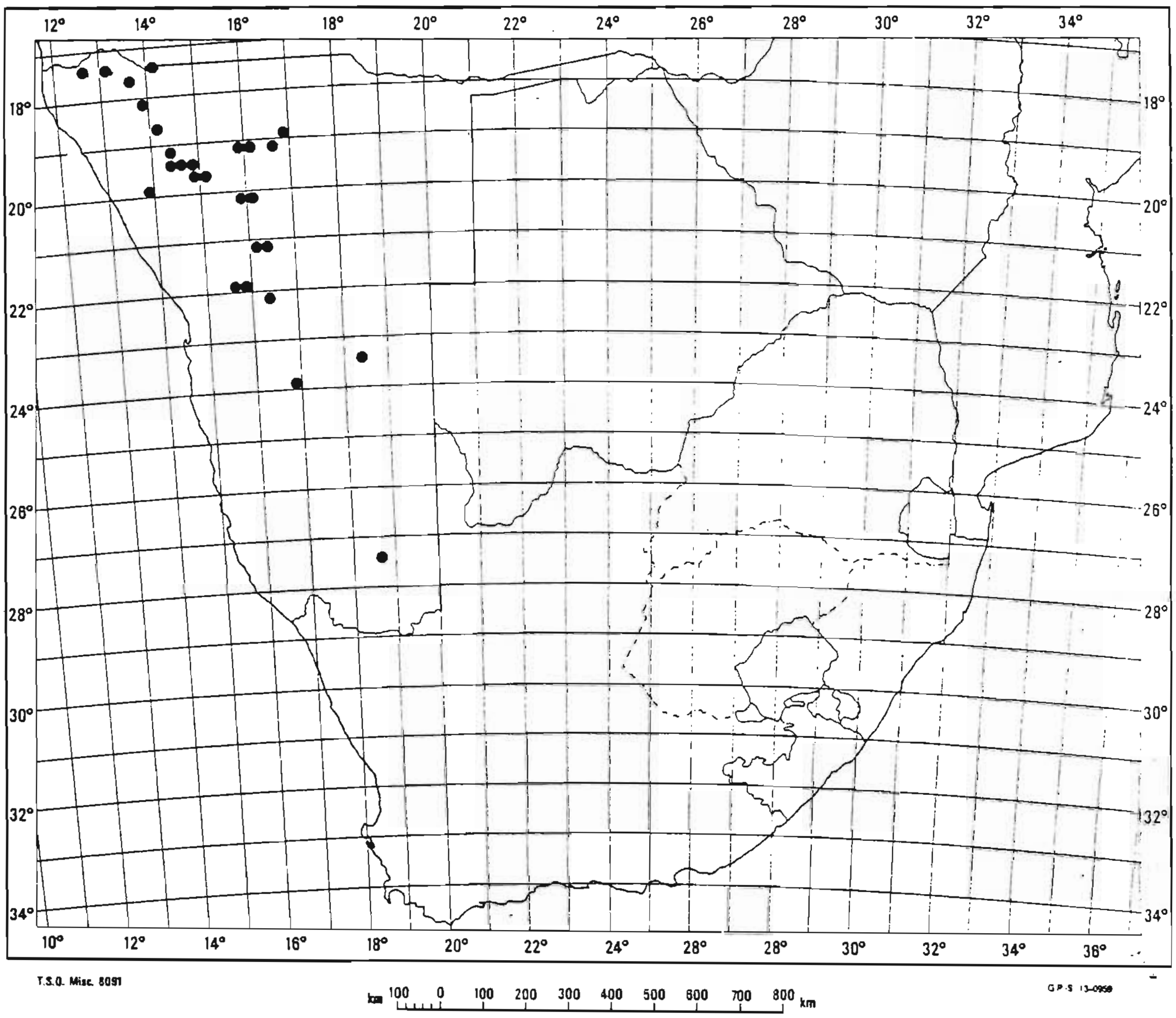
Vouchers: De Winter 3465 (PRE, WIND); Giess 8834 (PRE, SAM, WIND); Giess & Müller 14317; Leistner 1797 (KMG, PRE); Müller & Tilson 905.

The types of J. leucocraspedota and Monechma clarkei have not been located, but they are placed in the synonomy of J. guerkeana by P.G. Meyer in Fl. S. W. Afr. (1968).

18. **Justicia platysepala** (S. Moore) P.G. Meyer in Mitt. bot. StSamml. Münch. 2: 170 (1956), in Fl. S. W. Afr. 130 (1968). Type: Namibia, Damaraland, Een s.n. (BM!).

Monechma platysepalum S. Moore in J. Bot. Lond. 45: 231 (1907).

J. clavicarpa Schinz in Vjschr. naturf. Ges. Zürich 61: 439



Map 24. Recorded distribution of J. platysepala

(1916). Syntypes: Namibia, Otjikango, Rautanen 784; Qaipüts, Dinter 206; Outjo, Rautanen 255 (more of these specimens found).

Similar to J. guerkeana (above), from which it differs as follows: Leaves roughly and shortly pilose when young, becoming glabrous, without side veins from base but with 1-5 pairs arising along midrib. Bract and bracteoles lanceolate, 1-2 mm wide. Occurs mainly north of Windhoek, whereas J. guerkeana is mainly found to the south (Figure 6: 5; Map 24).

The species grows usually on hillslopes in various veld types, often in mopane veld, usually on granite or dolomite-derived soils.

Vouchers: De Winter & Leistner 5134 (PRE, WIND), 5235 (PRE, WIND); Hardy & De Winter 1425; Le Roux 845 (PRE, WIND); Merxmüller & Giess 30346; Seydel 933.

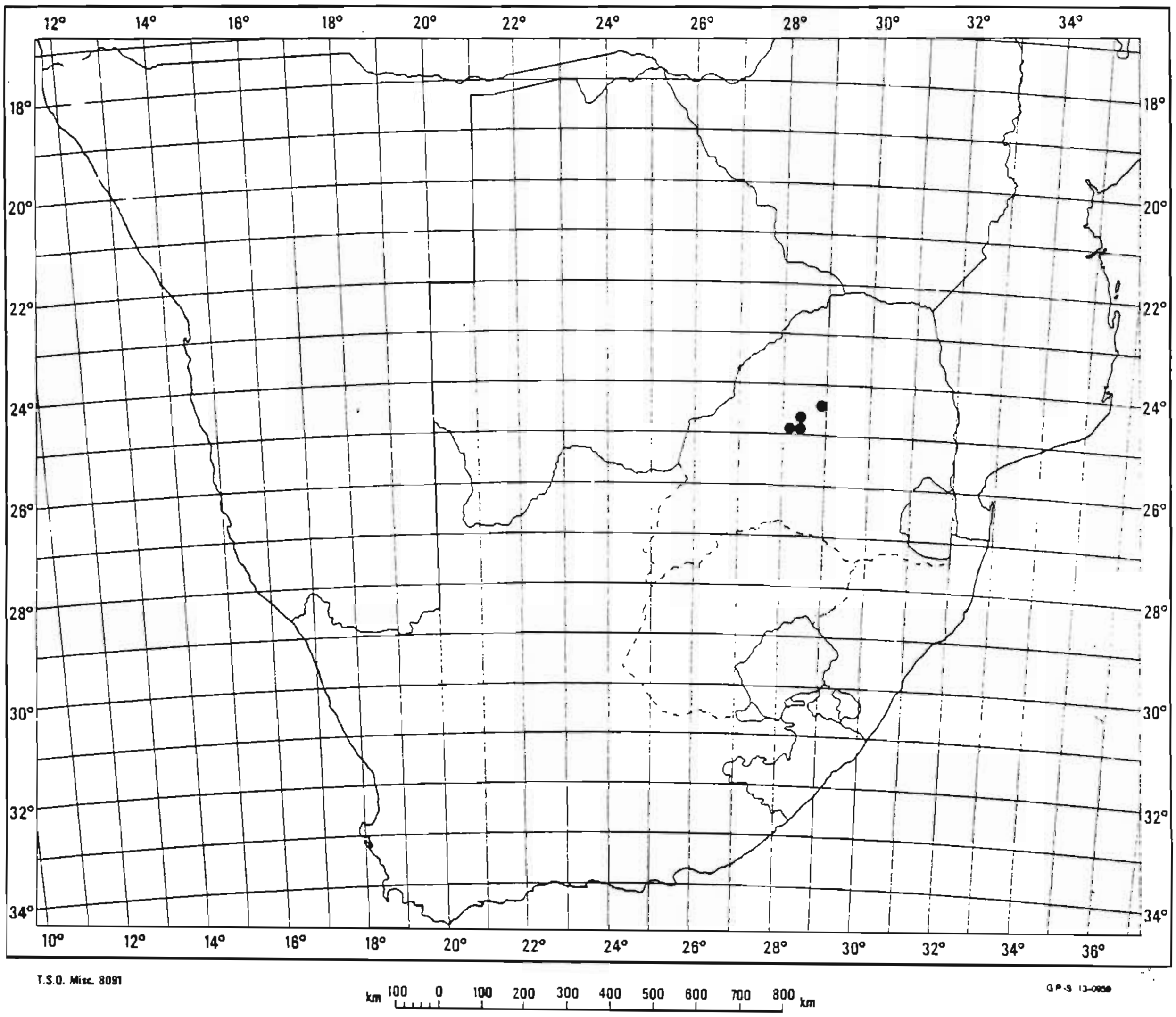
Though no type material of J. clavicarpa has been seen in this study, the localities and the description of the capsule and the membranous-margined calyx lobes and bracts, all support placing this name in the synonomy of J. platysepala, as is done in by P.G. Meyer (1968). The young leaves are also described as pubescent. The veining of the leaves is important in identifying the species. Though it is not mentioned in the original description, it is felt that, if had been 3-veined from the base, Schinz would probably have mentioned the fact in his long and detailed description.

19. **Justicia minima** A. Meeuse in Bothalia 7: 407 (1960). Type: Transvaal, near Magalakwin River, Schlechter 4267 (PRE!; BOL!).

J. spergulaefolia sensu C.B. Clarke in Thiselton-Dyer, Fl. Cap. 5.1: 60 (1912) partim excl. Damaraland specimen, non T. Anders. (1864). (J. spergulaefolia T. Anders. = Monechma divaricatum fide Munday, 1980). Type: as above.

Shrublet with gnarled woody base and erect to decumbent slender herbaceous stems, 0,15-0,4 m high. Leaves with a few hairs, linear to lanceolate, 8-40x1-4 mm, apex acute, base cuneate, sessile. Inflorescence a terminal, unbranched, elongate cyme, with flowers sessile and solitary at nodes. Bract one, with an empty bract on opposite side of axis, subulate to lanceolate, 1-7 mm long; bracteoles 2, subequal to bract. Calyx 4-lobed. Corolla 5-8 mm long, creamy white with maroon lines on palate. Capsule four-seeded, glabrous, delicate, up to 12 mm long. Pollen three-colporate, 30-39 um long, sexine areolate (Figures 6: 6, 30; Map 25).

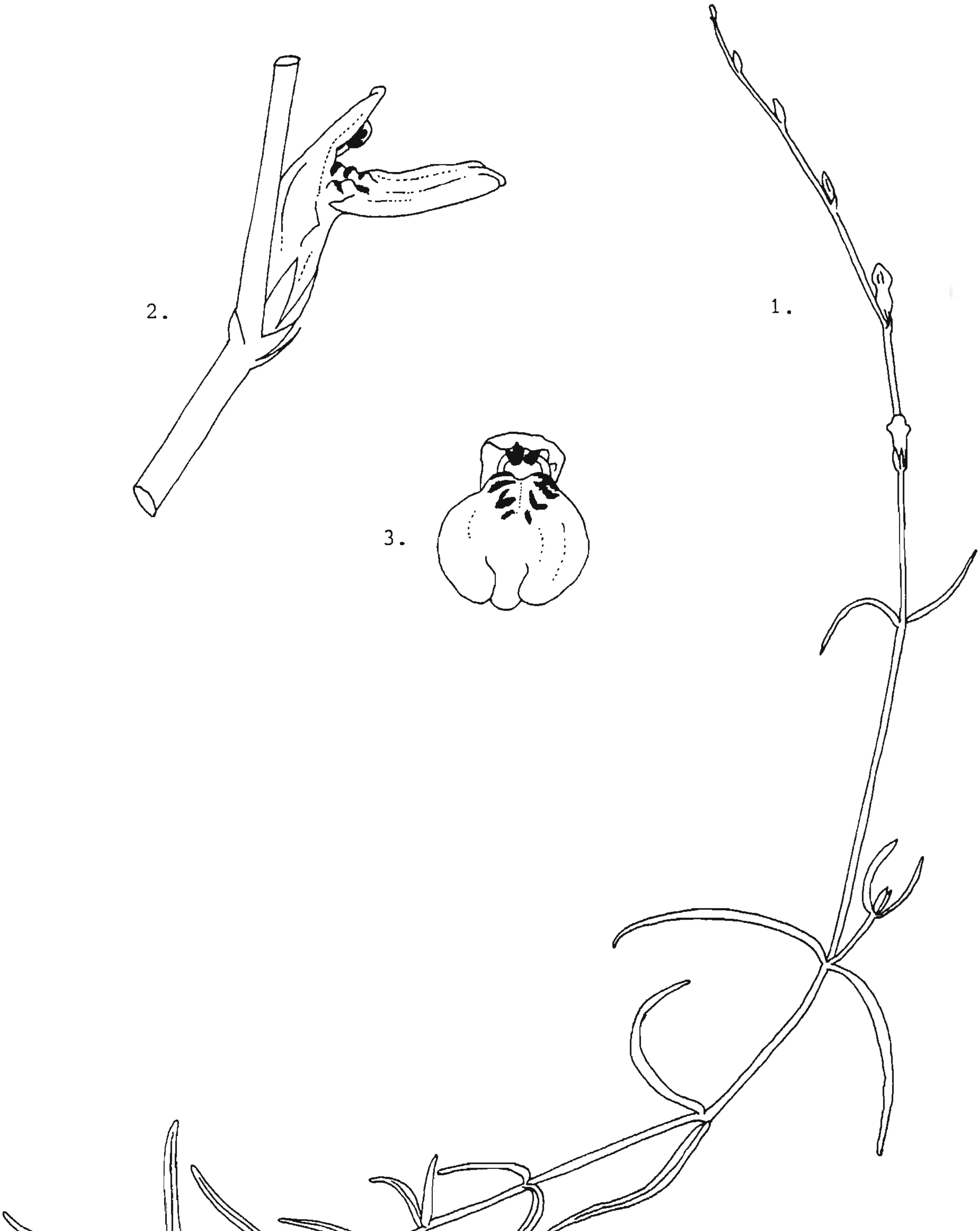
Restricted to the Waterberg of the Transvaal, where it grows mainly in crevices in rocks and on shallow soil. Distinguished from all other southern African Justicia spp. by the four-lobed calyx, the adaxial lobe being absent.



Map 25. Recorded distribution of J. minima

FIGURE 30: **Justicia minima**

1. Habit, X1
2. Flower, side view, X6
3. Flower, front view, X6
4. Capsule, X6



2.

1.

3.

Vouchers: Herman 228; Immelman 145; Meeuse 9334; Smuts & Gillett 3092.

The possesion of three-colporate, areolate pollen would place this species close to sect. Rostellularia, but the inflorescence is quite different. On the other hand, the pollen is quite different from that of sect. Ansellia, which has a similar inflorescence. Neither of these sections has a four-lobed calyx, and so it was considered best to place the species in a section of its own, the monospecific sect. Minima Immelman.

20. **Justicia anagalloides** (Nees) T. Anders. in J. Linn. Soc., Bot. 7: 42 (1864); Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 57 (1912); Letty, Wild Flower. Transv. 316, pl. 152 (1962); Van der Schijff, Checklist Vasc. Pl. Kruger Nat. Park 88 (1969); Compton, Fl. Swaziland 563 (1976). Type: Transvaal, Apies River, Burke s.n. (K; photo. in PRE!).

Adhatoda anagalloides Nees in DC., Prodr. 11: 403 (1847).

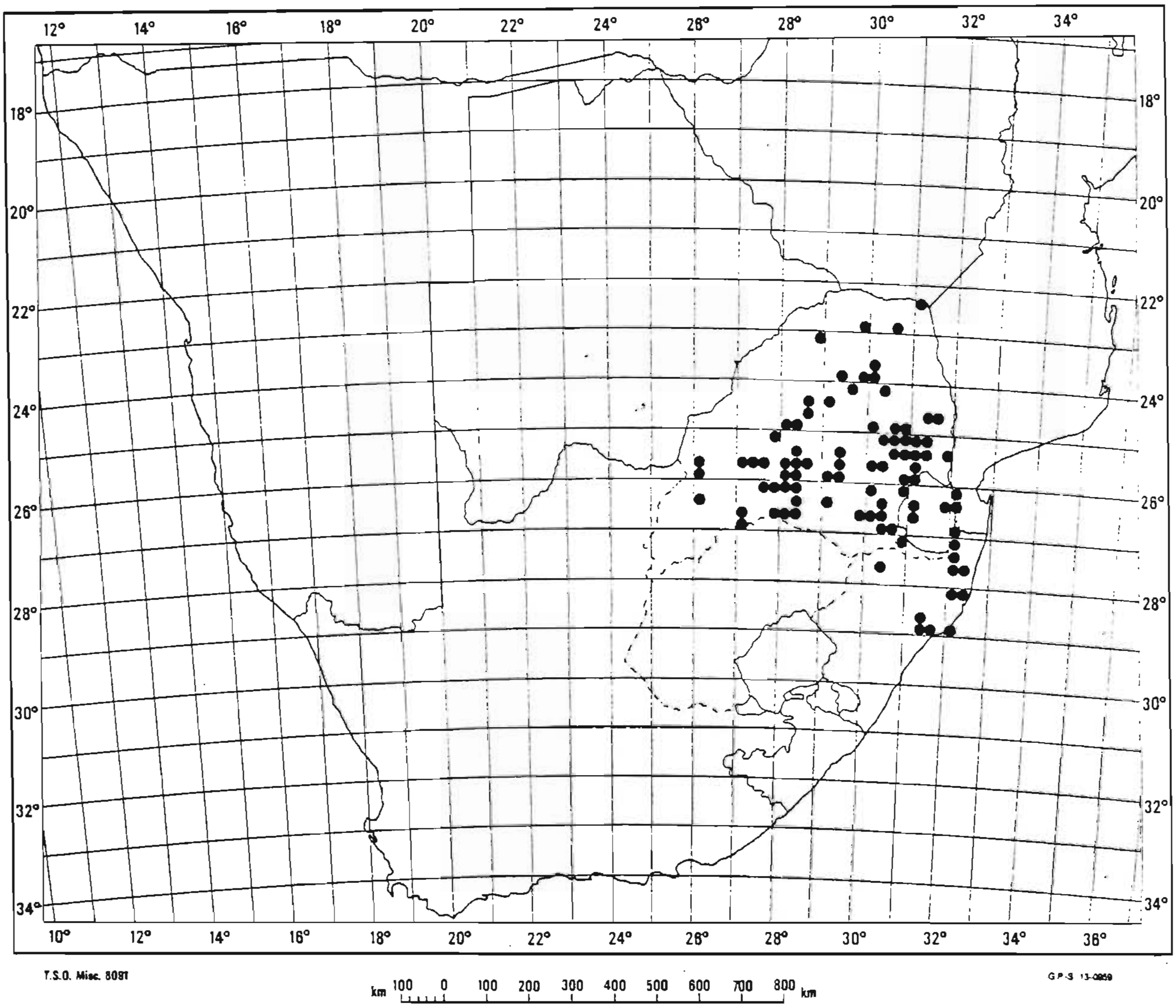
Perennial herb, with annual erect stems becoming prostrate and rooting at nodes, 0,03-0,5 m long. Leaves nearly glabrous to densely pilose, very narrowly to broadly ovate to obovate, apex acute to obtuse, base cuneate; petiole 0-4 mm long. Inflorescence of axillary elongated spike-like cymes, usually single at each node, peduncles slender, 5-47 mm long, with 2-4 flowers towards end. Flowers subsecund, sessile, solitary at each inflorescence node. Bract subulate, one, with another on opposite side of axis, up to 4 mm long; bracteoles two, similar to bract. Corolla (5)6-8 mm long, white, with or without maroon lines on palate. Capsule four-seeded, glabrous or with a few hairs near apex, delicate, up to 8 mm long. Pollen two-porate, 28-36 um long, sexine areolate (Figures 6: 7, 31; Map 26).

A common little herb the in grassveld of the Transvaal and Northern Natal, often found where overgrazing or some other factor has diminished the gound cover, as well as in open places such as roadsides.

Vouchers: Bolus 12213 (BOL, PRE); Buitedag 213 (NBG, PRE, SAM); Galpin 682 (BOL, NH, PRE, SAM); Gilfillan s.n., Galpin Herb. No. 6164; Scheepers 717.

This, and the following two species, are placed in sect. Ansellia C.B. Clarke, a well-defined section within the genus. The elongated axillary cymes are unique to the section within the southern African species, as is the presence of porate rather than colporate pollen in two of the species.

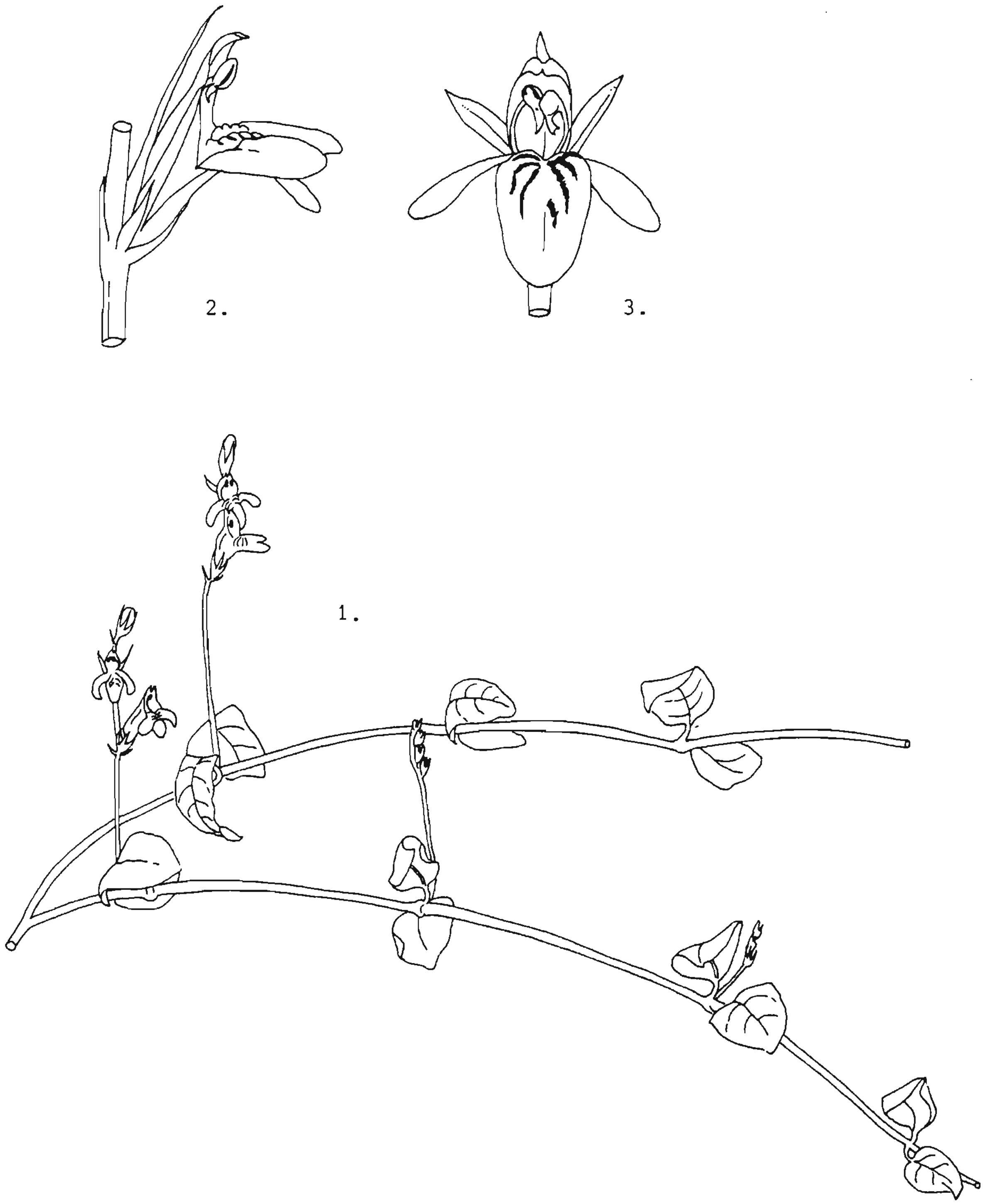
As in Adhatoda variegata and A. cheiranthifolia, the type is given by Nees as having been collected by Burchell, but is more probably a Burke specimen, as Burchell did not collect as far

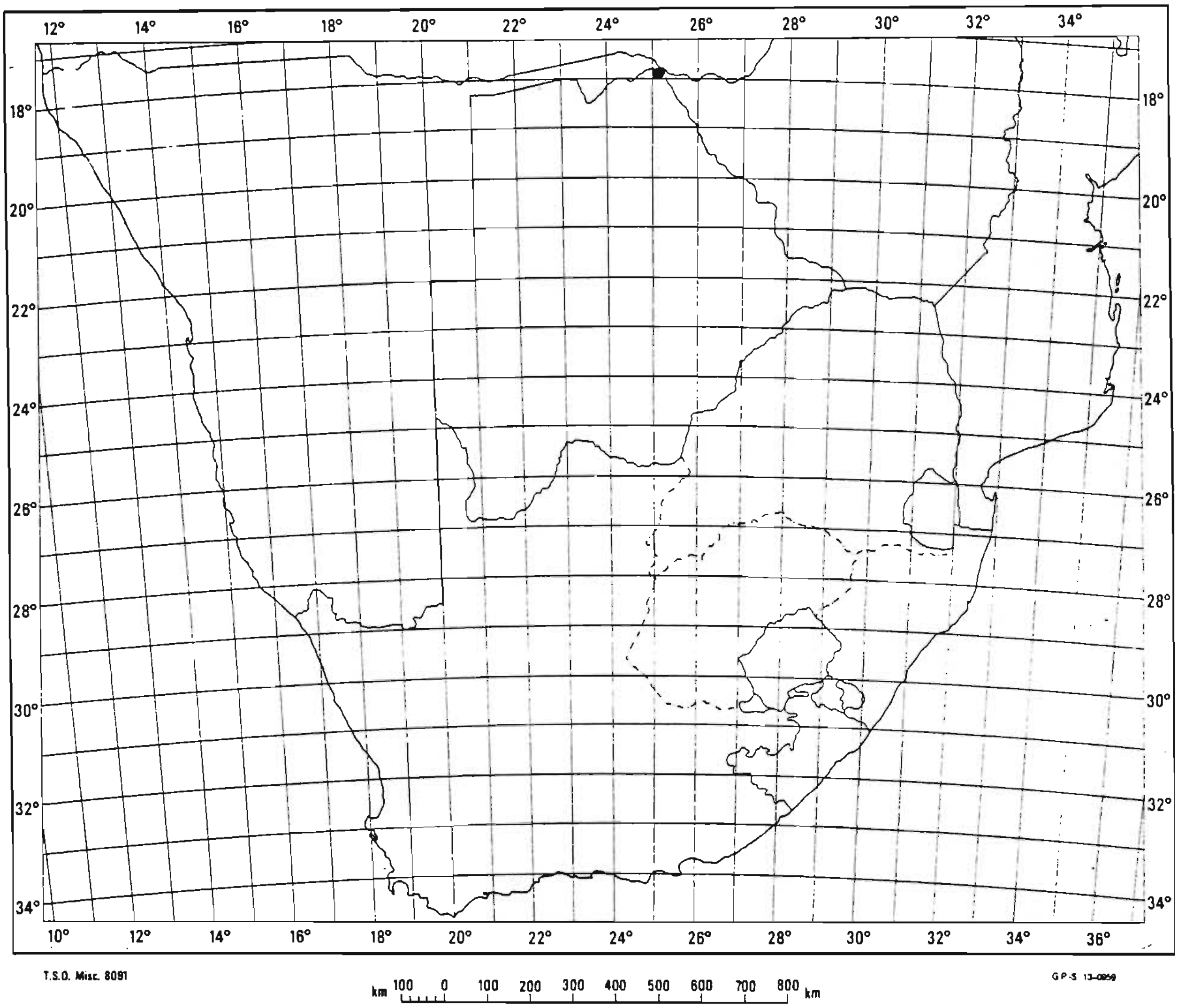


Map 26. Recorded distribution of J. anagalloides

FIGURE 31: **Justicia anagalloides**

1. Habit, X1
2. Flower, side view, X6
3. Flower, front view, X6
4. Capsule, X6


2.
3.
1.



Map 27. Recorded distribution of <u>J. crassiradix</u>

north as the Apies River (Gunn & Codd: 1981).

21. **Justicia crassiradix** Burkill & Clarke in Thiselton-Dyer, Fl. Trop. Afr. 5: 210 (1900). Type: Gabon, Urungu, Fwambo, Carson 62, 68, 107 of 1893 collection (not found).

Prostrate herb with long bare stolons. Leaves glabrous, ovate, c 30x10 mm, apex obtuse, base cuneate; petiole c 5mm long. Inflorescence one per node, peduncle slender, 14-20 mm long, with 2-3 flowers towards end. Bract and bracteoles as for J. anagalloides. Calyx glabrous. Corolla c 7 mm long. Capsule four-seeded, delicate, c. 8 mm long. Pollen shortly two-colporate, 18-20 um long, sexine areolate (Map 27).

There is a single record from the Caprivi Strip in Namibia, growing in a marsh.

Voucher: Killick & Leistner 3417 (PRE, WIND).

22. **Justicia anselliana** (Nees) T. Anders. in J. Linn. Soc., Bot. 7: 44 (1864) partim excl. syn. Adhatoda patula Nees; Burkill & Clarke in Thiselton-Dyer, Fl. Trop. Afr. 5: 208 (1900); Durand, Sylloge Fl. Congo. 429 (1909); Andrews, Fl. Pl. Anglo-Egypt. Sudan 3: 179 (1956); Heine in Fl. W. Trop. Afr. 2: 427 (1963); Binns, First Checklist Herb. Fl. Malawi 14 (1968); Agnew, Upland Kenya Wild Flowers 603, 606 (1974); Immelman in Flower. Pl. Afr. 49,1 & 2: pl. 1932 (1986); Immelman in Bothalia 16,1: 41 (1986). Syntypes: Lower Niger, Iba (=Abo), Vogel s.n. (K; photo. in PRE!); no locality given (Liberia, near Cape Palmas), Ansell s.n. (2 specimens in K; photos in PRE!).

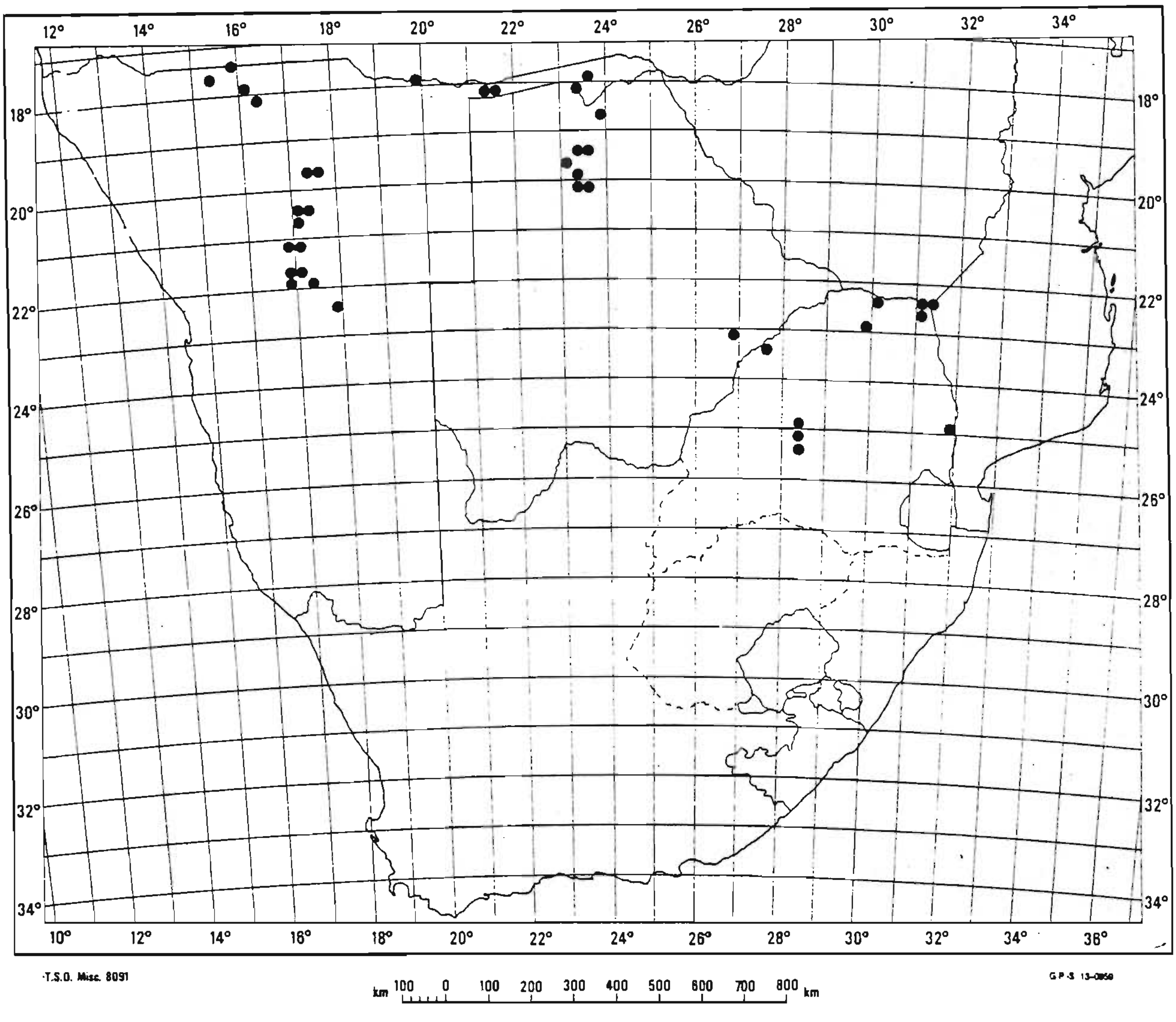
Adhatoda anselliana Nees in DC., Prodr. 11: 403 (1847).

A. matammensis Schweinf. in Verh. zool.-bot. Ges. Wien 18: 674 (1868).

Justicia matammensis (Schweinf.) Oliv. in Trans. Linn. Soc. Lond. 29: 674 (1875); Burkill & Clarke in Thiselton-Dyer, Fl. Trop. Afr. 5: 209 (1900), in Thiselton-Dyer, Fl. Cap. 5,1: 66 (1912); Durand, Sylloge Fl. Congo 430 (1909); Andrews, Fl. Pl. Anglo-Egypt. Sudan 3: 180 (1956); Binns, First Checklist Herb. Fl. Malawi 14 (1968); Meyer in Fl. S. W. Afr. 130 (1968); Van der Schijff, Checklist Vasc. Pl. Kruger Nat. Park 88 (1969); Agnew, Upland Kenya Wild Flowers 603 (1974). Type: E. Sudan, Gallabat, Matamma (=Metemma), Schweinfurth 130c (K; photo. in PRE!).

Justicia exigua S. Moore in J. bot. Lond. 38: 204 (1900); Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 57 (1912). Type: Zimbabwe, Bulawayo, Rand 389 (BM!).

Annual herb, stems erect or decumbent, 0,03-0,4 mm high. Leaves sparsely to densely pilose, lanceolate, ovate or slightly



Map 28. Recorded distribution of J. anselliana

obovate, 14-67x6-32 mm, apex acute or obtuse, base cuneate; petiole 2-10(-18) mm long. Inflorescences as for J. anagalloides (above) but usually two per node, one of each pair with a pair of reduced leaves near base, peduncles 6-38 mm long, with 3-6 flowers near top. Corolla 3-5 mm long, white, with maroon lines on palate. Capsule and pollen as for J. anagalloides (above) except pollen is 22-29 um long (Figure 6: 8; Map 28).

The species occurs in northern Namibia, Botswana, and from scattered localities in the Transvaal. It usually grows in sandy soil, frequently near water, in grassveld or open savanna under trees.

Vouchers: Acocks 16748; Camerick 103; Giess 8565 (PRE, WIND), 10153; Meeuse 9201; Merxmüller & Giess 2044 (PRE, WIND).

Anderson when he transferred this species to Justicia, placed it under "species incertae sedis", though he had seen both syntypes. Clarke, on the other hand, placed it in the synonomy of J. matammensis but gave the author as Lindau, while J. exigua he retained as a separate species. In Fl. S. W. Afr., Meyer mentioned in a note that J. anselliana is closely related to, and difficult to distinguish from J. matammensis but, as J. anselliana sensu P.G. Meyer did not occur in Namibia, he made no decision as to whether or not to place the name in synonomy.

Species **insufficiently known.**

Duvernoia tenuis Lindau in Engl. Jb. 20: 44 (1895); Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 77 (1912). Type: Pondoland, in Egosa Bush, near Dorkin, Bachmann 1275 (not found, B+). Placed under Adhatoda by C.B. Clarke, without formal transfer, but according to his note it might be J. campylostemon.

Gendarussa protracta subsp. microphylla var. laxior Nees in Linnaea 15: 371 (1841). Adhatoda protracta var. laxior (Nees) Nees in DC., Prodr. 11: 390 (1847). Type: E. Cape, near Balfour mission at Kat River, Ecklon s.n. (not found). This name is placed under J. pulegioides (= J. protracta) by C.B. Clarke (1912).

Justicia brycei C.B. Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 67 (1912); Immelman in Bothalia 16,1: 41 (1986). Type: Lesotho, near the summit of Machacha, 10 000 ft., Bryce s.n. (K; photo. in PRE!). This is **J. elegantula** S. Moore, but the species does not occur further south than Zimbabwe. Also, no southern African species of Justicia is known to grow at such high altitudes. Probably, as Jacot Guillarmod suggests in her "Flora of Lesotho", the locality of the specimen is incorrect, and should possibly be Macheke, Zimbabwe.

Justicia hantamensis Lindau in Bot. Jb. 20: 66 (1895); Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 67 (1912). Type: Cape, Hantam Mountains, H. Meyer s.n. (not found). The only species of Justicia in the area is J. cuneata, which does not have glabrous stems and leaves as stated by Lindau. C.B. Clarke (1912) put it under "Species insufficiently known".

Justicia patula Roem. & Schultes, Linn. Syst. Veg. 1: 164 (1817). Type: N. Cape, hills beyond Tkai Gariep (Orange River), near Prieska, with J. cuneata, Lichtenstein s.n. (B-W, microfiche in PRE, No 357!). The type has been seen on microfiche only. C.B. Clarke places the name in the synonomy of J. orchioides, but this species does not occur in the area. The two Justicia species in the area are J. cuneata and J. thymifolia but the microfiche does not resemble either of these. It could possibly be a Monechma.

Rhytiglossa rubicunda Hochst. in Flora 28: 71 (1845); Clarke in Thiselton-Dyer, Fl. Cap. 5,1:67 (1912); Immelman in Bothalia 16,1: 41 (1986). Type: S. Cape, Tsitsikamma forest, Krauss 1128 (not found). Placed tentatively in Justicia under "species insufficiently known", but without formal transfer, by C.B. Clarke. The type has not been found, nor does the description fit any Justicia species from that area.

Gendarussa pygmaea var. serpyllum Nees in DC., Prodr. 11: 394 (1847). Syntypes: No locality given, Mund; Maire s.n. (B+?). The types have not been located, and it is surmised that they were destroyed in Berlin. The name was placed under J. orchioides by C.B. Clarke, but as his concepts of this species and J. cuneata were confused, his identification cannot be accepted uncritically.

Excluded species

Adhatoda capensis subsp. arenosa Nees in DC., Prodr. 11: 391 (1847). Type: Burchell 1616 (K; photo. in PRE!). Is **Monechma divaricatum** (Nees) C.B. Clarke according to Munday (1980).

Justicia pulegioides subsp. late-ovata C.B. Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 62 (1912); Immelman in Bothalia 16,1: 41 (1986). Type: S. Cape, on the rocks of Zwartwater Poort, Burchell 3405 (K; photo. in PRE!), Burchell 3364 (K). This is **Siphonoglossa leptantha** subsp. **late-ovata** (C.B. Cl.) Immelman (ined.).

CHAPTER 6

TAXONOMY OF SIPHONOGLOSSA

Siphonoglossa Oersted, Vidensk. Meddr. dansk. naturh. Foren. 1854: 159 (1854); Lindau in Engler & Prantl, Natürl. Pflanzenfam. 4,3b: 388 (1894); Bentham in Benth. & Hook.f., Gen. 2: 1110 (1876); Clarke in Thistelton-Dyer, Fl. Cap. 5,1: 74 (1912); Dyer, Gen. 2: 596 (1975), Henrickson & Hilsenbeck in Brittonia 31,3: 373 (1979). Type species: S. ramosa.

Gendarussa Nees in Linnaea 15: 372 (1841), p.p. quoad G. leptantha.

Adhatoda Nees in DC., Prodr. 11: 384 (1847), p.p. quoad A. leptantha, A. tubulosa.

Justicia sensu Lindau in Engler & Prantl, Natürl. Pflanzenfam. 4,3b: 349 (1894), p.p. quoad J. leptantha; sensu T. Anderson in J. Linn. Soc., Bot. 7: 41 (1867), p.p. quoad J. tubulosa.

Aulojusticia Lindau in Bot. Jb. 24: 324 (1897); Dyer, Gen. 2: 600 (1975).

Perennial herbs or shrublets, often scrambling, rooting at nodes. Leaves opposite, simple, entire. Inflorescence of sessile contracted cymes scattered in leaf axils; bract 1, foliose; bracteoles 2, reduced. Calyx five-lobed to near base. Corolla with a long narrow tube, up to c.60 mm long, this sometimes shorter and broader and approaching some Justicia species in proportions, two-lipped, upper lip very shortly two-lobed, lower lip deeply three-lobed, pilose outside, with a slightly raised palate with raised diagonnal ridges. Stamens 2, filaments attached to tube, arching inside upper lip with stamens appressed to each other, not separating later as in Justicia; anthers with one locule above the other, both elongate, both shortly white-mucronate or lower locule shortly tailed. Ovary two-locular; style lying inside a channel (rugula) in upper lip; stigma minutely two-lobed. Capsule cylindrical, stipitate, rarely dimorphic with smaller four-winged, one-seeded capsules. Seeds four, rarely one, laterally compressed, testa rugose, without hydroscopic hairs. Pollen lenticular, two-colporate, sexine reticulate, margocolpus with 2(3) rows of areolae.

There are three southern African species, one with two subspecies, in the genus as here circumscribed. Aulojusticia, which has until recently been considered a separate genus, is here considered congeneric with Siphonoglossa, for reasons given under the species S. linifolia (see below).

The flowers of the genus Siphonoglossa differ from those of

Justicia only in the long corolla tube (which in S. leptantha subsp. late-ovata approaches the length and proportions of J. protracta), in the mucronate anther locules, and in the fact that the anthers do not reflex as the flowers age, as they do in all Justicia species. Occasional specimens have been found with dimorphic capsules of the same type as those commonly encountered in J. dinteri and also seen in a few specimens of J. protracta (Ch. 3.7). There is little doubt that at least the southern African species of Siphonoglossa are derived from some species of Justicia sect. Harnieria, but whether it has diverged sufficiently to warrant generic status is uncertain. This can only be decided when Justicia and related genera have been studied through their whole range, and until then it has been decided to maintain Siphonoglossa as a separate genus.

Hilsenbeck (1979) considers the South African species to belong in sect. Siphonoglossa. This section is characterised by having 4 sepals, the bracteoles reduced and subulate, the upper corolla lip rounded and not emarginate and the fertile part of the capsule ellipsoidal and usually pubescent. It cannot be considered that the South African species fit this description, as they all have 5 calyx lobes, an emarginate upper lip and glabrous capsules. Possibly the South African species should form a separate genus, which would then have the name Aulojusticia.

6.1 KEY TO SPECIES AND SUBSPECIES OF SIPHONOGLOSSA

1a Corolla (tube and upper lip) (35-)40-58 mm long; leaves 2-6 mm broad; Barberton area .... 3. S. linifolia

1b Corolla (tube and upper lip) 13-35 (-45) mm long; leaves over 6 mm broad; Natal, Transkei, E. and S. Cape 2

2a Corolla 34-45 mm long, lower lip 0,5-0,6 times as long as tube .... 2. S. nkandlaensis

2b Corolla 13-31 mm long, lower lip 0,2-1,2 times as long as tube 3

3a Corolla 13-22 mm long, lower lip (0,3-)0,6-1,2 times the length of the tube, tube 1,5-2 mm in diameter; Knysna-Tsitsikamma area, rarely as far east as Grahamstown .... 1b. S. leptantha subsp. late-ovata

3b Corolla 15-31 mm long, lower lip 0,2-0,5 times the length of the tube, tube 0,5-1,5 mm in diameter; from Grahamstown to Mtunzini .... 1a. S. leptantha subsp. leptantha

6.2 DESCRIPTIONS OF SPECIES AND SUBSPECIES OF SIPHONOGLOSSA

1. **Siphonoglossa leptantha** (Nees) Immelman comb. nov. ined. Type: Uitenhage, Olifantshoek, by Bosmansrivier, Ecklon s.n. (S, lecto.!).

Gendarussa leptantha Nees in Linnaea 15: 372 (1841).

Adhatoda leptantha (Nees) Nees in DC., Prodr. 11: 390 (1847).

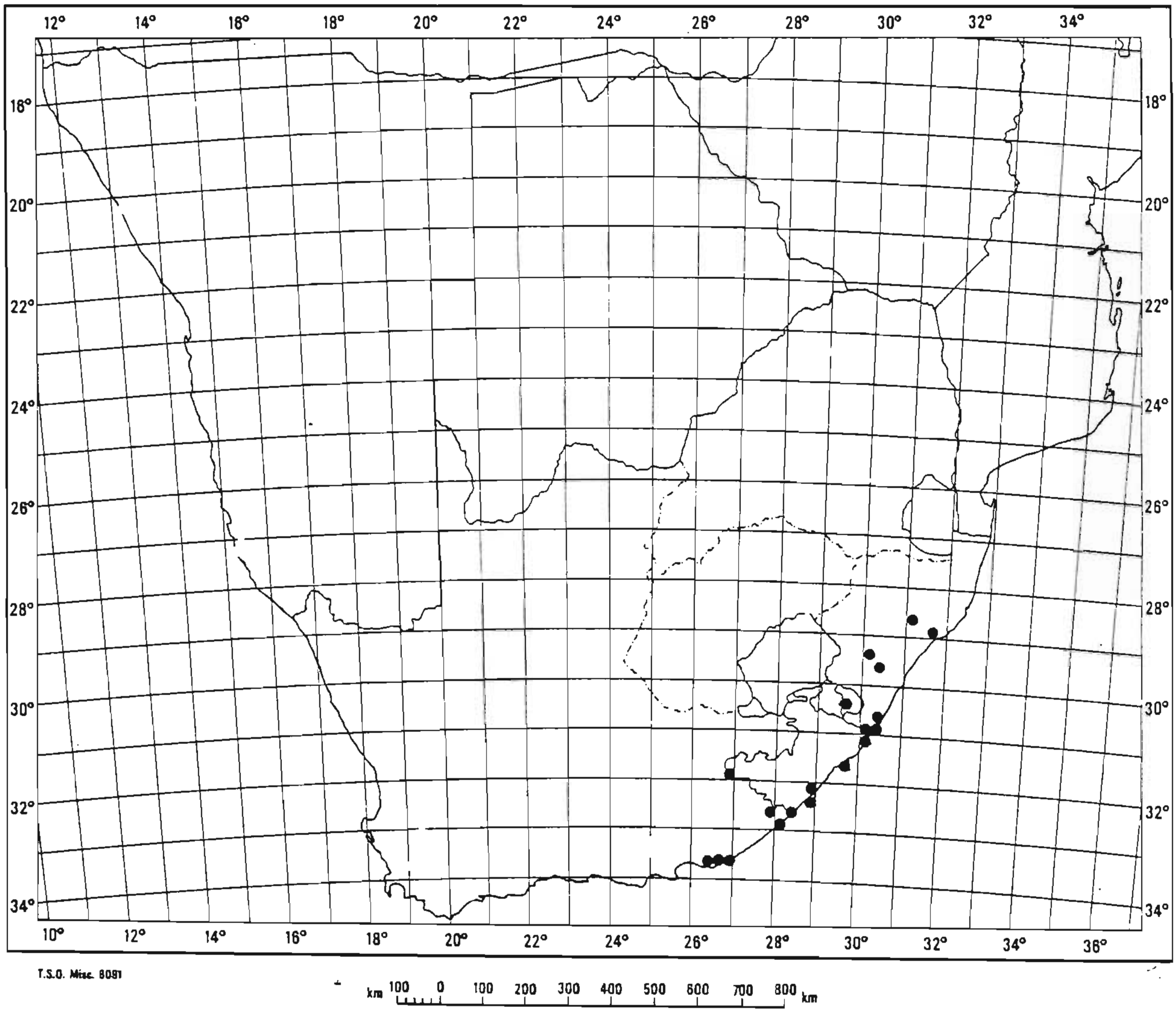
Justicia leptantha (Nees) Lindau in Engler & Prantl, Natürl. Pflanzenfam. 4,3b: 349 (1894).

Sprawling or scrambling shrublets or perennial herbs, sometimes rooting at nodes, up to 0,6 m high. Leaves lanceolate to broadly ovate, sometimes fleshy, 13-63x10-32 mm, apex obtuse or acute, base cuneate to slightly decurrent, margin entire or rarely very shallowly and broadly toothed, thinly to densely pubescent, hairs denser along veins and margin, sometimes glandular; petiole slender, 4-32 mm long. Bract foliose, ovate, petiolate, 2-17x1-9 mm. Bracteoles minute, subulate. Corolla (tube and upper lip) 13-31 mm long, tube 0,5-2 mm in diameter, corolla white to lilac with darker pink spotting in throat, lower lip 0,2-1,2 times length of tube. Capsule four-seeded, up to 11 mm long, rarely with smaller, four-winged, one-seeded capsules present with normal fruit; seeds rough. Pollen two-colporate, 58-77 um long, with 2 (-3) rows of areolae.

The species occurs from the southern Cape to northern Natal. It grows in forest as an undershrub, or scrambling in bush, usually where there is an opening or along margins.

There is considerable variation in the breadth of the corolla tube and its length relative to the lower lip in S. leptantha. These characters were found to correlate with each other, and with distribution. S. leptantha subsp. late-ovata, which C.B. Clarke (1912) originally described as a subspecies of J. pulegioides C.B. Clarke (= J. protracta (Nees) T. Anders.) has a short, broad tube very similar to J. protracta, the tube being shorter than to slightly longer than the lower lip. The tube, as stated in the key, is 1,5-2 mm in diameter and the total corolla length only 13-22 mm. The anthers are those of a Siphonoglossa. This taxon ocurs in the south-western part of the species range, mainly in the southern Cape with a few records from the Eastern Cape.

The typical subspecies usually has a longer corolla (15-31 mm), while the tube is 0,5-1,5 mm broad and from twice to four times as long as the lower lip. It occupies the north-eastern part of the species range, occurring from the Eastern Cape into northern Natal.



Map 29. Recorded distribution of S. leptantha subsp. leptantha

FIGURE 32: ***Siphonoglossa leptantha*** **subsp.** ***leptantha***

1. Habit, X1

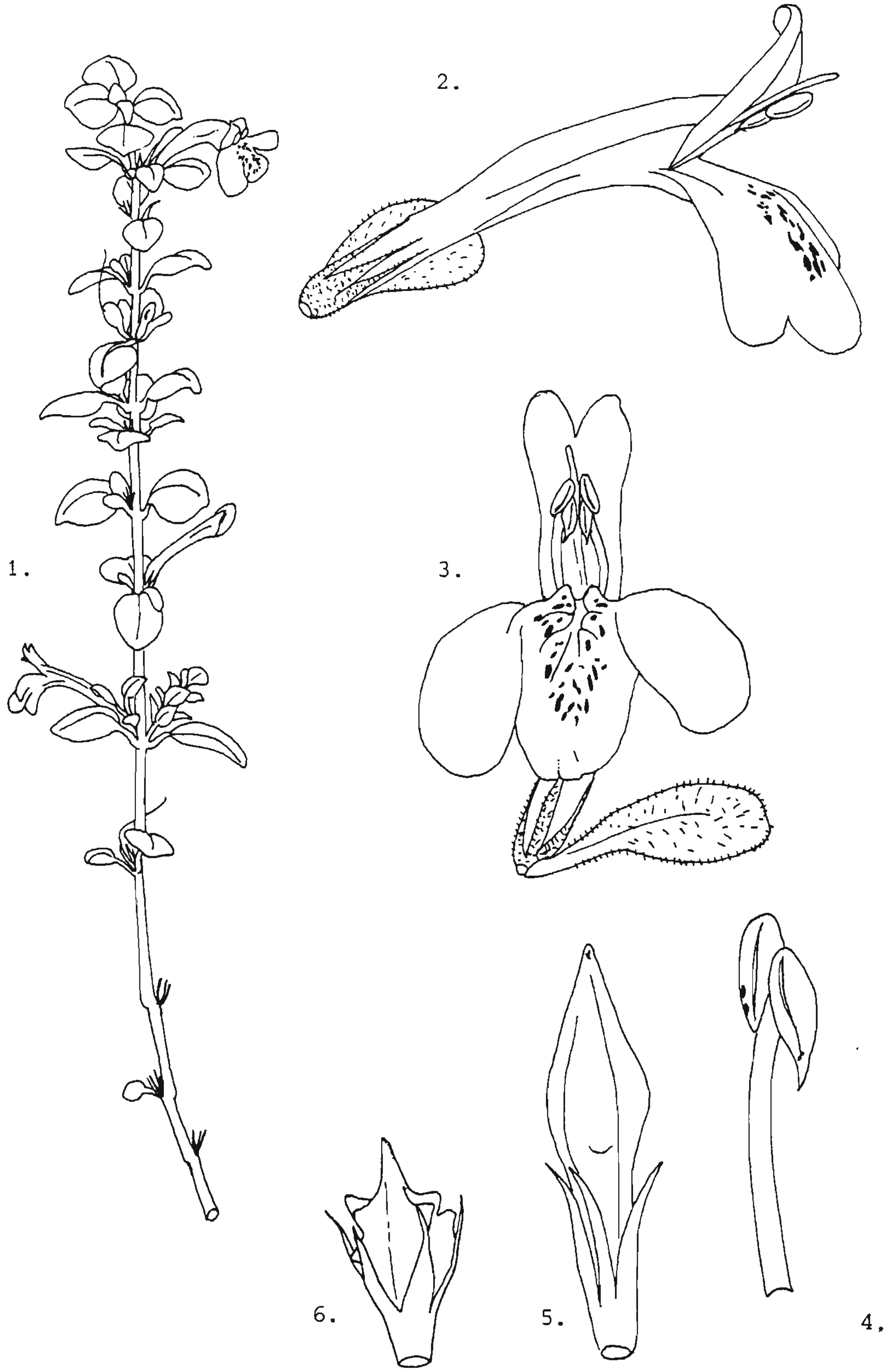
2. Flower, side view, X6

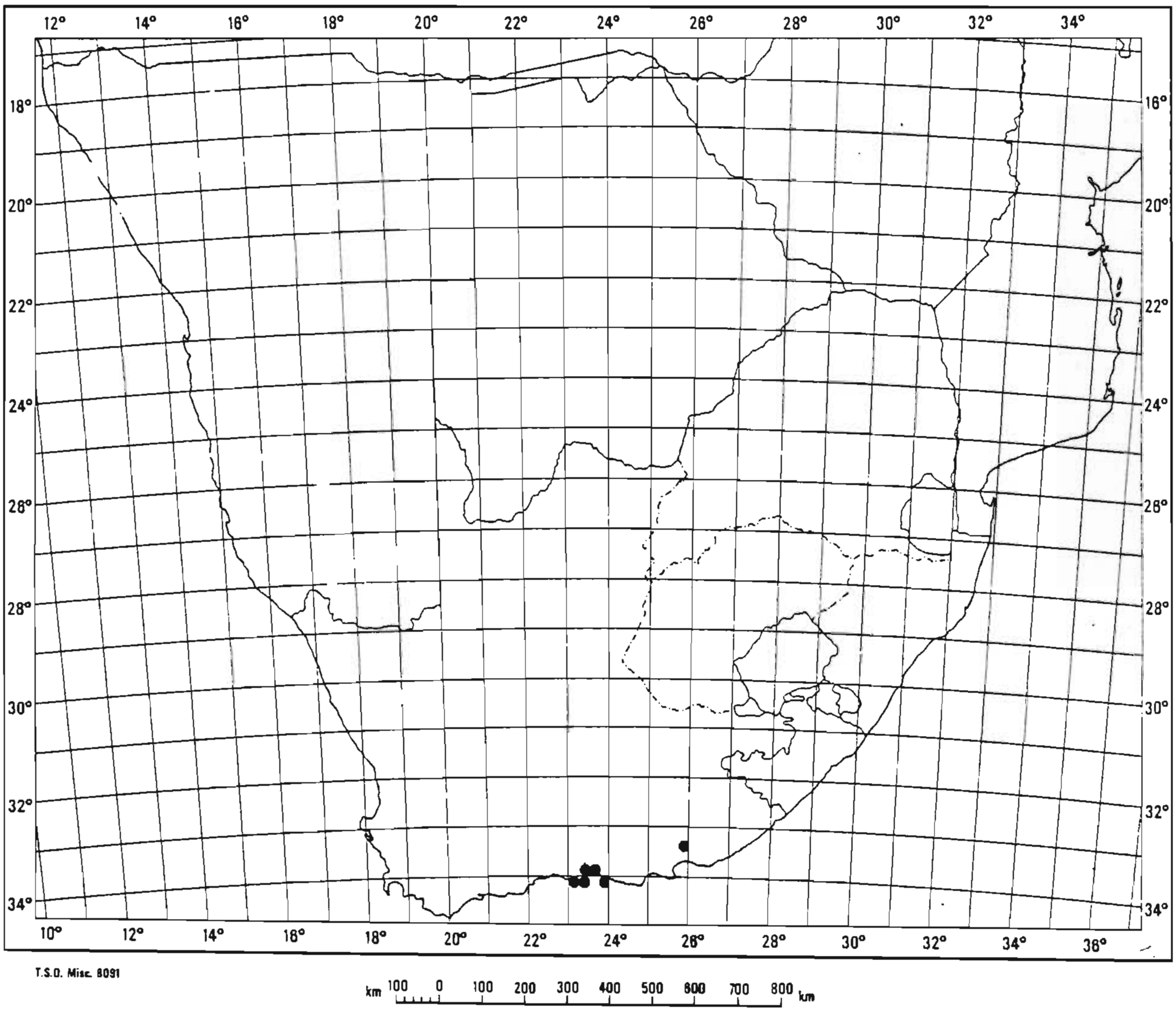
3. Flower, front view, X6

4. Anther, X12

5. Normal capsule, X6

6. 4-winged capsule, X6


1.
2.
3.
4.
5.
6.



Map 30. Recorded distribution of S. leptantha subsp. late-ovata

(a) subsp. **leptantha**

Adhatoda tubulosa Nees in DC., Prodr. 11: 392 (1847). Syntypes: Natal, Umzimvubu River, 500 ft., Drége s.n. (G-DC; microfiche at PRE!); locality indecipherable, Drége s.n. (G-DC; microfiche at PRE!).

Justicia tubulosa (Nees) T. Anders. in J. Linn. Soc., Bot. 7: 41 (1864).

Siphonoglossa tubulosa (Nees) Benth. ex Lindau in Engler & Prantl, Natürl. Pflanzenfam. 4,3b: 38 (1894); Benth. & Hook.f., Gen. 2: 1110 (1896); Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 74 (1912); Gledhill, E. Cape Veld Flowers 57, figs. 3, 4 (1969).

Siphonoglossa nummularia S. Moore in J. Bot., Lond. 18: 40 (1880); Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 75 (1912). Type: Cape Province, Keiskamma Hoek, Cooper 370 (not found).

Leaves (6-)16-63 mm long, apex obtuse or acute, thinly to moderately pubescent; petiole 5-32 mm long. Corolla (tube and upper lip) 15-31 mm long, tube 0,5-1,5 mm in diameter, lower lip 0,2-0,5 (-0,65) times length of tube (Figures 6: 9, 32; Map 29).

The subspecies occurs from Grahamstown to Mtunzini, mostly near the coast, but also occasionally far inland, e.g.b at Queenstown.

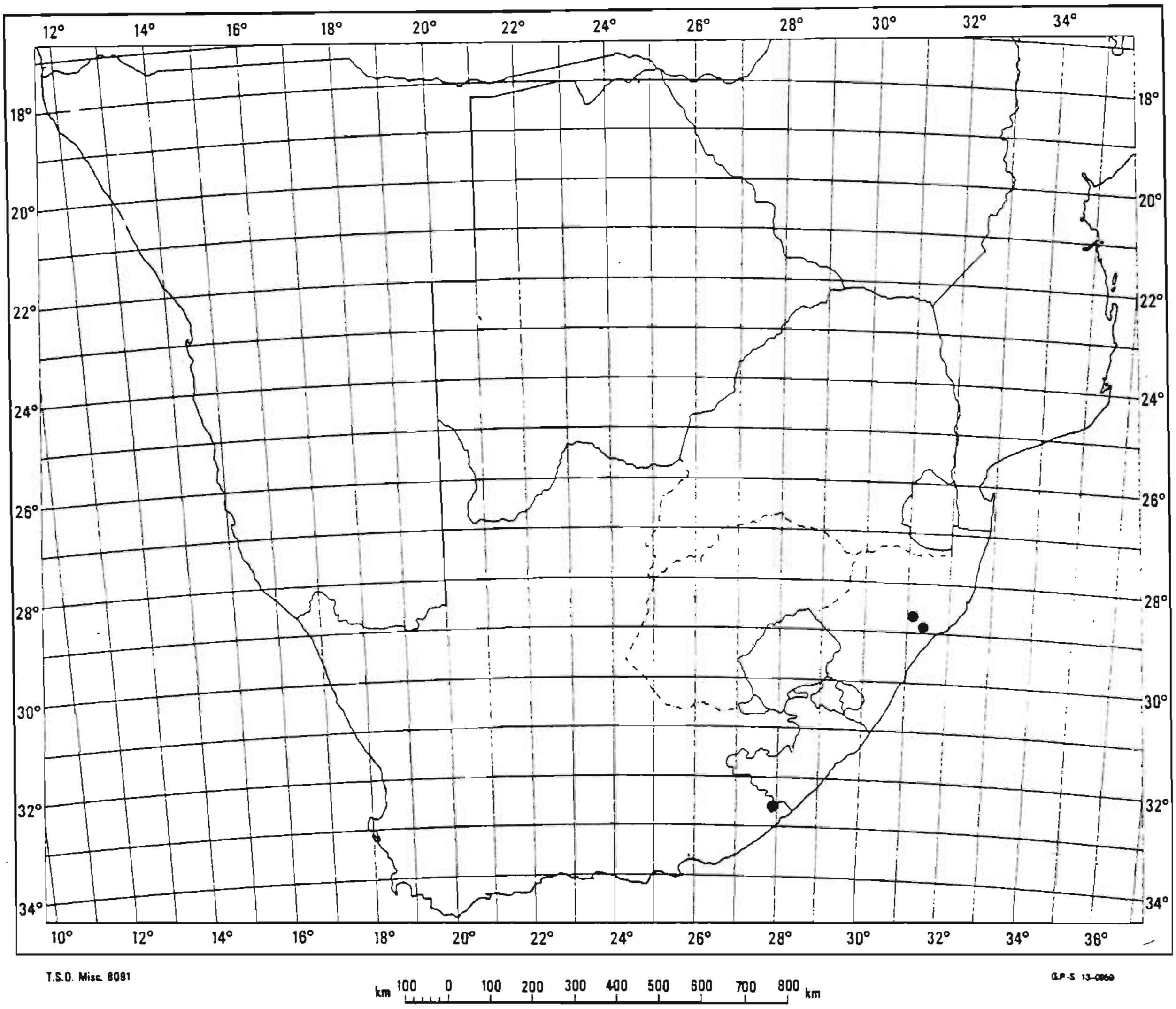
Vouchers: Codd 9359; Galpin 7752, 8156; Sidey 685; Tyson in PRE 40654.

One gathering from kloof forest near Port Shepstone (Strey 6191a) (PRE), shows narrow leaves only 6-12 mm broad, but there are also some broader leaves on duplicates of this specimen. The broader leaves occur lower down on the plant. It is probably a variant, not warranting formal taxonomic status.

(b) subsp. **late-ovata** (C.B.Cl.) Immelman, comb. nov. ined.

Justicia pulegioides subsp. late-ovata C.B. Clarke in Thiselton-Dyer, Fl. Cap 5,1: 62 (1912). Syntypes: Cape Province, on the rocks of Zwartwater Poort, Burchell 3405 (K, lecto!), 3364 (K!).

Similar to subsp. leptantha except for: Leaves 13-36 mm long, apex obtuse, moderately to densely pubescent; petiole 4-36 mm long. Corolla (tube and upper lip) 13-22 mm long, tube 1,5-2 mm in diameter, lower lip (0,3-)0,6-1,2 times length of tube (Figure 6: 10, Map 30).



Map 31. Recorded distribution of <u>S. nkandlaensis</u>

The subspecies is mainly confined to the area around Knysna-Tsitsikamma; occasionally found as far east as Grahamstown.

Vouchers: Acocks 21152; Botha 2245; Hafström & Acocks 1392; Heinecken K 88; Liebenberg 7767.

2. **Siphonoglossa nkandlaensis** Immelman sp. nov ined. Type: Natal, Nkandla, Wood 9000 (NH, holo.!).

Perennial herb, height unknown. Leaves lanceolate to ovate, 33-44x15-20 mm, pilose along margin and veins of undersurface, apex acuminate, base cuneate; petioles slender, 6-17 mm long, pilose. Bracts foliose. Calyx lobes narrowly lanceolate, acuminate, pilose. Corolla (tube and upper lip) 34-45 mm long, purple or yellow-green, lower lip 0,5-0,6 times as long as tube; stigma two-lobed. Capsule not seen. Pollen two-colporate, with three rows of areolae, 71-88 um long (Figure 6: 11, Map 31).

This rare species is found in a few localities in Natal and the Eastern Cape; it grows on forest margins and along forest paths.

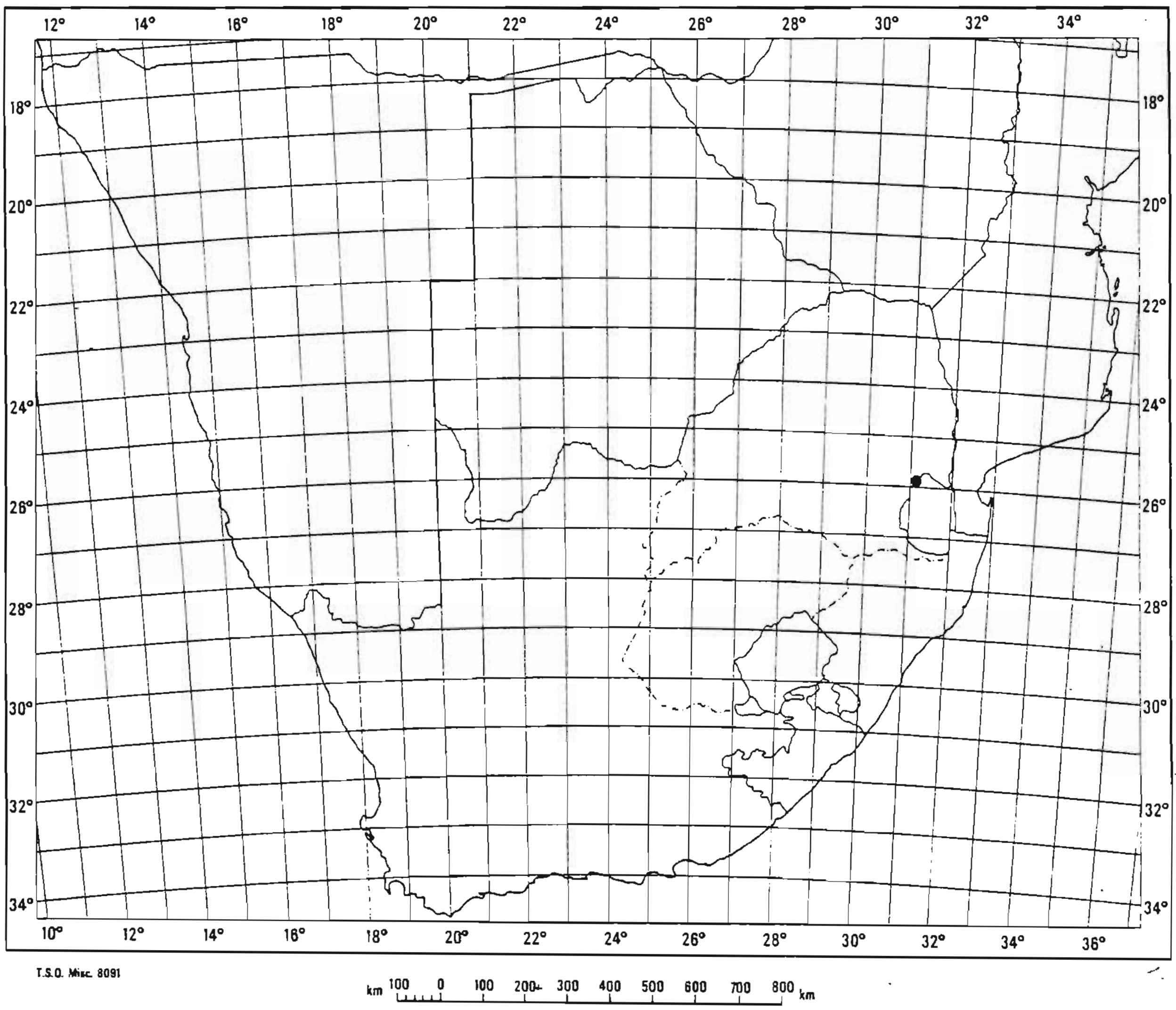
Vouchers: Flanagan 675 (GRA); Schönland s.n. (GRA); Venter 3486; Wells 2495.

The very long flowers and the length of the lower lip relative to the tube distinguish this species from S. leptantha subsp. leptantha. The flowers are most similar to S. linifolia which, however, is vegetatively quite different and which also has a different habitat and distribution.

3. **Siphonoglossa linifolia** (Lindau) C.B. Clarke in Thiselton-Dyer, Fl. Cap. 5,1: 75 (1912). Type: Barberton, Saddleback Mountains, 1300-1700 m, Galpin 825 (PRE, holo!).

Aulojusticia linifolia Lindau in Bot. Jb. 24: 324 (1897), in Engl. & Prantl, Naturl. Pflanzenfam. Nachtr. III: 309 (1908).

Densely tufted woody herb, 0,2-0,4 (-0,6) m high, with woody rootstock; stems decumbent or erect. Leaves sessile, linear to narrowly lanceolate, 25-38X2-6 mm, apex acute, base cuneate, midrib prominent with side veins obscure, with rasping hairs mainly on margins. Bracts similar to leaves but smaller, 10-20 mm long, with glandular and eglandular hairs. Bracteoles linear to narrowly lanceolate, c. 3 mm long. Corolla (35-)49-58 mm long (tube and upper lip), with glandular and eglandular hairs, lower lip 0,25-0,45 times the length of tube, pale to bright mauve-pink, rarely white, with dark purple anthers and 3-5 broad longitudinal lines or long dark blotches on lower lip. Stamens with upper locule mucronate or mucro nearly absent, mucro of lower locule forming a short tail. Capsule up to 9 mm long. Pollen two-colporate, 74-90 um long, with 2(-3) rows areolae (Figure 6: 12; Map 32).



Map 32. Recorded distribution of <u>S. linifolia</u>

The species is found only around Barberton in the Eastern Transvaal; growing in rocky grassveld.

Vouchers: Clarke 38; Codd 9533; Meeuse 10093; Rogers 29445.

S. linifolia was originally described in the monospecific genus *Aulojusticia*. It was C.B. Clarke (1912) who removed the species to *Siphonoglossa* and, after careful examination of the macromorphology of the species, as well pollen as of all species concerned, I have decided to follow him in this. No differences were noted in the pubescence of the corolla, in the stigma or in the pollen, all of which have at various times been used to distinguish the *Aulojusticia* from *Siphonoglossa*, though the mucro on the lower anther locule is longer than that of the other *Siphonoglossa* species, forming a short tail. The anther is therefore more like that of *Justicia* but, on the other hand, *S. linifolia* differs from *Justicia* in the same ways as do other species of *Siphonoglossa*: the pollen has 2-3 rows of areolae instead of 1-2, there is a long narrow corolla tube, and the anther filaments do not curl back as the flowers age. It is therefore placed in *Siphonoglossa* rather than *Justicia*.

APPENDIX 1: REPRESENTATIVE SPECIMENS

Justicia

1. J. glabra

- 1821 **(Andara)**:(-BD) Okavango River, east bank, 1km south of Caprivi border, 27/4/75, Biegel, Müller & Gibbs Russell 5014 (PRE).

- 1922 **(Nokoneng)**:**(-CA)** NE of Nokoneng, Mutsoi, 21/3/67, Lambrecht 93 (PRE).

- **2632 (Bela Vista)**:**(-CD)** Ndumu Game Reserve, near first confluence of Pongola with Usutu River, Usutu forest, 27/3/69, Pooley 454 (NH, NU); Ndumu, Pongola-Usuto floodplain, 3/12/63, Tinley 722 (NU).

- 2229 **(Waterpoort)**:**(-DD)** The Folly, 734 Ms, 13/2/85, Raal 134 (PRE).

- 1923 **(Maun)**:**(-AA)** Jokomotshou Island, off Moanachira River, 17/2/75, Smith 1246 (PRE).

- 2023 **(Kwebe Hills)**:(-BD) Botletle River, 9km east of Makalamabedi, 21/3/65, Wild & Drummond 7199 (PRE).

2. J. campylostemon

- 2230 **(Messina)**:(-CC) Entabeni Forest Reserve, c. 2 miles from forest station on road to main Sibasa road, 26/2/57, Meeuse 9801 (PRE); **(-CD)** Tate Vondo Forest Reserve, Tate Vondo, 15/1/78, Hemm 487 (PRE).

- 2330 **(Tzaneen)**:**(-CA)** Westfalia Estate, in high forest on Grootbosch, Bos 1140 (PRE); Westfalia Estate, Grootbos Govt. Forest Reserve, 22/3/60, Scheepers 924 (PRE), Westfalia, Duiwelskloof, 3/60, Scheepers s.n. (PRE); **(-CC)** Woodbush, 1/23, Wager s.n. (PRE).

- **2430 (Pilgrims Rest)**:**(-AA)** South of The Downs, farm Cyprus, 26/1/58, Codd 945 (PRE), Letaba district, Cyprus farm, 3/69, Renny 258 (PRE); **(-DB)** Marieskop, banks of Blyderiver, 18/11/58, Killick & Strey 2468 (PRE).

- **2531 (Komatipoort)**:(-CC) Barberton, Makwongwa forest, Swaziland border, 4/1890, Galpin 904 (GRA, PRE), Near Barberton, Makwongwa forest, 4/1890, Galpin 3995 (NBG); **(-CD)** Louws Creek, cultivated in Lowveld Bot. Gdns, 3/11/71, Buitendag 884 (NBG, PRE), Piggs Peak, King's Forest, 9//58, Compton 27874 (NBG, PRE), Piggs Peak, King's Forest, 17/3/60, Compton 29978 (NBG, PRE).

- **2631 (Mbabane):(-AB)** Mbabane, Gobholo, 15/2/65, Dlamini s.n. (NBG, PRE); **(-AC)** Ukutulu, 27/2/56, Compton 25669 (NBG, PRE); **(-DB)** 20 miles south of Stegi, west side of Lebombos, 1/2/48, Hornby 2856 (PRE).

- **2632 (Bella Vista):(-CA)** South of Siteki between Palala and Tikuba, western edge of Lebombo Mountains, Chilobe Forest, 5/2/77, Culverwell 0518 (PRE); **(-CC)** Lebombo Mountains Gwalaweni forest, 15/2/76, Brenan 14276 (PRE),, Gwalaweni Forest, 14/12/65, Burtt & Hilliard 3270 (NU), Gwalaweni Forest, 27/1/63, Strey 4672 (NH, PRE), Gwalaweni Forest, 24/2/68, Vahrmeijer & Hardy 1670 (PRE).

- **2731 (Louwsburg):(-CD)** Ngome Forest, 10/2/62, Edwards 2719 (NU, PRE), Ngome, Ngotshe district, 27/7/44, Gerstner 4852 (PRE).

- **2830 (Dundee):(-DB)** Qudeni Forest Reserve, 10/4/64, De Winter 8296 (PRE).

- **2831 (Nkandla):(-CA)** Lower Nkandla Forest, 14/2/61, Edwards 2480 (NU, PRE), Nkandla, 8/5/62, Strey 4159 (NH, PRE), Nkandla Forest, 14/2/61, Wells 2503 (NP, NU, PRE); **(-CD)** Eshowe, 1/37, Gerstner 2660 (BOL, PRE), Eshowe Bush, 4/2/33, Gerstner s.n. (NH), Eshowe Forest, 2/27, Kotz s.n. (PRE), Eshowe, Hospital Wood, 24/12/48, Lawn 76 (NH), Eshowe, 28/4/49, Lawn 91 (NH), Eshowe, Dlinza forest, 18/3/69, Ross 1996 (NU, PRE), Eshowe, 10/4/1899, Wood 7496 (PRE, SAM), Entumeni, 4/1888, Wood s.n. (SAM); **(-DC)** Mtunzini Ngoye Forest, 6/2/63, Huntley 232 (NH, NU, PRE), NW side of Ngoye Forest, 26/2/70, Moll 4952 (NH, PRE), Second RH branch of Ngoye Forest Road, 22/2/61, Wells & Edwards 119 (NH, NU, PRE), Ngoye bush, 17/4/02, Wood 8487 (NH, NU, PRE); **(-DD)** Ngoye Forest, 2/70, Venter 719 (PRE).

- **2832 (Mtubatuba):(-AA)** Near Hluhluwe Game Reserve, 13/2/4, Ward 2113 (NH, NU, PRE); **(-CC)** Richards Bay area, near Lake Mzinguzi, 24/5/74, Ward 8617 (PRE).

- **2929 (Underberg):(-DD)** Deepdale, 2/1894, Pole Evans 106 (NH), Polela district, Nxumeni, 24/1/66, Moll 2999 (NU, PRE).

- **2930 (Pietermaritzburg):(-AC)** Karkloof, 31/5/40, Fisher 138 (NU), Karkloof Forest, 31/5/40, Fisher 142 (NH), Dargle, Line, 20/11/65, Moll 2684 (PRE), Karkloof, Ehlatini Forest, Moll 2858 (NU, PRE), Karkloof Falls, 24/3/1898, Wylie 67 (NH); **(-BD)** Noodsberg, 23/4/1894, Wood 5333 (PRE); **(-CB)** Worlds View, 11/48, Fisher 165 (PRE); **(-DA)** Drummond, 21/2/29, Forbes 391 (NH), Pietermaritzburg, Table Mountain, 27/1/49, Killick 290 (NU), Drummond, 6/3/66, Strey 6486 (NH), Drummond, old road, 15/1/67, Strey 7309 (NH, NU, PRE); **(-DB)** Inanda, Groenberg, Johnson 1322 (NH, PRE), Inanda, 12/3/1886, Wood s.n. (NH); **(-DC)** Bothas Hill, 7/3/26, McClean 126 (NBG, PRE), Ismont, 26/1/69, Strey 8353 (NH, PRE), Wingfield, Umgwaghumbi, 31/10/61, Ward 3752 (NU), Inanda, 12/3/86, Wood 630 (BOL), Inanda, 1/1880, Wood 773 (BOL).

- **2931 (Stanger):(-CC)** Durban Bluff, 7/3, Marriott s.n. (NH).

- 3029 (**Kokstad**):(-**BD**) Near Clydesdale, Malowe Mountain, 2/1885, Tyson 892 (BOL), Clydesdale, 2/1885, Tyson 2003 (PRE), Near Clydesdale, Malowe mountain, 2/1885, Tyson 2083 (BOL, SAM); **(-DA)** Lower part of Ingeli Forest, 18/1/46, Dyer & Collett 4710 (PRE), Mount Ingeli, Impetyne forest, 17/3/72, Nicholson 1224 (PRE), Ingeli forest, 5/3/72, Strey 10905 (NH, PRE).

- 3030 **(Port Shepstone):(-AD)** Dumisa, 20/2/10, Rudatis 845 (PRE); (-**BB**) Amanzimtoti, 28/1/67, Ward 6040 (NH), PRE); **(-CA)** Oribi Gorge Nature Reserve, 1/77, Henderson, Brokensha & Collins 183 (PRE); **(-CB)** Near Mehlomnyana, 21/2/47, Acocks 13309 (PRE), Port Shepstone, 16/3/55, Codd 9361 (PRE), Port Shepstone, Strey 9571 (NH, PRE); **(-CC)** Port Shepstone, Umtamvuna side ravine, 3/8/65, Strey 5829 (NH, NU, PRE), Paddock, Elliotts' Farm, 29/12/66, Strey 7163 (NH, NU, PRE), Umtamvuna Nature Reserve, 15/3/73, White 10564 (NH, PRE); **(-CD)** Nongono River, 3 miles inland from Izotsha, 19/1/69, Nicholson 755 (PRE), Wichmann's farm, 19/1/69, Strey 8339 (NH, PRE), Uvongo, 22/1/73, Strey 11057 (NH).

- 3129 **(Port St Johns)**:(-**BC**) Egosa forest, 2/2/29, Galpin 9571 (PRE), Ntsubane forest, 11/5/69, Strey 8588 (NH, PRE); **(-BD)** Lusikisiki district, south side of Umsikaba Gorge, 13/1/47, Acocks 13259 (PRE); **(-CC)** 3 miles west of Umtata Mouth, 12/4/47, Sidey 589 (PRE); (-**DA**) Port St Johns, West Gate, 4/19, Galpin 2839 (GRA, PRE), Port St Johns, Eagles Nest, slope of West Gate, 7/2/24, Howlett 31 (PRE), Port St Johns, Noxolweni Forest, 26/1/33, Mogg 13086 (PRE), Ntafufu forest, 10/5/69, Strey 8528 (NH, PRE), Port St Johns, 15/6/50, Theron 814 (PRE), Port St Johns, near airfield, 25/4/79, Van Jaarsveld 3832 (NBG, PRE), Port St Johns, 2/21, Wager s.n. (PRE), Port St Johns, 1 mile from Needles Hotel on Umtata Road, 15/2/66, Wells 3389 (GRA, PRE).

- **3130 (Port Edward):(-AA)** On Umtamvuna River, 6 miles inland, 23/11/68, Nicholson 751 (PRE).

- 3225 (**Somerset East**):**(-BC)** Albany, Eagles Nest Kloof, Farm 'Orange Grove', 4/4/57, Comins 1642 (GRA, PRE); **(-DA)** Somerset East, Bowker s.n. (PRE).

- **3226 (Fort Beaufort):(-BC)** Katberg, 27/1/45, Adams 212 (NU); **(-CA)** Bedford, Caavus, 1/1892, Bennie 222 (GRA).

- **3227 (Stutterheim):(-CB)** Stutterheim, Evelyn Valley, 13/1/47, Compton 19265 (NBG), Stutterheim, Evelyn Valley, 14/1/47, Leighton 2726 (PRE, BOL), Stutterheim, Isidenge forest, 23/5/72, Von Gadon 95 (PRE); **(-CC)** Pirie forest, 24/5/1896, Galpin 3232 (PRE), Pirie Bush, 3/1894, Schönland 860 (GRA), Pirie, 1893, Sim 2719, 2720 (NU), Pirie, 26/1/36, Taylor 1810 (PRE); **(-CD)** King Williams Town, Tamacha, May, Sim 4161 (PRE); **(-DA)** Near Kei Road, Umtaleni, 14/260, Ranger 235 (NBG, PRE), Kei Road, 20/02/08, Rogers 3217 (GRA); **(-DB)** Near Komgha, 1/1890, Flanagan 102 (GRA, NBG, PRE, SAM), Komgha, Gwenkala, 28/2/29, Galpin 10451 (PRE); **(-DD)** Banks of Nahoon River, Horseshoe Valley, 5/27, Rattray 1351 (PRE).

- **3228 (Butterworth):(-BA)** Collywobbles, 25/2/60, Van Breda 873 (PRE); **(-BB)** Elliotdale, The Haven, 10/4/66, J. Gordon-Gray 316 (NU), Elliotdale, The Haven, 8/12/66, Gordon-Gray 1127 (GRA); **(-CB)** 4 miles north of Kentani, 10/3/55, Codd 9251 (PRE), Kentani, 3-5/1903, Pegler 340 (BOL, PRE), Kentani 3-5/03, Pegler 2896 (PRE).

- **3326 (Grahamstown):(-DB)** Kowie, Bells Reach and east bank bush, 23/4/19, Britten 1417 (GRA, PRE), Port Alfred, 5/1893, Schlechter 2743 (GRA, NBG), Port Alfred, 3/16, Tyson s.n. (PRE).

- **3327 (Peddie):(-AA)** Near Peddie, 11/01, Sim 4159 (GRA); **(-BB)** Buffalo Pass, south side, 1/3/48, Acocks 14027 (PRE), Banks of Buffalo River, 26/1/64, Batten 1 (GRA), East London, 8/04, Rattray 145 (GRA), East London, 8/1907, Rattray s.n. (PRE), East London, Cambridge, 4/1908, Wormold 54 (GRA).

Locality unknown

- **2930 (Pietermaritzburg):(-DD?)** Kloof Falls, in gorge, damp undergrowth of bush, 3/51, Hilliard 702 (NU).

- **3326 (Grahamstown):(-DB or -BC)** Kowie River, 9/15, Tyson s.n. (PRE).

- Umgazi River, 2/1896, Bolus 8746 (BOL), Marovuni, no date given, Junod 41 (PRE), Zoutpansberg, 2/19, Junod 4166 (PRE), Pondoland, 1/1886, Tyson s.n. (PRE), Natal, no date given, Guenzius s.n. (SAM).

3. **J. bolusii**

- **3128 (Umtata):(-DC)** Elliotdale, Rebetshane Forest, Miller s.n. (PRE).

- **3227 (Stutterheim):(-DD)** Nahoon River mouth, 6/07, Galpin 7742 (GRA, PRE), Nahoon River, left bank, Horseshoe Valley, 5/27, Rattray 1354 (NBG).

- **3228 (Butterworth):(-CB)** Kentani, 2/02, Pegler 374 (BOL, PRE, SAM), Kentani, 1903, Pegler 2897 (PRE).

- **3327 (Peddie):(-BB)** East London, Second Creek, 3/3/07, Rattray 7739 (PRE), East London, Horseshoe Valley, 1/27, Smith 3869 (PRE).

4. J. betonica

- **1713 (Swartbooisdrif):(-AC)** Omuhonga, 25/3/74, Merxmüller & Giess 30571 (PRE, WIND).

- **1715 (Ondangua):(-CB)** 2km from Oshikuku on road to Ogongo, 22/2/78, Van Jaarsveld 2947 (NBG); **(-DA)** Ovamboland, Okatana Mission Station, 18/2/59, De Winter & Giess 7072 (PRE, WIND).

- **1719 (Runtu):(-DD)** Grootfontein North, 16 miles east of Runtu, 12/3/58, Merxmüller & Giess 2131 (PRE).

- **1720 (Sambio):(-CC)** Kavango, Masari, 10/2/76, Vorster 2781 (PRE).

- **1813 (Ohopoho):(-AC)** 41 miles from Ohopoho on road to Sanitatas, 22/8/56, Story 5918 (PRE, SAM); **(-AD)** Track from Sanitatas to Kaoko Otavi, Hoaruseb River, 12/6/63, Kers 1447 (WIND); **(-BB)** Near Ohopoho, 1/4/57, De Winter & Leistner 5288 (PRE, WIND).

- **1820 (Tarikora):(-BB)** 1km SE of Kandtara school, in dry Jossa Pan, 22/4/77, Müller & Giess 482 (PRE, WIND).

- **1821 (Andara):(-BA)** Bagoni Camp, 19/1/56, De Winter 4325 (PRE, WIND); **(-BD)** Okavango River south of Mohembo, on west bank, 28/4/75, Biegel, Muller & Gibbs-Russell 5030 (PRE).

- **1917 (Tsumeb):(-DD)** Road from Rietfontein to Waterberg, 17 miles from Rietfontein, 27/4/63, Kers 352 (WIND).

- **1922 (Nokoneng):(-AB)** Okavango Swamp, Gwetshaa Island, 24/2/73, Smith 437 (PRE).

- **1923 (Maun):(-BC)** Moremi Wildlife Reserve, Maxara Pan, 5/3/76, Smith 1617 (PRE).

- **2017 (Waterberg):(-AC)** Otjiwarongo, Waterberg, Farm Hohensee, Meyer 1189 (PRE, WIND); **(-DA)** 15 miles from Okakarara, 5/49, Liebenberg 4705 (PRE, WIND).

- **2025 (Mumpswe):(-BA)** 75km WNW of Francistown on Maun road, tributany of Marsupe river, 2/5/57, Drummond 5300 (PRE).

- **2117 (Otjosondu):(-AA)** Waterberg, Quickborn, 1928, Bradfield 188c (PRE).

- **2230 (Nuanetsi):(-CC)** Entabeni, 3/8/35, Taylor 737 (PRE); **(-CD)** Sibasa, Tate Vondo Forest Reserve, Hemm 140 (PRE).

- **2326 (Mahalapye):(-BB)** Around Mahalapye village, 16/12/63, Yalala 397 (PRE).

- **2329 (Pietersburg):(-AB)** Pietersburg, 20/4/24, Pole-Evans 1244 (PRE); **(-BB)** Louis Trichardt, 2/1919, Breyer s.n. (PRE); **(-CD)** Pietersburg, Murray 590 (PRE).

- **2330 (Tzaneen):(-CA)** Pietersburg, Duiwelskloof, 15/7/29, Galpin 9719 (PRE), Westfalia Estate, slashed firebreak along railway line by Merensky Dam, 15/10/58, Scheepers 510 (PRE), Westfalia Estate, eastern face of Piesang Kop, 12/4/60, Scheepers 945 (PRE), 32 miles east of Pietersburg on road to Mokeetsi, Mokeetsi Valley, 14/5/62, Van Vuuren 1483 (PRE) **(-CC)** New Agatha, 13/11/18, McCallum s.n. (PRE); 2km east of Steilkop, New Agatha Forest Reserve, 22/4/71, Müller & Scheepers 79 (PRE).

- **2425 (Gaberone):(-DB)** Gaberone, near Content Farm, about 2km south of Agricultural Research Station, 23/1/73, Kelaole 130 (PRE).

- **2426 (Mochudi):(-AC)** 6km SSE of Morwa, 20/10/78, Hansen 3493 (PRE); **(-CB)** Derde Poort, 18/10/1904, Leendertz 368 (GRA), Derde Poort, 18/10/1904, Leendertz 8623 (PRE).

- **2428 (Nylstroom):(-BC)** Sterkrivierdam Nature Reserve, 9/1/73, Jacobsen 2435 (PRE), Sterkrivierdam Nature Reserve, 9/1/73, Jacobsen 2444 (PRE); **(-CA)** about 6km from turnoff to Polela from Nylstroom-Vaalwater road, on Polela road, 26/4/55, Meeuse 9647 (PRE); **(-CB)** Nylstroom, 2/1919, Van Dam s.n. (PRE), Nylstroom 11/1919, Van Dam s.n. (PRE); **(-CD)** Warmbaths, 23/12/1903, Burtt Davy 871 (PRE, SAM), Warmbaths, 11/1908, Gilfillan s.n. (PRE), Warmbaths, 11/08, Leendertz 1304 (GRA, SAM), Warmbaths, 29/9/1908, Leendertz 5568 (PRE), A few miles from Warmbaths on road to Grobelersdal, Farm Sandfontein, near "Sandbult" on farm, 22/12/53, Meeuse 9099 (PRE), Toowoomba Pasture Research Station, northern edge of Springbok Flats, 19/1/48, Sidey 1402 (PRE); **(-DB)** A few miles from Naboomspruit on road to Crecy, in lowlands of Nyl Valley, 13/12/54, Meeuse 9435 (PRE).

- **2429 (Zebediela):(-AA)** Near Potgietersrust, 2/04, Bolus 11138 (BOL), 12 miles NNE of Potgietersrust, Rietvlei, 28/1/67, Dahlstrand 1932 (PRE), Percy Fyfe Nature Reserve, 28/1/68, Huntley 1125 (PRE), Percy Fyfe Nature Reserve, 24/11/67, Huntley 1346 (PRE), Potgietersrust, 28/9/08, Leendertz 1269 (BOL), Potgietersrust, 28/9/1908, Leendertz 5632 (PRE), Potgietersrust, 3/22, Melle s.n. (PRE), Potgietersrust, 28/9/08, Rogers 1269 (GRA), Potgietersrust, 12/28, Thode A1754 (NH, PRE); **(-AC)** About 12 miles from Potgietersrust on road to Zebediela, 15/12/54, Meeuse 9490 (PRE); **(-CD)** Lebowa, on road, on far side of camp north of milking-shed, 5/12/78, Lessing 74 (PRE).

- **2430 (Pilgrims Rest):(-AA)** The Downs, 11/1918, Rogers 18949 (PRE), The Downs, 11/18, Rogers 21913 (NH, PRE); **(-DB)** 5km from Klaserie on road to Mariepskop, 11/1/79, Botha 2491

(PRE); **(-DC)** Barberton, Mount Sheba, Bolus s.n. (BOL); **(-DD)** Pilgrims Rest, 1879, Greenstock s.n. (BM).

- **2431 (Acornhoek):(-CB)** Manyeleti Game Reserve, 2/3/77, Bredenkamp 1714 (PRE); **(-DA)** Manyeleti Game Reserve, 8/3/76, Bredenkamp 1450 (PRE).

- **2525 (Mafeking):(-BA)** Lobatsi, 12/24, Power s.n. (BOL), Lobatsi, 12/26, Tapscott 2552 (KMG), Lobatsi, 12/26, Tapscott s.n. (BOL).

- **2526 (Zeerust):(-AA)** Marico district, Nietverdiend, 15/12/69, Cole & Carter 846 (PRE); **(-AB)** Marico district, Rooderand Farm, 9/12/69, Carter 846 (PRE); **(-CA)** Zeerust, 1/12, Pott 4168 (PRE, SAM), Zeerust, 12/27, Thode A 1478 (NH, PRE).

- **2527 (Rustenburg):(-AA)** Pilanesberg, 5/1/78, Peeters, Gericke & Burelli 614 (PRE); **(-BC)** Beestekraal, 12/1908, Jenkins 6950 (PRE); **(-CA)** Rustenburg, Magaliesberg, 6/1906, Nation 318 (BOL); **(-CD)** Brits, Buffelspoort Dam, 1/1/59, Repton 4918 (PRE).

- **2528 (Pretoria):(-AD)** About 10 miles from Hammanskraal on road to Rust de Winter, 29/12/53, Meeuse 9130 (PRE), Near Apiesrivier, 3/11/1893, Schlechter 3613 (BM, BOL, SAM), Apies River, October, Zeyher 1399 (SAM); **(-BA)** 6 miles south of Hammanskraal, 9/12/47, Codd 3640 (PRE), 25 miles north of Pretoria, 1/10/38, Hafström & Acocks 1397 (PRE); **(-BC)** 17 miles NE of Pretoria, Pienaars River, 23/2/47, Repton 3331 (PRE); **(-CA)** Pretoria, 18/10/04, Leendertz 368 (BOL), Pretoria, Gezina, 27/12/1904, Leendertz 8622 (PRE), Pretoria, Riviera, hill near Public School and north slope of Meintjies Kop, 22/12/25, Smith 1838 (PRE), Pretoria, Riviera, commonage near school, 15/11/26, Smith 3367 (PRE), Pretoria, Riviera, commonage above top end of school, 15/11/26, Smith 3375 (PRE), Pretoria, Rooikop, 31/12/32, Smuts & Gillett 2512 (PRE).

- **2529 (Witbank):(-AD)** Loskop Dam Nature Reserve, 8/12/59, Mogg 31234 (PRE).

- **2530 (Lydenburg):(-BD)** Nelspruit, Killarney, Schagen, 4/36, Anderson 4 (PRE), Lowveld Botanic Garden, 13/5/80, Kluge 2279 b (PRE, SAM), Nelspruit, 6/11/05, Rogers 369 (269?) (BOL, PRE), Nelspruit, 12/1919, Rogers 23532 (PRE); **(-DD)** Schoonoord, bordering on Ida Doyer Nature Reserve, 22/4/76, Botha 1504 (PRE).

- **2531 (Komatipoort):(-AB)** Komapite, 15/1/53, Van der Schijff 1681, 1682 (KNP), Pretoriuskop, 10/2/53, Van der Schijff 2054 (KNP, PRE); **(-AC)** Plaston, 10/31, Holt 107 (NH, PRE); **(-AD)** Malelane, Sigaas (Nsikazi) area, 2/3/60, Brynard & Pienaar 4432 (KNP, PRE), Kruger National Park, 5 miles west of Malelane, 24/2/49, Codd 5241 (KNP, PRE); **(-BD)** Komatipoort, 7/12/1918, Rogers 19306 (PRE), Komatipoort, 18/12/1897, Schlechter 11817 (BOL, GRA, PRE), Komatipoort, Twello Farm, 6/2/74, Van der Merwe 256 (PRE); **(-CB)** Louws Creek Timber Co., Farm Kamhlabana Kop, 19/3/80, Buitendag 1276 (NBG), Kaapmuiden, 4/5/29, Mogg 1340 (PRE), Nelspruit-Komatipoort road, 6/12/55, Noel 50 (PRE), Kaapmuiden, 12/21, Rogers 25062 (PRE), Kruger National Park, junction of Sigaas (Nsikazi) and Crocodile Rivers, 8/11/54, Van der Schijff 3953 (KNP, PRE); **(-CC)** Barberton, 11/6/03, Burtt Davy 319 (BOL, PRE), 2,4km south of Barberton, Mukwana Heights, 25/8/74, De Souza 430 (PRE), Barberton, 5/24, Edwards 15 (PRE), Barberton, Saddleback Mountains, 10/1889, Galpin 616 (BOL, GRA, NH, PRE), Between Louws Creek and Maid of the Mist Mountain, 6/1/29, Hutchinson 2437 (BOL, PRE), Twelo, just behind Barberton on Saddleback hill, 16/5/80, Kluge 2280 (SAM), Havelock Mine, 6/1956, Miller 3594 (PRE), 38km SE of Barberton, Ida Doyer Nature Reserve, 8/12/71, Muller 2081 (PRE), Barberton, 9/21, Rogers 24291 (GRA, NH), Near Barberton, 18/5/1889, Thorncroft 427 (NH), Hills above Barberton, 25/5/03, Thorncroft 544 (NH), Barberton, Ives Luck, 10/1904, Thorncroft 599 (NH), Barberton, 5/1907, Thorncroft 4559 (PRE), Near Barberton, Thorncroft s.n. (GRA); **(-DC)** Kruger National Park, ESE of Ship Mountain, Komapite windpump, 15/1/53, Acocks 16705 (PRE), Tshaneni, 14/10/69, Barrett 44 (PRE); **(-DD)** Figtree, 4/1919, Eyles 1611 (SAM).

- **2631 (Mbabane):(-AA)** Komati Bridge, 15/4/57, Compton 26836 (NBG, PRE), Near Komati Bridge, 1/5/59, Compton 28837 (NBG, PRE), Komati Pass, 21/2/62, Compton 31299 (NBG, PRE), Komati Pass, 2/5/62, Compton 31576 (NBG); **(-AB)** Mbabane, Malandela, 17/12/65, Compton 32480 (NBG, PRE, SAM); **(-AC)** Between Mbabane and Bremersdorp, 1/06, H. Bolus 12214 (BOL, PRE); **(-AD)** Manzini, Tulwane, 24/4/59, Compton 28803 (NBG, PRE); **(-BD)** Isateki Beacon, 25/11/58, Compton 28387 (NBG, PRE), Stegi, Palala, 11/1/62, Compton 31218 (NBG); **(-DC)** Hlatikulu, Kubuta, 15/10/59, Compton 29230 (NBG, PRE).

- **2632 (Bela Vista):(-AC)** On road from Stegi to Goba, 100 metres from Mozambique border, Lebombo Mountains, 11/8/70, Brummitt 12471 (PRE); **(-CC)** Gwalaweni Forest, 17/4/68, Strey 8161 (NU, PRE); **(-CD)** Ndumu Hill, 29/11/68, Pooley 209 (NH, NU).

- **2730 (Vryheid):(-DB)** Hlobane, below waterfall, 12/3/50, Johnstone 346 (NU).

- **2732 (Ubombo):(-AA)** 20 miles from Ndumu on road to Ingwavuma, foothills of Lebombo, 6/11/69, Moll 4335 (PRE), East of Ingwavuma, 27/1/63, Strey 4699 (NH), Inguavuma foothills, 24/11/70, Strey 10268 (NH, PRE), Ingwavuma, 29/11/60, Wells 2230 (NH, PRE); **(-AB)** 16 miles east of Pongola River on road to Maputa, 20/11/69, Moll 4652 (NH, PRE); **(-BA)** Near Pelindaba, Ilala Flats, 10/12/68, Pooley 247 (NH, NU); **(-CB)** Mkuzi Game Reserve, Ndawana, 26/11/75, Goodman 360 (NU).

- **2830 (Dundee):(-DC)** Melmoth road, c. 1 mile south of Umhlatuzi bridge, 9/10/51, Lawn 2166 (NH).

- **2831 (Nkandla):(-AC)** Hlabisa, Palm Ridge Farm, 8/9/67, Harrison 133 (NH, PRE), Hlabisa, Palm Ridge Farm, 7/4/68, Harrison 441 (NH, PRE), Babanango, in small valley near old Goldmine, 18/11/66, Venter 2961 (PRE); **(-AD)** Mahlabathini, Zondela, 24/12/40, Gerstner 4254 (NH); **(-CD)** Eshowe, 23/2/49, Lawn 275 (NH), Eshowe, 6/3/49, Lawn 314 (NH); **(-DB)** Umfolozi Reserve, junction of Enselenyana and Enseleni Rivers, 24/5/22, Curson 166 (PRE); **(-DC)** Empangeni, Umhatuzana Hills, near hospital, 29/7/65, Venter 1999 (NH, PRE); **(-DD)** Mtunzini, "Hamewith", 1/5/19, Mogg 4355 (NBG, PRE), Mtunzini, "Hamewith", 18/11/19, Mogg 5838 (PRE), Mtunzini, "Hamewith", 18/11/19, Mogg 6015 (PRE).

- **2832 (Mtubatuba):(-AA)** Hluhluwe Game Reserve, 13/4/56, Codd 9625 (PRE), Hluhluwe Game Reserve, Nyimane, 7/10/71, Hitchins 352 (PRE), Hlaza/Mbemkedwini, 18/11/71, Hitchins 730 (PRE), Hluhluwe Game Reserve, 30/11/53, Ward 1880 (NU), Hluhluwe Game Reserve, 15/3/54, Ward 2178 (PRE), Hluhluwe village, at gate of Reserve, 22/11/60, Wells 2110 (PRE); **(-AD)** St Lucia Estuary Game Park, 15/6/78, Pooley 2097 (NU), Dukuduku, Futululu, 13/5/70, Strey 9782 (NBG, NU).

- **2930 (Pietermaritzburg):(-DB)** Inanda, Wood 108 (SAM); **(-DD)** Durban Westville, 5/36, Hesom s.n. (NH).

- **2931 (Stanger):(-AD)** Stanger, 27/4/44, Acocks 10361 (NH), Stanger, 27/4/44, Pentz & Acocks 10361 (PRE), Stanger district, Nonoti lagoon, 3/3/77, Ward 9120 (PRE); **(-CA)** Tongaat Beach, 31/5/46, Fisher 1023 (NH, NU), Tongaat Beach, 5/7/57, Hillary 383 (NU), Tongaat, 5/1878, Wood 108 (NH), Duffs Road, 26/1/14, Wood 12570 (PRE); **(-CC)** Near Durban, 5/5/1885, Wood 9919 (NH), Near Durban, Spring Grange, 24/4/1887, Wood s.n. (NH).

- **3030 (Port Shepstone):(-BB)** Near Isipingo, 29/6/1893, Schlechter 2816 (BOL, NBG, PRE), Isipingo, 22/6/1893, Schlechter 21337 (PRE), Umlazi, main Umbumbulu-Winkelspruit Road (near Adams Mission), 23/3/66, Ward 5535 (PRE), Illovo, 4/5/1897, Wood 6417 (PRE); **(-BC)** Park Rynie, Lauder's Farm, 8/4/67, Baijnath 347 (NU), Umzinto, 4/36, Marriott s.n. (NH); **(-BD)** Scottburgh, 5/54, Garbutt 14 (NU), Scottburgh, beside railway line, 26/5/41, Goossens 1712 (PRE), Scottburgh, 7/49, Wahl 14029 (PRE); **(-CA)** Oribi Gorge, 4/37, McClean 557 (NH); **(-CB)** Port Shepstone, 4/1897, no collector's name (PRE); **(-CD)** Uvongo Beach, 4/68, Liebenberg 8111 (PRE).

- **3129 (Port St Johns):(-CA)** 3 miles NE of Ngqeleni, 12/3/55, Codd 9287 (BOL, PRE); **(-CC)** Coffee Bay, 1 mile from sea, 19/2/66, Wells 3507 (GRA, PRE).

- **3130 (Port Edward):(-AA)** Port Edward beach, 4/8/65, Strey 5839 (NH).

- **3226 (Fort Beaufort):(-DD)** Cape, Lovedale, 5/1894, Bennie 731 (GRA), Alice, on Tyumie River banks, 17/3/43, Giffen 960 (PRE), Fort Hare, near Bible School, banks of Tyumie River, 20/3/35, Giffen 1006 (PRE).

- **3227 (Stutterheim):(-CD)** 1,1 miles NW of Zela P.O., 28/2/59, Acocks 20280 (PRE), King Williams Town, Bolasse, Sim 4155 (GRA, PRE); **(-DA)** Kei Road, "Umtaleni", 21/2/60, Ranger 236 (PRE); **(-DB)** Near Komgha, 3/1891, Flanagan 670 (BOL, NH, PRE, SAM); **(-DC)** East London district, Fort Jackson, 22/2/1900, Levey s.n. (PRE).

- **3228 (Butterworth):(-BC)** Manubi, 23/2/66, Wells 3607 (PRE); **(-CB)** Kentani, 5/02, Pegler 466 (BOL, PRE).

- **3327 (Peddie):(-BB)** East London West, Airlie, 4/3/29, Galpin 9850 (PRE), East London, 8/07, Rattray 23 (GRA), East London, 28/2/1896, Wood s.n. (PRE).

Locality unknown

- **2115 (Karibib):(-BB?)** Kaokokoveld, Tjironda, 25/1/58, Merxmüller & Giess 1369 (PRE).

- **2531 (Komatipoort)** Between Louws Creek and Maid of the Mist Mountain, 6/1/29, Hutchinson 2437 (PRE).

- Magaliesberg, December, Burke 327 (SAM), Magaliesburg, no date given, Zeyher 1400 (SAM, PRE), Soutpansberg, 22/6/45, Compton 18079 (BOL), Zululand, Farm 273, 4-6/22, Curson 214 (PRE), Zululand, Farm Egoa, 1/22, Curson s.n. (PRE), Farm ?Kamakari (difficult to decipher), 1953, Dickmann 64 (WIND), Middledrift, 7/13, Salisbury 267 (GRA), Okasima Ka, Namutenya, 31/1/1886, Schinz 36 (GRA), 3 miles SE of Komati River, 10/2/62, Schlieben 9480 (PRE), South Coast, near Botha House, 9/44, Smuts 2337 (PRE), Chininda Forest, 5/1905, Swynnerton 48 (NH), Gazaland, 27/7/06, Swynnerton 136 (SAM), Magaliesberg, no date given, Zeyher 1399 (BM), No locality or date given, Chen 1271 (NH).

5. **J. montis-salinarum**

- **2229 (Waterpoort):(-CD)** Zoutpan 193, Zoutpansberg, above cave, 23/11/32, Obermeyer, Schweikerdt & Verdoorn 168 (PRE); **(-DC)** Waterpoort, Van Colllers Pass, 20/5/82, Van Wyk 5536 (PRE); **(-DD)** Messina district, Farm Wallfield 773 MS, 1-2km from homestead, 15/8/79, Fourie 341 (PRE).

- **2329 (Pietersburg):(-AB)** Soutpansberg, Vivo, school grounds, 10/1/53, Mogg 24448 (PRE); **(-BA)** Along road to Sandrivier bridge on Louis Trichardt-Mara-Vivo road, c. 1 mile from Dundee Farm, south slopes of Soutpansberg, Meeuse 10213 (PRE).

6. J. flava

- **2227 (Palapye):(-CA)** 5 miles south of Palapye road at Serowe turn-off, 14/1/60, Leech & Noel 55 (PRE).

- **2229 (Waterpoort):(-AB)** Dongola, Greefswald, hippo-pool, 15/3/48, Bruce 56 (PRE), c. 56 miles NW of Messina, Farm Greefswald, 8/1/74, Pienaar 404 (PRE), Messina district, Greefswald, 8/1/74, Theron 2923 (PRE); **(-BC)** Dongola area, Farm Little Muck 604, 18/8/48, Codd 4329 (PRE); **(-CC)** Langjan Nature Reserve, 11/74, Zwanziger 414 (PRE); **(-CD)** Soutpansberg, Farm Soutpan, foot of mountains behind house, 11/32, Obermeyer, Schweikerdt and Verdoorn 21 (PRE); **(-DC)** Soutpansberg, Waterpoort, 3/9/18, Rogers 21505 (PRE); **(-DD)** Wylies Poort, 17/10/38, Hafström & Acocks 1404, 1405 (PRE), Near Wylies Poort, 26/11/25, Pole-Evans & Van Nouhuys 1949 (PRE), Near Louis Trichardt, Soutpansberg, 6/3/48, Rodin 4000 (PRE).

- **2230 (Messina):(-AC)** Messina, Sandrivierpoort, 1/10/18, Pole-Evans H. 18899 (PRE), Soutpansberg, Messina, 1/18, Rogers 19283 (PRE).

- **2231 (Pafuri):(-CA)** Punda Maria, 28/11/32, Lang s.n. (PRE), Punda Maria, 30/11/32, Lang s.n. (PRE), south of Punda Maria, 31/1/62, Schlieben 9308 (PRE).

- **2326 (Mahalapye):(-BB)** Mahalapye, 11/27, Manseng s.n. (BOL).

- **2327 (Ellisras):(-BB)** Central District, Seleka Ranch, 22/2/77, Hansen 3050 (PRE).

- **2329 (Pietersburg):(-BB)** Louis Trichardt, 2/19, Breyer 19515 (PRE).

- **2330 (Tzaneen):(-CA)** Hans Merensky Nature Reserve, 10/12/69, Oates 131 (PRE), Hans Merensky Nature Reserve, 24/5/67, Gilliland 788 (PRE), Road from Shiny to Silwane's location, 6/17, Breyer 18370 (PRE).

- **2426 (Mochudi):(-AC)** Mochudi, January-April 1914, Harbor 13 (BOL, KMG, PRE, SAM), Mochudi, 3/14, Rogers 6359 (PRE, SAM).

- **2427 (Thabazimbi):(-AD)** Waterberg, near Sentrum, 16/12/65, Vahrmeijer 1306 (PRE); **(-BC)** 10km from turnoff on road to Matlabas, 7/5/77, Germishuizen 211 (PRE), c. 10km from turnoff to Buffelsdrift on road from Thabazimbi to Matlabas, Kranzberg, 7/5/77, Venter 1902 (PRE).

- **2428 (Nylstroom):(-BB)** Magalakwin River drift, 23/1/29, Hutchinson 2660 (BOL, PRE); **(-BD)** Moorddrift, near children's graves, 24/12/28, Hutchinson 2283 (BOL), Moorddrift, 10/09, Leendertz 2138 (GRA), Moorddrift, 10/1909, Leendertz 7314 (PRE); **(-CD)** Near Warmbaths, in Waterberg, 1/06, Bolus 122116

(BOL, PRE), Warmbaths, 8/12/05, Burtt Davy 2603 (PRE), Toowoomba Pasture Research Station, 5/38, Collett 516 (NH, PRE), Warmbaths, 11/08, Leendertz 1386 (SAM), Warmbaths, 20/9/1908, Leendertz 5643 (PRE), Near Warmbaths, 12/31, Murray 707 (PRE), Warmbaths, 11/08, Rogers 1386 (GRA); **(-DA)** Naboomspruit, Mosdene, 22/1/19, Galpin M. 274 (NBG, PRE), 6 miles SW of Naboomspruit, Bad se Loop, (owner Mr L J Van Zyl), 31/5/64, Mogg 31215 (PRE).

- **2429 (Zebediela):(-AA)** Langjan Nature Reserve, 6/4/68, Huntley 1836 (PRE), Potgietersrust, 2/31, St John 15 (PRE), Potgietersrust, 12/28, Thode A1753 (NH, PRE); **(-CB)** Potgietersrust, a few miles from Grass Valley on road to Roedtan, farm Doornpoort, 15/12/54, Meeuse 9168 (PRE).

- **2430 (Pilgrims Rest):(-AA)** The Downs, no date given, Junod 4334 (PRE); **(-AB)** Letaba district, gorge about 7 miles SW of Ofcolaco, 26/1/56, Story 5405 (PRE); **(-BA)** Selati Railway, 6/12, Rogers 12805 (PRE); **(-BD)** Strydom Tunnel, beside tar-road, 8/4/74, Van Wyk 350 (PRE); **(-DA)** 3 km from Ohrigstad on road to Tzaneen, 3/73, Arnold 355 (PRE), Ohrigstad-Branddraai road, Ohrigstad Valley, 22/11/33, Young A591 (PRE), Pilgrims Rest, Branddraai, 23/11/33, Young A634 (PRE).

- 2431 **(Acornhoek):(-AC)** Between Hoedspruit and Klaserie, Farm Thornybush 78 KV, 7/4/77, Zambatis 750 (PRE); **(-AD)** Klaserie Private Nature Reserve, 31/10/73, Zambatis 357 (PRE); **(-BD)** Satara, 3/75, Gertenbach 5423 (KNP, PRE); **(-DA)** Manyeleti Game Reserve, Sarabank, 8/1/76, Bredenkamp 1293 (PRE), Manyeleti Game Reserve, 8/3/76, Bredenkamp 1476 (PRE); **(-DC)** Kruger National Park, Skukuza, 10/34, Letty 206 (PRE).

- 2525 **(Mafeking):(-AB)** Pharing, Kanye, 5/48, Miller B/611 (PRE), Pharing, Kanye, 11/48, Miller B/711 (PRE); **(-BA)** Lobatsi, 12/26, Tapscott 2594 (KMG), Lobatsi, 12/26, Tapscott s.n. (BOL).

- 2527 **(Rustenburg):(-AA)** Pilanesburg, 6/1/78, Peeters, Gericke & Burelli 639 (PRE); **(-AC)** c. 8km from Matooster to Pilanesberg police station, Pilanesberg, 20/10/76, Venter 1103 (PRE); **(-BD)** 25km NW of Pretoria, Farm Rooibos, 5/77, Liebenberg 8594 (PRE).

- 2528 **(Pretoria):(-AB)** Radium, 14/4/74, Drijfhout 594 (PRE), Near Rust de Winter dam, 16/1/37, Repton 775 (NH, PRE), Middelkop, Middelkop Farm, near Pienaars River, Springbok Flats, 20/1/26, Smith 2119 (PRE); **(-AC)** Pretoria, Saltpan, 7/2/29, Leemann s.n. (PRE); **(-AD)** 4 miles north of Hammanskraal, Mauve 1036 (PRE), Hammanskraal, about 5 miles from north road on Rust de Winter road, 29/12/53, Meeuse 9121 (PRE); **(-CA)** Pretoria, Wonderboom, 21/3/24, Cameron 4 (PRE), Pretoria, Vermeulen Street, 9/1/28, Mogg 15403 (PRE), Pretoria, Vermeulen Street, 9/1/28, Mogg s.n. (NBG), Pretoria, corner of Vermeulen and Hamilton Roads, 7/4/25, Smith 179

(PRE), Pretoria, corner of Hamilton & Proes Streets, 11/12/25, Smith 1566 (PRE), Pretoria, Rooikop, 13/12/32, Smuts & Gillett 2026 (PRE), Pretoria, Rooikop, 31/12/32, Smuts & Gillett 2513 (PRE), Pretoria, Rooikop, 8/12/35, Smuts & Gillet 3004 (PRE); **(-CB)** Pretoria, Botanic Gardens, 12/74, Drijfhout 968 (PRE); **(-CC)** Pretoria, Fountains Valley, 11/29, Obermeyer 60 (PRE).

- **2529 (Witbank):(-AB)** c. 4 miles WSW of Groblersdal, 15/9/63, Acocks 23364 (PRE), Vicinity of Groblersdal S., 18/12/66, Mogg 33144 (PRE); **(-AD)** Loskop Dam, 11/1/67, Theron 1098 (PRE).

- **2531 (Komatipoort):(-AA)** Sabi Sand Reserve, Sparta Camp, 15/10/77, Hes 7 (PRE), Sabi Sand Reserve, Sparta Camp/Sparta Break, 6/11/77, Hes 23 (PRE); **(-AB)** 17 miles NE of Pretoriuskop, at watercourse, 4/2/49, Codd 4981 (KNP, PRE), Kruger National Park, Skipberg, 15/1/53, Van der Schijff 1662 (KNP, PRE); **(-AD)** Kruger National Park, Klokwene, rocky koppie east of Picket, 18/2/52, Van der Schijff 197 (KNP, PRE), Pretoriuskop, Sigaas (Nsikazi), 12/11/52, Van der Schijff 1300 (KNP), 10 miles from Skipberg on road to Malelane, stream-banks, 16/1/53, Van der Schijff 1711 (KNP); **(-BD)** Komatipoort, 11/13, Rogers 13281 (PRE); **(-CB)** Barberton, Althorp Siding, 20/4/56, Thorncroft 84 (PRE); **(-CC)** Near Barberton, 9/1886, Bolus 9726 (BOL); Barberton, 12/16, Pott 5666 (PRE); Barberton, 4/14, Thorncroft 874 (NH); **(-DA)** Figtree, 16/1/71, Nel 88 (NBG, PRE); **(-DC)** Swaziland Irrigation Scheme between Komati and Umbeluzi Rivers at foot of Managa Mountain, 43 miles south of Komatipoort, 20/3/67, Clarke 545 (PRE), Swaziland Irrigation Scheme, 31/12/72, Horler 111 (PRE).

- **2631 (Mbabane):(-BA)** Ranches, 6/11/54, Compton 24694 (NBG); **(-BB)** Hlane Wildlife Sanctuary, 18/12/72, Stephen 1424 (PRE), Near Stegi, 28/6/56, Compton 26020 (NBG, PRE); **(-DA)** Manzini, Sipofaneni, 9/2/64, Karsten s.n. (NU).

- **2632 (Bella Vista):(-CD)** Ndumu, between two arms of Manalakunzi Pan, 19/7/74, Burd 9 (NU), Ndumu Game Reserve, edge of Pongola floodplain, 12/68, Pooley 11 (NU), Ndumu Game Reserve, 1 mile NE of rest camp, 12/2/69, Ross 1908 (NH, PRE), Ndumu Game Reserve, Usutu River floodplain, 23/10/59, Tinley 514 (NH, NU, PRE), Ndumu Game Reserve, Bunguzane district, 23/1/64, Tinley 871 (NU).

- **2729 (Volksrust):(-DB)** Ingago, Allendeane, 10/5/20, Mogg 7600 (PRE).

- **2731 (Louwsburg):(-BC)** Pongola, Baylis 3439 (NBG), Pongola Bushveld Farm, no date given, Nel 37 (NH), Pongola Bushveld Farm, no date given, Nel 73 (NH, PRE) (Note: there is some doubt as to whether the label is correct); **(-BD)** Jozini Dam, 14/12/65, Burtt & Hilliard 3226 (NU), Jozini Dam, banks of river, 7/8/63, Repton 6032 (PRE); **(-DA)** Ngotshe, Magudu, 4/2/36, Gerstner 2005 (NH).

- **2732 (Ubombo):(-AA)** 5 miles from Ingwavuma on road to Ndumu, 29/10/69, Moll 4115 (NH, PRE), Ingwavuma, Sand Forest, 28/1/63, Strey 4762 (NH, PRE); **(-AC)** Jozini, below dam, Makatini flats, 14/2/76, Brenan 14234 (NBG, PRE); **(-CA)** Mkuzi Game Reserve, beacon, 25/9/75, Goodman 335 (NU), Mkuzi Game Reserve, banks of Nhlehlela stream, 29/3/62, Gush 17 (PRE).

- **2830 (Dundee):(-CD)** Muden, 26/1/39, Galpin 14733 (NH); **(-DD)** Tugela River Valley, Krantzkop district, 11/5/43, Dyer 4342 (PRE), Kranskop, Jamesons Drift road, 10/5/43, Dyer 4375 (PRE).

- **2831 (Nkandla):(-AC)** Hlabisa, Palm Ridge Farm, Harrison 134 (NH, PRE); **(-BD)** Umfolozi Game Reserve, Thoboti, 18/3/69, Downing 528 (NU, PRE), Umfolozi Game Reserve, 31/3/65, Schlieben 10192 (PRE); **(-DB)** Empangeni Village, High School campus, 23/10/62, Venter 612 (PRE); (-DD) Empangeni Road, near bridge over Umhlatuzi River, Lawn 687 (NH).

- **2832 (Mtubatuba):(-AA)** Hluhluwe Game Reserve, Enzimane, 17/12/69, Bourquin 666 (PRE), Hluhluwe Game Reserve, Maphumulo, 16/3/70, Bourquin 765 (PRE), Hluhluwe Game Reserve, 24/2/62, Hitchins 170 (NH), Hluhluwe Game Reserve, Nqungqulu, 4/11/71, Hitchins 528 (NH, PRE), Hluhluwe Game Reserve, 21/11/53, Ward 1738 (NH, NU, PRE), Hluhluwe Game Reserve, near Hluhluwe River, Ward 2142 (NH, PRE).

- **2930 (Pietermaritzburg):(-DA)** Umgeni Dam, 5/1/48, Barker 5218 (NBG), Nagle Dam, 13/6/57, Wells 1336 (PRE); **(-DC)** Shongweni Dam, 22/2/66, Morris 767 (NH, NU, PRE); **(-DD)** Durban, Reservoir Hills, off Burlington Drive, 21/5/67, Baijnath 449 (NU, PRE), Westville, 5/9/65, Coleman 212 (NH), Mariannhill, 7/7/32, Forbes 1040 (NH), Durban Westville, Chiltern Hills, 11/2/68, Ward 6444 (NU, PRE).

- **2931 (Stanger):(-AA)** Mapumulo district, end of Oqaqueni road at bottom of Tugela valley, 1/4/57, Edwards 1851 (PRE); **(-AB)** Tugela Valley below San Souci, 1/12/56, Edwards 1655 (NU, PRE); **(-CA)** Mapumulo, Mvoti valley, 20/9/65, Moll 2208 (NU, PRE); Umhlanga, 5/5/1896, Wood s.n. (NH); **(-CC)** Near Sydenham, Rooikop, 20/4/30, Forbes 545 (NH), Durban, near Duffs Road station, 9/7/32, Galpin 12126 (PRE), Durban, 2/1909, Jenkins s.n. (PRE), Durban, Burman Drive, 20/6/38, Ogilvie 16 (NH), Durban, no date given, Pappe s.n. (SAM), NE end of Berea, 6/20, Pillans s.n. (BOL), Umgeni River mouth, 28/6/1893, Schlechter 2851 (BOL, NBG, NH, PRE), Avoca, 4/7/1893, Schlechter 21336 (PRE), Near Durban, 2/1880, Wood 831 (NH).

- **3030 (Port Shepstone):(-CB)** Oribi Flats, 4/37, Maclean 412 (NH), Gibraltar Rock, Umzimkulu River, 24/10/70, Nicholson 951 (PRE), Gibraltar, 24/10/70, Strey 10004 (NU, PRE); **(-CD)** Margate, 2/31, Rump s.n. (NH); **(-CA)** Ngqeleni Valley, 13/3/49, Lawn 360 (NH).

Locality unknown

- **2229 (Waterpoort):(-DB)** Soutpansberg, Bloukop, 8/16, Breyer s.n. (PRE).

- **2327 (Ellisras):(-DC) or 2428 (Nylstroom):(-AC)** Between Vaalwater and Elmeston, 7/1/59, Werdemann & Oberdieck 1744 (PRE).

- **2329 (Pietersburg):(-AB)** Blinkwater, Sandrivier, Farm Baden Baden, 6/20, Breyer 21610 (PRE).

- **2732 (Ubombo):(-CA, -CB)** Mkuzi, bank of Mkuzi river, 4/9/32, Galpin 13707 (PRE), Mkuzi Game Reserve, 14/10/75, Goodman 350 (NU), Mkuzi Game Reserve, Masundweni, 26/11/75, Goodman 364 (NU), Mkuzi, 21/7/51, Johnson 70 (NBG).

- **2732 (Ubombo):(-CD), or 2832 (Mtubatuba):(-AB)** False Bay, 5/33, Gerstner s.n. (NH), False Bay Park, 13/4/63, Scott-Smith & Ward 25 (NH).

- Skurwepoort, 7/19, Breyer 20348 (PRE), Wambia, 31/1/62, Ihlenfeldt 2246 (PRE), Groot Marico, Mooiland, 28/4/27, Liebenberg S147 (PRE), Natal, 5/1912, Paterson s.n. (GRA), Cultivated, 6/54, Meeuse s.n. (PRE), Wilgerpoort, 10/12, Van Dam 12002 (PRE), Umfolozi River, 7/22, Wager s.n. (PRE), Black Umfolozi valley, 7/36, Verdoorn 1702 (PRE), Soutpansberg, 1936, Smuts & Gillett 4095 (PRE), Marico, no date given, Louw 788 (PRE).

7. **J. kirkiana**

- **1824 (Kachikau):(-AC)** On slopes of Goha Hills, 15/8/67, Lambrecht 267 (PRE).

- **1923 (Maun):(-CB)** Quoroque Island, Santantadibe River, 22/4/76, Smith 1714 (PRE).

8(a). **J. petiolaris subsp. petiolaris**

- **2430 (Pilgrims Rest):(-AB)** Tzaneen, Trichardtsdal, Makoetsie Kloof, 14/6/75, Hall 4568 (PRE, SAM); **(-BC)** Strydom Tunnel, south side, 3/3/76, McMurtry 1532 (PRE); **(-DA)** Blyderivierpoort Reserve, western slope of Mariepskop, 3/11/71, Buitendag 886 (NBG, PRE), Abel Erasmus Pass, 19/4/60, Schlieben & Strey 8396 (PRE); **(-DB)** Mariepskop, Blyderivier, kloof on western bank, 4/7/61, Van der Schijff 5509 (PRE), Blydepoort Holiday Resort, below restaurant, at starting point of Kadishi Trial, bank of Kadishi river, 30/11/78, Viljoen 31 (NBG, PRE).

- **2631 (Mbabane):(-BD)** Stegi, Mnyami, 28/1/60, Compton 29727 (NBG).

- **2632 (Bela Vista):(-CC)** Gwalaweni Forest, 14/12/65, Burtt & Hilliard 3240 (NH, NU), Gwalaweni forest, 27/1/63, Strey 4671 (NH, PRE), Gwalaweni, 17/4/68, Strey 8162 (PRE).

- **2732 (Ubombo):(-AA)** Ingwavuma, 15/2/39, Gerstner 3773 (NH); **(-AC)** Jozini Pass, 12/2/76, Brenan 14191 (NBG, PRE), Pongola Poort, 25/3/62, Ward 4118 (NH, PRE); **(-CA)** Boundary of Ubombo-Ngotshe districts, top of Mountain Road to Jozini dam, west edge of Lebombo Mountains, 24/1/63, Edwards 2906 (NU, PRE); **(-CD)** Hlabisa district, Listers Point area, False Bay, 13/3/59, Oatley 5 (PRE), False Bay Park, Listers Point, 13/5/72, Ward 7668 (NH, NU).

- **2831 (Nkandla):(-DC)** Entumeni, Umhlatuzi Valley, 4/11, Wood 11854 (NH, PRE).

- **2832 (Mtubatuba):(-AA)** Hluhluwe Game Reserve, 25/3/63, Fakude 66 (NH), Hluhluwe Game Reserve, Manzibomvu stream, 22/4/61, Hitchins 13 (NH, NU, PRE), Hluhluwe Game Reserve, 27/3/54, Ward 2244 (GRA, NH, NU, PRE).

- **2930 (Pietermaritzburg):(-DA)** Nagle Dam, 13/6/57, Wells 1341 (NU, PRE); **(-DD)** Mlazi River, 3/3/32, Gerstner 2080 (NH).

- **2931 (Stanger):(-AB)** Ndulinde, 18/4/1888, Wood 3953 (BOL, NH, PRE); **(-CC)** Near Durban, Sydenham, 23/3/04, Wood 9471 (NH, PRE, SAM), Near Durban, 17/7/01, Wood 9612 (BOL, PRE).

- **3030 (Port Shepstone):(-AA)** 20 miles north of Highflats, 16/3/55, Codd 9371 (PRE); **(-CB)** Port Shepstone, 17/12/44, Acocks 10894 (PRE), Port Shepstone, 4/1897, Dimoch-Brown 467 (NH).

Locality unknown

- **2732 (Ubombo):(-CD) or 2832 (Mtubatuba):(-AB)** Hlabisa district, Bahene Forest, False Bay, 8/4/58, Oatley B.A4 (PRE).

- Natal, hills above Palmiet, 3/1894, Evans 155 (NH), Swaziland, eastern slopes of Lebombos, Tibilati stream, 5/2/48, Hornby 2841 (PRE).

8(b.) J. petiolaris subsp. bowiei

- **3227 (Stutterheim):(-DD)** East London, kranz near Nahoon river mouth, 15/6/1907, Galpin 7755 (PRE).

- **3325 (Port Elizabeth):(-DC)** Redhouse, 8/15, Paterson 3164 (GRA).

- 3326 **(Grahamstown):(-BC)** Grahamstown, 20/12/1899, Rogers 159 (GRA); (**-DA**) Kenton-on-sea, 30/6/55, Acocks 18335 (PRE); **(-DB)** Bathurst, Barville Park, 18/11/67, Bayliss s.n. (NBG), Bathurst Research Station, 23/10/70, Brink 175 (GRA), Kowie, 12/11/17, Britten 425 (PRE), Kowie, First Picnic Place, 24/4/19, Britten 1429 (PRE), Bathurst, "Pensinsula", 10/26, Fletcher 25 (PRE), Port Alfred, 9/11/1895, Galpin 3040 (PRE), Port Alfred, 1/07, Gray College Herb 192 (BOL), Port Alfred, 1/1907, Potts 192 (GRA); Near Port Alfred, 5/1893, Schlechter 2689 (BOL, GRA, NBG).

- 3327 **(Peddie):(-BB)** Woolridge, 5/5/66, Bayliss 3353 (PRE), Banks of Buffalo River, 3/62, Bokelman 6 (NBG), East London, 12/16, Breyer s.n. (PRE), Buffalo Pass, 28/11/45, Compton 17786 (NBG), East London, Quigney, 8/1896, M E Galpin s.n. (PRE), East London, Queens Park, 27/9/35, Marriott 3 (NH, PRE), East London, no date given, Sim 4148 (GRA), East London, 5/11/1896, Wood 3374 (PRE).

Locality unknown

- Bushmans River Mouth, 10/32, Holland 3906 (BOL)

8(c). **J. petiolaris** subsp. **incerta**

- **2427 (Thabazimbi):(-BC)** About 5 miles east of Rooiberg-Matlabas road, north of Kransberg, Horse-Shoe Ranch, 3/2/59, Meeuse 10487 (PRE).

- 2428 **(Nylstroom):(-AC)** About 1,4 miles from Vaalwater on road to Hermanusdoorns, 6/1/59, Meeuse & Strey 10415 (PRE); **(-CD)** A few miles from Warmbaths on Groblersdal road, Farm Sandfontein, 22/12/53, Meeuse 9100 (PRE), Warmbaths, 1/29, Thode A 1755 (PRE); **(-DA)** Naboomspruit, Mosdene, Galpin M 507 (PRE), Banks of Badseloop Rivier where it crosses Naboomspruit-Pretoria road, 9/3/77, Van Jaarsveld 1893 (SAM).

- **2431 (Acornhoek)(-CB)** Timbavati Private Nature Reserve, on Timbavati river, 1/4/83, Zambatis 1553 (PRE).

- 2527 **(Rustenburg):(-CA)** Rustenburg, Farm Boshoek, 26/8/43, Rose Innes 40 (PRE).

- 2528 **(Pretoria):(-AB)** Main road to Warmbaths, 5 miles north of Pienaars River, 15/2/46, Codd 837 (PRE).

- 2632 **(Bella Vista):(-CD)** Ndumu Reserve, Ndumu Hill, 27/11/68, Pooley 41 (NU), Ndumu Game Reserve, Ndumu Hill, 28/3/68, Pooley 194 (NU), Ndumu Game Reserve, Ndumu Hill, 14/12/76, Pooley 1823 (NU).

- 2731 **(Louwsburg):(-DC)** 7 miles east of Nongoma, 13/4/56, Codd 9605 (PRE), Nongoma townlands, 23/11/43, Gerstner 4682 (PRE).

- **2832 (Mtubatuba):(-AA)** Hluhluwe Reserve, Nzimane, 5/11/71, Hitchins 560 (NH, PRE), Hluhluwe Game Reserve, 26/11/53, Ward 1818 (NH).

Locality unknown

- **2428 (Nylstroom):(-AC) or 2327 (Ellisras):(-DC)** Between Vaalwater and Elmeston, 7/1/59, Werdemann & Oberdieck 1724 (PRE).

- **2732 (Ubombo):(-CA, -CB)** Mkuze Game Reserve, Nkongolwana Stand 14, 15/3/77, Goodman 933 (NU).

- **2732 (Ubombo):(-CD) or 2832 (Mtubatuba):(-AB)** Hlabisa district, False Bay Park, 2/5/62, Ward 4132 (PRE).

- Transvaal, 1946, Gomes Pedro 756 (PRE).

9(a) **J. protracta** subsp. protracta

- **2229 (Waterpoort):(-DD)** Louis Trichardt, summit of Hangklip Peak, 21/8/29, Galpin 14228 (NH, PRE), 20 miles NE of Louis Trichardt, Hangklip, 18/2/46, Gerstner 6014 (PRE), Soutpansberg, Punch Bowl, 25/1/54, Meeuse 9167 (PRE).

- **2329 (Pietersburg):(-CD)** Pietersburg Nature Reserve, 10/1/79, Bredenkamp & Van Vuuren 200 (PRE).

- **2330 (Tzaneen):(-CA)** Westfalia Estate, southern slopes of Piesangkop, path up to stream and rock ledges, Scheepers 430 (PRE), Westfalia Estates, Duiwelskloof, 3/60, Scheepers s.n. (PRE); **(-CC)** Letaba, Woodbush Forest Station, 24/1/56, Story 5369 (PRE).

- **2427 (Thabazimbi):(-BC)** Kransberg, 6/1/59, Werdemann & Oberdieck 1682 (PRE).

- **2428 (Nylstroom):(-CB)** Nylstroom, October-November 1901, De Jongh s.n. (PRE), About 2 miles from Nylstroom on road to Naboomspruit, near roadside, 17/10/56, Meeuse 9737 (PRE), A few miles from Warmbaths on Groblersdal road, Farm "Sandfontein", 22/12/53, Meeuse 9113 (PRE); **(-DA)** Naboomspruit, Mosdene, 8/2/19, Galpin M 276 (PRE).

- **2429 (Zebediela):(-CB)** About 2 miles south of Grass Valley on road to tin-mine, 21/1/55, Meeuse 9609 (PRE).

- **2430 (Pilgrims Rest):(-AA)** Malta, Junod 4450 (PRE), Selati Poort, Malta, 3/1919, Junod 4459 (PRE); **(-AB)** Trichardsdal, Makoetsie Kloof, 14/16/75, Hall 4563 (NBG, PRE), Pilgrims Rest, Farm "Paris", 8/3/74, Vahrmeijer 2385 (PRE); **(-AD)** About 20 miles north of Burgersfort on road to Penge Mine, 10/6/54, Meeuse 9324, 9351 (PRE); **(-BB)** Near Mica, on Olifants River, Farm "Cambridge", 12/11/73, Zambatis 510

(PRE); **(-DA)** 3 miles south of Ohrigstad, 21/11/33, Young A518 (PRE), Ohrigstad-Branddraai road, 22/11/33, Young A606 (PRE), Near Branddraai, Nooitgedacht Mountain, 24/11/33, Young A695 (PRE); **(-DB)** Blyderivierpoort, Potholes, 23/2/78, Meyer 6265 (PRE), Mariepskop, Blyderiver, 4/7/61, Van der Schijff 5507 (PRE); **(-DD)** Bourkes Luck Mine, Three Sisters Mountain at base of summit kranz, 25/2/37, Galpin 14339 (BOL, PRE).

- **2431 (Acornhoek):(-AD)** Kruger National Park, Nwanedzi test-plots, 17/3/78, Coetzee 6065 (PRE); Kruger National Park, Satara test-plots, 7/4/78, Coetzee 6066 (PRE); **(-CA)** Klasserie, 20/11/58, Killick & Strey 2513 (PRE); Pilgrims Rest, Acornhoek, 5/25, Roberts s.n. (PRE); **(-CD)** Newington, 2/19, Rogers s.n. (PRE); **(-DC)** Kruger National Park, Skukuza, 10/34, Letty 47 (PRE), Kruger National Park, 10 miles from Nahpe on road to Skukuza, 10/2/53, Van der Schijff 2090 (PRE).

- **2530 (Lydenburg):(-BD)** Lowveld Botanic Gardens, Hall & Sons side, 26/5/70, Buitendag 540, 649 (NBG, PRE).

- **2531 (Komatipoort):(-AA)** Nahpe, 13/1/53, Van der Schijff 1542 (KNP, PRE), 10 miles from Nahpe on road to Skukuza, 10/2/53, Van der Schijff 2090 (PRE); **(-AB)** Skipberg, 15/1/53, Van der Schijff 1661 (KNP, PRE); **(-AD)** Komati Bridge, 7/9/61, Compton 30699 (SAM); **(-CC)** Near Piggs Peak, 6/12/70, Edwards 303 (PRE); Barberton, 12/16, Pott 5691 (PRE), Barberton, 4/20, Rogers 23983 (NH), Barberton, Rimers Creek, 13/5/56, Thorncroft 99 (PRE), Barberton, 10/22, Wager s.n. (PRE); **(-DC)** Tshaneni, slopes of Mananga Mountain (Lebombo range), 13/11/69, Barrett 180 (PRE).

- **2631 (Mbabane):(-AC)** Mbabane, Gobolo, 15/10/64, Dlamini s.n. (SAM); **(-BA)** Swaziland, Ranches, 7/11/54, Compton 24673 (NBG, PRE); **(-BD)** Isateki (Stegi) Beacon, 8/2/57, Compton 26618 (NBG), Near Stegi, Lebombo Mountains, 24/7/58, Compton 27902 (NBG, PRE), Isateki (Stegi) Beacon, 22/10/59, Compton 29265 (NBG, PRE), 5 miles south of Stegi, 2/6/60, Compton 30060 (NBG, PRE), Stegi, Blue Jay Ranch, 4/4/62, Compton 31446 (SAM); **(-CA)** Usutu (Malkerns) Canal, 15/4/58, Compton 27746 (NBG, PRE); **(-CD)** Hlatikulu, Grand Valley Hills, 10/1/58, Compton 27441 (NBG), Hlatikulu district, Grand Valley Hills, 23/6/59, Compton 28951 (PRE, SAM), Hlatikulu, 8/10, Stewart s.n. (PRE).

- **2632 (Bela Vista):(-AA)** Stegi, Border Gate, 8/9/57, Compton 27016 (PRE, SAM); **(-CC)** Gwalaweni Forest, 27/1/63, Strey 4673 (NH, PRE), Gwalaweni Forest, 17/4/68, Strey 8160 (NH, NU, PRE); **(-CD)** Bella Vista district, 30/10/69, Moll 4147 (NH, PRE), Ndumu Game Reserve, Ndumu Hill, 27/11/68, Pooley 41 (NU), Ndumu Game Reserve, Ndumu Hill, 28/3/68, Pooley 194 (NU), Ndumu Game Reserve, no date given, Pooley 1186 (NU), Ndumu Game Reserve, Area 7, 14/1/71, Pooley 1194 (NU), Ndumu Game Reserve, east of Shokwe, 13/2/71, Pooley 1250 (NU).

- **2730 (Vryheid):(-BB)** Piet Retief, 12/21, Leipoldt s.n. (PRE).

- **2731 (Louwsburg):(-AC)** Itala Nature Reserve, along west fence 3-4 miles south of Itala River, 23/1/76, Brown & Shapiro 509 (PRE); **(-BB)** Hlatikulu, near Ingwavuma Poort, 5/3/59, Compton 28585 (NBG); **(-BD)** Jozini Dam, 7/8/63, Repton 5988 (PRE); **(-DC)** Nongana Townlands, 10/10/43, Gerstner 4676 (PRE).

- **2732 (Ubombo):(-AA)** Near Ingwavuma, Lebombo Mountains, 7/36, Verdoorn 1681 (PRE); **(-AB)** Sihangwane, 18/6/75, Hall-Martin 1849 (PRE); **(-AC)** Pongola Poort, 7/8/63, Repton 6002 (PRE); **(-CA)** Mkuzi Game Reserve, Msinga, 18/3/69, Tinley 43 (PRE); **(-CD)** False Bay Park, Listers Point, 13/5/72, Ward 7669 (NU, PRE).

- **2830 (Dundee):(-CC)** Near Weenen on Muden, Valley Bushveld, 12/3/47, Acocks 13459 (PRE), 3 miles west of Weenen, 27/3/54, Codd 8615 (NH, NU, PRE), Weenen, Bloukranz, Pentz 210 (PRE); **(-CD)** Road to Muden, 28/9/39, West 1237 (PRE).

- **2831 (Nkandla):(-AD)** Mahlabatini, 24/12/41, Gerstner 4264 (NH); **(-BB)** Hlabisa, Palm Ridge Farm, 23/8/67, Harrison 43 (NH, PRE); **(-BC)** Spruit near Munywane River, July, Aitken & Gale 15 (NU, PRE); **(-BD)** Umfolozi Game Reserve, 29/9/81, Phelan 559 (NU), Umfolozi Game Reserve, 2/9/53, Ward 1460 (NH), Umfolozi Game Reserve, 22/11/59, Ward 3314 (NH, PRE), Umfolozi Game Reserve, 22/9/62, Ward 4384 (NH, PRE); **(-CD)** Eshowe, 13/6/49, Lawn 786 (NH); **(-DC)** Umhlatuzi bridge, 24/5/49, Lawn 689 (NH), Mtunzini district, Umhlatuzi valley, near bridge, 14/7/65, Venter 1952 (PRE), Umhlatuzi Flats, Icubu Lake, 13/9/66, Venter 2596 (PRE), Second RH branch of Ngoye forest road, 21/2/61, Wells & Edwards 110 (NH, NU, PRE); **(-DD)** Mtunzini, 18/7/50, Lawn 1581 (NH), Mtunzini, 9/28, Thode A 1539 (NH, PRE), Mtunzini, 9/09, Wood 11369 (SAM).

- **2832 (Mtubatuba):(-AA)** Hluhluwe Game Reserve, 8/5/61, Hitchins 20 (NH, PRE), Hluhluwe Game Reserve, 26/9/62, Scott-Smith 9 (PRE), Hluhluwe Game Reserve, 26/2/54, Ward 2152 (NH, NU, PRE), Hluhluwe Game Reserve, 12/7/56, Ward 3009 (PRE); **(-AB)** Charters Creek area, west of Fanies Island, 24/11/55, Ward 2746 (NU, PRE), Hlabisa, West of Fanies Island, 24/11/55, Ward 2747 (NH); **(-CA)** 48km NE of Empangeni on road to Hluhluwe, 12/8/70, Brummitt 12500 (PRE), Enseleni Nature Reserve, 10/6/66, Ward 5664 (PRE); **(-CC)** Richards Bay, 8/3/49, Lawn 344 (NH), Richards Bay, 6/4/64, Ward 4941 (NH, PRE).

- **2930 (Pietermaritzburg):(-AC)** Houtboschrand, 22/9/1893, Schlechter 2235 (PRE), Houtboschrand, 22/9/93, Schlechter 3324 (BOL); **(-AD)** Baynes Drift, 24/5/44, Fisher 614 (NU); **(-BA)** Umvoti district, Seven Oaks, 31/1/59, Guy 52 (PRE), Greytown, 5/32, Wylie s.n. (NH, PRE); **(-CB)** 4 miles from

Pietermaritzburg on Richmond road, 4/57, Brayshaw 23 (NU), Ashburton, 11/42, Fisher 388 (NU), Hilton Road, June 1930, Ford s.n. (NH), Pietermaritzburg, Chase Valley, 22/4/44, Hillary 40 (NU); **(-DA)** Between Drummond and Inchanga, Valley of a Thousand Hills, 23/1/36, Forbes 501 (NH), Drummond, 30/8/28, Galpin 10280 (PRE), Inchanga, 4/54, O'Connor 78 (NU), Inchanga, 31/5/49, Hoal 17 (NU), Pietermaritzburg, Table Mountain, 9/3/26, McClean 149 (PRE), Camperdown, 18/8/65, Moll 1891 (NU, PRE), Nagle Dam, 13/6/57, Wells 1350 (NU), Camperdoun, 11/11, Wood 12005 (NH, PRE); **(-DB)** Inanda district, Groenberg, 9/10/66, Strey 7004 (NH, PRE), Inanda, May-June 1880, Wood 418 (BOL), Inanda, Wood 423 (PRE), Inanda, no date given, Wood 566 (BOL, NH, SAM); **(-DC)** Bothas Hill, 7/3/26, McClean 138 (NBG, PRE), Shongweni Dam, 22/2/66, Morris 779 (NH, PRE), Inchanga/Hammarsdale turnoff from Pietermaritzburg-Durban highway, 8/1/81, Schrire 213 (NH); **(-DD)** Westville, 5/9/65, Coleman 213 (NH), Marianhill Mission, near the dam, 8/4/44, Fisher 556 (NH, NU), Marianhill, 1958, Fuller 1963 (PRE), Kloof, 9/6/32, Galpin 12682 (PRE), Kloof, no date given, Galpin s.n. (BOL), Kloof Nature Reserve, Kloof forest, 15/6/66, Moll 3258 (PRE), Durban, Clairmont, 26/6/1893, Schlechter 2837 (BOL, NBG, PRE), Durban, Wentworth, 8/3/67, Ward 6146 (NH, PRE).

- **2931 (Stanger):(-AA)** Lower Tugela Valley, below Maqumbi, 1/3/63, Edwards 3059 (NU, PRE); **(-AB)** Tugela Beach, 22/1/52, Johnson 417 (NBG), Tugela, 8/11/08, Wood s.n. (BOL, PRE); **(-AD)** Between Stanger and Stanger beach, 27/4/44, Acocks 10397 (NH), Between Stanger and Stanger Beach, 27/4/44, Pentz & Acocks 10397 (PRE); **(-CA)** Tongaat Beach, 5/7/47, Hillary 382 (NU), 5 miles west of Verulam, 15/9/65, Moll 2078 (NU, PRE); **(-CC)** Port Natal (Durban), Gueinzius 378 (S), Durban, Berea, 10/20, Lansdell s.n. (PRE), Durban, Merebank East, 7/3/66, Ward 5404 (NU, PRE); Berea, near Durban, October 1883, Wood 194 (SAM); Near Durban, 28/4/97, Wood 6420 (BOL, PRE, SAM), Durban Flat, 10/1883, Wood s.n. (NH).

- **3029 (Kokstad):(-BD)** Umzimkulu, Emyembi forest, 2/1885, Tyson 2579 (BOL, SAM).

- **3030 (Port Shepstone):(-AA)** Ixopo, Lufafa Road, Shirley s.n. (NU); **(-BB)** Clausthal, 11/7/54, Gallwey 101 (NU), Winkelspruit, 5/24, Indian Collector s.n. (NH), Umbogintwini, 11/12/56, Ward 3023 (NH); **(-BC)** Pennington, 4/50, Gower 20 (NU), Park Rynie, 7/58, Newmark 35 (NU); **(-BD)** Scottburgh, 7/14, Wahl s.n. (PRE); **(-CA)** Izingolweni, near Eyles Dam, 30/4/74, Nicholson 1433 (PRE); **(-CB)** Port Shepstone, Shelly Bay, Mogg 11917 (PRE), Shelly Bay, 7 miles south of Port Shepstone, 12/1930 - 1/1931, Mogg 12168 (PRE), Port Shepstone district, Horseshoe Farm, 17/12/65, Strey 6619 (NH, NU, PRE), Port Shepstone, 4/1897, no collector's name (PRE); **(-CD)** Margate, 5/7/38, Cohen s.n. (NBG), Uvongo Beach, 3/67, Liebenberg 8005 (PRE), Uvongo Beach, 4/68, Liebenberg 8096 (NH, PRE), Southbroom, 5/9/56, Marais 1141 (NBG, PRE), Uvongo, 15/12/36, Mogg 13161 (PRE), Uvongo, 15/12/36, Mogg 13228 (PRE), Marina Beach, 25/11/67, Nicholson 672 (NH), Near Uvongo, 8/7/70, Nicholson 887 (PRE), Ramsgate, 1/5/56, Whellan 1056 (PRE).

- **3126 (Queenstown):(-DD)** Queenstown district, Gwatyn, 15/4/11, Galpin 8157 (PRE).

- **3129 (Port St Johns):(-AB)** Enseleni Nature Reserve, 10/6/66, Ward 5664 (PRE); **(-CA)** Ngqualeni commonage, 13/5/54, Barker 8244 (NBG).

- **3130 (Port Edward):(-AA)** Port Edward, 14/9/71, Nicholson 1088 (PRE).

- **3225 (Somerset East):(-BA)** Cradock Road, roadside, 24/7/74, Bayliss 6453 (SAM).

- **3226 (Fort Beaufort):(-DD)** Garfield, 8/11/64, Acocks 23512 (PRE), Tyumi River, near Bokwes, 16/3/38, Giffen 839 (PRE), Victoria East (Alice) district, Sandilis Kop, near gate to quarry, 6/9/35, Giffen 1007 (PRE).

- **3227 (Stutterheim):(-CD)** King Williams Town, banks of Buffalo River, 10/11/01, Galpin 5941 (GRA, PRE), Bolasse, no date given, Sim 4154 (GRA, PRE), King Williams Town, Sim 4173 (PRE); Bolasse, 12/1899, Sim 4199 (PRE), King Williams Town, 7/1882, Tyson 2234 (NBG, PRE); **(-DB)** Prospect Siding, no date given, Flanagan s.n. (NBG, PRE).

- **3228 (Butterworth):(-BB)** Elliotdale, The Haven, 19/4/66, J. Gordon-Gray 452 (NU).

- **3324 (Steytlerville):(-CA)** Baviaans Kloof, 27/8/75, Bayliss 7584 (SAM); **(-DB)** Zwartkopsrivier, October, Ecklon & Zeyher s.n. (S).

- **3326 (Grahamstown):(-AB)** 15 miles from Grahamstown on Cradock road, Hell Poort, 26/6/75, Brink 337 (GRA); **(-AD)** Howiesons Poort, Ecklon and Zeyher s.n. (S), Bothas Ridge, 24/3/62, Wells 2622 (GRA, PRE); **(-BC)** 10 miles from Grahamstown, Queens Road, 5/26, Dyer 486 (PRE), Bothas River valley, Glen Craig, 8/29, Dyer 2007 (GRA), Grahamstown, near Hamilton Reservour, Gane 62 (GRA), Grahamstown, 10/23, Rogers 27369 (PRE); **(-BD)** Frasers Camp, 30/11/50, Barker 6981 (NBG, PRE).

- **3327 (Peddie):(-AA)** Near Thorns, 17/4/1894, Wood 5271 (NH); **(-AD)** Hamburg, 18/11/61, Acocks 21825 (PRE).

Locality unknown

- **2723 (Kuruman):(-CD)** Hills between Khosis and Mariemane, 4/40, Esterhuysen 2399 (BOL).

- No locality or date given, Ecklon & Zeyher s.n. (MEL), Ga Mhane Peak, 2/1886, Marloth 1076 (PRE).

9(b). **J. protracta** subsp. **rhodesiana**

- **2014 (Welwitschia):(-AB)** Nuargas, 4/1/1919, Lightfoot 3 (SAM, WIND).

- 2217 (**Windhoek**):(-CA) Auas Mountans/Windhoek, Moltkeblick, 24/3/69, Giess 10771 (PRE, WIND).

- **2227** (**Palapye**):**(-BB)** Pikwe, 12/77, Kerfoot & Falconer 100 (PRE).

- **2229 (Waterpoort):(-AB)** Farm Greefswald, Mapungubwe, 8/1/75, Eicker & Students 136 (PRE), c. 56 miles NW of Messina, Farm Greefswald, 8/1/74, Pienaar 370 (PRE), c. 56 miles north of Messina, farm Greefswald, 8/1/74, Theron 2883 (PRE); **(-BC)** Dongola Reserve, Hackthorn, Pole Evans 4555 (PRE); **(-CC)** Langjan Nature Reserve, 11/74, Zwanziger 527 (PRE); **(-DD)** Wylies Poort, 17/10/38, Hafström & Acocks 1388 (PRE), Wylies Poort, 26/1/54, Meeuse 9197 (PRE).

- 2230 **(Messina)**:**(-AC)** Messina, 1917, Rogers 19413 (BOL, NH, PRE); **(-CC)** Entabeni Forest Reserve, Muchindudi Falls, 5/6/48, Codd 4197 (PRE), Entabeni, 11/31, Obermeyer s.n. (PRE), Mazwimba, NE side of mountain, 22/5/82, Van Wyk 5701 (PRE); (**-C**D) Tate Vondo Forest Reserve, 9/12/76, Hemm 41 (PRE), Sibasa, Junod 4523 (PRE); About 3 miles south of Lake Funduzi, 19/11/54, Meeuse 9419a, 9419b (PRE), Thononda, near summit, 5/10/81, Van Wyk & Theron 4557 (PRE), Dzamba, 6/10/81, Van Wyk & Theron 4868 (PRE).

- 2326 **(Mahalapye):(-BB)** 1-2km north of Levubu Gorge, near Mutale Spruit, 11/80, Fourie 1473 (PRE), Mahalapye, 1/12, Rogers 6098 (PRE).

- **2327 (Ellisras):(BB)** Beauty, 9/1/59, Werdemann & Oberdieck 1785 (PRE).

- **2329 (Pietersburg):(-AC)** Bochum, 20/1/31, Bremekamp & Schweickerdt 166 (PRE); **(-BB)** Louis Trichardt, 1/22, Breyer s.n. (PRE); **(-CD)** Near Pietersburg, 2/04, Bolus 10885 (BOL, GRA, NH, PRE); **(-DD)** Magoebas Nek, Farm Skrikfontein, 53 miles NW of Potgietersrust, 10/1/52, Maguire 1502 (BOL, NBG).

- 2331 **(Phalaborwa):(-CB)** 5 miles north on Shawo road, 18/6/52, Van der Schijff 556 (KNP, PRE), 43km from Letaba on road to Shingwidzi, 18/3/77, Van Jaarsveld 1992 (NBG); **(-DC)** 3 ½ miles west of Letaba Camp, 4/11/48, Codd & Dyer 4692 (PRE).

- **2428 (Nylstroom):(-AD)** Waterberg, Vier-en-twintig Riviere, 7/11/78, Germishuizen 969, 974 (PRE).

- **2429 (Zebediela):(-AA)** 10 miles north of Potgietersrust, 14/6/51, Taylor 3029 (NBG).

- 2430 **(Pilgrims Rest):(-DA)** About 2 miles south of Branddraai on Vaalhoek-Ohrigstad road, 4/3/57, Meeuse 10027 (PRE).

- **2431 (Acornhoek):(-BC)** Kruger National Park, 3/75, Gertenbach 5092 (PRE); **(-BD)** Santara, 3/75, Gertenbach s.n. (KNP).

- **2527 (Rustenburg):(-DB)** Brits, farm Welgevonden, 6/4/35, Mogg s.n. (PRE).

- 2531 **(Komatipoort):(-BD)** Komatipoort, 5/12/18, Rogers 22214 (BOL).

- **2616 (Aus):(-CA)** Farm Klein Aus, 12/5/49, Kinges 2243 (PRE).

10. **J. parvibracteata**

- **2231 (Pafuri):(-AC)** Pafuri, 18/2/76, Van Rooyen 86 (KNP).

- 2722 **(Olifantshoek):(-DC)** 12 miles NNW of Olifantshoek, Toto Mountain, 27/8/61, Leistner & Joynt 2736 (KMG, PRE), 11 miles NNW of Olifantshoek, in Toto Mountains, 8/3/67, Tölken & Schlieben 1176 (PRE); **(-DD)** Sishen, 13/5/67, Collins 1 (PRE).

- 2723 **(Kuruman):(-AD)** Kuruman, Batharos, 3/21, Silk 239 (BOL, KMG); **(-DA)** 17 miles from Kuruman on road to Daniels Kuil, Broncote, Asbestos Hills, 23/3/39, Esterhuysen 1011 (BOL, PRE), 17 miles south of Kuruman, Asbestos Hills, Broncote, 23/3/39, Lewis 430 (SAM).

- 2821 **(Upington):(-DD)** 15-16 miles NNW of Winstead, Twin Koppies, quartzite koppies, 3/37, Acocks 2047 (BOL, KMG, PRE).

- **2822 (Glen Lyon):(-BB)** 4 miles west of Lucas Dam, 17/3/60, Leistner 1657 (BOL, KMG, PRE); **(-BC)** Bergenaars Pad, upper east slopes of Langeberg, 7/8/36, Acocks 586 (KMG, PRE), Slopes of the Langeberge at Bergenaars, 23/10/36, Hafström H 1102 (PRE), Hay, Dunmurray, slopes of the Langebergen, 27/9/39, Vigne 5659 (BOL, KMG, NH), Hay, Dunmurray, hills east of Asbestos Hills, 2/23, Wilman 2262, 2263 (KMG), Hay, Dunmurray, 2/23, Wilman s.n. (BOL); **(-BD)** Hay district, near Sunnyside, 26/3/36, Acocks s.n. (PRE), Floradale, 4/40, Esterhuysen 2354 (BOL, PRE).

- **2823 (Griekwastad):(-AA)** north of Postmasburg, Klipfontein, 3/38, Esterhuysen 5371 (BOL, KMG); **(-AD)** 18 miles ENE of Postmasburg, 27/3/59, Leistner 1402 (KMG, PRE); **(-BA)** Danielskuil, hills near Ouplaas, 4/40, Esterhuysen 2041 (BOL); **(-CC)** Griquatown, Asbestos Hills, 2/37, Esterhuysen 4073 (KMG, BOL).

11. **J.** dinteri

- **1712 (Posto Velho):(-DD)** Entanga, banks of Etanga River, 7/4/57, De Winter & Leistner 5434 (PRE, WIND).

- **1715 (Ondangua):(-CB)** Ogongo Agricultural College, 26/2/78, Van Jaarsveld 2980 (SAM).

- **1716 (Enana):(-CA)** Ombalambuenge, 28/3/2896, Rautanen 814 (PRE).

- **1719 (Runtu):(-DD)** Runtu, banks of Okavango River, 27/2/56, De Winter & Marais 4906 (PRE, WIND).

- 1813 **(Ohopoho):(-BB)** 2 miles east of Ohopoho, 2/4/57, De Winter & Leistner 5320 (PRE, WIND).

- **1821 (Andara):(-BA)** Caprivi Zipfel, Popa Falls, bank at Island, 9/3/58, Merxmüller & Giess 2008 (PRE, WIND); **(-BD)** Samocimo, 24/4/75, Biegel, Müller & Gibbs-Russell 4981 A (PRE).

- **1917 (Tsumeb):(-BA)** Tsumeb West, 10/4/69, Cole T4 (PRE), Tsumeb, 8/11, Dinter 3020 (SAM), Tsumeb, 8/1911, Dinter 3047 (SAM); **(-BC)** Farm Elandshoek (GR 771), below dolomite rock-face, 23/4/78, Giess 15126 (PRE).

- **1918 (Grootfontein):(-CA)** 25 miles east of Grootfontein, 11/1/34, Schoenfelder S405 (PRE).

- **1923 (Maun):(-AD)** Maun, Thamalakane river floodplain, 14/1/74, Smith 778 (PRE), Maun, 31/3/75, Smith 1339 (PRE); **(-CA)** Boro Floodplain, 14/1/74, Biggs M500 (PRE).

- 2014 **(Welwitschia):(-BD)** Outjo, on the road between Welwitschia and Fransfontein, 29/3/63, Volk 6116 (WIND).

- 2015 **(Otjihorongo):(-AA)** 26 miles from turnoff to Welwitschia via Fransfontein towards Outjo, 28/3/65, Tölken & Hardy 857 (PRE, WIND).

- **2016 (Otjiwarongo):(-BC)** 8km from Otjiwarongo on road to Okahandja, 15/4/68, Meyer 1166 (PRE, WIND).

- 2017 **(Waterberg):(-AD)** Waterberg, farm Hohensee (Otjahevita), 24/5/68, Meyer 1185 (PRE, WIND); **(-CA)** Farm Okamuru (OTJ 289), Waterberg, 5/3/74, Merxmüller & Giess 30045 (PRE), Middle SE slopes of Omuverume Plateau, 25/4/71, Rutherford 388 (WIND), SE slopes of the Omuverume plateau, 25/4/71, Rutherford 409 (WIND).

- **2022 (Lake Ngami):(-DD)** North of Ngwanalekau hills, 4/3/69, Buerger 1144 (PRE, WIND).

- **2023 (Kwebe Hills):(-BD)** Botletle River, 9km east of Makalamabedi, 21/3/65, Wild & Drummond 7207 (PRE).

- **2217 (Windhoek):(-AB)** Midgardberge (OK 191), 3/5/61, Seydel 2835 (WIND).

- **2327 (Rehoboth):(-DD)** 41,6 miles north of Vaalwater on Beauty road, 7/1/59, Meeuse & Strey 10457 (PRE), c. 41,6 miles north of Vaalwater on Beauty road, 4/2/59, Meeuse 10551 (PRE).

Locality unknown

- **1821 (Andara):(-DB or -DA)** Tsodilo, 2/5/75, Biegel, Muller & Gibbs Russell 5061 (PRE).

- Tsumeb, Omahake on the Heidelberg Road, 4/34, Dinter 7156 (BOL), Kwebe, 1/1897, FD & EJ Lugard 129 (GRA), Locality and date obliterated, Dinter 87 (SAM).

12. **J. odora**

- **1714 (Ruacana Falls):(-AC)** 20km west of Ruacana Falls, 31/3/73, Rodini 9195 (WIND, PRE).

- **1813 (Ohopoho):(-BB)** 6 miles west of Ohopoho, 27/3/57, De Winter & Leistner 5214 (PRE, WIND).

- **1816 (Namutoni):(-DD)** Klein Namutoni, 1/19, Breyer s.n. (PRE), north of Fischers Pan, no date given, Le Roux 284 (WIND).

- **1817 (Tsintsabis):(-CC)** 45,3 miles NW of Tsumeb on road to Namutoni, 28/3/55, De Winter 2949 (PRE, WIND).

- **1913 (Sesfontein):(-BD)** Grootberg Plateau, 2/5/77, Lavranos & Barod 15318 (WIND).

- **1914 (Kamanjab):(-AD)** Otowasandu, 25/1/58, Merxmüller & Giess 1342 (PRE, WIND).

- **1915 (Okaukuejo):(-BB)** Etosha Park, 5 miles west of Okankueo, 2/67, Tinley 1197, 1469 (WIND); **(-BD)** Etosha Park, Okaukuejo, on way to Ombika, 25/4/75, Le Roux 1300 (WIND).

- **1916 (Gobaub):(-AB)** Etosha Park, Rietfontein, 2/75, Le Roux 1267 (WIND).

- **1917 (Tsumeb):(-AB)** Farm Guinas See (GR 455); 24/4/63, Giess, Volk & Bleissner 6428 (PRE, WIND); **(-BA)** Tsumeb, Kalkberge, 1/12, Dinter 2485 (SAM), Farm Otjiguinas (GR/TS 458), 5/2/71, Giess 11235 (PRE, WIND); **(-BB)** Farm Heidelberg (GR/TS 291), 5/1/61, Giess 3367 (PRE, WIND); (-BD) Track from Tsumeb to Abenab, 9 miles from main road, 25/4/63, Kers 415 (WIND); **(-CA)** Farm Kumkauas (GR 552), 7/3/73, Giess 12467

(PRE, WIND), Farm Kumkauas (GR 552), 4/2/69, Giess & Smook 10637 (WIND), Farm Kumkauas, near the homestead, 30/3/53, Kinges 2761 (PRE); **(-CB)** Otavi, 26/1/25, Dinter 5473 (BOL, PRE, SAM).

- **1918 (Grootfontein):(-CA)** Tsintsabis-Kuringkuru, 1-2/34, Schoenfelder S534 (PRE).

- **1924 (Joverega):(-DC)** Nxai Pan National Park, 13/3/76, Smith 1646 (PRE).

- **2016 (Otjiwarongo):(-BC)** Otjiwarongo district, 28/12/58, Giess 2183 (PRE).

- **2017 (Waterberg):(-AC)** Waterberg Plateau Park, 20/6/75, Müller 1375 (WIND); **(-CA)** Farm Okamuru (OTJ 289), on slopes of Waterberg, 5/3/74, Merxmüller & Giess 30052 (PRE, WIND), Eastern slopes of Omuverume Plateau, 23/4/71, Rutherford 375 (WIND).

- **2022 (Lake Ngami):(-BD)** Near Sihetwe, Mwaku Pan, 12/1970, Van der Spuy 34 (PRE).

- **2024 (Bushman Pits):(-AA)** Motopi Irrigation Scheme, 19/12/78, Smith 2602 (PRE).

- **2116 (Okahandja):(-AA)** Omaruru, Omburo NE, 7/12/79, Van Koenen 442 (WIND), Omaruru, Omburo NE, 4/4/80, Van Koenen 617 (WIND); (-BA) Omatako, Farm View (OK 256), 7/3/74, Woortman 169 (WIND); **(-DB)** 33km north of Okahandja on road to Otjivarongo, farm Okaruheke, 27/3/68, H & H E Wanntorp 414 (PRE).

- **2124 (Rakops):(-BA)** Taromoja, Botletle River, 22/4/75, Ngoni 426 (PRE).

- **2125 (Lothlekane):(-AD)** Orapa, Blue Drum pan, 10/2/75, Allen 271 (PRE).

- **2126 (Tlala Mabeli):(-AA)** Tlalamabele-Mosu area, near Soa Pan, 14/1/74, Ngoni 328 (PRE).

- **2229 (Waterpoort):(-CD)** Soutpan, west side, 21/1/31, Bremekamp & Schweikerdt 250 (PRE), "Zoutpan 193", 24/11/32, Obermeyer, Schweikerdt & Verdoorn 190 (PRE); **(-DB)** Liliput, 6/12/60, Strey 3495 (PRE).

- **2230 (Messina):(-AC)** Messina, No 12 working, 2/67, Wild 7627 (PRE); **(-CA)** Louis Trichardt, Tshipise area, 27/1/61, Van der Schijff 5259 (PRE).

- **2231 (Pafuri):(-CA)** Punda Maria, beside Madzarengwe spruit, Van Rooyen 628 (KNP).

- 2327 **(Ellisras):(-CA)** 7,1 miles from Kruispad, 3/2/29, Pole Evans 2520 (PRE).

- **2427 (Thabazimbi):(-BA)** 14 miles NW of Hermanusdoorns, 24/2/54, Codd 8499 (PRE).

- **2428 (Nylstroom):**(-BC) Sterkrivier Dam Nature Reserve, 10/2/72, Jacobsen 2175 (PRE).

- 2429 **(Zebediela):(-BB)** Near Ganspoort, 9/6/54, Meeuse 9307 (PRE), 29 miles from Chuniespoort Police Station on road to The Downs, 26/3/53, Story 4100 (GRA, PRE); (-B**C)** About ½ mile east of Chunies Poort on road to Maliepsdrift, 20/1/55, Meeuse 9595 (PRE); **(-CB)** Near Grass Valley on road to Roedtan, about ½ mile from entrance gate of farm "Doornpoort" (=Rehmann's "Klippan"), 14/12/54, Meeuse 9455 (PRE).

- 2430 **(Pilgrims Rest):(-AA)** Pietersburg, Dublin Mine, 4/57, Miller 4274 (PRE); **(-AC)** Penge, southern mineshaft, 10/12/71, Nel 156 (NBG); **(-AD)** Penge district, Weshang, above Sirkularskag, 10/12/71, Teichman 103 (PRE); **(-CB)** Near Burgersfort, 8/6/54, Meeuse 9285 (PRE).

- **2431 (Acornhoek):(-AD)** Avoca, hillsides, 12/1890, Galpin 1238 (GRA, NH, PRE, SAM).

- 2525 **(Mafeking):(-AB)** Kanye, Pharing, 12/11/48, Hillary & Robertson 467 (PRE), Kanye, Pharing, 5/43, Miller B281 (PRE), Near Kanye, 6/48, Miller B624 (PRE).

- 2528 **(Pretoria):(-BA)** Between Rust de Winter and Skilpadfontein, about 33 miles NE of Hammanskraal, 11/1/54, Meeuse 9530 (PRE).

- 2529 **(Witbank):(-AD)** Loskop Dam Nature Reserve, 8/12/59, Mogg 30678 (PRE), Loskop Dam Nature Reserve, 18/2/76, Pienaar 782 (PRE), Loskopdam, north side of Loskop, Theron 970 (PRE), Loskopdam, on far side of wall, 14/10/68, Theron 1853 (PRE).

- **2731 (Louwsburg):(-BC)** Pongola Bushveld Farm, 1/72, Nel 106 (PRE).

- **2732 (Ubombo):(-AB)** Sibaya, 28/11/70, Strey 10307 (NH).

- 2830 **(Dundee):**(-CC) c. 12 miles WNW of Muden, 15/3/47, Acocks 13468 (PRE), Msinga-Weenen district, Farm Lorraine, above Tugela, 29/1/81, Milton 176 (NU); **(-CD)** 1 mile west of Muden, 27/3/54, Codd 8603 (PRE), Muden valley, 6/4/61, Edwards 2504 (NU, PRE), 6 miles from Muden on Keats Drift road, 12/4/62, Edwards 2791 (PRE), Muden, 26/1/39, Galpin 14733 (PRE), Muden, 26/1/39, Galpin s.n. (BOL), Between Greytown and Keats Drift on Dundee road, 5/12/75, Hilliard & Burtt 8363 (NU, PRE).

- **2930 (Pietermaritzburg):(-BA)** Greytown, upper mountain slopes, 10/2/39, Galpin 14813 (PRE).

- **2931 (Stanger):(-CC)** Durban, Merebank East, 7/3/66, Ward 5404 (NH).

Locality unknown

- **2017 (Waterberg):(-AC or -AD)** Waterberg Plateau, 12/35, Boss s.n. (PRE).

- Arms, 25/12/08, Dinter 842 (SAM), Waterberg, near Rasthaus, 28/12/58, Giess 2183 (WIND), Waterberg, campground by police-station, 28/4/63, Giess, Volk & Bleissner 6617 (WIND), Botswana, margin of small talc pan, 2/3/69, Buerger 1138 (PRE), Lebombo Mountains, 9/1/31, Pole Evans s.n. (PRE), Locality uncertain, 14/3/1886, Schinz s.n. (GRA).

13. J. capensis

- **2632 (Bela Vista):(-CD)** Ndumu Game Reserve, 100 yds above Banzi Pan, edge east of Inyamiti crossroads, 9/6/69, Pooley 583 (NH), Ndumu Game Reserve, 19/11/59, Tinley 555 (NH, PRE).

- **2732 (Ubombo):(-BB)** Kosi Bay, Boteler Point, dune forest, 6/11/65, Bourquin 519 (NH), Near Manzengwenya Inspection Quarters, 29/11/69, Moll 4849 (NH, PRE); **(-BC)** 12,2 miles from Manzengawenya on road to Mbazwane, 26/10/66, De Winter & Vahrmeijer 8544 (PRE), Lake Sibayi, 28/11/67, Moll & Strey 3964 (NH, PRE).

- **2832 (Mtubatuba):(-AB)** False Bay, near Bay, 28/10/53, Ward 1640 (NH, PRE), False Bay Park (south sector), 3/6/72, Ward 7720 (PRE).

- **3126 (Queenstown):(-DD)** Queenstown district, Gwatyn, on Junction Farm, 16/4/11, Galpin 8158 (PRE).

- **3128 (Umtata):(-DD)** Mqanduli, Zingqolo station, 21/12/13, Pegler 2039 (BOL, PRE).

- **3226 (Fort Beaufort):(-DD)** Alice, Garfield, 15/12/58, Acocks 20100 (PRE).

- **3227 (Stutterheim):(-CB)** Frankfort, November, Sim 4168 (GRA, PRE); **(-CD)** King Williams Town, no date given, Sim 4157 (PRE), King Williams Town, no date given, Sim 4158 (GRA); **(-DD)** Nahoon, base of kranz, near Elizabeth Island, 7/10/1900, Galpin 5766 (PRE); East London, kranz near Nahoon River mouth, 15/6/1907, Galpin 7756 (PRE).

- **3228 (Butterworth):(-AD)** Kentani, Qora Bridge, Qora valley, 10/12/45, Acocks 12289 (PRE); **(-CA)** Near Komgha, Fort Warren river, 11/1889, Flanagan 69 (GRA, SAM, PRE); **(-CB)** Near Kei

Mouth, Windsor, 7/1894, Flanagan 2350 (BOL, PRE), Keiskamma, April, Pappe s.n. (SAM).

- **3324 (Steytlerville):(-CA)** Baviaans Kloof, 14/8/73, Bayliss 6061 (NBG); **(-DB)** Zwartkop River, Drège 1837 (PRE), between Zwartkop River and Koega River, Ecklon & Zeyher 3593 (NBG, PRE, S), Zwartkops River, by house of Paul Marē near Uitenhage, April, Ecklon & Zeyher 87 (BOL), Zwartkop River, October, Pappe s.n. (SAM).

- 3325 **(Port Elizabeth):(-AD)** East of Kariega, January, MacOwan 758 (GRA), Kariega, January, MacOwan s.n. (PRE); **(-CB)** 16 miles north of Uitenhage, 2/5/47, Acocks 13741 (PRE); **(-CC)** Humansdorp, Gamtoos gorge, 13/4/52, Barker 7908 (NBG), Van Stadens Pass, 12/11/65, Troughton 165 (GRA); **(-CD)** Near Uitenhague, Amanzi, 27/5/67, Acocks 23885 (PRE), Uitenhage, Ecklon & Zeyher s.n. (S), Krakakamma, between Port Elizabeth and Vanstaadensberg, Ecklon & Zeyher (MEL), Uitenhage, Cannon Hill, 12/3/95, Kensit 9 (BOL), Near Uitenhage, 14/5/93, Schlechter 2493 (BOL), Uitenhage, 11-12/25, Thode A693 (NH, PRE); **(-DC)** between Zwartkops and Coega rivers, February, Ecklon & Zeyher 3593 (BOL), 12 miles NE of Port Elizabeth, 27/11/50, Maguire 570 (SAM), Near Port Elizabeth, 9/9/47, Rodin 1205 (BOL, PRE).

- 3326 **(Grahamstown):(-AC)** Alicedale, 9/17, Cruden 52 (GRA); **(-AD)** Howiesons Poort, 26/12/23, Britten 5095 (PRE), Howiesons Poort, 5/26, Dyer 462 (PRE); **(-BA)** Bothasberg, by Great Fish River, October, Ecklon & Zeyher s.n. (MEL, S); **(-BC)** Near Grahamstown, Bloukrans Bridge, 10/1888, Galpin 258 (PRE); **(-BD)** Hopewell, Kariega Valley, 3/11/45, Acocks 12073 (PRE), Albany, Blaauwkrantz, 7/10/18, Hilner 69 (GRA); **(-CA)** Port Elizabeth, Dassieklip, 7/31, L. Bolus s.n. (BOL); **(-CB)** Alexandria district, De Bega, 11/3/52, Archibald 4124 (PRE); **(-DA)** Between Boesmansrivier and Kariegarivier, by Jagersdrift, October, Ecklon & Zeyher s.n. (MEL, S); **(-DB)** Kowie River, Rabbit Rocks, 13/11/17, Britten 436 (PRE), Kowie River, First Picnic Place, 24/4/19, Britten 1434 (GRA), Port Alfred, Rogers 3772 (GRA), Port Alfred, 19/10/1908, Rogers 12343 (PRE), Port Alfred, 12/20 or 2/10/23, Rogers 28069 (PRE).

- 3327 **(Peddie):(-AC)** Bathurst, near Fish River Mouth, 24/2/54, Dyer 5446 a & b (PRE); **(-BB)** East London, 12/16, Breyer s.n. (PRE), East London, Queens Park 27/9/35, Marriott 2 (NH, PRE), East London, 08/07, Rattray 141 (GRA).

- 3422 **(Mossel Bay):(-AA)** 7,5km west of Groot Brak River bridge, Klein Brak River extension No 4, 15/11/72, Taylor 8336 (PRE).

Locality unknown

- **3325 (Port Elizabeth):(-BC or -BD)** Addo Elephant Park, Addobas, 24/3/55, Brynard 442 (PRE), Addo., 6/1908, Drége s.n. (PRE).

- **3326 (Grahamstown):(-BC or -DB)** Albany, east of Kowie River, November, Ecklon & Zeyher s.n. (S).

- Kei River, 9/1889, Flanagan s.n. (PRE), Hlabisa district, Thöles farm, 28/10/44, Gerstner 5065, 5066 (PRE), Transkei, Kabongaba, 26/10/51, Taylor 3697 (NBG), Ingwavuma district, slopes facing Lake Nhlange, 9/12/58, Tinley 378 (PRE), Caput Bonae Spei, no date given, Zeyher s.n. (PRE), No locality or date given, Drége s.n. (PRE), No locality or date given, Ecklon & Zeyher s.n. (S).

14(a). **J. cuneata** subsp. cuneata

- **3324 (Steytlerville):(-DB)** Zwartkops River, October, Pappe s.n. (SAM), Zwartkop River, by house of Paul Maré, October, Ecklon & Zeyher s.n. (S), Zwartkop River, valley and neighbouring hill of Villa Paul Maré to Uitenhage, 10/c. 1830, Zeyher 3592 (PRE).

- **3325 (Port Elizabeth):(-CD)** Vicinity of Uitenhage, Ecklon & Zeyher s.n. (MEL), Krakakamma, Ecklon & Zeyher (S), Uitenhage district, Bethelsdorp Kloof, 31/8/30, Fries, Norlindh & Weimarck 230 (PRE), Bethelsdorp, 28/9/30, Long 402 (PRE), Carnovim, 02/ 1848, Prior s.n. (PRE), Bethelsdorp, 09/08, West 352 (BOL, GRA); **(-DC)** 10 miles north of Port Elizabeth, Markmans Industrial Area, 1/11/68, Dahlstrand 1575 (GRA), 10 miles north of Port Elizabeth, Markman Industrial Area, 5/11/69, Dahlstrand 1772 (PRE), Port Elizabeth, Markman Industrial Area, 23/10/74, Dahlstrand 3157 (PRE), Redhouse, 10/12, Paterson 78 (BOL, GRA, PRE), Port Elizabeth, opposite Veeplaas, 22/9/71, Small, Robbertse & Olivier 125 (GRA).

Locality unknown

- Klein Zwartkopsrivier, no date given, Ecklon & Zeyher 3591 (S), No locality or date given, Ecklon & Zeyher s.n. (S).

14(b.) **J. cuneata subsp. latifolia**

- **2817 (Vioolsdrif):(-CD)** 13 miles east of Stinkfontein, Farm Ecksteenfontein, 12/5/69, Leistner 3370 (PRE).

- **2917 (Springbok):(-AC)** Between Annenous and Abbevlakte, 9/1880, Bolus 672 (BOL, GRA, NH, PRE, SAM); c. 15 miles east of Port Nolloth, Gemsbokvlei, 17/7/72, Van der Westhuizen 277 (PRE).

- **3118 (Van Rhynsdorp):(-BC)** Between Knersvlakte and Sandveld, 7/41, Leipoldt 3772 (BOL, SAM, PRE), 20 miles north of Van Rhynsdorp, 18/7/48, Reynolds 5426 (PRE), 20 miles north of Van

Rhynsdorp, 18/7/48, Steyn 20547 (NBG); **(-CC)** Van Rhynsdorp, near Doringbaai, 1/9/63, Booysen 9919 (NBG), Van Rhynsdorp, Holbak near Doornbaai, 5/9/64, Hall 2860 (NBG); **(-DA)** 6 ½ miles north of Van Rhynsdorp, 26/7/57, Acocks 19385 (KMG, PRE), Vredendal Veld and plain, 8/10/73, Bayliss BRI.B 569 (PRE), Near Van Rhynsdorp, 23/7/41, Compton 11063 (NBG), Van Rhynsdorp, 3/9/45, Compton 17429 (NBG), Just north of Van Rhynsdorp, 23/7/41, Esterhuysen 5392 (BOL), North of Van Rhynsdorp, 3/9/45, Leighton 1374 (PRE), Knersvlakte, 3 miles north of Van Rhynsdorp, 9/45, Lewis 1736 (SAM), Between Van Rhynsdorp and Klaver, Bidouw River, 26/8/54, Lewis 4558 (SAM), Van Rhynsdorp, Vredendal road, 8/9/49, Maguire 445 (NBG), Van Rhynsdorp, 2/9/57, Maguire 946 (NBG), Near Van Rhynsdorp, 3/9/48, Steyn 20867 (NBG); **(-DB)** Matsikamma valley between Urionskraal and waterfall, 13/8/76, Goldblatt 3840 (PRE); **(-DC)** Heerenlogement, 11/18, Belgrave s.n. (BOL), Heerenlogement, 21/7/41, Esterhuizen 5550 (BOL, GRA, PRE), Near Klawer, on Van Rhynsdorp road, 8/32, Lavis s.n. (BOL).

- 3120 **(Williston):(-AB)** Between Nardouw and Pakhuis, Oumuur, 9/47, L. Bolus s.n. (BOL).

- 3218 **(Clanwilliam):(-BA)** Graafwater, 21/7/41, Bond 1070 (NBG), Near Graafwater, south of Klipfontein Koppe, Rondeklipheuwel A, 9/2/78, Boucher 3618 (PRE); **(-BB)** Clanwilliam, Kanalvlei, 6/9/47, Maguire 1054 (NBG); Langekloof, 6/7/1896, Schlechter 8052 (BOL, PRE); **(-BD)** Clanwilliam, Tierkloof, 14/10/40, Henrici 3343 (PRE).

- **3219 (Wuppertal):(-AA)** Clanwilliam, Bidouw River, 27/8/54, Barker 8422 (NBG).

- 3224 **(Graaf Reinet):(-BC)** 6 miles SSW of Graaf Reinet, 10/1868, Bolus s.n. (BOL), Near Graaf Reinet, Swartrivier, 3/12/50, Willems 727 (NBG).

- 3321 **(Ladismith):(-AD)** Zoar, hills west of settlement, 22/3/76, Thompson 2783 (PRE); **(-BA)** 3,4 miles from Ladismith to Barrydale, 28/9/60, Marsh 1421 (PRE); **(-BC)** Huisriver pass, near Calitzdorp, 23/9/75, Van Breda 4288 (PRE); **(-DA)** Ladismith-Oudtshoorn, Roodeberg Pass, 8/8/49, Maguire 5485 (SAM), Road to Rooiberg Pass, SW of Radleigh, 6/10/71, Thompson 1417 (PRE).

- 3325 **(Port Elizabeth):(-DA)** Redhouse, 23/9/71, Bayliss 4876 (NBG).

Locality unknown

- 3017 **(Hondeklipbaai):(-AD)** Between Hondeklip Bay and Lintjies River, 10/24, Pillans s.n. (BOL).

- **3218 (Clanwilliam):(-BB)** Clanwilliam, Nortier Reserve, 9/46, Leipoldt 4364 (BOL).

- **3319 (Worcester):(-BB)** Bokkeveld, 10/19, Watermeyer s.n. (PRE).

- Between Bergvalley and Kruis, June, Ecklon 1394 (BOL), No locality or date given, Ecklon & Zeyher s.n. (S).

14(c). **J. cuneata** subsp. **hoerleiniana**

- **2715 (Bogenfels):(-AD)** Near Bogenfels, Graniteberg, 8/11, Schafer 15 (PRE); (-BC or -BD) Klinghardtsberge, 27/9/22, Dinter 3947 (BOL, PRE), Klinghardtsberge, 27/9/22, Dinter 3949 (SAM).

Locality unknown

- Namibia, Prince of Wales Bay, 8/11, Schafer s.n. (PRE).

15(a). J. orchioides subsp. orchioides

- **3325 (Port Elizabeth):(-DB)** Uitenhage, November, Ecklon & Zeyher 1392 (S), Uitenhage, November, Ecklon & Zeyher s.n. (S); **(-DC)** 7 miles ENE of Coega, 4/3/48, Acocks 14053 (PRE), Port Elizabeth, Fairview Golf Course, 1/2/33, Long 920 (PRE).

Locality unknown

- **3325 (Port Elizabeth)(-BC or -**BD) Addo Park, 12/2/54, Brynard 334 (PRE), Addo Park, Zuurkop, Liebenberg 7742 (PRE).

- No locality or date given, Ecklon & Zeyher 20 (BOL), No locality or date given, Ecklon & Zeyher s.n. (MEL).

15(b). J. orchioides subsp. glabrata

- **2526 (Zeerust):(-DD)** Panfontein Game Reserve, 9/10/51, Louw 1969 (PRE).

- **2725 (Bloemhof):(-BB)** Just outside Wolmaransstad, farm of J. Liebenberg, 3/32, Liebenberg 3003 (PRE).

- **2726 (Odendaalsrust):(-CD)** 18,7 miles west of Odendaalsrus, 27/2/48, Acocks 14011 (PRE).

- **2727 (Kroonstad):(-CA)** Kroonstad, Farm Laetitia, 12/34, Henrici 2675 (PRE), Kroonstad district, near Vals Rivier, Pont 524 (PRE).

- **2824 (Kimberley):(-DB)** A few miles NW of Kimberley, Vooruitzicht, 3/37, Acocks 1889 (KMG, PRE), Dronfield, 10/36, Hafström & Acocks 905 (BOL, KMG, PRE), 6,5 miles north of Kimberley, 23/9/57, Leistner 833 (KMG, PRE), Dronfield, 3/19, Moran 14 (BOL, KMG, SAM).

- **2825 (Boshof):(-DB)** 9 miles NNE of Dealesville, 27/2/48, Acocks 14013 (PRE).

- **3125 (Steynsburg):(-AC)** Middelburg district, Culmstock, 3/1910, Southey 7941 (PRE).

- **3221 (Merweville):(-BC)** 20 miles NW of Bulwater P.O., 17/3/48, Acocks 14149 (PRE), 29,8km NNW of Bulwater, 30/4/71, Acocks 24556 (PRE).

- **3224 (Graaf-Reinet):(-AC)** SW of Aberdeen, 3/12/50, Maguire 743 (NBG); **(-BC)** Graaf Reinet, October, Ecklon & Zeyher s.n. (MEL).

- **3225 (Somerset East):(-BA)** Cradock, c. 9/1960, Horn s.n. (PRE); **(-BB)** Cradock district, Rietfontein Plantation, 21/3/1900, Sim 5653 (PRE).

- **3321 (Ladismith):(-DA)** Ladismith-Oudtshoorn, Roodeberg Pass, 8/8/49, Maquire 5485 (NBG).

- **3322 (Oudshoorn):(-BB)** Near Kommandokraal, Zondagsrivier, April-May, Ecklon & Zeyher 860 (BOL), Kommandokraal, April-May, Zeyher 860 (SAM); **(-BC)** On road from Humansdorp to Andrieskraal, Drooge Kloof, 12/27, Fourcade 3531 (PRE).

- **3324 (Steytlerville):(-CA)** Baviaanskloof, between Zandvlakte and Studtis, 10/34, Fourcade 5158 (BOL).

- **3325 (Port Elizabeth):(-AD)** Uitenhage, Kirkwood, 30/10/53, Taylor 4161 (NBG); **(-CD)** Uitenhage, 11/1847, Prior s.n. (PRE).

- **3326 (Grahamstown):(-AB)** Between Piggotts Bridge and Hornslow, 1/11/70, Jacot Guillarmod 6902 (GRA, PRE).

- **3421 (Riversdale):(-AA)** Near Corents River, 11/12, Muir 1100 (BOL, PRE).

Locality unknown

- **2725 (Bloemhof):(-CB, -DA)** Bloemhof, S.A. Lombard Nature Reserve, near south boundary, 12/2/59, Leistner 1242 (KMG).

- **3325 (Port Elizabeth):(-BC, -BD)** Addo Park, Korhaan Vlakte, 19/10/51, Archibald 3755 (PRE), Addo, Rhino camp, 17/10/76, Hall-Martin 5602 (GRA), Addo Park, Rhino camp, 13/12/76, Hall-Martin 5712 (PRE).

16. J. thymifolia

- **2722 (Olifantshoek):(-DC)** Top of Langeberg near Olifantshoek Road, Andriesfontein, 18/6/36, Acocks 437 (KMG, PRE), 12 miles NNW of Olifantshoek, Toto Mountain, 27/8/61, Leistner & Joynt

2744 (KMG, PRE), 12 miles NNW of Olifantshoek, in Toto mountains, 3/3/65, Tölken & Hardy 600 (PRE).

- **2822 (Glen Lyon):(-BA)** 8 miles south of Olifantshoek, Langeberg, 22/4/29, Pole-Evans 2493 (PRE); **(-BC)** Dunmurray, 21/3/20, Pole-Evans s.n. (PRE), Dunmurray, slopes of the Langeberge, 27/9/39, Vigne 27 (NH), Dunmurray, 2/23, Wilman s.n. (BOL); **(-BD)** Floradale, 4/40, Esterhuysen 2448 (BOL, PRE); **(-CA)** Gordonia, Dinas Rus, southern Skurweberge, 23/3/59, Leistner 1354 (KMG, NBG, PRE); **(-DA)** Hay, Dunmurray, hills north of Matsap, 2/23, Wilman 2296 (KMG).

- **2823 (Griekwastad):(-DB)** Herbert, Dikbos, above escarpment, 6/37, Acocks 2320 (KMG, PRE).

- **2919 (Pofadder):(-AB)** c. 5 miles north of Pofadder, 16/6/48, Acocks 14399 (PRE).

- **2922 (Prieska):(-DA)** Prieska Commonage, 7/21, Bryant J316 (PRE), Gathead, Waterfall Kloof, 4/35, Bryant 1092 (PRE), Gathead, just north of Orange River, 25/4/36, Bryant 1187 (PRE), Prieska, north of Orange River, 5/36, Bryant 3662 (BOL, KMG).

Locality unknown

- 2428 **(Nylstroom):(-CB or -CD)** Warmbad-Nylstroom road, pass just after Warmbad, 23/1/62, Ihlenfeldt 2008 (PRE).

- **2431 (Acornhoek):(-CB, -DA)** Manyeleti Game Reserve, 23/3/77, Bredenkamp 1808 (PRE), Manyeleti Game Reserve, Sarabank, 8/1/76, Bredenkamp 1437 (PRE), Manyeleti Game Reserve, 10/3/76, Bredenkamp 1502 (PRE).

- 2531 **(Komatipoort)** Between Hectors Spruit and Horo, 8/1/29, Hutchinson 2526 (GRA).

- **2631 (Mababane):(-CB)** Hlatikulu, Usutu Poort, 30/10/61, Compton 30926 (NBG).

- **2732 (Ubombo):(-CB)** Mkuzi Game Reserve, Nkonogolwana Stand 14, 15/3/77, Goodman 933 (NU).

- **3418 (Simonstown):(-BB?)** Sir Lowrys Pass (Note on specimen, "Wrong label?" Outside distribution range for this species), Marloth s.n. (PRE).

- Hay, Excelsior, rocky lower slopes of Langebergen, 7/36, Acocks 485 (KMG), No locality or date given, Drége s.n. (PRE), c. 6 miles from Bulwer Farm on Doornkop road, 10/4/51, Edwards 1925 (NU, PRE), Catembe, 8/19, Junod s.n. (PRE), Kei Valley, northern edge of valley, 18/4/47, Sidey 664 (PRE), Umfolozi River, 7/22, Wager s.n. (PRE), Zululand, 5/08, Wood 10997 (PRE).

17. J. guerkeana

- 2014 (**Welwitchia**):(**-CB**) only grid reference given, 11/6/78, Craven 863 (WIND), Khorixas, Farm Twyfelfontein, Adam & Eve, 13/3/76, P & D Craven 142 (WIND).

- 2217 (**Windhoek**):(**-BC**) Windhoek, Farm Bodenhaüsen, Kamp I, 12/3/59, Seydel 1819 (WIND); (**-CD**) Windhoek, Farm Rietfontein-Binsenheim (WIN 85), 27/3/63, Leippert 4429 (WIND).

- 2218 (**Gobabis**):(**-AD**) Eskadron, Witvlei, 20/1/70, Mason 2620 (PRE), Around Witvlei, 12/55, Basson 96 (PRE, WIND), Gobabis, Farm Grünental, 14/1/58, Merxmüller & Giess 1235 (PRE, WIND); (**-BC**) Near Gobabis, Klein Witvley, fairly common in this district, 1/21, Gillman 106 (PRE, SAM).

- 2316 (**Nauchas**):(**-BA**) Rehoboth, Farm Naos, 10/3/53, H & E Walter 1654 (WIND); (**-CA**) Farm Ubib (REH 39.6), 21/8/72, Merxmüller & Giess 28124 (PRE, WIND); (**-DD**) Groendoorn, 1931, Ortendahl 365 (PRE).

- 2317 (**Rehoboth**):(**-AC**) Rehoboth, 10/4/11, Dinter 2180 (SAM); (**-BC**) Farm Gravenstein (REH 65), 30/3/56, Volk 11623 (WIND); (**-DB**) Farm Uhlenhorst, 3/3/56, Volk 11623 (PRE).

- 2318 (**Leonardville**):(**-DD**) Stampriet road, 22/5/73, Bayliss BRI.B 347 (PRE).

- 2415 (**Sossusvlei**):(**-BB**) Abendruhe, NE of Sossusvlei, 11/5/76, Oliver, Müller & Steenkamp 6558 (PRE).

- 2416 (**Maltahohe**):(**-AB**) Büllsport, 5/4/11, Dinter 2134 (SAM); (**-AC**) Maltahöhe, Farm Felseneck (MAL 124), Naukluft, Distelschlucht, 15/2/63, Leippert 4863 (WIND), Lemoenputs, 16/5/78, Müller & Tilson 905 (PRE); (**-AD**) Rehoboth, Farm Berghoek, 23/2/54, Giess 1811 (WIND); (**-CB**) Maltahöhe, Farm Friedland, 18/3/53, H & E Walter 1909 (WIND); (**-CD**) Maltahöhe, in the Zaries Mountains, 5/56, Basson 206 (PRE), Maltahöhe, Farm Bergplaas (MAL 125), 21/5/65, Giess 8834 (PRE, SAM, WIND).

- 2417 (**Mariental**):(**-BB**) 13,4 miles south of Kalkrand on road to Mariental, 10/5/55, De Winter 3492 (PRE, WIND), Farm Twilight (GIB 113), 3/3/63, Giess, Volk & Bleissner 5637 (PRE, WIND); (**-BC**) Farm Narib (GIB 106), 3/3/63, Giess, Volk & Bleissner 5607 (PRE, WIND); (**-DA**) Farm Haribes (GIB 18/19), 4/56, Volk 12223 (WIND).

- 2516 (**Helmeringhausen**):(**-DD**) Bethanien, Farm Helmeringhausen, 20/4/49, Kinges 2178 (PRE).

- 2518 (**Tses**):(**-AA**) Farm Goamus (GIB 70), 7/1/65, Giess 8235 (PRE, WIND).

- **2519 (Koes)**:(-CC) NE of Koës, Kalkrand, 23/1/65, Giess 8354 (PRE); 14 miles east of Koës, 9/4/60, Leistner 1797 (KMG, PRE).

- 2616 **(Aus)**:(**-BB**) Bethanien, Farm Chamis-sud, 25/3/53, H & E Walter 2171 (WIND).

- **2617** (**Bethanie**):(**-CD**) Seeheim, Sandverhaar, 16/1/10, Dinter 1201 (SAM).

- **2618 (Keetmanshoop)**:(-DA) 26,5 miles east of Keetmanshoop on road to Aroab, 7/5/55, De Winter 3465 (PRE, WIND).

- **2619 (Aroab)**:(**-AA**) 13 miles SE of Köes, 15/10/49, Acocks 15597 (PRE); **(-AB)** Farm Morgenzon North (KEE 219), Barnard 122 (PRE, WIND); (**-CB**) 12,5 miles west of Aroab on road to Keetmanshoop, De Winter 3465 (PRE).

- 2717 **(Chamaites)**:**(-CA)** South of Farm Uitzig (LV 82), Hunsberg, Nuab River, Staatsgebied, 9/6/76, Giess & Müller 14317 (PRE); (**-DA**) Farm Hobas (WAR 374), 30/5/72, Giess & Müller 12294 (PRE), Fish River Canyon, by river, 30/3/53, Walter 2266 (WIND).

- **2819 (Ariamsvlei)**:**(-CC**) Pella, on road to Orange River, 10/4/69, Meyer 217 (PRE).

18. **J. platysepala**

- **1712** (**Posto Velho**):**(-BC)** Otjihipa Mountains, 8/7/59, Davies, Thompson & Miller 83 (WIND).

- **1713** (**Swartbooisdrif**):**(-AC)** NW end of Omuhonga Mountains, 16/7/76, Leistner, Olivier, Steenkamp & Vorster 207 (PRE); **(-DA)** East of Epembe, 27/3/74, Merxmüller & Giess 30600 (PRE, WIND).

- 1714 **(Ruacana Falls)**:**(-AC**) 6km from Ruacana on road to Ruacana Falls, 3/75, Vahrmeijer & du Preez 2632 (PRE).

- **1813 (Ohopoho)**:**(-BB)** About 6 miles west of Ohopoho, 28/3/57, De Winter & Leistner 5235 (PRE, WIND), 3,5 miles north of Ohopoho, 29/3/57, De Winter & Leistner 5252 (PRE), Okorosawa, 27/1/58, Merxmüller & Giess 1385 (PRE), 15 miles east of Ohopoho, 31/1/58, Merxmüller & Giess 1497 (WIND), Ohopoho, 22/12/40, Smuts & Pole Evans 2247 (PRE).

- **1814 (Otjitundua)**:**(-CA**) On road between Ohopoho and Otjovasandu, Okahozu, foot of Kranseberg, 20/6/60, Giess 3169 (PRE, WIND).

- **1816 (Namutoni)**:**(-DD)** Klein Namutoni, 2/19, Breyer s.n. (PRE).

- 1913 **(Sesfontein):(-DD)** Farm Juries Draai (OV 709), 18/4/64, Giess 8086 (WIND).

- **1914 (Kamanjab):(-AB)** Etosha Park, 7 miles NW of Otjovasandu, 12/4/67, Joubert D25 (WIND); **(-AD)** Otjovasandu, Etosha Park, 29/4/75, Le Roux & Jankowitz 1469 (WIND); **(-BC)** Grootberg Plateau, 2/4/77, Lavranos & Barod 15330 (WIND), Kaross, 21/1/53, Schweidtfeger 1/245 (WIND); **(-BD)** Farm Helaas, border road between Etosha Pan and Outjo, 24/1/58, Merxmüller & Giess 1339 (PRE); **(-DB)** Kamanjab granite hills, 22/3/57, De Winter & Leistner 5134 (PRE, WIND), Outjo, Farm Franken, Hausberg, 19/3/53, Schwerdtfeger 2/142 (WIND).

- **1915 (Okaukuejo):(-BB)** 4 miles SW of Okaukuejo, 2/75, Le Roux 1256 (WIND), Etosha Park, 5 miles west of Okaukuejo, 3/67, Tinley 1572 (WIND); **(-CA)** Farm Winkelhaak (OU 286), 16/3/74, Merxmüller & Giess 30346 (PRE).

- **1916 (Gobaub):(-AA)** Etosha Park, by Kapupahedi, 23/2/76, Giess & Müller 13996 (PRE, WIND); (-**BA**) By Halali, 30/1/69, Giess & Smook 10584 (PRE, WIND), Halali, 23/5/72, Schmidt 304 (WIND).

- 2015 **(Otjihorongo):(-BB)** 16,9 miles west of Outjo on road to Fransfontein, 4/4/55, De Winter 3043 (PRE, SAM, WIND), Farm Straussenheim (OU 134), 26/3/63, Giess, Volk & Bleissner 6001 (WIND).

- 2016 **(Otjiwarongo):(-AA)** Outjo, 3/1891, Rautanen s.n. (WIND), Outjo, Grootberg, 1953, Schweidtfeger s.n. (WIND).

- **2115 (Karibib):(-DC)** Erongo Mountains, Davib Ost Farm, 15-16/3/80, Craven 1142 (WIND), Farm Ameib (KAR 60), Teufelskanzel and surrounding area, 20/3/63, Giess, Volk & Bleissner 5863 (PRE, WIND), Farm Ameib, north of Usakos, near Phillips Caves, 14/3/64, Hardy & De Winter 1425 (PRE), Ameib, New Camp, 3/71, Jensen 1443 (WIND), c. 5km east of Ameib farmhouse on track to Karibib, 23km NNE of Usakos, 19/4/68, Wanntrop 965 (PRE); **(-DD)** Karibib, 4/48, Keet 1609 (PRE, WIND).

- **2116 (Okahandja):(-AA)** 21 miles from Omaruru on road to Otavi, 20/3/65, Tölken & Hardy 744 (PRE, WIND).

- **2216 (Otjimbingwe):(-AA)** Farm Otjozondu (KAR 36), SW slope of Kuduberge, 6/6/61, Giess 3471 (WIND); **(-AB)** Farm Westfalenhof (Wilhelmstal), 12/5/53, Schwerdtfeger 2/338 (WIND), Okomitundu, 14/3/57, Seydel 933 (PRE).

- **2316 (Nauchas):(-DD)** SWA, Groendorn, 8/6/31, Ortendahl 365 (BOL).

- 2318 **(Leonardville):(-AD)** Jakhalswater, Boss A46 (PRE)

- 2718 **(Grunau):(-BC)** Groot Karas Mountains, Kreikloof, 25/6/31, Ortendahl 492 (BOL).

Locality unknown

- Etosha National Park, west of Grootvlakte, at Buschstreyfen, 27/3/63, Giess, Volk & Bleissner 6049 (WIND), Etosha, Rhenosterkom, 25/4/74, Le Roux 845 (PRE, WIND), Etosha Park, C. Marais dam, Le Roux 1357 (WIND), Etosha Park, Miernes, 4/75, Le Roux 1511 (WIND), Etosha Park, south boundary, Hestria, 30/5/75, Le Roux 1712 (WIND), SWA, Gurumanas, 7/1/16, Pearson s.n. (BOL).

19. J. minima

- 2428 **(Nylstroom):(-CB)** 9 miles north of Warmbaths, in Waterberg, 27/11/47, Sidey 1329 (PRE), c. 6 miles from Nylstroom on Naboomspruit road, 17/10/56, Meeuse 9736 (PRE), Waterberg above Warmbaths, 1/1/36, Smuts & Gillett 3314 (PRE); **(-CC)** 13,2 miles NW of Warmbaths, Acocks 23569 (PRE); **(-CD)** 9 miles north of Warmbaths on road to Nylstroom, on Waterberg range, 3/12/47, Codd 3448 (PRE), Near Vyeboom, Shangri-Ra Guest Farm, 7/54, Meeuse 9334 (PRE), Near Warmbaths, Waterberg, 16/1/37, Repton 793 (PRE), Hilltop north of Warmbaths, 20/12/35, Smuts & Gillett 3092 (PRE).

Locality unknown

- **1914 (-CB or -BC)** Between Kaientes & Kaross, 3/25, Thorne s.n. (SAM).

- Schaapsrivier, 5/3/11, Dinter 1911 (SAM), Between Windhoek and Walfish Bay, 1918, Esdaile s.n. (BOL, PRE), SWA, 4/5/13, Range ?1687 (SAM), Fish River Canyon, 30/3/53, Walter 2242 (WIND).

20. J. anagalloides

- 2229 **(Waterpoort):(-DD)** Wylies Poort, 10/38, Lanjouw 937 (PRE).

- 2230 **(Messina):(-DC)** About 4 miles south of Lake Funduzi, 16/11/54, Meeuse 9406 (PRE).

- 2231 **(Pafuri):(-AC)** Kruger National Park, Shahulu fountain, 10/7/60, Brynard & Pienaar 4492 (PRE).

- 2328 **(Baltimore):(-BB)** Pietersburg, Leipzig, Blaauwberg, 17/1/31, Bremekamp & Schweikerdt 69 (PRE).

- 2329 **(Pietersburg):(-CD)** Pietersburg, Houtbosch, 2/04, Bolus s.n. (BOL, NH, PRE, SAM); **(-DD)** Hills near Haenertsburg, 20/10/38, Hafström & Acocks 1390, 1391 (PRE), Haenertsburg, Mogg s.n. (PRE), Haenertsburg, 11/13, Pott 4777 (PRE).

- 2330 **(Tzaneen)**:(-CA) Westfalia Estate, eastern face of Piesangkop, 9/10/59, Scheepers 717 (PRE); **(-CC)** Woodbush, Mountain Home Farm, 18/12/35, Mogg 13988 (PRE), Woodbush Village, 8/12/07, Swierstra s.n. (PRE).

- 2428 **(Nylstroom)**:**(-BC)** Sterkrivier Dam Nature Reserve, 9/2/72, Jacobsen 1995 (PRE); **(-CC)** Warmbaths, 2/10/38, Hafström & Acocks 1387 (PRE); **(-CD)** Warmbaths, 30/9/08, Leendertz s.n. (PRE); **(-DA)** Naboomspruit, Mosdene, 3/3/19, Galpin M275 (PRE), Naboomspruit, 13/12/34, Galpin 13482 (PRE), Naboomspruit, (mixed gathering), 13/12/34, Galpin s.n. (PRE).

- **2429 (Zebediela)**:**(-AC)** About 10 miles from Potgietersrust on road to Zebediela, 15/12/54, Meeuse 9493 (PRE); **(-BA)** Near Chuniespoort, Donkerkloof, 14/3/74, Vahrmeijer 2412 (PRE).

- **2430 (Pilgrims Rest)**:**(-AB)** Shiluvane, 3-5/1905, Junod 5281 (PRE), Pretoriuskop, 18/11/52, Van der Schijff 1329 (PRE); **(-DC)** Ohrigstad Nature Reserve, 19/11/70, Jacobsen 1307 (PRE), Ohrigstad Dam Nature Reserve, 9/11/71, Jacobsen 1770 (PRE); **(-DD)** Graskop Spruit, 3/12/37, Galpin 14583, 14584 (PRE), Graskop Spruit, 13/12/34, Galpin s.n. (BOL), Between Kouwyns Pass and Sabie Bridge, 3/12/35, Gillett 1024A (PRE).

- **2431 (Acornhoek)**:(-CB) Manyeleti Game Reserve, 3/3/77, Bredenkamp 1730 (PRE); **(-DA)** Manyeleti Game Reserve, Dixie koppie, 21/2/77, Bredenkamp 1664 (PRE).

- **2526 (Zeerust)**:**(-CA)** Zeerust, 1/12, Leendertz s.n. (PRE); **(-CC)** Lichtenburg, Grasfontein, 8/12/29, Sutten 320 (PRE, SAM).

- **2527** (**Rustenburg**):**(-BB)** Klipvoor Dam, 8/1/78, Peeters, Gericke & Burelli 656 (PRE); **(-CA)** Rustenburg, NE of town, no date given, Nation 152 (BOL); **(-CB)** 20km from Rustenburg on road to Pretoria, Farm Waagfontein, on mountain side of road, 5/11/71, Coetzer 96 (PRE); **(-DA)** Near Woluterskop, 12/3/54, Meeuse 9275 (PRE).

- 2528 **(Pretoria)**:(-AD) 6 miles south of Hammanskraal, 9/12/47, Codd 3470 (PRE); **(-CA)** Near Pretoria, 10/1886, Bolus 9724 (BOL), Near Pretoria, Apies River, 2/04, Bolus 10844 (BOL, GRA), Pretoria, Prinshof, 6/2/36, Chippendall 223 (PRE), Pretoria, Wonderboom South, south facing slope of Magaliesberg in line with 19th Avenue, 14/11/69, Coetzee 10 (PRE), Pretoria, Waterkloof, 30/10/43, Fairall 1578 (NBG), Pretoria, Muckleneuk, 15/9/30, Goossens 79 (PRE), Pretoria, Eloffsdal, Erf 61, 3/12/71, Hanekom 1662 (PRE), Pretoria, Schanzkop, 20/1/29, Leemann s.n. (PRE), Pretoria, Koppies, 28/9/04, Leendertz 308 (GRA, PRE), Prinshof, Liebenberg 3230 (PRE), Pretoria, Hatfield, Schagen, 19/11/34, Liebenberg 3244 (PRE), Pretoria, Daspoort, 29/9/15, Mogg A11502 (PRE), Pretoria, Brooklyn, 26/11/31, Mogg 16608 (PRE), Pretoria, Union Buildings grounds, 10/17, Mogg s.n. (PRE), Pretoria, 23/11/19, Phillips 3060 (PRE), Premier Mine, 28/10/19, Phillips 3125 (PRE), Pretoria, Fountains Valley, 17/10/28, Repton 26 (PRE), Fountains Valley, 24/1/29, Repton 199 (PRE), Pretoria, Hornneck, north slopes of Magaliesberg, 7/11/37, Repton 1112 (NH, PRE), Pretoria, Magaliesberg, 9/1/61, Schlieben & Strey 8459 (PRE), Pretoria, hillsides west of Groenkloof, 13/9/25, Smith 611 (PRE), Pretoria, commonage near Riviera Public School, 12/10/25, Smith 848 (PRE), Pretoria, Bryantirion, between Government House and Old Fort, 14/11/26, Smith 3342 (PRE), Pretoria, Waterkloof, 25/10/20, Verdoorn 132 (PRE), **(-CB)** Pretoria, National Botanic Gardens, 11/74, Drijfhout 946 (PRE); **(-CC)** Pinedene, 27/10/04, Burtt Davy 2304 (SAM), Irene, Doornkloof, 2/1/29, Hutchinson 2384 (BOL), About 2 miles from Fountains on Delmas road, 21/10/54, Meeuse 9371 (PRE), Fountains, 11/29, Nouhuys & Obermeyer s.n. (SAM), Transvaal, Mooifontein, 23/10/93, Schlechter 3565 (BOL, GRA, PRE, SAM), Fountains Valley, 22/10/28, Verdoorn 521 (PRE); **(-CD)** 20 miles SE of Pretoria on road to Delmas, 3/2/47, Codd 2573 (PRE), Garsfontein and surrounding area, 2/77, Liebenberg 8680 (PRE), Pretoria, Rietvlei Reserve, 12/10/46, Repton 3134 (PRE), Faerie Glen, 27/11/71, SAAB 3/13 (PRE), Faerie Glen, 27/11/71, SAAB 4/27 (PRE), Faerie Glen, Oregon Road 474-488, SAAB 2/57 (PRE), **(-DA)** 15km NE of Cullinan on road to Sybrandskraal, 27/1/74, Davidse 5991 (PRE), Premier Mine, 12/19, Rogers 25231 (GRA).

- 2529 **(Witbank):(-AD)** Loskop Dam, hill west of Scheepersloop, 19/12/66, Theron 845 (PRE); **(-CB)** Near Middelburg, Klein Oliphants River, 6/11/33, Young A81 (PRE); **(-CC)** Witbank, Sondagsfontein, 12-3/1930-31, Thode A2853 (NH, PRE); **(-CD)** Middelburg, 11/10, Jenkins s.n. (PRE).

- 2530 **(Lydenburg):(-AB)** Western Steenkampsberg, Boschhoek, 16/11/33, Young A400 (PRE), Near Lydenburg, Farm Zwagershoek, 1/30, Obermeyer 337 (PRE), Near Lydenburg, Wilms 1201 (PRE); **(-BA)** c. 9 miles SE of Lydenburg, De Kuilen Farm, 7/12/75, Anderson A101, 102 (PRE); **(-BC)** Wonderkloof Nature Reserve, 18/11/74, Elan-Puttick 180 (PRE), Wonderkloof Nature Reserve, top of escarpment, 17/11/78, Kluge 1407 (PRE); **(-BD)** Nelspruit, 12/17, Breyer s.n. (PRE), Lowveld Botanic Garden, garden side, 16/10/69, Buitendag 213 (PRE, SAM), Witklip Forestry Station, 24/10/73, Kluge 276 (PRE), Witklip Forestry Station, 21/2/74, Kluge 496 (PRE), Nelspruit Horticultural Station, 14/11/36, Penny s.n. (PRE); **(-CA)** Belfast, 1/1909, Jenkins s.n. (PRE), Barberton, Russells Beacon, Fairview mine, 22/10/65, Mauve 4425 (PRE), Machadodorp, 25/11/32, Galpin s.n. (BOL), Waterval Boven, 1/10/05, Rogers 268 (GRA, PRE); **(-CB)** Belfast district, near Helvetia, 13/11/33, Young A265 (PRE); **(-DD)** Cythna Letty Nature Reseve, Edwards 4099 (PRE).

- 2531 **(Komatipoort):(-AA)** Shabeni, 14/1/53, Van der Schijff 1572 (KNP, PRE); **(-AB)** Pretoriuskop, 9/9/52, Van der Schijff 440 (KNP, PRE), Pretoriuskop, east of rest camp, 10/2/53, Van der Schijff 2056 (KNP, PRE); **(-AC)** White River, 9/19, Rogers

23485 (NH); **(-AD)** Komati Bridge, 22/5/57, Schirach s.n. (SAM); **(-BD)** Komatipoort, 9/13, Rogers 12950 (PRE); **(-CA)** 17 miles from Nelspruit on road to Kaapmuiden, 18/12/64, Burtt & Scheepers 2936 (PRE); **(-CC)** Barberton, upper slopes of Saddleback, 11-12/1889, Galpin 682 (BOL, NH, PRE, SAM), Havelock Mine, 10/55, Miller 3060 (PRE), Havelock Mine, 3/58, Miller 5201 (PRE), Barberton, 9/09, Williams s.n. (PRE).

- **2626 (Klerksdorp):(-AC)** Lichtenburg, Hakboslaagte, 12/11/48, Kinges 1963 (PRE).

- **2627 (Potchefstroom):(-BA)** Sterkfontein Caves and Zwartkrans 67, 26/12/69, Mogg 34654 (PRE); **(-BB)** Florida, 22/1/06, Hutton 626 (GRA); (-CA) Potchefstroom, Klington, 31/10/39, Goossens 1636 (PRE), Potchefstroom, Boskop, 15/10/39, Louw 389 (PRE), Road from (Potchefstroom?) to Witkoppiesfontein, Zandfontein, 7/12/76, Ubbink & Van Wyk 549 (PRE), Potchefstroom, Dassierand, 4/12/39, Van der Westhuizen 816 (PRE); **(-CC)** Oudedorp, 4/11/76, Botha & Ubbink 1761 (PRE); **(-DB)** Vereeniging, Leeuwkuil Pasture Research Station, 3/11/35, Story 32 (PRE).

- 2628 **(Johannesburg)**:(-AA) Johannesburg, Turffontein, 29/3/19, Bryant D31 (SAM), Johannesburg, Bryant s.n. (PRE), Johannesburg, Elandsfontein, 11/1890, Galpin s.n. (GRA), Near Johannesburg, Elandsfontein, 11/1896, Gilfillan s.n. (PRE), Johannesburg, 11-12/1898, Gilfillan s.n. (PRE), Bryanston, 25/11/54, Gilliland s.n. (PRE), Modderfontein, 28/1/0/52, Gilliland s.n. (BOL), Frankenwald, 8/12/39, Gluckmann s.n. (PRE), Johannesburg, 1/15, Holden s.n. (PRE), North of Rivonia, 6/4/48, Prosser s.n. (NBG, PRE), Johannesburg, 12/2/09, Rogers 1362 (PRE), Germiston, 12/13, Rogers 2169 (BOL); **(-AB)** Benoni, 16/9/34, Bradfield T191 (PRE), Kaalfontein, 14/11/17, Pole-Evans s.n. (PRE); **(-AD)** Suikerbosrand, Boschfontein, 2/12/72, Bredenkamp 884 (PRE), Heidelberg, 23/11/09, Leendertz s.n. (PRE); **(-CA)** Suikerbosrand, Wolwekloof, 27/12/72, Bredenkamp 1008 (PRE), Suikerbosrand Nature Reserve, 11/3/70, Lambrecht 117 (PRE); **(-CB)** Suikerbosrand, Sedaven, 6/11/71, Bredenkamp 222 (PRE).

- **2629 (Bethal):(-AC)** Bethal, Vaalbank, 15/1/24, Webb 13 (SAM); **(-DB)** Ermelo, 1/09, Collins s.n. (PRE), Ermelo, Farm Nooitgedacht, 22/10/26, Henrici 1087 (PRE), Ermelo, Nooitgedacht 10, 12/26, Henrici 1322 (PRE, SAM).

- **2630 (Carolina):(-AA)** Carolina, 18/10/32, Galpin 12482 (PRE), Carolina, 18/10/32, Galpin s.n.; **(-AD)** Near Lothair, 1/11/74, K.D. Gordon-Gray s.n. (NU); **(-BB)** Lochiel, 1/14, Rogers 11511 (BOL); **(-CA)** Ermelo, March, Burtt-Davy 17422 (GRA), Mavieriestad, 11/15, Pott s.n. (PRE); **(-CB)** Ermelo, Athole Pasture Research Station, 14/11/35, Norval 34 (PRE); **(-CD)** Ermelo, Nooitgedacht Research Station, 19/1/76, Balsinhas 2893 (PRE); (**-DC**) Iswepe, 12/11/49, Sidey 1945 (PRE).

- **2631 (Mbabane):(-AC)** Mbabane, 1/05, Burtt-Davy 2871 (BOL), Mbabane, 1/1/02, Burtt-Davy 5042 (PRE), Mbabane, 15/1/51, Compton 22376 (SAM), Mbabane, 5/2/52, Compton 23256 (NBG), Mbabane, 20/12/52, Compton 23769 (SAM), Ukutula, 24/10/54, Compton 24569 (SAM), Mbabane, Ukutula, 24/11/54, Compton 24735 (NBG, PRE), Mbabane, Ukutula, 18/11/55, Compton 25254 (PRE, SAM), Mbabane, Poliniane River, 27/9/62, Dlamini s.n. (SAM), Near Mbabane, The Caves, 19/1/64, Hilliard 3089 (NU); **(-BD)** Stegi, Palala, 11/1/62, Compton 31201 (SAM), Top of Lebombo Mountains, near Umbeluzi Beacon, south bank of Umbuluzi Poort, 6/9/76, Culverwell 0200 (PRE); **(-CA)** Near Mankaiana, 27/10/60, Compton 30209 (SAM).

- **2632 (Bela Vista):(-AA)** 3 miles NW of Goba/Mhlumeni borderpost, Lebombo Mountains, south of Umbeluzi Gorge, Blue Jay Ranch, 2/10/77, Culverwell 1004 (PRE); **(-AC)** 5 miles SW of Mhlumeni/Goba borderpost, Lebombo Mountains, Mlawula, 28/5/77, Culverwell 818 (PRE); **(-CD)** Ndumu Game Reserve, 5/11/69, Moll 4298 (NH, PRE), Ndumu Game Reserve, Ndumu Hill, 22/12/71, Pooley 1588 (NU, PRE).

- **2730 (Vryheid):(-BB)** Near Piet Retief, 13/1/51, Compton 22355 (SAM), Piet Retief, 4/11/62, Devenish 921 (PRE), Piet Retief, 7/10/29, Galpin 9867 (PRE); **(-CB)** Utrecht, 10-11/27, Thode A1294 (NH, PRE), Utrecht, 10/27, Thode s.n. (NH), 3 miles (from Utrecht) on road to Pietersburg, 10/1/67, Venter 3143 (PRE).

- **2732 (Ubombo):(-AA)** 1 mile SW of Ingwavuma, 22/11/69, Moll 4663 (NH, PRE); **(-AC)** Jozini Pass, 12/2/76, Brenan 14202 (PRE).

- **2831 (Nkandla):(-CB)** Melmoth, 1/9/31, Forbes 741 (NH), Eshowe, 2/11/49, Lawn 1299 (NH); **(-DC)** Nkwaleni Valley, 13/3/49, Lawn 370 (NH), Umhlatuzi Valley, 29/5/49, Lawn 741 (NH).

- 2832 (Mtubatuba):(-AA) Hluhluwe Game Reserve, Esangweni, 4/11/71, Hitchins 538 (PRE), Hluhluwe Game Reserve, 27/10/53, Ward 1620 (PRE); **(-AB)** Hluhlulwe Reserve, along the road to the graph, 11/65, Wearne 54 (NH, PRE); **(-CC)** Richards Bay, 21/2/51, Lawn 1880 (NH).

Locality uncertain

- **2530 (Lydenburg)** Schoonoord, 8/1/39, Barnard & Mogg 891 (PRE).

- **2630 (Carolina):(-A or -B)** between Carolina and Swaziland, Highveld, 12/1905, Bolus 12213 (BOL, PRE).

- **2731 (Louwsburg):(-AC, -AD, -CA, -CB)** Itala Nature Reserve, Craigadam Farm, 3/1/77, McDonald 356 (NU).

- 2732 **(Ubombo):(-CA, -CB)** Mkuzi Game Reserve, Nganikomo (Stand 64), 13/3/77, Goodman 914 (NU).

- Kruger National Park, Kingfisherspruit, 3/75, Gertenbach 5029 (KNP), Viljoens Drift, 22/1/12, Rogers 13115 (PRE), Zululand, Ntondweni, 7/12/03, Wood 9286 (NH, PRE), Soutpansberg, 2/19, Junod 4336 (PRE), 30 miles north of Nelspruit, 11/56, Miller 3873 (PRE), Witwatersrand, 4/1895, Hutton s.n. (GRA), Swaziland, 9/1910, Stewardt s.n. 11/1890, (PRE), Transvaal, no date given, McLea s.n. (BOL).

21. J. crassiradix

- 1725 **(Livingstone):(-CC)** Eastern Caprivi Zipfel, near Kazungula, Kakumba Island, 17/1/59, Killick & Leistner 3417 (PRE, WIND).

22. J. anselliana

- 1715 **(Ondangua):(-BD)** 25km SE of Oshikango, near Oshandi, 19/3/73, Rodin 9102 (PRE); **(-CB)** Ogongo Agricultural College, 21/2/78, Van Jaarsveld 2951 (SAM).

- 1716 **(Enana):(-CC)** Ondangua, Onipa, 6/2/66, Soini 100 (WIND), Ondangua, Onipa, 22/2/67, Soini 442 (WIND).

- 1719 **(Runtu):(-DD)** Between Runtu and Mupini, 31/1/56, Marais 1120 (PRE).

- 1723 **(Singalamye):(-DC)** Caprivi Strip, east of the Kwando River, 10/45, Curson 1016 (PRE).

- 1816 **(Namutoni):(-AB)** 50,6 miles north of Namutoni on road to Ondangua, 4/2/59, De Winter & Giess 6841 (PRE, WIND), c. 40 miles SE of Ondangua on sand road to Namutoni, at Omuramba Ovambo, 13/2/59, De Winter & Giess 6992 (PRE, WIND).

- 1821 **(Andara):(-AB)** Andara, near rest camps, 10/3/58, Merxmüller & Giess 2044 (PRE, WIND); **(-BA)** Bagoni Camp, 19/1/56, De Winter 4323 (PRE, WIND).

- 1823 **(Siamsisso):(-AB)** Near Kurando Hunters Camp, 23/1/78, Smith 2214 (PRE); **(-DB)** Chobe National Park, Tsantsarra Pan, 22/1/78, Smith 2189 (PRE).

- 1917 **(Tsumeb):(-CB)** Otavi, 1/2/25, Dinter 5523 (BOL, PRE, SAM); **(-DA)** Farm Kaiserfeld (GR 758), 2/4/65, Giess 8565 (PRE, WIND), 11 miles from Otavi on road to Grootfontein, 2/4/65, Tölken & Hardy 918 (PRE).

- 1923 **(Maun):(-AD)** Moreni Wildlife Reserve, 22/1/73, Smith 366 (PRE); **(-BC)** Moreni Wildlife Reserve, edge of Maxara Pan, 5/3/76, Smith 1618 (PRE); **(-CA)** Island, Boro floodplain, 14/1/74, Biggs M506 (PRE); **(-CD)** Maun, c. 350 yds. from river, 5/4/67, Lambrecht 141 (PRE).

- **2017 (Waterberg):(-AC)** Waterberg, mountain slope by police station, 28/4/63, Giess, Volk & Bleissner 6566 (WIND), Along the track at Waterberg, 27/4/63, Kers 458 (WIND); **(-AD)** Farm Hohensee (Otjahevita) OTJ 304, by spring on slopes of Waterberg, above farmhouse, 8/5/67, Giess 10153 (PRE); **(-CA)** Rocky terrace at SW point of Omuverume plateau, 22/4/71, Rutherford 353 (WIND), lower SE slops of Omuverume plateau, 25/4/71, Rutherford 394 (WIND).

- **2023 (Kwebe Hills):(-AB)** Xanakuna-Moshu Road, 11/12/74, Smith 1215 (PRE); **(-BA)** 17km SE of Maun, Botletle River, Samadupe drift, away from river, 23/1/72, Biegel and Russell 3732 (PRE).

- **2116 (Okahandja):(-BB)** c. 2 miles north of Sukses, 22/4/63, Kers 334 (WIND); **(-DB)** Okhandja, Farm Erichsfelde, 3/56, Volk 11915 (WIND); **(-DD)** Ohahandja, Ohahango, 20/3/1907, Dinter 476 (PRE, SAM).

- **2117 (Otjosondu):(-AA)** Quickborn, 1928, Bradfield 188 (PRE); **(-CA)** Okakango, 3/1907, Dinter 476 (GRA, SAM); **(-CD)** Otjosondu, Farm Schoongelegen (WIN 152), 12/3/61, Seydel 2672 (WIND).

- **2217 (Windhoek):(-BD)** 60 miles east of Windhoek on road to Gobabis, Farm Omitara, 25/2/55, De Winter 2518 (PRE, SAM, WIND).

- **2229 (Waterpoort):(-DD)** Wylies Poort, 17/12/28, Hutchinson 2083 (PRE), Msekwas Poort, north of Wylies Poort, 26/1/54, Meeuse 9201 (PRE).

- **2230 (Messina):(-AC)** Messina, 3/18, Rogers s.n. (PRE).

- **2231 (Pafuri):(-AC)** Kruger National Park, Shahulufontein, 10/7/60, Brynard & Pienaar 4492 (KNP); **(-AD)** Pafuri, Mutale outpost, 5/77, Nel 7041 (PRE), Pafuri, ridge by hippo pool, 18/2/54, Van der Schijff 3570 (KNP, PRE); **(-CA)** 10 miles NE of Punda Maria, 20/1/53, Acocks 16773 (PRE), Near Punda Maria, west of Pafuri Rest Camp, 19/4/50, Bruce 202 (PRE).

- **2326 (Mahalapye):(-BB)** Mahalapye, beside road, 16/3/77, Camerick 103 (PRE).

- **2327 (Ellisras):(-BC)** 3 miles NW of P.O. Monte Christo, Farm Newlands, 16/5/51, Codd 6593 (PRE).

- **2428 (Nylstroom):(-CD)** Warmbaths, 1/09, Leendertz 2072 (PRE).

- **2431 (Acornhoek):(-DD)** Around Leeuwpan, 18/1/53, Acocks 16748 (PRE), Tshokwane, Leeupan, 18/1/53, Van der Schijff 1804 (KNP).

- **2528 (Pretoria):(-AB)** Pienaarsriver, 18/5/68, Vahrmeijer 1783 (PRE); (**-AD)** Hammanskraal, 16/1/1894, Schlechter 4203 (BOL, PRE, SAM).

Locality uncertain

- **1715 (Ondangua)**:(-BD?) Odibo, 12/4/73, Rodin 9255 (WIND).

- Okanjande, 1/4/09, no collector's name (BOL); between Pietersburg and Bochem, 30/5/53, Esterhuizen 21411 (BOL).

Siphonoglossa

1(a). **S. leptantha** subsp. **leptantha**

- 2831 (**Nkandla**):(-**DC)** Mtunzini, Ngoye Forest, 6/2/63, Huntley 235 (PRE).

- **2931 (Stanger):(-CA)** Inanda, Hawaan Forest, 20/4/66, Moll 3212 (PRE).

- **3030 (Port Shepstone):(-CB)** 1 ½ miles SE of Mehlomnyama, 16/3/55, Codd 9359 (PRE), Port Shepstone, Holgate's Farm Paddock, 20/12/65, Strey 6191a (PRE); **(-CC)** Umtamvuna Nature Reserve, 9/10/82, Abbott 331 (PRE), Umtamvuna Reserve, 26/10/73, Nicholson 1340 (PRE); Umtamvuna River Reserve, 22/4/79, Nicholson 1958 (PRE); **(-CD)** Uvongo River, 14/4/71 Nicholson 1022 (PRE).

- **3126 (Queenstown):(-DD)** Queenstown, Gwatyn, Junction Farm, 17/11/11, Galpin 8156 (PRE).

- **3129 (Port St Johns):(-CC)** Coffee Bay, 20/2/66, Wells 3511 (PRE); **(-DA)** Port St Johns, 2/4/99, Galpin 2835 (PRE), Port St Johns, Schönland 3998 (PRE), Port St Johns, 2/21, Wager s.n. (PRE).

- 3130 **(Port Edward):(-AA)** Umtamvuna Reserve, Bululu River, 9/4/81, Nicholson 2173 (PRE).

- 3227 **(Stutterheim):(-BD)** Moordenaarskop, 3/1898, Flanagan s.n. (PRE).

- **3228** (B**utterworth):(-BB)** Dwesa Forest, 19/4/47, Sidey 685 (PRE); **(-CC)** Near Gonubie River Mouth, 15/6/07, Galpin 7752 (PRE); (-CB**)** North of Kentani, 10/3/55, Codd 9250 (PRE), Quora Mouth, 15/7/56, Meeuse 9673, Kentani, 5/12, Pegler 117 (PRE).

- **3325 (Port Elizabeth):(-BD)** North of Sandflats, Addo Bush, 24/4/47, Acocks 13639 (PRE).

- **3326 (Grahamstown):(-CB)** Alexandria Forest, 10/6/31, Galpin 10856 (PRE); **(-DA)** Hopewell, Kariega River; Valley Bushveld, 1/7/55, Acocks 18340 (PRE), **(-DB)** Port Alfred, Tyson s.n. (PRE).

1(b). S. leptantha subsp. late-ovata

- **3323 (Willowmore):(-CD)** Keurbooms River Nature Reserve, 5/71, Heineken K88 (PRE); **(-DC)** Knysna, Groot River, 18/10/42, Fourcade 5786 (PRE).

- **3423 (Knysna):(-AA)** Western part of Robbeberg peninsula, 6/7/60, Acocks 21152 (PRE), Knysna, 3/21, Breyer s.n. (PRE), Knysna, June 17, Michell s.n. (BOL), Knysna, 28/11/62, Taylor 4418A (PRE); **(-AB)** Keurboomstrand, 12/11/78, Botha 2245 (PRE), Bietou River, 4/28, Fourcade 3724 (PRE), Keurboom River, 2/26, Gillett s.n. (BOL), Plettenberg Bay, 12/11/38, Hafström & Acocks 1392 (PRE), Plettenberg Bay, Robberg, 4/76, Lavranos 12930 (PRE), Near Plettenberg Bay, Robberg, 15/8/54, Taylor 1355 (PRE); **(-BB)** Storms River Mouth, Tsitsikamma Park, 29/1/66, Liebenberg 7767 (GRA, PRE), Storms River Mouth, 26/11/50, Maguire 501 (SAM).

2. S. nkandlaensis

- **2831 (Nkandla):(-CA)** Nkandla Forest Reserve, 25/3/67, Venter 3486 (PRE), Nkandla, 14/2/61, Wells 2495 (PRE): **(-CD)** Nkandla, Wood 9000 (NH).

- **3227 (Stutterheim):(-DB)** Komgha, 3/1891, Flanagan 675 (GRA, PRE), Kei Bridge, Schönland s.n. (GRA).

3. S. linifolia

- **2531 (Komatipoort):(-CC)** 10 miles from Barberton on Havelock road, 24/3/56, Clarke 38 (PRE), 6 ½ miles SE of Barberton, 7/3/56, Codd 9533 (PRE), 4,5km south of Barberton, Brommer's Farm, near Elephants Head, 31/3/75, De Souza 537 (PRE), Barberton, upper slopes of Saddleback Mountain, 22/2/1890, Galpin 825 (PRE), About 4 miles from Barberton on Havelock road, 8/2/62, Ihlenfeldt 2409 (PRE), Barberton, hill behind town, 18/2/31, Liebenberg 2418 (PRE), 6 miles from Barberton on Havelock road, Makondjwe mountains, Meeuse 10093 (PRE), Barberton, Rogers 29445 (PRE), 4 miles south of Barberton on road to Havelock, 8/2/62, Schlieben 9417 (PRE), 2,5km south of Barberton, Mukwana Heights, 29/3/75, Stirton 1786 (PRE), Barberton, 2/06, Thorncroft 2480 (PRE), Barberton, Saddleback, White 10291 (PRE).

APPENDIX 2: SOURCES OF MATERIAL FOR PHYTOCHEMICAL SURVEY

J. petiolaris subsp. petiolaris

Immelman 185 - Near Ubombo on road to Mkuzi

Immelman 194 - On dirt road from Mkuzi Game Reserve to Hluhluwe

J. petiolaris subsp. bowiei

Immelman 372 - Above Nahoon Dam, East London

Immelman 378 - Mouth of Gonubie River, East London

J. petiolaris subsp. incerta

Immelman 393 - c. 20 km from Vaalwater on road to Beauty

J. minima

Immelman 388 - c. 13 km from Warmbaths on road to Nylstroom

J. campylostemon

Immelman 250 - Natal, Karkloof forest, Ehlatini

Immelman 362 - Port Alfred, banks of lagoon

J. bolusii

Immelman 376 - NE bank of Nahoon River Mouth

J. anagalloides

Immelman 197 - At gate of Hluhluwe Game Reserve

J. betonica

Immelman 179 - Ndumu Game Reserve, edge of Nyamite Pan

J. flava

Immelman 249 - 10 km along turnoff to Nagle Dam from main road

Immelman 170 - Northern Natal, Pongola

Nichols 430 - Southbroom

Balkwill s.n. - UNP gardens, provenance unknown

J. protracta subsp. protracta

Balkwill 145 - Louis Trichardt, Hangklip State Forest

Balkwill 162a - Soutpansberg, Harnham

Balkwill s.n. - Abel Erasmus Pass

Jenkins s.n. - Mtunzini

J. capensis

Immelman 181 - Ndumu Game Reserve

Immelman 351 - Baviaanskloof, c. 180 km from Willowmore

Immelman 359 - Howiesons Poort, near turnoff to Kenton-on-Sea

Immelman 361 - Kenton-on-Sea, near lagoon

Immelman 375 - East London, SE bank of Nahoon River Mouth

APPENDIX 3: LIST OF REFERENCES

Agnew, A.D.Q. 1974. Upland Kenya Wild Flowers: 601 - 605. Oxford University Press, London.

Ahmad, K.J. 1974a. Cuticular studies in some Nelsonioideae (Acanthaceae). Botanical Journal of the Linnaean Society 68: 73 - 80.

Ahmad, K.J. 1974b. Cuticular studies in some species of *Mendoncia* and *Thunbergia* (Acanthaceae). Botanical Journal of the Linnaean Society 69: 53 - 63.

Ahmad, K.J. 1978. Epidermal hairs of Acanthaceae. Blumea 24: 101 - 117.

Airy Shaw, H.K. 1978. In Willis, A dictionary of the flowering plants and ferns, edn 8. Cambridge University Press, London.

Anderson, T. 1864. An enumeration of the species of Acanthaceae from the continent of Africa and the adjacent islands. Journal of the Linnaean Society of London, Botany 7: 13 - 54.

Anderson, T. 1867. An enumeration of the Indian species of Acanthaceae XXIX: *Justicia*. Journal of the Linnaean Society of London, Botany 9: 509 - 517.

Andrews, F.W. 1956. The flowering plants of the Anglo-Egyptian Sudan: *Justicia* 3: 177 - 181. Buncle & Co., Arbroath.

Baden, C. 1981a. The genus *Macrorungia* (Acanthaceae), a taxonomic revision. Nordic Journal of Botany 1: 143 - 153.

Baden, C. 1981b. The genus *Anisotes* (Acanthaceae), a taxonomic revision. Nordic Journal of Botany 1: 623 - 664.

Balkwill, K. & Getliffe Norris, F. 1985. Taxonomic studies in the Acanthaceae: the genus *Hypoestes* in southern Africa. South African Journal of Botany 51: 133 - 144.

Balkwill, K. & Getliffe Norris, F. & Schoonraad, C. 1986. Taxonomic studies in the Acanthaceae: Testa microsculpturing in southern African species of *Peristrophe*. South African Journal of Botany 52: 513 - 520.

Bhaduri, S.A. 1944. A contibution to the morphology of pollen grains of Acanthaceae and its bearing on taxonomy. Calcutta University Journal, Department of Science N.S. 1,4: 25 - 38.

Binns, B. 1968. A first checklist of the herbaceous flora of Malawi: 14. Government Printer, Zomba.

Bremekamp, C.E.B. 1944. Materials for a monograph of the Strobilanthinae (Acanthaceae). Verhandlingen der Koninklijke Nederlandsche Akademie van Wetenschappen, afdeeling Natuurkunde (Tweede Sektie) 41: 1 - 306.

Bremekamp, C.E.B. 1948. Notes on the Acanthaceae of Java. Verhandlingen der Koninklijke Nederlandsche Akademie van Wetenschappen, afdeeling Natuurkunde (Tweede Sektie) 45,2: 1 - 78.

Bremekamp, C.E.B. 1953. The delimitation of the Acanthaceae. Verhandlingen der Koninklijke Nederlandsche Akademie van Wetenschappen, afdeeling Natuurkunde (Tweede Sektie) 56: 533 - 546.

Bremekamp, C.E.B. 1965. The delimitation and subdivision of the Acanthaceae. Bulletin of the Botanical Survey of India 7: 21 - 30.

Britton, N.L. 1918. Flora of Bermuda: 354. Charles Scribner's Sons, New York.

Burkhill, I.H. & Clarke, C.B. 1900. Acanthaceae. In W.T. Thistleton-Dyer, Flora of Tropical Africa 5: 1 - 262. Reeve, London.

Clarke, C.B. 1885. Acanthaceae. In J.D. Hooker, The Flora of British India 4: 387 - 558.

Clarke, C.B. 1912. Acanthaceae. In W.T. Thistleton-Dyer, Flora Capensis 5,1: 1 - 92. Reeve, London.

Compton, R.H. 1976. Flora of Swaziland: Justicia. Journal of South African Botany, Supplementary Volume 11: 563 - 565.

Cronquist, A. 1981. An integrated system of classification of flowering plants: 972-973. Columbia, New York.

De, A. 1967. Cytological, anatomical and palynological studies as an aid in tracing affinity and phylogeny in the family Acanthaceae III. General anatomy. Transactions of the Bose Research Institute 30,2: 51 - 62.

De, A. 1968. Cytological, anatomical and palynological studies as an aid in tracing affinity and phylogeny in the family Acanthaceae IV. Palynology and final conclusion. Transactions of the Bose Research Institute 31,1: 17 - 29.

Durand, T. and Durand, H. 1909. Justicia. Sylloge Florae Congolanae (Phanerogamae): 429 - 430. Maison Albert de Boeck, Bruxelles.

Dyer, R.A. 1975. Acanthaceae. The genera of Southern African Flowering Plants 1: 598. Department of Agricultural Technical Services, Pretoria.

Endlicher, S.L. 1839. Acanthaceae. Genera plantarum supplementum quartum: 676 - 708. Beck, Vindobonae.

Erdtman, G. 1952. Pollen Morphology and Plant Taxonomy: 18. Almqvist & Wiksell, Stockholm.

Forsskaol, P. 1795. Wild flowers of Natal (Coastal Region): pl. 99: 4, 5 and 6. The Trustees of the Natal Publishing Trust, Durban.

Gledhill, E. 1969. Eastern Cape Veld Flowers: 57, figs. 3, 4. Cape Department of Nature Conservation, Cape Town.

Graham, V. 16 Hawthorne Way, Guildford, Surrey, GU 4-7 JZ, England.

Grant, W.F. 1955. A cytogenetic study in the Acanthaceae. Brittonia 8,2: 121 - 149.

Gunn, M. & Codd, L. W. 1981. Botanical Exploration of Southern Africa 109. Balkema, Cape Town.

Hansen, B. 1985. A taxonomic revision of the SE Asian species of Isoglossa (Acanthaceae). Nordic Journal of Botany 5,1: 1 - 13.

Harbourne, J.B. 1972. Phytochemical methods. Chapman & Hall, London.

Heine, H. 1963. Justicia. in Hutchinson & Dalziel, Flora of West Tropical Africa 2: 426 - 428. Crown Agents for Overseas Administrations, London.

Heine, H. 1966. Justicia. In Aubreville, Flora du Gabon 13: 213 - 226, pl. 28: 10 - 13, pl. 45, 46. Muséum National d'Histoire Naturelle, Paris.

Hilsenbeck, R.A. 1983. Systematic studies of the genus Siphonoglossa sensu lato (Acanthaceae). PhD thesis, University of Texas, Austin (Botany Dept.).

Henrickson, J. & Hilsenbeck, R.A. 1979. New taxa and combinations in Siphonoglossa (Acanthaceae). Brittonia 31,3: 373 - 378.

Hitchcock, A.S. & Green, M.L. 1929. Standard-species of Linnaean genera of Phanerogamae (1753-54). International Botanical Congress, Cambridge (England), 1930: Nomenclature Proposals by British botanists: 110-199. H.M.S.O., London.

Hochstetter, C.F. 1843. Nova genera plantarum Africae: Tyloglossa. Flora 26: 72 - 74.

Hochstetter, C.F. 1845. Pflanzen des Cap- und Natal-Landes, gesammelt und zugesammengestellt von Dr Ferdinand Krauss: Acanthaceae. Flora 28: 70 - 72.

Hooker, J.D. 1876. Acanthaceae. In G. Bentham & J.D. Hooker, Genera Plantarum 2: 1060 - 1122. Cramer, Weinheim.

Hutchinson, J. 1973. Acanthaceae. The families of flowering plants, edn. 3: 306 - 307. Clarendon Press, Oxford.

Immelman, K.L. 1984a. J. petiolaris. In D. Killick, Flowering Plants of Africa 48,1 & 2: pl. 1897.

Immelman, K.L. 1984b. J. flava. In D. Killick, Flowering Plants of Africa 48,1 & 2: pl. 1898.

Immelman, K.L. 1985. J. capensis. In D. Killick, Flowering Plants of Africa 48,3 & 4: pl. 1920.

Immelman, K.L. 1986a. J. bolusii. In D. Killick, Flowering Plants of Africa 49,1 & 2: pl. 1931.

Immelman, K.L. 1986b. J. anselliana. In D. Killick, Flowering Plants of Africa 49,1 & 2: pl. 1932.

Immelman, K.L. 1986c. Notes of southern African species of Justicia L. Bothalia 16,1: 39 - 41. 48,3 & 4: pl. 1920.

Inamdar, J.A. 1970. Epidermis structure and ontogeny of caryophyllaceous stomata in some Acanthaceae. Botanical Gazette 131,4: 261 - 268.

Johnson, H.B. 1975. Plant pubescence: an ecological perspective. Botanical Review 41: 233 - 258.

Jussieu, A.L. de. 1789. Ordo III Acanthi. In: Genera plantarum 102 - 104. Cramer, Weinheim.

Jussieu, A.L. de. 1807. Sur le Curanga, genre nouveau de plantes de la famille des Persoonees. Annales du Muséum National d'Histoire Naturelle, Paris 9: 169.

Leonard, E.C. 1958. The Acanthaceae of Colombia. Contributions from the United States National Herbarium 31, 1-3: 1 - 781.

Le Roux, A. & Schelpe, E.A.C.L.E. 1981. Namaqualand and Clanwilliam -- S.A. Wild Flower Guide 1: 128. Botanical Society of South Africa, Cape Town.

Letty, C. 1962. Wild flowers of the Transvaal: 316, pl. 158: 6, fig. 12,1. Wild Flowers of the Transvaal Book Fund, Pretoria.

Lindau, G. 1894. Acanthaceae. In H.G.A. Engler & K.A.E. Prantl, Die Natürliche Pflanzenfamilien 4,3b: 274 - 354. Wilhelm Engelmann, Leipzig.

Lindau, G. 1895. Acanthaceae africanae II. Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie 20: 66.

Lindau, G. 1898. Acanthaceae africanae IV. Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie 24: 324 - 325.

Lindau, G. 1908. Acanthaceae. In H.G.A. Engler & K.A.E. Prantl, Die Natürlichen Pflanzenfamilien, supl. Nachtrage III, zu Teil IV Abteilung 3b: 321 - 326. Engelmann, Leipzig.

Lindau, G. 1909. Acanthaceae africanae XXXV. Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie 43: 357 - 358.

Linnaeus, C. 1737. Genera plantarum ed. 1. Wishoff, Lugduni.

Linnaeus, C. 1753. Species Plantarum: 10. Cotta, Stuttgart.

Linnaeus, C. 1754. Genera plantarum ed. 5: 10. Salvii, Stockholm.

Long, R.W. 1970. The genera of Acanthaceae in the southeastern United States. Journal of the Arnold Arboretum 51: 259 - 309.

Manning, J.C. & Getliffe Norris, F. 1985. Taxonomic studies in the genera Duvernoia and Adhatoda in southern Africa. South African Journal of Botany 51,6: 475 - 484.

Martineau, R.A.S. 1953. Rhodesian Wild Flowers: 80 - 81. Longmans, Green & Co., London, Cape Town and New York.

McNeill, J., Odell, E.A., Consaul, L.L. & Katz, D.S. 1987. American Code and later lectotypifications of Linnaean generic names dating from 1753: A case study of discrepancies. Taxon 35,2: 350-401.

Meeuse, A.D.J. 1956. Justicia incerta. In R.A. Dyer, Flowering Plants of Africa 31: pl. 1237.

Meeuse, A.D.J. 1960. Notes and new records of African flowering plants: Acanthaceae. Bothalia 7: 407 - 412.

Melchior, H. 1964. Acanthaceae. In H.G.A. Engler, Syllabus der Pflanzenfamilien, edn 12, vol. 2: 456 - 460. Gebr. Borntraeger, Berlin.

Merxmüller, H. & Roessler, H. 1980. Merkmals-Introgression bei Forsskaolea (Urticaceae). Landbouwhogeschool Wageningen, Miscellaneous Papers 19: 263 - 280.

Meyer, P.G. 1957. Beitrag zur Kenntnis der Acanthaceen Südwestafrikas. Mittelungen der Botanischen Staatsammlung München 2: 303 - 305.

Meyer, P.G. 1968. Justicia. In Merxmüller, Prodromus einer Flora von Südwestafrika 130: 33 - 37. Cramer, Lehre.

Mohan Ram, H.Y. & Wadhi, M. 1964. Endosperm in Acanthaceae. Phytomorphology 14: 388 - 413.

Moore, S. Le M. 1880. Alabastra diversa 4. Journal of Botany, British and Foreign, London 18: 40.

Moore, S. Le M. 1900. Alabastra diversa 6. Journal of Botany, British and Foreign, London 38: 204 - 205.

Moore, S. Le M. 1907. Alabastra diversa 15. Journal of Botany, British and Foreign, London 45: 231.

Moore, S. Le M. 1913. Alabastra diversa 23. Journal of Botany, British and Foreign, London 51: 188.

Moore, S. Le M. 1919. Alabastra diversa 31. Journal of Botany, British and Foreign, London 57: 246.

Munday, J. 1980. The genus Monechma Hochst. (Acanthaceae tribe Justicieae) in southern Africa. MSc thesis, University of the Witwatersrand, Johannesburg.

Nees, C.G. von E. 1832. Acanthaceae Indiae Orientalis. In Wallich, Plantae Asiaticae Orientalis 3: 76, 105. Treutel & Würtz, Paris, and Richter, London.

Nees, C.G. von E. 1841. Acanthaceae Africae Australioris ab Ecklonio collectae adiectis nonnullis Drégeanis: Gendarussa. Linnaea 15: 366 - 373.

Nees, C.G. von E. 1847. Acanthaceae. In A.P. De Candolle, Prodromus systematis naturalis regni vegetabilis 11: 46 - 521, 720 - 732. Treutel & Würtz, Paris.

Oersted, A.S. 1854. Mexicos og Centralamerikas acanthaceer. Vidensk. Medd. natürl. Foren. Kjobenhaven 6: 113 - 181.

Oliver, D. 1875. The botany of the Speke and Grant Expedition. Transactions of the Linnaean Society of London 29: 129 - 130.

Paliwal, G.S. 1966. Structure and ontogeny of stomata in some Acanthaceae. Phytomorphology 16: 527 - 532.

Petriella, B. 1968. El Polen do las Acanthaceae Argentinas. Universidad Nacional de la Plata, facultdad de ciencias naturelles y museo, revista del museo de la Blata, Botanica, N.S. 53: 51 - 68.

Presl, K.B. 1844. Botanische Bemerkungen: 95. Hofbuch druckerei von Gottlieb Haase Söhne, Prague.

Raj, B. 1961. Pollen morphological studies in the Acanthaceae. Grana Palynologica 3: 1 - 108.

Reichenbach, H.G.L. 1837. Handbuch des natürlichen Pflanzensystems: 190. Arnoldischen Buchhandlungen, Dresden & Leipzig.

Retief, E.R. 1977. 'n Morphologies-Taksonomies study van die genus Thunbergia Retz in suidelike Afrika. MSc thesis, University of Pretoria, Pretoria.

Rizzini, C.T. 1949. Contribuicao ao conhecimento da tribo Justicieae. Arquivos Jardin botanicodo Rio de Janeiro 9: 37 - 67.

Roemer, J.J. & Schultes, J.A. 1817. Linnaeus systema vegetabilium secundum 1: 164. Cotta, Stuttgard.

Roxburgh, W. 1820. Flora Indica, edn 1,1: 115. Mission Press, Serampore.

Schinz, H. 1890. Verhandlungen des Botanischen Vereins der Provinz Brandenburg 31: 203.

Schinz, H. 1916. Vierteljahresschrift der Natürforschenden Gesellschaft in Zürich 61: 439 - 440.

Schweinfurth, G. 1868. Verhandlungen der Zoologisch-botanischen Gesellschaft in Wien 18: 674.

Solms-Laubach, H.M.C.L.F. 1864. Sitzungsberichte der Gesellschaft natürforsschender Freunde zu Berlin 1864: 21.

Sporne, K.R. 1974. The morphology of angiosperms: the structure and evolution of flowering plants. Hutchinson & Co. London.

Sreemadhaven, C.P. 1977. Diagnoses of some new taxa and some new combinations in Bignoniales. Phytologia 37,4: 412 - 413.

Stearn, W.T. 1971. Taxonomic and nomenclatural notes on Jamaican gamopetalous plants. Journal of the Arnold Arboretum 52,4: 614 - 648.

Takhatajan, A. 1969. Flowering plants: origin and dispersal, translated by C. Jefferey 232. Oliver & Boyd, Edinburgh.

Taylor J., Hollingsworth P.G., & Bigelow W.C. 1974. Scanning Electron Microscopy of Liverwort Spores and Elaters. The Bryologist 77,3: 281 - 327.

Tieghem, P.E.L. van. 1907. Structure du pistil de l'ovule du fruit et de la graine des Acanthacees. Annales de sciences naturelles 9,7: 1 - 24.

Thunberg, C.P. 1794. Prodromus plantarum capensium 104. Edman, Uppsala.

Thunberg, C.P. 1813. Flora capensis 2: 478. Edman, Uppsala.

Trimen, H. 1895. Justicia. A Handbook to the Flora of Ceylon: 333 - 336. Dulau, London.

Uphof, J.C.Th. & Hummel, K. K. 1962 Plant hairs. Encyclopedia of plant anatomy 10,1: 1 - 206. Nicolasse, Berlin.

Vahl, M. 1790 - 94. Symbolae botanicae 2: 10. Müller, Copenhagen.

Vahl, M. 1804. Justicia. Enumeration plantarum 1: 108 -171. Müller, Copenhagen.

Van der Schijff, H.P. 1969. A Checklist of the Vascular Plants of the Kruger National Park: 88. Van Schaik, Pretoria.

Visser, J. 1981. South African parasitic plants: 89, pl. 135. Juta, Cape Town & Johannesburg.

Wilman, M. 1946. Preliminary checklist of the flowering plants and ferns of Griqualand West: 221 - 222. Deighton Bell, Cambridge, and Alexander McGregor Memorial Museum, Kimberley.

Wood, J.R.I., Hillcoat, D. & Brummit, R.K. 1983. Notes on the types of some names of Arabian Acanthaceae in the Forsskal Herbarium. Kew Bulletin 38,3: 429 - 456

APPENDIX 4: INDEX TO TAXA AND SYNONYMS IN JUSTICIA AND SIPHONOGLOSSA

PAGE