A PALYNOLOGICAL-TAXONOMIC STUDY OF THE GENUS *ASYSTASIA* AND A PALYNOLOGICAL STUDY OF SOME RELATED GENERA IN THE ACANTHACEAE

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A Palynological - Taxonomic Study of the Genus Asystasia and A Palynological Study of some Related Genera in the Acanthaceae.

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ABSTRACT

The pollen morphology of nineteen species of Acanthaceae: nine of *Asystasia* and ten of five other genera have been investigated using light and/or electron microscopes. The five genera *Graptophyllum*, *Jacobinia*, *Justicia*, *Mackaya* and *Styrosasia* can be separated from each other by the number and character of apertures, exine stratification and/or by the nature of the "trema area". The study has revealed that the pollen grains of the genus *Asystasia* are three-porate and the surfaces are provided with nine colpoid streaks. The sexine is smooth. The species can be separated from each other by the difference in the prominence of the colpoid streaks and by the nature of the sexinuous region around the pore.

A detailed study of the pan-tropical species *A. gangetica* (L.) T. Anders. has resulted in its subdivision into two geographical subspecies on the basis of corolla and style and stigma lengths. It is also supported by pollen size and seed morphology. The subspecies with long corolla and style and stigma is designated as subsp. *gangetica* and the one with short corolla and style and stigma subsp. *micrantha*. The distribution of both taxa is illustrated.

INTRODUCTION

Early studies of acanthaceous pollen were made by Bischoff, Fritzsch and Von Mohl, but the taxonomic value of pollen characters in the classification of the family was first pointed out by Radlkofer (Long, 1970). Lindau (1895, 1897) classified the family Acanthaceae mainly on the basis of pollen morphological characters.

Recently many investigators have made contributions to pollen morphological studies in the family. Bhaduri (1944) studied thirty species of Acanthaceae and reported that dimorphism in size and shape have been found a definite character of the pollen grains of many of the species.

Campo (1955) made a detailed study of the pollen grains of Eranthemum nervosum R. Br. Raj (1961, 1965, 1973) investigated the pollen grains of 260, 2 and 143 species of Acanthaceae, respectively.

Sharma and Vishnu-Mittre (1963) examined the pollen morphology of eleven species of Acanthaceae; eight of Eranthemum and three of Pseuderanthemum. They distinguished four pollen types based on aperture and exine pattern and concluded that both genera are eurypalynous.

Vishnu-Mittre and Gupta (1966) investigated the pollen morphology of several species of Strobilanthes. They divided all the species into two groups based on the apertures: porate

and colporate types. They further distinguished two major types of pollen grains based on exine pattern: the banded and the spinulose types.

Petriella (1968) studied the pollen morphology of the genera of Argentine Acanthaceae. He investigated the pollen grains of thirty species in fifteen genera and concluded that it is possible to separate the genera on the basis of pollen characteristics except the genera Justicia and Jacobinia which can be separated from the rest but not from one another.

Hsieh and Huang (1974) dealt with the general morphology, vegetative and floral anatomy, palynology and geographical distribution of thirty four species of Taiwan Acanthaceae belonging to twenty genera. They established ten pollen types based on the aperture and exine stratification.

Medus and Sonokho (1974) studied the pollen morphology of eight species of Hygrophila. Brummitt et al. (1980) discovered pollen grains referable to Crossandra stenostachya which are so exceptional in size and shape that they are among the most remarkable ever reported in the plant kingdom (520x19 µm).

Apart from the studies on pollen grains of one species of Asystasia Blume by Bhaduri, ten by Raj and three by Chaubal in the works quoted above, the pollen grains of many species of that genus have not been investigated.

The genus Asystasia was established by Blume (1826) on material from Java and the type species is A. nemorum Nees (A=intrusa Blume). According to Long (1970) forty species of Asystasia Blume have been described, chiefly from tropical Africa, Asia and the East Indies. In addition to these, Brummitt and Chisumpa (1978) described two new species of the genus from Malawi and Zambia.

The generic name is derived probably from the Greek word asystatos meaning not holding together, in reference to the wide-spreading valves of the dehisced capsules (Long, 1970).

Linnaeus (1759) established Justicia gangetica on materials from India. The specific epithet alludes to the type locality, the Ganges River.

Nees (1832) described Asystasia coromandeliana on material from Coromandel, India. He included three varieties based on the degree of hairiness of the stem and leaves. Furthermore, Nees (1847) described seven varieties of A. coromandeliana Nees based mainly on the hairiness of the stems and leaves except his variety alpha* micrantha which differ from the rest by its bigger leaves and from the variety alpha by its corolla and capsule which are half the size of those of variety alpha.

Many other taxa of the genus Asystasia Blume have also been described by Nees, but most of them are now designated as synonyms of A. coromandeliana Nees (Anderson, 1864; Baker, 1877; Clarke in Hooker 1884-1885, Clarke in Thiselton-Dyer, 1899-1900, 1901-1912; Cufodontis 1959-1966. Hiern, 1900; Hutchinson and Dalziel, 1963; Schwartz, 1939). However, the description of A. quaterna Nees does not agree with that of A. coromandeliana Nees, particularly regarding the length of calyx. In A. quaterna, Nees states that "the corolla tube is as long as the calyx", whereas in all specimens of A. coromandeliana investigated the length of the calyx is never equal to that of the corolla tube.

Klotzsch (1862) described eight species of Asystasia Blume on materials from Mozambique and its neighbouring islands. All of them have been found to be synonyms of A. coromandeliana Nees (Clarke in Thiselton-Dyer, 1899-1900). Anderson (1864) transferred Justicia gangetica L. (=Asystasia coromandeliana Nees) to A. gangetica (L.) T. Anders.

The chromosome numbers of A. gangetica (L.) T. Anders. have been counted by several workers (Naryanan, 1951; Grant, 1955; Kaur, 1965; De, 1966; Mangenot and Mangenot, 1970; Fernandes and Franca, 1975) and their findings indicate the occurence of polyploidy in the species.

2. MATERIAL AND METHODS

This study is based on herbarium material obtained on loan from the following herbaria: BR, C, ETH, FI, K, S, and UPS (abbreviations according to Holmgren and Keuken, 1974). The pollen grains of nineteen species of Acanthaceae: nine of Asystasia Blume and ten species of five other genera have been investigated. Furthermore, the pan-tropical species A. gangetica (L.) T. Anders. s.l. has been revised on the basis of pollen and gross morphological characters.

2.1. PREPARATION OF POLLEN GRAINS FOR LIGHT MICROSCOPY

2.1.1. Acetolysis:

Flowers and/or buds were collected from herbarium material. These were placed in a dilute solution of wetting agent for a few minutes. Anthers were picked out under a dissecting microscope and placed in centrifuge tubes. The anthers were crushed with a glass rod and about five millilitres of glacial acetic acid was added and the mixture was centrifuged. After decanting, an acetolysis mixture (nine parts of glacial acetic anhydride and one part of concentrated sulphuric acid) was added drop by drop stirring the mixture with a glass rod. The mixture was then heated to about 95°C in a copper plate stirring frequently, until

the colour of the mixture changed to yellow. After centrifuging, the solution was decanted and five millilitres of distilled water was added to the sediment which was washed thoroughly using a mixer. The mixture was filtered twice through a mesh of brass net and then centrifuged.

2.1.2. Bleaching: When pollen grains of Asystasia Blume were heated to more than 95°C, the mixture changed to brown and the pollen darkened. This required dividing the sediment: half of the sediment was taken for chlorination to bleach the pollen grains for exine studies and the other half was placed in a few drops of 50% glycerine for size studies.

To bleach the darkened pollen grains, five millilitres of glacial acetic acid, one to two drops of sodium chlorate solution and two or three drops of concentrated hydrochloric acid were added and the mixture stirred. The mixture was then centrifuged and decanted. The sediment was washed twice using distilled water, centrifuged and decanted. The chlorinated and unchlorinated pollen grains were mixed. About twelve drops of 50% glycerine were added and the mixture allowed to

stand for fifteen minutes. The mixture was centrifuged and decanted. The centrifuge tube containing the sediment was allowed to stand upside down on a filter paper for two hours to remove the glycerine before slides were made.

2.1.3. Slide Preparation

Glycerine jelly was cut into a number of pin-head sized cubes. A pin-head sized cube was taken on a clean needle, the pollen material was touched with the jelly cube and transferred to a clean labelled slide. The slide was warmed so that the jelly melted and the melted jelly was stirred with the same needle used to pick up the sample to avoid contamination. The jelly was then rewarmed and a circular cover glass was placed on the pollen material and sealed off with paraffin, melting point about 70°C.

2.1.4. Microscopic Investigation

Microscopic investigations were carried out using Optic Leitz Wetzlar for most specimens of Asystasia gangetica (L.) T. Anders. and Olympus BH for others. All measurements were made using oil immersion and ocular micrometer. The measurements were taken as the average of ten (rarely less)

acetolyzed and unchlorinated pollen grains. As noted by Erdtman (1969) the chlorinated pollen grains should not be used for size measurements because they swell in bleaching. These were used to study the exine stratification.

2.1.5. Photography

All photographs were taken with oil immersion using Carl Zeiss and Olympus photomicrographic cameras. Slides made during the study are kept in the Palynological Laboratory of the National Herbarium, Addis Ababa University with duplicates in the Palynological Laboratory of the Swedish Natural History Museum, Stockholm.

2.2. PREPARATION OF POLLEN GRAINS FOR SCANNING ELECTRON MICROSCOPY

Pollen grains were acetolyzed as above. After acetolysis, the sediment was washed twice using distilled water, centrifuged and decanted. The pollen material was then kept in 30, 50, 80, 95 and 100 per cent acetone for fifteen minutes in each concentration. The pollen material was allowed to stand in 100 per cent acetone or it was directly transferred to a clean bronze cube (stub) using micropipettes under a dissecting micriscope. The pollen material was then spread over the

surface of the stub and then kept in a dust free area or the stub with the pollen grains was coated with gold in Geol Fine Coat and the pollen grains were analyzed and scanned with Geol JSM-25S II Scanning Electron Microscope.

2.3. PREPARATION OF POLLEN GRAINS FOR TRANSMISSION ELECTRON MICROSCOPY

Anthers were removed under a dissecting microscope using forceps and placed in vials. TAG (solution of 1 per cent tanic acid and 2 per cent glutaraldehyde in 0. 1M phosphate buffer Srrensen of pH 7.4) was added and the mixture was allowed to stand for two hours. The pollen material was then dehydrated using acetone of 30, 50, 70, 95 and 100 per cent, allowing for fifteen minutes in each concentration. After four changes of 100 per cent acetone, the pollen material was placed in 1:2 ratio Spurr: acetone and allowed to stand for two hours. The pollen material was then transferred to a concentrated Spurr and allowed to stand for twelve hours. After replacing the old Spurr with a freshly made Spurr, the pollen material and the Spurr was transferred to a small embedding capsule and placed in an oven (70°C) for five hours, checking the hardness of the capsule and Spurr at intervals.

After the capsule attained proper hardness, it was cut lengthwise and the Spurr with the pollen material was removed. The material was then fixed in a holder under a binocular microscope and trimmed into a pyramid to expose the pollen bearing part of the anther for cutting.

After cleaning the knife with pith tissue, it was mounted in a holder in a slightly curved position in a trough. The trough was filled to the brim with water and fixed to the microtome (Ultratome Model 4801 A main unit and model 4802 A Control Unit). The object holder was screwed in place and the pyramid was adjusted. The screws controlling the speed and thickness of the sections were adjusted and a final adjustment for sectioning was made under a binocular microscope.

The pyramid was brought to the level of the knife. The trough holding the knife was filled with distilled water to the brim using a syringe and the motor was started. After enough sections were made, the motor was stopped. The sections in ribbon were separated with a hair inserted in a tooth-pick and collected on grids of copper.

Uranyl acetate solution was transferred to a small plastic beaker using a pipette. The sections were placed in the beaker, covered with a dark cloth and allowed to stand for fifteen minutes. After rinsing the sections with

distilled water of pH 4, each grid was placed in a drop of lead citrate in a petri-dish and kept in the dark for fifteen minutes. The sections were rinsed using distilled water of pH 8 and placed near potassium hydroxide crystals in a petri-dish to remove water. The sections were removed from the grids and allowed to dry by placing on lens papers. Then the sections were replaced in the grids and kept in a dust free place. The sections were observed and photographed using transmission Electron Microscope (Model 10A/EM 10B).

2.4. MATERIAL FOR GROSS MORPHOLOGICAL STUDIES

The morphological studies of Asystasia gangetica (L.) T. Anders. s.l.are based on materials obtained on loan from the herbaria earlier mentioned. A total of 526 specimens were received. All of them were inspected but only 96 specimens which had enough flowers, leaves and/or fruits and seeds were measured and recorded in detail. Both the vegetative and reproductive parts were measured using a hand rule assisted by a binocular microscope when necessary. Each figure (number) represents an average of three or more measurements except for parts such as stamens and pistils which were based on a single measurement due to lack of enough flowers on a specimen.

3. RESULTS AND DISCUSSION

3.1 EXAMPLES OF POLLEN MORPHOLOGICAL VARIATION IN THE ACANTHACEAE

3.1.1 Descriptions of Pollen Grains

Graptophyllum pictum Griff., New Guinea III. 1958 Bergman 255 (S). Fig. 1. A-C. Pollen grains radially symmetrical, isopolar, 3-colporate, peritreme, prolate-spheroidal, 59 x 56 μ m (P/E. 100 = 105). Pollen grains oval in equatorial view, amb circular.

Apocolpium diameter 17μ m. Colpi 44 x 5μ m with tapering ends, membrane granular. Ora circular, 3μ m in diameter. Each apertural region has two colpoid streaks, 33 x 1μ m and tapering towards the poles (shorter and narrower than the colpi).

Exine 4 μ m thick at poles, 3 μ m thick at equator. Sexine 2.5 μ m thick at poles, 2 μ m at equator, tectate. Tectum provided with perforations that are circular to irregular in shape. Nexine 1.5 μ m thick at poles, 1 μ m at equator.

Note Raj (1961) described the pollen grains of this species as 3-porate & the sexine reticulate. But this study has revealed that the pollen grains are 3-colporate and the sexine is smooth.

Jacobinia glaziovii Hiern, Brazil V. 1902 Dusén 233 (S). Fig. 2. A-C. Pollen grains 2-colporate, isopolar, bilaterally symmetrical (59 x 34 x 25 µm).

Colpi 52 x 4 µm, tapering towards the poles, membrane granular. Ora lalongate, 4 x 6 µm. Each apertual region has two colpoid streaks which are interrupted by four rows of circular, reticulate insulae (4.5µm in diameter).

Exine 3µm thick at poles, 4 µm at equator. Sexine 2 µm at poles, 3 µm at equator, reticulate.

Reticulum homobrochate. Muri straight, less than 1 µm wide. Lumina circular to polygonal, less than 1 µm in diameter. Nexine 1µm thick at poles a little more than 1 µm at equator.

Justicia flava (Vahl) Vahl, Ethiopia: Eritrea mooney 8005; Gilbert 1235 (both ETH). Pollen grains radially symmetrical, isopolar, 3-porate, pleurotreme, prolate 45 x 27 µm (P/E·100 = 166). Pollen grains oval in equatorial view, amb triangular.

Pores circular, 3 µm in diameter, membrane granular. Each apertural region has a faint colpoid streak passing through the pore.

Exine 2 μm thick at poles, 7 μm at equator. Sexine 0.5 μm thick at poles, 4 μm at equator, ±reticulate (ectosexine about 0.5 μm thick, ±undulating). Nexine 1.5 μm thick at poles, 3 μm at equator.

J. hyssopifolia L. Asplund 585 (UPS). Pollen grains 2-colporate, isopolar, bilaterially symmetrical (54 x 40 x ? μm).

Colpi 25 x 4 μm, tapering at both ends, membrane grandular. Ora lalongate, 6 x 8 μm, margin thickened. Each apertural region has two faint colpoid streaks.

Exine 2.5 μm thick at poles, 4.5 μm at equaor. Sexine 1 μm thick at poles, 2 μm at equator, ± reticulate. Nexine 1.5 μm thick at poles, 2 μm at equator.

Note: Raj (1961) described the pollen grains of this species as 2-porate, but it appears that they are 2-colporate.

J. natalensis T. Anders. South Africa: Natal Wood 1512 (UPS). Pollen grains radially symmetrical, isopolar, 3-colporate, pleurotreme, prolate, 42 x 29 μm (P/E. 100 = 144). Pollen grains oval in equatorial view, amb triangular.

Apocolpium diameter 20 µm. Colpi slightly tapering towards the poles (34 x 5 µm), membrane granular. Mesocolpium 17 µm. Ora lalongate, 6 x 8 µm, margin thickened. Each apertural region provided with two colpoid streaks.

Exine 2 µm thick at poles, 3 µm at equator. Sexine 1 µm thick, reticulate.

Reticulum appears to be heterobrochate. Muri straight, less than 0.5 µm wide. Lumina polygonal, about 0.5 µm in diameter. Nexine 1 µm thick at poles, 2 µm at equator.

J. pinguior C.B.Cl., Ethiopia: Kaffa Brehme s.n. (ETH). Fig. 3 A-C. Pollen grains 2-porate, isopolar, bilaterally symmetrical (47 x 29 x 23 µm).

Pores slightly lalongate, 3 x 4 µm, membrane granular. Each apertural region has a faint colpoid streak passing through the pore, 23 x 0.5 µm. Each apertural region is provided with two rows of about ten circular, reticulate insulae.

Exine 3 µm thick at poles, 4 µm at equator. Sexine 2 µm thick at poles, 3 µm at equator, ± reticulate. Nexine 1 µm thick at poles, 2 µm at equator.

J. schimperi (Hochst). Dandy, Ethiopia: Tigrai Gilbert & Getachew 2801 (ETH). Fig. 4. A-B. Pollen grains 2-porate, isopolar, bilateral (54 x 35 x 20 μm).

Pores lalongate, 3 x 4 μm, membrane granular. Each apertural region is provided with a faint colpoid streak passing through the pore, 30 x 0.5 μm. Each apertural region has four rows of circular, reticulate insulae (about 3 μm in diameter).

Exine 2 μm thick at poles, 6 μm at equator. Sexine 2 μm thick at poles, 3 μm at equator, reticulate.

Reticulum homobrochate. Muri straight, less than 1 μm wide. Lumia polygonal, mainly pentagonal, 1 μm in diameter. Nexine 1 μm thick at poles, 2 μm at equator.

J. trinerva Vahl, Ethiopia: Wollega Mooney 6845 (ETH). Fig. 4C. Pollen grains radially symmetrical, isopolar, 3-colporate, pleurotreme, prolate, 40 x 24 μm (P/E. 100 = 16 7). Grains oval in equatorial view, amb triangular.

Apocolpium diameter 13 μm. Colpi 37 x 5 μm with tapering ends and fusing at the poles, membrane granular. Ora lalongate 4 x 6 μm, margin thickened, mesocolpium 11 μm. Each apertural region has two colpoid streaks, each seems to fuse with its connterparts in the other apertural regions.

Exine 2.5 μm thick at poles, 3.5 μm at equator. Sexine 1 μm thick at poles, 1.5 μm at equator, reticulate.

Reticulum heterobrochate, Muri straight, less than 0.5 μm wide. Lumina polygonal, less than 1 μm in diameter. Nexine about 1.5 μm thick at poles, 2 μm at equator.

Mackaya bella Harv., South Africa: Natal 1885 Adlem 240 (UPS). Fig. 5. A-C. Pollen grains radially symmetrical, isopolar, 3-colporate, peritreme, prolate-spheroidal, 62 x 59 μm (P/E. 100 = 105). Pollen grains oval in equatorial view, amb circular.

Syncolpate, colpi 47 x 6 μm with tapering ends, membrane granular. Ora circular 9 μm in diameter. Each apertural region is provided with two colpoid streaks, that are as long as the colpi but narrower (47 x 1 μm).

Exine 4 μm thick. Sexine 2 μm thick, tectate. Tectum smooth, provided with circular to slit-like perforations. Nexine 2 μm thick.

Note: Raj (1961) described the pollen grains of this species as having a reticulate sexine whereas this study revealed that the pollen grains have a smooth sexine with perforated tectum.

Styasasia sp. nov., Tanzania: Bushiri XI. 1950 Faulkner K 731 (S) Fig. 5 D. Pollen grains 5-porate spheroidal 53 µm in diameter.

Pores 5 µm in diameter, membrane granular. Exine 4 µm (spinules not included). Sexine 1.5 µm thick provided with spinules 2.5 µm long. Nexine 2.5 µm thick.

Note: The terminology used is according to (Erdtman, 1969; Erdtman et al., 1961; Raj, 1961).

3.1.2. Key to the Species Based on Pollen Characters

1. Pollen grains porate.....2
1. Pollen grains colporate.....5
2. The pollen grains 5-porate, spinulose.....Styasasia sp. nov.
2. The pollen grains 2-or 3-porate, nonspinulose.....3
3. Pollen grains 3-porate, radially symmetrical.....Justicia flava
3. Pollen grains 2-porate, bilaterally symmetrical.....4
4. "Trema area" provided with 4 rows of insulae.....J. schimperi

4. "Trema area" provided with 2 rows of insulae.....*J. pinguior*

5. Pollen grains 2 colporate.....6

5. Pollen grains 3-colporate.....7

6. "Trema area" provided with 4 rows of insulae.....*Jacobinia glaziovii*

6. "Trema area" not provided with insulae.....*Justicia hyssopifolia*

7. Polar axis upto 45 µm; equatorial diameter upto 30 µm.....8

7. Polar axis more than 45 µm; equatorial diameter more than 30 µm.....9

8. Equatorial dimater 22-24 µm .....*J. trinerva*

8. Equatorial diameter 28-30 µm.....*J. natalensis*

9. Colpi meet at poles; tectal perforations circular to slit-like .....*Mackaya bella*

9. Colpi don't meet at poles; tectal perforations with irregular shapes.....*Graptophyllum pictum*

3.1.3. Discussion of Pollen Morphological Features:

Of the ten species of Acanthaceae belonging to five genera investigated, Justicia trinerva and J. natalensis have the smallest pollen grains while Graptophyllum pictum, Mackaya bella and Jacobinia glaziovii have the largest.

Based on apertures, the pollen grains can be divided into two types: the porate and the colporate. the porate pollen grains are found in Justicia flava, J. pinguior, J. schimperi and Styasasia sp. nov. The porate pollen grains can be subdivided based on number of pores. J. pinguior and J. schimperi have 2-porate pollen grains. J. flava has 3-porate whereas Styasasia sp. nov. has 5-porate pollen grains.

Similarly the colporate pollen grains of Graptophyllum pictum, Jacobinia glaziovii, Justicia trinerva, J. hyssopifolia, J. natalensis and Mackaya bella can be further subdivided based on the number of the apertures: the two colporate and the three colporate types. Two colporate pollen grains are found in Jacobinia glaziovii and Justicia hyssopifolia while three colporate pollen grains are found in Graptophyllum pictum, Justicia natalensis, J. trinerva and Mackaya bella.

The stratification of the exine varies being smooth in Graptophyllum pictum and Mackaya bella, spinulose in Styasasia sp. nov. and ±reticulate in Jacobinia glaziovii and all species of Justicia.

Considering symmetry the pollen grains of Graptophyllum pictum, Justicia flava, J. trinerva, J. natalensis and Mackaya bella are radially symmetrical whereas those of Jacobinia glaziovii, Justicia pinguior, J. schimperi and J. hyssopifolia are bilaterally symmetrical.

In all pollen grains that have colpoid streaks, the colpoid streaks are wider at the equatorial region and taper towards the poles.

The pollen grains of the five genera can be separated from each other by their size, the number and character of the apertures and the exine pattern. The pollen grains of Graptophyllum pictum and Mackaya bella are 3-colporate, the sexine is smooth and the tectum is provided with perforations. They can be separated from each other by their size, nature of the colpi at the poles and the perforations of their tectum. The colpi meet at the poles (syncolpate) in Mackaya bella while the colpi do not meet at the poles in Graptophyllum pictum. The tectal perforations are circular to slit-like in Mackaya bella while they have irregular shapes in Graptophyllum pictum.

The pollen grains of Jacobinia glaziovii and six species of Justicia can be separated although they are closely related (both genera have ±reticulate sexine). The major diagnostic pollen characters are the nature of the colpi and the insulae in the "trema area".

The pollen grains of Styasasia sp. nov. can easily be separated from the rest by the number of apertures (5-zono-porate) and the spinulose grains.

3.2. POLLEN MORPHOLOGICAL VARIATION IN THE GENUS ASYSTASIA BLUME

3.2.1. Description of Pollen Grains

A. calycina Nees, Ghana: Accra Dalziel 152 (C). Fig. 6 A-C. Pollen grains radially symmetrical, isopolar, 3-porate with 9 colpoid streaks, pleurotreme, prolate, 81 x 49 µm (P/E. 100 = 165). Pollen grains oval in equatorial view, amb triangular.

Pores circular, 4 µm in diameter, membrane studded with blunt and pointed processes. Each apertural region is provided with 3 colpoid streaks. "Trema area" provided with six circular insulae (about 5 µm in diameter).

Exine 5 µm thick at poles, 12 µm at equator. Sexine 2 µm thick at poles, 7 µm at equator, tectate. Tectum smooth, provided with densely spaced circular to slit-like perforations. Nexine 3 µm thick at poles, 5 µm at equator.

A. charmian S. Moore, Kenya: Thika XII. 1952 Verdcourt 849 (S). Fig. 7 A-B. Pollen grains radially symmetrical, isopolar, 3-porate, pleurotreme, prolate, 109 x 66 µm (P/E. 100 = 165).

Pores circular, 5 µm in diameter, membrane granular. Each apertural region is provided with about 24 circular insulae of 7 µm in diameter. The insulae are arranged in four rows and are provided with perforations. The surface of the pollen grain is provided with nine colpoid streaks near and at the poles and fusing at the poles but interrupted by the insulae near and at the pores.

Exine 7 µm thick at poles, 20.5 µm at equator. Sexine 3 µm thick at poles, 14.5 µm at equator ±smooth. Tectum provided with perforations at and near the poles and ±reticulate in equatorial region between the pores. Nexine 4 µm at poles, 6 µm thick at equator.

A. drakebrockmanii Turrill, Kenya: Mandera Gilbert and Thulin 1450 (UPS). Fig. 8 A-C. Pollen grains radially symmetrical, isopolar, 3-porate, pleurotreme, prolate, 82 x 50 µm (P/E. 100 = 164).

Pores circular, 6 µm in diameter, membrane granular. Each apertural region is provided with three narrow colpoid streaks, the middle passing through the pore is wider than the lateral ones. The lateral colpoid streaks have irregular margins and are interrupted by about ten poorly delimited circular insulae near and at the pore.

Exine 6 µm thick at poles, 11 µm at equator. Sexine 3 µm thick at poles, 7 µm at equator, tectate. Tectum smooth, provided with perforations. Nexine 3 µm thick at poles, 4 µm at equator.

A. guttata (Forssk.) Brummitt (=A. somalensis (Franch.) Lebrum & Touss.), Ethiopia: Sidamo, Zambaba x. 1980 Ensermu 440 (ETH). Pollen grains radially symmetrical, isopolar, 3-porate, pleurotreme, prolate, 87 x 52 µm (P/E. 100 = 167).

Pores circular, 4 µm in diameter, membrane granular. Each apertural region has three colpoid streaks of which the middle passing through the pore is prominent whereas the lateral ones are visible only near and at the poles. "Trema area" provided with about 18 circular insulae (SEM).

Exine 7 µm thick at poles, 15 µm at equator. Sexine 3 µm thick at poles, 11 µm at equator (ectosexine undulating), tectate. Tectum smooth, provided with perforations. Nexine 4 µm thick.

A. macrocarpa Nees, India: Bengal III. 1932 Parker 3206 (S). Fig. 9 A-B. Pollen grains radially symmetrical, isopolar, 3-porate, pleurotreme, prolate, 65 x 46 µm (P/E. 100 = 141). Pollen grains oval in equatorial view, amb triangular.

Pores circular 6 μm in diameter, membrane granular. Each apertural region is provided with one prominent colpoid streak, the middle that passes through the pore, and two faint colpoid streaks with irregular margins.

Exine 3 μm thick at poles, 5 μm at equator. Sexine 1 μm thick at poles, 2 μm at equator, tectate. Tectum smooth and perforated. Nexine 2 μm thick at poles, 3 μm at equator.

A. oppositiflora Bremek., Celebes: Boetom II. 1929 Kjellberg 318 (S). Fig. 10 A-C. Pollen grains radially symmetrical, isopolar, 3-porate with nine colpoid streaks, pleurotreme, subprolate, 73 x 49 μm (P/E, 100 = 149).

Pores circular, 8 μm in diameter, membrane studded with blunt and pointed processes. Each apertural region has three colpoid streaks. Each colpoid streak fuses with its counterparts in the other apertural regions. The nine colpod streaks divide the exine into three broad and six narrow sexinuous regions.

Exine 5.5 μm thick at poles, 7 μm at equator. Sexine 2.5 μm at poles, 3 μm thick at equator, tectate. Tectum smooth and provided with densely spaced circular to

slit-like perforations. Each narrow sexinuous region is less than or equal to 4 μm in width. Nexine 3 μm thick at poles, 4 μm at equator.

A. scandens Hook., Sierra Leone: Diano I. 1796 Peter 9 (UPS). Pollen grains radially symmetrical isopolar, 3-porate, pleurotreme, prolate, 86 x 56 μm (P/E. 100 = 157). Pollen grains oval in equatorial view, amb triangular.

Pores circular, 8 μm in diameter, membrane granular. Each apertural region has three colpoid streaks which have irregular margins, especially at the pore where there are about six poorly delimited circular insulae (five circular and 1 more or less rectangular, diameter about 8 μm). The colpoid streak that passes through the pore is wider near and at the pore, tapering towards the poles while the lateral colpoid streaks are faint and have irregular margins.

Exine 5 μm thick at poles, 7 μm thick at equator. Sexine 2 μm thick at poles, 3 μm at equator, tectate. Tectum smooth, provided with circular perforations. Nexine 3 μm thick at poles 4 μm at equator.

A schimperi T. Anders., Ethiopia: Hararge IX. 1980 Ensermu and Tamrat 335 (ETH); Gilbert and Thulin 64 (ETH); Somalia: Gelib Mooney 7657 (ETH). Pollen grains radially symmetrical isopolar, 3-porate, pleutrotreme, prolate, 73 x 44 μm (P/E. 100 = 165).

Pores circular, 3.5 μm in diameter, membrane granular. Each apertural region is provided with three colpoid streaks of which the middle, passing through the pore, is prominent while the lateral ones are visible only near and at the poles. Each apertural region has about ten circular insulae of about 7 μm in diameter. The insulae have perforations.

Exine 6 μm thick at poles, 15 μm at equator. Sexine 3 μm thick at poles, 10.5 μm at equator, (ectosexine undulating), tectate. Tectum smooth, provided with perforations. Nexine 3 μm thick at poles, 4.5 μm at equator.

Note: Raj (1961, 1973) has investigated the pollen grains of ten species and Chaubal (in Raj, 1973) three. The former has described the pollen grains as 3-porate whereas the latter as 3-zonicolporate. This study has revealed that the pollen grains of the genus Asystasia are3-porate. The former author also described the exine pattern, the sexine as reticulate while this study has revealed that the sexine is smooth and tectum provided with perforations. There is some kind of reticulation in the "trema area" equatorially between the pores in A. charmian. The sexine of this species is intermediate between smooth and reticulate.

3.2.2. Key to the Species of Asystasia based on Pollen Characters.

1. Polar axis upto 67 μm; exine 4 μ m thick at poles; .....A. macrocarpa

1. Polar axis more than 67 μm; exine more than 4 μm thick at poles.....2

2. "Trema area" provided with about 24 perforated insulae; polar axis more than 88 μ m; equatorial diameter more than 56 μm.....A. charmian

2. "Trema area" provided with at most 18 smooth insulae or insulae absent; polar axis not exceeding 88 μ m; equatorial diameter not exceeding 56 μm.....3

3. The Trema area" provided with insulae.....4

3. The "Terma area" not provided with insulae.....8

4. "Trema area" provided with 6 insulae....5

4. "Trema area" provided with more than 7 insulae.....6

5. Insulae all circular; exine 11-13 μm, sexine 7-8 μm thick at equator; pores 3-5 μm in diameter.....A. calycina

5. Insulae 5 circular and 1 rectangular; exine 5-7 μ m, sexine 2-3 μ m thick at equator; pores 6-8 μ m in diameter.....A. scandens

6. Lateral colpoid streaks continuous through the pores; exine 9-11 μm, sexine 6-7 μm thick at equator.....A. drakebrockmanii

6. Lateral colpoid streaks discontinuous at and near the pores; exine 13-16 μm, sexine 9-12 μm thick at equator.....7

7. "Trema area" provided with about 10 insulae; polar axis 68-75 μm; equatorial diameter 42-48 μm.....A. schimperi

7. "Trema area" provided with about 18 insulae; polar axis 81-92 μm; equatorial diameter 49-56 μm.....A. guttata

8. The narrow sexinuous regions on the lateral sides of the pores more than 4 μm wide, tectal perforations in two rows or irregularly arranged.....A. gangetica

8. The narrow sexinuous regions on the lateral sides of the pores less than or equal to 4 μm wide, tectal perforations in one row.....A. oppositiflora

4.3. Discussion of Pollen Morphological Features.

The pollen grain of all species investigated are radially symmetrical. The shape of the pollen grains does not show much variation. It is prolate in all species. The smallest pollen grains are found in A. macrocarpa (65 x 46 µm) and the largest are found in A. charmian (109 x 66 µm).

Considering aperture, the pollen grains of all species are 3-zonoporate and are provided with nine colpoid streaks, three in each apertural region. These colpid streaks are equally prominent in four species, viz. A. calycina, A. drakebrock manii, A. gangetica and A. oppositiflora and relatively faint in two: A. macrocarpa and A. scandens. The colpoid streaks are interrupted by insulae at and near the pores in A. charmian, A. guttata and A. schimperi.

The major pollen morphological character that helps separate the nine species is the region around the pore. The pollen grains of A. gangetica and A. oppositiflora are very similar. However, they can be separated by the differences in width of the narrow sexinuous regions around the pore. The narrow sexinuous regions on the lateral sides of the pore are broader in A. gangetica (more than 4 µm) than in A. oppositiflora (less than or

equal to 4 μm). Furthermore, the perforations of the tectum are in two rows or irregularly distributed in the former whereas they are found in one row in the latter.

The pollen grains of A. macrocarpa and A. scandens are similar in that the colpoid streaks have irregular margins. They can be separated by the presence or absence of insulae. The pollen grains of A. macrocarpa have no insulae in the "Trema area" whereas those of A. scandens have six insulae (five circular and one rectangular).

The pollen grains of A. charmian, A. gutta and A. schimperi are similar in the aperture region. They can be separate from the other species by having faint colpoid streaks (especially lateral ones) which are visible only near and at the poles. They are separated from each other by the presence of about 24 circular and perforated insulae in A. charmian; ten circular and perforated insulae in A. schimperi and 18 circular and poorly delimited insulae in A. guttata (SEM). The pollen grains of A. charmian also differ from the other two by the more or less reticulate sexine in the equatorial region between the pores. These three species can also be separated from each other by the difference in the pollen grain size (LM).

The stratification of the exine in all species has the same pattern although there is some deviation in *A. charmain*. The pollen grains of all species have a generally smooth sexine but in *A. charmian* there is some form of reticulation of the sexine. The tectum in the pollen grains of all species is perforated. The perforations are circular to slit-like in most species and are similar in shape and size. But in the pollen grains of *A. macrocarpa* and *A. scandens* the perforations are smaller than in the others and they are circular.

The pollen grains of the nine species of *Asystasia* can be separated from each other based on the region around the pores. The size of the pollen grains also helps to some extent, in the discrimination of the species. Therefore, it can be concluded that the genus *Asystasia* is eurypalynous.

3.3. POLLEN MORPHOLOGY IN ASYSTASIA GANGETICA (L.) T. ANDERS. s.l.

Figs. 11-14. Pollen grains radially symmetrical, isopolar, 3-porate, with nine colpoid streaks, pleurotreme, prolate, 56-87 x 36-50 μm (P/E. 100 = 141-184). Pollen grains oval in equatorial view, amb triangular.

Pores (2-) 3-5 μm in diameter, circular to oval, membrane densely studded with blunt processes which become pointed towards the periphery. Each apertural region has three narrow colpoid streaks dividing the exine into three broad and six narrow strips; the central colpoid streak passes through the pore and fuses with its counterparts at the poles; the ends of the lateral colpoid streaks belonging to different apertural region fuse like arches in the polar region.

Exine 4-6 μm thick at poles, (8-) 10-15 μm thick at equator, Sexine (1-) 2 μm thick at poles, (5-) 6-8 (-9) μm thick at equator, tectate, Tectum smooth, provided with densely spaced circular to slit-like perforations. The narrow sexinuous strips are either continuous or band-like or broken into two rarely four ±crescent or bar-like pieces at the pores. The bacula at the equatorial region are relatively long and slender, continuous or broken either suspended from the tectum or standing on the nexine, those

standing on the nexine with their ends free or in contact with the suspended bacula. At the base of the bacula there is a granular layer; the bacula in the polar region are continuous or broken shorter and stouter than those in the equatorial region.

Nexine (2-) 3-4) (-5) µm thick at poles, 4-7µm at equator inner outline dumb-bell-shaped, straight at the equator.

The pollen grains of 56 specimens of A. gangetica (L). T. Anders. s.l. have been investigated using light (LM), scanning electron microscope (SEM) and transmission electron microscope (TEM).

Of the 56 specimens of the species, the smallest pollen grains are found in the following specimens from tropical Africa: Drummond and Hemsley 1949 (56 x 36 µm) from Kenya and Fries 3604 (58 x 37 µm) from Tanzania. The largest pollen grains among the specimens from Africa and its neighbouring islands are found in a specimen from South Africa, Nielsen 1450 (78 x 50 µm).

Among the specimens from India and other countries, the smallest pollen grains are found in Bremer et al. 190 (70 x 44 µm) from Sri Lanka and the largest in Kew 2269 (87 x 50 µm) a specimen grown in Kew Botanical Garden from seed obtained from India.

In general, the specimens from southern Africa have larger pollen grains than those from tropical Africa and the neighbouring islands. The specimens from India and other countries possess larger pollen grains than most specimens from Africa.

In all pollen grains investigated, the surface of the pollen grains have nine narrow colpoid streaks dividing the sexine into three broad and six narrow strips. The narrow sexinuous strips are continuous in many of the pollen grains (Fig. 11 A and D). However, in some pollen grains, the narrow sexinuous strips are broken on the polar sides of the pores (Fig. 11 B). Still in others the narrow sexinuous strips are broken on both the polar and the equatorial sides of the pores (Fig. 11. C).

Transmission electron microscope photographs (Fig. 14) have revealed that the bacula at the equatorial region are longer and thinner than those in the polar region. In both regions, the bacula are either continuous or broken and suspended from the tectum or standing on the nexine. The ends of the standing bacula are free or in contact with the suspended bacula. Raj (1961) described the pollen grains of this species (A. gangetica) as having reticulate sexine.

Bhaduri (1944) and Chaubal in Raj (1961) described the pollen grains as 3-colporate. But this study has revealed that the sexine is smooth, the tectum provided with perforations and the pollen grains are 3-porate.

3.4. VARIATION IN GENERAL MORPHOLOGY IN ASYSTASIA GANGETICA (L.) T. ANDERS.

Clarke (in Thiselton-Dyer, 1899-1900) used the character of leaf shape and size, inflorescence type, bract size, calyx length, corolla length, and pubescence to separate fifteen species of Asystasia Blume. Nees in Wallich (1832) included three and in de Candolle (1847) seven varieties of A. coromandeliana Nees (=A. gangetica (L.) T. Anders. s.l.) based on the pubescence of stems and leaves and/or leaf and corolla length. In the study reported here these and other characters were studied and the materials were found to belong to two groups, one characterized by smaller flowers and a more or less yellowish corolla in dry state and the other by bigger flowers and purplish to pale-yellow corolla with reticulate conspicuous veins. The first group is designated as the African group and the second the Indo-Malayan.

Leaf shape and size: this character varies in both groups. The African group has ovate, subovate, lanceolate or rarely oblong leaves (2.5-8.0 x 1.4-4.5 cm), even up to 10.0 x 5.0 cm for Pappi 4071 from Ethiopia and 13.0 x 7.0 cm for Bullock 2321 from Tanzania. The Indo-Malayan group possesses ovate or subovate leaves (1.9-6.5 x 1.5-4.0 cm). In general, the Indo-Malayan group has shorter and more ovate leaves than the African group. But this character does not show discontinuous

variation and it is not found a useful character for taxonomic discrimination (Fig. 16).

Inflorescence type: the inflorescence of both groups is a terminal raceme which tends to be much branched in the Indo-malayan group and less so in the African group. But the gap between them is bridged by some specimens from the African group which have much branched inflorescences forming a terminal panicle, similar to the former group.

Bract size: this character shows continuous variation within and between the two groups. The bracts of the African group are 0.8 to 3.0 mm long and 0.3 to 0.8 mm wide (at the base) while those of the Indo-malayan group are 1.0 to 2.0 mm long and 0.4 to 0.8 mm wide.

Calyx length: this character also shows continuous variation. The calyx length of the African group varies from 4.0 to 7.5 mm whereas that of the Indo-malayan group varies from 4.5 to 10.0 mm. Although the latter group tends to have a longer calyx than the former, this character has not been found taxonomically useful (Fig. 17).

The two quantitative characters that show a more or less discontinuous variation are corolla length and style and stigma length (Fig. 18 and 19, respectively). The distribution of these characters are shown in a scatter diagram (Fig. 20).

Almost all specimens from the African group have corolla of less than 25 mm whereas almost all specimens from the Indo-malayan group have corolla of 25 mm and above in length.

Among the African group, specimens from South Africa: Fries 3596 and 3597, Larsen 21 and Nielsen 1450 have corolla length of 24.7 mm, 25.0 mm, 25.0 mm and 26.0 mm, respectively. However, one other specimen from South Africa, Wood 1006, has corolla length of 20.0 mm while all specimens of the tropical African group have corolla less than 25.0 mm long. Thus, the specimens from South Africa except the last one have their corolla intermediate between the two groups.

A few specimens in the Indo-Malayan group also deviate in their range of corolla length from that for the group as a whole. The specimen from Biaro Island, Nielsen 795 and a specimen from Sri Lanka, Wanntorp 2587, have corolla of 20.0 mm and 25.0 mm, respectively.

All specimens of the African group have a style and stigma less than 15.0 mm long. Almost all specimens of the Indo-Malayan group possess style and stigma of more than 15.0 mm long. But a few specimens, the one from Biaro Island, Nielsen 795, one from Florida, Brumbach 6638 and the rest from Sri Lanka (three of the four) have style and stigma length of less than 15.0 mm.

There is a marked tendency for specimens from Biaro Island and Sri Lanka to deviate from the Indo-Malayan group. The specimen from Biaro Island has the shortest corolla and style and stigma among the Indo-Malayan group. Its style and stigma are even shorter than the shortest style and stigma in the African group. Although the specimens studied from Sri Lanka are only four, the placing of these specimens in the Indo-Malayan group is doubted due to few reasons. Except one specimen, the rest have the shortest corolla among their members besides the specimen from Biaro Island. These specimens also have the shortest style and stigma length apart from the specimens from Biaro Island and Florida.

The South African specimens deviate from the tropical African group in their longer corolla and relatively longer style and stigma. The South African populations of the group could probably have been introduced to South African from India and/or other centres of the Indo-Malayan group. But these populations also deviate from the Indo-Malayan group by their shorter corolla and style and stigma lengths. Until further studies are done on more material from the region, the specimens from South Africa should be kept in the African group.

Other characters: the variation in pollen size (Figs. 21, 22 and 23) supports the distinction between the two groups revealed by the variation in corolla and style and stigma lengths. But since the distinction in the pollen size is not very sharp, its taxonomic usefulness is limited.

The length of the capsules shows continuous variation from 18.0 to 28.0 mm in the African group and 21.0 to 31.0 mm in the Indo-Malayan group. The capsules of the majority of the specimens of the African group are less than 25.0 mm long whereas those of the majority of the other group are more than 25.0 mm. But the usefulness of this character is limited by its continuous variation.

Seed morphology seems to be the most important qualitative character. In the African group the larger part of the surface is covered by almost confluent processes of more or less equal size, whereas in the Indo-Malayan group the processes are of unequal size and relatively isolated from each other (Fig. 15). In the African group the margin of the seed is more or less undulate to slightly crenate while in the Indo-Malayan group it is double dentate. Moreover, the seeds of the African group are smaller (4-5 mm in diameter) than the Indo-Malayan group (5-5.5 mm in diameter). As few of the specimens had mature fruit it was not possible to make as thorough an investigation of the distribution of fruit and seed characters as it was for vegetative and floral ones.

4. TAXONOMIC CONCLUSION

Although the South African specimens deviate from the tropical African specimens, they are retained in the African group until further studies are performed on more material from South Africa. Similarly, the specimens from Biaro Island and Sri Lanka are kept in the Indo-Malayan group.

Specific distinction normally requires that discontinuous variation should be found in two or more independent character (Stebbins, 1950; Steenis, 1957; Bjornstad et al. 1971). Subspecific rank is the only one in which geographical distribution can be taken as a decisive character in association with a single morphological difference (Davis & Heywood, 1963). Although the two groups are separated mainly by the corolla and style and stigma lengths, these features are not considered independent characters since as Hedberg (1957) states a larger corolla tends to be associated with a larger style. Accordingly, the rank of subspecies is given to the two groups.

The African group is given the name used by Nees (1847) for a variety raised to subspecies micrantha. The varietal epithet micrantha is selected because it defines the small-flowered African group. Furthermore, Nees described this

variety as having a corolla about half the length of that in his variety alpha (based on material from India). The type specimen (microfiche photograph seen) is also a good representative of the African group, and was collected from the Sudan.

SYNOPSIS TO THE TAXA TREATED AND SPECIMENS SEEN

KEY TO THE SUBSPECIES

Corolla normally more than 25.0 mm long; style and stigma normally more than 15.0 mm long....subsp. gangetica

Corolla normally less than 25.0 mm long; style and stigma less than 15.0 mm long.....subsp. micrantha

Asystasia gangetica (L.) T. Anders. (1864) subsp. gangetica.

Justicia gangetica L., Amoen. Acad. 4: 299-300 (1759).

Orig. coll.: There are two specimens in the Linnaean Herbarium, nos. 28.27 and 28.28 (seen on microfiche only).

SYNONYMS

Ruellia secunda Vahl., Symb. Bot. 1:85 (1790).

R. digitalis Koen., in Spreng., Syst. 2: 852 (1825).

A. coromandeliana Nees in Wall., Pl. As. Rar. 3: 89 (1832)

A. plumbaginea Nees in Wall., P. As. Rar. 3: 89 (1832).

A. coromandeliana Nees var. alpha Nees in DC., Prod. 11:165 (1847)

A. coromandeliana Nees var. beta Nees in DC., Prod. 11:165 (1847) partly.

A. coromandeliana Nees var. beta* Nees in DC., Prod. 11:165 (1847).

A. coromandeliana var. gamma Nees in DC., Prod. 11:165 (1847) partly.

A. coromandeliana Nees var. gamma* variabilis Nees in DC., Prod. 11:165 (1847).

A. coromandeliana Nees var. delta tomentosa Nees in DC., Prod. 11:165 (1847).

A. violacea Dalz. in Hook., Kew Journ. 2:139 (1850).

NOMINA NUDA

Ruellia filiformis Wall., Cat. n. 2401 partly.

R. coromandeliana Wall. Cat. n. 2399 partly.

R. obliqua Wall., Cat. n. 2339 partly.

R. biloba Hochst. in Schedulis, criptis.

R. zeylanica Koen., in Roxb., Fl. Ind. 3:42 (1832).

DESCRIPTION

Perennial suffrutescent herb with trailing woody stem, rarely suberect 0.7 to 2.0 m long. Stem branched, subquadrangular or quadrangular, pubescent or nearly glabrous except at nodes. Leaves ovate or subovate; base cordate, truncate, round or cuneate; apex acute, mucronate,

truncate or rarely apiculate; sparsely pubescent or nearly glabrous; upper and/or lower surface covered with ± densely spaced bar-like cystoliths; lateral veins 4 to 6 pairs; petiole (2.0 -) 5.0 - 30.0 (-54.0) mm long. Inflorescence a terminal raceme, lax; peduncles 2.0 to 25.0 cm long; flowers one-sided, alternate rarely opposite, pubescent or nearly glabrous; pedicels 1.5 to 3.0 mm long, pubescent with glandular and eglandular hairs. Bracts and bracteoles minute, 1.0 to 2.0 mm long; base 0.4 to 0.8 mm wide ± glabrous, triangular, margin ciliate; apex acuminate rarely acute. Calyx 4.5 to 10.0 mm long, lobes 0.8 to 1.5 mm wide at base, ± equal, linear lanceolate, apex acuminate; sparsely pubescent with glandular and eglandular hairs, glandular hairs dominating on the tube. Corolla purplish rarely yellowish or whitish with reticulate and conspicuous veins, 25.0 to 40.0 mm long rarely less; tube 21.0 to 31.0 mm long; sparsely pubescent with glandular and eglandular hairs, eglandular hairs dense below the attachment of the stamens (inside the tube). Stamens didynamous, one long and one short; longer pair 6.0 to 10.5 mm long and provided with a line of short glandular hairs (along the length); shorter pair 5.0 to 8.0 mm long ±glabrous; anthers 2.0 to 4.0 mm long, cells unequally placed, tailed at the base. Ovary conical,

2.0 to 3.5 mm long; style pubescent at and near the base (about one-third of its length), 14.0 to 22.0 mm long including the stigma, rarely less; stigma slightly bifid. Capsule 21.0 to 31.0 mm long, hirsute with glandular and eglandular hairs. Seeds compressed, about 5.0 to 5.5 mm in diameter, glabrous but provided with unequal sized processes, margin double dentate, grey in colour.

DISTRIBUTION

Amboina, Barbados, Biaro, Florida, Galathea, Hawaii, India, Jamaica, Java, Malaya, New Guinea, Philippines, Sri Lanka, Thailand, Trinidad, Venezuela (Fig. 24). Also reported from British Guiana and Colombia (Leonard 1953).

HABITAT

Grassland, roadside, riverine forest and hilly grounds. The only altitudes recorded are 50 and 200 m for New Guinea and Thailand, respectively.

COLLECTIONS MEASURED

AMBOINA: 1913 Robinson 1784 (C).

BARBADOS: Codrington House 1958 no. coll. (K)

BIARO ISLAND, INDONESIA VII 1929 Nielsen 795 (C)

BORNEO: Sandakan I. 1950 Kadir A 2705 (K)

FLORIDA: Edison Estate Garden III. 1969 Brumbach 6638 (UPS); Fair Child Tropical Garden III. 1969 Gillis 7917 (S).

HAWAII: Cultivated Degner & Jakawato 10123 (S)

INDIA: South II. 1935 Barnes 83 (K) Madras, Chenzapalli II. 1908 Bourne 5085 (K); I. 1883 Gamble 11901 (K); in garden IV. 1924 Franck 348 (S); Woodoo, Mulcullay X. 1952 Wight 2269 (K); Royal Garden Kew K 2269 (C); IV 1980 Thanikaimoni 1538 (C).

? Vahl s.n. (K).

JAMAICA: XII. 1955 stearn 33 (S).

JAVA: west III. 1930 Franck 1054 (C).

MALAYA: Selangor 1937 Franck 1084 (C).

NEW GUINEA: Sentani dist., Ifar 50 m XII 1954 Mckee 1809 (C)

SRI LANKA: IV 1973 Bremer et al. 190 (S); Batticaloa XII. 1976 Cramer 4776 (K); Thwaites 1988 (BR); IV 1973 Wanntorp 2587 (S).

THAILAND: Muak Lek Falls 200 m II. 1962 Larsen s.n. (C); Bangkok Sorensen et al. 1983 (C); Zimmermann 67 (C).

TRINIDAD: near Rio Claro V. 1957 Richardson 15443 (K)

VENEZUELA: Orinoco Rysly & Squire 38 (K)

OTHER COLLECTIONS

GALATHEA: Bay of Bengal Wallich 1262 (C).

HAWAII: Mouth of Niu stream X. 1946 Fosberg 27119 (S).

INDIA: 1854 Wallich two collections s.n. (C); III. 1813 Wallich 268 (C); Vahl two collections s.n. (C) Rottoboll three Collections s.n. (C); Schumacher s.n. (C)

PHILIPPINES: Mindanoa, Siara plantation XI. 1950 Anonuevo 13467 (BR).

SRI LANKA: Pinnawala IV 1973 Bremmer et al, 194 (C).

THAILAND: Bangkock 1899 Zimmermann 68 (BR).

A. gangetica (L.) T. Anders. subsp. micrantha (Nees) E. Kelbessa comb. et stat. nov.

Basionym: A. coromandeliana Nees var. alpha* micrantha Nees in DC., Prod. 11:165 (1847).

Orig. coll.: Sudan, Sennaar Acerbi 687 (DC. holotype, microfiche photograph seen).

SYNONYMS:

Ruellia intrusa Forskal, Fl. Aeg-Arab. 113 (1775).

A. capensis Nees in Schlechtend., Linnaea 356 (1841.

Dyschoriste biloba Hochst., Flora 3:72 (1845).

A. chelonoides Nees var. delta arabica Nees in DC., Prod. 11:164 (1847).

A. coromandeliana Nees var. beta Nees in DC., Prod. 11:165 (1847) partly.

A. coromandeliana Nees var. beta* Nees in DC., Prod. 11:165 (1847) partly.

A. coromandeliana Nees var. delta tomentosa Nees in DC., Prod. 11: 165 (1847)?

A. intrusa Nees in DC., Prod. 11:166 (1847).

A. bojeriana Nees in DC., Prod. 11:166 (1847).

A.comorensis Bojer ex Nees in DC., Prod. 11:166 (1847)

A. calycina Benth. non Nees in Hook., Fl. Nigr. 478 (1849)

A. podostachys Klotzsch in Peters, Reise Mossamb. Bot. 199 (1862).
A. subhastata " " " " " " 200 "
A. floribunda " " " " " " " "
A. acuminata " " " " " " 201 "
A. pubescens " " " " " " 202 "
A. scabrida " " " " " " " "
A. multiflora " " " " " " 203 "
A. querimbensis " " " " " " 204 "

A. quanterna auct. non Nees: Anderson. in Journ. Linn. Soc. London 7:52 (1864) and in Thwaites, Enum. Pl. Zeyl. 235 (1864)
A. parvula auct. non Nees Ake Assi Contri. 1:209 t.16 (1961).

NOMINA NUDA:

Tyloglossa longipes Hochst. ex. Solms-Laub in Schweinf., Beitr. Fl. Aethiop. 104 (1867).
Ruellia quaterna Schumach., Beskr. Guinea Pl. 284
Ramusia nyctaginea E. Meyer in Drege Zwei, Aflazenfam. Decumente 150, 160 and 215.

DESCRIPTION

Weakly scrambling suffrutescent herb, rooting at lower nodes, rarely erect, 0.25 to 2.0 m long. Stem branched, rarely simple. Leaves ovate, subovate, lanceolate or rarely oblong, 2.5 to 13.0 cm long, 1.4 to 7.0 cm wide; base cordate,

truncate, rounded or rarely oblique; apex acuminate, acute, mucronate or rarely obtuse or apiculate; petiole 3.5 to 57.0 mm long. Peduncles 1.5 to 23.0 cm long, 3-many flowered; pedicels 0.8 to 3.0 mm long. Bract 0.8 to 3.0 mm long, 0.3 to 0.8 mm wide at base. Calyx 4.0 to 7.0 mm long, lobes 0.5 to 1.5 mm wide at base. Corolla white with violet markings on the lower lip, rarely pale blue or pale mauve, dries yellow, 12.0 to 26.0 mm long, tube 8.5 to 19.0 mm long. Stamens; longer pair 3.5 to 9.0 mm long; shorter pair 2.5 to 7.0 mm long; anthers 1.5 to 3.0 mm long, rarely provided with dark-blue line dorsally. Ovary 2.0 to 4.0 mm long; style and stigma 6.0 to 14.5 mm long. Capsule 18.0 to 26.0 mm long. Seeds 4.0 to 5.0 mm in diameter provided with ±equal sized processes, margin undulate or crenate.

DISTRIBUTION

Aldabra, Angola, Benin, Botswana, Burundi, Cameroon, Central African Republic, Chad, Congo, Ethiopia, Gabon, Ghana, Ivory Coast, Kenya, Liberia, Madagascar, Malawi, Mozambique, Namibia, Nigeria, Réunion, Rwanda, Senegal, Seychelles, Sierra Leone, Socotra, South Africa, Sudan, Tanzania, Togo, Uganda, Yemen Arab Republic, Zaire, Zambia, Zimbabwe (Fig. 24). Also reported from Boror, equatorial Guinea, Macias Nguema Biyoga, Niger, Rrincipe,

Sao Tome and Swaziland (Compton, 1976; Exell, 1944; Bentham, in Hooker, 1849).

HABITAT:

Generally disturbed habitats such as roadsides, forest clearing and old farm lands and all soil types. 0-2200 m (reported from 3100 m in Kenya).

COLLECTIONS MEASURED

ALDABRA: South Island I. 1968 Renvoize 797 (BR).

ANGOLA: Kampushi River I. 1938 Milne-Redhead 4229 (BR).

BOTSWANA: Kwando area I. 1976 Williamson 71 (BR).

CAMEROON: Adamwa, Gashaka II. 1954 Latilo & Daramola 28963 (K); 10 km N. of Betare-Oya II. 1966 Leeuwenberg 7751 (BR); Kumba dist. IV. 1951 Olorunfemi 30552 (K).

ETHIOPIA: Kaffa around Giren 2000 m XIII. 1972 Friis 1706 (C); 10 km E. of Jimma ±2000 m De Wilde 7631 (C); Eritrea, Hamasen IV. 1902 Pappi 4071 (S); Tigrai, 28 km S of Indaselassie 1700 m. IX. 1970 De Wilde 7093 (BR); Illubabor, ±1 km E. of Mettu 1630 m. XII. 1972 Friis 1565 (ETH); Wallega ±5 km E. of Nekemte ±1800 m De Wilde 8901 (UPS); E. slope of Didessa R. Valley 1300 m. IX. 1975 Gilbert & Thulin 652 (UPS); 13 km. E. of Nekemte 1900 m. IX. 1975 Gilbert & Thulin 845 (UPS).

GABON: V. 1972 Gavage 2 (UPS).

GHANA S. of Axim III. 1953 Morton 8482 (K).

IVORY COAST: S.E. of Abidjan VII. 1967 Geerling & Bokdan 380 (BR); 40 km N.E. of Abidjan ±40 m. X. 1968 Leeuwnberg 1737 (BR, K).

KENYA: Mombassa Island I. 1953 Drummond & Hemsley 1049 (S) Kwale dist. sea level VII. 1953 Drummond & Hemsley 3914 (BR), S); 1600 m IX. 1949 Geesteranus 6254 (S); Teita Hills, E. of Kidaya 1560 m II. 1966 Gillett & Burtt 170 (BR); Kakamega dist. 1700 m Kerstin & Lenart-Holm 16 (UPS).

LIBERIA: Gola forest VII. 1966 Bos 2357 (BR); Tapeta area Bos 2629 (BR).

MALAWI: 1350 m Stolz 290 (C).

MOZAMBIQUE: Quelimane dist; Faulkner 125 (S); Lumbo IX. 1949 Faulkner 461 (S); Delegoa Bay IX. 1929 Mortensen 4 (C).

NIGERIA: Jos plateau VII. 1960 Batten-Poole 185 (K); Obubra V. 1959 Binuyo 41363 (K); 12 miles N. of Ibadan Feiling 3.5 (C); Lagos XII. 1927 Hagerup 843 (C); Sapoba III. 1969 Lowe 1692 (K); Bibundi I. 1891 Jungner 12 (UPS).

RWANDA: 1750 m III. 1972 Bouxin 1411 (BR); Mutara XII. 1958 Troupin 9599 (BR).

SEYCHELLES: Mahe-Biole 200 m XI. 1961 Jeffrey 355 (S).

SIRRA LEONE: Shenge V. 1967 Morton & Jarr 3994 (K); Ronietta ±75 m II. 1921 Thomas 5289 (BR).

SOUTH AFRICA: Natal, Durban II. 1914 Fries 3596 & 3597 (UPS); I. 1927 Larsen 21 (C); Probe Durban 1886 Wood 1006 (UPS); Birghton Beach I. 1950 Nielsen 1450 (C).

TANZANIA: Amani 1000 m VII. 1974 Baagoe et al. 179 (C); Ikuu 1060 m I. 1950 Bullock 2321 (BR); Tanga dist. VII. 1953 Drummond & Hemsley 3231 (S); Bushiri Estate 1950 Faulkner 615 (S); Mbulu Island, L. Tanganyka II. 1955 Richards 4521 (FI); Mblu 970 m VI 1965 Greenway & Kanuri 11914 (BR); Manyoni dist. 1320 m IV 1964 Greenway & Polhill 11580 (S); Kisarawe XI. 1969 Ruffo 324 (BR); Shubi 1515 m II. 1959 Tanner 4509 (BR); Ngara dist. 1670 m XII. 1959 Tanner 4662 (BR); Great Ruaha River 450 m IX. 1970 Thulin & Mhoro 872 (UPS); Bushubi 1515 m Turner

5895 (S); Massazine sea level upwards VII. 1959 Faulkner 2303 (BR).

YEMEN ARAB REPUBLIC: Hadi Hadaba 1400 m I. 1975 Hepper and Wood 5977 (C).

ZAIRE: VII. 1971 Iwarsson 115 (UPS); Garamba National Park VII 1950 Noirfalise 941 (BR).

ZAMBIA (N. RHODESIA): Sesheka dist. Angus 1073 (BR).

ZIMBABWE (S. RHODESIA): Hartley dist. II. 1951 Homley 3226 (S); Salisbury 1120 m Chase 7901 (S); Chipinga dist. 730 m V. 1957 Chase 7733 (BR, S).

OTHER COLLECTIONS

ANGOLA: Mexico dist. I. 1938 Milne-Redhead 4040 (BR); Kampushi River I. 1938 Milne-Redhead & Ciess 1918 (BR).

BENIN: Porto Novo I. 1964 Kimbe 111 (BR).

BURUNDI: Kitega III. 1958 Van der Ben 1970 (BR); Buhonga 1120m X. 1967 Lewalle 2077 (BR); Bujumbura 800 m X. 1969 Lewalle 3964 (BR), Ruzizi, Kigamba 1500 m I. 1975 Reekmans 4157 (BR); Bubanza, Gihungwe 850 m I. 1975 Reekmans 4264 (BR); Nyamagama Valley 1600 m X.1971 Reekmans 1094 (BR); Bujumbura, Kikoma 1000 m XII. 1971 Reekmans 1229 (BR); Ruzizi valley 800 m XII. 1973 Reekmans 2954 (BR); Bururi 1500 m V. 1974 Reekmans 3575 (BR); ± 850 m IX. 1974 Van der Veken 11309 (BR); beach of L. Tanzanyika IX. 1974 Van der Veken 11165 (BR); 1900 m V. 1971 Reekmans 672 (BR); IX 1932 Berquet 169 (BR); 1900 m Reekmans 253 (BR); Kiof IX. 1952 Michel 3829 (BR); Kiharo IV. 1951 Michel & Reed 1700 (BR);

Urundi III. 1952 Michel & Reed 1328 (BR); Gisuru XII. 1951 Michel & Reed 903 (BR); Kiharo IV. 1951 Michel & Reed s.n. (BR); Mosso-Ruyigi IX. 1951 Michel & Reed 432 (BR).

CAMEROON: Eseka XII. 1967 Bamps 1397 (BR); ±17 km S of Meiganga 900 m XI. 1964 De Wilde et al. 3937 (BR); 100 km N of Meiganga 100 m De Wilde et al. 4116 (BR); 8 km N of Masok 400 m IV. 1965 Leeuwenberg 5407 (BR); shore of Barombi crater lake 350 m Leeuwenberg 6873 (BR); near village Zilly ±700 m XII. 1961 Breteler 2061 (BR); Yaunde station 800 m Zenber et Staudt 489 (BR); Adamwa plateau X. 1960 Breteler 550 (BR, FI); Bertoua Breteler 744 (BR); Gabadouma Breteler 1475 (BR),

CENTRAL AFRICAN REPUBLIC: membere River XII. 1965 Leeuwnberg 7218 (BR); Near Mhabza km 15 off Nola Solo road Leeuwnberg 7107 (BR); Yalinga VI. 1952 Le Testu 4332 (BR).

CHAD: Mongo IX. 1935 Louis 149 (BR, C).

CONGO: Boko 1932 Vanderyst 29486 & 29811 (BR).

ETHIOPIA: Eritrea, Ghinda-Baresa II. 1893 Pappi 75 (FI); 850 m XI. 1909 Fiori 765 (FI); Beni Amer 750 m II. 1911 Pappi 8805 (FI); 700 m III. 1911 Pappi 8812 (FI); 750 m IX 1907 Pappi 7521 (FI); 800 m X. 1907 Pappi 7658 (FI); Pappi 7592 (FI); 600 m. X. 1907 Pappi 7421 (FI); Hamasen I. 1902 Pappi 3511 (FI); ±1270 IV. 1932 Beneditis 420 (FI); turn to Adi Ugri IX. 1907 Bellini 20 (FI); Barea 630 m II. 1909 Pappi 768 (FI), Saati-

Ghinda III. 1892 Pappi 19 (FI); near mereb I. 1906 Pappi 6948 (FI); Medri ad Tesfa X. 1905 Pappi 42 & 6566 (FI); XI. 1905 Beccari 214 (FI); Embat Kalla 1400 m V. 1892 Barbey 2000 (FI); Ghinda al Dongolo 960 m I. 1909 Fiori 766 (FI); Bogas IX. 1909 Pappi 8553 (FI); IV 1909 Pappi 8479 (FI); Mensa 1400-1600 m I. 1893 Pappi 2187 & 2252 (FI); Hamasen IV 1902 Pappi 4071 (BR, FI); Sabarguma - Domgolo III. 1903 Terhm 1620 & 1662 (FI); Ghinda Dongolo Barbey et al. 2120 (BR); Barnescin 1000-1300 m IV. 1924 Fiori 140 (FI); Hamasen 830 m I. 1909 Fiori 765 (FI); 700 m III. 1909 Fiori 767 (FI); 160 m Riva 1452 (FI); Keren X. 1902 Terhm 1060 (FI); Amhara Tselemti XII. 1909 Cheovenda 3214 (FI); 1600 m XI 1912 Tesfu 167 (FI); Kaffa ±28 km E. of Bonga ±1300 m IV. 1969 De Wilde 5640 (BR); Jimma VIII. 1937 Saccardo 13 & 84 (FI); X. 1938 Lantucci 422 (FI); Ghion-Hotel 1750 m XI. 1964 Meyer 8815 (FI); 1880 Mooney 5867 (BR, ETH, FI); around Giren 2000 m XI 1972 Friis 1565 (BR); ±8 km E. of Jimma De Wilde 7631 (BR); Gojeb XI. 1939 Saccardo 455 (FI); at km 585 on the Jimma Mettu road I. 1978 Mesfin 151 (ETH. UPS); Gondar ±22 km from Bahr Dar ±1900 m X. 1980 Ensermu (ETH. UPS); Illubabor, Batchi 1250 m XII. 1960 Mooney 8837 (ETH, FI); 1 km E. of Mettu I. 1972 Friis 1706 (BR, ETH); Sidamo 7 km N. of Dilla 1810 m XI. 1967 Westphal & Westphal-Stevens 2832 (BR, C) near Adola ±1850 m I. 1954 Mooney 5651 (BR, ETH, FI, S); Tigrai, ±28 km E. of Enda-sellasie IX. 1970 De Wilde 7093 (BR); Wollega, Dembi Dollo 1820 m II. 1957 Mooney 6807 (BR, FI); Barea-Agordat 500 m I. 1893 Pappi 2797 (FI); X. 1937 Benedetto 217 (FI); ±5 km E. of

Nekemte De Wilde 8901 (BR, ETH); 13 km E. of Nekemte IX. 1975 Gilbert & Thulin 845 (ETH); E. slope of Didessa River Valley IX. 1975 Gilbert & Thulin 652 (ETH); Gamo Goffa, Lopo L. Margherita II. 1950 Vatova 1840 (FI); at River Kulufo ±1250 m X. 1980 Ensermu 430 (ETH, UPS); VIII. 1969 De Wilde 5640 (BR).

GABON: Moanda I. 1887 Berolinens 198 a (UPS); V. 1972 Gavage 2 (UPS); Libere ville V. 1900 De Beaux 133 (BR).

GHANA: Kumasi VII. 1951 Darko 697 (BR); near Kumasi market VII 1961 Irvine 4517 (K).

KENYA: Mombassa Island I. 1953 Drummond & Hemsley 1045 (BR); Turkana Prov. W. Suki ± 1210 m Thorold 2793 (BR); Kisumu, Njahera XII. 1939 Bally 648 (BR); Shimba hills 3000 m XII. 1968 Mwangangi 1274 (BR); Kungwe-Mahali Peninsula ±770 m Harley 9446 (BR); Teita hills, E. of Kidaya 1560 m II. 1966 Gillett & Burtt 17072 (BR); coast, Mrima Hills 280 m XII. 1969 Bally B 13720 (FI); Cherengany Hills ±1060 m Mabberly & McCall 273 (FI); Shimba hills ± 1800 Magogo & Glover 916 (FI); Longom, Wangandi area ±440 m Magogo & Golver 173 (BR, FI); Mombassa 1933 Dariva 1744 (FI); Kwale forest area ± 380 m III. 1968 Magogo & Clover 423 (FI); Kilifi dist. XII. 1969 Rerdue & Kiduwa 10170 (BR); Maburu 3000 m IX. 1963 Marcello s.n. (FI); Kakamega forest I. 1970 Kerstin & Lenart-Holm 16 (K); Shimba hills 300 m II. 1953 Drummond & Hemsley 1061 (BR, FI, S); Mombassa Island X. 1954 Drmmond & Hemsley 1049 (BR, FI); Shimoni sea level VIII. 1953 Drummond & Hemsley 3914 (FI);

Kakamega forest station ±1600 m IX 1949 Geesteranus 6254 (BR).

LIBERIA: Nimba mountain 450 m Adam 21040 (UPS) 3 km NE. of Suacoco Gbaranga II. 1951 Konneh 131 (BR); suehn XI. 1926 Linder 1391 (K).

MADAGASCAR: Cammerson s.n. (C); Central VIII. 1880 Parker s.n. (FI).

MALAWI: Zamba plateau VI. 1952 Boughey 1284 (BR); Goche kirk 1600 m I. 1959 Robson 1349 (BR); Cholo mountain 1200 m IX. 1946 Bhase 17709 (BR); 1892 Buchman 163 (BR); Descamps s.n. (BR); Senga Bay Hotel 470 m II. 1959 Robson 1630 (BR).

MOZAMBIQUE: Lumbo IX. 1949 Faulkner 461 (BR); Inhambane Gomes & Sousa 1659 (BR); Lourenco Marques 1893 Quintas 11 (BR) 1890 Junod s.n. (BR); I. 1898 Van der Bossche 12041 (BR); Kombat Port 1898 Vander Bossche 11754 (BR); Inhaca Island IX. 1958 Mogg 28353 (FI); IV 1936 Gomes & Sousa 1738 (BR); Quelimane dist. Faulkner 125 (BR. C).

NAMIBIA Myara III. 1958 Mac-Miller & Ciess 1918 (BR).

NIGERIA Ebute-Ikorodu VIII. 1962 Gillett 15345 (BR); Niger delta VIII. 1964 Anderson 1392 (K); Gombe 1921 sampin s.n. (BR); Saboba III. 1959 Binuyo 41364 (K); Bibundi X. 1891 Jungner 277a (UPS).

REUNION: Cirque de Salorize IV. 1980 Billiet & Jadin 780 (BR); Entre Saint Philippe IV. 1980 Billeet & Jadin 831 (BR).

RWANDA: Kigali Burgersa 1480 m VII 1958 Troupin 7844 (BR);

Biumba ±1400 m VII. 1958 Troupin 7953 (BR); Kagera N.P., Kiburgu IV. 1958 Troupin 6880 (BR); Mohoro 1400 m IV 1958 Troupin 6788 (BR); 1450-1500 m IX. 1958 Troupin 8109 (BR); Biumba ±1400 m X. 1956 Troupin 2794 (BR); X. 1957 Troupin 4917 (BR); Gissako shore 1500 m IV. 1969 Bouxin & Radoux 279 (BR); Mutara 1400 m Troupin 5099 (BR); L. Ihema 1350 m IV. 1970 Bouxin & Radoux 1902 (BR); Kidama ±1450 m II. 1958 Troupin 9096 (BR); Biumba II. 1958 Troupin 5977 (BR); Kagera N.P. Troupin s.n. (BR); 1370m Troupin 6111 (BR); Bugesera Troupin s.n. (BR); L. Kiva, Nyamashabe 1530 m 1929 Bouxin 528 (BR).

SENEGAL: XII. 1947 Berhaut 731 (BR); Dakar-Annee II. 1948 Adam 557 (BR).

SEYCHELLES: Mahe XII. 1929 Nielsen 1329 (C); Parslin X. 1970 Schlieben 11743 (BR); Mahe X. 1976 Ghyoot 22 (BR);

SIERRA LEONE: Afzelius five collections s.n. (UPS); Buttam shore Afzelius s.n. (UPS); Yoni mamila XII. 1950 King 5B (K); Mafara XI. 1955 Marmo 173 (K).

SOCOTRA:Kishen Valley VIII. 1956 Gwgnne 63 (BR).

SOUTH AFRICA: Mezeppa bay III. 1952 Therson 1215 (S, UPS); Nai Durban I. 1930 Nielsen 1401 (C).

SUDAN: Yei River Switoe 435 (UPS); Bahr el Jebel Valley 1906 Jardika 80 (BR).

TANZANIA: ±4 km N.E. of Kigonsera ±960 m IV. 1956 Milne-Redhead & Taylor 9722 (BR); Kigombe 1900 m X. 1955 Milne-Redhead & Taylor 7276 (BR); IV. 1953 Drummond and Hemsley 323

(BR); Bushiri Estate 1950 Faulkner 615 (BR); Amani I. 1950 Verdcourt 15 (BR); Siyi near Amani 1950 Verdcourt 24 (BR); Tanga II. 1893 Nolbens 163 (BR); Kakombe VII. 1959 New bould & Harley 4260 (BR); S. Amani IV. 1969 Ngoundai 311 (BR); Massaguti VI. 1931 Schlieben 677 & 1148 (BR); Mhali peninsula VIII. 1959 Harley 9446 (BR); Kungwe mountain 1575 m VII. 1959 New bould & Harley 4579 (BR); Lushoto 1515 m I. 1966 Archbold 670 (BR); Pangani beach IX. 1950 Faulkner 668 (BR); Rukwa Valley I. 1947 Pielou 54 & 73 (BR); Ulungurus 1212 m I. 1935 Bruce 427 (BR); Arusha dist. ± 1215 m X. 1965 Greenway and Kanuri 12188 (BR); Kidatu II. 1971 Mhoro 495 (UPS); Kiberoge IV. 1971 Mhoro 1039 (UPS); XII. 1921 Fries 3604 (UPS); Usumburas-urira road IV. 1953 Van der Ben 335 (BR); Bulimba 914 m V. 1975 Kahuranga 2656 (BR); Naka Wali River 930 m III. 1956 Milne-Redhead & Taylor 9126 (BR); Madanga sea level Morogoro ±670 m XI. 1934 Bruce 93 (FI); VII. 1955 Tanner 1926 (BR); Insel Mafia VIII. 1932 Schlieben 2681 (BR); Dar es Salaam area sea level III. 1968 Batty 15 (BR); Mabako, L. Victoria XII. 1939 Sromy S. 1076 (BR).

TOGO: Lome Prov. Warneke 272 (BR).

UGANDA: W. Nile dist. ±910 IX. 1953 Chancellor 299 (BR); Ruwenzori Hauman 288 (BR); Tororo 1200 m IX. 1963 Marcello s.n. (BR). Route Kampala-Berunda XI. 1957 Bamps 72 (BR).

YEMEN ARAB REPUBLIC: Montes kadiensis Balghose s.n. (C); Forskal 370 & 371 (C).

ZAIRE: Albert National Park, Katanda 950 m II. 1957 Lebrun 7603 & 7671 (BR); Isahamui ±1000 m X. 1937 Lebrun 8002 & 8071 (BR); Rumaka ±1600 m I. 1947 Germain 3374 (BR); De Witte 9889 (BR); ±1400 m IX. 1954 De Witte 11110, ±950 m IX. 1954 De Witte 11321 ±925 m.I. 1955 De Witte 11710; ±1000 m II. 1956 De Witte 12941 & 12992, ±1023 m VII. 1956 De Witte 13305 & 13369, ±1025 m IX. 1956 De Witte 13471 & 13488, ±915 m. 1956 De Witte 13689, ±1010 m XI. 1956 De Witte 13780, ±935 m XI. 1956 De Witte 13800, 13841 & 13897, ±970 m I. 1957. De Witte 13954, 13996, 14005 & 14024, ±100 m. II. 1957 De Witte 14062, 14074, 14086, 14098, 14180 & 14192, ±1100 m III. 1957 De Witte 142114, 14225 & 14258 (all BR); Yangabi ±470 m VII 1941 Louis 15565 (BR); Balomba IV. 1905 Laurent 54 (BR); Nvembo I. 1907 Vanderyst 182 (BR); Kilobola V. 1906 Pynaert 70 (BR); N. Kolia kando 1903 Laurent 42 (BR); Bambesa III. 1935 Steyaert 127 (BR); Yalinga XI. 1922 Le Tesfu 4336 (BR); Haute-Kotto VIII. 1922 A.E.F. s.n. (BR); Bamania VIII. 1914 Nannan 115 (BR); R. zungbe II. 1936 De Graer 453 (BR); Ruzizi plain I. 1950 Germain 5638 (BR); Songololo XII. 1959 Campere 1040 (BR); Madimba Kimpako IV. 1960 Campere 1917 (BR); Lake Banza IV. 1960 Campere 1872 (BR); L. Edward ±925 m IX. 1954 De Witte 11461 (BR); L. Kivu 1500 m XII. 1953 Rich-Sermolli 152 (FI) Mvuaza IV. 1948 Devred 172 (BR); Vanderyst 17571 (BR); Mfumu Dimi IV. 1953 Calens 1570 (BR); Lovanium IX. 1965 Carrington 62 (BR); Beni 1200 m IX. 1936 Gille 236 (BR); IV.

1914 Bequaert 3388 (BR); Kisangani VI. 1979 Linsowski 52575 (BR); Lwiro 1700 m I. 1972 Auquier 2187 (BR); between L. Kivu L. Edward 1460-2000 m 1937 Humbert 8171 (BR); Yangabi ±470 m VII. 1938 Louis 10398 (BR, FI); Nay Ya Nato ±950 m XI. 1935 DE Witte 2020 (BR), Karisimbi V. 1934 De Witte 1637 (BR); Landana VIII. 1895 Deurevre 217 (BR); Ougi VIII. 1914 Bequaert 5307 (BR); Boambella IV. 1913 De Giorgi 395 & 478 (BR); Bilimolo II. 1913 De Giorgi 353 (BR); IX. 1913 De Giorgi 1307 (BR); Kasenga II. 1912 Bequaert 236 (BR); Bokada IV. 1913 Niilis s.n. (BR); Mokaba VIII. 1913 Vanderyst 1663 (BR); Illa Basali ±470 m IX. 1938 Louis 11159 (BR); Lukula VII. 1913 Bequaert 653 (BR); Mongala 440 m II. 1909 Thonner 208 (BR); Bokuma II. 1941 Houlotaert 107 (BR); Kisantu Collens 95 (BR); Crokola 27 (BR); Kanunkina II. 1936 Luxen 430 (BR); Ngilliov 1920 Billomaert 52 (BR); Eala 1906 Punaert 633 (BR); Ikelunda 1913 Bonnwair 17 (BR); Kisenga Vanderyst s.n. (BR); Asbrida ±1650 m IV. 1960 Hendrickx 7645 (BR); Lomani 1891 Descamps 131 (BR); Maleina I. 1903 Laurent s.n. (BR); between L. Kivu & L. Tanganyika XII. 1911 Fries 1437 (UPS); Katana IX. 1953 Van Der Ben 833 (BR); L. Kivu 1460 m Germain 3297 (BR); Plain of L. Edward VI. 1945 Germain 3843 (BR); Kimwenza III. 1966 Breyene H. 100 (BR); Dibaya X. 1956 Liben 1838 (BR); L. Tumba 350 m X. 1957 Thonet 76 (BR); Goma 1460 m Baudet 574 (BR); Lubero 1580 m IX. 1959 Leonard 5319 (BR); Kabare 1650-1700 m XI. 1956 Troupin 2908 (BR); kiobo 350 m IV. 1940 Donis

236 (BR); Luki I. 1947 Donis 1432 (BR); Eala garden Leonard 903 (BR); Lubumbashi III. 1970 Linsowski 10147 (BR); Euv de Lakandu VI. 1905 Gossaert s.n. (BR); Yukari 1913 Bavicchi 223 (BR); Kionzo XI. 1913 Ureschueven 970 (BR); Myansjore V. 1899 Dupius s.n. (BR); Monda IV. 1913 Vanderyst s.n. (BR) Dima VI. 1913 Vanderyst 915 (BR), Kikwit I. 1914 Vanderyst 2875 (BR); Kisanta III. 1911 Vanderyst s.n. (BR); Koma 1909 Allard 36 (BR); Catra 41 (BR); Inkin Valley 1910 Allard 482 (BR); Kisantu 1907 Gillett s.n. (BR); Bambila X. 1950 Vos 101 (BR); Bangala Sapin s.n. (BR); Ladja IV. 1939 Gillardin 541 (BR); Imese 1912 Sapin s.n. (BR); Kechero 1958 Thonner 75 (BR); Uvira ±773 m VII. 1955 Seymonens 1117, 1240 & 1253 (BR); ±800 m XI. 1955 Seymoens 1924 (BR): Bopote, Anhohe VIII. 1896 Thonner 3 (BR); Benja Massola X. 1903 Laurent s.n. (BR); Kisantu 1932 Vanderyst 35161 (BR), Vanderyst s.n. (BR); Kisantu IV. 1930 Vanderyst 24606 (BR); Lulubourg 1930 Vanderyst s.n. (BR); Formulat 1932 Vanderyst 28911 (BR); Sonso 1932 Vanderyst 28892 (BR); Kiwango 1926 Vanderyst 1912 (BR); Eala VII. 1936 Cauteaux 3 (BR); Kipako 1932 Vanderyst 20218 (BR); Lindi 240 m 1955 Schlieben 5295 (BR); IX. 1936 Couteax 93 (BR); Bangala VI. 1914 Vermoesen 415 (BR); Angessera IX. 1953 Van der Oosten 56 (BR); Quzi IX. 1914 Bequaert 5815 (BR); Katanda ±1000 m IX. 1974 d'Haurt 78 (BR); Nyokakoma ±950 m IX. 1974 d'Haurt 46 (BR); Bambesa III. 1935 Steyaert 119 (BR); Mulugu 1974 Hendrickx 37 (BR); Kaniama, Haunt Lomami ±860 m IV. 1943

Mullenders 479 (BR); W. Katana ±2200 m 1929 Van der Houdt 283 & 296 (BR); L. Edward, Vitshumbi Bay I. 1953 Van der Ben 6 (BR); Akanyamakoma VI. 1953 Van der Ben 555 (BR) Baudoninville VII. 1957 Devred 3475 (BR); Kisantu 1935 Louis 10 (BR); Yelulutcha ±470 m XI. 1938 Louis 12807 (BR); Bandwana Ya Lome 470 m III. 1938 Louis 8540 (BR); Bogambe V. 1955 Eurard 886 (BR); Bambesa III. 1935 Steyaert 42, 50, 68 & 78 (BR); XII, 1952 Gerard 436 (BR); VI 1954 Shreurs 70 (BR) Garamba N.P. VIII. 1950 Noirfalise 661 (BR) IX. 1952 Noirfalise 822 (BR); I. 1950 Saeger 67 (BR); VII. 1952 Troupin 1476 & 1551 (BR); VI. 1952 Troupin 1261 (BR); VIII. 1951 Saeger 1313 (BR); VIII 1952 Troupin 1443, 1808 & 1855 (BR); VII 1948 Troupin 3113 (BR).

ZAMBIA (N. RHODESHIA): Chikoma mission X. 1955 Robson & Angus 14 (BR); Ndola II. 1954 Fanswe 773 & 443 (BR); Mapanza west ±1060 Robinson 260 (BR); Lunzua valley above kafakulo ±940 m III. 1955 Richards 4787 (BR); Mufulira ±1210 m I. 1948 Cruse 167 BR); Mufulira 1950 Cruse s.n. (BR).

ZIMBABWE (S. RHODESIA)Bembwe forest 1934 Martin A 17/34 (BR); Unsweswe River I. 1958 Mitler 4957 (BR); Chirinda de Wilde 1920 (BR); Chipinga Phipps 622 (BR); Umtali ? 3700 m III. 1963 Bhase 7961 (BR).

TABLE 1A: Measurements of Pollen Morphological Characters from Five Genera of Acanthaceae.
The Range of 10 Measurements. All measurements are in μm.

Species	CHARACTER									
	P	EP	SP	NP	E	EE	SE	NE	DP(O)	CO
Graphtophyllum pictum	57–61	3–4	2–3	1–2	53–60	2–4	1–2	1–2	7–8	45–48X5–7
Jacobinia glaziovii	59–63	2–3	1–2	1–2	31–35 24–27	3–4	2–3	1–2	3–5	51–53X3–5
Justicia flava	42–48	2–3	0.5–1	1–2	26–30	5–7	4–6	2–3	2–3	–
J. hyssopifolia	52–56	2–3	1–1.5	4–6	38–42 ?	2–3	2–3	6–7	7–8	24–27X2–4
J. natalensis	40–45	2–3	1–1.5	1–1.5	28–30	2–3	0.5–1	2–3	5–7X7–8	33–36X4–6
J. pinguior	45–49	2–3	1–2	1–2	26–31 21–25	4–5	2–3	1–2	2–3X4–5	
J. schimperi	52–55	2–3	2–3	0.6–1	33–36 18–22	5–3	3–4	1.5–2	4–5	–
J. trinerva	38–42	2–3	1–2	1–2	22–24	3–4	1–1.5	2–3	3–5X5–7	32–35X2–4
Mackaya bella	59–65	4–5	2–3	2–3	52–55	3–5	2–3	2–3	8–9	44–47X4–5
Styasasia sp. nov.	52–55	3–4	1–1.5	2–2.5	–	–	–	–	5–6	–

For Abbreviations see table 1B.

TABLE 1B. Measurements of Pollen Morphological Characters from Five Genera of Acanthaceae. Each Figure is the Average of 10 Measurements in µm.

Species	CHARACTER								
	P	EP	SP	NP	E	EE	SE	NE	A
Graptophyllum pictum	59	4	2.5	1.5	56	3	2	1	ora = 8 colpi = 44X5
Jacobinia glaziovii	59	3	2	1	34	4	3	1	ora = 4X6 colpi = 52X4
Justicia flava	45	2	0.5	1.5	27	7	4	3	3
J. hyssopifolia	54	2	1	1	40	5	2.5	2.5	ora = 6X8 colpi = 25X4
J. natalensis	42	2	1	1	29	3	1	2	ora = 6X8 colpi = 34X5
J. pinguior	47	3	2	1	29 23	4	2.5	1.5	3X4
J. schimperi	54	3	2	1	35 20	6	4	2	3X4
J. trinerva	40	3	1.5	1.5	24	3.5	1.5	2	ora = 4X6 colpi = 37X3
Mackaya bella	62	4	2	2	59	4	2	2	ora = 9 colpi 47 X6
Styasasia sp. nov.	53	4	1.5	2.5					3

Abbreviations: P = polar axis, EP = exine at poles, SP = sexine at poles, NP = nexine at poles, E = equatorial diameter, EE = exine at equator, SE = sexine at equator, NE = nexine at equator, A = apertures.

TABLE 2A. Measurements of Pollen Morphological Characters from Nine species of Asystasia Blume. The Range of 10 Measurements. All measurements are in µm.

Species	CHARACTER								
	P	EP	SP	NP	E	EE	SE	NE	DP
Asystasia calycina	79-83	4-6	3-4	1-2	47-51	11-13	7-8	5-6	3-5
A. charmian	105-112	6-8	2-4	3-5	63-71	19-21	14-16	5-6	5-6
A. drakebrockmanii	79-87	5-6	2-3	2-3	47-53	9-11	6-7	2-4	5-6
A. gangetica	56-87	4-6	1-2	3-4	36-50	8-14	6-8	4-6	3-5
A. guttata	81-92	6-7	2-3	3-4	49-56	13-16	9-12	2-4	4-5
A. macrocarpa	62-67	2-4	1-2	1-2	43-48	4-6	1-2	2-4	5-6
A. oppositiflora	69-76	4-6	2-3	2-3	47-50	9-12	5-8	3-4	3-4
A. scandens	85-89	4-5	2	2-3	55-57	5-7	2-3	3-4	6-8
A. schimperi	68-75	5-6	2-3	2-4	42-48	13-16	9-12	3-5	2-4

For Abbreviations see table 1B.

TABLE 2B. Measurements of Pollen Morphological Characters from Nine Species of Asystasia Blume. Each Figure is the Average of 10 Measurements in µm.

Species	CHARACTER								
	P	EP	SP	N P	E	EE	SE	NE	A
A. calycina	81	5	2	3	49	12	7	5	4
A. charmian	109	7	3	4	66	21	15	6	5
A. drakebrockmani	82	6	3	3	50	11	7	4	6
A. gangetica	74	5	2	3	46	13	8	5	4
A. guttata	87	7	3	4	52	15	11	4	4
A. macrocarpa	65	3	1	2	46	5	2	3	6
A. oppositiflora	73	5.5	2.5	3	49	7	3	4	8
A. scandens	88	5	2	3	56	7	3	4	8
A. schimperi	73	6	3	3	44	15	10	5	3.5

Abbreviations as in Table 1B

TABLE 3A: Measurements of Pollen Morphological Characters from Twelve Specimens of Asystasia gangetica subsp. gangetica. Each Figure is the Average of 10 Measurements in μm.

Collection	CHARACTER								
	P	EP	SP	NP	E	EE	SE	NE	A
Kadir A 2705	73	6	2	4	48	13	8	5	4
Gillis 7917	77	5	2	3	47	13	8	5	5
Hawaii no. coll. OHAU	80	5	2	3	47	12	7	5	4
Barnes 83	84	6	2	4	46	14	9	5	4
Kew K 2269	87	6	3	3	50	13	9	4	5
Stearn 33	73	5	2	3	48	13	8	5	4
Franck 1084	77	5	2	3	49	13	7	6	5
Franck 1054	86	6	2	4	47	13	7	6	5
Mckee 1809	75	5	2	3	44	13	8	5	4
Bremer et al 190	70	6	2	4	48	13	8	5	4
Wanntorp 2587	76	5	2	3	48	12	7	5	4
Sorensen et al. 1938	74	5	2	3	47	14	8	6	3

Abbreviations as in Table 1B

TABLE 3B: Measurements of Pollen Morphological Characters from 44 Specimens of A. gangetica subsp. micrantha. Each Figure is the Average of 10 Measurements in µm.

Collection	CHARACTER								
	P	EP	SP	NP	E	EE	SE	NE	A
Williamson 71	68	5	2	3	43	15	8	7	3
Friis et al. 1565	69	5	2	3	42	12	7	5	4
De Wilde 4680	72	5	2	3	44	11	6	5	4
De Wilde 7631	68	5	2	3	44	13	7	6	4
Ensermu 414	68	5	2	3	40	12	7	5	3
Ensermu 430	67	5	2	3	40	11	6	5	4
Ensermu 450a	66	5	2	3	42	13	7	6	4
Ensermu 450b	68	5	2	3	45	12	7	5	4
Gilbert 1608	67	5	2	3	42	12	7	5	4
Gilbert & Thulin 845	70	5	2	3	42	13	7	6	3
Mooney 5651	69	5	2	3	44	13	7	6	4
Mooney 5867	70	4	1	3	47	9	5	4	4
Mooney 8837	72	5	2	3	44	12	7	5	3
Pappi 4071	69	5	2	3	42	12	7	5	3
Westphal 2832	70	5	2	3	43	14	7	7	3
Gavage 2	66	5	1	4	41	11	7	4	3
Drummond & Hemsley 1049	56	6	2	4	36	12	7	5	2
Geesteranus 6254	66	4	1	3	40	12	7	5	4
Powek 6742	75	5	2	3	46	13	7	6	3
Stolz 290	66	6	2	4	39	11	6	5	3
Faulkner 125	77	6	2	4	47	13	8	5	3
Feiling 3.5	70	5	2	3	40	13	8	5	4
Hagerup 843	71	5	2	3	42	12	7	5	3
Jeffrey 355	69	5	2	3	42	11	7	4	4
Fries 3597	67	5	2	3	43	12	7	5	4
Nielsen 1450	78	5	2	3	50	14	9	5	4

TABLE 3B (Cont'd)

Collection	CHARACTER								
	P	EP	SP	NP	E	EE	SE	NE	A
Wood 1006	76	5	2	3	48	12	7	5	4
Jardika 80	66	5	2	3	43	12	7	5	4
Switoe 435	71	5	2	3	43	14	8	6	3
Drummond 3231	64	5	2	3	37	11	7	4	4
Faulkner 615	69	5	2	3	48	13	7	6	4
Greenway 11580	69	5	2	3	39	11	7	4	4
Verdcourt	76	5	1	4	45	11	6	5	4
Hepper & Wood 5977	66	5	2	3	40	11	6	5	4
Auquier 2187	67	5	2	3	47	12	7	5	5
Chesquiere 3538	68	5	2	3	45	14	7	7	4
De Wilde 14086	70	5	2	3	44	14	8	6	4
Fries 1437	69	5	2	3	40	10	6	4	3
Iwarsson 115	59	5	2	3	36	8	5	3	3
Angus 1073	71	5	2	3	42	13	7	6	4
Cruse 167	76	5	2	3	43	12	7	5	4
Fries 3604	58	5	2	3	37	11	7	4	3
Chase 7961	70	4	2	2	44	12	7	5	5
Chase 7733	70	5	2	3	47	12	7	5	4

For abbreviations see Table 1B

TABLE 4A: Measurements of Gross Morphological Characters from 28 Specimens of A. gangetica subsp. gangetica. Figures in mm.

Collection	CHARACTER							
	LL	LW	BL	KL	CL	SSL	CPL	SD
Thanikaimoni 1538	34.0	24.0	2.0	8.0	33.3	17.0	25.0	5.0
Franck 1054	43.0	35.0	1.5	7.0	39.1	21.0	31.0	5.5
Franck 1084	37.0	24.0	1.6	6.5	38.8	20.0	-	-
Wanntorp 2587	31.0	22.0	2.0	6.0	25.0	16.5	25.0	-
Bremer et al. 190	19.0	15.0	1.0	5.0	26.7	12.7	-	-
Sorensen et al 1983	33.0	18.0	1.5	7.5	39.3	20.0	25.0	-
Gillis 7917	31.0	30.0	1.5	6.0	39.0	18.0	-	-
Degener & Jakawato 10123	41.0	30.0	2.0	5.5	33.0	17.5	-	-
Kew K 2269	51.0	28.0	1.5	6.0	30.0	20.1	25.0	-
Stearn 33	25.0	20.0	2.0	5.5	35.0	16.1	-	-
Nielsen 795	65.0	38.0	2.5	4.5	20.0	4.1	-	-
Thwaites 1988	40.0	32.0	-	-	26.0	14.0	-	-
Larsen s.n.	40.0	26.0	-	-	38.0	18.0	-	-
Zimmermann 67	60.0	40.0	-	-	34.0	17.0	-	-
Mckee 1809	-	-	-	10.0	12.0	19.0	-	-
Wight 2269	-	-	-	7.0	34.0	20.0	21.0	-
Barnes 83	-	-	-	7.0	34.0	17.5	-	-

TABLE 4A (Cont'd)

Collection	CHARACTER							
	LL	LW	BL	KL	CL	SSL	CPL	SD
Franck 348	-	-	-	7.0	34.0	20.0	21.0	-
Robinson 1784	-	-	-	6.0	33.0	16.0	-	-
Kew s.n.	-	-	-	-	27.0	17.0	-	-
Kadir A2705	-	-	-	-	32.0	19.0	27.0	-
Bourne 5085	-	-	-	8.5	36.0	-	25.0	-
Brumbach 6638	-	-	-	5.0	28.0	10.0	-	-
Cramer 4776	-	-	-	-	33.0	15.0	-	-
Richardson 15443	-	-	-	10.0	35.0	20.5	-	-
Rusley & Squire 38	-	-	-	-	40.0	19.5	-	-
Gamble 11901	-	-	-	6.0	32.0	20.0	26.0	5.2
Vahl s.n.	-	-	-	8.0	32.0	18.0	-	-

Abbreviations: LL = leaf length, LW = leaf width, BL = bract length, KL = calyx length, CL = corolla length, SSL = style and stigma length, CPL = capsule length, SD = seed diameter.

TABLE 4B: Measurementw of Gross Morphological Characters from 68 Specimens of *A. gangetica* subsp. *micrantha* Figures in mm.

Collection	CHARACTER							
	LL	LW	BL	KL	CL	SSL	CPL	SD
De Wilde 7631	38.5	22.0	1.5	6.0	17.5	9.5	24.5	4.5
Friis 1706	61.5	39.0	1.6	6.0	16.5	8.9	22.0	5.0
Gilbert & Thulin 652	70.0	28.0	2.0	7.5	20.0	10.6	25.0	5.0
Gavage 2	52.0	29.0	2.0	6.0	18.0	5.9	22.5	4.5
Leeuwenberg 1737 (BR)	70.0	34.0	1.0	5.0	14.5	7.5	23.0	4.5
Drummong & Hemsley 1049	38.5	23.0	1.0	5.5	18.0	8.0	24.0	5.0
Kerstin & Lanart-Holm 16	52.0	27.0	1.5	5.0	20.0	9.5	24.0	5.0
Jungner 12	32.0	21.5	1.5	5.0	17.5	8.8	23.0	4.0
Fries 3596	25.0	17.0	1.6	7.0	24.7	12.8	28.0	5.0
Fries 3597	49.0	31.0	2.0	6.5	25.0	13.0	25.0	5.0
Wood 1006	40.0	26.0	2.0	6.0	20.0	11.0	25.0	5.0
Hepper & Wood 5977	48.0	27.0	1.0	5.5	18.3	10.0	25.5	5.0
Hagerup 843	48.0	38.0	1.0	6.0	17.3	9.0	25.5	-
Nielsen 1450	29.0	19.0	2.0	7.0	26.0	14.3	23.0	-
Drummond & Hemsley 3231	41.0	27.0	1.5	6.0	17.0	8.8	25.0	-
De Wilde 8901	34.0	16.5	1.0	5.5	18.5	9.9	-	-
Gilbert & Thulin 845	31.5	18.5	1.6	5.0	20.0	9.0	-	-
Pappi 4071	100.00	50.0	1.3	4.0	17.5	9.9	-	-
Drummond & Hemsley 3914 (S)	40.0	34.0	1.8	6.5	13.8	7.3	-	-
Geesteranus 6254	47.0	26.0	1.5	5.0	18.0	9.0	-	-

TABLE 4B (Cont'd)

Collection	CHARACTER							
	LL	LW	BL	KL	CL	SSL	CPL	SD
Stolz 290	45.5	21.0	3.0	5.0	22.0	9.3	-	-
Faulkner 125	51.0	28.0	1.2	5.5	19.5	12.3	-	-
Feiling 3.5	40.0	21.0	1.5	5.5	16.5	8.0	25.0	-
Jeffrey 355	59.0	24.0	1.5	5.0	13.9	11.0	-	-
Thomas 5289	62.0	32.0	2.0	5.6	14.0	6.5	-	-
Renvoize 797	25.0	14.0	1.5	5.0	14.3	-	18.0	-
Faulkner 615	50.0	25.0	1.0	4.0	14.0	7.5	-	-
Greenway & Polhill 11580	36.0	20.0	0.8	5.0	12.3	6.8	-	-
Iwarsson 115	58.0	37.0	1.5	6.0	16.5	6.8	-	-
Chase 7733 (S)	55.0	26.0	2.0	5.0	19.6	13.3	-	-
Chase 7901	70.0	30.0	1.1	4.3	24.0	12.1	-	-
Milne-Redhead 4229	59.5	25.0	1.3	5.0	-	8.0	-	4.5
Williamson 71	-	-	-	5.0	17.0	11.3	22.0	4.5
Latilo & Daramola 28963	-	-	-	4.5	14.0	7.5	20.0	5.0
Leeuwenberg 7751	-	-	-	6.0	18.0	8.3	19.0	-
Olorunfemi 30552	-	-	-	6.0	-	8.5	-	4.8
De Wilde 7093	-	-	-	7.0	22.0	11.0	-	-
Friis 1706	-	-	-	5.5	18.5	9.0	-	-
Morton 8482	-	-	-	7.0	17.0	10.0	-	4.0
Geerling & Bokdan 380	-	-	-	6.0	22.0	12.5	19.0	4.0
Leeuwenberg 1737 (K)	-	-	-	5.5	15.0	6.5	21.0	-
Larsen 21	-	-	-	7.0	25.0	11.3	-	-
Baagoe et al. 179	-	-	-	6.0	18.5	12.5	-	-
Bullock 2321	130.00	70.0	-	6.0	18.5	12.5	-	-
Greenway & Kanuri 11914	80.0	45.0	-	-	20.0	-	23.0	4.4

TABLE 4B (Cont'd)

Collection	CHARACTER							
	LL	LW	BL	KL	CL	SSL	CPL	SD
Ruffo 324	-	-	-	-	12.0	-	21.0	-
Tanner 4509	-	-	-	-	18.0	-	-	-
Tanner 4662	55.0	16.0	-	-	18.0	-	-	-
Thulin & Mhoro 872	45.0	25.0	-	-	17.5	10.3	-	-
Turner 5895	-	-	-	-	17.5	9.0	23.0	4.0
Noirfalise 941	-	-	-	5.0	18.5	11.0	20.0	4.5
Faulkner 2303	-	-	-	6.0	18.0	9.8	-	4.6
Angus 1073	-	-	-	5.5	19.5	12.5	-	-
Chase 7733 (BR)	-	-	-	5.0	23.0	13.0	-	-
Homley 3226	-	-	-	5.0	16.0	11.0	-	-
Richards 4521	-	-	-	6.8	19.0	10.5	-	-
Drummond & Hemsley 3914 (BR)	-	-	-	6.8	20.0	7.8	-	-
Gillett & Burtt 170	50.0	30.0	-	-	19.0	-	-	-
Bos 2357	38.5	25.0	1.0	4.5	-	-	-	-
Bos 2629	50.0	30.0	1.5	7.0	-	-	-	-
Faulkner 461	-	-	-	5.0	13.0	6.5	25.0	-
Mortensen 4	-	-	-	-	18.0	-	-	5.0
Batten-Poole 185	-	-	-	5.0	14.0	10.0	-	-
Binuyo 41363	-	-	-	5.5	19.0	-	-	-
Lowe 1692	-	-	2.5	7.0	17.0	7.5	-	-
Bouxin 1411	-	-	-	5.0	18.5	9.8	-	-
Troupin 9599	-	-	-	6.5	20.0	10.5	-	-
Morton & Jarr 3994	-	-	1.0	5.0	16.0	6.5	-	-

Abbreviations as in Table 4A.

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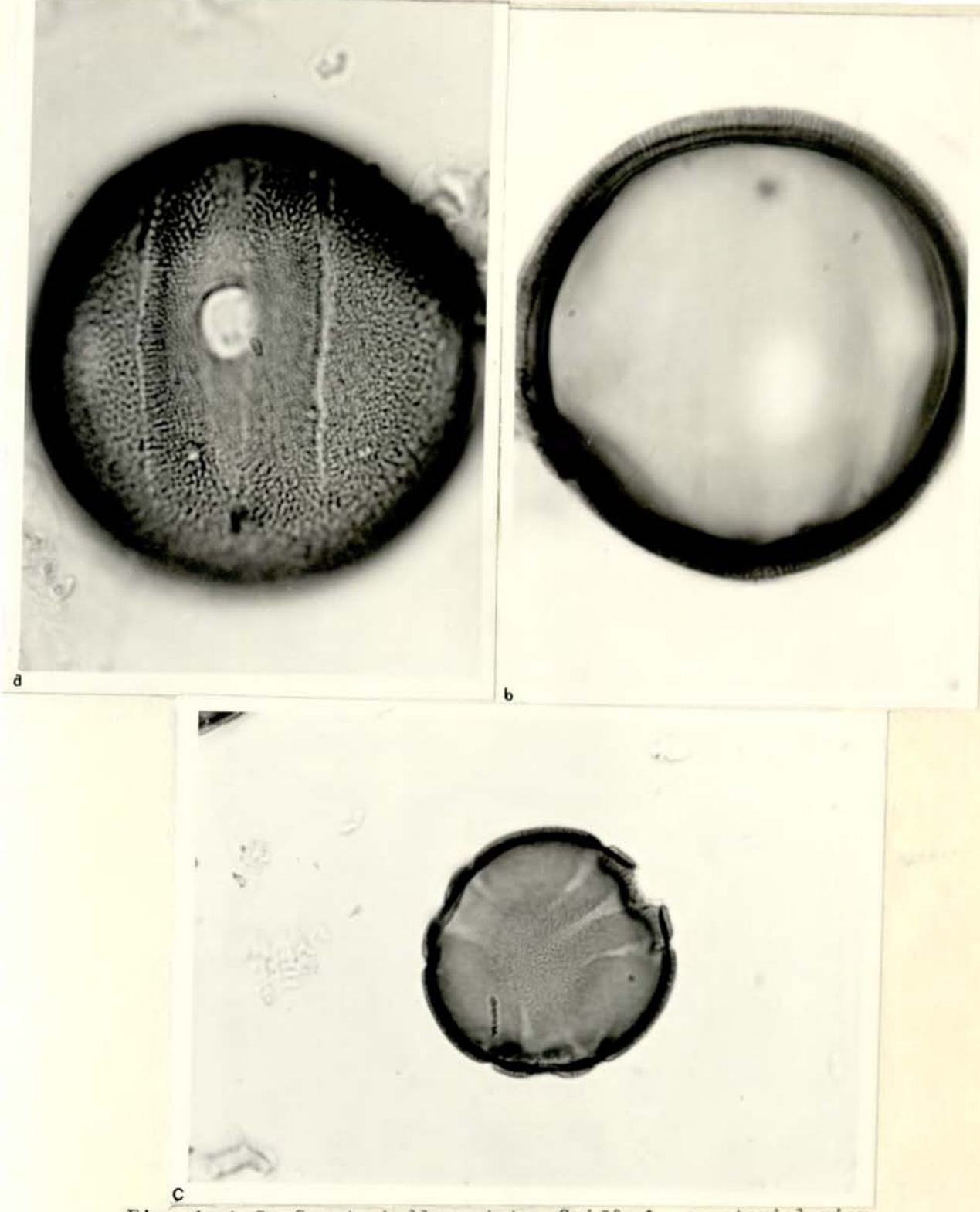


Fig. 1 A-C. Graptophyllum pictum Griff. A, equatorial view showing colpus, os and two colpoid streaks; B optical section (both X 1300); C, polar view (X 1000) slightly tilted.

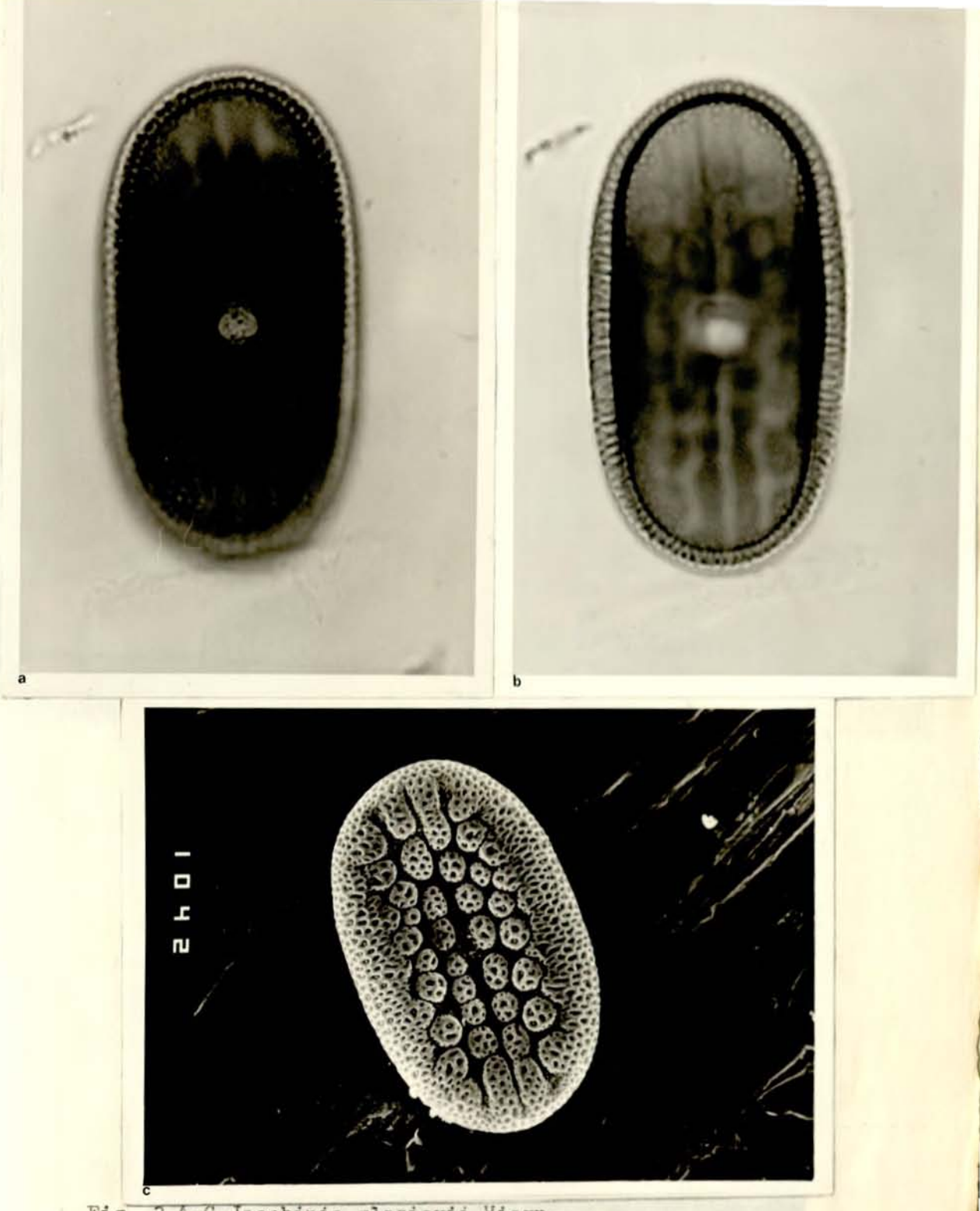
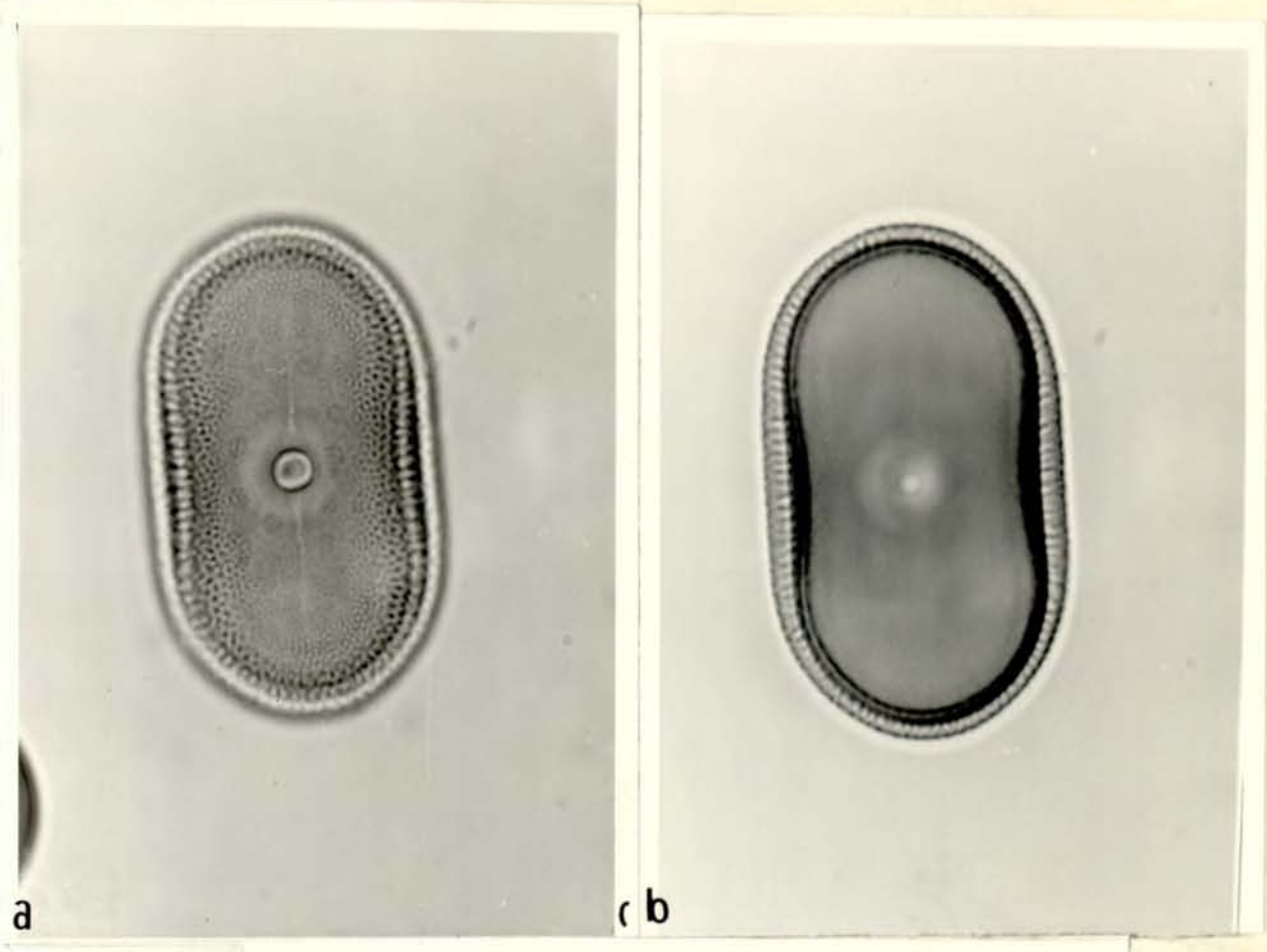


Fig. 2 A-C Jacobinia glaziovii Hiern.
A-B, LM photographs (X 1300); B, equatorial view showing colpus, os, and four rows of circular, reticulate insulae B, optical section; C, SEM micrograph (X 1000).



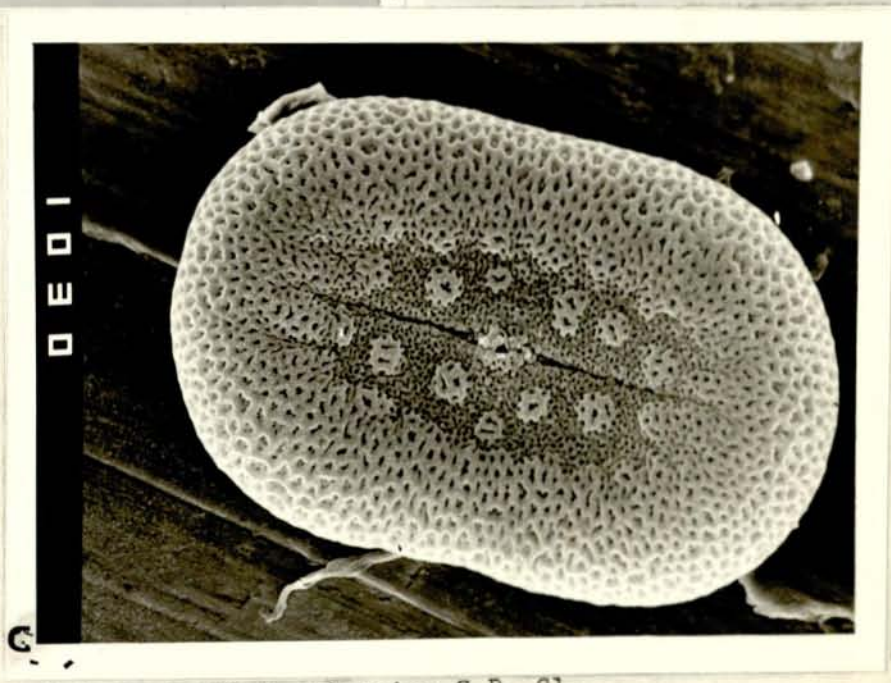
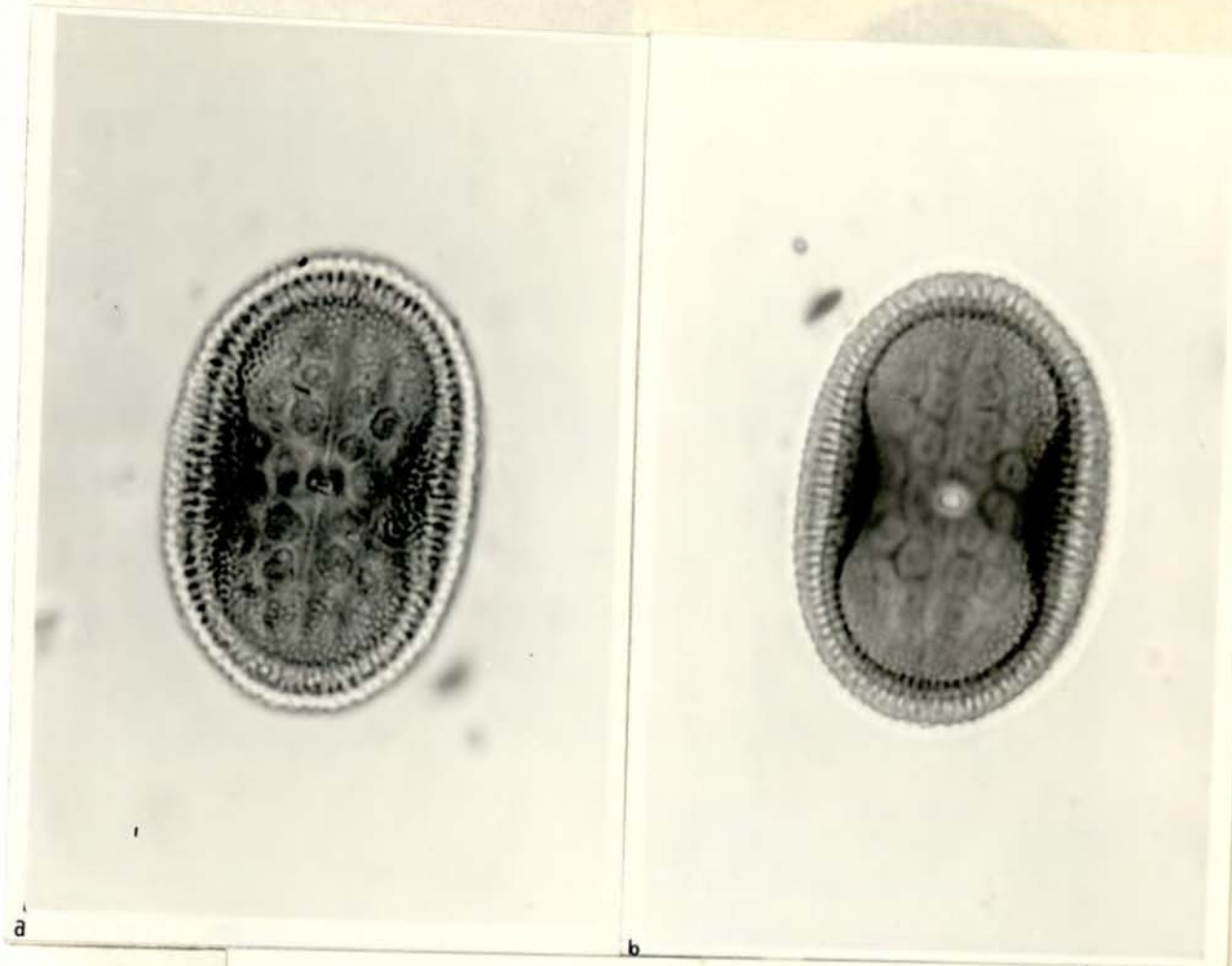


Fig. 3 A-C. Justicia pinguior C.B. Cl.
A-B LM photographs (X 1400); A, equatorial view showing pore and a narrow, faint colpoid streak; B, optical section; C, SEM micrograph (X 1700) showing two rows of insulae, pore and a narrow colpoid streak.



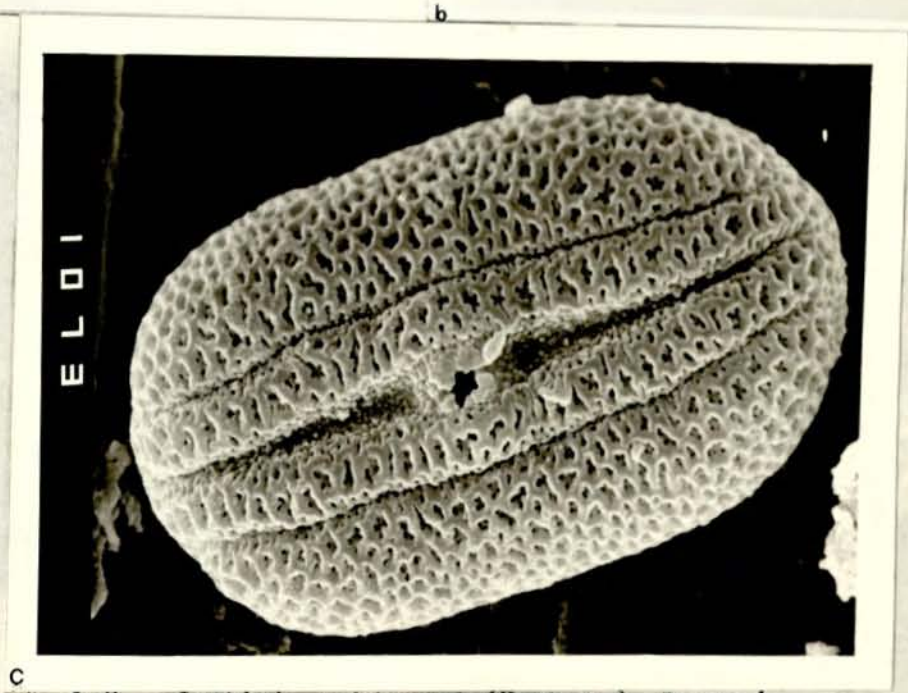


Fig. 4 A-B, Justicia schimperi (Hochst.) Dandy A, equatorial view showing pore, colpoid streak and insulae; B, same under lower focus. (both X 1200)

Fig. 4 C. J. trinerva Vahl, SEM micrograph (X 2300)

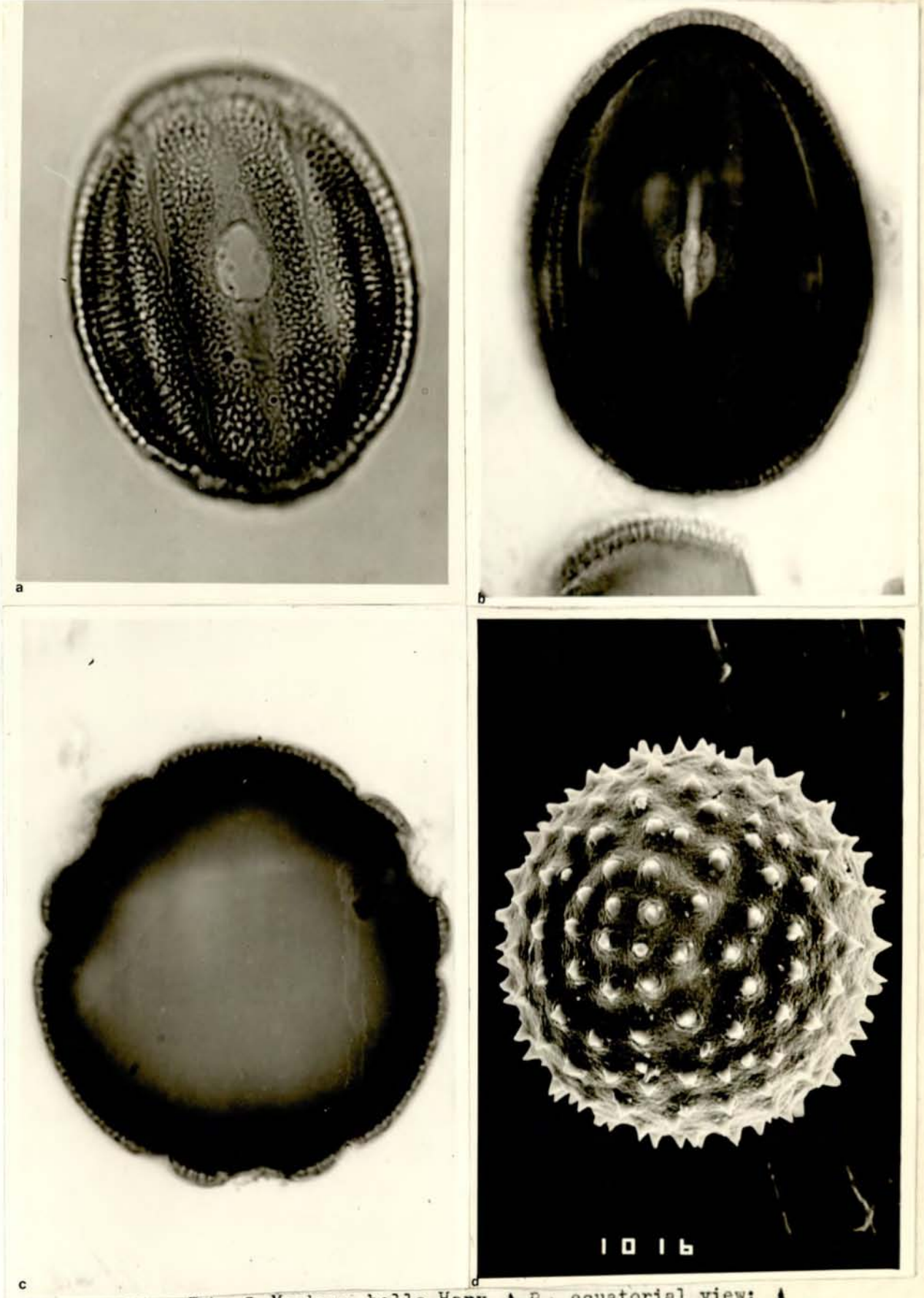


Fig. 5 A - C Mackaya bella Harv. A-B, equatorial view; A showing colpus and os (X 1200); B, optical section (X 1400); C, polar view, optical section (X 1300)

Fig. 5 D Styasasia sp. nov., SEM micrograph (X 1300).

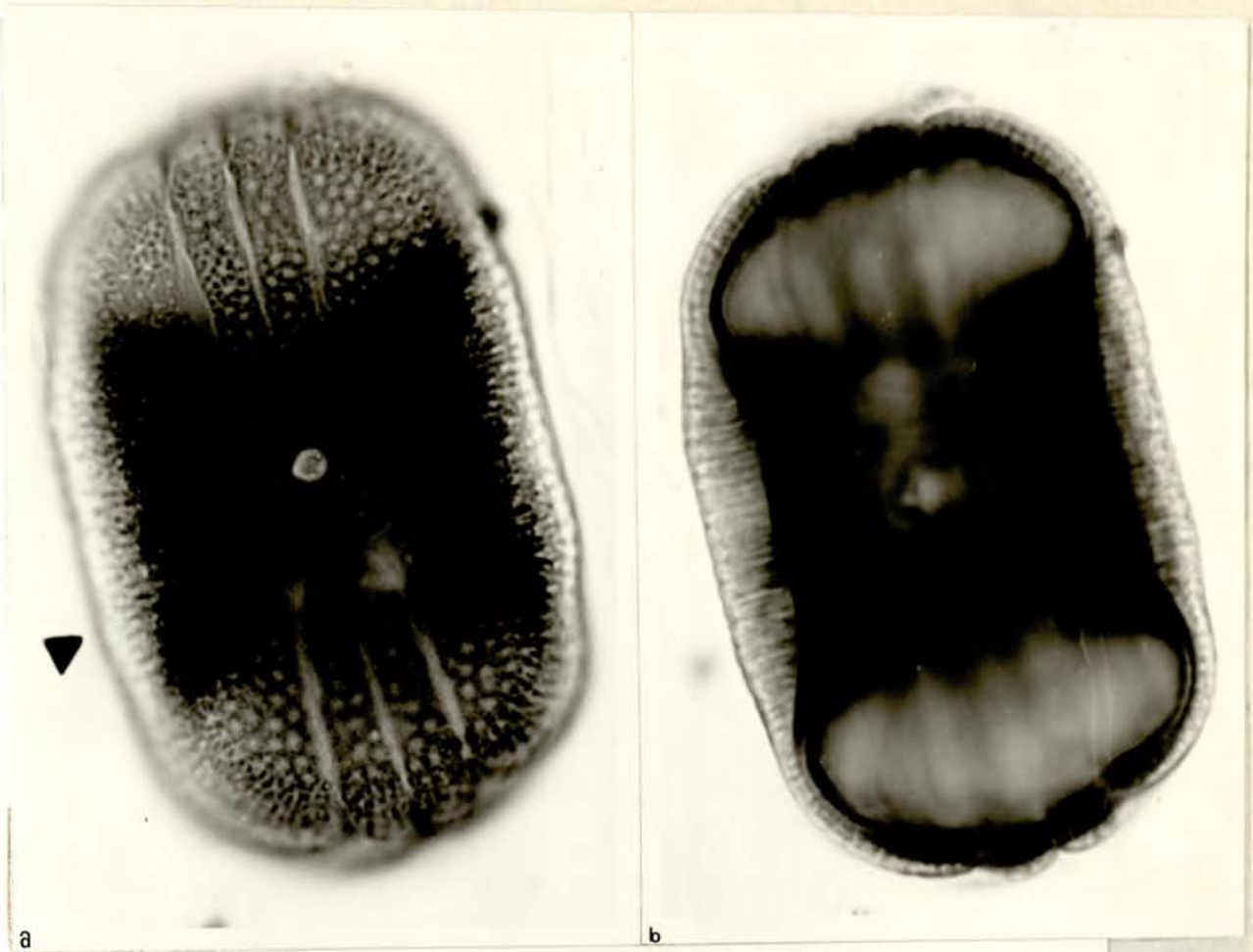


Fig. 6 A-D. Asystasia calycina Nees A-B, equatorial view (X 1200); A, showing pore, three colpoid streaks and six circular insulae around the pore; B, optical section; C polar view, tectal perforations seen as white dots.

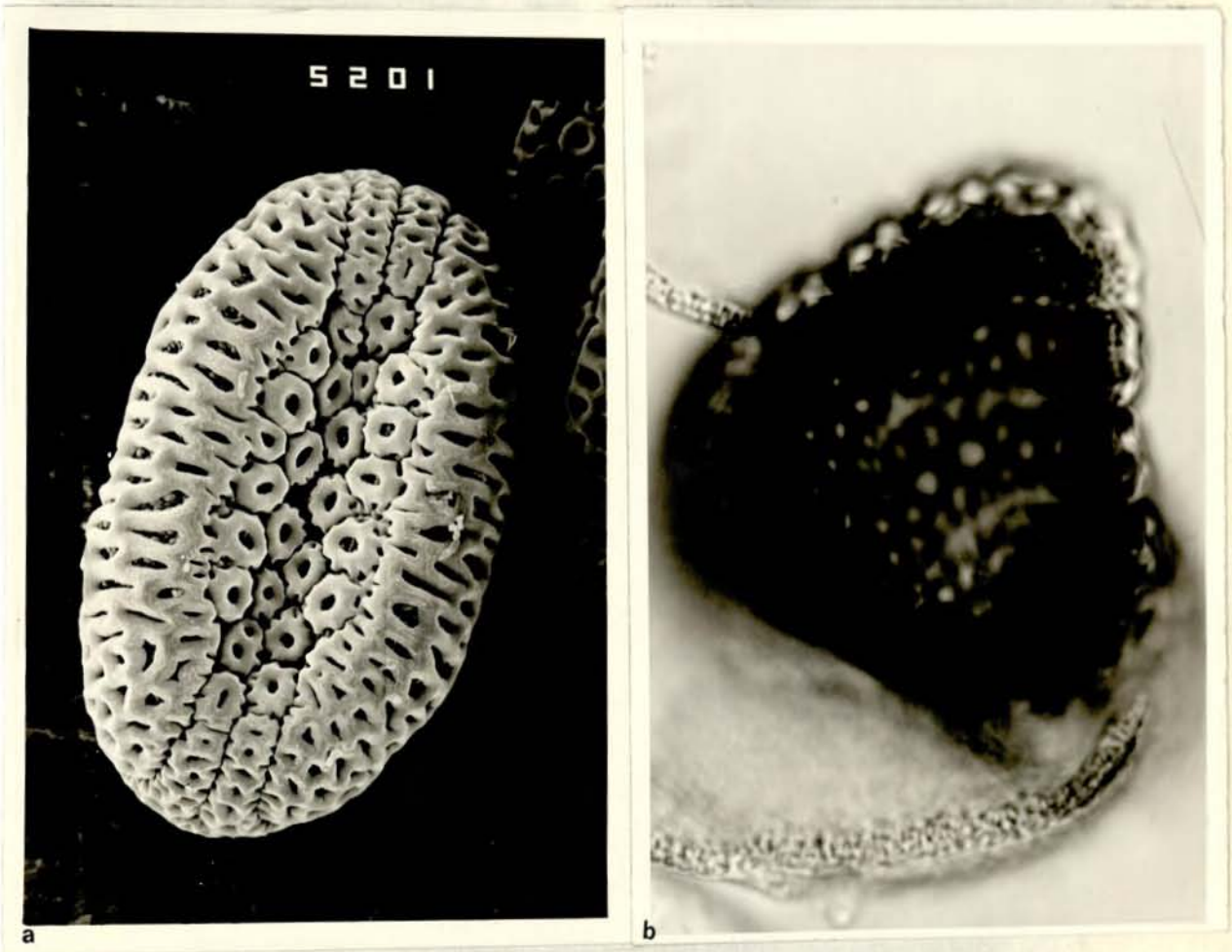


Fig. 7 A-B, Asystasia charmian S. Moore
A, equatorial view, SEM micrograph (X 800);
B, polar view, LM photograph (X 1000).

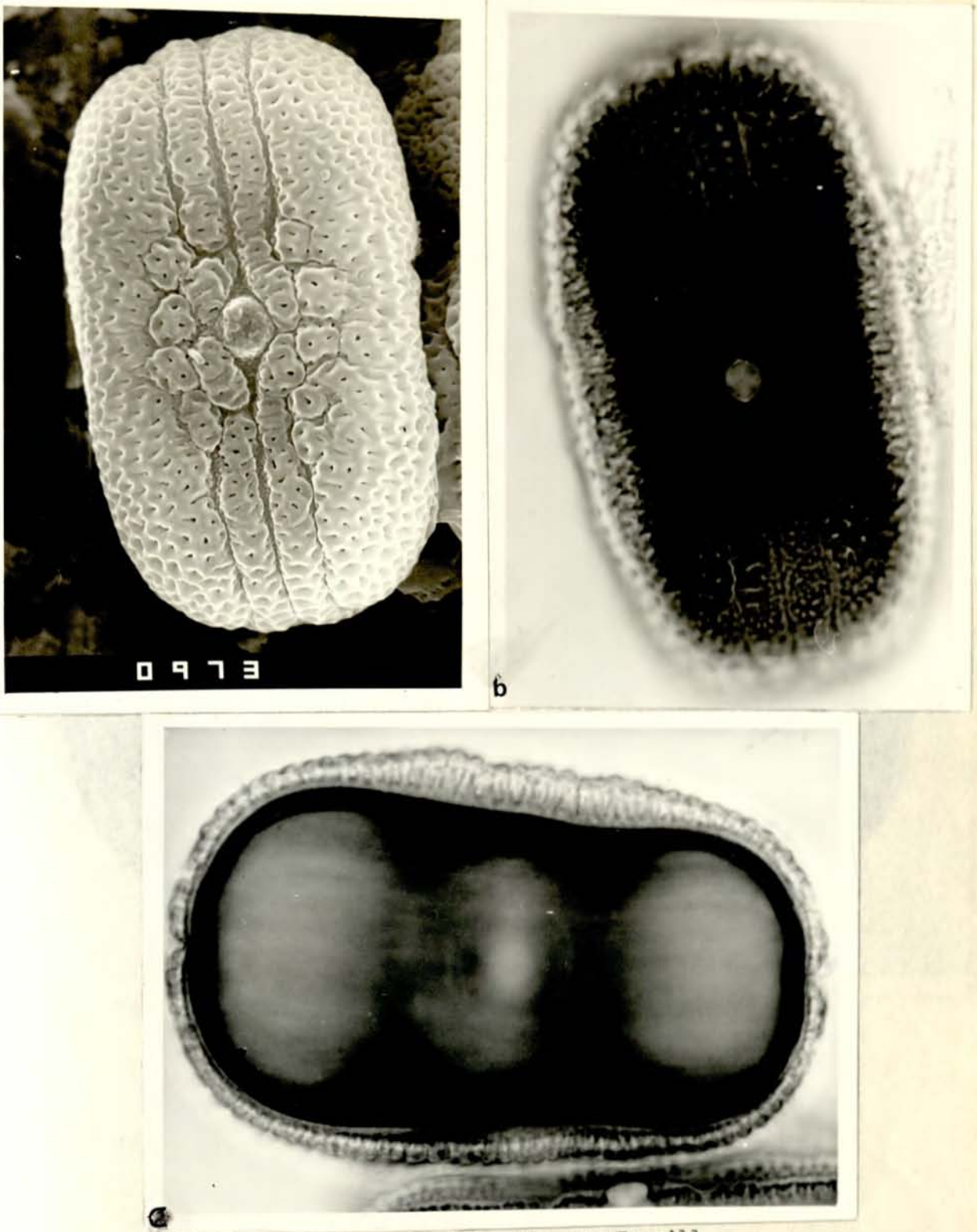


Fig. 8 A-C, Asystasia drakebrockmanii Turrill, equatorial view; A, SEM micrograph (X 1100); B-C, LM photographs (X 1400); B, showing pore and three colpoid streaks; C, optical section.

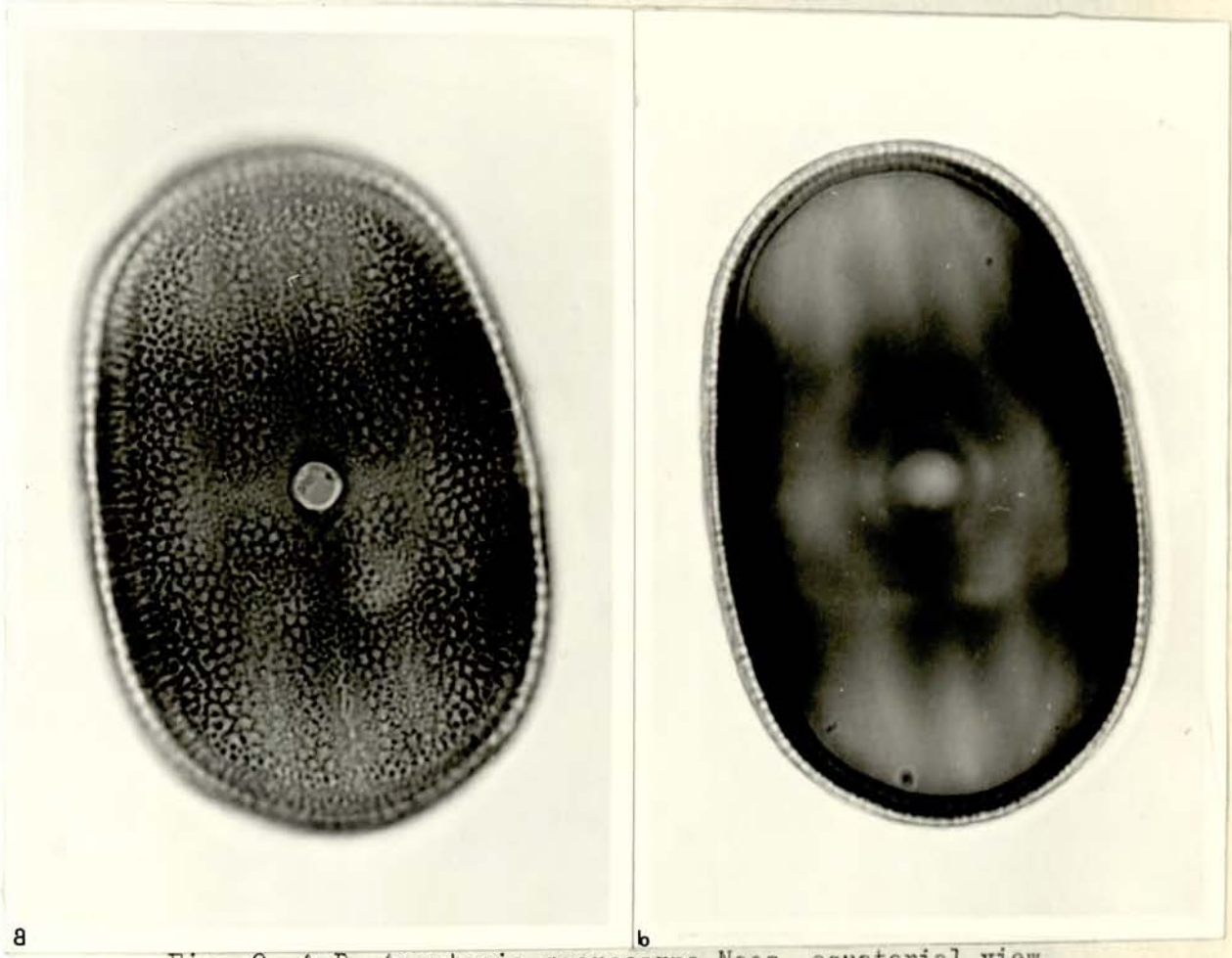


Fig. 9 A-B. Asystasia macrocarpa Nees, equatorial view (X 1400); A showing pore and three faint colpoid streaks; B, optical section.

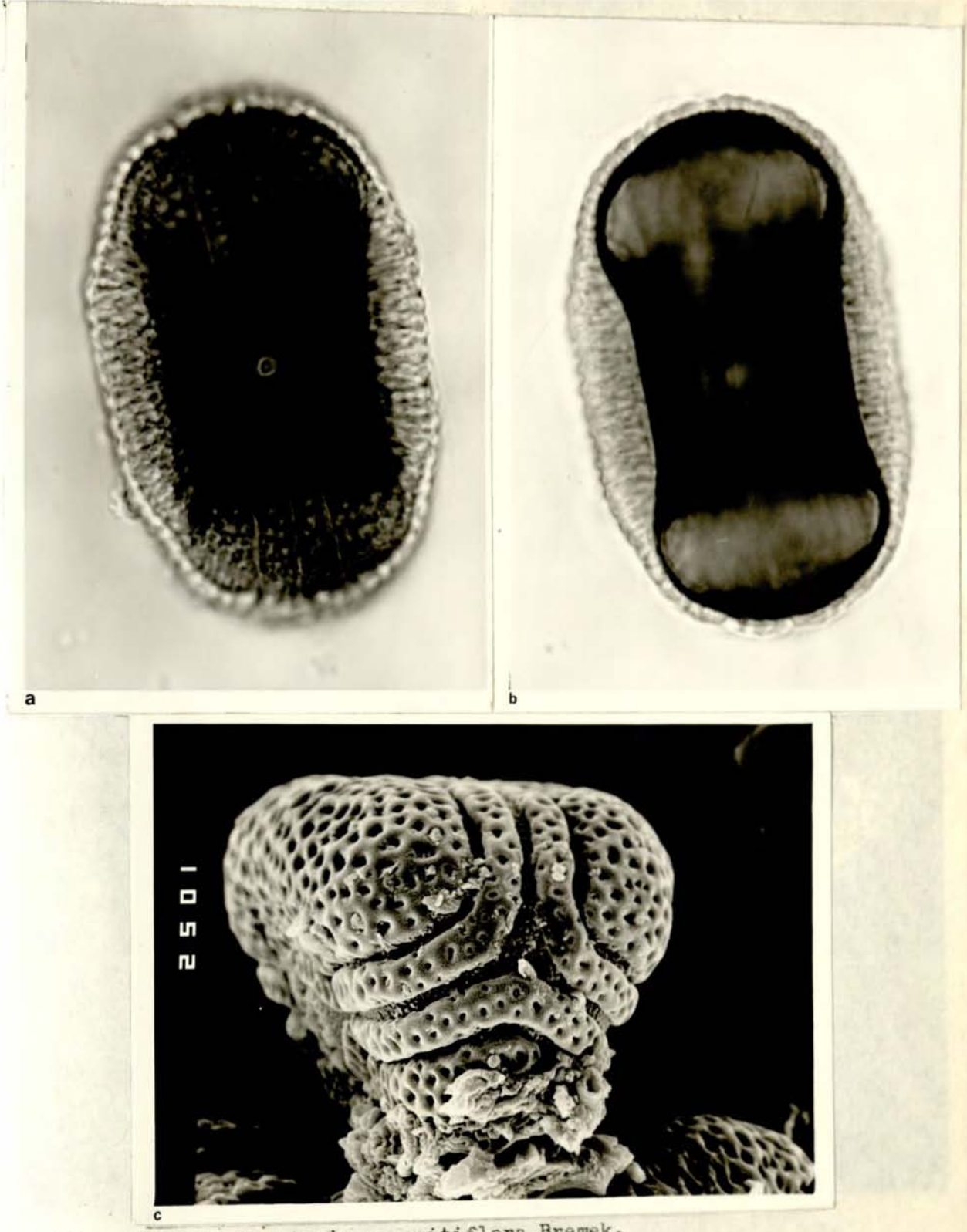


Fig. 10 A-C. Asystasia oppositiflora Bremek. A-B, equatorial view (X 1300); A, showing pore and three colpoid streaks; B, optical section; C, polar view, SEM micrograph (X 1300) showing fused colpoid streaks.

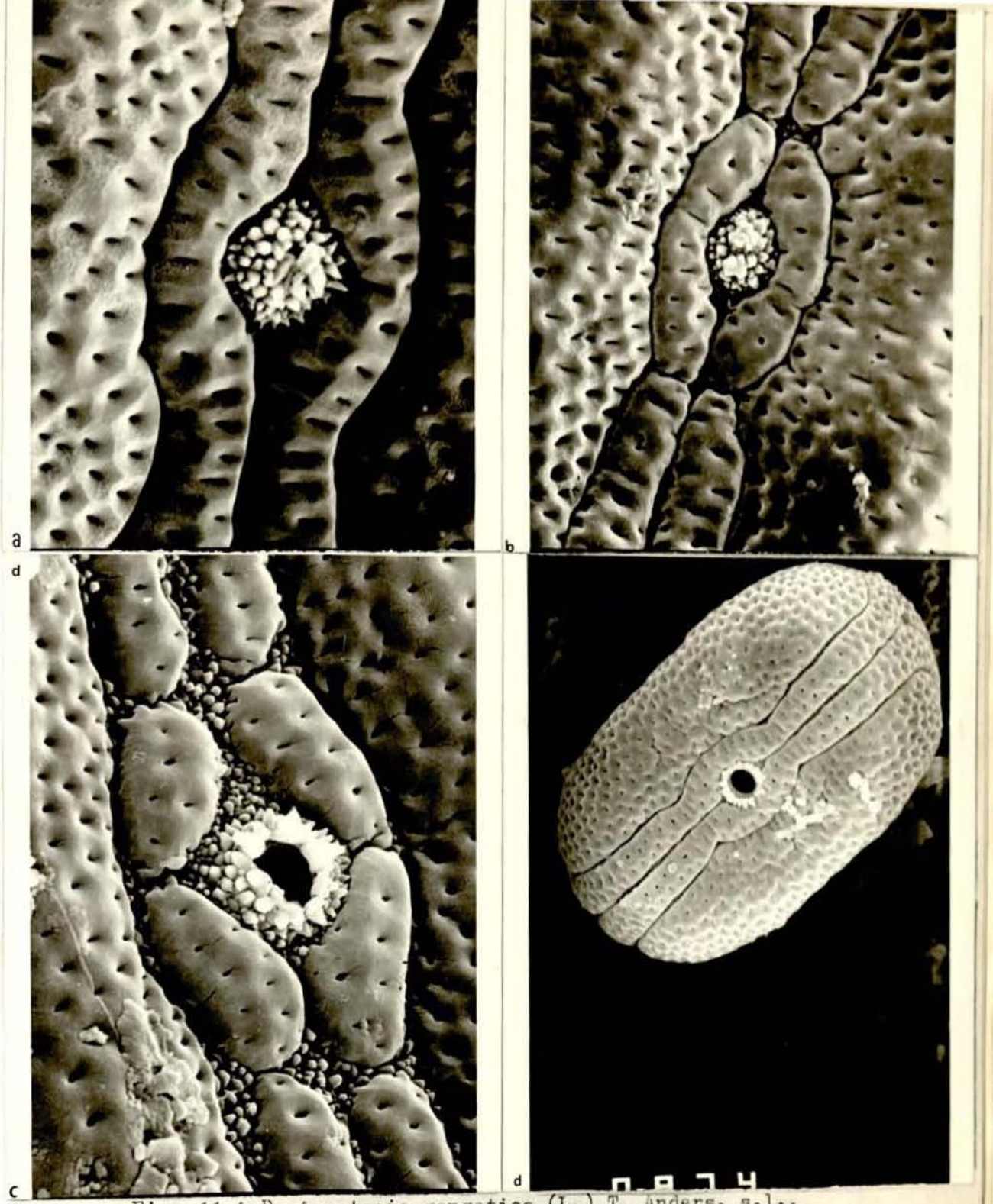


Fig. 11 A-D. Asystasia gangetica (L.) T. Anders. s.l., equatorial view, SEM micrographs (A-C, X 8000) showing processes of the pore membrane and nature of the narrow sexinuous regions near and at the pore; A, Ethiopia Gilbert and Thulin 845, UPS; B, New Guinea McKee 1809, C; C, Nigeria Lowe 1692, D (X 1000), Yemen Arab Republic Hepper and Wood 5977, S.

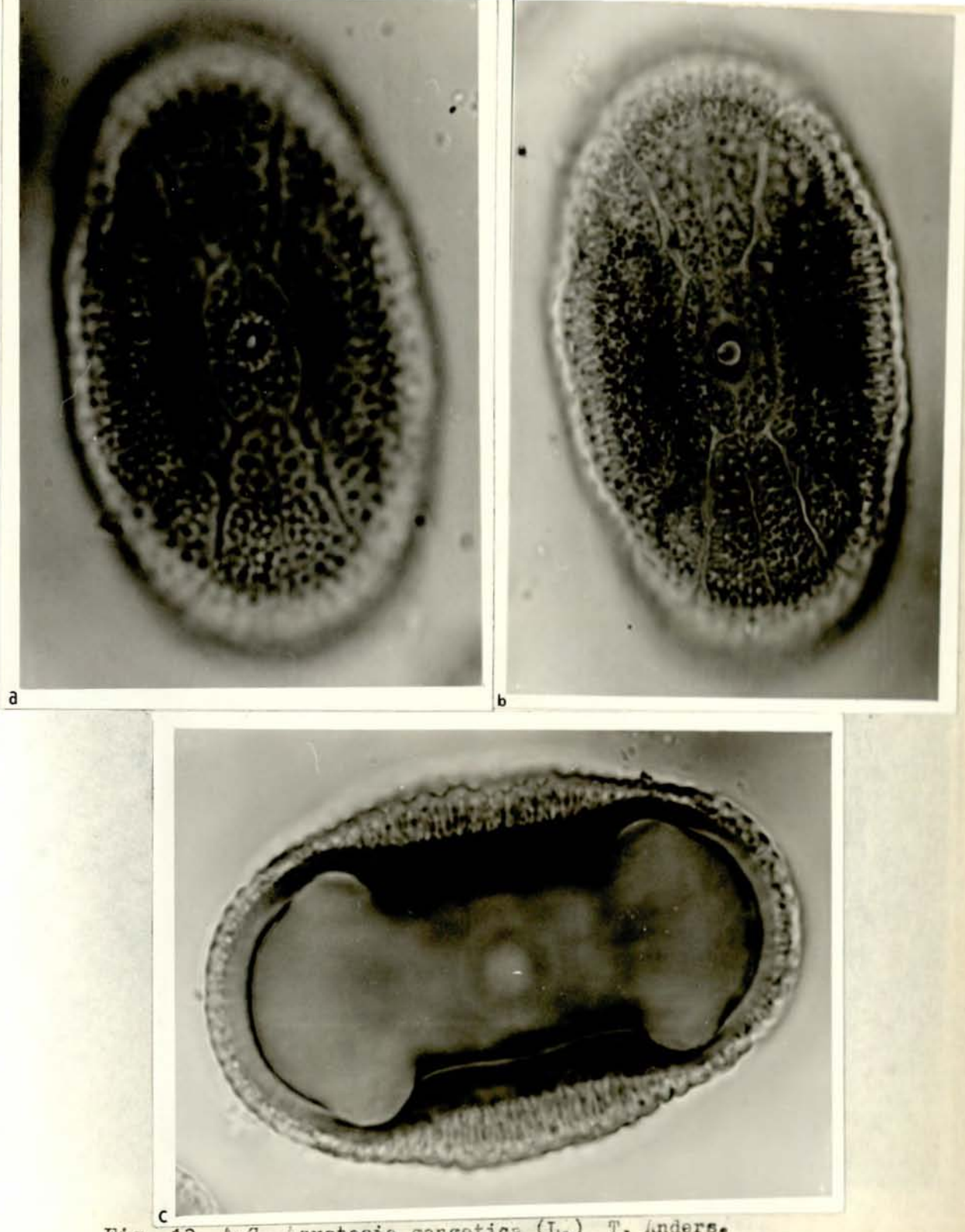


Fig. 12, A-C. Asystasia gangetica (L.) T. Anders. Equatorial view (X 1500); A, perforations seen as black dots; B, perforations turn white under lower focus; C, optical section.

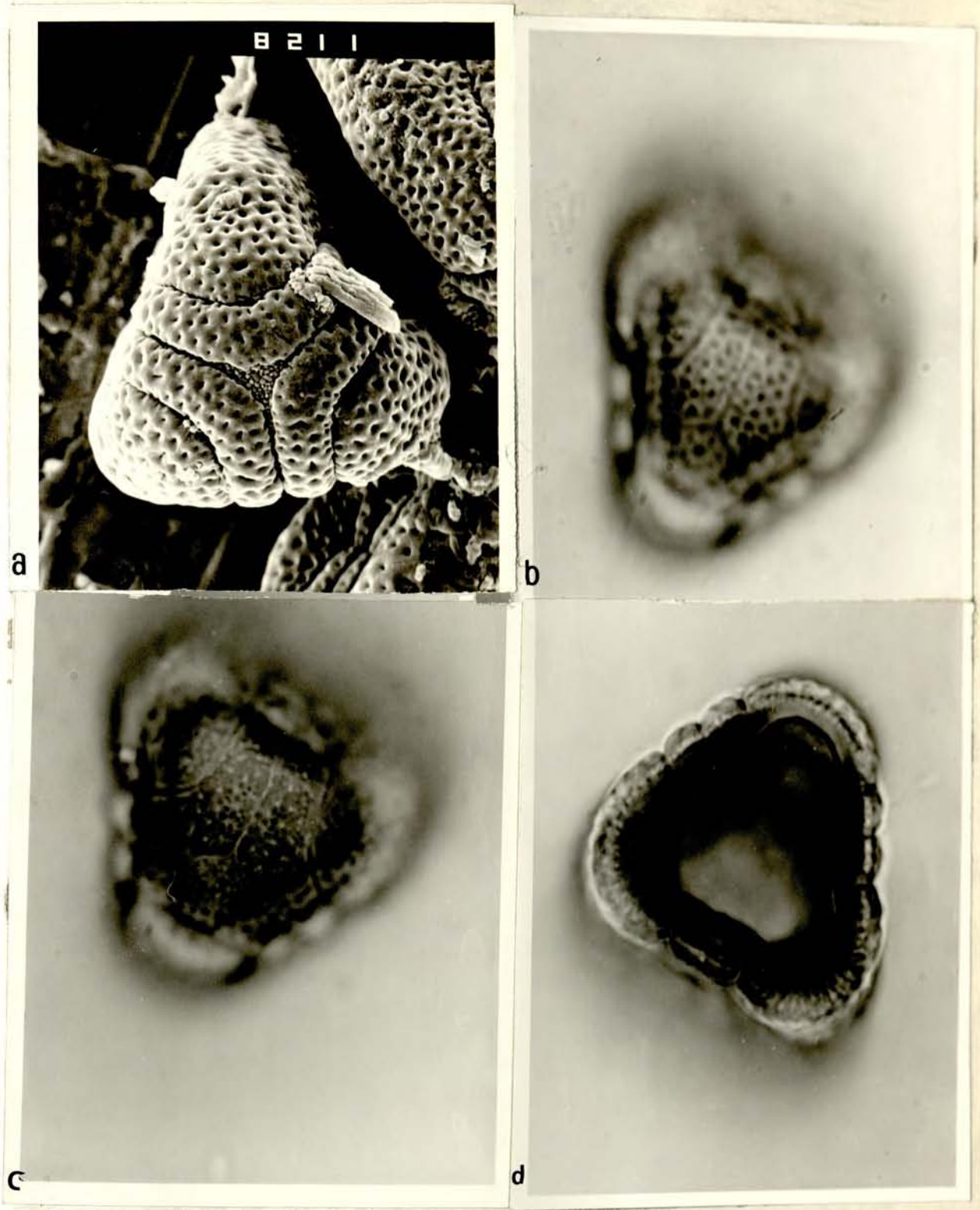


Fig. 13 A-D. Asystasia gangetica (L.) T. Anders., polar view; A, SEM micrograph (X 1500), New Guinea Mckee 1809, UPS; B-D, LM photographs (X 1300), Ethiopia Mooney 5651, ETH; B showing perforations as black dots; C, perforations turn white under lower focus; D optical section.

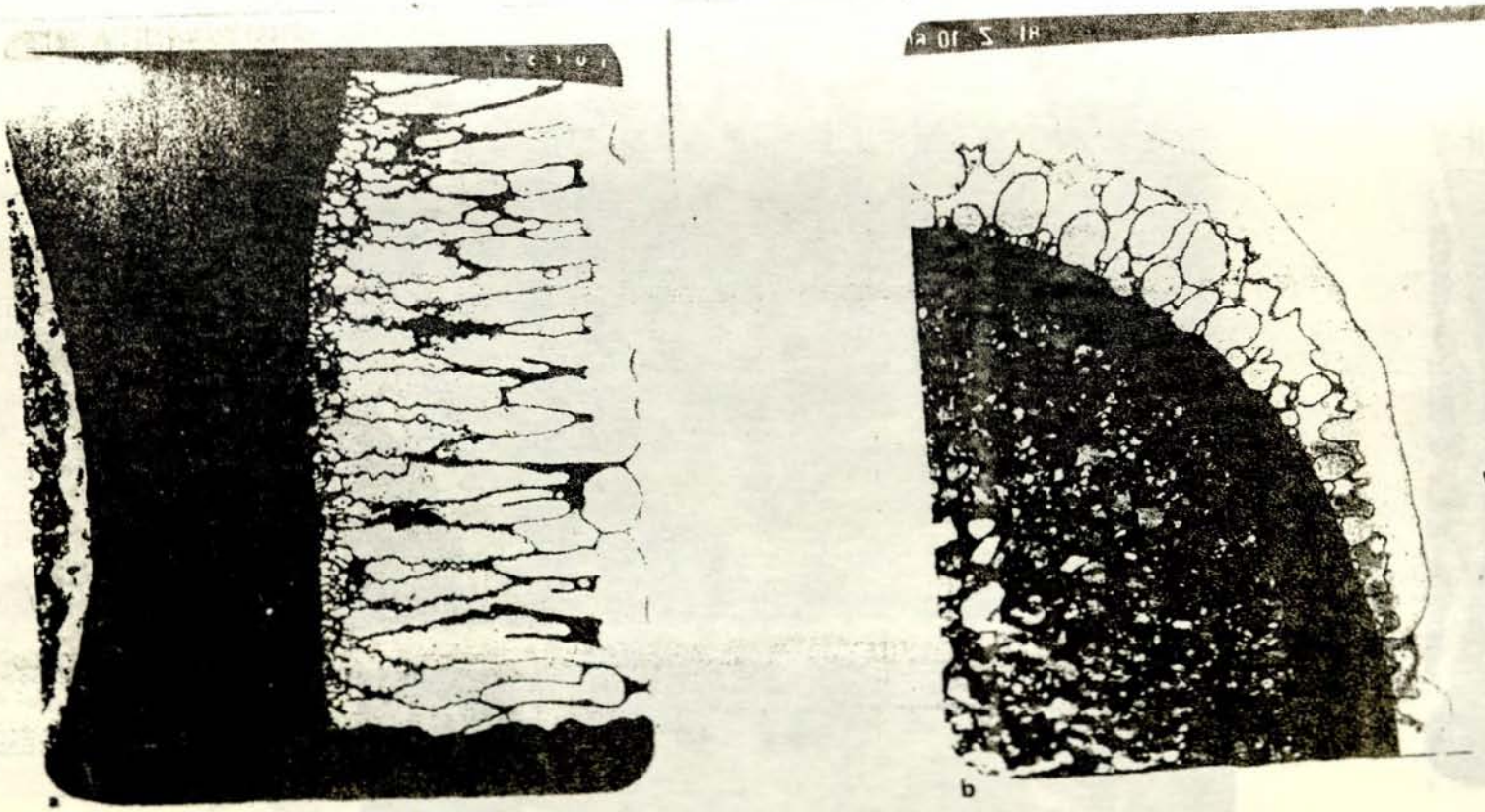
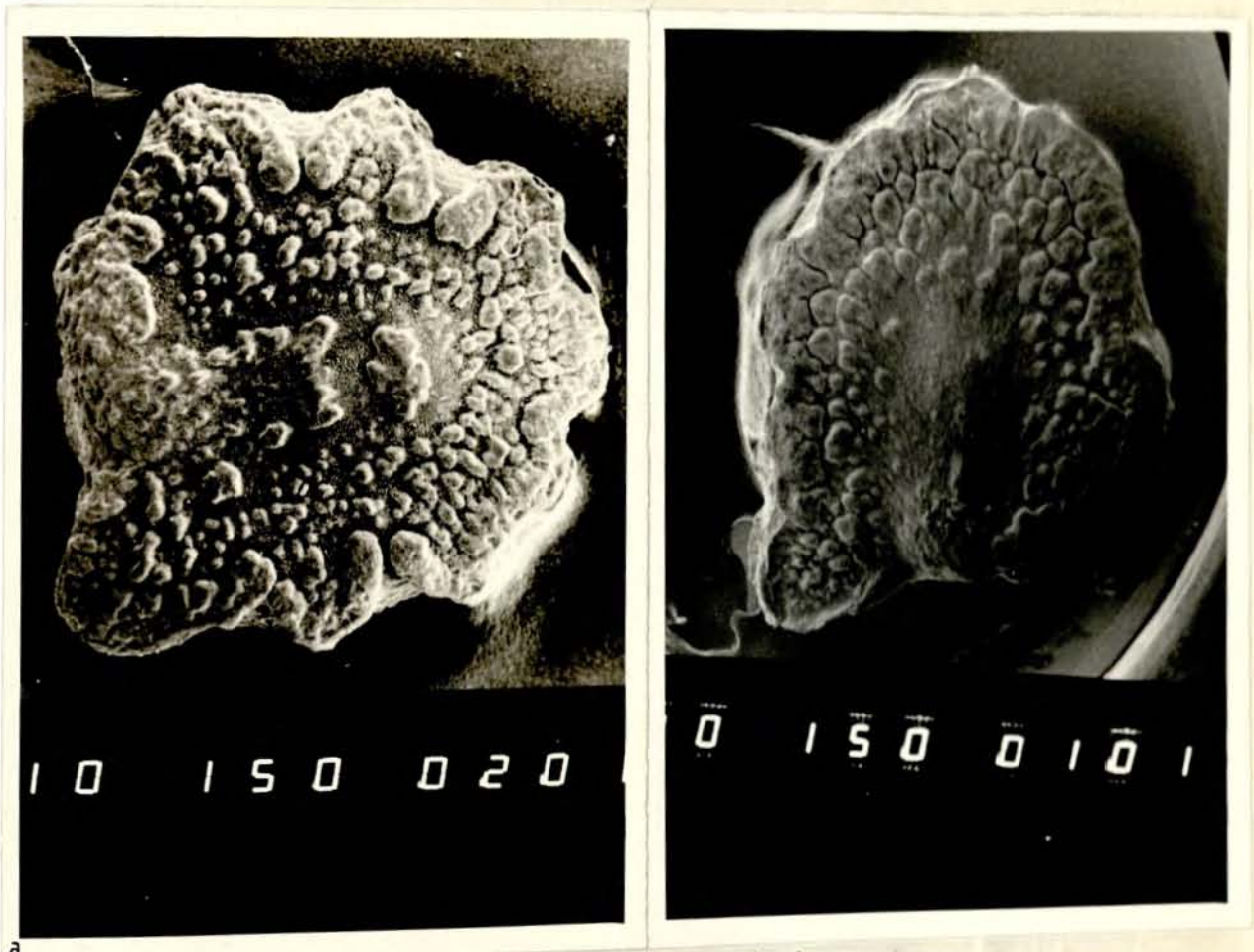


Fig. 14. A-B, Asystasia gangatica (L.) T. Anders., TEM photographs; A, equatorial region; B, polar region, Ethiopia De Wilde 8901; UPS.



a

Fig. 15 A-B. Asystasia gangetica (L.) T. Anders., SEM micrographs of seeds (X 16); A, subsp. gangetica, India Thankaimoni 1538, S; B; subsp. micrantha, Cameroon Olorunfemi 30552, K.

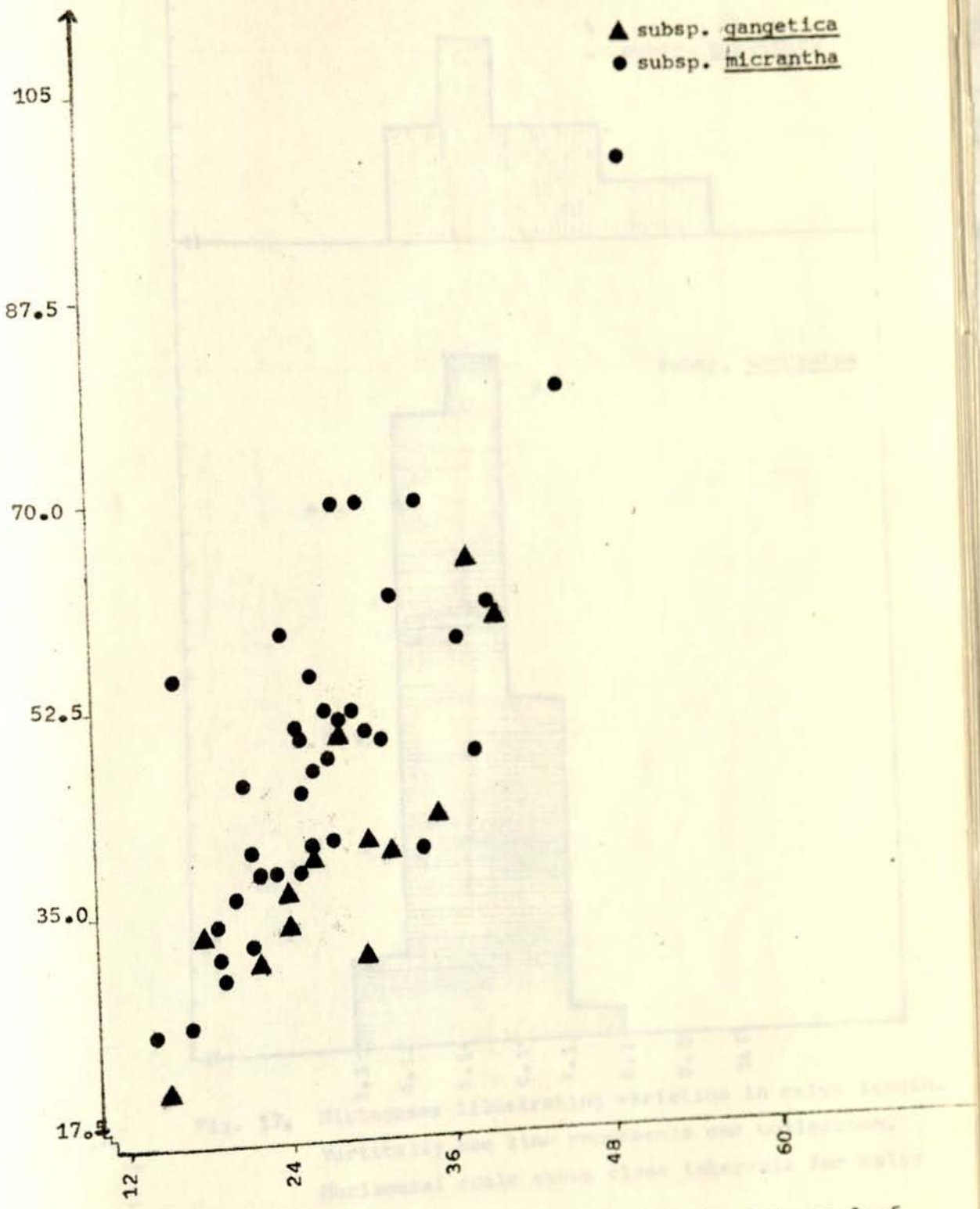


Fig. 16. Scatter diagram illustrating correlation between leaf length (vertical axis) and leaf width (horizontal axis) both in mm. Note: Bullock 2321 is not included.

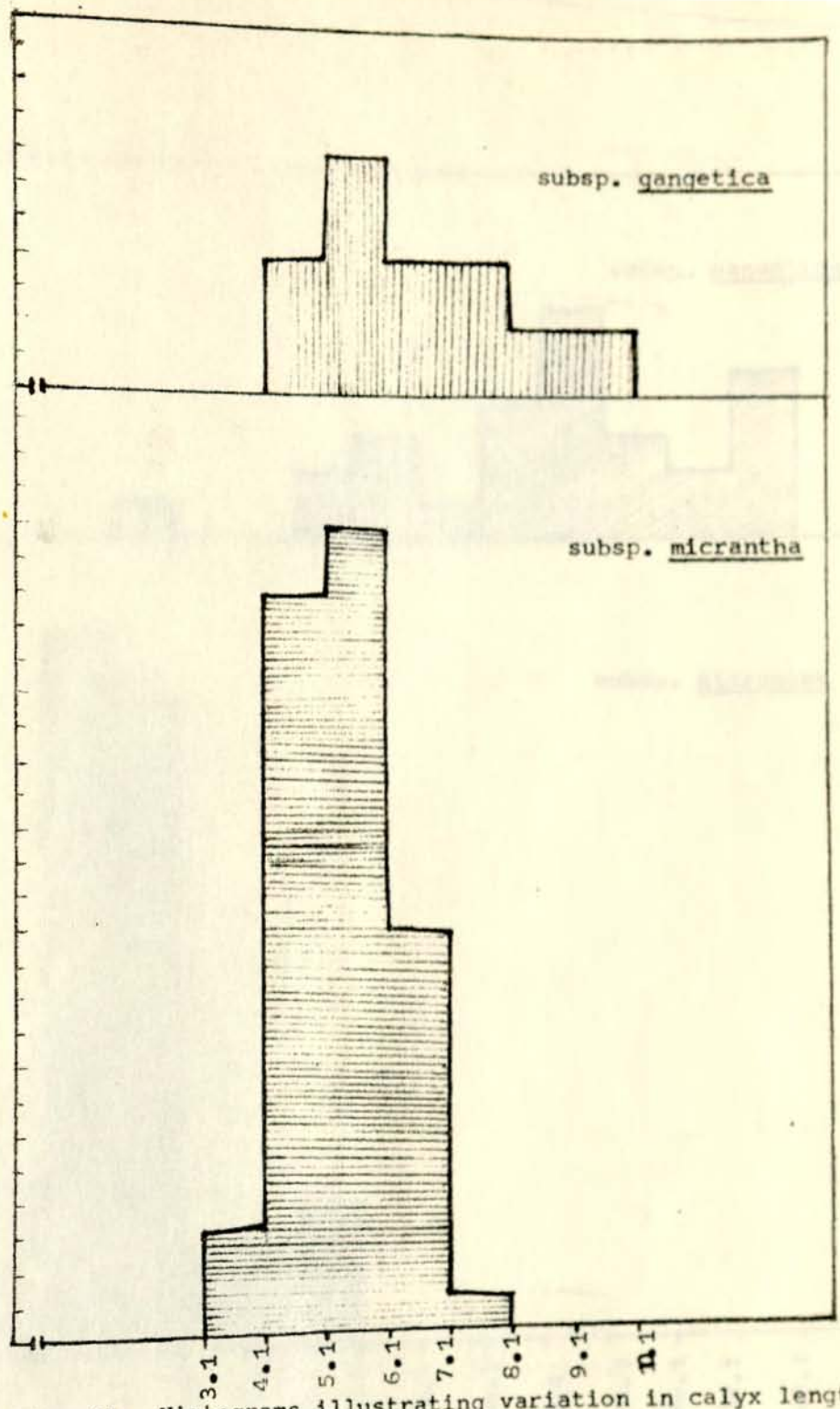


Fig. 17. Histograms illustrating variation in calyx length. Vertically one line represents one collection. Horizontal scale shows class intervals for calyx length.

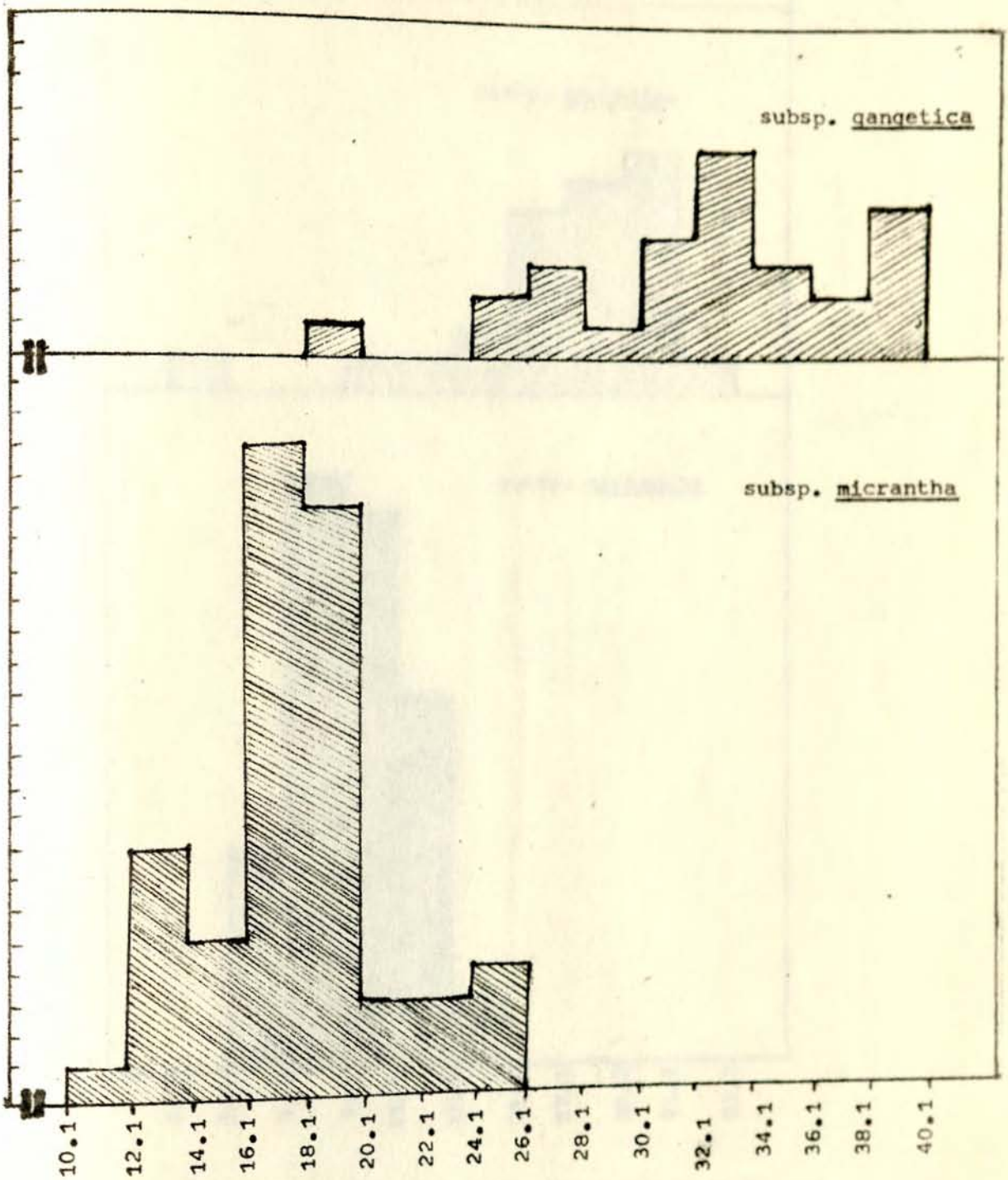


Fig. 18. Histogram illustrating variation in corolla legth. Horizontal scale shows class intervals for corolla length. Vertically one line represents one collection

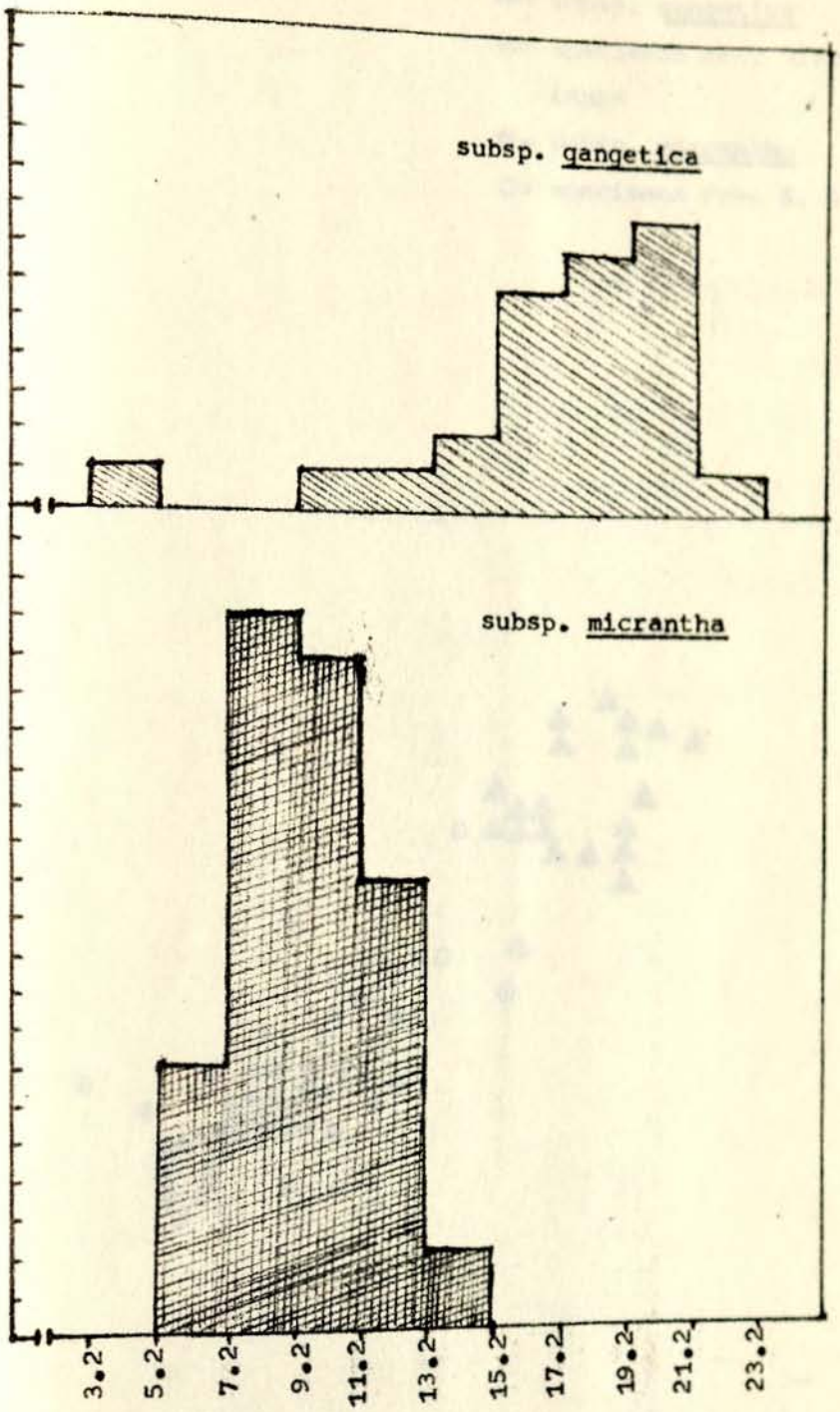


Fig. 19. Histograms illustrating variation in style and stigma length. Horizontal scale shows class intervals for style and stigma length. Verticall one line represents one collection.

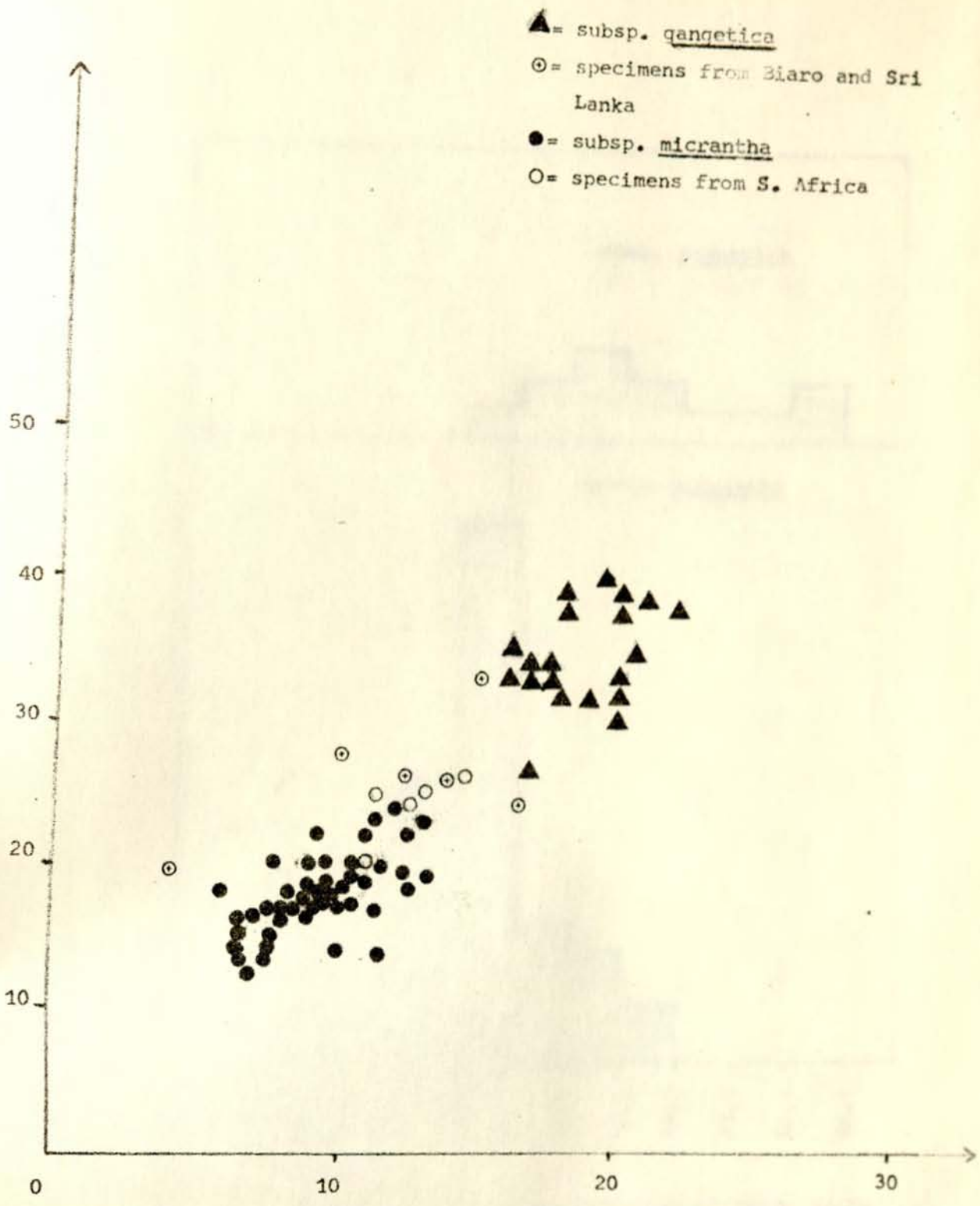


Fig. 20. Scatter diagram illustrating correlation between corolla length (vertical axis) and style and stigma length (horizontal axis). Measurements in mm.

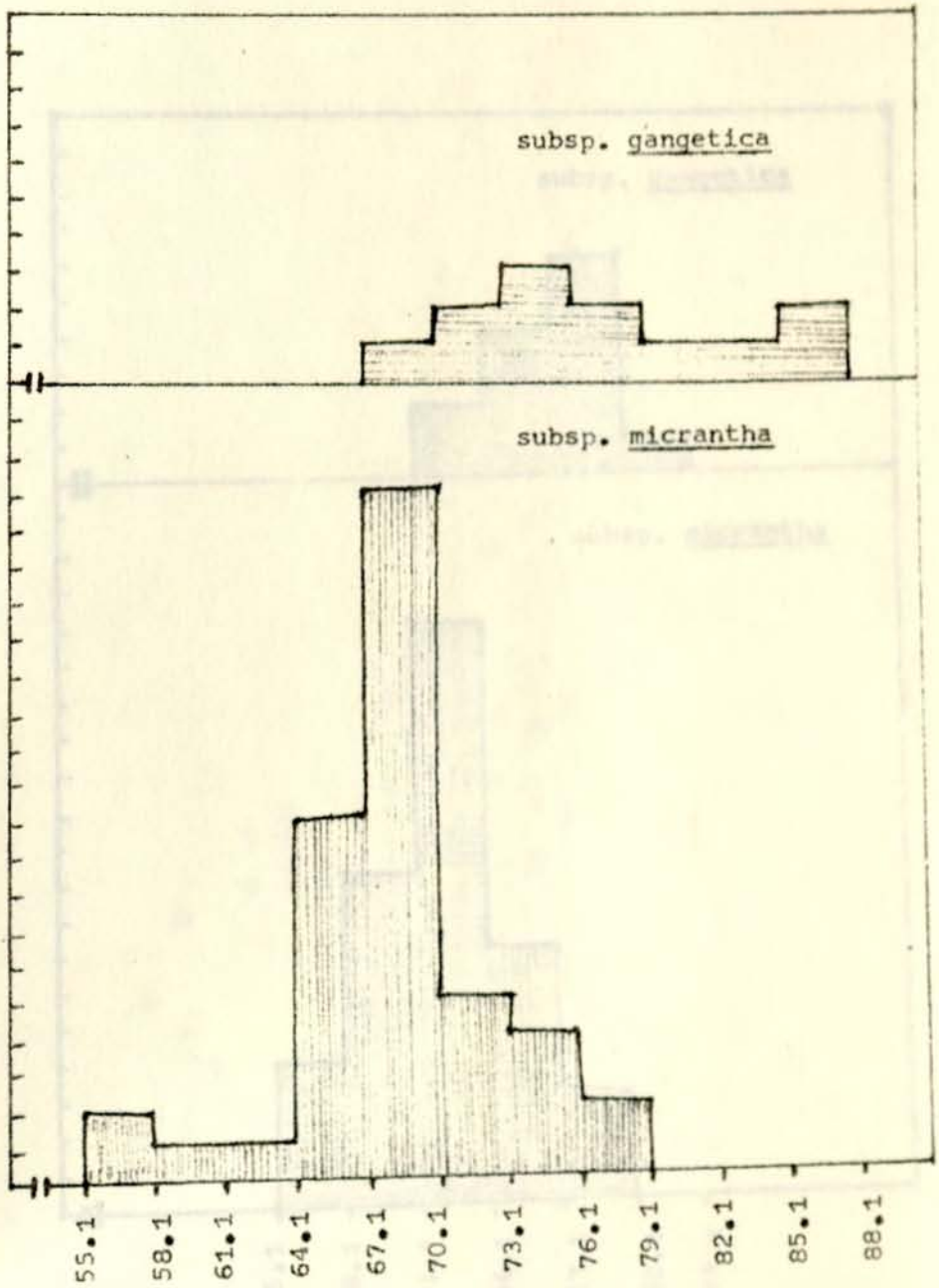


Fig. 21. Histograms illustrating variation in polar axis. Horizontal scale shows class intervals for polar axis. Vertically one line represents one collection.

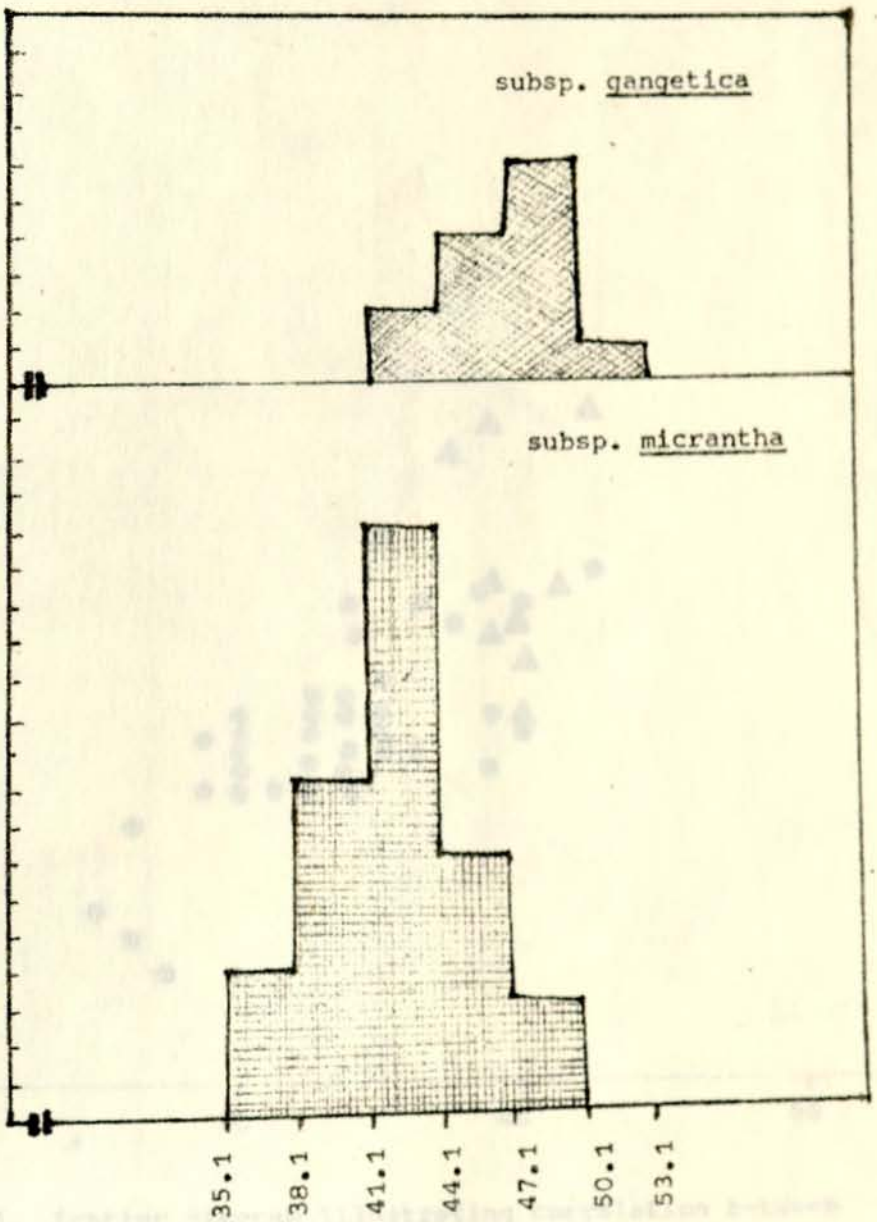


Fig. 22. Histograms illustrating variation in pollen size (Equatorial diameter). Vertically one line represents one collection. Horizontal scale shows class intervals for equatorial diameter.

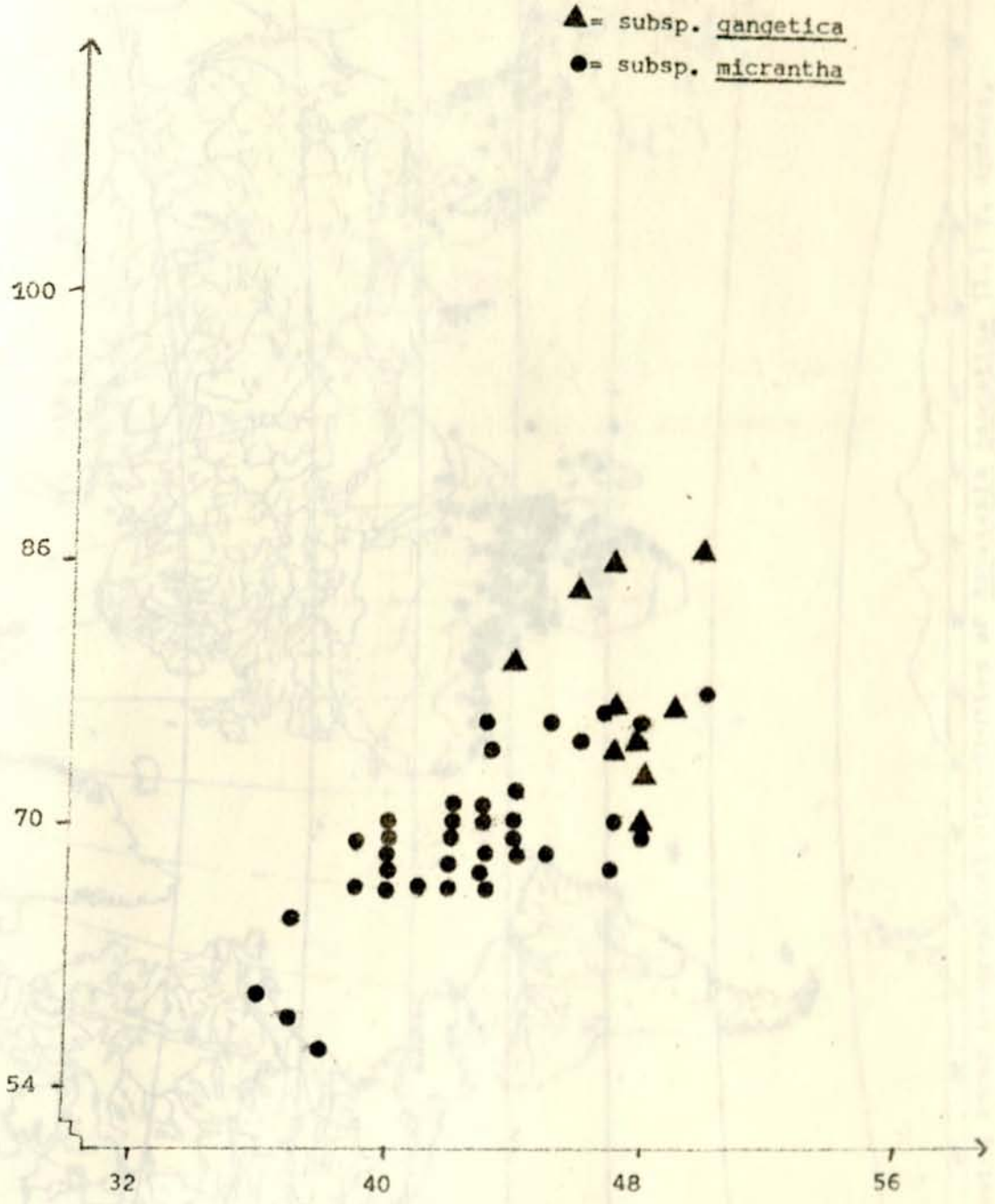


Fig. 23. Scatter diagram illustrating correlation between Equatorial diameter (horizontal axis) and polar axis (vertical axis). Measurements are in μm.

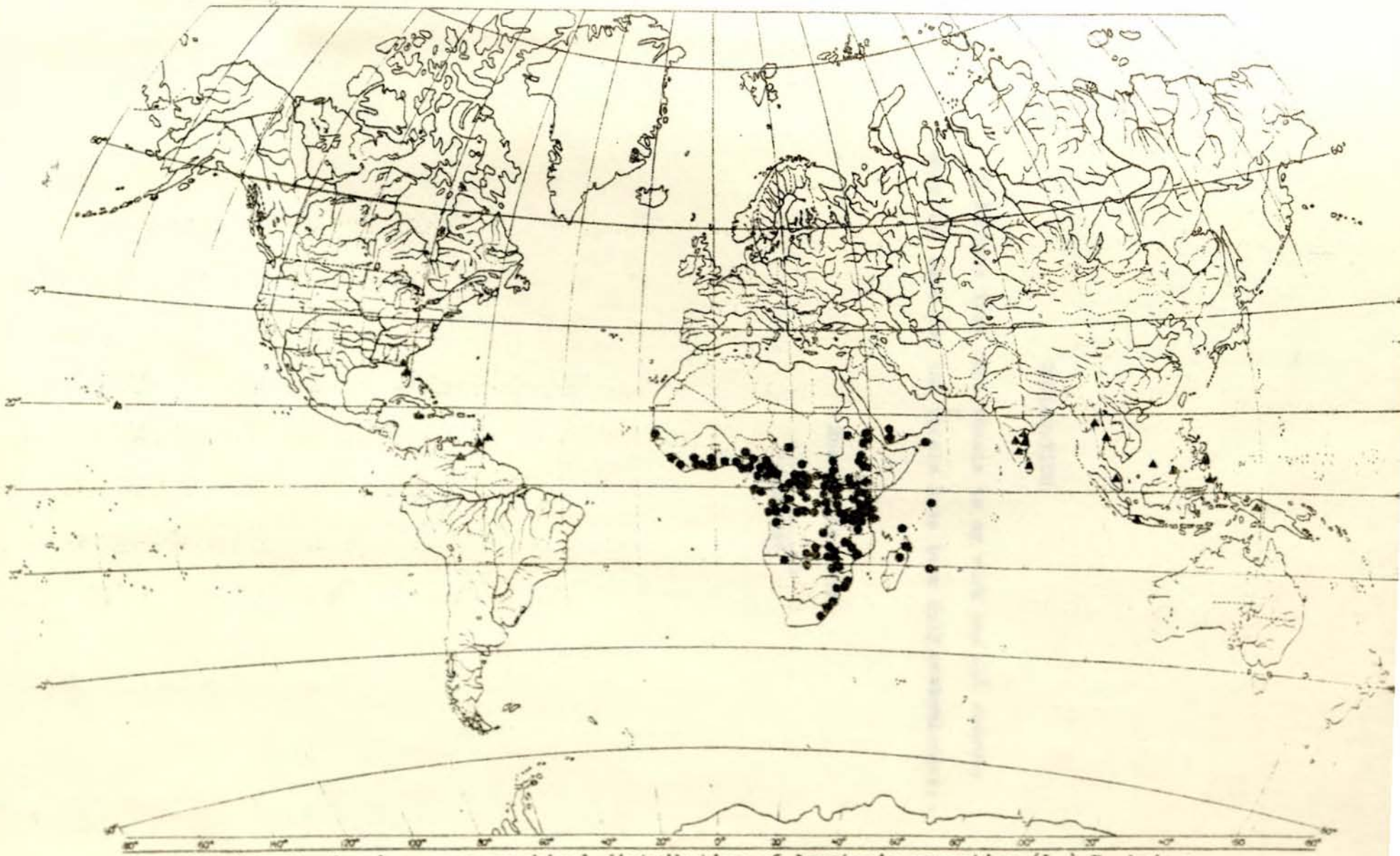


Fig. 24. Map showing known geographical distribution of Asystasia gangetica (L.) T. Anders. subsp. gangetica (black triangles) and subsp. micrantha (black dots).

Scale. 1:150,000,000.

DECLARATION

I declare that this thesis is my work and all sources of material used for the thesis have been duly acknowlodged..

Ensermu Kelbessa