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# COMPOSITAE

# NEWSLETTER

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**A NEW SPECIES OF *BACCHAROIDES*  
(ASTERACEAE:VERNONIEAE)  
FROM UGANDA, EAST AFRICA**

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**Abstract**

*Baccharoides tayloriana* formerly including in the *Vernonia hymenolepis* group is described as a species new to science. The new species is found on the Ruwenzori mountain, Uganda. A short discussion of its systematic position and an illustration are provided.

**Introduction**

The genus *Baccharoides* Moench was resurrected by Robinson (1990) who transferred three *Vernonia* species to the genus on the basis of its lophate pollen with polar areoles, which is distinctive among Old World tricolporate Vernoniaeae. Isawumi (1993) transferred four other species and seven infraspecific taxa from the genus *Vernonia* to *Baccharoides* based on its strikingly distinctive floral characteristics which separate it from the genus *Vernonia s.l.* The resurrected genus was found to possess corollas with long, slender, basal tubes, abruptly expanded cylindrical limbs and comparatively short erect lobes; phyllaries are apically appendaged; and the style bases are completely enclosed by long keeled nectaries.

During a comprehensive study of the genus *Baccharoides* (Isawumi & El-Ghazaly in press) using pollen morphology and floral microcharacters to diagnose the species it became obvious that a specimen from Ruwenzori in Uganda, hitherto treated as belonging to *Vernonia hymenolepis* A. Rich., should be separated as a new species.

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\* Permanent address:  
Natural History Museum, Obafemi Awolowo University, Ile-Ife, Nigeria, after May 31, 1995

**Baccharoides tayloriana Isawumi, sp. nov.**

(Fig. 1 A1-A3; PL1 A-G)

Holotype: Uganda, Ruwenzori, Namwamba valley, Kilembe, c. 2,850-3,150 m, 6.i.1935, Taylor 2934 (S).

Frutex erectus tomentosus. Folia alterna petiolata, lamina plana elliptico-lanceolata herbacea, pinnatinervia, margine serrata, 13.5–25 cm. longa et 5–8.5 cm. lata, inferne lanata-tomentosa, super sparsim puberula, apice acuminata. Capitula c. 3.5 cm. diametro, homogama, discoidea, in corymbum laxum terminalem disposita. Pedunculus 2–5 cm. longus. Involucrum late campanulatum. Phyllaria 1.7–2.6 cm. longa, pluriseriata, scariosa, appendicibus apicalibus, apice acuminata. Receptaculum convexum epaleatum. Flosculi disci hermaphroditi, c. 14 mm. longi, corolla e tubo angusto abrupte ampliata lobis quinque erectis. Antherae basi calcaratae; appendicibus apicalibus ovatis-lanceolatis, pilis unicellularibus tectis; endothecio polarato. Filamentum collum dilatatum; filamenta longa torsiva, nectario connata. Cypselae homomorphae 5–6 mm. longae, 16–20-costatae, sparsim pilosae. Pappi setae pluriseriatae barbellatae caducae.

An erect shrub, copiously tomentosely hairy. Leaves alternate; lamina 13.5–25 x 5–8.5 cm, flat, pinnateveined, distinctly serrate at margin with many callose-tipped teeth on each side, elliptic-lanceolate, with cuneate attenuate base tapering into a petiole c. 3-5 cm long, lower surface woolly tomentose with appressed matted T-shaped hairs interspersed with scattered glandular hairs, upper surface sparsely puberulous with scattered patent hairs; apex acuminate. Capitula c. 3.5 cm in diam., homogamous, discoid, in loose terminal flat-topped corymbs. Peduncles 2–5 cm long, with a few lanceolate bracts below the capitula. Involucre broadly campanulate. Phyllaries pluriseriate, with overlapping margins, scarious, apically appendaged; outer phyllaries lanceolate c. 1.7 cm long, glabrescent apically, tomentose basally, with a midvein and usually 2 veins on either side; middle phyllaries c. 2.4 cm long including the appendage, acuminate at tip, broadly lanceolate, tomentose at the junction of the appendage and the base, with a midrib and about 4 veins on either side, acuminate at tip; inner phyllaries c. 2.6 cm long including the appendages, tomentose on the appendage and the margins of the phyllary base, elliptic-lanceolate, gradually tapering to the acuminate apex. Receptacle somewhat convex, epaleate. Disc-florets perfect, c. 14 mm long with long, slender, basal tubes, abruptly expanded cylindrical limbs and 5 lanceolate erect lobes. Veins forming an arch at the corolla lobe without median trace; corolla with capitate glands and biseriate eglandular trichomes concentrated on corolla lobe tips also with many biseriate eglandular trichomes and few capitate glandular hairs on the throat and the tube. Epidermal cells of the adaxial corolla lobe elongate and distinctly wavy. Anthers calcarate; apical appendage ovate-lanceolate, narrower than the thecae, acute at tip, completely covered with unicellular hairs; distal hairs acute/acuminate, proximal hairs obtuse. Endothecial tissue polarized. Filament collar somewhat dilated distally but not thicker than the filament; filament long, coiled and connate to the nectary at the base of the corolla tube. Style base slightly dilated and

enclosed by a long cylindrical nectary; style branches apically tapering, long exerted and curved, with distinctly stigmatic areas throughout the inner portions, outsides covered with unicellular hairs down to the upper portion of the shaft. Cypselas homomorphic, dark brown, 5–6 mm long, narrowly oblong, terete, 16–20-costate, sparsely pilose with short twin hairs, few capitate glands and many idioblasts; testa epidermis ornamented; carpodium large, annular, the cells heavily thickened with simple pits; ovary crystals broad, lozenge-shaped. Pappus bristles pluriserial, caducous, flat, acute/acuminate at tip with some dilated distally, basally connate to form an annulus, barbellate on margins, stramineous or somewhat fulvous. Pollen echinolophate, tricolporate, micropunctate with long colpi.

### Discussion

The striking distinguishing characters of the new species are, *inter alia*, the complete covering of the apical anther appendage with unicellular hairs (Fig.1A2, Pl.1A–B) and the extraordinarily long coiled filaments which are connate to the nectary at the base of corolla tube (Fig.1A3). These characters are autapomorphic for the species, and clearly distinguishes it from the *Vernonia hymenolepis* group and other species of *Baccharoides*. The strange apical anther appendage has not been observed in any other species in the family Asteraceae (Karis, Anderberg, Nordenstam, pers. comm.).

*V. hymenolepis* belongs to the genus *Baccharoides* (Isawumi & El-Ghazaly in press) because it shares with the genus all the diagnostic characteristics mentioned above. The new species is superficially somewhat similar to *V. hymenolepis*. As a result, most authors might have been lumping it with either *V. hymenolepis* (Wild 1978, Jeffrey 1988) or *V. tolypophora* Mattf. (Pope 1992). With the above listed characters, *B. tayloriana* is, however, distinct, but if it is put as a separate genus, *Baccharoides* may become paraphyletic.

The crystals in the ovary wall of the new species are broad and lozenge-shaped (Dorner 1961, Plate 1), whereas those of *V. hymenolepis* and other species of *Baccharoides* are elongate and hexagonal in shape. The observably different macrocharacters of the new species from *V. hymenolepis* are the larger capitula and larger leaves.

The new species belongs to the genus *Baccharoides* because it shares some morphological characters which define the genus. Some of the characters have already been mentioned above and include the elongate corolla tube with abruptly expanded cylindrical limbs and phyllaries apically appendaged. It also shares with the genus some major pollen characters which separate it from the genus *Vernonia s.l.*, some of the characters being lophate pollen with long colpi (Pl.1H) and with equatorial lacunae (Pl.1G). Its pollen is therefore echinolophate, tricolporate, micropunctate and with large basal columellae, the sort of grains classified by Jones (1981) as 'type C' pollen. The 'type C' pollen is said to be unique to section *Stengelia* (now genus *Baccharoides*) in the Old World and is different from most type C of the Neotropics by the presence

of three equatorial areoles of the intercolpi and strong basal columellae under the crests of the exine (Robinson 1990).

### Acknowledgements

I would like to acknowledge the assistance of Prof. B. Nordenstam and Dr. A. Anderberg for reading the manuscript and offering valuable comments and also Dr. P. O. Karis for discussion of microscopic observations. I am also grateful to Pollyanna Lidmark for the illustration.

Financial support from the Swedish Institute is also gratefully acknowledged.

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## FIGURE LEGENDS

**Fig. 1** *Baccharoides tayloriana* Isawumi.

A: Habit; A1: Disc-floret; A2: Stamen with anther apical appendage covered with unicellular trichomes; A3: Floret with long, coiled filaments which are connate to the nectary at the base of corolla tube. – A–A3: Taylor 2934 (S).

**Pl. 1** Microcharacters of the floret of *B. tayloriana* Isawumi

A: Anther apical appendage covered with unicellular trichomes, x 250.

B: Base of anther apical appendage, x 100.

C: Corolla lobe showing glandular and unicellular eglandular trichomes, x 100.

D: Middle of corolla lobe showing wavy epidermal cells, x 250.

E: Polarized endothelial tissue, x 250.

F: Ovary crystals lozenge-shaped, x 250.

G: LM, polar view of pollen, x 400.

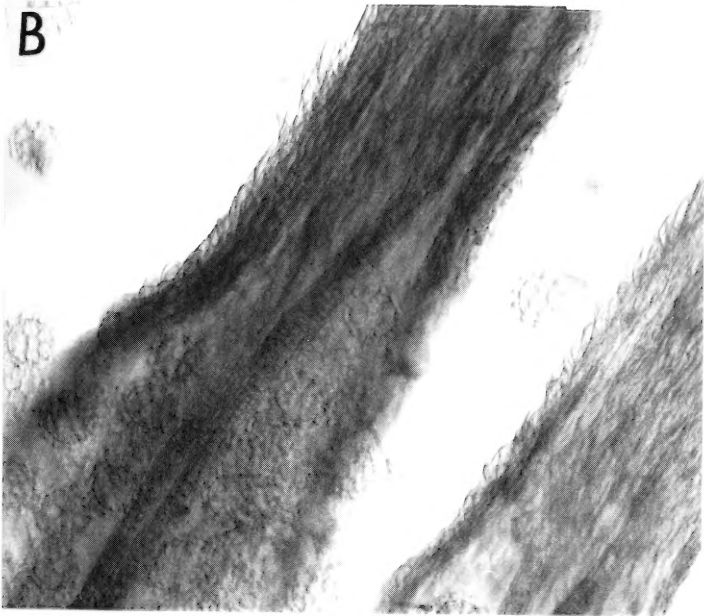
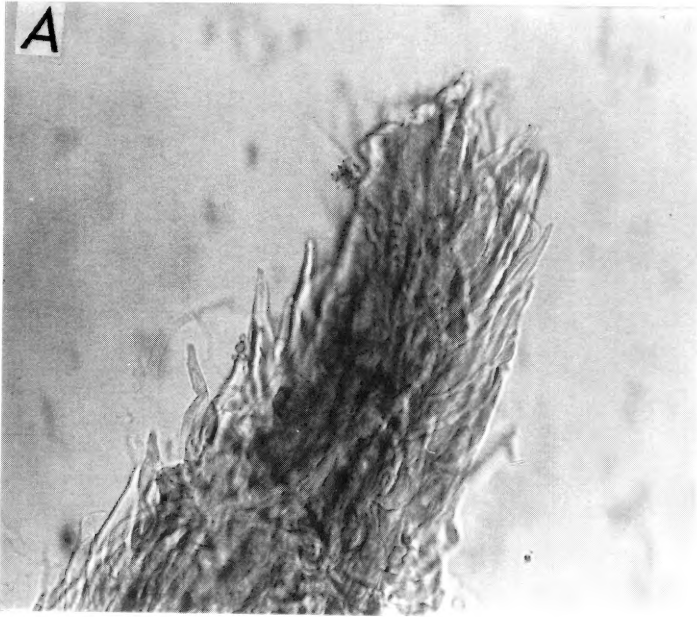
H: LM, equatorial view of pollen with long colpus, x 400.

– A–H: Taylor 2934 (S).

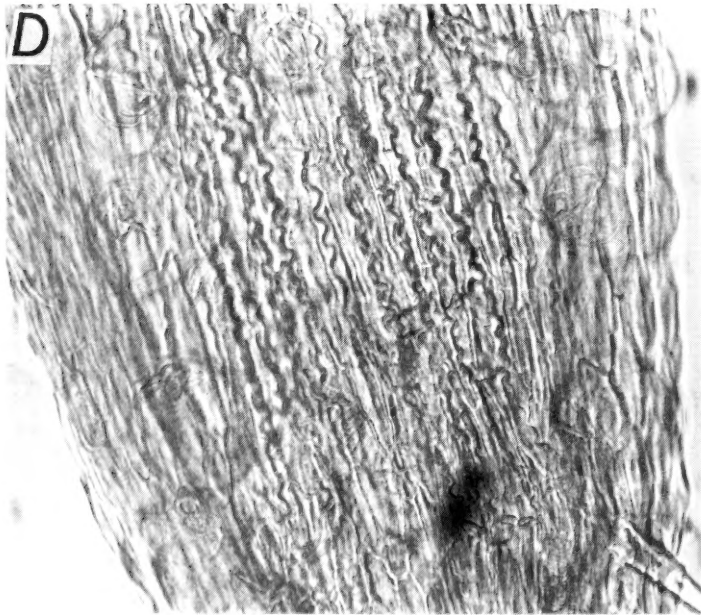
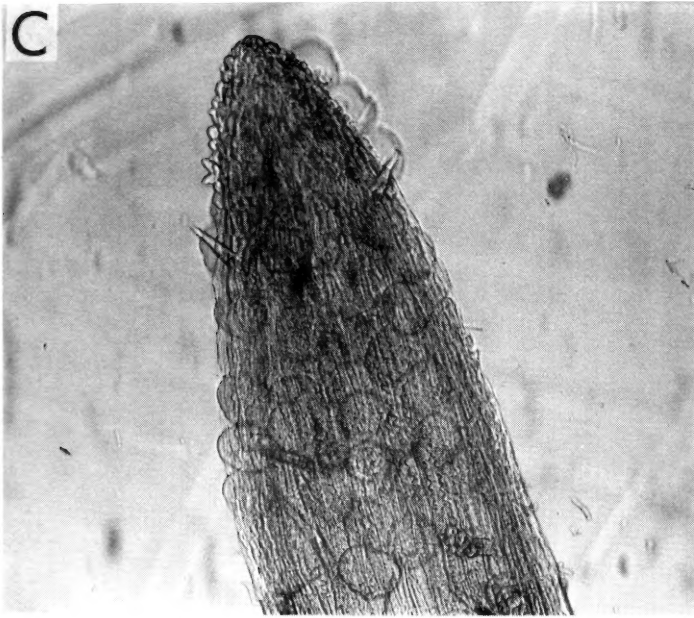


Fig. 1

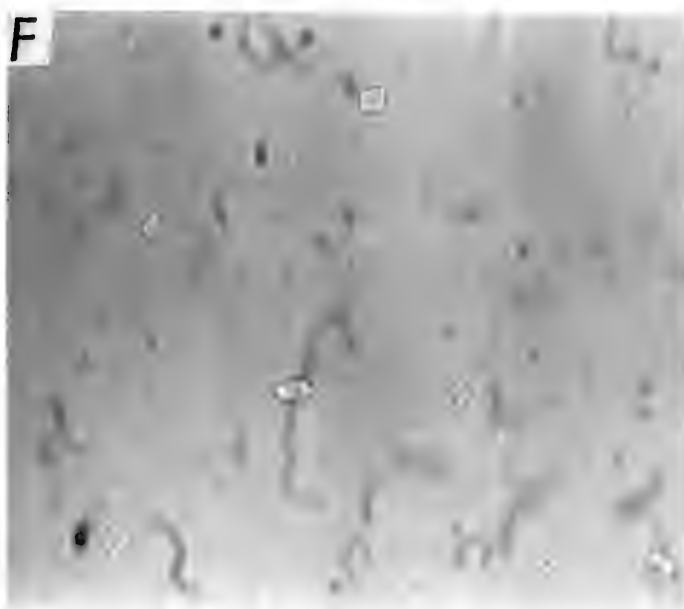
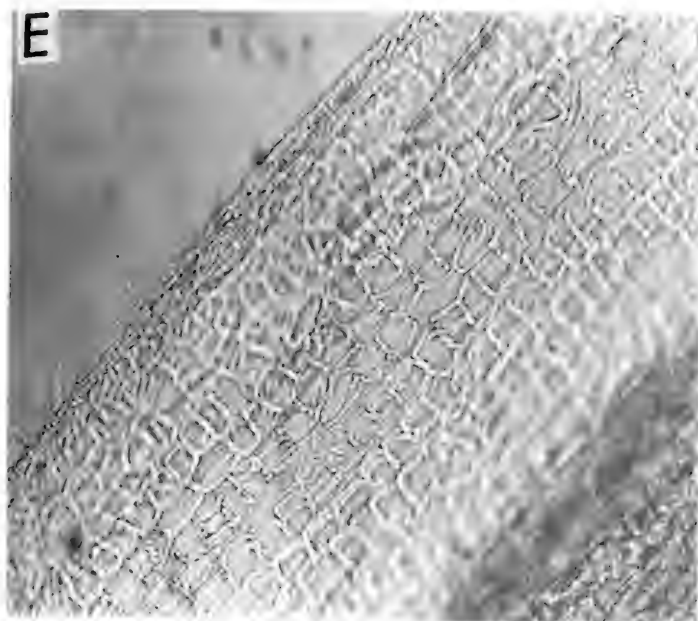




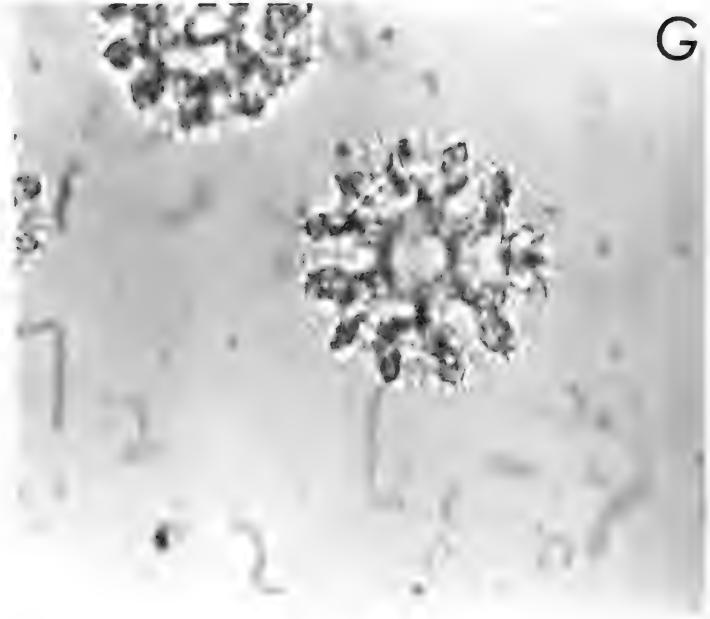
Pl. 1 A & B



Pl. 1 C & D



Pl. 1 E & F



G



H

Pl. 1 G & H

# FLORAL MICROCHARACTERS AND TAXONOMY OF THE *CYANTHILLIUM CINEREUM* COMPLEX (ASTERACEAE: VERNONIEAE)

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## Abstract

In this study of *Cyanthillium cinereum* (L.) H. Robinson four varieties are recognized, one of which is new and three are new combinations. The floral microcharacters of the species and its varieties are described.

## Introduction

The genus *Cyanthillium* Blume was resurrected by Robinson (1990) who transferred *Vernonia cinerea* (L.) Less., *V. stellulifera* (Benth.) C. Jeffrey and *Conyza patula* Ait. to the genus. The transfer was based on the pollen characteristics, which are remarkably different from those of the genus *Vernonia* and other Vernonieae in that the colpus is not evident and the grains have a polar areole surrounded by a tier of five to seven areoles. In other words the polar organization is basically different from most forms in the tribe which have well developed colpi. According to Robinson (1990) the genus *Cyanthillium* is distinctive within the non-colporate genera of the Old World by the modification of the basal columellae of the exine to form bridges under the crests.

However, the genus is substantially different from the genus *Baccharoides* Moench, which possesses grains with long colpi (Isawumi & El-Ghazaly in press). The pollen study of *V. cinerea* by Kingham (1976) also pointed out the lack of colpi in the species.

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## Materials and Methods

The material for this study was obtained from the herbarium of the Swedish Museum of Natural History in Stockholm (S). For the micro morphological observations, florets were softened in boiling water to which a drop of detergent was added, dissected under a stereo microscope, mounted in Hoyer's solution (Anderson 1954, King & Robinson 1970) and studied with LM.

## Results and Discussion

### MORPHOLOGICAL MICROCHARACTERS

#### Corolla pubescence

Pubescence of the corolla lobes is a common feature in the Asteraceae. Uniseriate eglandular trichomes and capitate glands are commonly found on the corolla lobe tips of *Cyanthillium cinereum* and its varieties in all the geographical areas where they occur (Fig. 1A), except var. *ugandense*, which has unicellular eglandular trichomes and T-shaped trichomes in addition (Fig. 2E). On the corolla lobe tips of the varieties in Madagascar are found uniseriate and biseriate stalked glands in addition to the ones mentioned above. In all the varieties, the same types of trichomes found on the corolla lobe tips are present on the limbs and tubes with sometimes slight modifications.

The uniseriate eglandular trichomes are different from those found in the genus *Baccharoides* (Isawumi & El-Ghazaly in press) because they are usually very long, about 2–3 cells long, with the apical cells much longer than the others. These trichomes are also different from those present on the corolla lobes of *Vernonia s.l.* This character can be conveniently used to separate the varieties occurring in Uganda and Madagascar.

#### Anther apical appendage

The anther apical appendages are sufficiently different within the species to bring about the delimitation of the varieties. In the varieties that occur in Australia, Tanganyika, Zimbabwe (S. Rhodesia) and Malawi, the apical appendages are distinctly ovate and obtuse at tips (Fig. 2H). Some varieties which occur in Uganda, Jamaica, Trinidad (West Indies), and Philippines, have apical appendages that are slightly dilated proximally, taper towards the apex and are obtuse or sometimes acute at tips (Fig. 3I).

In Madagascar there are two types of apical appendages. In var. *viale*, the appendage is more or less lanceolate or ovate-lanceolate and obtuse at tip (Fig. 3J), while in var. *ovatum* it is ovate with truncate tip which is slightly notched in the middle (Fig. 3K).

The anther apical appendages are not conspicuously constricted at the base as normally in the tribe Vernonieae (sensu King & Robinson 1970) but they are as wide as the thecae (cf. Anderberg 1991). Furthermore the appendages do not have glands like the neotropical Vernonieae (Robinson & Kahn 1986).

### Endothelial tissue

The endothelial tissue in the species and its varieties is intermediate (Fig. 1B) with the cells thickened on both the horizontal and radial walls (Dormer 1962, Nordenstam 1978). The thickenings are weakly connected across the external surface of the cells (Fig. 1B) as usually found in the tribe Vernonieae (Robinson 1977). This character is autapomorphic for the tribe Vernonieae.

The endothelial tissue in the genus *Baccharoides* is distinctly polarized (Isawumi & El-Ghazaly in press) and therefore different from the one in this species which is placed in the resurrected genus *Cyanthillium*.

### Filament collars

The filament collars have long been used by synantherologists for taxonomic discrimination (Nordenstam 1978). The collars are the uppermost parts of the filaments. They are narrowly cylindrical, elongate, straight and not wider than the filaments (Fig. 2G) in all the varieties of this species. They are different from those found in the genus *Baccharoides* which are ovate and sometimes dilated distally (Isawumi & El-Ghazaly in press).

The filaments in this species are inserted on the corolla at the limb/tube junction.

### Base of anther thecae

The terminology to describe the basal portion of the anthers, suggested by Robinson (1983), viz., calcarate (spurred) versus ecalcarate, has been used in synantherology by many authors (Bremer 1987, Anderberg 1991, Karis 1993). The anthers in *Cyanthillium cinereum* are long calcarate because the thecae extend below the point where the filament connects with the anther (Fig. 2G).

### Ovary wall crystals

Ovary crystals have been used successfully in the taxonomic evaluation of several tribes of the family Asteraceae (Dormer 1961, Nordenstam 1978, Nordenstam & El-Ghazaly 1977, Anderberg 1991). Crystals are usually absent in tribes with carbonized achene walls (Robinson 1977).

In *C. cinereum* the ovary wall crystals are narrowly elongate och hexagonal in surface view and rectangular in side view (Fig. 2F).

Crystals sometimes found in the corolla and style may have various shapes - spindle-shaped, hexagonal, clustered, lozenge.

### Style base

The style base is conspicuously ring-like with the cells well thickened with simple pits (Fig. 1D). The cells are more or less rectangular and range from 1–5 in a row. The ring-like style base is absent in the genus *Baccharoides*, which has the style base completely covered by the nectary (Isawumi 1993).

### Cypsela

The term cypsela (sensu Stearn 1966, Fahn 1982) is often considered more strictly correct than the term achene (sensu Wagenitz 1976). The cypsela of *C. cinereum* is subfusiform, terete, more or less ribbed, and narrowed below.

The pubescence of the cypselas in the varieties shows some slight variations. The cypselas may have many idioblasts, few capitate glands and many twin hairs whose parallel cells fuse almost to their apices (Fig. 1C). In the varieties occurring in Zimbabwe, Uganda, Malawi, and Madagascar, one of the parallel cells is longer than the other cell. The parallel cells in the varieties in Trinidad, Madagascar (i.e. var. *ovatum*), British Guiana, and Tanganyika are almost of equal length (Fig. 1C). The cypsela trichomes have been called twin hairs (Hess 1938), but they usually have three cells (Nordenstam 1968, Bremer 1987, Anderberg 1991), one basal-lateral and two elongated parallel cells. At the point of fusion of the two parallel cells are sometimes found simple pits (Fig. 1C).

### Testa epidermis

Testa epidermis in *C. cinereum* and its varieties is ornamented with pattern rather different from that of *Baccharoides* (Isawumi & El-Ghazaly in press).

### Carpopodium

The carpopodium of the species and its varieties has cells which are heavily thickened with pits like in the genus *Baccharoides*.



## Pappus

The species has an outer pappus of distinct, short, linear, fimbriate scales. The inner pappus bristles are white, terete and readily caducous. Sometimes the outer pappus scales may be absent.

The pappus has been a classical source of information at the generic level but less so at higher levels (Bremer 1987), and much emphasis has been given to this structure in the classification of *Vernonia s.l.* (Jeffrey 1988, Wild 1978, Pope 1992, Isawumi 1989, 1993).

## TAXONOMY

*Cyanthillium cinereum* (L.) H. Robinson, in Proc. Biol. Soc. Wash. 103: 252 (1990).

*Conyza cinerea* L., Sp. Pl. 2: 862 (1753).

*Vernonia cinerea* (L.) Less. in Linnaea 4: 291 (1829); DC., Prodr. 5: 24 (1836); Oliv. & Hiern in F.T.A. 3: 275 (1877); Eyles in Trans. Roy. Soc. S. Afr. 5: 503 (1916); Mendonca, Contrib. Conhec. Fl. Angol., 1 Compositae: 14 (1943); Adams in F.W.T.A. ed. 2, 2: 283 (1963); Wild in Kirkia 11: 80 (1978); Maquet in Fl. Rwanda, Spermat. 3: 558 (1985); C. Jeffrey in Kew Bull. 43: 224 (1988); G.V. Pope in Fl. Zambesiaca 6: 143 (1992); H. Humbert in Fl. Madagascar 1: 18 (1960); Fawcett and Rendle in Fl. Jamaica 7 (5): 162 (1936); Cheeseman, Hill & Burt in Fl. Trinidad and Tobago: 58 (1940); Bentham in Fl. Australiensis 3: 459 (1866, reprint 1967). Type: Sri Lanka, Hermann (Lectotype BM, Herb. Hermann, vol. 3).

### (i). var. *cinereum*

*Vernonia cinerea* (L.) Less. subsp. *cinerea*, H. Humbert in Fl. Madagascar, Composées 1: 19 (1960).

Phyllaries 3-seriate, outer linear, inner lanceolate, c. 4 mm long; cypsela c. 1.5 mm long; outer pappus scale-like, slightly persistent; inner ones terete, barbellate, white, c. 3.5 mm long.

Distribution: This variety is pantropical. Madagascar, Majunga, Viguier et Humbert s.n. (S), cited by Humbert (1960); Decary 10592 (S); also in Kenya, Tanzania. A specimen without locality in P (Humblot s.n.) also belongs here. Humblot collected in Madagascar and the Comoro Islands.

### (ii). var. *ugandense* (C. Jeffrey) Isawumi comb. nov.

Basionym: *Vernonia cinerea* (L.) Less. var. *ugandensis* C. Jeffrey, in Kew Bull. 43: 224 (1988); G.V. Pope in Fl. Zambesiaca 6: 143 (1992). Type: Uganda, West Nile Dist. Terego, Hasel 492 (K holotype).

Corolla lobe tip with unicellular and T-shaped eglandular trichomes and many capitate and long stalked uniseriate glands. Anther apical appendage lanceolate-ovate and

obtuse at tip; filament collar straight, elongate, with the cells much thickened on the horizontal walls. Cypselas 5-costate, 1.5–1.8 mm long, sparsely pilose with twin hairs having parallel cells of unequal length; inner pappus bristles c. 3 mm long.

Taxonomic note: This variety, according to Jeffrey (1988) and Pope (1992) can be distinguished by its shorter inner pappus. It has other distinguishing characteristics which include the presence of T-shaped trichomes on the corolla lobe tip (Fig. 2E). This character is found only in this variety.

Distribution: Uganda, Ruwenzori, Kilembe, alt. c. 1,200–1,500 m, Taylor 2464 (S); also in Kenya.

(iii). var. *viale* (DC.) Isawumi, comb.nov.

Basionym: *Vernonia vialis* DC., Prodr, 5: 25 (1836). - *V. cinerea* (L.) Less. subsp. *vialis* (DC.) H. Humbert in Fl. Madagascar, Composées 1: 20 (1960). Type: Madagascar, Tamatave, Bojer s.n. (BM). Syn. *V. arguta* Bak. in J. Linn. Soc. 20:175 (1883).

Corolla lobe tip with few unicellular eglandular trichomes (like twin hairs), many long uniseriate eglandular trichomes and capitate glands; outer phyllaries linearfiliform, inter phyllaries lanceolate, acuminate/apiculate, 6 mm long. Anther apical appendage lanceolate-ovate and obtuse at tip. Crystals in the style tiny and spindle-shaped. Cypselas c. 1 mm long; inner pappus bristles c. 5 mm long.

Taxonomic note: This variety has been found only in Madagascar. Its anther apical appendage is long, lanceolate-ovate (Fig. 3J). It also has many spindle-shaped crystals in the style.

Specimen examined: Madagascar, Firingalava, Perrier 597 (S), cited by Humbert (1960).

(iv). var. *ovatum* Isawumi, var. nov.

Holotype: "Lecta in Madagascar a D. Thunberg", ex herb. Swartz (S).

Herba annua erecta. Folia lanceolata, petiolata, margine serrata; supra pilosa, infra dense pilosa. Receptaculum convexum epaleatum. Phyllaria 3-seriata, dense pilosa; externis linearibus, internis linearibus-lanceolatis 5 mm. longis, acuminatis apiculatis. Corolla 3.5–5 mm. longa. Antherae basi calcaratae; appendicibus apicalibus ovatis truncatis leviter incisuris. Filamentum collum rectum elongatum. Cypselae 1 mm. longae, 5-costatae, sparsim pilosae. Pappi setae interiores c. 4 mm. longae, barbellatae, albae, caducae.

An erect annual herb. Stems branching above, longitudinally ribbed, densely pilose. Leaves lanceolate, petiolate, with serrate margins, pilose above, densely pilose beneath. Receptacle convex, epaleate. Phyllaries c. 3-seriate, densely pilose with very long hairs; outer ones linear, inner ones linear-lanceolate, c. 5 mm long, acuminate-apiculate at tips. Corolla 3.5–5 mm long, very narrowly funnel-shaped; corolla lobe tip with many uniseriate and biseriate stalked glands. Filament collar straight, elongate

with the cells rectangular and uniformly thickened. Anthers calcarate; anther apical appendage ovate with more or less truncate tip, slightly notched in the middle; some of the hairs on the style branches and upper part of shaft short and obtuse at tip; endothecial tissue intermediate with thickenings on both the horizontal and radial walls. Cypselas 1 mm long, 5-costate, turbinate, sparsely pilose with twin hairs having parallel cells of unequal length, few capitate glands and few idioblasts. Pappus without outer scales, inner ones c. 4 mm long, barbellate, white, terete, caducous.

**Taxonomic note:** This variety is different from the other ones because it has anther apical appenage which is ovate with truncate tip slightly notched in the middle (Fig. 3K). The varietal epithet refers to the distinct ovate shape of the apical appendage.

**Distribution:** It occurs probably only in Madagascar, if the location is correct. Swartz' annotation on the back of the type, "lecta in Madagascar a D. Thunberg" is obviously incorrect, since Thunberg never visited Madagascar.

### **Taxonomic notes on geographically separated populations of *C. cinereum* var. *cinereum***

#### (a) Tanganyika

Stem branches are densely pilose with long hairs intermingled with long uniseriate ones clustered at nodes and up to 20 cells long. Cypselas are 1.8–2 mm long, densely appressed pilose with twin hairs whose parallel cells are almost equal in length and with acute tips. Pappus with outer scales slightly broader than the inner ones which are terete, barbellate, white, c. 4 mm long, and readily caducous.

Specimen examined: Tanganyika, Pangani, Misubugwe forest, Tanner 2190 (S).

#### (b) Malawi

The variety in Malawi is differing slightly from the one in Tanganyika by lacking outer pappus scales, and the twin hairs on the cypselas have parallel cells which are of unequal length. These are minor variations which cannot be used to create a new variety.

Specimen examined: Malawi, Zomba Dist, Makoka Agric. Resea, Balaka & Usi 1514 (S).

#### (c) Trinidad

The twin hairs on the cypselas are similar to the ones in the variety in Tanganyika but different from those found in Malawi because their parallel cells are almost of equal length (Fig. 1C). The anther apical appendage is ovate, much dilated proximally and tapering to the apex and obtuse/acute at tip.

Specimen examined: Trinidad, Broadway 7947 (S).

## (d) The Philippines

This population is similar to the one in Tanganyika.

Specimen examined: Philippines, Ramos & Edano 43993 (S).

## (e) Jamaica

The variety in Jamaica is similar to the ones in the Philippines and Tanganyika in all respects.

Specimen examined: Jamaica, Yunker 17890 (S).

## (f) British Guiana

Specimen examined: British Guiana, Georgetown, Hitchcock 16595 (S).

## (g) Zimbabwe

The variety in this area is similar to the ones above except that it has no outer pappus and the twin hairs on cypsela have parallel cells which are of slightly unequal length and are acute/obtuse at tips. The cypselas are terete without ribs.

Specimen examined: Zimbabwe (S. Rhodesia), Royen 13461 (S).

## (h) Australia

The Australian population is similar to the ones in the Philippines, Jamaica and Tanganyika.

Specimen examined: Australia, Eriksson 402 (S).

## (i) India

The population is similar to the one in Zimbabwe with respect to the cypsela which is not ribbed; its cypsela is c. 2 mm long.

Specimen examined: India, Madras, Keebola' 8197 (S).

## (j) China

The specimen seen is similar to the ones from India, Philippines, etc. Its cypsela is densely pilose, c. 0.6 mm long; inner pappus bristles terete, white, c. 4.5 mm long and readily caducous.

Specimen examined: China, Wulsin *et al.* 12481 (S).

### Conclusion

The species and its varieties are rightly transferred from *Vernonia s.l.* to the resurrected genus *Cyanthillium* because of its distinct pollen characteristics and floral microcharacters. Its pollen has no colpus in contrast to the genus *Baccharoides* (Isawumi & El-Ghazaly in press) and the genus *Vernonia s.l.* The endothelial tissue is

intermediate unlike the one in *Baccharoides* which is distinctly polarized (Isawumi & El-Ghazaly in press). The filament collar is elongate and straight unlike the ones in *Baccharoides* which are more or less shortly cylindrical and sometimes somewhat dilated distally.

There are about three varieties in East Africa and three also in Madagascar. The var. *lenti* (O. Hoffm.) C. Jeffrey reported by Jeffrey (1988) as occurring in Kenya and Tanzania could not be included in this work. The area of greater diversity of the species is therefore probably in East Africa and Madagascar. It is suggested that the species might have originated either in East Africa or Madagascar and spread by introduction to other parts of tropical areas of the World.

Hitherto the varieties have been delimited on the bases of the size of inner phyllaries, cypselas and inner pappus bristles (Jeffrey 1988, Pope 1992). It is found in this study that the microcharacters are strongly diagnostic for the varieties and can be easily used along with other characters for their separation and identification.

The species is pantropical and found in tropical Asia, India, China, Philippines, Australia, Jamaica, West Indies, South America, and Madagascar. On the African continent it is known from Zimbabwe, Malawi, Mozambique, Zaire, Rwanda, Uganda, Kenya, Tanzania, Tanganyika, Angola, and other parts of Southern Africa, and also in tropical West Africa. It thus occurs throughout the paleotropical region and is widely adventive in the neotropics (Robinson 1990).

### Acknowledgements

I would like to acknowledge the assistance of Prof. B. Nordenstam for reading the manuscript and offering valuable comments. Financial support from the Swedish Institute is also gratefully acknowledged. I am particularly grateful to the staff members of the Botany Department of the Swedish Museum of Natural History for their assistance and cooperation during the course of the study.

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### FIGURE LEGENDS

- Fig. 1** A: *Cyanthillium cinereum* var. *cinereum* in Trinidad - Corolla lobe tip with eglandular trichomes 2–3 cells long and capitate glands, x 230;
- B: Endothecial tissue intermediate with both horizontal and radial walls thickened, x 325;
- C: Twin hairs with parallel cells almost of equal length, fused almost to the apices and with simple pits at the fused areas; idioblasts on cypsela. x 230; Broadway 7947 (S).
- D: *C. cinereum* var. *cinereum* in Jamaica –Style base ring-like with thickened cells, x 230; Yuncker 17890 (S).
- Fig. 2** E: *C. cinereum* var. *ugandense* – Corolla lobe tip with T-shaped trichome and capitate glands, x 230 (S);
- F: Ovary wall crystals and idioblasts on cypsela, x 230; Taylor 2464 (S).
- G: *C. cinereum* var. *cinereum* in Australia – Filament collar elongate, narrow and cylindrical, x 230;
- H: Anther apical appendage ovate in shape, endothecial tissue intermediate, x 230; Eriksson 402 (S).
- Fig. 3** I: *C. cinereum* var. *cinereum* in the Philippines – Anther apical appendage ovate and tapering towards the apex, x 230; Ramos & Edano 43993 (S);
- J: *C. cinereum* var. *viale* in Madagascar – Anther apical appendage lanceolate–ovate with obtuse tip, x 80; Perrier de la Bathie 597 (S).
- K: *C. cinereum* var. *ovatum* in Madagascar – Anther apical appendage ovate with truncate tip slightly notched in the middle, x 230; Thunberg s.n. (S).



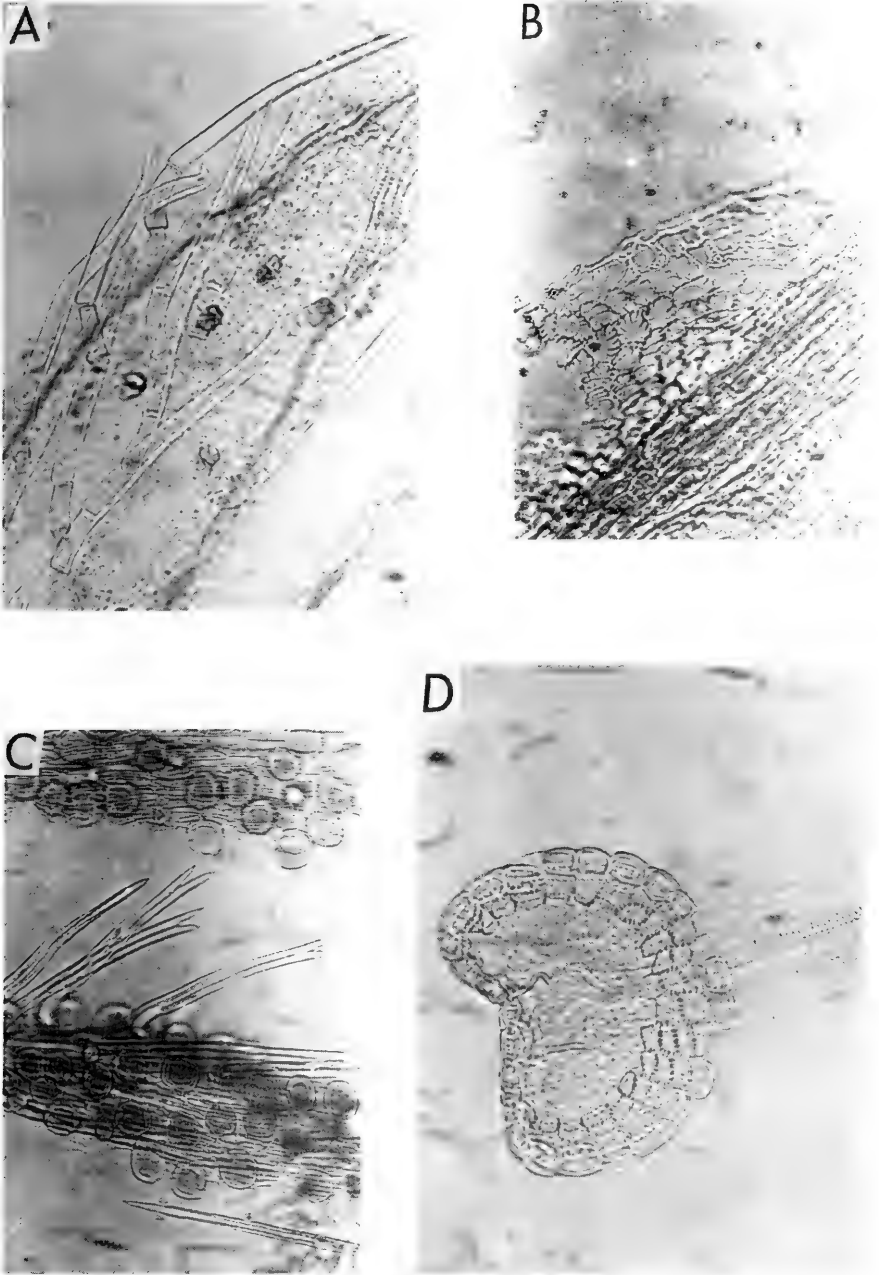


Fig. 1 A—D

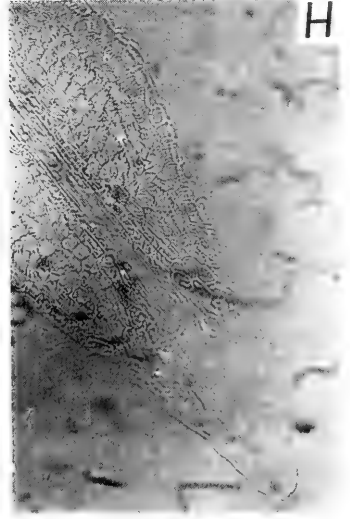
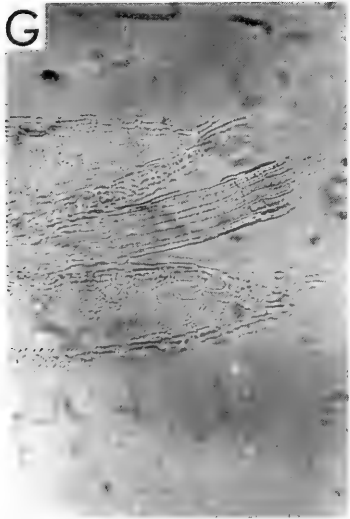
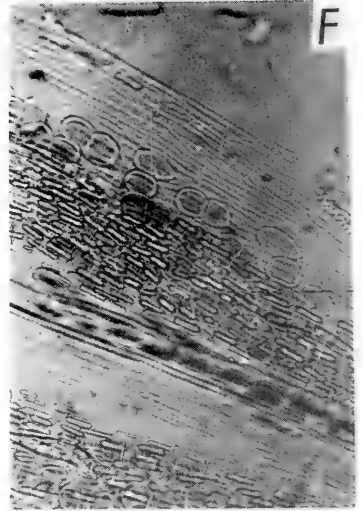


Fig. 2 E—H

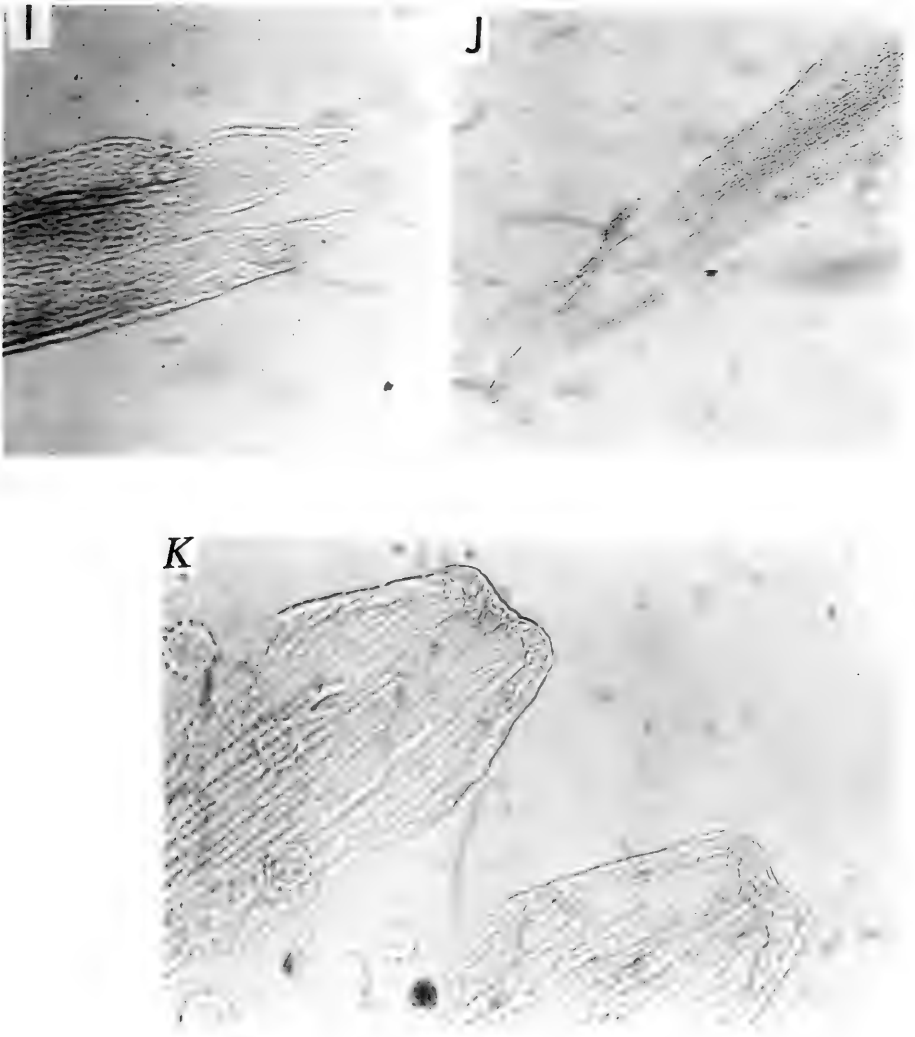


Fig. 3 I—K

# STUDIES ON THE REPRODUCTIVE BIOLOGY OF *VERNONIA* SCHREB. (ASTERACEAE)

## III. Floret shapes/number, pappus types and surface structure among different growth habits

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### Abstract

Floral attributes displayed low variability within and among species of *Vernonia*, and are thus considered of great diagnostic value in taxonomic evaluation.

Floral dimorphism in one of the species studied (*V. biafrae*) constitutes a noteworthy variant of the usual reports on sexual characters of species in the genus *Vernonia*.

Pappus surface structures give additional evidence as regards their function in achene (fruit) dispersal. The surface structure of pappus (i.e., absence, presence and number of bristles) among the species, is of value recommendable for growth habit delimitation within the genus.

### Introduction

The capitula of the species of the genus *Vernonia* are reported to show interspecific variation in floret shapes. The florets are reported to be bisexual in species described (Hutchinson & Dalziel 1973, Keay *et al.* 1964, Jones 1976). The fruits (achenes) are crowned by a pappus composed of numerous bristly hairs. Pappus hairs are either uniform or variable in length in different species (Keay *et al.* 1964, Jones 1976, Isawumi 1982, Ayodele 1987). The pappus is one of the morphological attributes useful for taxonomic evaluation of the genus (Faust 1972, Jones 1973, Isawumi 1982).

The objective of this paper is to report the observed variations in floret shapes and sexual characters of the flowerheads of some Nigerian species of *Vernonia*. This paper will also report observed variations in the pappus, including details of surface structures, among the different growth forms studied. These will enhance useful deductions on certain aspects of reproductive efficiency in the genus *Vernonia*.

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## Materials and Methods

Capitula at anthesis were harvested randomly from *Vernonia* plants among field populations, garden and screen house plants. At least five capitula from five plants of each species were used during each investigation of floret morphology and assessment of number of florets per capitulum.

Each capitulum was dissected by means of a pair of forceps and a mounted needle to detach the florets from the receptacle. Floret counts were taken, using a tally-counter.

The structures of the pappus hairs were observed under a light microscope. A slide mount of pappus hair in water was made and observed under scanning power of a photomicrographic equipment. Photographs of the pappus hair surface structure were taken for each of the species. Drawings were made of floret shapes and fruits with pappus crown.

Means of floret counts and coefficient of variation were estimated for the different species. The floret count values were analysed by Duncan's multiple range test for significant differences among the species.

## Observations/Results

There were significant differences among some of the species in the number of florets contained in each capitulum. The 16 species investigated formed 10 groups of non-significant differences in floret counts (i.e. within group). Of the 10 groups however, there were 6 distinctly separable groups, while the other 4 groups overlapped (Table 1).

Each of the distinct groups contained mainly one growth form (a shrub or a herb), whereas the overlapping groups contained arboreal, shrubby and herbaceous forms (Table 1).

Generally, the species with a large-size capitulum contained higher number of florets, irrespective of the growth form. The overlapping groups contained mainly those species with small-size capitulum from among the different growth forms. The variability in floret counts within each species was observed to be low for the different growth forms.

*Vernonia* florets in all the specimens from the different locations were tubular in shape (Fig. 1). Florets were generally hermaphroditic except in *V. biafrae* (Fig. 1:8), which had mainly ligulate female florets and a few (1-3) hermaphroditic florets in the capitulum. The style of the florets was bifurcated in all the species. The bifurcated stigma, wrapped in fused anther thecae, was exerted in some species (Fig. 1). The style branches were long and recoiled in some species, and usually dusted with a mass of pollen grains, even at anthesis (Fig. 4, 5 & 6).

Among the different species, the pappus hairs showed different orientations (Fig. 2A & B). For example, on broad and heavy fruits (Fig. 2A:4 & 5) there was a 180°

spreading orientation, like a fully-opened hand-wave fan. On other, lighter and narrower fruits, the pappus was either non-spreading (Fig. 2B:13) or showed the reduced-spreading "shuttle-cock" pappus type (Fig. 2B:12).

Photomicrographs (100x) of pappus hairs showed projections (teeth) of various shapes and sizes, on the superficially smooth-looking surfaces (Fig. 3 A & B). The number of such teeth or projections and their frequency on each hair varied among the species. The distribution of pappus teeth along each hair also varied among the growth forms of the species investigated.

The herbaceous species clearly had more projections on each pappus hair (Fig. 3B). These were spine-like and well distributed over the entire length of the hair (Fig. 3B: 11, 12 & 13). The pappus of the herbs thus was of the plumose type. The shrubby species had fewer teeth (Fig. 3A: 4, 6 & 7) especially located on the distal portions of the hair (Fig. 3A:4). Thus a capillary form of pappus was prevalent among the shrubs. Fig. 3A & B also show the distinct differences in the relative sizes of pappus hair for the species studied.

### Discussion

Although there were significant differences in floret counts among the species studied, the variation of this attribute within each species was relatively low, when compared with other morphological traits. The variation was particularly low for those species with overlapping values (Table 1) irrespective of the growth form.

The small-size capitula plants from among all growth forms particularly had low variability in floret counts. The low variability trend in the number of florets per capitulum is noteworthy. Burt (1977) noted that the constancy of the characteristics of florets, in spite of variation occurring in capitulum character, was one reason for the outstanding success in the Compositae. The attributes of the florets are, therefore, emphasized by plant taxonomists in classification and identification of the Compositae (Burt 1977).

The florets of *Vernonia* generally have characteristics which complement other reproductive strategies among the species. A good example is the compensatory roles of small-size capitulum/low number of florets, but with larger clusters of capitula on the plants. This compared with the large-size capitulum with numerous florets, but lesser capitula clustering (Ayodele 1992).

The floral dimorphism observed in *V. biafrae* contradicts previous reports of only bisexual florets in *Vernonia* (Hutchinson & Dalziel 1973, Keay *et al.* 1964).

Heywood *et al.* (1977) noted a correlation between pappus structure and growth habit of some members of the family Compositae. However, *Vernonia* was not one of the genera mentioned. They highlighted the increase in the proportions of capillary or plumose pappus in progression from annual to perennial herbs to shrubs. This report

by Heywood *et al.* (1977) is in conformity with the observed variations, as they relate to the growth habits of the species of *Vernonia* (Fig. 3A & B).

The herbs which produced large-size fruits had more projections on the pappus hair than the shrubby species with large fruits. In herbs, the entire length of the pappus hair carries projections. In shrubs, the lower portions of pappus hair have scanty teeth or are totally smooth (Fig. 3B:11 & 16 compared with Fig. 3A: 4, 5 & 6). The presence or absence of projections and distribution along the pappus hair is recommendable as a useful tool for delimitation of growth forms in the genus *Vernonia*.

The role of projections (and indeed the pappus hair on which they are located) in fruit dispersal, can be deduced from the observed interlocking device of pappus hairs on two adjacent fruits on a receptacle (Fig. 4). Only the upper and middle part of the pappus hairs are interlocked in *V. tenoreana*, a shrub. In *V. galamensis*, a herb, the pappus hairs are interlocked along the entire length (Fig. 4A & B). Projections are absent in the lower portion of pappus hair in *V. tenoreana* (Fig. 3A:4).

The amount of interlocking was observed to be related to the number of fruits dispersed together when shed from the receptacle. Fruits were dispersed either solitarily or in groups of 2-5 fruits with interlocked pappus hairs, for the large-size fruits. The small-size, light-weight fruits formed a cottony mass of tangled pappus for a larger group dispersal unit of fruits. In some species (e.g., *V. biafrae*) a sticky oily substance was observed in such a mass of tangled fruits, which are usually dispersed by wind.

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**Table 1. Number of florets per capitulum in some species of *Vernonia***

Species grouping* from Duncan's multiple range test	Species name	Mean	Range	CV%**	Species growth habit
A	<i>V. galamensis</i> var. <i>ethiopica</i>	152.72	116-210	16.77	Herb
B	<i>V. kotschyana</i>	146.24	131-168	6.98	Erect shrub
C	<i>V. tenoreana</i>	135.44	111-169	12.59	Erect shrub
	<i>V. stenostegia</i>	135.60	112-160	10.93	Erect shrub
D	<i>V. purpurea</i>	98.24	92-109	7.11	Herb
E	<i>V. galamensis</i> (= <i>pauciflora</i> )	81.20	55-152	27.63	Herb
F	<i>V. ambigua</i>	39.16	36-43	5.29	Herb
	<i>V. perrottetii</i>	35.00	28-45 0-3+	18.35 36.74+	Herb
G	<i>V. biafrae</i>	34.96	22-47	20.73	Stragglng shrub
	<i>V. migeodi</i>	29.44	26-33	6.52	Herb
H	<i>V. cinerea</i>	21.76	20-25	7.29	Herb
	<i>V. colorata</i>	19.24	18-21	5.48	Tree
I	<i>V. nestor</i>	17.96	17-19	3.70	Herb
	<i>V. amygdalina</i>	13.88	10-16	10.03	Tree
J	<i>V. conferta</i>	13.32	11-15	9.64	Tree
	<i>V. glaberrima</i>	4.08	3-5	17.13	Erect shrub

Note: \* Means with the same letter are not significantly different

\*\* Coefficient of variation of attribute.

+ Values are for bisexual tubular and unisexual ligulate female florets respectively.

**Table 2. Analysis of variance (ANOVA) in number of florets per capitulum of *Vernonia***

Character	Source of variation	Sums of squares (SS)	Degree of freedom (DF)	Mean square (MS)	F-value
Number of florets per capitulum in <i>Vernonia</i>	Model	1092388.36	15	72825.89	613.88 *
	Error	45554.80	384	118.631	
	Corrected				
	Total	1137943.16	399		

\* Significant at 0.05% level.

LSD (0.05) = 6.057.

## FIGURE LEGENDS

**Fig. 1** Drawings showing variation in shape of florets in some species of *Vernonia*.

Key: S = stigma;                    O = ovary;                    a.l. = anther lobe

1. *V. conferta* Benth.
2. *V. amygdalina* Del.
3. *V. colorata* (Willd.) Drake
4. *V. tenoreana* Oliv.
5. *V. stenostegia* (Stapf) Hutch. & Dalz.
6. *V. kotschyana* Sch. Bip.
7. *V. glaberrima* Welw. ex O. Hoffm.
8. *V. biafrae* Oliv. & Hiern
9. *V. migeodi* S. Moore
10. *V. cinerea* (Linn.) Less.
11. *V. galamensis* (= *pauciflora*) (Cass.) Less.
12. *V. ambigua* Kotschy & Peyr.
13. *V. perrottetii* Sch. Bip.
14. *V. nestor* S. Moore
15. *V. purpurea* Sch. Bip.

**Fig. 2A & B** Fruit shapes and pappus orientation on fruits of some species of *Vernonia*.

A: Tree and shrubby species.                    B: Herbaceous species.

Key to numerals as in Fig. 1.

**Fig. 3A & B** Photomicrographs of surface structure of pappus hairs of some species of *Vernonia*.

A: Tree and shrubby species.                    B: Herbaceous species.

Key to numerals (1-15) as in Fig. 1, plus 16 = *V. galamensis* var. *ethiopica* (Cass.) Less. & Gilb.

**Fig. 4** Fruit dispersal in *Vernonia*. Pappus hair interlocking device for corporate fruit dispersal.

A. *V. tenoreana* (shrub).                    B: *V. galamensis* (herb).

C: Cottony mass of fruits in *V. biafrae*.



Fig. 1

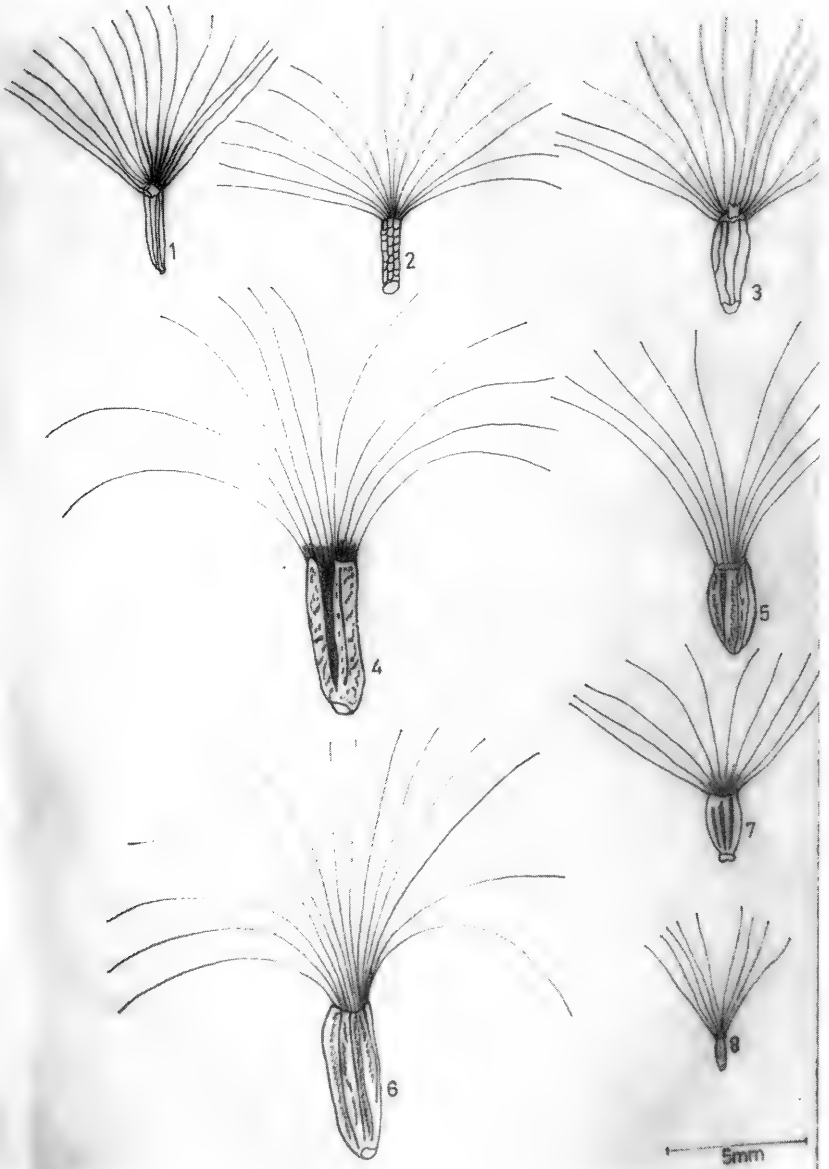


Fig. 2A

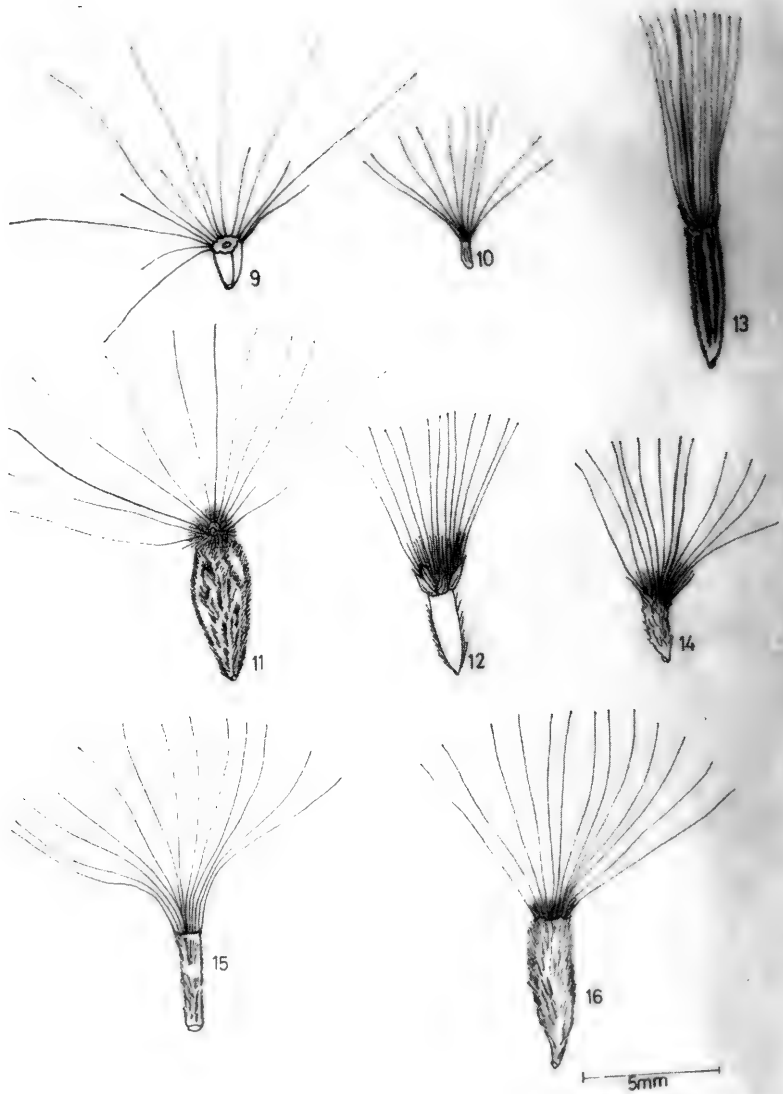


Fig. 2B

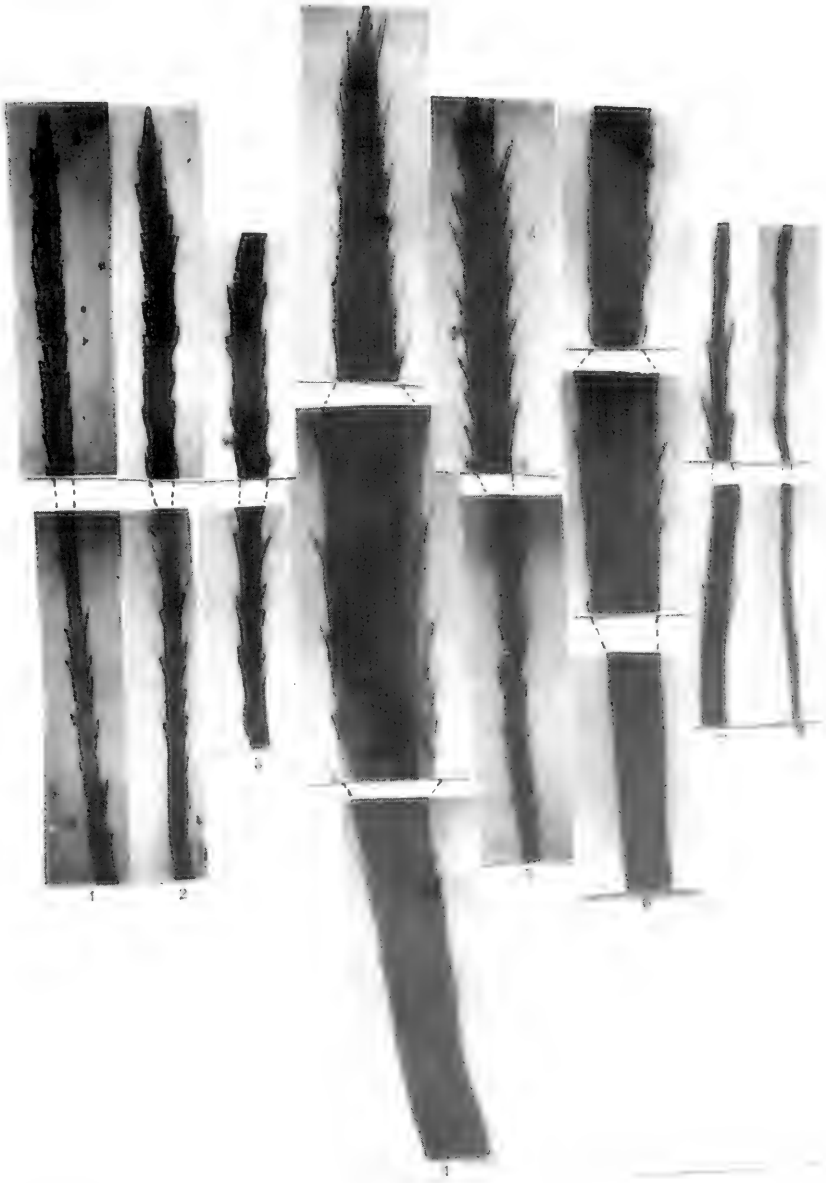


Fig. 3A

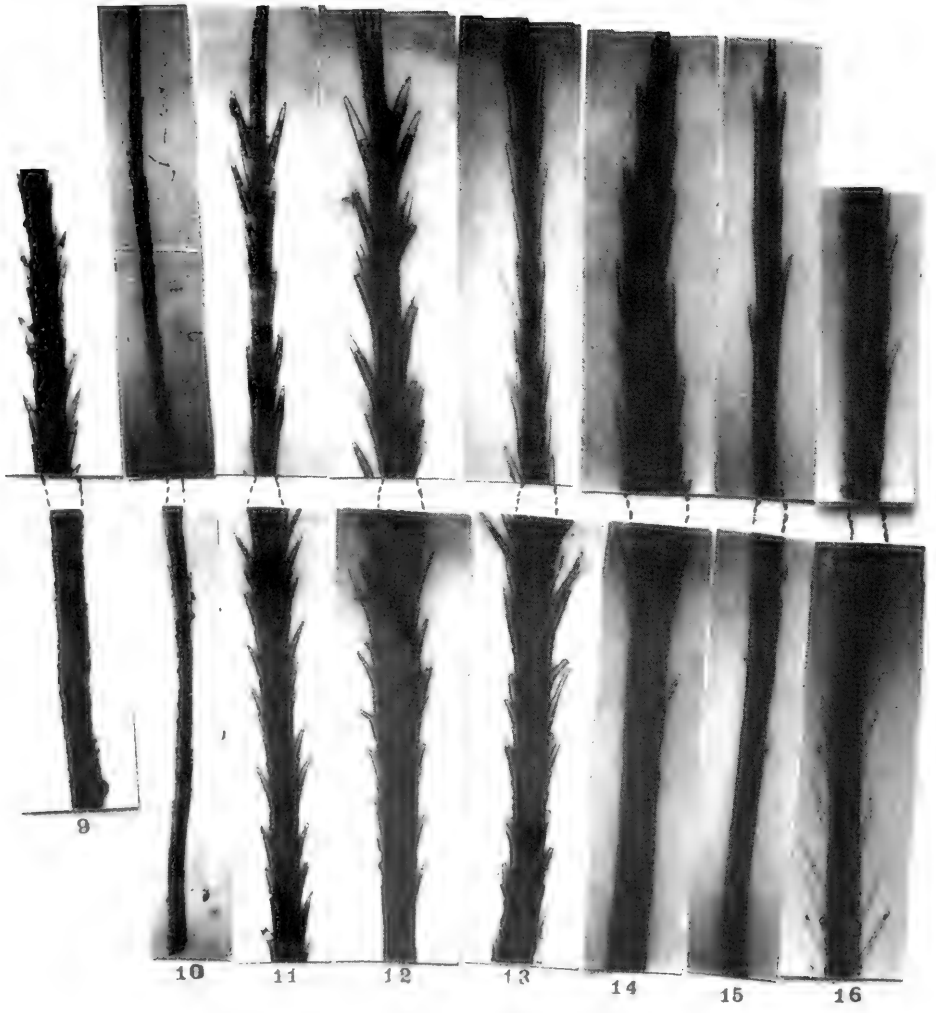


Fig. 3B



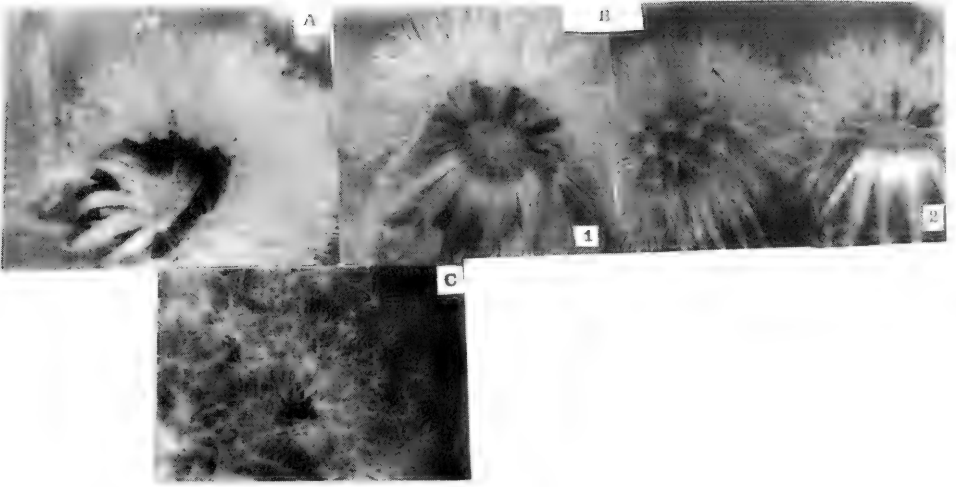


Fig. 4

# ETUDE ANATOMIQUE PRELIMINAIRE DES AKENES DE QUELQUES *ARTEMISIA* DANS LE BASSIN MEDITERRANEEN OCCIDENTAL

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## Résumé

L'auteur décrit l'anatomie des akènes de quelques *Artemisia* en Méditerranée occidentale et discute spécialement la corrélation qui pourrait exister entre la taille, l'absence ou la présence des cellules épidermiques gélifiées et les conditions climatiques du biotope, ainsi que la valeur taxinomique des cellules gélifiées.

## Abstract

The author describes the anatomic structure of the achenes of *Artemisia* in the west Mediterranean basin and specially discusses the probable correlation between the size, presence or absence of the mucilaginous epidermic cells and the climatic conditions in the biotope. Besides, the taxonomic value of the mucilaginous cells is discussed.

## Introduction

Cette étude fait suite à deux articles antérieurs (Ouyahya & Viano 1984 & 1990), traitant les caractéristiques morphologiques et biométriques des akènes des taxons marocains et à titre de comparaison les taxons affines du bassin méditerranéen occidental.

Nous avons entrepris l'étude anatomique des akènes des armoises étudiées en nous basant sur le travail de Korobkov (1973). Celui-ci constitue la meilleure contribution à l'étude carpologique de certaines espèces du genre *Artemisia* au nord-est de l'ex URSS. Cet auteur a suggéré que, sur la base de la morphologie et de l'anatomie de l'akène, la différenciation spécifique est tout à fait remarquable.

## Matériel et méthode

Comme Korobkov (1973), nous avons procédé à des coupes transversales sur plusieurs akènes par taxon. Les coupes ont été effectuées à main levée sur les akènes secs, préalablement trempés dans un mélange d'eau, de glycérine et d'alcool éthylique (1/1/1 V). Les coupes ont été ensuite traitées de la façon suivante: eau de javel (15 min.); rinçage à l'eau; eau acétique à 5 % (5 min.); carmino-vert (10 min.); rinçage à l'eau; montage dans la glycérine. Cette méthode a donné de bons résultats pour les akènes dépourvus de cellules gélifiées tels que ceux de *A. verlotorum* et *A. vulgaris*. Mais pour les akènes qui ont des cellules gélifiées qui se déchirent en présence d'eau dans les réactifs, nous avons réalisé des coupes sur des akènes secs, puis les coupes ont été montées directement dans la glycérine pure.

## Résultats et discussion

A l'observation au microscope photonique, la paroi des akènes apparaît relativement homogène au sein des taxons analysés. Cette paroi se compose des parties suivantes:

- un péricarpe (paroi du fruit), comprenant un épiderme à une seule couche de cellules gélifiées ou non, à cuticule plus ou moins mince et de rares faisceaux libéro-ligneux. En présence de l'eau, les cellules épidermiques se gélifient, se gonflent tout en demeurant très réfringentes. Ces cellules jouent un rôle physiologique important dans l'absorption de l'eau, au moment de la germination, tout en formant une couche de mucilage plus ou moins épaisse (selon le degré de gélification).
- un tégument (paroi de la graine) dont l'épiderme externe (épistesta) est plus ou moins développé, alors que la couche interne est presque complètement résorbée.
- un albumen réduit à une seule assise de cellules protéiques, allongées dans le sens tangentiel.

Les résultats obtenus ont été consignés dans le tableau 1. On y distingue trois groupes, suivant la présence ou l'absence des cellules gélifiées et leur taille.

- Le premier groupe comprend les akènes à paroi pourvue de grandes cellules gélifiées (> 50 µm d'épaisseur). Ce type d'akènes caractérise *A. herba-alba* (Fig. 2a).
- Le second groupe renferme la majorité des espèces étudiées dont les akènes possèdent, en effet, des cellules gélifiées de petite taille (< 20 µm d'épaisseur) (Figs. 1a à 4d) ou de taille moyenne (à épaisseur comprise entre 20 et 50 µm) (Figs. 2b-2c et 3a à 3d).
- Les espèces du troisième groupe se distinguent facilement des akènes dépourvus de cellules gélifiées (Figs. 4a à 4c), c'est le cas par exemple de: *A. verlotorum*, *A. vulgaris*, *A. campestris* subsp. *lloydii*, *A. crithmifolia* et *A. alba* subsp. *chiachensis*.

Korobkov (1973) avait établi le même type de découpage et avait corrélé l'aptitude à la gélification, avec la répartition géographique et les conditions climatiques des armoises russes étudiées.

Selon cet auteur les espèces à akènes très gélifiés occupent essentiellement les régions sèches (espèces continentales), celles à akènes moins gélifiées croissent dans des lieux bien drainés et le troisième type à akènes dépourvus de cellules gélifiées est représenté par des espèces océaniques ou subocéaniques.

Pour les *Artemisia* marocains, la corrélation est du même ordre: chaque groupe est corrélé avec l'aridité du biotope.

Cependant, l'adhérence du péricarpe à la graine confirme la subdivision du genre *Artemisia* en deux unités distinctes (*Artemisia* et *Seriphidium*) dont le rang systématique est discutable. Ce résultat recoupe ceux que fournissent la nature des capitules, d l'indument etc. (Ouyahya 1987). Ce caractère s'ajoute à l'absence ou la présence des cellules gélifiées s'avèrent un excellent critère de discrimination (Tableau 1).

**Tableau 1. Tableau résumant les données relatives aux caractéristiques anatomiques des akènes des *Artemisia* étudiés (les coupes anatomiques transversales ont été faites sur 30 akènes par taxon). Epaisseur (ép.) en  $\mu\text{m}$ .**

Taxon étudiés	Paroi du fruit (péricarpe)		Cellules gélifiées			
	nb. de couches de cellules	adhérent à la graine	absentes	présentes ép. $\geq 50$	présente 20 <ép. <50	présentes ép. $\leq 20$
<i>A. absinthium</i>	1	+				+
<i>A. alba</i> subsp. <i>chitachensis</i>	1-2	+	+			
<i>A. atlantica</i> var. <i>maroccana</i>	1	+				+
<i>A. campestris</i> subsp. <i>glutinosa</i>	1	+				+
subsp. <i>lloydii</i>	1	+	+			
<i>A. crithmifolia</i>	1	+	+			
<i>A. dracunculus</i>	1	+				
<i>A. flahaultii</i>	1	+				
<i>A. judaica</i> subsp. <i>sahariensis</i>	1	+			+	+
<i>A. mesatlantica</i>	1	+			+	+
<i>A. negrei</i>	1	+			+	
<i>A. reptans</i>	1	+			+	
<i>A. verlotiorum</i>	1	+	+			
<i>A. vulgaris</i>	1	+	+			
<i>A. herba-alba</i>	1	±		+		
<i>A. ifranensis</i>	1	-			+	
<i>A. caerulescens</i> subsp. <i>gallica</i>	1	-			+	
<i>A. vallesiaca</i>	1	-			+	

## Bibliographie

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- Briquet, J. 1916. Etude carpologique sur les genres de Composées *Anthemis*, *Ormenis* et *Santalina*. *Ann. Cons. Jard. Bot. Genève* 18-19: 257-313.
- Korobkov, A.A. 1973. Caractéristiques morphologique et anatomique des akènes de *Artemisia* sp. du Nord-Est de l'URSS. *Bot. Zh. SSSR*. 58 (9): 1302-1315.
- Ouyahya, A. 1987. *Systématique du genre Artemisia L. au Maroc*. Doctorat d'état ès-Sciences, Aix-Marseille III, 433 pp.
- Ouyahya, A. & J. Viano 1984. Contribution à l'étude morphologique et biométrique des akènes de taxones endémiques marocains du genre *Artemisia*. *Lagascalia* 12 (2): 223-228.
- Ouyahya, A. & J. Viano 1990. Etude au MEB du testa des akènes du genre *Artemisia*. *Bol. Soc. Brot.*, ser.2, 63: 99-113.

## Légendes des figures

- Fig. 1 Coupes anatomiques transversales des akènes de *Artemisia*: a- *A. absinthium*, b- *A. campestris* subsp. *glutinosa*, c- *A. mesatlantica*, d- *A. judaica* subsp. *sahariensis*.  
I- péricarpe de l'akène;  
II- tégument de la graine;  
III- albumen. Faisceaux conducteurs (f.con.); épiderme externe (ép.ext.); épiderme interne (ép.int.) du tégument de la graine; cellules gélatifiées (c.gel.).
- Fig. 2 Coupes anatomiques transversales des akènes de *Artemisia*. a- *A. herba-alba*, b- *A. negrei*, c- *A. flahaultii*.
- Fig. 3 Coupes anatomiques transversales des akènes de *Artemisia*: a- *A. ifranensis*; b- *A. atlantica* var. *maroccana*; c- *A. dracuncululus*, d- *A. reptans*.
- Fig. 4 Coupes anatomiques transversales des akènes de *Artemisia*: a- *A. alba* subsp. *chitachensis*, b- *A. verlotiorum*, c- *A. crithmifolia*.  
I- péricarpe de l'akène;  
II- tégument de la graine;  
III- albumen. Faisceaux conducteurs (f. con.); côte (co.); cuticule (cu.); couche sous-épidermiques (c.ss.ép.); épiderme externe (ép. ext.); épiderme interne (ép.int.) du tégument de la graine.

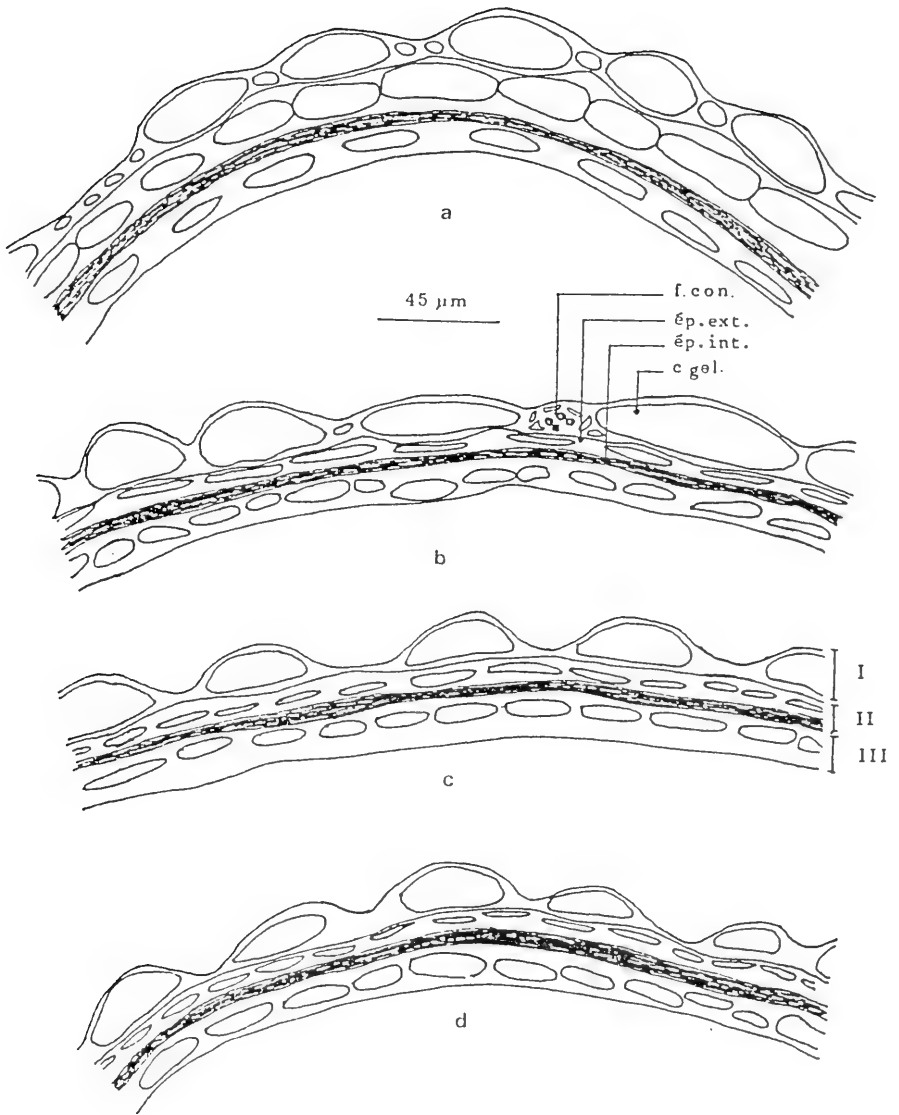
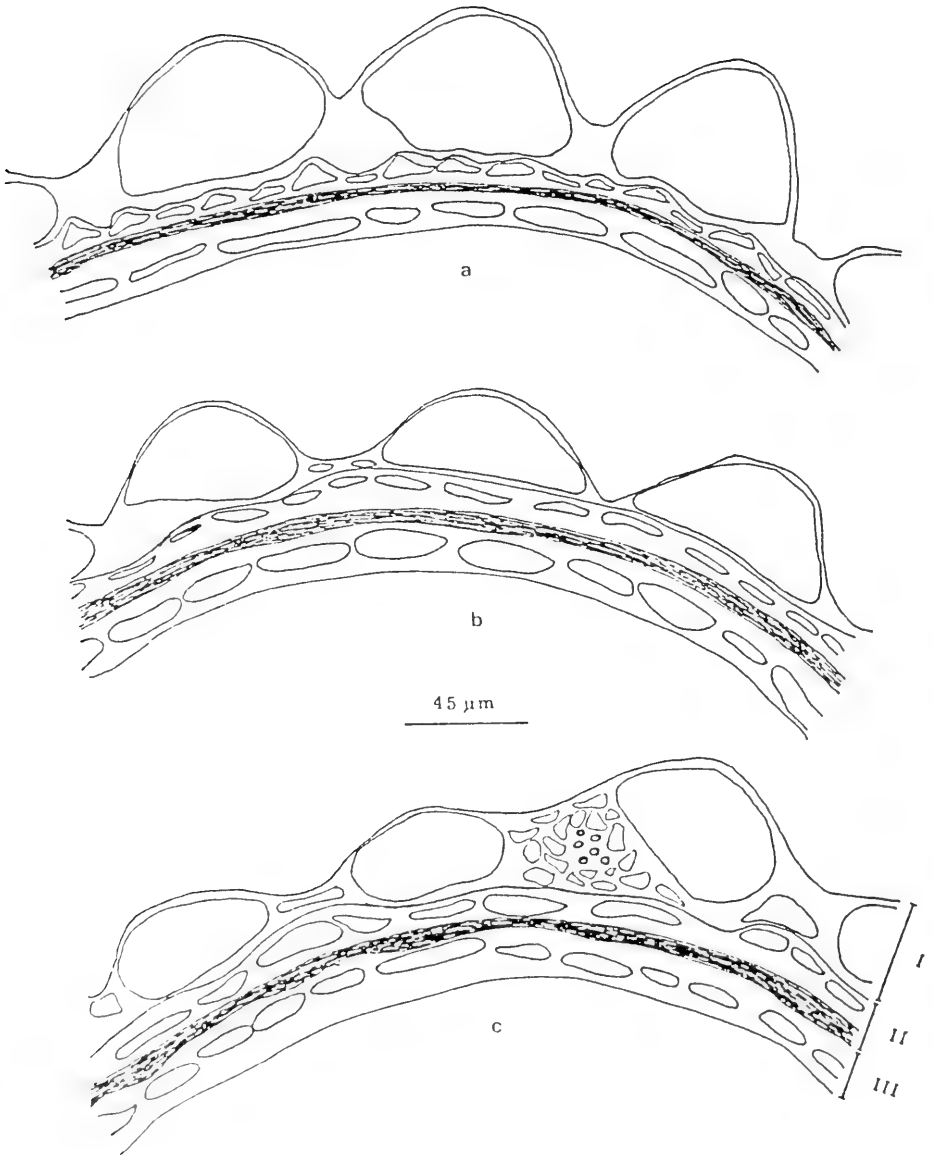


Fig. 1



**Fig. 2**



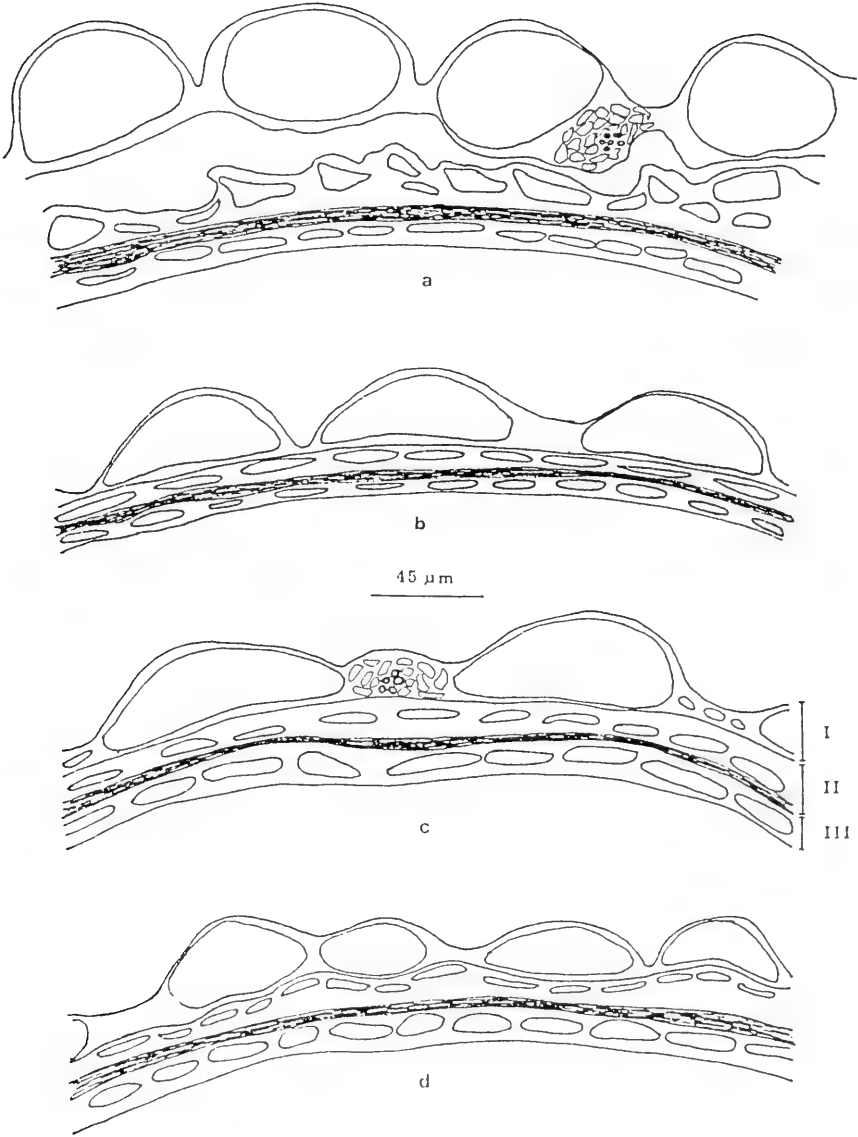


Fig. 3

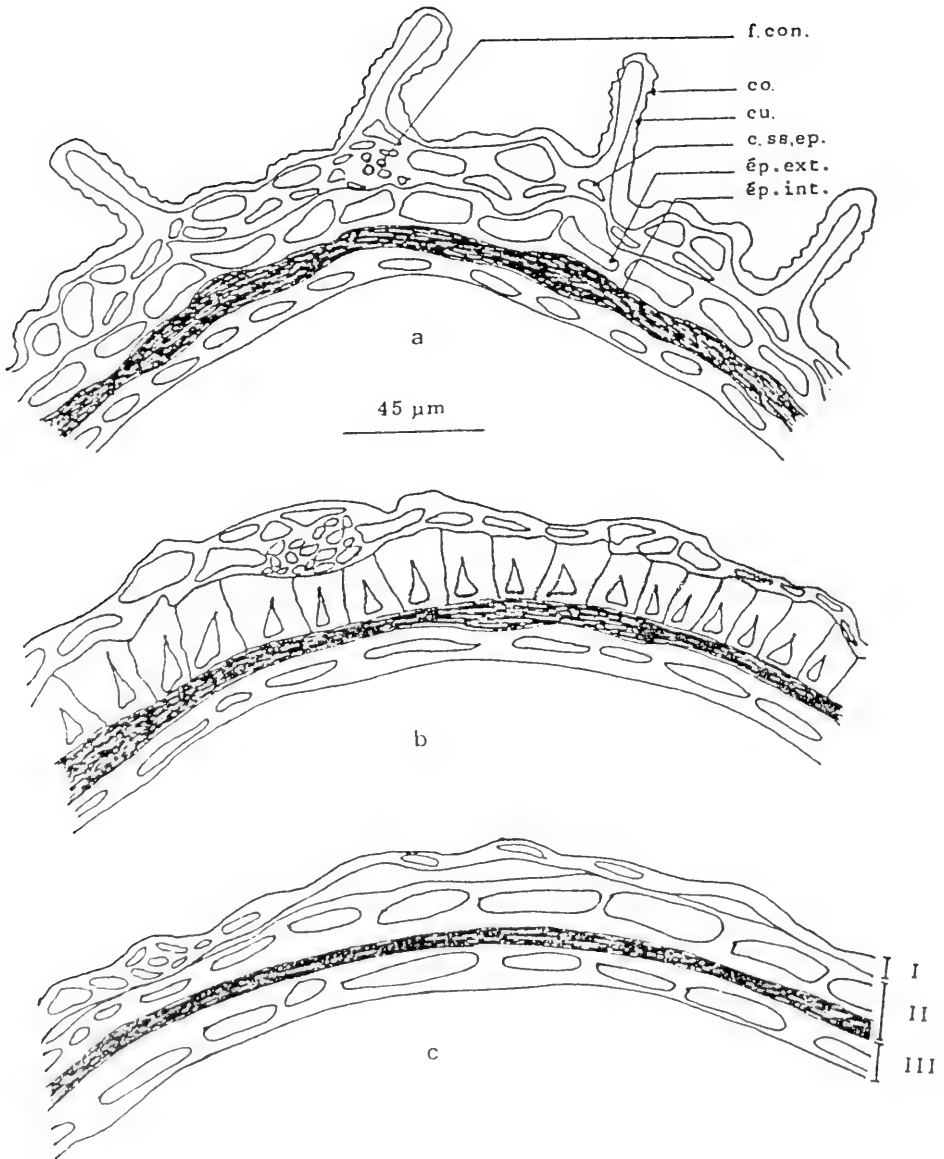


Fig. 4

# SURVEY OF *ARTEMISIA* AND *SERIPHIDIUM* (ASTERACEAE-ANTHEMIDEAE) IN THE HIMALAYAN MOUNTAINS AND THE SOUTH ASIAN SUBCONTINENT

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The author has checked specimens cited in Clarke's *Compositae Indicae*, or in Hooker's *Flora of British India* vol. 3 and in *Materials of Artemisia Linn., sensu lato, in Asia* by R. Pampanini. Also collections from South Asia have been studied, either in the Herbaria of Kew Garden (K) incl. the Wallich Herbarium, British Museum of Natural History, incl. Clifford specimens, which were cited by Linnaeus (BM), Linnaeus Herbarium in Linnean Society (LINN), the Botany School of Cambridge University (CGE), Edinburgh Botanic Garden (E), or Paris Museum of Natural History (P), Rijksherbarium, Leiden (L) and Gray Herbarium of Harvard University, USA (GH), and a few from India \*) (\*\*). Specimens from these herbaria are cited excl. some newly recorded species in *Flora Xizangica* vol. 4. A re-collation and a revision of this material is presented.

**I. *Artemisia* Linn.**, Sp. Pl. 2: 845 (1753) et Gen. Pl. ed. 5: 367 (1754) senu stricto, excl. sect. *Seriphidium* Bess.

## 1. Subgen. *Artemisia*

### 1). Sect. *Absinthium* DC.

**A. *macrocephala*** Jacq. ex Bess. in Bull. Soc. Nat. Mosc. 9: 28 (1836); Hook. f., Fl. Brit. Ind. 3: 329 (1881); Nasir et Ali, Fl. W. Pakistan 717 (1972). — **A. *griffithiana*** Boiss., Fl. or. 3: 376 (1875).

N. India, Kashmir, Nepal, China (N., N.-W., N.-E. et S.-W.), Iran, Mongolia, Afghanistan, Kazakhstan, Kyrgyzstan, Tadjikistan, Russia. (Specimens in BM, E, K, P).

**A. *sieversiana*** Ehrh. ex Willd., Sp. Pl. 3: 1845 (1800); C.B. Clarke, Comp. Ind.: 165 (1876); Hook. f., Fl. Brit. Ind. 3: 329 (1881); Nasir et Ali, Fl. W. Pakistan 719 (1972).

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\*) Lucknow, Central Institute of Medicinal and Aromatic Plants, India.

\*\*) Howrah, National Herbarium, India.

— *A. persica* sensu Schlagint. Cat. [671, 988 (1856), (BM, K)], non Boiss. — *A. laciniata* sensu Schlagint. Cat. [1116, 1307, 1527, 2285, (BM, E, K, L)] — *A. macrantha* auct., non Ledeb.: Pamp. in Nuov. Giorn. Bot. Ital. n.s. 34: 677 (1927); p.p. quoad Pl. Ind. — *Absinthium sieversianum* (Ehrh. ex Willd.) Bess. in Bull. Soc. Nat. Mosc. 1 (8): 259 (1829).

N. India, Kashmir, N. Pakistan, Nepal, China (N., N.-W., N.-E. et S.-W.), N. Japan, N. Korea, Mongolia, Afghanistan, Kazakhstan, Kyrgyzstan, Tadjikistan, Turkmenistan, Uzbekistan, E. Europ. (BM, CGE, E, GH, K).

*A. absinthium* Linn., Sp. Pl. 2: 848 (1753); C. B. Clarke, Comp. Ind. 164 (1876); Hook. f., Fl. Brit. Ind. 3: 328 (1881); Nasir et Ali, Fl. W. Pakistan 714 (1972). — *A. kulbadica* Boiss. et Buhse in Nouv. Mém. Soc. Nat. Mosc. 12: 120 (1860). — *Absinthium vulgare* Lamarck, Fl. Fr. 2: 45. 1778.

N. India, Kashmir, N. Pakistan, China (N.-W. & Xizang), Afghanistan, Iran, Kazakhstan, Kyrgyzstan, Russia, Europe, N. et W. Africa, N. America. (BM, CGE, E, K).

*A. rutifolia* Steph. ex Spreng., Syst. Veg. 3: 488 (1826); Nasir et Ali, Fl. W. Pakistan 718 (1972). — *A. falconeri* C. B. Clarke ex Hook. f., Fl. Brit. Ind. 3: 328 (1881). — *A. turczaninowiana* Bess. var. *falconeri* (C. B. Clarke) O. Fedtsch. in Act. Hort. Petrop. 24: 322 (1905).

Kashmir, Nepal, N. Pakistan, China (N.-W. & Xizang), Afghanistan, Iran, Mongolia, Kazakhstan, Kyrgyzstan, Tadjikistan, Russia. (BM, K, P).

*A. minor* Jacq. ex Bess. in Bull. Soc. Nat. Mosc. 9: 22 (1836); Hook. f., Fl. Brit. Ind. 3: 329 (1881); Nasir et Ali, Fl. W. Pakistan 717 (1972). — *A. sieversiana* Ehrh. ex Willd. var. *tibetica* C.B. Clarke, Comp. Ind. 165 (1876). — *A. tibetica* Hook. f. et Thoms. ex Hook. f., l.c. : 329 (1881) pro syn.

N. India, N. Pakistan, Kashmir, Sikkim, China (Xizang), Iran, Tadjikistan. (BM, E, GH, K).

*A. stracheyi* Hook. f. et Thoms. ex C. B. Clarke, Comp. Ind. 164 (1876); Hook. f., Fl. Brit. Ind. 3: 328 (1881); Nasir et Ali, Fl. W. Pakistan 720 (1972).

Kashmir, N. Pakistan, China (Xizang). (T.T., Type, Tibet Occ., CGE, K).

*A. younghusbandii* J.R. Drumm. ex Pamp. in Nuov. Giorn. Bot. Ital. n.s. 34: 708 (1927).

China (Xizang). (K, L).

*A. persica* Boiss., Diagn. ser. 1, 1 (6): 91 (1845); C. B. Clarke, Comp. Ind. 165 (1876); Hook. f., Fl. Brit. Ind. 3: 327 (1881); Nasir et Ali, Fl. W. Pakistan 718 (1972).

Kashmir, N. Pakistan, China (Xizang et Qinghai), Afghanistan, Iran, Tadjikistan (BM, E, K).

2). *Sect. Abrotanum* Bess. *sensu stricto* (excl. *sect. Artemisia*)

*A. macrantha* Ledeb. in Mém. Acad. Sci. Petersb. 5: 573 (1815). — *A. macrantha* Ledeb. var. *turtzchaninoviana* (Bess.) Pamp. et var. *occidentalis* Pamp. in Nuov. Giorn. Bot. Ital. n.s. 34: 677-678 (1927).

N. India, China (N.-W. et N.), Mongolia, Tadjikistan, Turkmenistan, Uzbekistan, Russia.

*A. sacrorum* Ledeb. in Mém. Acad. Sci. Petersb. 5: 571 (1815); C. B. Clarke, Comp. Ind. 160 (1876); Hook. f., Fl. Brit. Ind. 3: 326 (1881); Nasir et Ali, Fl. W. Pakistan 719 (1972). — *A. annua* auct., non Linn.: Pall. Reise 2: 523 (1773). — *A. gmelinii* auct., non Web. ex Stechm.: Poljak. Fl. URSS 26: 464 (1961).

var. 1. *sacrorum*

N. India, Nepal, N. Pakistan, Kashmir, China, Mongolia, Korea, Japan, Afghanistan, Tadjikistan, Russia, Kazakhstan, m Kyrgyzstan. (BM, E, K, GH, Lucknow, Howrah).

var. 2. *messerschmidtiana* (Bess.) Y.R. Ling, *comb. nov.* — *A. messerschmidtiana* Bess. in Nouv. Mém. Soc. Nat. Mosc. 3: 27 (1834).

N. India, N. Pakistan, China, Afghanistan, Mongolia, Korea, Japan, Russia. (K).

*A. gmelinii* Web. ex Stechm., Dissert. Artem. 30 (1775); Hook. f., Fl. Brit. Ind. 3: 330 (1881). — *A. santolinaefolia* Turcz. ex Bess. in Nouv. Mém. Soc. Nat. Mosc. 3: 87 (1834). — *A. laciniata* auct., non Willd.: Hook. f., l.c.: 326 (1881); Nasir et Ali, Fl. W. Pakistan 716 (1972). — *A. sacrorum* Ledeb. var. *santolinaefolia* Pamp. in Nuov. Giorn. Bot. Ital. n.s. 34: 693 (1927), incl. formae et subformae. — *A. sacrorum* sensu Schlagint., Cat.[11738 (1856), Tibet, (E)], non Ledeb.

N. India, Kashmir, Nepal, China (N.-W. et S.-W.), Mongolia, Kazakhstan, Kyrgyzstan, Tadjikistan, Uzbekistan, Ukrain, Russia. (BM, E, GH, Lucknow).

*A. vestita* Wall. ex Bess. in Nouv. Mém. Soc. Nat. Mosc. 3: 25 (1834); C. B. Clarke, Comp. Ind. 160 (1876); Hook. f., Fl. Brit. Ind. 3: 326 (1881). — *A. laciniata* auct., non Willd.: C.B. Clarke, Comp. Ind. (1878). — *A. sacrorum* Ledeb. var. *minor* Ledeb. f. *wallichiana* Pamp. in Nuov. Giorn. Bot. Ital. n.s. 34: 690 (1927).

N. India, Kashmir, N. Pakistan, China (S.-W.). (Wallich Cat. 3301/411, Type, Kumaon, BM, CGE, E, GH, K, L).

*A. carvifolia* Buch.–Ham. in Roxb., Hort. Beng. 61 (1814), nom. nud., Fl. Ind. 3: 422 (1832); C.B. Clarke, Comp. Ind. 162 (1876) ("*caruifolia*"); Hook. f., Fl. Brit. Ind. 3: 324 (1881). — *A. apiacea* Hance in Walp., Ann. Bot. Syst. 2: 895. (1852). — *A. carvifolia* Buch.–Ham. ex Roxb. var. *apiacea* (Hance) Pamp. in Nuov. Giorn. Bot. Ital. n.s. 34: 648 (1927).

N. India, Nepal, China (E., C., S. et S.-W.), Burma, Indo-China, Korea, Japan, [Wallich Cat. 3299/409 (1824), Type, Bengal, BM, CGE, K)].

*A. annua* Linn., Sp. Pl. 847 (1753); Hook. f., Fl. Brit. Ind. 3: 323 (1881); Nasir et Ali, Fl. W. Pakistan 715 (1972). — *A. wadei* Edgew. in Trans. Linn. Soc. Bot. 20: 72 (1846). — *A. stewartii* C. B. Clarke, Comp. Ind. 163 (1876). — *A. tournefortiana* sensu Schlagint., Cat. [2670. (N.-W. Ind.), (E)] non Reichb.

Widely distr. N. Hemisphere and N. Africa. (BM, E, GH, K, Lucknow).

*A. hedinii* Ostenf. et Pauls. in S. Hedin, S. Tibet 6 (3): 41, pl. 3. fig. 1 (1922). — *A. biennis* auct., non Willd.: Hook. f., Fl. Brit. Ind. 3: 325 (1881); Nasir et Ali, Fl. W. Pakistan 715 (1972).

N. India, N. Pakistan, Nepal, Sikkim, Kashmir, China (N.-W. et S.-W.), Tadjikistan (BM, E, GH, K, P).

*A. pallens* Wall. ex Bess. in Nouv. Mém. Soc. Nat. Mosc. 3: 85 (1834).

N.-E. India, N. Thailand. (BM, K).

*A. tournefortiana* Reichb., Ic. Exot. Cent. 1: 6, tab. t. (1827); C. B. Clarke, Comp. Ind. 163 (1876); Hook. f., Fl. Brit. Ind. 3: 324 (1881); Nasir et Ali, Fl. W. Pakistan 720 (1972). — *A. pinnatifida* Jacq. ex DC., Prodr. 6: 120 (1837) pro syn.

N. Pakistan, Kashmir, China (N.-W. et S.-W.), Afghanistan, Iran, Mongolia, Kazakhstan. (BM, CGE, J. Gay (1833), Type, GH, K).

*A. filiformilobulata* Y.R. Ling et H. S. Puri in Guihaia 5 (1): 1, fig. 1 (1985).

N. India, (N.C. Shah 266a, Type CIMAP, Lucknow).

### 3). Sect *Artemisia*

*A. austro-yunnanensis* Ling et Y.R. Ling in Bull. Bot. Res. 4 (2): 20, fig. 4: 10-18 (1984). — *A. burmanica* Pamp. f. *latiloba* Pamp. in Nuov. Giorn. Bot. Ital. n.s. 33: 455 (1925). — *A. dubia* Wall. ex Bess. var. *longeracemulosa* Pamp. f. *tonkingensis* Pamp., l.c. 36: 439 (1930).

N.-E. India, China (S.-W.), N. Thailand, N. Burma, Indo-China (K).

*A. lavandulaefolia* DC., Prodr. 6: 110 (1837). — *A. vulgaris* auct., non Linn.: C.B: Clarke, Comp. Ind. 161 (1876) p.p.; Hook. f., Fl. Brit. Ind. 3: 325 (1881) p.p. quoad syn. — *A. dubia* Wall. ex Bess. var. *multiflora* Pamp. in Nuov. Giorn. Bot. Ital. n.s. 36: 382 (1929) p.p., quoad pl. Ind. Occ.

W. India (L, P).

*A. verlotorum* Lamotte in Mém. Assoc. Franc. Cong. Clerm.-Ferr. 511 (1879). — *A. leptostachya* auct., non D. Don: DC., Prodr. 6: 113 (1837). — *A. vulgaris* auct., non Linn.: C. B. Clarke, Comp. Ind. 161 (1876); quoad var. *vulgaris* p.p.; Hook. f., Fl. Brit. Ind. 3: 325 (1881), quoad syn. — *A. leptostachya* DC.: Nasir et Ali, Fl. W. Pakistan 720 (1972) p.p. — *A. dubia* Wall. ex Bess. var. *legitima* (Bess.) Pamp. f. *genuina*

Pamp. sf. *puberula* Pamp., f. *communis* Pamp. sf. *intermedia* Pamp., var. *acuminata* Pamp. f. *leptostachya* (DC.) Pamp. et var. *orientalis* Pamp. in Nuov. Giorn. Bot. Ital. n.s. 36: 435-438 (1930). — *A. dubia* auct., non Wall. ex Bess.; Kitam. in Act. Phytotax. Geobot. 23 (1-2): 11 (1968), quoad pl. Nepal. — *A. indica* auct., non Willd.: Kitam. l.c. 23 (1-2): 12 (1968), quoad pl. Nepal. et Bhutan.

Widely distr. Eurasia (except North) et E. et N. Africa. (BM, E, K).

*A. velutina* Pamp. in Nuov. Giorn. Bot. Ital. n.s. 36: 413 (1930). — *A. dubia* Wall. ex Bess. var. *legitima* (Bess.) Pamp. f. *communis* Pamp. sf. *intermedia* Pamp., l.c. 32: 449 (1926).

Kashmir, N.-E. India, China (S.-W., C. et S.) (BM).

*A. roxburghiana* Wall. ex Bess. in Bull. Soc. Nat. Mosc. 9:57 (1836); Hook. f., Fl. Brit. Ind. 3: 326 (1881); Nasir et Ali, Fl. W. Pakistan 718 (1972). — *A. hypoleuca* auct., non MB.: Edgew. in Trans. Linn. Soc. 20: 71 (1846); C.B. Clarke, Comp. Ind. 164 (1876). — *A. revoluta* Edgew., l. c. 20: 72 (1846). — *A. dubia* Wall. ex Bess. var. *jacquemontiana* Pamp. in Nuov. Giorn. Bot. Ital. n.s. 33: 454 (1926) p.p., incl. formae. — *A. eriocephala* Pamp., l.c. : 454 (1926). — *A. indica* Willd. var. *exilis* Pamp., l.c.: 33: 459 (1926). — *A. roxburghiana* Wall. ex Bess. var. *acutiloba* Pamp. op. c. 36: 29 (1930), incl. f. *vestita* Pamp.

#### var. 1. *roxburghiana*

India, Nepal, Kashmir, China (S.-W. et N.-W.), Afghanistan, Thailand, (BM, CGE, K, Lucknow).

var. 2. *grata* Hook. f., l.c. : 326 (1881); Nasir et Ali, l.c. 718 (1972). — *A. grata* Wall. ex Bess. in Mém. Soc. Nat. Mosc. 3: 57 (1834). — *A. dubia* Wall. ex Bess. var. *myriantha* (Wall. ex Bess.) Pamp., l.c.: 450 (1926) p.p.

N. India, Nepal, N. Pakistan. (K).

var. 3. *purpurascens* (Jacq. ex Bess.) Hook. f., l.c. 3: 326 (1881); Nasir et Ali, l.c. 718 (1972). — *A. purpurascens* Jacq. ex Bess., op.c. 9: 60 (1836). — *A. strongylocephala* Pamp., op. c. 34: 176 (1927).

N. India, Nepal, N. Pakistan, Kashmir, China (S.-W.). (K).

*A. robusta* (Pamp.) Ling et Y.R. Ling, comb. nov. — *A. strongylocephala* Pamp. var. *sinensis* Pamp. f. *robusta* Pamp. in Nuov. Giorn. Bot. Ital. n.s. 34: 178 (1927). — *A. dubia* Wall. ex Bess. var. *myriantha* (Wall. ex Bess.) Pamp., op. c. 36: 381 (1929) p.p.

N. India, Sikkim, China (S.-W.). (E).

*A. indica* Willd., Sp. Pl. 3: 1846 (1800); Nasir et Ali, Fl. W. Pakistan 716 (1976). — *A. leptophylla* D. Don, Prodr. Fl. Nep. 182 (1825) p.p. — *A. indica* Willd. var. *multiflora* Wall. ex Bess., var. *nepalensis* Bess. et var. *heyneana* Wall. ex Bess. in Nouv.

Mém. Soc. Nat. Mosc. 3: 56-57 (1834) et var. *legitima* Bess. in Bull. Soc. Nat. Mosc. 9: 55-56 (1836) p.p. — *A. grata* Wall. ex Bess., l.c. 3: 57 (1834) p.p. — *A. wallichiana* Bess., l.c. 3: 69 (1834). — *A. vulgaris* Linn. var. *indica* (Willd) Maxim., Fl. Amur. 160 (1859). — *A. vulgaris* auct., non Linn.: Hook. f., Fl. Brit. Ind. 3: 325 (1881) p.p. quoad syn.; Nasir et Ali, Fl. W. Pakistan 720 (1972) p.p. — *A. dubis* auct., non Wall. ex Bess.: Pamp. in Nuov. Giorn. Bot. Ital. n.s. 33: 447-452 (1926) et 36: 434-441 (1930) incl. var. *legitima* (Bess.) Pamp. cum f. *genuina* Pamp. et f. *communis* Pamp., var. *acuminata* Pamp. f. *congesta* Pamp., var. *multiflora* (Wall. ex Bess.) Pamp., var. *grata* (Wall. ex Bess.) Pamp., var. *orientalis* Pamp., var. *septentrionalis* Pamp., var. *compacta* Pamp. et var. *gracilias* Pamp., cum formae; Nasir et Ali, l.c. 716 (1972). — *A. nilaritica* (C. B. Clarke) Pamp., l.c. 33: 452 (1926) p.p., incl. var. *lobata* Pamp. — *A. eriocephala* Pamp., l.c. 33: 454 (1926); Nasir et Ali, l.c. 721 (1972). — *A. dolichocephala* Pamp., l.c. 34: 175 (1927); Nasir et Ali, l.c. 721 (1972). — *A. myriantha* auct., non Wall. ex Bess.: Y.R. Ling in Journ. Nanj. Techn. Coll. For. Prod. 1: 83 (1981).

**var. 1. *indica***

Widely distr. Asia, except North. (BM, CGE, E).

**var. 2. *elegantissima* (Pamp.) Y.R.Ling et C.J. Humphries comb. nov.** — *A. elegantissima* Pamp., l.c. 33: 454 (1926), incl. formae et var. *kumaonensis* Pamp.; Nasir et Ali, l.c. 716 (1972).

N. India, Nepal, Kashmir, China (S.-W.). (BM, K).

*A. incisa* Pamp. in Nuov. Giorn. Bot. Ital. n.s. 33: 456 (1929) incl. var. *kunawarensis* Pamp.; Nasir et Ali, Fl. W. Pakistan 721 (1972). — *A. vulgaris* Linn. var. *myriantha* (Wall. ex Bess.) Pamp. in Nuov. Giorn. Bot. Ital. n.s. 33: 450 (1926) p.p.

Nepal, N. Pakistan, Kashmir, China (S.-W.). (T.T., Type, Kash., BM, K).

*A. nilagirica* (C. B. Clarke) Pamp. in Nuov. Giorn. Bot. Ital. n.s. 33: 452 (1926). — *A. vulgaris* Linn. var. *nilagirica* C. B. Clarke, Comp. Ind. 162 (1876).

N. India, China (S.-W.), N. Burma, (BM, K).

*A. amygdalina* Decne in Jacq., Voy. Bot. 92. t. 100 (1836); Hook. f., Fl. Brit. Ind. 3: 325 (1881); Nasir et Ali, Fl. W. Pakistan 715 (1972).

N. India, N. Pakistan, Kashmir. (BM, K, P).

*A. moorcroftiana* Wall. ex DC., Prodr. 6: 117 (1837); Hook. f., Fl. Brit. Ind. 3: 327 (1881); Nasir et Ali, Fl. W. Pakistan 717 (1972). — *A. wallichiana* Bess. in Nouv. Mém. Nat. Mosc. 3: 69 (1834) p.p. — *A. hypoleuca* auct., non Edgew.: Hook. f., l.c. 3: 326 (1881) p.p., pro syn. — *A. stronglylocephala* Pamp. var. *cachemirica* Pamp. in Nuov. Giorn. Bot. Ital. n.s. 34: 176 (1927). — *A. brunnea* Pamp. in Lav. Inst. Bot. Univ. Cagl. 8: 2 (1938).



N. India, Bhutan, Nepal, N. Pakistan, Kashmir, China (N.-W. et S.-W.). (BM, CGE, K).

*A. tainingensis* Hand.-Mazz. in Act. Hort. Gothob. 12: 277 (1938). — *A. campbellii* Hook. f. et Thoms. ex C.B. Clarke var. *limprichtii* Pamp. in Nuov. Giorn. Bot. Ital. n.s. 34: 642 (1927) p.p.

**var. 1. *tainingensis***

China (S.-W., et Qinghai). (E).

**var 2. *nitida* (Pamp.) Y.R. Ling comb. nov.** — *A. moorcroftiana* Wall. ex DC. f. *nitida* Pamp., l.c. 34: 681 (1927). — *A. moorcroftiana* Wall. ex DC. var. *nitida* (Pamp.) Ling et Y.R. Ling in Act. Phytotax. Sin. 18 (4): 505 (1980).

N.-W. India, Kashmir, China (S.-W.). (K).

*A. austro-himalayana* (Y.R. Ling et H.S. Puri) Y.R. Ling et H.S. Puri in Guihaia 8 (1): 64 (1988). — *A. tenuifolia* auct., non Adam ex DC.: Y.R. Ling et H.S. Puri, l.c. 5 (1): 2 (1985).

N. India. (N.C. Shah et S.C. Singh, Type, CIMAP, Lucknow).

*A. tukuchaensis* Kitam. in Act. Phytotax. Geobot. 30: 127 (1979).

Nepal (BM).

*A. campbellii* Hook. f. et Thoms. in C. B. Clarke, Comp. Ind. 164 (1876); Hook. f., Fl. Brit. Ind. 3: 327 (1881); Nasir et Ali, Fl. W. Pakistan 715 (1972). — *A. tibetica* sensu Schlagint., Cat. [1399, Tibet. (P)], non Hook. f. et Thoms. ex Hook. f.

Bhutan, Sikkim, N. Pakistan, Kashmir, China (Xizang). (BM, CGE, E, GH, K, P).

**4). Sect. *Viscidipubes* Y.R. Ling**

*A. viscida* (Mattf.) Pamp. in Nuov. Giorn. Bot. Ital. n.s. 36: 424 (1930); Nasir et Ali, Fl. W. Pakistan 721 (1972). — *A. moorcroftiana* Wall. ex DC. var. *viscida* Mattf. in Feddes Rep. Sp. Nov. 22: 247 (1926).

N. Pakistan, China (S.-W.).

*A. vexans* Pamp. in Nuov. Giorn. Bot. Ital. n.s. 36: 427 (1930).

Bhutan, China (S.-W.). (BM).

*A. thellungiana* Pamp. in Nuov. Giorn. Bot. Ital. n.s. 33: 457 (1926). — *A. vulgaris* auct., non Linn.: Hook. f., Fl. Brit. Ind. 3: 325 (1881) p.p.

N. India, Sikkim, China (S.-W.). (BM, K).

*A. myriantha* Wall. ex Bess. in Nouv. Mém. Soc. Nat. Mosc. 3: 51 (1834). — *A. vulgaris* Linn. var. *myriantha* (Wall. ex Bess.) C. B. Clarke, Comp. Ind. 162 (1876)

excl. syn. *A. paniculata* Roxb. — *A. vulgaris* auct., non Linn.: Hook. f., Fl. Brit. Ind. 3: 325 (1881) p.p., quoad syn. — *A. dubia* auct., non Wall. ex Bess.: Pamp. in Nuov. Giorn. Bot. Ital. n.s. 33: 447-454 (1926), 34: 653 (1927), 36: 434-441 (1930), 46: 562 (1939) p.p. incl. var. *legitima* (Bess.) Pamp. cum f. *genuina* Pamp. et f. *communis* Pamp., sf. *intermedia* Pamp., var. *acuminata* Pamp. et var. *longeracemulosa* Pamp. et var. *grata* Pamp. p.p. — *A. burmanica* Pamp., l.c. 33: 455 (1926) excl. f. *latiloba* Pamp. — *A. pleiocephala* Pamp. var. *typica* Pamp. f. *yunnanensis* Pamp., l.c. 36: 446-448 (1930).

#### var. 1. *myriantha*

N. India, Bhutan, Nepal, Kashmir, China (S.-W. et Qinghai), N. Burma. (BM, E, K).

var. 2. *pleiocephala* (Pamp.) Y.R. Ling, l.c. 42 (2): 446 (1987). — *A. vulgaris* auct., non Linn.: Hook. f., l.c. 3: 325 (1881) p.p., quoad syn. — *A. dubia* auct., non Wall. ex Bess.: Pamp., l.c. 33: 449-450 (1926) p.p., incl. var. *legitima* (Bess.) Pamp. f. *communis* Pamp. sf. *pauciflora* Pamp. et var. *myriantha* (Wall. ex Bess.) Pamp. cum f. *meridionalis* Pamp. — *A. pleiocephala* Pamp. var. *typica* Pamp. cum f. *latiloba* Pamp. et f. *discolor* Pamp., l.c. 36: 446-448 (1930).

N. India, Bhutan, Nepal, Kashmir, China (S.-W. et Qinghai), N. Burma, N. Thailand. (BM, CGE, K, L).

### 5). Sect. *Albibractea* Y.R. Ling

*A. lactiflora* Wall. ex DC., Prodr. 6: 115 (1837). — *A. lactiflora* Wall. ex DC. f. *genuina* Pamp., f. *septemlobata* Pamp. et f. *heryana* Pamp. in Nuov. Giorn. Bot. Ital. n.s. 34: 674-675 (1927).

N.-E. India, China (S., C., S.-W. et S.-E.), Thailand, Indo-China, Indonesia. (E).

### 2. Subgen. *Dracunculus* (Bess.) Peterm.

#### 6). Sect. *Dracunculus* Bess. *sensu stricto*, excl. sect. *Latilobus* Y.R. Ling

*A. wellbyi* Hemsl. et Pears. ex Deasy, Tibet Chin. Turk. 397 (1901) nom. nud., in Journ. Linn. Soc. 35: 183 (1902). — *A. salsoloides* auct., non Willd.: C.B. Clarke, Comp. Ind. 156 (1876) p.p.; Hook. f., Fl. Brit. Ind. 3: 321 (1881) p.p., incl. var. *salsoloides* Hook. f.; Nasir et Ali, Fl. W. Pakistan 719 (1881) p.p. — *A. falconeri* C.B. Clarke ex Hook. f., l.c.: 328 (1881) p.p. — *A. salsoloides* Willd. var. *wellbyi* (Hemsl. et Pears. ex Deasy) Ostenf. et Pauls. in Hedin, S. Tibet. 6(3): 40 (1922); Nasir et Ali, l.c. 719 (1972). — *Oligosporus wellbyi* (Hemsl. et Pears. ex Deasy) Poljak. in Mat. Fl. Veg. Kaschg. 11: 169 (1961).

N. India, Sikkim, China (Xizang). (BM, E, GH, K, P).

*A. waltonii* J.R. Drumm. ex Pamp. in Nuov. Giorn. Bot. Ital. n.s. 34: 707 (1927).

China (S.-W. et Qinghai). (L).

*A. xigazeensis* Ling et Y.R. Ling in Act. Phytotax. Sin. 18 (4): 511 (1980). — *A. salsoloides* Willd. var. *salsoloides* Hook. f. p.p. et var. *paniculata* Hook. f., incl. syn. *halimodendron* Ledeb. ex Hook. f., Fl. Brit. Ind. 3: 321 (1881) p.p.

China (Xizang). (CGE, GH, K).

*A. dracunculus* Linn., Sp. Pl. 2: 849 (1753); C. B. Clarke, Comp. Ind. 157 (1876); Hook. f., Fl. Brit. Ind. 3: 321 (1881) p.p.; Nasir et Ali, Fl. W. Pakistan 716 (1972). — *A. glauca* auct., non Pall. ex Willd.: Hook. f., l.c.: 322 (1881); Nasir et Ali. l.c. 721 (1972). — *Oligosporus dracunculus* (Linn.) Poljak. in Mat. Fl. Veg. Kaschg. 11: 166 (1961).

**var. 1. *dracunculus***

N. India, N. Pakistan, Kashmir, Sikkim, China (N., N.-E. et N.-W.), Afghanistan, Mongolia, C. & W. Asia, Russia, E., C. & W. Europe et N. America. (BM, CGE, E, K, L).

**var. 2. *pamirica* (C. Winkl.) Y.R. Ling et C.J. Humphries, comb. nov. —**

*A. pamirica* C. Winkl. in Act. Hort. Petrop. 11: 329 (1890) incl. var. *aschurbazewi* C. Winkl. — *A. simplicifolia* Pamp. in Nuov. Giorn. Bot. Ital. n.s. 46: 584 (1939); Nasir et Ali, l.c. 720 (1972). — *Oligosporus pamiricus* (C. Winkl.) Poljak. in Mat. Fl. Veg. Kaschg. 11: 166 (1961).

N. Pakistan, China (Xizang, Xinjiang), Afghanistan, Tadjikistan. (P).

*A. scoparia* Waldst. et Kit., Pl. rar. Hung. 1: 66, tab. 65 (1802); C. B. Clarke, Comp. Ind. 158 (1876); Hook. f., Fl. Brit. Ind. 3: 323 (1881); Nasir et Ali, Fl. W. Pakistan 719 (1972). — *A. mollissima* D. Don, Prodr. Fl. Nep. 182 (1825); Hook. f., l.c.: 330 (1881). — *A. elegans* Roxb., Fl. Ind. 3: 321 (1832). — *A. trichophylla* Wall. ex DC., Prodr. 6: 100 (1837); C. B. Clarke, l.c.: 158 (1876). — *A. sacrorum* sensu Schlagint., Cat. [1352 (1856), Tibet (E)], non Ledeb. — *A. kohatica* Klatt in Sitzb. Akad. Muench. 91 (1878); Hook. f., l.c.: 330 (1881) (dubia). — *A. capillaris* Thunb. var. *scoparia* (Waldst. et Kit.) Pamp. in Nuov. Giorn. Bot. Ital. n.s. 34: 642 (1927) incl. formae. — *Oligosporus scoparius* (Waldst. et Kit.) Less. in Linnæa 9: 191 (1834).

Widely distr. in Eurasia. (BM, CGE, E, GH, K).

*A. edgeworthii* Balakr. in Journ. Bombay Nat. Hist. Soc. 63: 329 (1967). — *A. stricta* auct., non Heyne ex DC.: Edgew. in Trans. Linn. Soc. 20: 73 (1846); C. B. Clarke, Comp. Ind. 158 (1876); Hook. f., Fl. Brit. Ind. 3: 323 (1881); Nasir et Ali, Fl. W. Pakistan 720 (1972). — *A. stricta* Edgew. f. *genuina* Pamp. in Nuov. Giorn. Bot. Ital. 34: 705 (1927).

**var. 1. *edgeworthii***

N. India, Nepal, Sikkim, Kashmir, China (S.-W.). (BM, CGE, E, GH, K).

**var. 2. *diffusa*** (Pamp.) Ling et Y.R. Ling in Act. Phytotax. Sin. 18 (4): 509 (1980). — *A. stricta* Edgew. f. *diffusa* Pamp., l.c. 34: 705 (1927).

N. India, Nepal, Kashmir, China (S.-W.). (L).

*A. demissa* Krasch. in Act. Inst. Bot. Acad. Sci. USSR 1(3): 348 (1936).

Nepal, China (N.-W. & Xizang). (BM).

**7). Sect. *Latilobus* Y.R. Ling**

*A. desertorum* Spreng., Syst. Veg. 3: 490 (1826). — *A. desertorum* Spreng. var. *sprengeliana* Bess. in Bull. Soc. Nat. Mosc. 8: 65 (1835). — *Oligosporus desertorum* (Spreng.) Poljak. in Mat. Fl. Veg. Kaschg. 11: 167 (1961).

**var. 1. *desertorum***

Bhutan, Sikkim, China (S.-W., N., N.-E.), Japan, Korea, Mongolia, E. Russia. (K, P).

**var. 2. *foetida*** (Jacq. ex DC.) Ling et Y.R. Ling comb. nov. — *A. foetida* Jacq. ex DC., Prodr. 6: 98 (1837). — *A. desertorum* auct., non Spreng.: C. B. Clarke, Comp. Ind. 158 (1878) p.p.; Nasir et Ali, Fl. W. Pakistan 715 (1972) p.p.

N. Pakistan, Nepal, N. India, Kashmir, China (S.-W.). (BM).

**var. 3. *tongolensis*** Pamp. in Nuov. Giorn. Bot. Ital. n.s. 34: 651 (1927).

China (S.-W.). (P).

*A. japonica* Thunb., Fl. Jap. 308 (1784). — *A. glabrata* Wall. ex Bess. in Bull. Soc. Nat. Mosc. 8: 20 (1835). — *A. cuneifolia* DC., Prodr. 6: 126 (1837). — *A. parviflora* auct., non Buch.–Ham. ex Roxb.: C. B. Clarke, Comp. Ind. 159 (1876); Hook. f., Fl. Brit. Ind. 3: 322 (1881) p.p.; Nasir et Ali, Fl. W. Pakistan 718 (1972) p.p. — *A. jacquemontiana* auct., non Bess.: Hook. f., l.c.: 321 (1881). — *A. dracunculus* auct., non Linn.: Hook. f., l.c.: 321 (1881). — *A. japonica* Thunb. var. *myriocephala* Pamp. in Nuov. Giorn. Bot. Ital. n.s. 34: 665 (1927) et var. *lanata* Pamp. in Lav. Inst. Bot. Univ. Cagl. 8: 3 (1938). — *Oligosporus japonicus* (Thunb.) Poljak. in Mat. Fl. Veg. Kaschg. 11: 169 (1961).

Widely distr. in Asia. (BM, CGE, K).

*A. parviflora* Busch.–Ham. in Roxb., Hort. Beng. 61 (1814) nom. nud., Fl. Ind. 420 (1832) nom. conserv.: C. B. Clarke, Comp. Ind. 159 (1876) p.p.; Hook. f., Fl. Brit. Ind. 3: 322 (1881) p.p.; Nasir et Ali, Fl. W. Pakistan 718 (1972) p.p. — *A. japonica* Thunb. var. *parviflora* (Buch.–Ham. ex Roxb.) Pamp. in Nuov. Giorn. Bot. Ital. n.s. 34: 665 (1927). — *A. subdigitata* auct., non Mattf.: Kitam. in Kihara, Fau. Fl. Nep.

Himal. 1: 246 (1952-1953). — *Oligosporus parviflorus* (Buch.-Ham. ex Roxb.) Poljak. in Mat. Fl. Veg. Kaschg. 11: 170 (1961).

India, Pakistan, Sikkim, Bhutan, Nepal, Kashmir, N. Thailand, China (S.-W.). (BM, E, K, Lucknow, P).

*A. dubia* Wall. ex Bess. in Nouv. Mém. Soc. Nat. Mosc. 3: 39 (1834) (Sect. *Abrotanum* Bess.). — *A. vulgaris* auct., non Linn.: Hook. f., Fl. Brit. Ind. 3: 325 (1881) p.p., quoad syn. — *A. subdigitata* Mattf. in Feddes Rep. Sp. Nov. 2: 243 (1926) p.p. — *A. dracunculus* Linn. var. *inodora* auct., non Bess.: Pamp. in Nuov. Giorn. Bot. Ital. n.s. 34: 653 (1927) p.p., quoad pl. C.B. Clarke. — *A. dracunculus* Linn. var. *subdigitata* (Mattf.) Pamp. f. *thomsonii* Pamp. l.c. 36: 379 (1929) incl. syn. — *A. thomsonii* C.B. Clarke ex Pamp., cum f. *chinensis* Pamp. p.p. — *A. subdigitata* Mattf. var. *thomsonii* (C.B. Clarke) S.Y. Hu in Quart. Journ. Taiwan Mus. 18 (3-4): 263 (1965).

**var. 1. *dubia***

N. India, Bhutan, Nepal, China (N., N.-W., C. et S.-W.). (BM, Wallich Cat. 3307a/417, Blinkworth, Isotype, Kumaon, CGE, E, K, L).

**var. 2. *subdigitata*** (Mattf.) Y.R. Ling, l.c. 42(2): 445 (1987). — *A. jacquemontiana* Bess. in Bull. Soc. Nat. Mosc. 8: 61 (1835) p.p. incl. syn. — *A. glabra* Jacq. ex Bess. — *A. cannabina* Jacq. ex Bess. in DC., Prodr. 6: 97 (1837) pro syn. — *A. desertorum* Spreng. var. *jacquemontiana* DC., l.c. 98 (1837). — *A. royleana* DC., l.c. 115 (1837); Hook. f., l.c.: 329 (1881). — *A. desertorum* auct., non Spreng.: C. B. Clarke, Comp. Ind. 158 (1876); Hook. f., l.c.: 332 (1881); Nasir et Ali, Fl. W. Pakistan 715 (1972). — *A. glauca* auct., non Pall. ex Willd.: Hook. f., l.c.: 332 (1881). — *A. dubia* Wall. ex Bess. var. *jacquemontiana* (Bess.) Pamp. l.c.: 451 (1926). — *A. subdigitata* Mattf. l.c.: 243 (1926) p.p., incl. var. *falciloba* Mattf. — *A. foetida* auct., non Jacq. ex DC.: Pamp. l.c.: 655 (1927) p.p. — *A. dracunculus* Linn. var. *inodora* Bess. f. *pinnata* Pamp. et var. *subdigitata* Pamp., incl. f. *chinensis* Pamp., f. *falciloba* Pamp. et f. *intermedia* Pamp. cum sf. *oblonga* Pamp., l.c.: 379-381 (1929). — *Oligosporus jacquemontiana* (Bess.) Poljak. in Mat. Fl. Veg. Kaschg. 11: 168 (1961).

N. India, Bhutan, Nepal, Kashmir, China (N., C. et S.-W.). (BM, K, P).

**II. *Seriphidium*** (Bess.) Poljak. in Mat. Fl. Veg. Kaschg. 11: 171 (1961). — *Artemisia* Linn. sect. *Seriphidium* Bess. in Bull. Soc. Nat. Mosc. 1 (8): 222 (1828). — *Artemisia* Linn. subgen. *Seriphidium* (Less.) Peterm., Deutschl. Fl. 294 (1848).

*S. brevifolium* (Wall. ex DC.) Ling et Y.R. Ling in Act. Phytotax. Sin. 18 (4): 513 (1980). — *Artemisia brevifolia* Wall. ex DC., Prodr. 6: 103 (1837); Nasir et Ali, Fl. W. Pakistan 715 (1972). — *A. maritima* Linn. *vera* C. B. Clarke, Comp. Ind. 159 (1878). — *A. maritima* auct., non Linn.: Hook. f., Fl. Brit. Ind. 3: 323 (1881) p.p., quoad syn.; Nasir et Ali, l.c. 717 (1972) p.p. — *A. maritima* Linn. var. *genuina*

Pamp. in Nuov. Giorn. Bot. Ital. n.s. 34: 679 (1927) incl. f. *suberecta* Pamp. — *A. maritima* Linn. var. *pauciflora* auct., non Ledeb.: Pamp., l.c. 46: 573 (1939).

N. India, N. Pakistan, Kashmir, China (W. Xizang). (BM, GH, P).

*S. thomsonianum* (C. B. Clarke) Ling et Y.R. Ling in Act. Phytotax. Sin. 18 (4): 513 (1980). — *Artemisia maritima* Linn. var. *thomsonianum* C.B. Clarke, Comp. Ind. 160 (1878). — *A. maritima* auct., non Linn.: Hook. f., Fl. Brit. Ind. 3: 323 (1881) quoad syn. — *A. lehmanniana* auct., non Bge.: Hook. f., l.c.: 323 (1881) pro syn.; Nasir et Ali, Fl. W. Pakistan 717 (1972) p.p. — *A. herba-alba* auct., non Asso: Nasir et Ali, l.c. 716 (1972).

N. Pakistan, Kashmir, China (W. Xizang), Afghanistan. [Schlagint. Cat. 6218 (1856), Tibet, CGE, GH, K].

*S. aucheri* (Boiss.) Ling et Y.R. Ling in Act. Phytotax. Sin. 18 (4): 513 (1980). — *Artemisia aucheri* Boiss., Fl. Or. 3: 367 (1875); Nasir et Ali, Fl. W. Pakistan 715 (1972). — *A. maritima* Linn. var. b. C. B. Clarke, Comp. Ind. 159 (1878) incl. syn. — *A. griffithiana* sensu C. B. Clarke, non Boiss. — *A. maritima* Linn. var. *aucheri* (Boiss. Pamp. in Nuov. Giorn. Bot. Ital. n.s. 34: 680 (1927).

N. Pakistan, China (W. Xizang), Iran, Afghanistan. (BM, CGE, K).

*S. lehmannianum* (Bge.) Poljak. in Mat. Fl. Veg. Kaschg. 11: 175 (1961). — *Artemisia lehmanniana* Bge. in Mém. Acad. Sci. Petersb. 7: 340 (1854). — *A. maritima* auct., non Linn.: Hook. f., Fl. Brit. Ind. 3: 323 (1881) quoad syn.

N.-W. India. (E).

# POLLEN MORPHOLOGY IN THE *SENECIO NEMORENSIS* GROUP (COMPOSITAE) FROM THE CARPATHIANS

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## Abstract

A description of the external morphology and size of pollen grains in five "pure" and four hybrid taxa of the *S. nemorensis* group from the Carpathians is presented. The pollen grains of all 9 taxa were examined using image analyser ASBA and SEM. No expressive differences in the size, shape and external morphology of the pollen between the studied taxa were recorded. The length and diameter ranges between 29–54 x 17–32  $\mu\text{m}$ , the shape is prolate, subprolate to spheroidal.

**Key words:** *Senecio nemorensis* group, pollen, external morphology, length, diameter, Carpathians.

## Introduction

Reviews of the external morphology of Compositae pollen grains have been made several times (Skvarla & Turner 1966, Mesfin 1984, Otieno & Mesfin 1992 etc.). However, there are no published data about the pollen grains of the *Senecio nemorensis* group.

The aim of the present study is to describe and document the morphology of pollen grains of the *S. nemorensis* group and is part of taxonomical study of this group in the Carpathians. Five taxa (*S. hercynicus* Herborg subsp. *hercynicus*; *S. ovatus* (P. Gaertn., B. Mey. et Scherb.) Willd. subsp. *ovatus*; *S. germanicus* Wallr. subsp. *germanicus*; *S. ucranicus* Hodálová nom. prov.; *S. nemorensis* auct. non L. and four

new hybrids (*S. x futakii* Hodálová nom. prov. (*S. germanicus* subsp. *germanicus* x *S. ovatus* subsp. *ovatus*) (Hodálová & Marhold, submitted); *S. germanicus* subsp. *germanicus* x *S. ucranicus*; *S. germanicus* subsp. *germanicus* x *S. nemorensis*; *S. germanicus* subsp. *germanicus* x *S. hercynicus* subsp. *hercynicus* x *S. ovatus* subsp. *ovatus*) were recorded. Morphological investigation indicated that great morphological variation observed in many populations of this group is probably caused by introgressive hybridization (Hodálová 1994; Hodálová & Marhold, submitted; Hodálová & Valachovic, submitted).

### Material and Methods

Morphological data were obtained from herbarium specimens (deposited at SAV) collected by us throughout the Carpathians (Slovakia, Ukraine, Romania) during 1990 through 1993.

Morphological analysis of pollen grains was based on material from a total of 25 populations (for localities see Appendix) representing all taxa of the *S. nemorensis* group in the Carpathians. Pollen grains were mounted on slides in glycerine jelly after soaking in glycerine jelly for 3 days. Measurements for morphometrical analysis were made using an image analyzer ASBA (Wild, Heerbrugg, Switzerland) on 120 grains per taxon and computed on a special program made for ASBA - STAT program (Anonymus 1985). Length is defined as the maximum of 4 projections, diameter as area/length. Form factor values characterize the shape of pollen grains (form factor 5.09 for a circular shape, 6 for a square, 7 for a rectangle with a side ratio of 2:1, and 12.4 for a rectangle with a side ratio of 5:1; for more details see Baluška *et al.* 1990). The mean and standard deviations were calculated using the STATGRAPHICS program.

Scanning electron microscopic (SEM) studies were performed on 2 populations for each taxon. Pollen grains were acetolyzed as follows (modified from Erdtman 1969): tubular flowers were soaked in a 9:1 solution of acetic acid anhydride and sulphuric acid for 15 min, then placed in a boiling water bath for 5 min. They were then centrifuged for 4 min, at 4000 rpm and rinsed with distilled water. Centrifugation and rinsing were repeated three times. The pollen grains were then twice centrifuged and rinsed with 97% ethanol. Acetolyzed pollen was mounted on brass stubs, dehydrated, coated with gold-palladium, and visualized and photographed using a Jeol Scanning Microscope (JSM-840). Unacetolyzed pollen grains of taxa of the *S. nemorensis* group were studied for comparison (Fig. 10).



### Results and Discussion

No taxonomically significant differences between the taxa of the *S. nemorensis* group for length, diameter and external morphology of pollen grains were found. The pollen grains of "pure" and hybrid taxa were well developed (all studied populations have the same chromosome numbers —  $2n=40$  (unpublished) and the genetic barriers between the taxa are very weak) which could be one of the many reasons that introgressive hybridization between studied taxa occurs very frequently.

**Table 1. Number of population samples (n) (number of population samples refers to the numbers of localities in Appendix), mean and standard deviation for length ( $\mu\text{m}$ ), diameter ( $\mu\text{m}$ ) and form factor values for pollen grains of taxa of the *S. nemorensis* group from the Carpathians**

Taxon	n	length diameter mean/(range)	standard deviation	form factor
<i>S. hercynicus</i> subsp. <i>hercynicus</i>	1–3	37.01/(29–46) 47.64/(18–28)	3.00 2.07	5.47
<i>S. ovatus</i> subsp. <i>ovatus</i>	4–7	38.52/(29–48) 49.78/(20–31)	3.82 2.68	5.46
<i>S. germanicus</i> subsp. <i>germanicus</i>	8–13	37.15/(31–54) 47.56/(19–30)	4.93 2.31	5.53
<i>S. ucranicus</i>	14–15	37.42/(28–47) 48.32/(19–32)	4.13 2.95	5.48
<i>S. nemorensis</i>	16	37.95/(25–47) 48.90/(17–28)	5.85 2.18	5.48
<i>S. germanicus</i> subsp. <i>germanicus</i> x <i>S. ovatus</i> subsp. <i>ovatus</i>	17–19	37.99/(29–46) 49.06/(20–30)	3.04 1.98	5.47
<i>S. germanicus</i> subsp. <i>germanicus</i> x <i>S. ucranicus</i>	20–21	35.00/(29–43) 44.50/(17–29)	2.66 2.52	5.49
<i>S. germanicus</i> subsp. <i>germanicus</i> x <i>S. nemorensis</i>	23–24	38.53/(32–46) 50.46/(21–30)	2.24 1.55	5.45
<i>S. germanicus</i> subsp. <i>germanicus</i> x <i>S. hercynicus</i> subsp. <i>hercynicus</i> x <i>S. ovatus</i> subsp. <i>ovatus</i>	24–25	39.14/(31–48) 50.52/(19–29)	4.07 1.82	5.45

## Size

Variation in pollen grain length and diameter is relatively great within all studied taxa. The length ranges between 29–43  $\mu\text{m}$ , the diameter between 17–32  $\mu\text{m}$ .

## Shape and Apertures

The pollen grains are radially symmetrical and isopolar. No taxonomically significant differences between the taxa in shape were recorded, however, the shape of the pollen grains within each studied taxon is variable (Figs. 4–5). The shape is characterized by form factor values (Tab. 1). According to these values the pollen grains could be described as prolate, subprolate to spheroidal, similar to most pollen grains in Compositae (Mesfin 1984: 28; Otieno & Mesfin 1992), also the pollen grains in the studied taxa are tricolporate (Fig. 2) with colpi having longitudinal ora (Figs. 1, 3, 5, 9).

## Spines

The sculpture of the grains is echinate, with the perforations concentrated obviously at the spine bases. The length of spines ranges between 3.0 – 5.2  $\mu\text{m}$ .

## Perforations

The perforations at the spine bases and on the tectal surface between spines are irregular in their size and distribution. The holes on the tectal surface between spines are usually smaller than the perforations at the spines. The largest cavities are located away from the extreme base of spines (Figs. 1, 2, 4, 5, 6, 7, 8). Distal part of the spines is obviously without perforations (Fig. 7). Intraspecific variation in the number and distribution of holes was observed. Nonperforate pollen grains were also rarely found (Fig. 9).

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## Appendix

## List of the localities of the population samples.

1. Slovakia, Nízke Tatry, Mt. Chopok (Hodálová 1990).— 2. Slovakia, Západné Beskydy, Suchá Hora (Hodálová 1990). — 3. Poland, Tatry, Dolina Kondratowa, Pieklo (Hodálová 1990). — 4. Slovakia, Bukovské vrchy, Nová Sedlica (Hodálová 1989). — 5. Slovakia, Turčianska kotlina, Valca (Hodálová 1993). — 6. Slovakia, Slovenské rudohorie, Roznava (Hodálová 1993). — 7. Slovakia, Malá Fatra (Krivánska Fatra), Terchova (Futák, Jasicová & Zahradníková 1964). — 8. Ukraine, Prikarpat'ja, Knjaz Dvor (Hodálová & Kagalo 1990). — 9. Ukraine, Zakrpat's'ke peredgir'ja, Ugelja (Hodálová & Kagalo 1991). — 10. Slovakia, Bukovské vrchy, Nová Sedlica (Hodálová 1989). — 12. Ukraine, Gorgany, Kremenci (Hodálová & Kagalo 1990). — 13. Romania, Muntii Cindrel, Sibiu, Paltinis (Hodálová 1992). — 14. Ukraine, Cvcyno-Grynjavski gory. Mt. Cvcyn (Ginda 1990). — 15. Ukraine,

Cornogora, Mt. Corna gora (Hodálová et Kagalo 1991). — 16. Romania, Muntii Retezat, Cimpu lui Neag (Hodálová and Valachovic 1993).— 17. Slovakia, Provazsky Inovec, near the chalet Chata na Inovci (Hodálová 1992). — 18. Slovakia, Biele Karpaty, Mt. Velká Javorina (Hodálová 1993). — 19. Slovakia, Slánske vrchy, between the villages Herlany and Banské (Hodálová 1989). — 20. Ukraine, Cornogora, Mt. Goverlo (Hodálová et Kagalo 1990). — 21. Ukraine, Cornogora, Mt. Dancer (Hodálová et Kagalo 1990). — 22. Romania, Muntii Retezat, Cimpu lui Neag (Hodálová et Valachovic 1993). — 23. Romania, Muntii Cindrel, Sibiu, Paltinis (Hodálová 1992). — 24. Slovakia, Vysoké Tatry, Mt. Solisko (Hodálová 1989). — 25. Slovakia, Vysoké Tatry, Strbské Pleso (Hodálová 1993).

### FIGURE LEGENDS

- Figs. 1 - 9 Scanning electron micrographs of acetolyzed pollen grains of *S. nemorensis* agg.
1. *S. hercynicus* subsp. *hercynicus* (magnification x 2700)
  2. *S. ovatus* subsp. *ovatus* (magnification x 1900)
  3. *S. germanicus* subsp. *germanicus* (magnification x 2000)
  - 4-5. *S. ucranicus* (magnification x 1500, 2000)
  6. *S. nemorensis* (magnification x 2300)
  7. *S. germanicus* subsp. *germanicus* x *S. ovatus* subsp. *ovatus* (magnification x 6500)
  8. *S. germanicus* subsp. *germanicus* x *S. ucranicus* (magnification x 2500).
  9. *S. germanicus* subsp. *germanicus* x *S. nemorensis* (magnification x 2000)
- Fig. 10 Unacetolyzed pollen grain of *S. germanicus* subsp. *germanicus* x *S. hercynicus* subsp. *hercynicus* x *S. ovatus* subsp. *ovatus* (magnification x 1990).

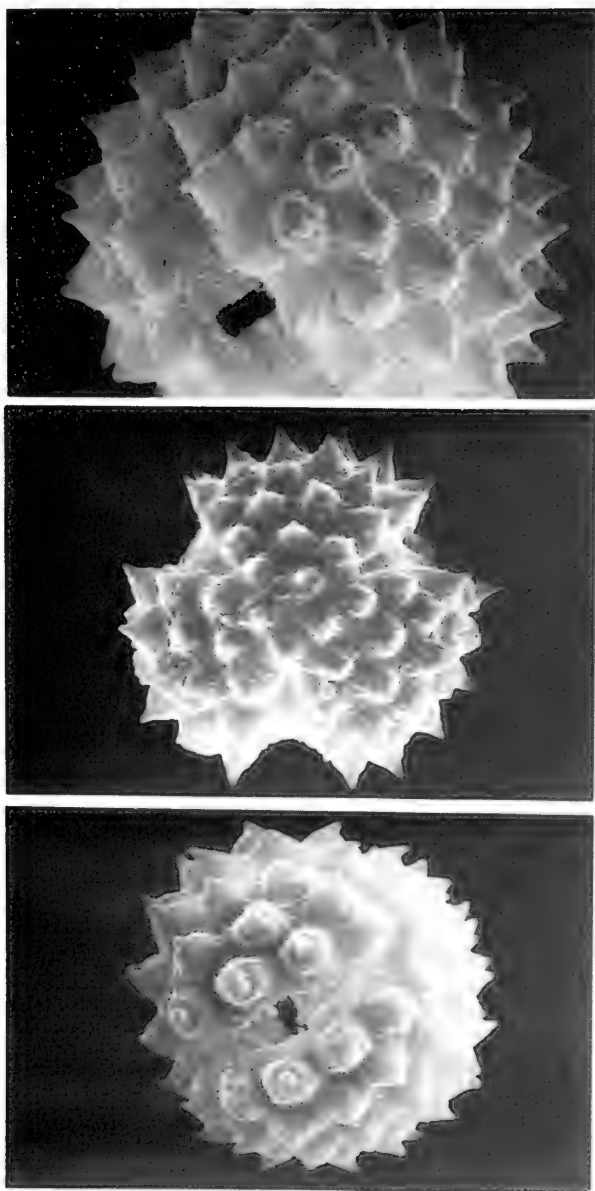


Fig. 1 — 3

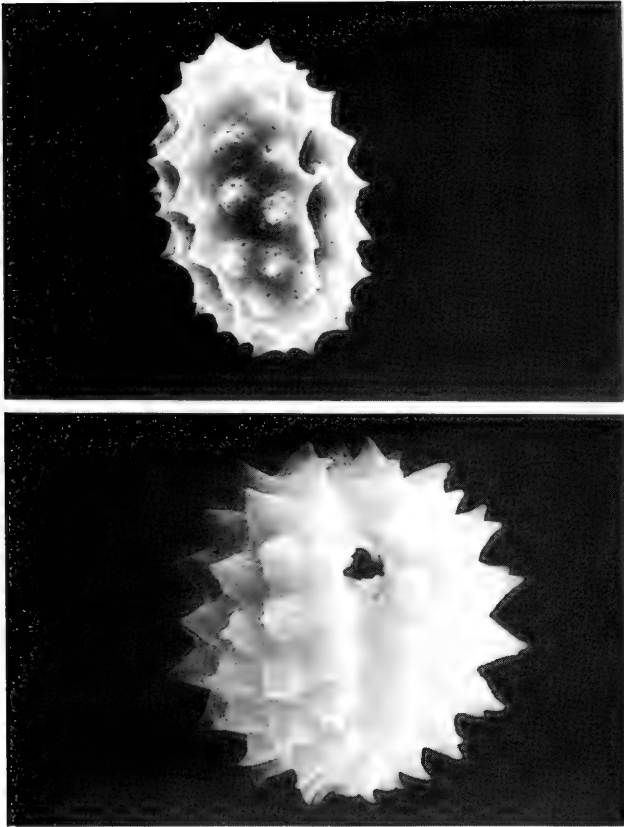


Fig. 4—5

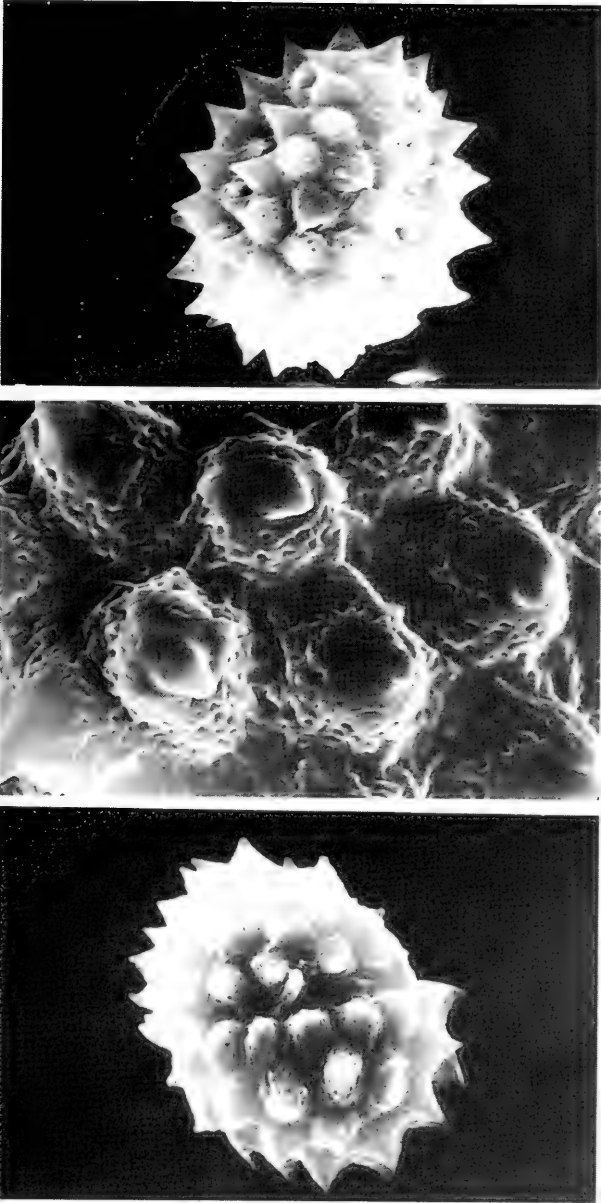


Fig. 6—8

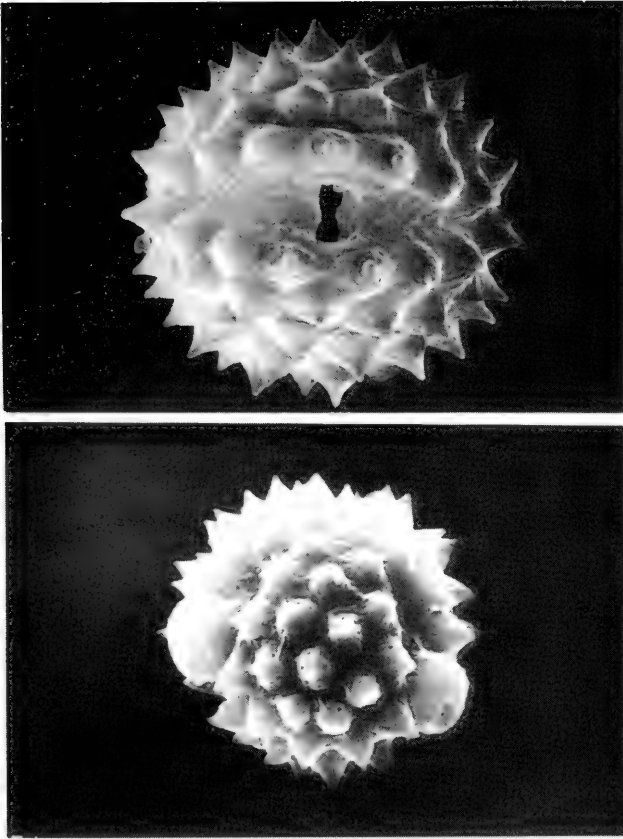


Fig. 9 — 10



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