

THE SYSTEMATIC ANATOMY OF SOUTH INDIAN CYPERACEÆ : CYPERUS L. SUBG. PYCREUS (PAL. BEAUV.) C. B. CL.

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ABSTRACT: Anatomic investigation of 17 species, 1 subspecies and 1 variety of *Cyperus* subg. *Pycnus* from South India. These taxa are divided into two clear cut groups by the type of subsidiary cells of the laminal stomata; other features (presence or absence of hypodermis, number and nature of bundle sheaths, sclerenchyma strands, bulliform cells, vascular bundles, etc.) allow to identify every taxon.

Résumé : Étude anatomique de 17 espèces, 1 sous-espèce et 1 variété de *Cyperus* subg. *Pycnus* de l'Inde méridionale. Ces taxons se répartissent en deux groupes selon la forme des cellules compagnes des stomates du limbe foliaire; d'autres caractères (présence ou non d'hypoderme, corps siliceux, gaines périvasculaires, massifs sclérénchymateux, cellules bulliformes, faisceaux vasculaires, etc.) permettent d'identifier chacun d'eux.

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Out of 10 South Indian species PFEIFFER (1927) has studied only the leaf anatomy of 7 species but nevertheless his work suffers in general not only for want of adequate emphasis on those anatomical characters which are now considered to have taxonomic importance and application but also as pointed out by METCALFE (1971) his anatomical description differs particularly in regard to three important points. On the whole there are 100 species recognized under *Pycnus* out of which 6, including only one South Indian species, have been thoroughly investigated by METCALFE (1971). Considering the total number of species belonging to the genus *Pycnus* as a whole against the number of taxa for which the anatomical information is now available, the inadequacy of the latter becomes obvious and hence the necessity for further investigation seems to be warranted. Following the revision work of KÜKENTHAL (1935-6), the embryographical evidences of VAN DER VEKEN (1965) and the strong anatomical resemblance to *Cyperus* as reported by METCALFE (1971) the taxon *Pycnus* although recognized as a distinct genus (CLARKE, 1893) is treated here as one of the subgenera of *Cyperus*. In the present work not only all the 10 species of South India (CLARKE, 1893; FISCHER, 1931) have been thoroughly studied except *Cyperus hyalinus* Vahl (= *Pycnus hyalinus*, see GOVINDARAJALU, 1975 b) but 7 new species described by the

author (GOVINDARAJALU, 1973, 1975 a) have also been investigated together with two infraspecific taxa out of which one is alien to South India.

MATERIAL AND METHODS

The materials used in the present work are deposited in the Herbarium of the Presidency College, Madras and cited here as PCM. In the case of the majority of the species, materials fixed in FPA were used. The examined specimens are cited at the end of the description of individual species.

The methods followed in all the earlier works (GOVINDARAJALU, 1966; 1968 a, b; 1969; 1974) have been adopted here also. The designation of the type of vascular bundles and metaphloem is according to CHEADLE & UHL (1948 a, b). The characters that have already been reported by METCALFE (1971) as common characters for the genus *Pycnus* are referred here as follows (MET.). The descriptive terms are those that have been recommended by METCALFE & GREGORY (1964).

CHARACTERS COMMON TO THE GENUS

LEAF

1. Adaxial epidermal cells larger than those of the abaxial (MET.).
2. Stomata paracytic; subsidiary cells either low dome-shaped or parallel-sided.
3. Intercostal cells axially elongated; cell walls frequently smooth, except *C. polystachyos*.
4. Hypodermis of translucent cell layers frequently present, except *C. macrostachyos* and *C. puncticulatus* (MET.).
5. Small vascular bundles belonging to type I.
6. All vascular bundles nearer to abaxial than to adaxial epidermis and in a few cases tending to be in two rows (MET.).

CULM

7. Transectional outlines usually subcircular, triangular or trigonous (MET.).
8. Large vascular bundles belonging to type III B, except *C. decumbens*, and small ones to type I.

DESCRIPTIONS OF INDIVIDUAL SPECIES

Cyperus atroglumosus Govind., Proc. Ind. Acad. Sci. 81 (5): 187-196 (1975) ('*atroglumosa*').

LEAF. *Abaxial surface*: Intercostal cells elongated, broad, thin-walled, smooth. Stomata (L. 30.6-36.0 μm ; W. 21.6-25.2 μm), oblong-

elliptic or subcircular, thin-walled; subsidiary cells low dome-shaped. Silica-cells long, narrow, each cell containing 5-6 cone-shaped silica-bodies surrounded by satellites and occurring in a single continuous row.

Adaxial surface: see abaxial surface.

Lamina, transverse section (Pl. 2, 2) : Outline W-shaped, asymmetrical. Keel bluntly triangular; margins rounded, upcurved. Cuticle moderately thick on either surface. Adaxial epidermal cells variable in shape and size, thin-walled while abaxial epidermal cells more or less uniform throughout, thick-walled. Adaxial hypodermis in each laminal half on either side of the keel 2-3-layered consisting of large translucent cells variable in size and shape. Bulliform cells not differentiated. Air-cavities absent. Sclerenchyma strands (adaxial submarginal: Ht. & W. 27 μ m) pulviniform or rounded; adaxial laminal (Ht. & W. 18 μ m) squarish; abaxial laminal (Ht. 21.6-27.0 μ m; W. 18-27 μ m) pulviniform or hexagonal; keel (Ht. 27 μ m; W. 45 μ m) pulviniform. Vascular bundles 24 in number; large vb's belonging to type III B and smaller vb's to type I but not regularly alternating with each other and arranged in a single row. Metaphloem of "regular type". Bundle sheaths double, both complete; O.S. parenchymatous, I.S. fibrous in all large vb's; small vb's having a single parenchymatous sheath. Tannin idioblasts common.

CULM. Epidermis, surface view: Cells elongated, broad, thin-walled, smooth. Stomata (L. 32.4-36.0 μ m; W. 27 μ m), broadly elliptical, thin-walled; subsidiary cells parallel-sided. Silica-cells not observed.

Transverse section (Pl. 6, 5): Outline trigonous with invaginations and furrows. Cuticle thick. Epidermal cells isodiametric, thick-walled. Guard cells thick-walled having both outer and inner ledges; substomatal chamber rather broad. Sclerenchyma strands (Ht. 18.0-46.8 μ m; W. 36.0-72.0 μ m) pulviniform, sometimes triangular. Ground tissue parenchymatous consisting of large cells arranged without intercellular spaces. Air-cavities few, present in the centre. Vb's c. 28 in number out of which 12-13 large (type III B) and the rest small (type I); large vb's containing protoxylem lacunae; both large and small vb's forming more or less a ring at the periphery but not regularly alternating with each other. Vessel members (D. 10.8-12.6 μ m). Metaphloem of "regular type". Bundle sheaths of all vb's single-layered, complete; large vb's with fibrous sheath while small vb's with parenchymatous sheaths. Circumvascular sclerenchyma 3-4-layered, crescentiform, forming an inner cap in all the large vb's. Tannin idioblasts very common.

ROOT. Transverse section: Diameter of the root examined 0.3 mm. Exodermis: cells variable in size and shape. Cortex: outer consisting of c. 3 layers of thick-walled cells, compactly arranged; inner cortex of larger thin-walled cells, 2-3-layered arranged without intercellular spaces. Endodermis: cells uniformly thickened with oval-shaped lumina. Pericycle

consisting of thick-walled cells with narrow lumen. Central ground tissue scanty, just 2-layered, sclerenchymatous. Metaxylem vessel elements (D. 23.4 μm), solitary, central, circular in outline. Protoxylem units 5 alternating with as many metaphloem units, each unit of the latter containing one sieve tube element and 2 companion cells.

MATERIAL EXAMINED : *Govindarajulu* 4826, Megaravalli, Shimoga dist., Mysore state (type); 5187, Guddakere, Shimoga dist., Mysore state; 12362, Iyerpadi, Valparai, Coimbatore dist.

***Cyperus decumbens* Govind., J. Ind. bot. Soc. 52: 72-81 (1973).**

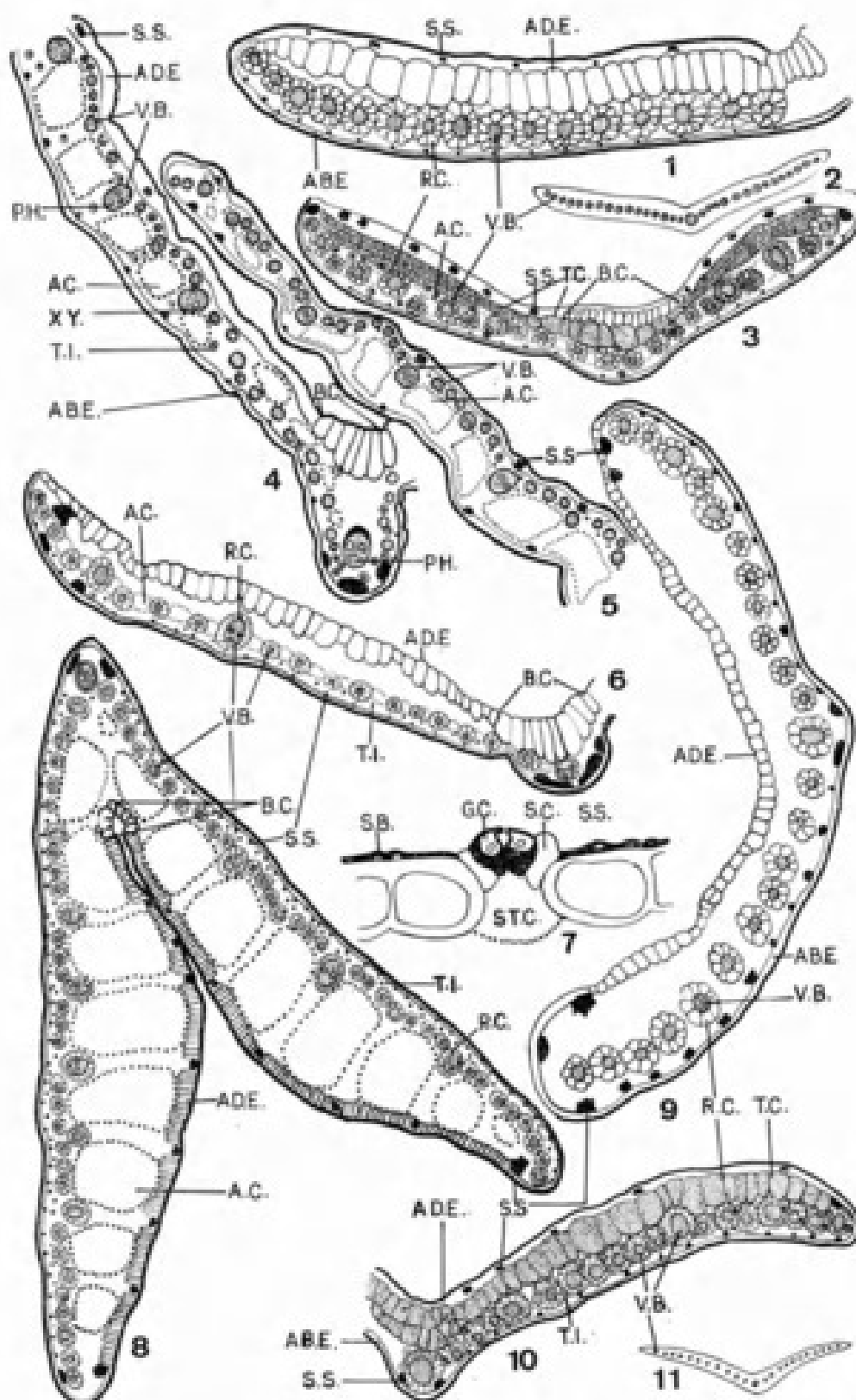
LEAF. Abaxial surface: Intercostal cells axially elongated, hexagonal with straight end walls; cell walls thin, smooth. Stomata (L. 35.6- μm ; W. 23.4-27.0 μm) narrowly elliptic oblong; subsidiary cells low dome-shaped; interstomatal cells long with concave ends. Silica-cells long, narrow, thin-walled, occurring in a single continuous row; each cell containing 4-6 silica-bodies surrounded by satellites.

Adaxial surface: see abaxial surface.

Lamina, transverse section (Pl. 2, 3): Outline deeply crescentiform, symmetrical. Cuticle moderately thick on either surface. Keel not distinct; margins rounded, incurved. Adaxial epidermal cells tangentially elongated, uniform in size and shape throughout; abaxial epidermal cells variable in size and shape. Bulliform cells not differentiated. Sclerenchyma strands (Ht. 9.0:18.0 μm ; W. 18-27 μm) pulviniform. Vb's 17 in number out of which keel and submarginal vb's belonging to type III A, larger than the rest (type I); small and large vb's not regularly alternating with each other and arranged in a single row. Metaxylem vessel members (D. 18 μm). Metaphloem of "intermediate type". Bundle sheaths single-layered, complete, parenchymatous in all vb's. Air-cavities absent. Tannin idioblasts very common.

CULM. Epidermis, surface view: Cells elongated, variable in size; cell walls thick, smooth with straight end walls. Stomata (L. 36-45 μm ; W. 18.0-21.6 μm) narrowly elliptic oblong; subsidiary cells parallel-sided; interstomatal cells long usually with straight ends. Silica-cells moderately long, thin-walled, occurring in a single more or less continuous row, each cell containing 3-4 cone-shaped silica-bodies without satellites.

Transverse section (Pl. 6, 4): Outline tetragonous with invaginations on one side. Cuticle very thick, lamellated. Epidermal cells isodiametric, thick-walled. Guard cells thick-walled with outer ledges; substomatal chamber very narrow. Sclerenchyma strands (Ht. 36.0-67.5 μm ; W. 54.0-67.5 μm) usually pulviniform (rounded). Air-cavities absent. Ground tissue consisting of large parenchymatous cells showing intercellular spaces. Vb's 19 in number out of which 5 large (type III A) and the remainder small



Pl. 1. — Transverse section of leaf, ground plan: 1, *Cyperus unioloides* R. Br., lamina, in part, $\times 60$; 2, *id.*, in full, diagrammatic; 3, *C. flavidus* Retz., lamina, $\times 30$; 4, *C. macrostachyos* Lam. $\times 40$; 5, *id.*, lamina, in part $\times 40$; 6, *C. sulcinux* C. B. Clarke, lamina in part $\times 45$; 7, *C. macrostachyos* Lam., stroma $\times 400$; 8, *C. puncticulatus* Vahl, lamina $\times 40$; 9, *C. substramineus* Kükenth., lamina $\times 60$; 10, *C. sanguinolentus* Vahl, lamina, in part, $\times 45$; 11, *id.*, in full, diagrammatic.

(type I); protoxylem lacunæ present in large vb's; small vb's arranged more or less in a single peripheral ring. Metaxylem vessel members (D. 13.5 μ m). Metaphloem of "regular type". Bundle sheaths of large and small vb's single-layered, complete, fibrous. Circumvascular sclerenchyma of large vb's 2-3-layered, crescentiform, forming an inner cap. Tannin idioblasts not common.

ROOT. *Transverse section* (Pl. 7, 2): Diameter of the root examined 0.3 mm. Exodermis: cells moderately thick-walled, variable in size and shape with outer tangential walls suberized. Hypodermis of single layer of compactly arranged, fairly thick-walled cells. Cortex consisting of several regularly arranged air-cavities being separated by radiating rows of parenchyma cells. Endodermis: distinct, containing tangentially elongated cells with thickening on the inner tangential cell walls and broad lumen. Pericycle not distinct. Metaxylem central with 2 elements, more or less angular (D. 18 μ m); protoxylem units 8, alternating with as many metaphloem units, each unit of the latter containing a single sieve tube element and 2 companion cells. Central ground tissue few-layered, sclerenchymatous.

MATERIAL EXAMINED: *Sedgwick 4792, Mahabaleshwar (type).*

***Cyperus flavidus* Retz. (= *Cyperus globosus* All., *Pycneus globosus* Reichenb., *P. flavidus* (Retz.) Koy.)**

LEAF. *Abaxial surface:* Intercostal cells axially elongated, narrow, moderately thick-walled, pitted, smooth with straight end walls. Stomata (L. 44-52 μ m; W. 28-32 μ m), narrowly elliptical, thick-walled; subsidiary cells parallel-sided; interstomatal cells long with concave ends. Silica-cells over the costa long, narrow, moderately thick-walled, smooth, occurring in a single discontinuous row, each one of them characterized by (4) 5(6) small cone-shaped silica-bodies surrounded by satellites.

Adaxial surface: Cells moderately long, hexagonal, thick-walled, smooth, pitted; end walls straight. Silica-cells overlying the costa long, narrow, moderately thick-walled, occurring in a single discontinuous row, each cell containing 3-4 large cone-shaped silica-bodies with satellites.

Lamina, transverse section (Pl. 1, 3): Outline shallowly V-shaped, asymmetrical. Cuticle thick, uniform. Keel broadly rounded; margins obtuse. Epidermis, see *C. macrostachyos*. Bulliform cells 15-16, see *C. macrostachyos*. Hypodermis consisting of 1 layer of inflated translucent cells becoming 2-layered towards the margin. Sclerenchyma strands: abaxial (Ht. 16-32 μ m; W. 28-40 μ m) trapezoid; adaxial strands (Ht. 16-28 μ m; W. 20-28 μ m) trapezoid or squarish; marginal strands (Ht. 40-44 μ m; W. 64-72 μ m) pulviniform. Assimilatory tissue comprising radiating chlorenchyma. Air-cavities small, narrow containing stellate paren-

chyma. Guard cells and substomatal chamber, see *C. macrostachyos*. Vb's 24 in number comprising large (type III B) and small vb's (type I) both of them almost regularly alternating with each other and all arranged to form a single row. Vessel members (D. 24-28 μ m). Metaphloem of "regular type". Bundle sheaths double, complete; O.S. fibrous, I.S. parenchymatous, cells of which containing tannin. Tannin idioblasts common.

CULM. *Epidermis, surface view*: Cells long, narrow, thick-walled, smooth with straight end walls. Stomata (L. 56-60 μ m; W. 28 μ m); subsidiary and interstomatal cells, see leaf. Silica-cells over the strands elongated, rather broad, occurring in discontinuous rows but instead of cone-shaped silica-bodies, few of them containing many spherical silica-bodies variable in size.

Transverse section (Pl. 4, 3): Outline obtusely triangular. Cuticle very thick, uniform. Epidermal cells isodiametric, thick-walled. Guard cells uniformly much thickened, see *C. macrostachyos*. Sclerenchyma strands (Ht. 20-40 μ m; W. 40-80 (-120) μ m) pulviniform. Assimilatory tissue consisting of radiating chlorenchyma appearing continuous throughout. Ground tissue parenchymatous at the perimedullary region and lysigenously becoming hollow in the centre. Vb's many, comprising large (type III B) and small vb's (type I); small vb's forming a regular peripheral ring; 9 large vb's forming inner ring; large vb's containing protoxylem lacunæ. Metaxylem vessel members (D. 24-28 μ m). Metaphloem of "regular type". Bundle sheaths, see *C. macrostachyos*. Circumvascular sclerenchyma 2-4-layered, crescentiform, forming an inner cap in the large vb's. Air-cavities containing stellate parenchyma occasionally present in between small vb's. Tannin idioblasts common.

ROOT. *Transverse section*: Diameter of the root examined c. 0.4 mm. Exodermal cells isodiametric, hexagonal, rather thin-walled. Hypodermis consisting of 2-3 layers of sclerenchyma. Metaxylem vessel members (D. 36 μ m). Other details as in *C. macrostachyos*.

MATERIAL EXAMINED: *Govindarajulu* 11938, Thuvanam, High Wavys Mts., Madurai dist.; 12256, Ervagalur, High Wavys Mts., Madurai dist.; 12533, Italiyar, Valparai, Coimbatore dist.; *Rangarajan*, Chemmedu, Kolli Hills, Salem dist.; *Rajasekaran* 13288, Javadi Hills, N Arcot dist.

***Cyperus latespicatus* Böck. (= *Pycneus latespicatus* (Böck.) C. B. Clarke)**

LEAF. *Abaxial surface*: Intercostal cells axially elongated, broad, hexagonal, smooth, with straight end walls. Stomata (L. 52-56 μ m; W. 32 μ m), nearly elliptical, thin-walled; subsidiary cells parallel-sided; interstomatal cells short with concave ends. Silica-cells over the costa

elongated, narrow, thin-walled, occurring in a single continuous row, each cell possessing 4(5) cone-shaped silica-bodies without satellites.

Adaxial surface: See abaxial surface.

Lamina, transverse section (Pl. 3, 4): Outline flat with upcurved margins, asymmetrical. Cuticle thick. Keel not distinct. Bulliform cells 5 in number and arranged in regular fan-shaped groups. Sclerenchyma strands (Ht. 24-28 μm ; W. 16-20 μm) trapezoid or rectangular; keel and submarginal adaxial strands (Ht. 32-40 μm ; W. 48-52 μm) pulviniform. Vb's 27 in number comprising (type III B) and small bundles (type I) and arranged more or less in two rows. Metaxylem vessel members (D. 20-24 μm). Metaphloem of "regular type". Bundle sheath single, fibrous, complete. Air-cavities alternating with vb's, each one of them containing stellate parenchyma. Assimilatory tissue of radiating chlorenchyma present. Tannin idioblasts common.

CULM. Epidermis, surface view: Cells moderately long, thick-walled, pitted, rather broad with straight end walls. Stomata (L. 60-68 μm ; W. 36-40 μm) thick-walled, narrowly elliptical; subsidiary and interstomatal cells, see leaf. Silica-cells overlying the peripheral strands elongated, rather broad, occurring in a single discontinuous row, each cell containing (4) 5-6 cone-shaped silica-bodies surrounded by satellites.

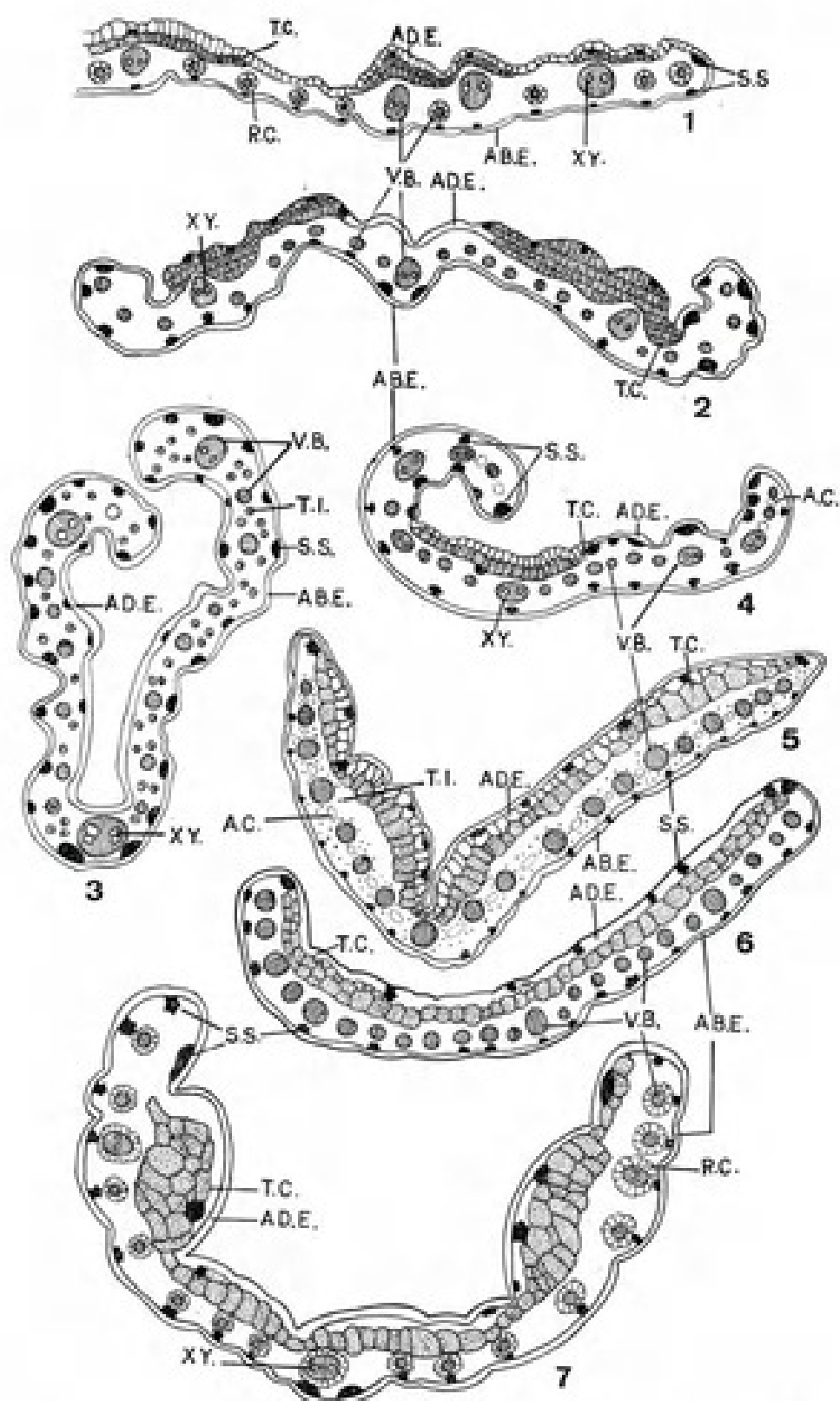
Transverse section (Pl. 4, 4): Outline trapezoid. Cuticle very thick. Epidermal cells isodiametric, thick-walled. Guard cells with outer ledges; substomatal chamber small, narrow. Hypodermis consisting of 3 layers of chlorenchyma. Sclerenchyma strands (Ht. 60-80 μm ; W. 60-100 μm) pulviniform or rounded. Centre lacunose characterized by a few large air-cavities. Vb's many comprising large (type III B) and small vb's (type I); outer smaller vb's forming a peripheral ring; inner large vb's forming more or less perimedullary ring; large vb's containing protoxylem lacunæ. Metaxylem vessel members (D. 20-24 μm). Metaphloem of "regular type". Bundle sheaths single, fibrous, complete. Tannin idioblasts common.

ROOT. Transverse section: Diameter of the root examined *c.* 0.5 mm. Metaxylem vessel members (D. 32-36 μm). Protoxylem units 8 with as many alternating metaphloem units. Other details, see *C. macrostachyos*.

MATERIAL EXAMINED: Rangarajan 9644, Campshed to Ariyur R.F., Kolli Hills, Salem dist.; Sedgwick 4588, Mahabaleshwar.

***Cyperus latevaginatus* Govind., J. Ind. bot. Soc. 52: 72-81 (1973)**
(*'latovaginata'*)

LEAF. Abaxial surface: Intercostal cells moderately elongated, broad, thin-walled, smooth with straight end walls. Stomata (L. 36.0-



Pl. 2. — Transverse section of leaf, ground plan: 1, *Cyperus plumbeosuccus* Govind., lamina, in part $\times 45$; 2, *C. atroglossus* Govind., lamina, $\times 40$; 3, *C. decumbens* Govind., lamina $\times 75$; 4, *C. luridus* Govind., lamina, $\times 50$; 5, *C. lateraginatus* Govind., lamina, $\times 40$; 6, *C. stricticulis* Govind., lamina, $\times 40$; 7, *C. plurinodosus* Govind., lamina, $\times 45$.

39.6 μm ; W. 30.6-32.4 μm) oblong elliptic, thin-walled; subsidiary cells low dome-shaped; interstomatal cells short with concave ends. Silica-cells moderately long, narrow, thin-walled, occurring in a single continuous row, each cell containing 3 (4) silica-bodies surrounded by satellites.

Adaxial surface: See abaxial surface.

Lamina, transverse section (Pl. 2, 5): Outline V-shaped, asymmetrical. Keel rounded; margins subacute. Cuticle moderately thick on either surface. Both adaxial and abaxial epidermal cells somewhat uniform in size and shape throughout, thin-walled. Hypodermis adaxial consisting of a single layer of radially elongated, thin-walled translucent cells. Sclerenchyma strands (adaxial: Ht. 27.0-45.0 μm ; W. 36.0-67.5 μm) pulviniform (rectangular); abaxial strands (Ht. 27.0-31.5 μm ; W. 27-36 μm) pentangular. Vb's 19 in number (11 + 1 + 7), large (type III A) and small (type I), not regularly alternating with each other and all arranged in a single row. Metaxylem vessel members (D. 13.5 μm). Metaphloem not easily distinguishable. Bundle sheaths double, complete; O.S. parenchymatous, I.S. fibrous in all vb's. Assimilatory tissue radiating. Air-cavities small, containing lobed parenchyma cells and regularly alternating with vb's. Bulliform cells not differentiated. Tannin idioblasts very common.

CULM. Epidermis, surface view: Subsidiary cells parallel-sided, containing silica particles. Silica-cells not observed. Other details, see abaxial surface of leaf.

Transverse section (Pl. 6, 1): Outline trigonous with ribs and furrows. Cuticle thick. Epidermal cells variable in size and shape, thick-walled. Guard cells thick-walled with outer ledges; substomatal chamber very narrow. Air-cavities present. Sclerenchyma strands (Ht. 18-54 μm ; W. 21.6-63.0 μm) pulviniform to rounded. Vb's 33-34 in number out of which 10 large (type III B) and the remainder small (type I); large vb's containing protoxylem lacunæ; vb's arranged in two concentric peripheral rings, the small vb's forming the outer ring and large vb's inner ring. Metaxylem vessel members (D. 10.8-18.0 μm). Metaphloem of "intermediate type". Bundle sheaths single-layered, complete in all vb's; large vb's having fibrous sheath while small vb's parenchymatous sheaths. Circumvascular sclerenchyma 2-3-layered, crescentiform in large vb's forming an inner cap. Ground tissue of large parenchymatous cells. Tannin idioblasts abundant.

MATERIAL EXAMINED: *Govindarajulu* 9299, Vattaparai, High Wavys Mts., Madurai dist. (type); 9309, Venniyar, High Wavys Mts., Madurai dist.; 11936, Thuvanam, High Wavys Mts., Madurai dist.

Cyperus luridus Govind., Proc. Ind. Acad. Sc. 81 (5): 187-196 (1975) ('*lurida*').

LEAF. *Abaxial surface*: Intercostal cells axially elongated, broad, thin-walled, smooth with straight end walls. Stomata (L. 36 μm ; W. 22.5-27.0 μm) thin-walled, narrowly oblong; subsidiary cells low dome-shaped; interstomatal cells long or short usually with concave ends. Silica-cells long, narrow, thin-walled, occurring in 2 more or less continuous rows, each cell possessing (2) 3 (4) silica-bodies without satellites.

Adaxial surface: Intercostal cells large, moderately elongated; cell walls thin, smooth with straight end walls. Stomata not observed. Silica-cells long, narrow, each cell containing 2-3 silica-bodies without satellites and occurring in 2 more or less continuous rows.

Lamina, transverse section (Pl. 2, 4): Outline crescentiform, asymmetrical. Cuticle thin on either surface. Keel wanting; margins rounded upcurved. Adaxial and abaxial epidermal cells near the margin thick-walled. Hypodermis: single layer of large translucent cells present in the median regions only. Sclerenchyma strands (adaxial: Ht. 27.0-31.5 μm ; W. 22.5-31.5 μm), pulviniform; adaxial marginal (Ht. 45-54 μm ; W. 54 μm) pulviniform; keel strands (Ht. 22.5 μm ; W. 45 μm) pulviniform; abaxial strands (Ht. 27 μm ; W. 36 μm) inversely securiform. Bulliform cells not sufficiently distinct from the underlying translucent cells. Air-cavities present towards the margin containing stellate parenchyma. Vb's 20 in number; large vb's (type III A) and small vb's (type I) arranged in a single row but not showing regular alternation. Metaxylem vessel members (D. 18 μm). Metaphloem of "intermediate type". Bundle sheaths double, both complete; O.S. parenchymatous, I.S. fibrous in all large vb's; small bundles having a single parenchymatous sheath, complete. Tannin idioblasts common.

CULM. *Epidermis, surface view*: Silica-cells over the peripheral strands not observed but small bodies of irregular shapes present in subsidiary cells. Other details, see abaxial surface of leaf.

Transverse section (Pl. 6, 6): Outline ovate with several ribs and furrows. Cuticle thick. Epidermal cells isodiametric, thin-walled. Guard cells thick-walled with outer ledges; substomatal chamber narrow. Air-cavities absent. Sclerenchyma strands (Ht. 54-72 μm ; W. 72-90 μm) pulviniform to triangular. Ground tissue consisting of large parenchymatous cells arranged with intercellular spaces. Vb's 20 in number out of which 10 large (type III B) and 10 small (type I). Protoxylem lacunae present in large vb's; both large and small vb's arranged in a peripheral ring and not alternating with each other. Metaxylem vessel members (D. 18.0-21.6 μm). Metaphloem of "regular type". Bundle sheaths of large vb's single, complete, fibrous; of small vb's double, complete; I.S. fibrous,

O.S. parenchymatous. Circumvascular sclerenchyma 2-4-layered, crescentiform, forming an inner cap in all large vb's. Tannin idioblasts very common.

ROOT. *Transverse section:* Diameter of the root examined *c.* 0.3 mm. Exodermis: single-layered; cells thick-walled, suberized, variable in size and shape. Cortex: outer narrow, 3-layered, consisting of thick-walled cells compactly arranged; inner cortex of 9-10 air-cavities separated by radiating rows of parenchyma. Endodermis prominent; cells tangentially elongated with uniform thickening and rather broad lumen. Pericycle prominent, cells of which resembling those of endodermis but with narrower lumen. Central ground tissue consisting of thick-walled cells. Metaxylem solitary, central; vessel members (D. 27.0-28.8 μ m). Protoxylem units 5-6 alternating with as many metaphloem units each one of the latter containing 1 large sieve tube element and 2-3 companion cells.

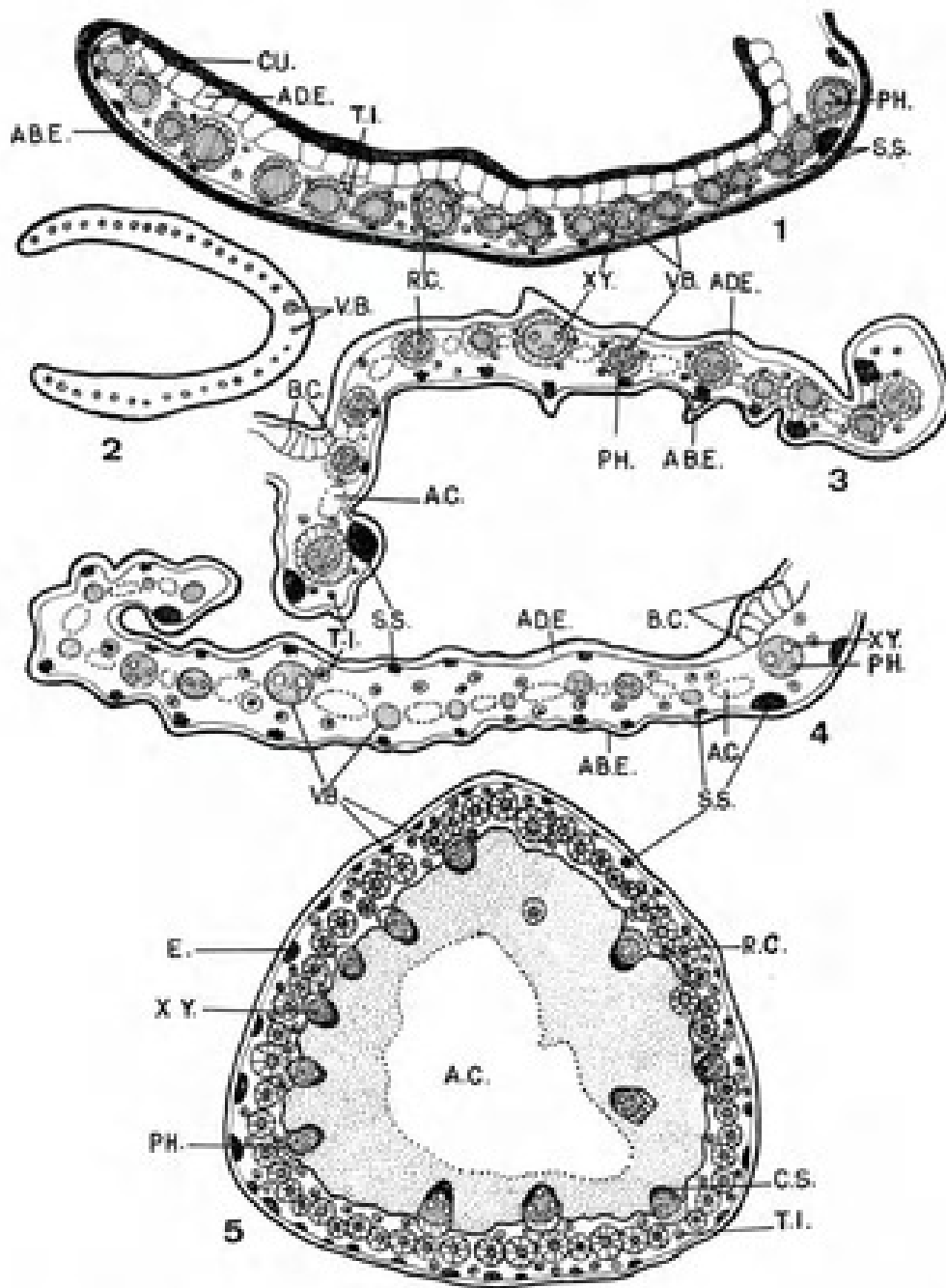
MATERIAL EXAMINED: *Govindarajulu 10742*, Akkamalai, Valparai, Coimbatore dist. (type); *Karunakaran 273*, Nirar, Valparai, Coimbatore dist.

***Cyperus macrostachyos* Lam. (= *Cyperus albomarginatus* Mart. & Schrad., *Pycneus macrostachyos* (Lam.) J. Rayn.)**

LEAF. *Abaxial surface:* Intercostal cells axially elongated, narrow, thin-walled, smooth, pitted with straight end walls. Stomata (L. 44-48 μ m; W. 28-32 μ m) thick-walled, narrowly oblong; subsidiary cells low dome-shaped; interstomatal cells long with concave ends. Silica-cells overlying the costa long, narrow, thin-walled, occurring in a single discontinuous row, each one of them containing 3-5 cone-shaped silica-bodies with satellites.

Adaxial surface: Cells elongated, hexagonal, moderately thick-walled smooth, pitted; end walls straight. Silica-cells over the costa, see abaxial surface.

Lamina, transverse section (Pl. 1, 4, 5, 7): Outline V-shaped, symmetrical. Keel obtusely triangular; margins obtuse. Cuticle thick on either surface. Abaxial epidermal cells thick-walled and superimposed with silica-bodies. Guard cells with outer ledges and thickened in their inner half; substomatal chamber narrow and small. Assimilatory tissue comprising radiating chlorenchyma. Sclerenchyma strands: abaxial (Ht. 28-40 μ m; W. 32-44 μ m) usually rounded (pulviniform); median strands in the keel (Ht. 60 μ m; W. 180 μ m) pulviniform; lateral strands in the keel (Ht. 60-80 μ m; W. 88-100 μ m) pulviniform; adaxial strands (Ht. 36-60 μ m; W. 20-80 μ m) rectangular. Vascular bundles 130, large (type III A) and small (type I) arranged in two rows. Bundle sheaths double, complete; O.S. parenchymatous, I.S. fibrous. Circumvascular sclerenchyma crescentiform forming a cap at the xylem pole in the keel bundle. Air-cavities



Pl. 3. — Transverse section of leaf and culm, ground plan: 1, *C. polystachyos* Rottb., lamina in part, $\times 80$; 2, *id.*, in full, diagrammatic; 3, *C. pulmilus* L., lamina, in part, $\times 110$; 4, *C. latespicatus* Böck., lamina, in part, $\times 90$; 5, *C. unioloides* R. Br., T. S. culm, $\times 36$.

regularly alternating with large vb's; cavities containing stellate parenchyma. Bulliform cells 7 occurring in regular fan-shaped groups. Tannin idioblasts common.

Interesting to observe occurrence of silica-bodies in the anticlinal cell walls of both the epidermis.

CULM. *Epidermis, surface view*: Cells elongated, narrow, moderately thick-walled; end walls straight. Stomata (L. 60 μm ; W. 24-28 μm) narrowly oblong; subsidiary cells parallel-sided; interstomatal cells long with concave ends. Silica-cells, see leaf.

Transverse section (Pl. 4, 5): Outline obtusely triangular. Cuticle thick. Epidermal cells isodiametric, thick-walled; epidermal cells overlaid with cone-shaped silica-bodies. Guard cells and substomatal chamber, see leaf. Ground tissue consisting of compactly arranged parenchyma. Air-cavities incipient, peripheral, occasional. Sclerenchyma strands (Ht. 60-80 μm ; W. 80-140 μm), variable (pulviniform, rounded, triangular). Vascular bundles many, comprising large (type III B) and small vb's (type I); large vb's possessing large protoxylem lacunæ; outer vb's forming a regular peripheral ring while the inner vb's scattered. Vessel members (D. 24-28 μm). Metaphloem of "regular type". Bundle sheaths double, complete; O.S. parenchymatous, I.S. fibrous. Circumvascular sclerenchyma 6-8-layered, crescentiform, forming an inner cap in the large vb's. Tannin idioblasts not seen.

ROOT. *Transverse section*: Diameter of the root examined *c.* 0.5 mm. Exodermis 2-3-layered; cells thick-walled, suberized, variable in size. Cortex: outer broad, consisting of air-cavities being separated by radiating rows of parenchyma; inner cortex consisting of 3 layers of sclerenchyma arranged in radial alignment with endodermal cells. Endodermis prominent; cells isodiametric, uniformly thickened, broad-lumened. Pericycle not distinct. Central ground tissue sclerenchymatous. Metaxylem elements central, solitary; vessel members (D. 60 μm). Protoxylem units 10. Metaphloem units 10, each unit consisting of one large sieve tube element with 3 companion cells.

Interesting to observe that the cell walls of all the tissues (except the vascular tissues) are dark brown in colour.

MATERIAL EXAMINED: *Aravind* 7149, Kannampara, Palghat, Kerala state; *Sedgwick* 3054, Dharwar; *Sreemadhavan* 7018, Perialthalamanna, Palghat, Kerala state.

Cyperus plumbeonuceus Govind., J. Ind. bot. Soc. 52: 72-81 (1973) (*'plumbeonucea'*).

LEAF. *Abaxial surface*: Intercostal cells axially elongated with straight end walls; cell walls thin, slightly sinuous. Stomata (L. 43.2-45.0 μm ; W. 19.8-27.0 μm) narrowly elliptic, thin-walled; subsidiary cells low dome-shaped; interstomatal cells elongated with concave ends. Silica-cells occurring in a single more or less continuous row, each cell containing 3-6 silica-bodies with and without satellites.

Adaxial surface: Cell walls conspicuously sinuous. Stomata absent. Other details, see abaxial surface.

Lamina, transverse section (Pl. 2, 1): Outline flat, symmetrical. Cuticle moderately thick on either surface. Keel not distinct; margins rounded. Abaxial epidermal cells variable in size and shape, thick-walled. Adaxial hypodermis consisting of 2-3 layers of large translucent cells interruptedly present opposite to large vb's. Air-cavities absent. Assimilatory tissue of radiating chlorenchyma around small vb's. Sclerenchyma strands (abaxial & adaxial; Ht. & W. 18.0-26.6 μm) squarish; adaxial submarginal strands (Ht. 21.6 μm ; W. 36.0 μm) pulviniform. Vb's 24 out of which 6-7 large vb's (type III A) and the rest small (type I) disposed in a single row and not regularly alternating with each other. Metaxylem vessel members (D. 18.0 μm). Metaphloem of "intermediate type". Bundle sheaths of large vb's 2-layered, complete; I.S. parenchymatous, O.S. fibrous; of small vb's single-layered, complete, parenchymatous. Bulliform cells not distinct. Tannin idioblasts common.

CULM. Epidermis, surface view: Cells moderately elongated, broad; cell walls thin, sinuous, with straight end walls. Stomata (L. 34.2-37.8 μm ; W. 32.4-36.0 μm) subcircular; subsidiary cells low dome-shaped; guard cells sometimes containing silica particles and minute silica-bodies; interstomatal cells short with concave ends. Silica-cells overlying the peripheral strands occurring in a single discontinuous row each cell possessing 2-3 silica-bodies with satellites.

Transverse section (Pl. 6, 2): Outline elliptic-ovate with several ribs and furrows. Cuticle thick. Epidermal cells isodiametric, thick-walled. Guard cells thick-walled with outer ledges; substomatal chamber rather narrow. Air-cavities absent. Sclerenchymatous strands (Ht. 36.0-39.6 μm ; W. 36-81 μm) pulviniform (rounded). Ground tissue of large parenchymatous cells. Vb's c. 42 out of which 18 large (type III B) and 24 small (type I); large vb's with protoxylem lacunæ; both large and small vb's arranged peripherally in 2 regular rings and not regularly alternating with each other. Metaxylem vessel members (D. 18 μm). Metaphloem of "regular type". Bundle sheaths of all vb's single-layered, complete; fibrous in large vb's and parenchymatous in small vb's. Circumvascular sclerenchyma of large vb's 3-4-layered, crescentiform, present as inner cap. Tannin idioblasts very common.

ROOT. Transverse section: Diameter of the root examined c. 0.4 mm. Exodermis: cells thin-walled, variable in size and shape. Cortex lacunose containing c. 6 air-cavities, separated by radiating rows of parenchyma. Endodermis prominent; cells isodiametric with U-shaped thickenings and broad lumen. Pericycle prominent containing fairly thick-walled rounded cells. Central ground tissue parenchymatous. Metaxylem vessel element large, central, solitary (D. 36 μm). Protoxylem units 6. Metaphloem units 6, each unit consisting of a single large sieve tube element and 3 companion cells.

MATERIAL EXAMINED: *Govindarajulu* 9453, Campshed, High Wavys Mts., Madurai dist. (type).

Cyperus plurinodosus Govind., Proc. Ind. Acad. Sci. 81 (5): 187-196 (1975) ("*plurinodosa*").

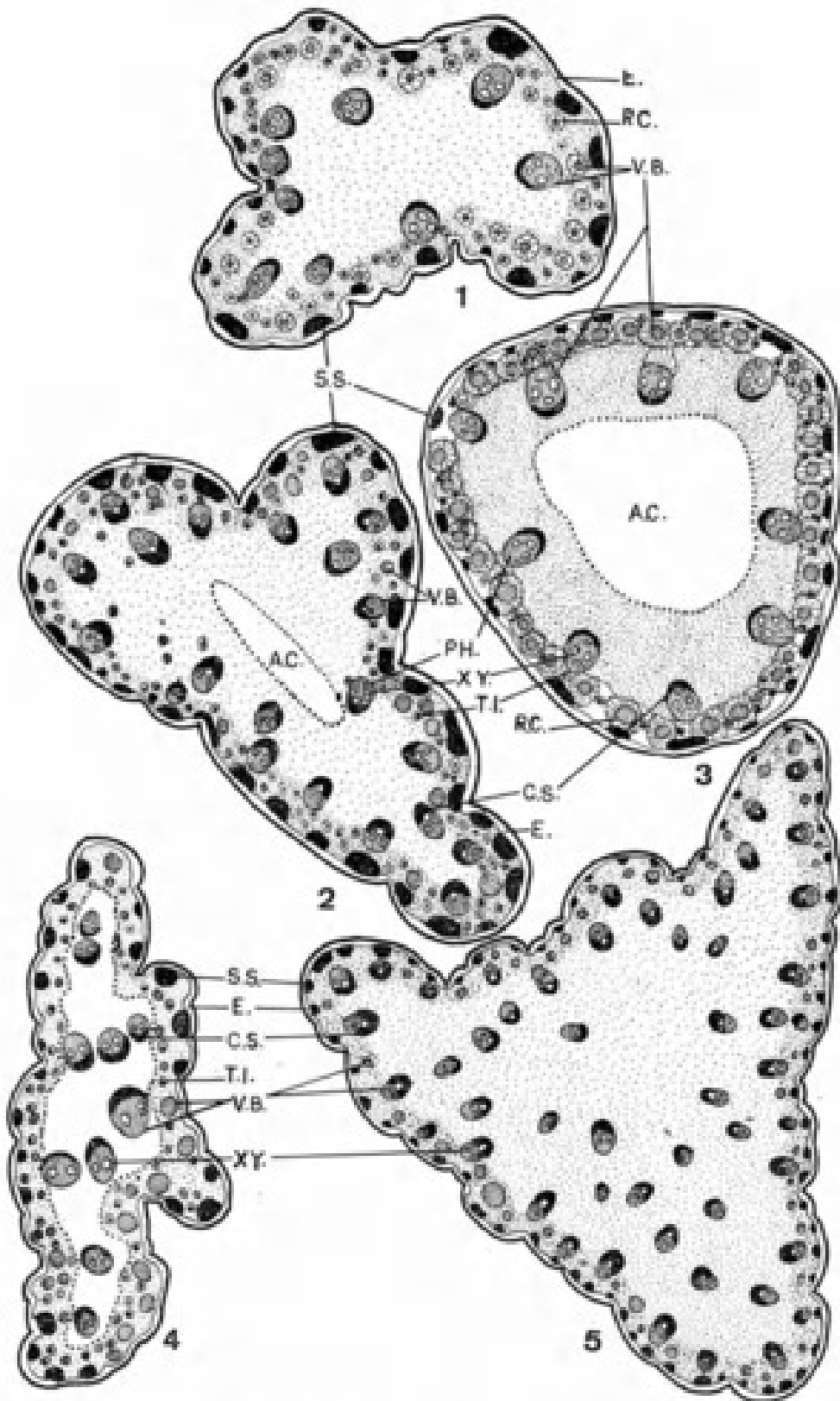
LEAF. *Abaxial surface*: Intercostal cells long, broad; cell walls smooth, moderately thick with straight end walls. Stomata (L. 28.8-30.6 μm ; W. 12.6 μm) narrowly oblong, thin-walled; subsidiary cells parallel-sided; interstomatal cells short, broad with concave ends or straight end walls. Silica-cells moderately long, rather broad, thin-walled, each one of them possessing (2) 3 (4) silica-bodies occurring in a single more or less continuous row; satellites absent.

Adaxial surface: Intercostal cells long, broad, thin-walled, smooth. Stomata (L. 32.4-39.6 μm ; W. 21.6 μm) occasional, narrowly oblong-elliptic, subsidiary cells parallel-sided. Silica-cells long, narrow, each cell characterized by 2-3 silica-bodies without satellites and occurring in a single discontinuous row.

Lamina, transverse section (Pl. 2, 7): Outline crescentiform with 5 adaxial grooves, symmetrical. Cuticle thick on either surface, lamellated. Adaxial and abaxial epidermal cells more or less uniform throughout. Keel not distinct; margins rounded. Bulliform cells not differentiated. Guard cells with outer ledges only; substomatal chamber very narrow and small. Hypodermis of a single layer of translucent cells variable in size and shape and tending to become 2-3-layered in the submarginal regions. Air-cavities absent. Assimilatory tissue of radiating chlorenchyma. Sclerenchyma strands: abaxial (Ht. 22.5-45.0 μm ; W. 22.5-54 μm) pentangular and squarish; adaxial, submarginal and keel strands (Ht. 18-27 μm ; W. 54 μm) pulviniform. Vb's 19 in number, comprising large (type III A) and small vb's (type I), all disposed in a single row. Metaxylem vessel members (D. 9 μm). Metaphloem belonging to "intermediate type". Bundle sheaths double, complete; O.S. parenchymatous, I.S. fibrous. Tannin idioblasts not common.

CULM. *Epidermis, surface view*: Cells elongated; end walls straight; cell walls moderately thick, slightly sinuous. Stomata (L. 45-54 μm ; W. 27.0-31.5 μm), oblong-elliptic, moderately thick-walled; subsidiary cells parallel-sided; interstomatal cells long with concave ends. Silica-cells, see leaf.

Transverse section (Pl. 6, 3): Outline elliptic with ribs and furrows. Cuticle very thick, lamellated. Epidermal cells isodiametric, thick-walled. Guard cells thick-walled with outer ledges; substomatal chamber very narrow. Air-cavities absent. Sclerenchyma strands (Ht. 27.0-46.8 μm ; W. 36-81 μm) usually pulviniform (triangular). Ground tissue of large



Pl. 4. — Transverse section of culm, ground plan: 1, *C. pumilus* L., $\times 70$; 2, *C. sulcinus* C. B. Cl., $\times 30$; 3, *C. flavidus* Retz., $\times 45$; 4, *C. lutespicatus* Böck., $\times 45$; 5, *C. macrostachyos* Lam., $\times 20$.

parenchymatous cells tending to become lacunose in the centre. Vb's 44 in number out of which 9 large (type III B) and the remainder small (type I), arranged in 2 rings; the small vb's forming an outer ring and the large ones an inner ring; large vb's containing protoxylem lacunæ. Metaxylem vessel members (D. 13.5 μ m). Metaphloem of "regular type". Bundle sheaths of large vb's single-layered, complete, fibrous; of small vb's 2-layered, complete; I.S. fibrous, O.S. parenchymatous. Circumvascular sclerenchyma of large vb's 3-4-layered, crescentiform with angular sides forming an inner cap. Tannin idioblasts not common.

MATERIAL EXAMINED: *Govindarajulu* 4825, Megaravalli, Agumbe, Shimoga dist. (type).

***Cyperus polystachyos* Rottb. (= *Pycnus polystachyos* (Rottb.) Pal. Beauv.)**

LEAF. *Abaxial surface*: Intercostal cells axially elongated, narrow, thick-walled, sinuous with straight end walls. Stomata (L. 36-40 μ m; W. 28 μ m) elliptical, thick-walled; subsidiary cells low dome-shaped; interstomatal cells long with concave ends. Silica-cells over the costæ, short, narrow, thin-walled, occurring in a single continuous row, each cell possessing (1) 2 silica-bodies without satellites.

Adaxial surface: Cells short, cubical, thin-walled, sinuous with straight end walls. Silica-cells, see abaxial surface.

Lamina, transverse section (Pl. 3, 1, 2): Outline deeply crescentiform, symmetrical. Cuticle excessively thick, uniform. Keel absent; margins unequal, one subrectangular, the other rounded. Adaxial and abaxial epidermal cells thick-walled. Guard cells with outer ledges; substomatal chamber narrow. Air-cavities absent. Assimilatory tissue of radiating chlorenchyma. Bulliform cells not differentiated. Sclerenchyma strands: abaxial (Ht. 24-44 μ m; W. 20-24 μ m) trapezoid; marginal and keel strands (Ht. 24-44 μ m; W. 44-60 μ m) pulviniform. Vb's 35 comprising large (type III A) and small vb's (type I) and all arranged in a single row. Metaxylem vessel members (D. 16 μ m). Metaphloem of "regular type". Bundle sheaths single, fibrous, complete. Tannin idioblasts abundant.

Although METCALFE (1971) has described the anatomy of this species, his material shows certain number of deviations from that of present author as follows: 1) lamina V-shaped with well developed keel; 2) presence of 1-3-layered hypodermis consisting of translucent cells; 3) presence of well developed bulliform cells; 4) incomplete bundle sheaths; 5) larger number of vb's; 6) mesophyll consisting of large conspicuously lobed chlorenchyma cells; 7) only pulviniform sclerenchyma strands and in the case of culms sclerenchyma strands are said to be variable with angular outline.

CULM. *Epidermis, surface view:* Cells long, narrow, thick-walled, sinuous, pitted with straight end walls. Stomata (L. 48 μm ; W. 36-40 μm) thick-walled, broadly elliptical; subsidiary cells low dome-shaped; interstomatal cells long with concave ends. Silica-cells over the peripheral sclerenchyma strands not observed.

Transverse section (Pl. 5, 1): Outline somewhat trigonous with submedian depression on one side. Cuticle, epidermal cells, guard cells, substomatal chamber, see leaf. Hypodermis consisting of 4-6 layers of chlorenchyma. Ground tissue parenchymatous; centre lysigenously becoming hollow. Sclerenchyma strands (Ht. & W. 80-100 μm) pulviniform to rounded. Vb's many, comprising large (type III B) and small vb's (type I); the latter forming a regular peripheral ring while the former forming an inner ring; large vb's containing protoxylem lacunæ. Metaxylem vessel members (D. 20-24 μm). Metaphloem of "regular type". Bundle sheaths, see leaf. Circumvascular sclerenchyma of large vb's deeply crescentiform forming an inner cap. Tannin idioblasts abundant.

ROOT. *Transverse section:* Diameter of the root examined c. 0.5 mm. Metaxylem units 5 present in perimedullary regions with as many protoxylem units; metaxylem vessel members (D. 24 μm). Metaphloem units 5, each unit consisting of 2 large sieve tube element and 2-3 companion cells. Other details, as in *C. macrostachyos*.

MATERIAL EXAMINED: *Govindarajulu* 5551, Red Hills, Madras; 5776, Mannargudi, Thanjavur dist.; 5879, Vaigai River bed, Madurai dist.; 8009, Kambakkam, Nellore dist.; *Rajasekaran* 9, Coimbatore dist.; *Rangarajan & al.* 11182, Tirupathi, Chittoor dist.

***Cyperus puncticulatus* Vahl (= *Pycneus puncticulatus* (Vahl) Nees)**

LEAF. *Abaxial surface:* Intercostal cells axially elongated, narrow, thin-walled, smooth with straight end walls. Stomata (L. 40-44 μm ; W. 28-32 μm) moderately thick-walled, elliptical; subsidiary cells parallel-sided; interstomatal cells long with concave ends. Silica-cells long, narrow, thin-walled, smooth, occurring in a single continuous file, each cell containing 4 small silica-bodies with satellites.

Adaxial surface: Cells long, hexagonal, broad, thin-walled, smooth with straight end walls. Silica-cells, see abaxial surface.

Lamina, transverse section (Pl. 1, 8): Outline V-shaped with median adaxial groove, symmetrical. Cuticle on the adaxial surface thicker than that of the abaxial. Adaxial epidermal cells radially elongated and some of them containing wedge-shaped silica-bodies in the sinuities of anticlinal walls. Keel triangular; margins obtuse. Substomatal chamber small, narrow. Bulliform cells 8 in number occurring in a regular fan-shaped group, cells of which thick-walled. Sclerenchyma strands: abaxial (Ht. & W. 12-16 μm), squarish; abaxial submarginal pulviniform; adaxial

strands (Ht. 20-24 μm ; W. 28-32 μm) trapezoid; keel strands pulviniform. Air-cavities large, radially elongated, rectangular (squarish) in outline, and regularly alternating with large vb's; air-cavities containing stellate parenchyma. Assimilatory tissue of radiating parenchyma. Vb's many, comprising large (type III A) and small vb's (type I) arranged in 2 rows; large vb's containing protoxylem lacunæ; metaxylem vessel members (D. 32-40 μm). Metaphloem of "regular type". Bundle sheaths: of small vb's double, complete; I.S. parenchymatous, O.S. fibrous; of large vb's single, fibrous, complete. Tannin idioblasts abundant.

CULM. *Epidermis, surface view*: Cells moderately elongated, hexagonal, narrow, thick-walled, smooth with straight end walls. Stomata (L. 44 μm ; W. 32-36 μm) thick-walled, elliptical, not common; subsidiary cells low dome-shaped; interstomatal cells moderately long with concave ends. Silica-cells not observed.

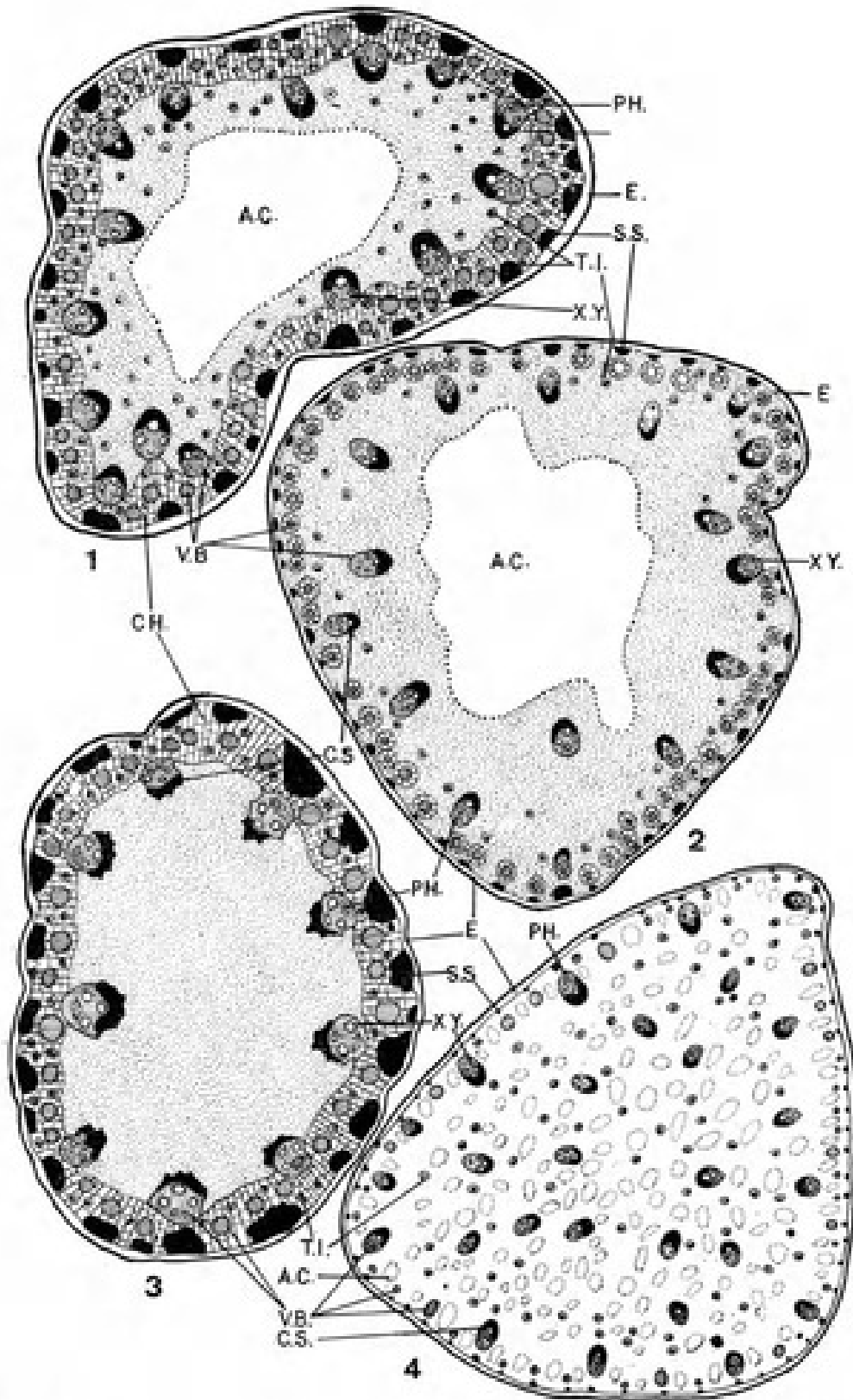
Transverse section (Pl. 5, 4): Outline trigonous. Cuticle thick. Epidermal cells isodiametric, thin-walled. Substomatal chamber narrow and small. Ground tissue parenchymatous characterized by many small air-cavities throughout the culm; those cells in the periphery containing starch grains; air-cavities containing stellate parenchyma. Sclerenchyma strands (Ht. 40-80 μm ; W. 60-100 μm) pulviniform or rounded. Vb's many, comprising large (type III B) and small vb's (type I); small vb's along with a few large vb's forming a regular peripheral ring and regularly alternating with air-cavities; large vb's in the centre scattered; protoxylem lacunæ present in large vb's; metaxylem vessel members (D. 36-40 μm). Metaphloem of "regular type". Bundle sheaths double, complete in all vb's; I.S. fibrous, O.S. parenchymatous. Circumvascular sclerenchyma of large vb's crescentiform forming an inner cap. Tannin idioblasts abundant in the central ground tissue.

ROOT. *Transverse section*: Diameter of the root examined 1 mm. Exodermis, outer cortex, see *C. polystachyos*. Inner cortex consisting of 1-2 layers of sclerenchyma. Endodermal cells rounded with uniform thickening throughout and rounded lumina. Pericycle sclerenchymatous. Metaxylem units central, solitary or in pairs. Protoxylem units 7. Metaxylem vessel members (D. 28-32 μm). Metaphloem units 7, each unit containing 2 large sieve tube elements and 2-3 companion cells. Central ground tissue scanty, sclerenchymatous.

MATERIAL EXAMINED: *Govindarajulu* 6369, Poondi, Chinglepet dist.; 7939, Red Hills, Madras; 11817, Thiruvottiyur, Madras; 11334, Banavaram, N Arcot dist.; *Krishnamurthy* 11867, Kolli Hills, Salem dist.

***Cyperus pumilus* L. (= *Pycneus pumilus* (L.) Nees)**

LEAF. *Abaxial surface*: Intercostal cells axially elongated, moderately broad, thin-walled, somewhat sinuous with straight end walls. Sto-



Pl. 5. — Transverse section of culm, ground plan: 1, *Cyperus polystachyos* Roth., $\times 45$; 2, *C. sanguinolentus* Vahl, $\times 30$; 3, *C. substramineus* Kükenth., $\times 60$; 4, *C. puncticulatus* Vahl, $\times 10$.

mata (L. 28-32 μ m; W. 24-28 μ m), subcircular, thin-walled; subsidiary cells low dome-shaped; interstomatal cells long with concave ends. Silica-cells long, narrow, thin-walled, occurring in a single continuous file, each cell possessing 5-8 silica-bodies with satellites.

Adaxial surface: Cells elongated, hexagonal, broad, thin-walled with straight end walls. Silica-cells long, narrow, thin-walled, occurring in a single continuous file; silica-bodies 2-4 per cell surrounded by satellites.

Lamina, transverse section (Pl. 3, 3): Outline flat with median adaxial groove, rectangular keel and upcurved margin; lamina symmetrical. Cuticle very thick. Guard cells with outer ledges; substomatal chamber narrow, small. Bulliform cells 5 in number present in regular fan-shaped groups. Assimilatory tissue of radiating chlorenchyma. Air-cavities regularly alternating with vb's, each one of them containing stellate parenchyma. Sclerenchyma strands: abaxial (Ht. 20-24 μ m; W. 20-32 μ m), trapezoid or rectangular; keel strands (Ht. 32-40 μ m; W. 40-52 μ m) pulviniform. Vb's 23 in number comprising large (type III B) and small vb's (type I) and arranged more or less in 2 rows. Metaxylem vessel members (D. 16 μ m). Metaphloem of "regular type". Bundle sheaths single, fibrous, complete. Tannin idioblasts common.

CULM. Epidermis, surface view: Cells elongated, thin-walled, narrow, smooth with straight end walls. Stomata (L. 36-40 μ m; W. 24 μ m), narrowly elliptical, thin-walled; subsidiary cells low dome-shaped; interstomatal cells long with concave ends. Silica-cells not observed but silica deposits of different size and shape (usually hemispherical in shape) very common in cells overlying the peripheral strands.

Transverse section (Pl. 4, 1): Outline irregularly tetragonal. Cuticle thick. Epidermal cells isodiametric, thin-walled. Substomatal chamber narrow, small. Assimilatory tissue consisting of radiating chlorenchyma. Central ground tissue parenchymatous. Sclerenchyma strands (Ht. 24-48 μ m; W. 48-72 μ m) pulviniform (rounded). Vb's 38 comprising 9 large (type III B) and 29 small vb's (type I); the latter forming a regular peripheral ring and the former an inner ring; large vb's containing protoxylem lacunæ. Metaxylem vessel members (D. 8-12 μ m). Metaphloem of "regular type". Bundle sheaths single, fibrous, complete. Circumvascular sclerenchyma of large vb's crescentiform forming an inner cap. Tannin idioblasts common.

ROOT. Transverse section: Diameter of the root examined c. 0.4 mm. Other details, see *C. macrostachyos*.

MATERIAL EXAMINED: Fyson 5190, Teynampet, Madras; Govindarajulu 5782, Mayuram, Thanjavur dist.; 6378, Ernavoor, Madras; 6926, Arappakkam, Chinglepet dist.

Cyperus sanguinolentus Vahl ssp. **sanguinolentus** (= *Pycneus sanguinolentus* (Vahl) Nees)

LEAF. Abaxial surface: Intercostal cells axially elongated, narrow, thin-walled, smooth with straight or overlapping end walls. Stomata (L. 48 μ m; W. 24-28 μ m), narrowly oblong, moderately thick-walled; subsidiary cells parallel-sided; interstomatal cells long with concave ends. Silica-cells long, narrow, thin-walled, smooth, occurring in a single discontinuous file; silica-bodies 4-5 per cell accompanied by satellites.

Adaxial surface: Cells long, narrow, rectangular, thin-walled, sinuous, with straight end walls. Silica-cells, see abaxial surface.

Lamina, transverse section (Pl. 1, 10): Outline V-shaped, symmetrical. Keel triangular; margins subacute. Cuticle thick. Abaxial and adaxial epidermal cells moderately thick-walled. Hypodermis consisting of a single layer of translucent cells. Bulliform cells 8 in number but not distinct from the subjacent translucent cells. Air-cavities absent. Sclerenchyma strands: adaxial (Ht. 16-24 μ m; W. 20-32 μ m), trapezoid or rectangular; abaxial strands (Ht. & W. 16 μ m) squarish; keel strands (Ht. 20 μ m; W. 28 μ m) pulviniform. Guard cells with outer ledges; substomatal chamber narrow and small. Assimilatory tissue of radiating chlorenchyma. Vb's 39 comprising large (type III B) and small vb's (type I) and all arranged more or less in a single row; large vb's containing protoxylem lacunæ. Metaxylem vessel members (D. 16 μ m). Metaphloem of "regular type". Bundle sheaths single, complete, fibrous. Tannin idioblasts abundant.

CULM. Epidermis, surface view: Cells elongated, narrow, thick-walled, pitted, sinuous with straight end walls. Stomata (L. 48-60 μ m; W. 36-40 μ m) elliptical, thick-walled; subsidiary cells parallel-sided; interstomatal cells long with concave ends. Silica-cells long, narrow, smooth, thin-walled, occurring in a single discontinuous file; silica-bodies 4-5 per cell, surrounded by satellites.

Transverse section (Pl. 5, 2): Outline ovate. Cuticle thick. Epidermal cells isodiametric, thick-walled. Assimilatory tissue consisting of radiating chlorenchyma. Ground tissue parenchymatous; centre hollow. Sclerenchyma strands (Ht. 24-64 μ m; W. 80-120 μ m) pulviniform. Vb's many, comprising large (type III B) and small vb's (type I) the latter forming a peripheral ring and the former an inner ring; large vb's with protoxylem lacunæ; metaxylem vessel members (D. 20-24 μ m). Metaphloem of "regular type". Bundle sheaths double, complete; of large vb's O.S. parenchymatous, I.S. fibrous; of small vb's both fibrous. Circumvascular sclerenchyma of large vb's crescentiform forming an inner cap. Tannin idioblasts common.

ROOT. *Transverse section*: Diameter of the root examined *c.* 0.6 mm. Metaxylem vessel members (D. 40 μ m). Other details, see *C. macrostachyos*.

MATERIAL EXAMINED: *Govindarajulu* 6227, Avalanche, Nilgiris dist.; 6819, Kodai-kanal, Madurai dist.; 12333, Chembrambakkam, Chinglepet dist.; *Rangarajan & al.* 9576, Kolli Hills, Salem dist.

***Cyperus sanguinolentus* ssp. *cyrtostachys* (Miq.) Kern.**

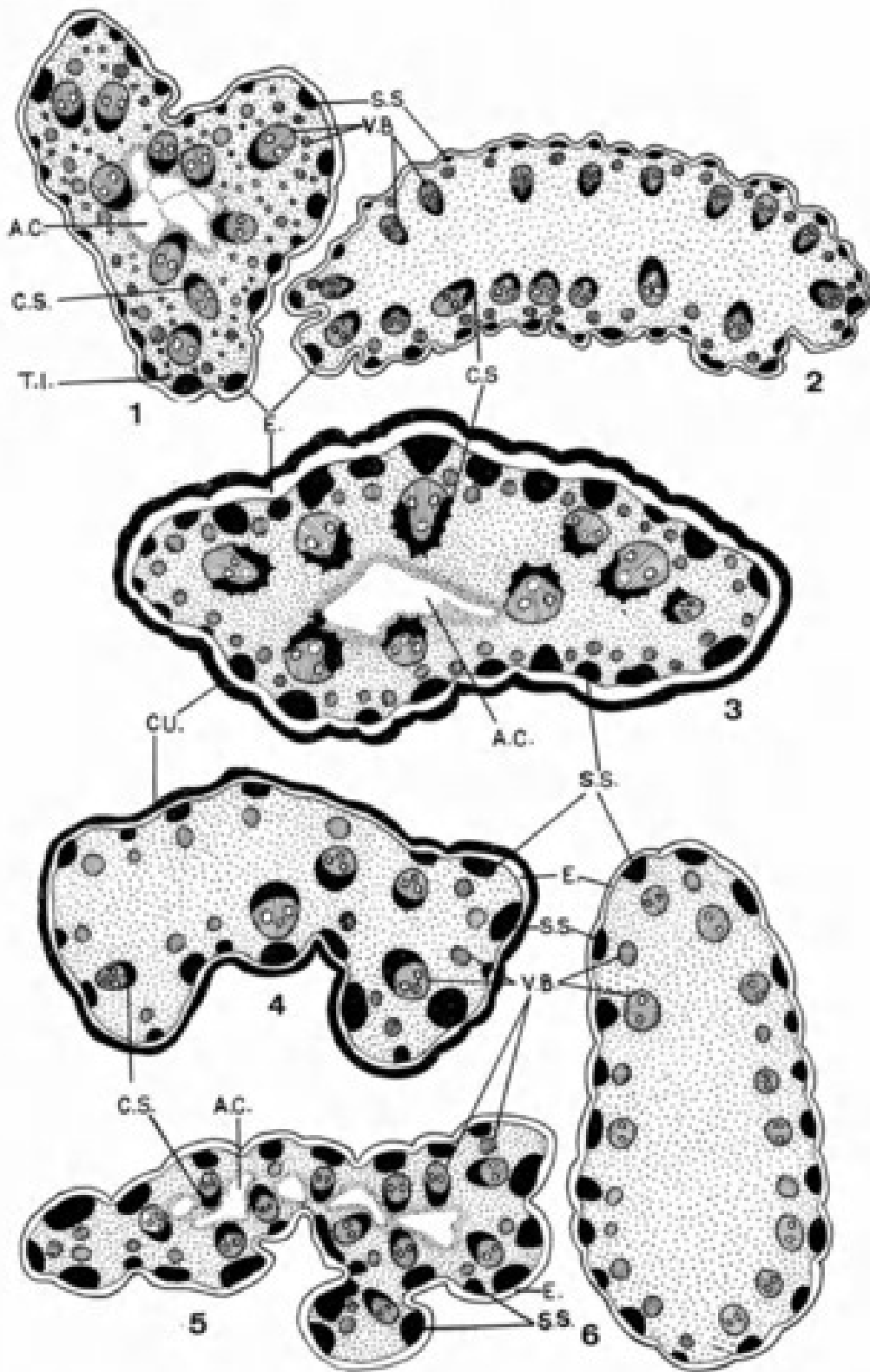
LEAF. *Abaxial surface*: Intercostal cells axially elongated, broad, thin-walled, smooth, pitted, with straight end walls. Stomata (L. 40.5-45.0 μ m; W. 22.5 μ m), narrowly oblong, thin-walled; subsidiary cells parallel-sided; interstomatal cells long with concave ends. Silica-cells long, narrow, thin-walled, occurring in a single continuous row, each cell containing 3-5 silica-bodies with satellites.

Adaxial surface: Silica-cells occasionally present in discontinuous file. Other details, see abaxial surface.

Lamina, transverse section (Pl. 7, 4, 5): Outline V-shaped, symmetrical. Cuticle thin on either surface. Keel and margins rounded. Bulliform cells not differentiated. Sclerenchyma strands; adaxial (Ht. 13.5-40.5 μ m; W. 18.0-22.5 μ m), trapezoid (squarish); abaxial (Ht. & W. 13.5 μ m), squarish; lateral strands in the keel (Ht. 27 μ m; W. 45 μ m) pulviniform. Guard cells with outer ledges; substomatal chamber small and very narrow. Hypodermis consisting of 2-3 layers of large translucent cells. Air-cavities containing lobed parenchyma cells as many as and regularly alternating with vb's. Vb's 27 comprising large (type III A) and small (type I) and arranged in a single row. Metaphloem of "intermediate type". Bundle sheaths in all vb's double, complete; O.S. parenchymatous, I.S. fibrous. Tannin idioblasts common.

CULM. *Epidermis, surface view*: Cells elongated, broad, moderately thick-walled, smooth; end walls straight. Stomata (L. 36.0-40.5 μ m; W. 27 μ m), oblong; subsidiary cells parallel-sided; interstomatal cells long with concave ends. Silica-cells not observed.

Transverse section (Pl. 7, 6): Outline trigonous with invaginations and furrows. Cuticle thick, lamellated. Epidermal cells variable in size and shape, thick-walled. Guard cells and substomatal chamber, see leaf. Ground tissue consisting of compactly arranged parenchyma interrupted at the periphery by air-cavities containing lobed parenchyma cells; air-cavities present in the centre. Sclerenchyma strands (Ht. 31.5-45.0 μ m; W. 54-110 μ m) pulviniform. Vb's 45-47 in number comprising large (type III B) and small vb's (type I); large vb's possessing protoxylem lacunæ; outer small vb's forming a peripheral ring while inner large vb's disposed more or less in a ring towards the centre. Metaxylem vessel



Pl. 6. — Transverse section of culm, ground plan: 1, *Cyperus latevaginatus* Govind., $\times 45$; 2, *C. plumbeonuceus* Govind., $\times 100$; 3, *C. plurinodosus* Govind., $\times 50$; 4, *C. decumbens* Govind., $\times 50$; 5, *C. atroglossus* Govind., $\times 40$; 6, *C. luridus* Govind., $\times 40$.

members (D. 13.5-18.0 μ m). Metaphloem of "regular type". Bundle sheaths single, fibrous, complete in all large vb's; small vb's characterized by 2-layered bundle sheaths; O.S. parenchymatous, I.S. fibrous. Circumvascular sclerenchyma 3-5-layered, crescentiform forming an inner cap in large vb's. Tannin idioblasts less common.

MATERIAL EXAMINED: *Duraiwamy* 7130, Kumbakonam, Thanjavur dist.; *Govindarajulu* 5360, Irumbuliyur, Madras; 5668, Sriperumpudur, Chinglepet dist.; 12333 A, Chembarampakkam, Chinglepet dist.; *Kathirvelu* 15, Perur, Coimbatore dist.

***Cyperus sanguinolentus* var. *micronux* (Clarke) Kükenth.**

CULM. *Epidermis, surface view*: Occasionally silica-bodies present on the anticlinal walls. Other details, see *C. sanguinolentus* ssp. *cyrtostachys*.

Transverse section (Pl. 7, 3): Outline irregularly oval with invaginations and ribs. Cuticle very thick, lamellated. Epidermal cells tangentially elongated, thick-walled. Ground tissue lacunose containing several air-cavities of variable size and shape. Sclerenchyma girders (Ht. 36.0-49.5 μ m; W. 81-156 μ m) pulviniform. Vb's c. 37 comprising 11 large (type III B) and 25 small vb's (type I) and arranged more or less in 2 peripheral rings; the large vb's containing protoxylem lacunæ; the outer ring consisting of small and the inner ring of large vb's. Metaxylem vessel members (D. 13.5-18.0 μ m). Metaphloem of "regular type". Bundle sheaths of both large and small vb's single-layered, complete, fibrous. Circumvascular sclerenchyma in large vb's 2-3-layered, crescentiform, forming an inner cap. Tannin idioblasts not observed.

MATERIAL EXAMINED: *Masters s.r.*, Assam (DD).

***Cyperus stricticulmis* Govind., Proc. Ind. Acad. Sci. 81 (5): 187-196 (1975).**

LEAF. *Abaxial surface*: Intercostal cells, see *C. luridus*. Stomata (L. 39.6-41.4 μ m; W. 12.8-16.4 μ m) narrowly oblong elliptic, thin-walled; subsidiary cells parallel-sided or low dome-shaped; interstomatal cells, see *C. luridus*. Silica-cells moderately long, broad, thin-walled, occurring in a single continuous row; silica-bodies 2-3 per cell without satellites.

Adaxial surface: Subsidiary cells low dome-shaped throughout. Other details, see abaxial surface.

Lamina, transverse section (Pl. 2, 6): Outline shallowly crescentiform, symmetrical. Cuticle thin on both surfaces. Keel absent; margins truncate or rounded. Adaxial epidermal cells variable in size and shape; abaxial epidermal cells consistent in size and shape; cells of both layers moderately thick-walled. Hypodermis: a single layer of more or less

isodiametric large translucent cells adaxially present except at the margin. Bulliform cells slightly differentiated composed of just 3 cells. Air-cavities absent. Assimilatory tissue of radiating chlorenchyma. Sclerenchyma strands: adaxial (Ht. & W. 27-36 μm), pentangular; adaxial submarginal (Ht. 54 μm ; W. 70 μm), pulviniform; abaxial (Ht. 21.6 μm ; W. 27 μm), pulviniform with angular sides. Vb's 25 in number comprising large (type III B) and small (type I) and not regularly alternating with each other but all arranged in a single row; metaxylem vessel element (D. 12.6 μm). Metaphloem of "regular type". Bundle sheaths of all vb's double, complete; I.S. parenchymatous, O.S. fibrous. Tannin idioblasts not seen.

CULM. *Epidermis, surface view:* Subsidiary cells parallel-sided. Some of the long cells adjoining the costæ containing silica-bodies of different sizes and shapes. Other details as in leaf abaxial surface.

Transverse section (Pl. 7, I): Outline subcircular with ribs and furrows. Cuticle thick. Epidermal cells uniform throughout, thick-walled. Guard cells thick-walled, with outer ledges; substomatal chamber very narrow. Air-cavities absent. Ground tissue consisting of large thin-walled parenchymatous cells arranged with intercellular spaces. Sclerenchyma strands (Ht. 45-90 μm ; W. 90-103.5 μm) pulviniform. Vb's 20-22 in number out of which *c.* 9 large (III B) containing protoxylem lacunæ and the remainder small (type I); vb's arranged in 2 rings, outer ring consisting of small vb's and inner of large vb's; metaxylem vessel members (D. 18 μm). Metaphloem of "intermediate type". Bundle sheaths single-layered, complete, fibrous in all vb's. Circumvascular sclerenchyma 3-4-layered, crescentiform, present as inner cap. Tannin idioblasts less common.

ROOT. *Transverse section:* Diameter of the root examined 0.3 mm. Exodermis of single layer of thin-walled cells variable in size and shape. Cortex; outer very narrow, 2-layered, consisting of thin-walled cells arranged without intercellular spaces; inner cortex tending to develop *c.* 9-10 air-cavities. Endodermis prominent; cells isodiametric with uniform thickening and rather broad lumina. Pericycle prominent, cells of which thick-walled having narrow lumina. Central ground tissue thin-walled, just 2-layered. Metaxylem vessel element solitary, central; vessel members (D. 27 μm). Protoxylem units 4-6, alternating with as many metaphloem units, each one of the latter containing one sieve tube element and 2 companion cells.

MATERIAL EXAMINED: *Gorindarajulu 9942*, Valparai, Coimbatore dist. (type).

***Cyperus substramineus* Kükenth. (= *Pycnus stramineus* (Nees) Clarke).**

LEAF. *Abaxial surface:* Intercostal cells axially elongated, narrow, moderately thick-walled, smooth with straight (overlapping) end walls. Stomata (L. 40-44 μm ; W. 20 μm) narrowly oblong, thick-walled; sub-

subsidiary cells parallel-sided; interstomatal cells long with concave ends. Silica-cells long, narrow, thin-walled, occurring in a single discontinuous file; silica-bodies 4-5 per cell surrounded by satellites.

Adaxial surface: Cells long, broad, rectangular, thin-walled, smooth with straight end walls. Silica-cells containing 2-4 silica-bodies with satellites. Other details as in abaxial surface.

Lamina, transverse section (Pl. 1, 9): Outline crescentiform, symmetrical with inconspicuous keel and rounded margin. Bulliform cells not differentiated. Air-cavities absent. Sclerenchyma strands; abaxial (Ht. 16-20 μm ; W. 24-28 μm); adaxial (Ht. 28-32 μm ; W. 40-44 μm), see *C. flavidus*; keel and marginal strands (Ht. 20-28 μm ; W. 56-60 μm) pulviniform. Vb's 23 in number not showing any regular alternation. Metaxylem vessel members (D. 12-24 μm). Other details as in *C. flavidus*.

CULM. Epidermis, surface view: Cells elongated, narrow, thick-walled, pitted, smooth with straight end walls. Stomata (L. 48-56 μm ; W. 24-28 μm), narrowly oblong, thick-walled; subsidiary cells parallel-sided; interstomatal cells long with concave ends. Silica-cells not seen.

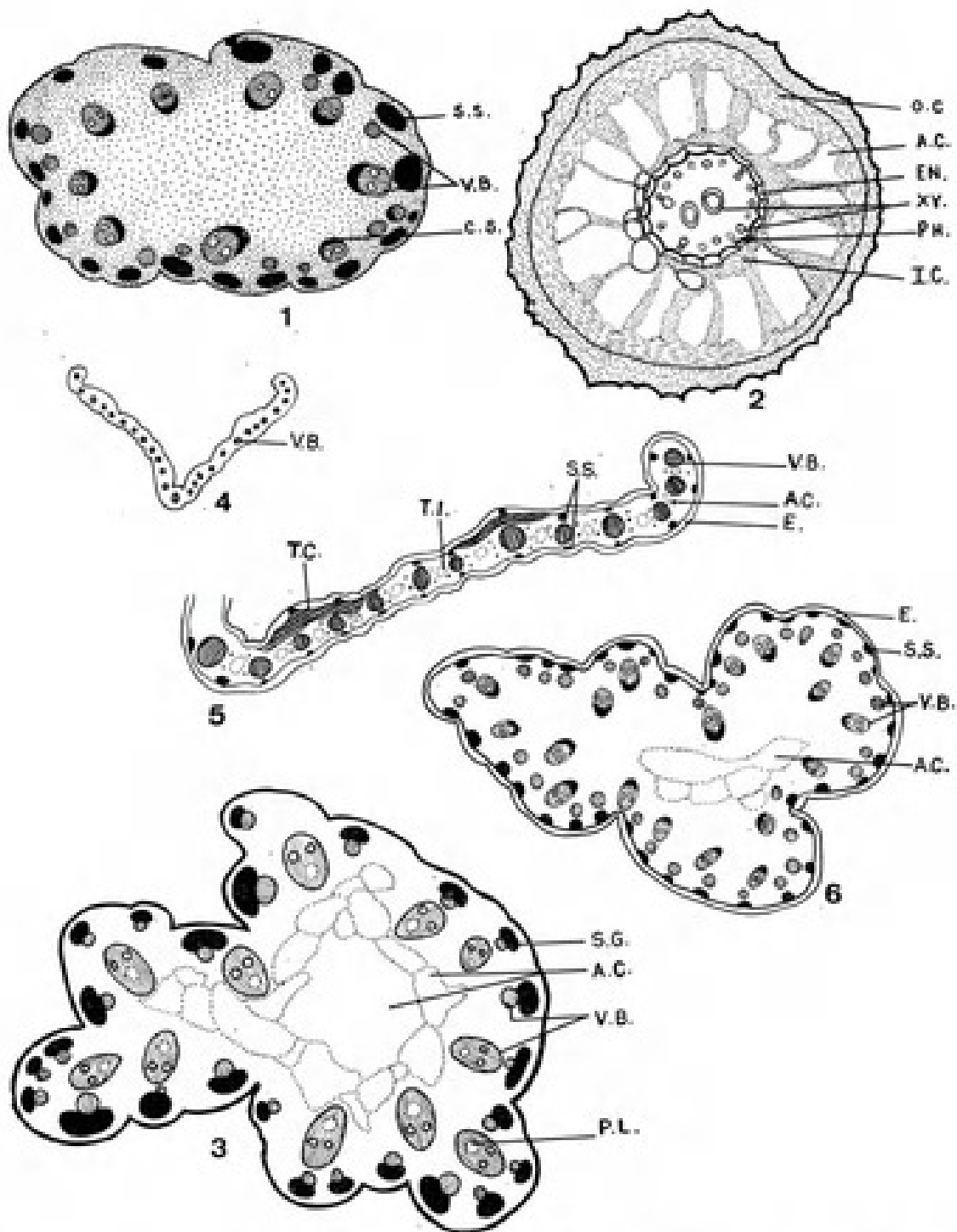
Transverse section (Pl. 5, 3): Outline subcircular. Cuticle very thick and of uniform thickness. Epidermal cells isodiametric, thick-walled. Substomatal chamber narrow and small. Hypodermis of 4-6 layers of chlorenchyma. Ground tissue parenchymatous. Air-cavities absent. Sclerenchyma strands (Ht. 40-64 μm ; W. 80-100 (-140) μm) pulviniform. Vb's 40 in number, comprising 9 large (type III B) and 31 small vb's (type I); the former forming a regular inner ring and the latter an outer ring; large vb's containing protoxylem lacunæ. Metaxylem vessel members (D. 16-20 μm). Metaphloem of "regular type". Bundle sheaths double, complete; I.S. fibrous, O.S. parenchymatous. Circumvascular sclerenchyma of large vb's deeply crescentiform, forming an inner cap with angular outlines. Tannin idioblasts common in the hypodermis.

ROOT. Transverse section: Diameter of the root examined c. 0.6 mm. Metaxylem vessel members (D. 36 μm). Other details as in *C. macrostachyos*.

MATERIAL EXAMINED: Govindarajulu 5979, Chalakudi, Kerala State; 6038, Anakayam, Poringalkuthu, Kerala state; 6116, Athirapalli, Anakayam, Kerala state.

***Cyperus sulcinus* C. B. Clarke (= *Pycneus sulcinus* (C. B. Cl.) C. B. Cl.).**

LEAF. Abaxial surface: Intercostal cells axially elongated, narrow, thick-walled, pitted, smooth with straight end walls. Stomata (L. 40-44 μm ; W. 28-32 μm) elliptical, thick-walled; subsidiary cells low dome-



Pl. 7. — Transverse section of leaf, culm and root, ground plan: 1, *Cyperus stricticulmis* Govind., T. S. culm, $\times 50$; 2, *C. decumbens* Govind., T. S. root, $\times 100$; 3, *C. sanguinolentus* var. *micronux* (C. B. Cl.) Kük., T. S. culm, $\times 15$; 4, *C. sanguinolentus* ssp. *cyrtostachys* (Miq.) Kern, T. S. lamina, in full, diagrammatic; 5, *id.*, T. S. lamina, in part, $\times 40$; 6, *id.*, T. S. culm, $\times 40$.

shaped; interstomatal cells long with concave ends. Silica-cells moderately long, narrow, thin-walled, smooth, occurring in 1-2 discontinuous files; silica-bodies 3-5 per cell, surrounded by satellites. Prickles (L. 120-140 μm) rigid, pointed, thick-walled, pointing upwards, present on the margin.

Adaxial surface: Cells elongated, broad, moderately thick-walled, smooth, hexagonal with straight end walls. Silica-cells, see abaxial surface.

Lamina, transverse section (Pl. 1, 6): Outline V-shaped, symmetrical. Cuticle thick on both surfaces. Guard cells uniformly thickened; substomatal chamber narrow and small. Bulliform cells 10 in number, forming a regular fan-shaped group. Keel rounded; margins subacute. Hypodermis of a single layer of large translucent cells. Assimilatory tissue of radiating chlorenchyma. Air-cavities as many as and regularly alternating with vb's; air-cavities containing stellate parenchyma. Sclerenchyma strands: submarginal adaxial and keel (Ht. 40-60 μm ; W. 80-120 μm) pulviniform; adaxial submarginal and abaxial (Ht. 28-40 μm ; W. 24-32 μm) trapezoid. Vb's 38 in number comprising large (type III A) and small vb's (type I), arranged in a single row; large vb's containing protoxylem lacunae; metaxylem vessel members (D. 20 μm). Metaphloem belonging to "regular type". Bundle sheaths single, complete, fibrous. Tannin idioblasts common.

CULM. Epidermis, surface view: Cells elongated, narrow, thick-walled, smooth with straight end walls. Stomata (L. 40 μm ; W. 24-28 μm), elliptical, thick-walled; subsidiary cells tall dome-shaped; interstomatal cells long with concave ends. Silica-cells not seen.

Transverse section (Pl. 4, 2): Outline obtusely triangular with lateral grooves. Cuticle thick. Epidermal cells isodiametric, thick-walled. Guard cells with outer ledges; substomatal chamber narrow and small. Ground tissue parenchymatous; cells large, compactly arranged; centre lysigenously becoming hollow. Sclerenchymatous strands (Ht. 60-80 μm ; W. 100-120 μm) pulviniform. Vb's many, comprising large (type III B) and small vb's (type I); small vb's forming an outer ring while large ones an inner ring; large vb's containing protoxylem lacunae. Metaxylem vessel members (D. 32-36 μm). Metaphloem belonging to "regular type". Bundle sheaths double, complete; O.S. parenchymatous, I.S. fibrous. Circumvascular sclerenchyma crescentiform, forming an inner cap in all large vb's. Tannin idioblasts common.

ROOT. Transverse section: Diameter of the root examined c. 0.4 mm. Exodermis consisting of 3 layers of thin-walled, hexagonal cells. Cortex: outer lacunose containing concentrically arranged air-cavities separated by

radiating rows of parenchyma cells: inner cortex of 6-8 layers of sclerenchyma. Endodermis prominent; cells radially elongated with uniform thickening throughout and narrow elongated lumina. Pericycle of single-layered sclerenchyma. Central ground tissue sclerenchymatous. Metaxylem units 12, perimedullary with as many protoxylem units. Metaxylem vessel members (D. 36-40 μm). Metaphloem occurring in 12 units, each unit characterized by 3 large sieve tube elements and 3-4 companion cells.

MATERIAL EXAMINED: *Govindarajulu 11541*, Kodhaiyar upper dam, Tirunelveli dist.

***Cyperus unioloides* R. Br. (= *Pycneus unioloides* (R. Br.) Nees).**

LEAF. *Abaxial surface*: Intercostal cells moderately elongated, narrow, thin-walled, somewhat sinuous with straight end walls. Stomata (L. 44-48 μm ; W. 28 μm) elliptical, thin-walled; subsidiary cells low dome-shaped; interstomatal cells short with concave ends. Silica-cells long, narrow, thin-walled, smooth, occurring in a single continuous file, each one of them characterized by (2) 3 silica-bodies with satellites.

Adaxial surface: Cells broad, short, hexagonal, thin-walled, smooth with straight end walls. Silica-cells, see abaxial surface.

Lamina, transverse section (Pl. 1, 1, 2): Outline flatly V-shaped, symmetrical. Cuticle relatively thin. Keel not prominent; margins obtuse. Epidermal cells thin-walled. Hypodermis of a single layer of abruptly enlarged translucent cells present adaxially. Bulliform cells 5 in number occurring in a regular fan-shaped group. Assimilatory tissue of radiating chlorenchyma. Air-cavities absent. Guard cells with outer ledges; substomatal chamber narrow and small. Sclerenchyma strands characteristically uniform throughout (Ht. 8-12 μm ; W. 12-16 μm), rectangular or trapezoid. Vb's 33 in number, all alike in size and shape and disposed in a single row; all belonging to type I except keel vb's (type III A). Metaxylem vessel members (D. 16 μm). Metaphloem belonging to "regular type". Bundle sheaths double, complete; O.S. fibrous, I.S. parenchymatous, cells of which containing tannin. Tannin idioblasts common.

CULM. *Epidermis, surface view*: Cells short, narrow, moderately thick-walled, smooth with straight end walls. Stomata (L. 48-52 μm ; W. 24-28 μm) narrowly oblong, thin-walled; subsidiary cells parallel-sided; interstomatal cells short with concave ends. Silica-cells elongated, rather broad, thin-walled, smooth, occurring in a single discontinuous row, each cell containing (3) 4-5 silica-bodies surrounded by satellites.

Transverse section (Pl. 3, 5): Outline ovate. Cuticle thick. Epidermal cells isodiametric, thin-walled. Hypodermis of 4-6 layers of chlorenchyma. Assimilatory tissue comprising radiating chlorenchyma. Sub-

stomatal chamber narrow and small. Air-cavities in the periphery absent. Ground tissue parenchymatous; centre hollow. Sclerenchyma strands (Ht. 20-60 μm ; W. 60-80 (-120) μm) pulviniform. Vb's many comprising large (type III B) and small vb's (type I), the latter forming a ring in the periphery and the former forming more or less an inner ring. Protoxylem lacunæ present in large vb's. Metaxylem vessel members (D. 16 μm). Metaphloem of "regular type". Bundle sheaths double, complete; of small vb's, see leaf; of large vb's, I.S. fibrous, O.S. parenchymatous. Circumvascular sclerenchyma of large vb's crescentiform forming an inner cap. Tannin idioblasts common in the hypodermis.

ROOT. *Transverse section*: Diameter of the root examined c. 0.8 mm. Metaxylem vessel members (D. 36-40 μm). Protoxylem units 7 alternating with as many metaphloem units. Other details as in *C. macrostachyos*.

MATERIAL EXAMINED: *Rajasekaran 55*, Avalanche, Nilgiris dist.

KEY BASED ON CHARACTERS VISIBLE IN T.S. AND SURFACE VIEW OF LEAF

Subsidiary cells low dome-shaped.

Hypodermis of translucent cells present.

Silica-bodies surrounded by satellites.

Abaxial sclerenchyma strands pulviniform and hexagonal; air cavities absent *C. atrogulosus*

Abaxial sclerenchyma strands pentangular; air-cavities with lobed parenchyma present *C. latevaginatus*

Abaxial sclerenchyma strands trapezoid; air-cavities with stellate parenchyma present *C. sulcinax*

Abaxial sclerenchyma strands rectangular and trapezoid; air-cavities absent *C. unioides*

Silica-bodies not surrounded by satellites.

Vb's 20 in number, belonging to types III A & I .. *C. luridus*

Vb's 24 in number, belonging to types III A & I .. *C. plumbeonuceus*

Vb's 25 in number, belonging to types III B & I .. *C. stricticulis*

Hypodermis of translucent cells absent.

Air-cavities with stellate parenchyma present.

Vb's 130; large vb's belonging to type III A *C. macrostachyos*

Vb's 23; large vb's belonging to type III B *C. pumilus*

Air-cavities absent.

Vb's 17; bundle sheath single, parenchymatous *C. decumbens*

Vb's 35; bundle sheath single, fibrous *C. polystachyos*

Subsidiary cells parallel-sided.

Hypodermis of translucent cells present.

Air-cavities with stellate parenchyma present; bulliform cells 15 in number *C. globosus*

Air-cavities absent.

Vb's 19 in number; bulliform cells not distinct *C. plurinodosus*

Vb's 23 in number; bulliform cells 15 in number ... *C. substramineus*

Vb's 39 in number; bulliform cells 5 in number *C. sanguinolentus* ssp. *sanguinolentus*

Vb's 43 in number; bulliform cells 7 in number *C. sanguinolentus* ssp. *cyrtostachys*

Hypodermis of translucent cells absent.

Bulliform cells 5 in number; silica-bodies without satellites; large Vb's belonging to type III B	<i>C. latespicatus</i>
Bulliform cells 8 in number; silica bodies with satellites; large Vb's belonging to type III A	<i>C. puncticulatus</i>

NOTE: *C. sanguinolentus* var. *micronux* not included in the key for want of leaf material.

CONCLUSION

Considerable number of anatomical characters pertaining to both leaves and culms of *Cyperus* subgen. *Pycneus* have been blocked out in the present work out of which those of the former portray more variation when compared with those of the latter. Based on the anatomical characters of the leaves a key is presented. The anatomical picture on the whole further confirms the taxonomic treatment of KÜKENTHAL, the embryographical conclusions of VAN DER VEKEN and the opinion of METCALFE in that the taxon *Pycneus* can be considered only as a subgenus of *Cyperus*.

KEY TO FIGURE LETTERING AND TEXT ABBREVIATIONS

AB.E., abaxial epidermis	O.C., outer cortex
A.C., air-cavity	O.S., outer bundle sheath
AD.E., adaxial epidermis	PH., metaphloem
B.C., bulliform cells	P.L., protoxylem lacuna
c., circa	R.C., radiating chlorenchyma
CH., chlorenchyma	S.B., silica-body
C.S., circumvascular sclerenchyma	S.C., subsidiary cell
CU., cuticle	S.G., sclerenchyma girder
D., diameter	S.S., sclerenchyma strand
E., epidermis	ST.C., substomatal chamber
EN., endodermis	T.C., translucent cell
G.C., guard cell	T.I., tannin idioblast
Ht., height	V.B., Vb., vascular bundle (plural Vb's)
I.C., inner cortex	W., width
I.S., inner bundle sheath	XY., metaxylem
L., length	

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