

MORPHOLOGICAL STUDIES IN APOCYNACEAE: EPIDERMAL STRUCTURES*

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ABSTRACT

The present paper describes the epidermal structures of 20 genera and 27 species of the family Apocynaceae. Many kinds of trichomes have been observed in this family. More than five types of trichomes have been recorded in *Rauwolfia tetraphylla*. Leaflets are generally hypostomatic except in *Tabernaemontana divaricata*, *Plumeria rubra*, *Catharanthus roseus* and *Atslonia macrophylla* where they are amphistomatic. Stomata are mostly paracytic (rubiaceous) rarely anomocytic (ranunculaceous), though both types occur in 8 species. Abnormalities like complete degeneration of guard cells and stomata with one guard cell or with three unequal subsidiary cells also occur. Giant stoma occurs in many species. Domatia of variable shape and size occur in *Ichnocarpus frutescens*, *Strophanthus wightianus*, *Trachelospermum lucidum*, *Cerbera odollam* and *Vallaris* sp. Attempts have been made to classify different tribes and genera of this family on the basis of epidermal characters.

INTRODUCTION

Recent studies on cuticles have brought to light their usefulness in the identification and classification of taxa. STACE (1961, 1965), PANT (1965) and AHMAD (1964) have studied cuticles both extensively and intensively.

The family Apocynaceae has hardly been tackled previously for its cuticular characters. KAPOOR *et al.* (1969) and CHANDRA *et al.* (1969), however, described the cuticles of this family though in a perfunctory manner. In this paper important cuticular characters of this family have been described; these appear to be of sufficient diagnostic value.

MATERIAL AND METHODS

Plants used in the present investigation were collected by the authors from the garden of the Botany Department and also from the herbarium of the Department. Methods used for obtaining cuticles are the same as suggested by STACE (1965). Terminology used here is the same as suggested by VAN COTTHEM (1970) and FRYNS-CLAESSENS AND VAN COTTHEM (1973).

DESCRIPTION

Important cuticular characters of some members of the family Apocynaceae are described below:

EPIDERMAL CELLS (Text-figs. 1-6 & 11).

Epidermal cells vary in shape and size from species to species. They are pentagonal to polygonal and in some species irregular in shape. The cells of the lower and upper foliar surface within the same species or on the same leaf may vary in shape (Table 1). In most

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of the species studied, the cells have straight walls while a few species show sinuous walls. Marginal cells are mostly elongated in the direction of the length of the leaf. In plants like *Ichnocarpus frutescens*, *Cerbera odollam*, *Wrightia tinctoria* and *Holarrhena antidysenterica* marginal cells are comparatively smaller than the cells of other parts of the leaf (Text-fig. 11).

STOMATA

Stomata are generally restricted to the lower foliar surface but in species like *Tabernaemontana divaricata*, *Plumeria rubra*, *Catharanthus roseus* and *Alstonia macrophylla* stomata occur on upper surface as well. They are mostly paracytic, rarely anomocytic (Text-figs. 1-6). Both anomocytic and paracytic type of stomata occur in *Alstonia macrophylla*, *Alstonia scholaris*, *Trachelospermum lucidum*, *Cerbera odollam*, *Carissa carandas*, *Thevetia peruviana*, *Holarrhena antidysenterica* and *Catharanthus roseus*. Frequency of stomata ranges from 14 to 132/mm²; size of stomata is constant for the individual plant and the species but varies from one species to another. Anisocytic stomata have been reported in *Rauwolfia serpentina* and *Catharanthus roseus* (Text-fig. 1) by us (TRIVEDI & UPADHYAY, 1976).

TRICHOMES (Text-figs. 12-17)

Morphology of trichomes is very interesting. In this family various type of trichomes occur in single species (TRIVEDI & UPADHYAY, 1973). Trichomes occur more frequently on the lower surface of the leaf in the intervenous regions than on the upper. In some species trichomes are common to both the surfaces but in some species they are totally absent from both surfaces. Different types of trichomes which occur in this family are listed below:

1. Papillate (Text-fig. 12).
2. Simple unicellular (Text-figs. 13-14).
3. Uniseriate multicellular (Text-fig. 15).
4. Branched multicellular (Text-fig. 17).
5. Glandular with multicellular head (Text-fig. 16).

Trichomes bases are mostly hexagonal (Text-fig. 18), rarely they may be rounded (Text-fig. 19). Glandular hairs also occur in this family.

ABNORMAL STOMATA (Text-figs. 7 and 9)

Rarely abnormal stomata with a single guard cell and a subsidiary cell occur in *Allamanda cathartica*, *Plumeria rubra* and *Rauwolfia serpentina* (Text-fig. 7). Stomata with three unequal subsidiary cells have sometimes been observed in *Allamanda cathartica* and *Rauwolfia serpentina* (Text-fig. 9). Abnormally large stomata (giant stomata) occur frequently in *Alstonia macrophylla*, *Ichnocarpus frutescens*, *Tabernaemontana divaricata*, *Trachelospermum lucidum*, *Strophanthus wightianus*, *Rauwolfia serpentina*, *R. tetraphylla*, *Plumeria alba* and *Vocanga foetida* (Text-fig. 8).

DOMATIA (Text-fig. 10)

In some genera, cavities (domatia) also occur. Presence of cavities in this family is regarded as an important feature. Domatia of variable shape and size occur in different species. They appear to be characteristic for each taxon.

CUTICULAR STRIATIONS

Cuticular striations occur rarely. Some genera, however, possess cuticular striations which may arise either from the guard cells or from the bases of trichomes. (Text-figs.

Table 1—Epidermal characters of some members of Apocynaceae

Name of Plant	Type	Stomata		Shape and wall of epidermal cells			Trichomes		Other features of cuticle including abnormalities	
		No./mm ²		Size in μ	Stomatal index	Lower	Upper	Lower		Upper
		Lower	Upper							
<i>Astonia macrophylla</i> Wall. ex DC.	Pa .. An.	76	+	19×13	42	Hexagonal straight	Hexagonal straight	Unicellular—some times septate	..	Giant stomata common
<i>A. schubleri</i> R. Br.	Pa .. An.	110	—	10×7	90	Hexagonal straight	Hexagonal straight	..	..	Epidermal cells highly striated
<i>Allamanda cathartica</i> Linn.	Pa ..	48	—	20×10	42	Cells with irregular outline, straight wall	Cells with irregular outline, sinuous wall	Unicellular and small	..	One guard cells and three subsidiary cells stoma common
<i>Chonemorpha macrophylla</i> G. Don.	Pa ..	51	—	13×5	26	Irregular and straight.	Hexagonal to polygonal and straight.	Unicellular on marginal side of leaf	..	..
<i>Agavea caryophyllata</i> G. Don.	Pa ..	24	—	30×7	13	Irregular cells straight wall	Irregular with straight wall	Rare short unicellular	..	Striated giant stomata common
<i>Ichneucarpus futescens</i> (L.) R. Br.	Pa ..	57	—	16.5×7	36	Irregular and striated cells	Irregular striated cells	Unicellular large	Unicellular large	Domatia present; striated stoma & giant stomata common
<i>Tabernaemontana divaricata</i> (L.) R. Br.	An	32	+	23×7	33	Various type of cell with sinuous wall	Hexagonal with sinuous wall	..	..	Giant stomata; sinuous wall
<i>Trachelospermum lucidum</i> (G. Don) K. Sch.	Pa .. An	45	—	17×7	28	Hexagonal and straight	Hexagonal and straight	Unicellular and branched	Scanty and small	Domatia and giant stomata common
<i>Strophanthus wrightianus</i> Wall.	Pa ..	47	—	26×7	52	Irregular with sinuous wall	Irregular and sinuous	..	..	Domatia and giant stomata common
<i>S. divaricata</i> Wall.	Pa ..	37	—	24×10	23	Irregular cells with sinuous wall	Irregular cells with straight wall	..	..	Domatia common
<i>S. andrichii</i> (S. dehtolona) A. DC.	Pa ..	31	—	18×6	21	Irregular cells with sinuous wall	Irregular cells with sinuous wall	..	..	—
<i>Caribea adblam</i> Gaertn.	Pa .. An	52	—	30×7	31	Irregular with straight wall	Irregular and straight	..	..	—
<i>Ranunculus serpentina</i> Benthes Kurz	Pa .. Anis.	14	—	13×7	12	Hexagonal and straight	Hexagonal and straight	Unicellular, long sepiate and branched	Small papillae like	Giant stoma common, stoma with one guard cells and three subsidiary cells also common
<i>R. tetraphylla</i> L.	Pa ..	15	—	17×8	14	Hexagonal and straight	Hexagonal and straight	Unicellular, branched or glandular	Small unicellular ..	Giant stomata common
<i>Cassia curandis</i> L.	Pa .. An.	132	—	17×10	90	Various type of cells and straight	Various type of cells and straight	Various type of cells and straight	..	Stomata closely packed
<i>Thevetia peruviana</i> (Pers.) Schum.	Pa .. An	25	—	17×8	12	Irregular with straight wall	Irregular with straight wall	..	..	..
<i>Hrightia tinctoria</i> R. Br.	Pa ..	44	—	16×7	61	Irregular and sinuous	Irregular and sinuous	Unicellular long ..	Unicellular small ..	..
<i>W. (a) waltava</i> R. & S.	Pa ..	34	—	20×12	28	Hexagonal with sinuous wall	Hexagonal with sinuous wall	Simple unicellular	..	..

Table 1—(continued)

Name of Plant	Type	Stomat		Size Sto- mal index	Shape and wall of epidermal cells			Trichomes		Others features of cuticle including abnormalities	
		No./mm ²			Lower	Upper	Lower	Upper	Lower		Upper
		Lower	Upper								
<i>W. coccinea</i> Summ.	Pa ..	32	—	24 × 15	Hexagonal and sinuate	Hexagonal cells straight	Unicellular simple	..	..	..
<i>Masceharia angustifolia</i> Britt. and Renole	Pa ..	28	—	23 × 10	Sinuate cells	Sinuate cells	..	..	..	Striations radiating from stomata
<i>Plumeria rubra</i> L. acuminate (Sant. and Irani ex Shah)	Pa ..	26	+	23 × 8	Penta-hexagonal and straight	Penta-hexagonal straight	Unicellular simple	..	..	One grand cell stomata striations from base of trichome and radiating from stomata
<i>P. alba</i> L. ..	Pa ..	29	—	38 × 16	Hexagonal and straight	Hexagonal and straight	Unicellular long	..	..	Giant stomata common
<i>Holarthra antidysenterica</i> Wall ex Dc.	Pa ..	30	—	20 × 9	Hexagonal and straight	Hexagonal and slightly sinuate	Unicellular long	..	..	Striations throughout the epidermal cells
<i>Calharanthus roseus</i> (L.) G. Don	Pa .. An Anis.	37	+	20 × 7	Irregular sinuous	Irregular sinuous	..	..	..	Striations arising from guard cells are common
<i>Brauntonia grandiflora</i> Wall.	Pa ..	67	—	13 × 8	Hexagonal and straight	Hexagonal straight.	Unicellular long	..	..	Scanty small papillae like
<i>Vallis solanacea</i> (V. heymt) (Rath O. Ktze.	Pa ..	65	—	14 × 8	Various type of cells with sinuous walls	Various type of cells with sinuous walls	..	..	..	Domatia common
<i>Vasanga foetida</i> Kollt	Pa ..	39	—	18 × 10	Hexagonal and slightly sinuous	Hexagonal and slightly sinuous wall	Unicellular long	..	..	Giant stomata common

An—Anomocytic; Pa—Paracytic; Anis—Anisocytic; —Absent; + Present.

6, 8 & 13) and may occur in any ordinary epidermal cell on the upper or lower foliar surface (Table 1).

DISCUSSION

Floral characters, pollen grains and wood anatomy have been pressed into service for classifying plants. Investigations of cuticular characters of taxa have received attention only recently. These studies have brought interesting results and have given support to taxonomy. In the light of investigations made, it can now be assessed whether epidermal morphology supports subdivision of Apocynaceae into different tribes as suggested by BENTHAM AND HOOKER (1876).

They divide the family Apocynaceae as follows:

Tribe 1. Carisseae	..	..	<i>Carissa, Allamanda</i>
Tribe 2. Plumerieae			
Subtribe I.	..	..	Rauwolfieae— <i>Rauwolfia</i>
Subtribe II.	..	..	Cerbereae— <i>Cerbera, Thevetia</i>
Subtribe III.	..	..	Euplumerieae— <i>Plumeria, Catharanthus, Alstonia, Holarrhena</i>
Subtribe IV.		..	Tabernaemontaneae— <i>Tabernaemontana, Voacanga</i>
Tribe 3. Echitideae			
Subtribe I.	..	..	Parsonsieae— <i>Vallaris, Wrightia</i>
Subtribe II.	..	..	Nerieae— <i>Strophanthus</i>
Subtribe III.	..	..	Ichnocarpeae— <i>Ichnocarpus</i>
Subtribe IV.	..	..	Euechitideae— <i>Beaumontia, Chonemorpha, Aganosma, Trachelospermum, Marscarenhasia</i>

The tribes as delimited by BENTHAM AND HOOKER on floral characters are characterised by distinct cuticular patterns. Each tribe possesses its own distinctive characters as can be seen below:

Tribe 1. Carisseae—Epidermal cells are variable in shape, stomata are small and closely packed. In this tribe both stomatal frequency (132/mm²) and stomatal index (90) are high.

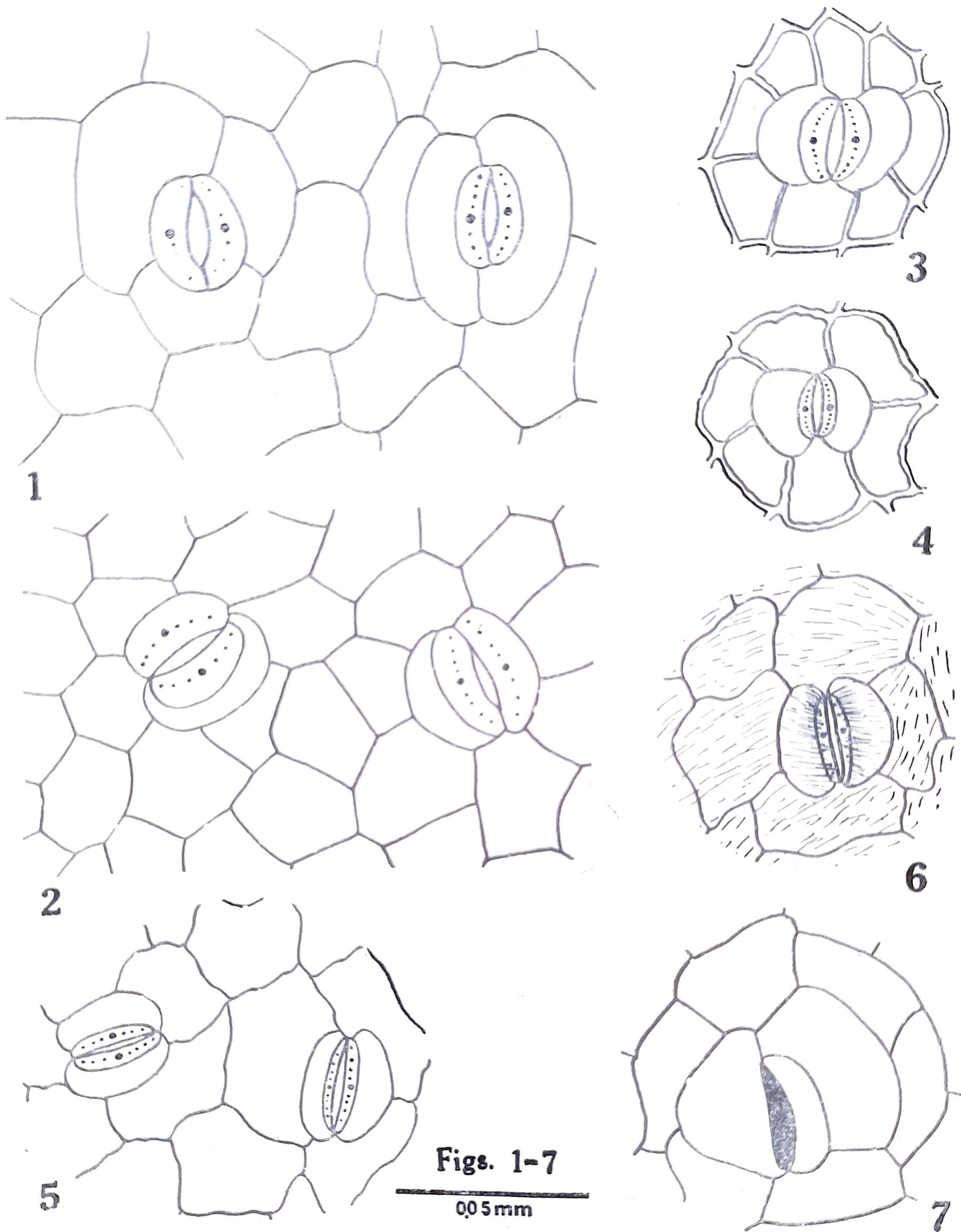
Tribe 2. Plumerieae (Text-figs. 1, 4-5)—Epidermal cells are generally variable in shape with straight or rarely sinuous walls, stomatal frequency (29 mm²) and stomatal index (23) are generally low.

Subtribe I. Rauwolfieae (Text-figs. 12, 16, 17)—Epidermal cells are hexagonal with straight walls, stomatal frequency (14/mm²) and stomatal index (12) both are low. Trichomes are more frequent and are of various type (Table 1).

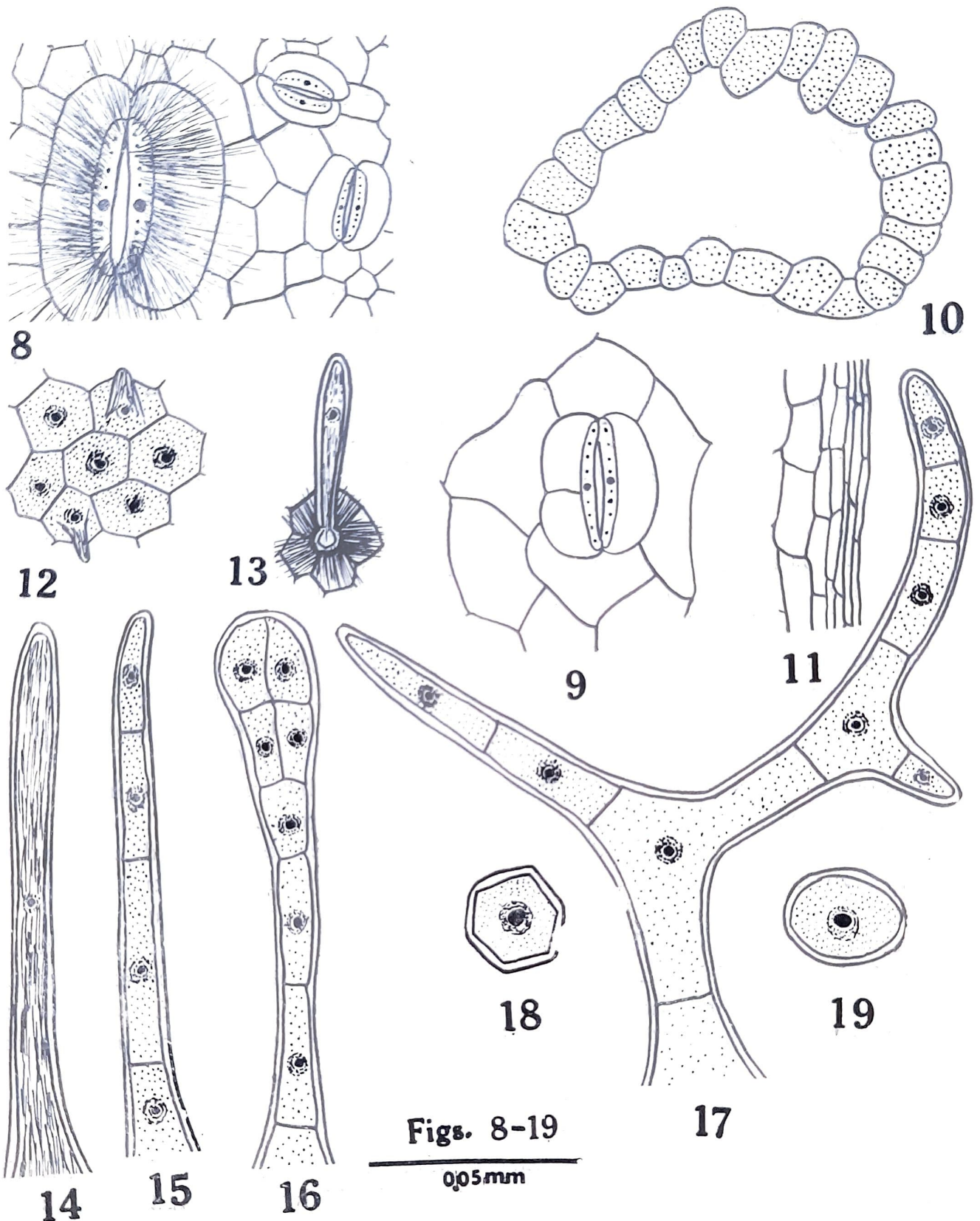
Subtribe II. Cerbereae (Text-fig. 5)—Epidermal cells are irregular, generally two types of stomata occur (Table 1). Trichomes are absent.

Subtribe III. Euplumerieae (Text-fig. 4)—Epidermal cells are variable with straight walls. Trichomes are long or short, unicellular; cuticular striations are common in all the epidermal cells but occur frequently at the base of trichomes and in association with stoma. This is a constant feature of this subtribe.

Subtribe IV. Tabernaemontaneae—Epidermal cells are variable with sinuous walls, stomata are present on both the surfaces of leaf and are almost equally distributed. Giant stomata are present.



Text-figs. 1—7: 1. Paracytic and anisocytic stomata (*Catharanthus roseus*), 2. Anomocytic stomata and *Alstonia macrophylla* respectively, 3 & 4. Straight and sinuous epidermal walls of *Strophanthus wightianus* and *Alstonia macrophylla* respectively, 5. Slightly sinuate epidermal walls and stomata of *Cerbera odollam*, 6. Striated stoma and epidermal cells of *Ichnocarpus frutescens*, 7. Stoma with single guard cell and a subsidiary cell (*R. serpentina*).



Text-figs. 8-19 : 8. Striated giant stoma and epidermal cell (*Vocanga foetida*), 9. Domatia of *Ichnocarpus frutescens*, 10. Stomata with three subsidiary cells (*R. serpentina*), 11. Marginal cells of *Ichnocarpus frutescens*, 12. Papillate trichome (*R. tetraphylla*), 13-14. Unicellular trichomes (*Alstonia macrophylla*), 15. Uniseriate multicellular trichome (*R. tetraphylla*), 16. Glandular trichome (*R. tetraphylla*), 17. Branched and septate trichome (*R. tetraphylla*), 18. Hexagonal trichome base (*Rauwolfia serpentina*), 19. Rounded trichome base (*R. serpentina*).

- Tribe 3. Echitideae—Epidermal cells are irregular, mostly with sinuous walls, rarely with straight walls. Trichomes are generally absent.
- Subtribe I. Parsonieae—Epidermal cells are sinuate, trichomes are long, unicellular. Trichomes are absent in *vallaris* but characteristic domatia are present.
- Subtribe II. Nerieae (Text-fig. 3)—Epidermal cells are irregular with highly sinuous walls. Trichomes are completely absent.
- Subtribe III. Ichnocarpeae (Text-figs. 6,7)—Epidermal cells are irregular, cuticular striations are present on the epidermal cells. Domatia are of common occurrence. Striated stomata and giant stomata are very frequent.
- Subtribe IV. Euechitideae—Epidermal cells always straight walled and are variable. Trichomes long, rarely short are characteristic of this subtribe.

Epidermal features of 27 species belonging to 20 genera of Apocynaceae have been investigated. It has been observed from the above studies that the genera of the family Apocynaceae show consistency in broad epidermal characters. However, a range of variation is discernable in different species of a genus.

The investigated species of the family show medium-sized stomata, epidermal cells with high hypostomatic frequency, unicellular or uniseriate hairs and paracytic or anomocytic type of stomata. Cuticular characters of all the 27 species are summarised in Table 1.

Leaves are hypostomatic in all the genera studied except in *Alstonia*, *Tabernaemontana*, *Plumeria* and *Catharanthus* where they are amphistomatic. In *Alstonia*, *Trachelospermum*, *Cerbera*, *Carissa*, *Thevetia*, *Holarrhena* and *Catharanthus* both anomocytic and paracytic type of stomata are found but the latter type predominate.

METCALFE AND CHALK (1950) describe five types of trichomes from this family. All these have been shown to occur in *Rauwolfia serpentina*. Glandular trichomes are absent from all the genera studied by us but occur exceptionally in *Rauwolfia tetraphylla*. Glandular trichomes have been listed in 15 families by METCALFE AND CHALK. The occurrence of glandular trichomes in the family Apocynaceae is recorded for the first time.

Stomatal abnormalities like the presence of a single guard cell (Text-fig. 7), three unequal subsidiary cells (Text-fig. 9) and giant stomata have been observed in many genera. Domatia (cavities) also occur in some genera. The occurrence of cuticular striations in a few species is also an interesting feature and is of some diagnostic value.

It has been noted during the course of this study that the minor epidermal characters may slightly be affected by environmental conditions but the more permanent ones like the structure and size of epidermal cells, the size and structure of stoma and trichomes remain unaffected and are constant. Cuticular characters, therefore, appear to be sufficiently resistant to change; consequently they are of diagnostic value.

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