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THE PHYSIOLOGICAL ANATOMY OF THE
PLANTS OF THE INDIAN DESERT

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(Continued from Vol. I, p. 287.)

COMPOSITAE

Vernonia cinerascens *Schult.*—Figs. 163, 164, 165, 166. Woody. Mesophyll isobilateral. Stomata depressed. Clothing hairs two-armed. Glandular hairs consisting of a spherical head and of a stalk-cell or of a short stalk. Collenchyma not developed in cortex. Wood composite. Medullary rays 1-3 seriate. Pith formed of lignified cells.

Pegolettia senegalensis *Cass.*—Figs. 167, 168, 169, 170. Herbaceous. Mesophyll composed of arm-palisade cells. Clothing hairs absent. Glandular hairs depressed, biseriate and spherical. Stomata elevated or depressed. Bundles of acicular crystals found near veins, in cortex and in pith. Collenchyma not developed in cortex. Wood composite. Medullary rays uniseriate. Endodermis formed of thin-walled cells. Pith consisting of thin-walled cells.

Pulicaria angustifolia *DC*—Figs. 171, 172. Herbaceous. Stomata elevated. Mesophyll consisting of arm-palisade cells. Clothing hairs in the form of flagellum trichomes. Glandular hairs depressed, biseriate and spherical. Collenchyma sub-epidermal. Wood composite and deeply lobed on the inner side. Pith formed of thin-walled cells.

Pulicaria rajputanae *Blatt. and Hall.*—Figs. 173, 174, 175, 176, 177. Woody. Stomata depressed. Mesophyll isobilateral. Secretory

cells found in mesophyll. Clothing hairs in the form of flagellum trichomes. Glandular hairs biseriata and club-shaped. Collenchyma composite and sub-epidermal in the axis. Wood composite. Medullary rays 1-3 seriate. Medullary xylem bundles present. Pith formed of cells with thickened and lignified walls. Some of the pith cells holding dark granular contents and also rounded bodies.

Eclipta erecta L. Figs.—178, 179. Very herbaceous. Stomata depressed. Mesophyll composed of arm-palisade cells. Clothing hairs absent. Glandular hairs depressed, biseriata and spherical. Collenchyma sub-epidermal in the axis. Wood composite and deeply lobed on the inner side. Pith formed of thin-walled cells.

Echinops echinatus R.—Figs. 180, 181, 182. Very herbaceous. Stomata elevated. Mesophyll formed of palisade tissue on the adaxial side and of arm-palisade tissue on the abaxial side. Clothing hairs in the form of flagellum trichomes. Glandular hairs long-stalked and with an irregularly divided spherical head. Collenchyma sub-epidermal in the axis. Endodermis formed of large thin-walled cells. Wood composed of large xylem bundles alternating with small ones. Pith consisting of thin-walled cells.

Volutarella divaricata Bth.—Fig. 183. Very herbaceous. Stomata elevated. Mesophyll isobilateral. Clothing hairs absent. Glandular hairs long-stalked and with a head irregularly divided. Collenchyma sub-epidermal in the axis. Wood more or less composite. Pith formed of thin-walled cells.

Dicoma tomentosa Cass.—Figs. 184, 185, 186, 187, 188, 189. Herbaceous. Stomata depressed. Mesophyll composed of palisade tissue on the upper side and of arm-palisade tissue on the lower. Clothing hairs in the form of uniseriate flagellum trichomes. Glandular hairs depressed, uniseriate and spherical. Collenchyma strengthening the ribs of the axis. Wood not composite. Pith consisting of thin-walled cells.

Launaea chondrilloides H. f.—Figs. 190. Herbaceous. Stomata depressed on the leaf but elevated on the axis. Mesophyll formed of arm-palisade cells. Clothing and glandular hairs absent. Collenchyma not developed in cortex. Wood not composite. Assimilatory tissue in the axis formed of palisade tissue. Pith formed of thin-walled cells.

Structure of the Leaf:—The epidermal cells are alike on both the sides and have the outer walls greatly thickened and convexly arched outwards. The lateral walls are thin and undulated; inner walls are usually thickened. The cells at the margin are rounded and have outer walls toothed in *D. tomentosa* and papillose in other members.

The epidermal cells of the mid-rib are much smaller than those on the other portions of the leaf-blade. The stomata are usually equally distributed on both the surfaces. Guard-cells are elevated in *Pegolettia senegalensis* (fig. 167), *Pulicaria angustifolia*, *E. echinatus* and *V. divaricata*, so that the front cavity is on a level with the surface. The guard-cells are situated in the plane of the surrounding cells in other members, so that the front cavity is placed in a depression formed by the outer thickened epidermal walls (figs. 174, 184, 190). In *Pegolettia senegalensis* elevated stomata occur side by side with depressed ones (fig. 167).

The mesophyll in *D. tomentosa* and *E. echinatus*, is composed of palisade tissue on the adaxial side and of arm-palisade tissue on the abaxial side; it is isobilateral in *V. cinerascens*, *P. rajputanae* and *V. divaricata*. In other members it consists of arm-palisade cells with horizontally elongated cells in the middle.

The veins are embedded except those of the mid-rib which are vertically transcurrent above and below by collenchyma. In *V. cinerascens* there are a few stone-cells on the upper side of the veins. The veins of the mid-rib are quite prominent beneath and are strengthened on the lower side by arcs of stone-cells.

Internal secretory organs are not found except in *P. rajputanae* in which secretory cavities occur one on either side of the veins of the mid-rib, with a lining layer of cells and with yellowish contents. Oxalate of lime occurs in *P. senegalensis*, in the form of bundle of acicular crystals near the veins, in cortex and in pith.

Hairy covering on the leaf and axis consists of clothing and glandular hairs. Clothing hairs, termed "flagellum-hairs" consist of a uniseriate stalk and of a flagellum-like terminal cell in *P. angustifolia*, *P. rajputanae*, *E. echinatus* and *D. tomentosa*; in *E. echinatus* the long terminal cell is bent on the stalk as on a hinge. In *V. cinerascens* (fig. 164) there are two-armed hairs, consisting of a uniseriate stalk and of a terminal unicellular two-armed cell; the arms are unequal. The glandular hairs are of various shape. They are placed in epidermal depressions and consist of a short uniseriate stalk and of a large biseriate head in *P. senegalensis* (fig. 167), *P. angustifolia*, (fig. 172) and *H. erecta*. The external glands, in *E. echinatus* (fig. 181) and *V. divaricata*, consist of a long uniseriate stalk and of a head irregularly divided; besides these there are in *E. echinatus* (fig. 179) spherical glands which are uniseriate, depressed and with thickened and verrucose walls. They are club-shaped in *P. rajputanae* (fig. 176) and are long-stalked, uniseriate and with the terminal cell much dilated to form the head in *V. cinerascens* (fig. 165, 166). Uniseriate, spherical and depressed glandular hairs are found in *V. cinerascens*

(fig. 163) and *D. tomentosa* (fig. 186); secretion collects below the cuticle which is swollen like a bladder. Besides the biseriate spherical glands, there are other glandular hairs on the axis of *P. senegalensis*, which are composed of a long, broad, biseriate stalk and of a small biseriate head (fig. 170): there are also peculiar hairs with a long multicellular stalk and with a small biseriate head, occurring in groups on the lower side of the mid-rib of the leaves (fig. 169). External glands are more numerous on the lower surface of the bifacial leaves; they check transpiration by pouring their secretion on the surface. The greater abundance of stomata on the lower surface brings about the development of a dense covering of clothing and glandular hairs on the lower surface.

Structure of the Axis.—The epidermis is one layered, the outer and inner walls being equally thickened. The former are convexly arched outwards. Lateral walls are thin and undulated. Guard-cells are elevated and the front cavity is on a level with the surface in *P. angustifolia*, *E. echinatus*, *D. tomentosa* (fig. 188) and *L. chondrilloides*; in other members guard-cells are situated in the same plane as that of the surrounding cells and the front cavity is situated in a depression produced by outer thickened epidermal walls. The elevated position of the stomata is necessitated by the abundance of thin-walled cortical parenchyma.

The primary cortex is characterised by the assimilatory tissue formed either of palisade tissue as in *L. chondrilloides* or of chlorenchyma as in other members. Collenchyma is developed in the ribs of *E. echinatus*, *V. divaricata* and *D. tomentosa*, while in *P. rajputanae* (Fig. 189 Cl) there occurs a continuous sub-epidermal ring of collenchyma. Endodermis is differentiated in *P. senegalensis*, *E. echinatus* and *D. tomentosa* (fig. 189), and it consists of thin-walled tabular cells with perhaps a water-storing function.

The pericycle consists of a more or less composite ring of groups of stone-cells with small lumina in all members except in *E. echinatus*, where it is formed of stone-cell groups separated by bast fibres (fig. 182). The arrangement of stone-cell groups in *D. tomentosa* is isobilateral, larger groups being developed on the side exposed to the direction of the prevailing winds.

PLANTS OF THE INDIAN DESERT.

Name of Species.	Structure of Wood.	VESSELS.			MEDULLARY RAYS.		INTERFASCICULAR WOOD PROSENCYMA.		General remarks.
		Abundance.	Size of Vessels.	Arrangement of vessels.	Size.	Abundance.	Lumen.	Abundance.	
<i>V. cinerascens.</i>	Composite	Few	Large	Rows	1-3 seriate	Numerous	Small	Extensive	Woody
<i>V. senegalensis.</i>	"	Numerous	Small	In groups of many rows	Uniseriate	"	"	"	Woody
<i>P. angustifolia.</i>	Composite and deeply lobed on the inner side	"	Large	"	Absent	"	"	"	Wood narrowed on the lower side of the inclined axis
<i>P. rajputanae.</i>	"	"	"	"	1-3 seriate	Numerous	Large	"	Occurrence of medullary vascular bundles between larger bundles
<i>E. erecta.</i>	Composite	"	Small	"	Absent	Absent	Small	"	Bundles connected by thick-walled small-celled pith
<i>E. echinatus.</i>	Composed of larger bundles alternating with smaller bundles. Larger bundles projecting deeply into pith	"	Large	"	"	"	Absent	"	
<i>E. divaricata.</i>	Composite	"	"	"	"	"	"	"	Quite herbaceous
<i>E. tomentosa.</i>	Composed of large and small bundles	"	Large in large bundles and small in small bundles	"	"	"	Large	Not extensive	"
<i>L. chondrilloides.</i>	Composed of bundles	"	Large	In groups of two rows	"	"	"	Absent	

The wood is composed of xylem bundles or forms a composite hollow cylinder, as will be seen from the tabular form. Vessels have simple perforations. The interfascicular wood prosenchyma is well developed only in *V. cinerascens* (fig. 165), *P. senegalensis* and *P. rajputanae* (fig. 173); medullary rays are found only in these members. Other members are more or less herbaceous and the structure of wood does not follow any definite lines of development, as it is found to vary in the same species.

The wood parenchyma is little developed and occurs on the inner side of the xylem bundles. The pith consists of thin-walled cells in all members except *V. cinerascens* and *P. rajputanae* where it is formed of cells with thick and lignified walls. Some of the pith cells of *P. rajputanae* contain black granular contents (fig. 173 G).

Anomalous structures are represented by small medullary xylem bundles close to the inner side of the wood cylinder of *P. rajputanae* (fig. 173 C).

SALVADORACEAE.

Salvadora persica L.—Figs. 191, 192, 193. Epidermis of the leaf locally two-layered. Larger veins with arcs of stone-cells on the lower side. Vascular ring more or less dumb-bell shaped. Vessels in the narrowed portion very small. Soft bast forming a continuous ring and following the outline of the wood cylinder.

Salvadora oleoides Dcne.—Figs. 194, 195, 196. Epidermis of the leaf uniformly two-layered. Vains with sclerenchyma on their upper and lower side. Short unicellular hairs found on branches. Wood forming a hollow cylinder of uniform breadth. Medullary rays continuous with cortical parenchyma. Soft bast forming groups.

Structure of the Leaf.—The epidermis in *S. persica* (fig. 191) is locally two-layered. The epidermal cells are tabular with outer walls thickened. The inner and lateral walls are also a little thickened and the former are convexly arched inwards. The epidermis in *S. oleoides* (fig. 194) is uniformly two-layered on both sides. The outer layer is formed of small tabular cells with the outer and lateral walls thickened; the inner layer consists of large thin-walled tabular cells with the inner walls convexly arched inwards, so as to come into close contact with the assimilatory tissue. There are a few large thick-walled ovoid epidermal cells found below the epidermis on both sides in either species; these cells probably have a water-storing function.

The stomata are associated with subsidiary cells and occur abundantly on both the surfaces. The guard-cells are situated in the plane of surrounding cells. The front cavity is usually situated in the de-

pression formed by the outer thickened epidermal walls (fig. 195); it may occasionally be found lying in a level with the surface (fig. 192).

The mesophyll (figs. 191, 194) is composed of short-celled palisade tissue on either side with an extensive tissue of vertically elongated large, thin-walled colourless cells in the middle. This middle tissue probably forms an aqueous tissue in both the species.

The veins are embedded and are enclosed in green bundle-sheaths. All the veins in *S. oleoides* have thin arcs of sclerenchyma on the upper and lower side, while only the larger veins in *S. persica* are protected on their lower side by arcs of stone-cells. There are numerous large groups of water-storage tracheids with pitted markings, occurring at intervals between the veins of both the species.

Internal secretory organs and oxalate of lime are not found.

Hairy covering is absent on the leaves of both the species. Short thick-walled unicellular clothing hairs are found on the axis of *S. oleoides* (fig. 196).

Structure of the Axis.— Epidermis consists of polygonal cells with outer walls greatly thickened and convexly arched outwards. Inner walls are thin. The stomata are like those on the leaf. Besides stomata, lenticels are found in *S. persica*. The primary cortex is composed on its outer side of chlorenchyma and on the inner side of tissue of thin-walled colourless cells probably aqueous.

The pericycle is formed of radially elongated large groups of stone-cells separated by cortical aqueous cells. The pericycle presents a dumb-bell shaped appearance corresponding with that of the wood cylinder.

The structure of the wood is characterised by islands of soft bast (figs. 193, 196). The wood cylinder is of uniform breadth in *S. oleoides*, while in *S. persica* it is much narrowed on opposite sides in one plane, thus giving a dumb-bell shaped appearance to the whole structure. Vessels are large and have rounded lumina, except those in the narrowed portion of the wood cylinder in *S. persica*, where the vessels are very small. Medullary rays are 3-5 seriate; and in *S. oleoides* they are continuous with cortical parenchyma between the stone-cell groups of the pericycle (fig. 196). Wood parenchyma is pretty abundantly developed on the inner side of the wood cylinder and in the neighbourhood of the islands of soft bast.

Soft bast in *S. oleoides* forms a continuous ring and follows the dumb-bell shaped outline of the wood-cylinder; in *S. persica* soft bast occurs in groups on the outer side of the xylem bundles.

The pith is composed of thin-walled cells and is characterised by numerous sieve-sclereids (fig. 193 SV).

ASCLEPIADACEAE.

Glossonema varians *Benth.*—Leaves fleshy. Epidermal cells with outer walls thickened. Guard-cells elevated. Mesophyll formed of palisade tissue on the adaxial side and of arm-palisade on the abaxial side. Cortical parenchyma extensive and formed of thin-walled colourless cells. Pericycle composed of rhomboidal groups of bast fibres with large lumina. Medullary rays uniseriate. Pith consisting of thin-walled cells with brownish contents.

Calotropis procera *Br.*—Figs. 197, 198 (*Leaf only*). Leaves fleshy. Epidermal cells with outer walls greatly thickened. Cuticle very thick. Guard-cells on the adaxial side situated quite below the plane of epidermal cells; those on the abaxial side elevated. Mesophyll consisting of extensive palisade tissue on the upper side and of extensive loose arm palisade tissue on the lower. Clothing hairs in the form of very short uniseriate trichomes.

Pentatropis cynanchoides *Br.*—Leaves fleshy. Epidermal cells with outer walls thickened. Guard-cells elevated. Mesophyll wholly of arm-palisade tissue. Epidermis of the axis two-layered. Oxalate of lime in the form of clustered crystals in cortex and soft bast. Internal secretory cells with tanniferous contents found in cortex and pith. Pericycle formed of long thin groups of stone-cells. Medullary rays uniseriate. Pith consisting of thin-walled cells.

Sarcostemma brevistigma *Wt.*—Fig. 199. Leafless. Epidermal cells longer than broad. Guard-cells quite below the plane of epidermal cells. Cortical parenchyma extensive and aqueous. Pericycle formed of rhomboidal groups of stone-cells. Medullary rays uniseriate. Pith consisting of thin-walled cells with granular contents.

Leptadenia spartium *Wt.*—Fig. 200. Almost leafless. Stomata in depressions formed by thickened outer epidermal walls. Mesophyll isobilateral. Clothing hairs in the form uniseriate trichomes with verrucose walls. Epidermis of the axis three-layered. Internal secretory cells with tanniferous contents. Pericycle of rhomboidal groups of stone-cells. Vessels large on the outer side and small on the inner side. Medullary rays 1-2 seriate. Pith consisting of thin-walled cells.

Structure of the Leaf.—The epidermis is composed of small polygonal cells in all members except in *C. procera* and *P. cynanchoides* where the epidermal cells are tabular. The outer walls are thickened and convexly arched outwards. The cuticle in *C. procera* is considerably thickened (fig. 197). In *C. procera* and *L. spartium* it is superficially granulated. The epidermal cells are alike on both the surfaces except in *G. varians* and *P. cynanchoides*, where the epidermal cells on the upper side are much larger than those on the lower.

The lateral walls are thin and undulated. The inner walls are thin in all members except in *G. varians*, where they are a little thickened.

The stomata are placed in depressions produced by the thickened outer epidermal walls in *L. spartium*. In *G. varians*, *C. procera* on the lower surface and *P. cynanchoides* the guard-cells are elevated and the front cavity is situated on a level with the surface. The stomata on the upper side in *C. procera* are placed in chimney-like depressions and the guard-cells are situated quite below the plane of the epidermal cells (fig. 197). Guard-cells are accompanied by subsidiary cells in all the members. The elevated position of the guard-cells is due to the fleshy character of the leaves. The depressed position of stomata in *L. spartium* and of those on the upper side in *C. procera* may be due to the poorly developed ventilating system and to the occurrence of compact palisade tissue on the upper side respectively.

The mesophyll is isobilateral in *L. spartium*, while in *P. cynanchoides* it consists wholly of arm-palisade tissue. It is composed of palisade tissue on the upper side and of arm-palisade tissue on the lower in *G. varians* and *C. procera*. In fleshy leaves the arm-palisade tissue is richly provided with a system of intercellular spaces. Chlorophyll grains are spherical and fairly large and are found along the walls of assimilatory cells.

Internal secretory organs are represented by secretory cells with tanniferous contents near the veins in *P. cynanchoides*. The veins are few, embedded and are not provided with bundle-sheaths.

The plants are entirely or almost leafless, or have fleshy leaves. This makes the development of a hairy covering quite unnecessary, except on young leaves and axes. Clothing hairs, present on young leaves and axes, may disappear, when they are fully developed. Short uniseriate trichomes, with verrucose walls and with a large terminal cell, occur though not in great number on both the surfaces of leaves of *G. varians* and *L. spartium*. *C. procera* has short, uniseriate, depressed trichomes which are more numerous on the lower surface (fig. 198).

Structure of the Axis.—The epidermis consists of small polygonal cells with outer walls thickened and convexly arched outwards. It is two-layered in *P. cynanchoides* and is three-layered in *L. spartium* (fig. 200). The epidermal cells in *S. brevistigma* are longer than broad, thus making the epidermis quite compact and rigid. The stomata are situated in depressions produced by thickened outer epidermal walls. The guard-cells are in the plane of the surrounding cells in all members except *S. brevistigma* where they occur quite below the plane of surrounding cells, this producing a chimney-like pit above. The depressed position of guard-cells is necessary in the

axis of *S. brevistigma*, in which cortical parenchyma forms an extensive aqueous tissue.

The primary cortex is characterised by an assimilatory tissue which is formed of parenchyma except in *L. spartium* where it consists of a 4-6 cell thick arm-palisade tissue. The cortical parenchyma in *S. brevistigma* is composed of an extensive tissue of thin-walled, elongated colourless cells with probably a water-storage function and is strengthened by small scattered groups of stone-cells (fig. 199).

Secretory cells with tanniniferous contents occur in the cortex, in the broad medullary rays and in the pith of *L. spartium* (fig. 200 G.) They are also found in the cortex of *G. varians* and in the cortex, soft bast and pith of *P. cynanchoides*. Numerous clustered crystals of oxalate of lime occur in the cortex and soft bast of *P. cynanchoides*. The pericycle is composed of closely placed groups of stone-cells, except in *G. varians* in which it consists of groups of bast fibres with large lumina.

The groups of stone-cells are rhomboidal in *P. spartium* and *S. brevistigma*; they are thin and long in *P. cynanchoides*. Bast fibre groups in *G. varians* are rhomboidal.

Structure of wood can best be understood from the following tabular form.

Name of Species.	VESSELS.			INTERFASCICULAR WOOD FIBRES (TRACHEIDS).		MEDULLARY RAYS.		General Remarks.
	Abundance.	Size.	Arrangement.	Abundance.	Size.	Abundance.	Size.	
<i>G. varians</i>	Few	Large	In rows in the inner portion.	Not extensive.	Large lumina.	Few	1-3 seriate.	Wood modified by the direction of the wind. Broader in the plane affected by wind.
<i>T. sphaeroides</i>	"	"	"	"	Small lumina.	"	"	Vessels large and few in the outer portion, small and numerous in the inner portion.
<i>S. brevialignis</i>	Numerous	Small.	In complete rows.	"	"	Numerous.	"	Vessels in complete rows.
<i>L. speciosus</i>	Few	Large.	In rows in the inner portion.	"	"	Few	1-3 seriate.	As in <i>G. varians</i> .

The peculiar isobilateral structure of the wood of *G. varians* is due to the fact that portions of the axis with greater development of wood represent the plane affected by the prevailing wind and possessing greater functional activity; the two opposite sides of the axis with poorly developed wood represent the plane less affected by the prevailing wind and have no necessity of developing an extensive water-conducting or strengthening tissue. The plane with well developed wood represents the direction of the prevailing wind. The wood parenchyma is not extensive and is found on the inner side of the wood ring.

The soft bast is very extensive in *P. cynanchoides*.

The pith consists of thin-walled cells. Some of the pith cells of *S. brevistigma* contain spherical granular bodies.

General Review.—The epidermal cells have the outer walls greatly thickened. The guard-cells are situated in the same plane or quite below the plane of the surrounding cells. The stomata are accompanied by subsidiary cells. The ventilating system is fairly extensive. Secretory cells with tanniniferous contents are found in some members. Oxalate of lime is found in the form of small, clustered crystals in *P. cynanchoides*. Hairs, when present occur in the form of short uniseriate trichomes. Cortical parenchyma is extensive. The pericycle is either composed of groups of stone-cells or of bast fibres. The wood forms a composite hollow cylinder. Perforations of the vessels are simple. The wood prosenchyma is composed of cells with thick walls and with small lumina. The medullary rays are 1—3 seriate. Pith consists of thin-walled cells.

GENTIANACEAE

Enicostemma litorale Bl.—Fig. 201. Epidermal cells with outer walls very greatly thickened and with inner walls convexly arched inwards. Lateral walls thin and undulated. Stomata on both the surfaces elevated. Mesophyll wholly of chlorenchyma. Internal glands absent. Oxalate of lime in the form of star-like clusters of acicular crystals. Leaves many-ribbed. Veins of ribs vertically transcurrent. Vascular bundles in leaf and axis bicollateral. Axis irregularly ribbed. Scleranchymatous pericycle absent. Cortex formed of chlorenchyma. Wood composite with an outer and inner ring of soft bast. Vessels in numerous complete rows. Medullary rays uniseriate. Pith of thin-walled cells.

Structure of the Leaf.—The epidermis consists of polygonal cells with outer walls very greatly thickened (fig. 201). The lateral walls are thin and undulated. The inner walls are thin. The cuticle is

striated. The epidermal cells at the margin have outer walls convexly arched outwards and have both the inner and outer walls thickened. The margins are strengthened by a few collenchymatous cells. The stomata occur abundantly on both the surfaces and are surrounded by ordinary epidermal cells. The guard-cells are elevated and the front cavity is on a level with the surface. The mesophyll is formed of a homogeneous tissue of horizontally elongated polygonal assimilatory cells. Internal secretory organs are found neither in the leaf nor in the axis.

The leaves are many-ribbed and the veins of the ribs are vertically transcurrent above and below by collenchyma. The smaller veins are embedded. The vascular bundles of the veins are bicollateral.

Clothing as well as glandular hairs do not occur on the leaf and axis.

Structure of the Axis.—The axis is irregularly ribbed, some of the ribs being wing-like. The ribs are strengthened by collenchyma. The epidermis consists of tabular cells with both outer and inner walls thickened. The cuticle is striated. The cortex is composed of chlorenchyma which extends to the ribs.

A sclerenchymatous pericycle is not developed. The wood is composite and is broader below the ribs. The vessels are small and are arranged almost in complete rows. Interfascicular wood prosenchyma is little developed. The medullary rays are uniseriate and numerous. The vascular bundles are bicollateral and have two continuous rings of soft bast—one on the outer and another on the inner side of the wood cylinder. The pith is composed of thin-walled cells.

Oxalate of lime occurs in the form of star-like clusters of acicular crystals in cortical parenchyma and pith.

(To be continued.)

Plate XIX

- 163-166. *Vernonia cinerascens*.
 163. Glandular hair on the leaf.
 Oc. 6 Com.; Ob. 3 mm. Ap.
 164. Hair on the leaf.
 Oc. 6 Com.; Ob. 8 mm. Ap.
 165. T. S. of the axis.
 Oc. 6 Com.; Ob. 8 mm. Ap.
 166. Glandular hair on the leaf.
 Oc. 6 Com.; Ob. 3 mm. Ap.
- 167-170. *Pegolettia senegalensis*.
 167. T. S. of the leaf showing stomata and a glandular hair.
 Oc. 4 Com.; Ob. 3 mm. Ap.
 168. T. S. of the leaf showing the epidermis.
 Oc. 4 Com.; Ob. 3 mm. Ap.
 169. T. S. of the leaf showing the lower portion of the mid-rib bearing glandular hair.
 Oc. 4 Com.; Ob. 8 mm. Ap.
170. Glandular hair on the axis.
 Oc. 4 Com.; Ob. 3 mm. Ap.
- 171-172. *Fulicaria angustifolia*.
 171. T. S. of the leaf showing the epidermis.
 Oc. 4 Com.; Ob. 3 mm. Ap.
 172. Glandular hair on the leaf.
 Oc. 4 Com.; Ob. 3 mm. Ap.
- 173-177. *Fulicaria rajputanae*.
 173. T. S. of the axis.
 Oc. 6 Com.; Ob. 8 mm. Ap.
 175. Hair on the leaf.
 Oc. 6 Com.; Ob. 8 mm. Ap.
 176. Glandular hair on the leaf.
 Oc. 4 Com.; Ob. 3 mm. Ap.
 177. Stomata in surface view.
 Oc. 4 Com.; Ob. 3 mm. Ap.
180. *Echinops echinatus*.
 Hair on the axis.
 Oc. 4 Com.; Ob. 3 mm. Ap.

N.B.—To get the original dimensions multiply by 1·7.



Plate XX

174. *Pulicaria rajputanae*.
T. S. of the leaf.
Oc. 6 Com.; Ob. 8 mm. Ap.
- 178-179. *Eclipta erecta*.
178. T. S. of the axis showing
epidermis and collenchy-
ma.
Oc. 4 Com.; Ob. 3 mm. Ap.
179. Glandular hair on the
leaf.
Oc. 4 Com.; Ob. 3 mm. Ap.
- 181-182. *Echinops echinatus*.
181. Glandular hairs on the
leaf.
Oc. 4 Com.; Ob. 3 mm. Ap.
182. T. S. of the axis.
Oc. 2 Com.; Ob. 8 mm. Ap.
183. *Volutarella divaricata*.
T. S. of the axis.
Oc. 2 Com.; Ob. 8 mm. Ap.
- 184-189. *Dicoma tomentosa*.
184. T. S. of the leaf showing
the upper epidermis and
stomata.
Oc. 6 Com.; Ob. 3 mm. Ap.
185. T. S. of the leaf showing
the lower epidermis.
Oc. 6 Com.; Ob. 3 mm. Ap.
186. T. S. of the leaf showing
the lower epidermis and
hairs.
Oc. 6 Com.; Ob. 8 mm. Ap.
187. T. S. of the leaf near the
axilla.
Oc. 4 Com.; Ob. 8 mm. Ap.
188. Stomata on the axis.
Oc. 6 Com.; Ob. 3 mm. Ap.
189. T. S. of the axis.
Oc. 6 Com.; Ob. 8 mm. Ap.
190. *Launaea chondrilloides*.
Stoma on the leaf.
Oc. 6 Com.; Ob. 3 mm. Ap.

N.B.—To get the original dimensions multiply by 1·7.



T. S. Sabnis del.

PLATE XX.

Plate XXI

- 191-193. *Salvadora persica*.
 191. T. S. of the leaf.
 Oc. 4 Com.; Ob. 8mm. Ap.
 192. Stoma on the leaf.
 Oc. 6 Com.; Ob. 3 mm. Ap.
 193. T. S. of the axis.
 Oc. 4 Com.; Ob. 8 mm. Ap.
- 194-196. *Salvadora oleoides*.
 194. T. S. of the leaf.
 Oc. 4 Com.; Ob. 8 mm. Ap.
 195. Stoma on the leaf.
 Oc. 4 Com.; Ob. 3 mm. Ap.
 196. T. S. of the axis.
 Oc. 4 Com.; Ob. 8 mm. Ap.
- 197-198. *Calotropis procera*.
 197. T. S. of the leaf.
 Oc. 4 Com.; Ob. 8 mm. Ap.
 198. Hair on the leaf.
 Oc. 6 Com.; Ob. 3 mm. Ap.
199. *Sarcostemma brevistigma*.
 T. S. of the axis.
 Oc. 2 Com.; Ob. 3 mm. Ap.
200. *Leptadenia spartium*.
 T. S. of the axis.
 Oc. 6 Com.; Ob. 8 mm. Ap.
201. *Enicostemma litorale*.
 T. S. of the leaf showing the
 epidermis.
 Oc. 6 Com.; Ob. 8 mm. Ap.

N.B.—To get the original dimensions multiply by 1.7.



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PLATE XXI.



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