

Uncaria gambier Roxb., the structure of its leaves and young shoots*

MUN SUM LEONG AND BETTY P. JACKSON

The morphological and histological characters of the leaves and young shoots of *Uncaria gambier*, which are used in the preparation of catechu, are fully described and illustrated.

SEVERAL attempts have been made in the past to establish the origin of the vegetable material found in catechu. Gilson (1893) has suggested that the hairs found in the drug are the same as those occurring on the surface of the sepals and petals of *Uncaria gambier*, the plant from which the extract is prepared. Brumwell (1911) has examined microscopically the leafy fragments found in catechu and after comparing them with the surface characters of the leaves of *Uncaria gambier* and of some allied plants, concluded that they were derived exclusively from *Uncaria gambier*. In the same paper Brumwell also reported the presence of large numbers of hairs in the water-insoluble residue of catechu but did not comment upon their origin. In addition, later authors (Trease, 1960; Wallis, 1960) have reported that the vegetable fragments found in catechu are part of *Uncaria gambier*, and this fact has also been stated in the official monographs of the more recent editions of the British Pharmaceutical Codex (1954, 1959, 1963).

The plant *Uncaria gambier*, family Rubiaceae, was first described by Roxburgh (1832), and an account of its gross morphology is included in some of the standard botanical works (Baillon, 1891 (under *Ourouparia*); Bentley & Trimen, 1880). There is, however, practically no information available concerning the histological structure of the plant. Consequently, although earlier work has indicated that the vegetable fragments commonly found in catechu are derived exclusively from *Uncaria gambier*, it has not been possible to identify them and to relate their structure to that of the plant itself. In view of this, it was decided to carry out a full anatomical investigation of the leaves and young shoots of *Uncaria gambier* in order that the origin of the vegetable fragments occurring in catechu could be elucidated; at the same time, it was hoped that this would provide a standard for the material used in the preparation of the drug.

Materials

Two specimens of *Uncaria gambier* were used in this investigation, namely:

(1) Dried specimens of leaves and immature fruits, labelled "*Uncaria gambier*, Paris Exhibition, 1878", and obtained in 1960 from the Herbarium of the Pharmaceutical Society of Great Britain.

From the Department of Pharmacognosy, School of Pharmacy, Sunderland, Technical College.

* The subject-matter of this communication forms part of a thesis by one of us (M.S.L.) accepted by the University of London for the degree of Master of Pharmacy.

(2) Aerial parts, including flowers and fruits, preserved in ethanol containing 5% formalin, also fresh specimens of leaves, stems and hooks, all collected in 1962 from plants growing in a Gambier plantation in Johore. The fresh material had been collected and sent by air without any preliminary treatment. On arrival it was in a slightly moist condition, and it was allowed to dry at room temperature.

The two samples of material were authenticated by comparison with Herbarium specimens of *Uncaria gambier* at the Royal Botanic Gardens, Kew.

Macroscopical and Histological Characters

(i) Leaves

MACROSCOPICAL CHARACTERS

Fully grown leaves are lanceolate to ovate, averaging about 6 to 11 cm in length and about 4.5 to 6 cm in greatest breadth, somewhat thick and coriaceous; margin entire, apex acuminate and bluntly pointed; base asymmetric; midrib and lateral veins prominent on the lower surface; lateral veins, 4 to 6 on each side, each forming an angle of about 50° with the midrib and anastomosing about 1 to 2 mm from the margin. In the angles between the midrib and the lateral veins, on the lower surface only, there are small, dense patches of long, brownish hairs; other, smaller, hairs occur scattered over the midrib on both surfaces and over the lateral veins on the lower surface (see Fig. 1, A and B). Petiole, 0.6 to 2 cm long and often longitudinally furrowed.

HISTOLOGICAL CHARACTERS

Lamina. The upper epidermis consists of tetragonal to hexagonal tabular cells measuring about H 22 to 25 μ and Lev L and B 18 to 32 μ^* ; the outer periclinal walls thickened and covered by a cuticle having marked striations; stomata and covering trichomes absent (Fig. 1, D). The palisade consists of a single layer of cylindrical cells measuring about H 34 to 70 μ and Lev L and B 14 to 18 μ and containing numerous chloroplasts. Beneath the palisade there is a layer of subrectangular or sometimes triangular collecting cells measuring about H 21 to 36 μ and Lev L and B 10 to 18 μ ; the remaining spongy mesophyll consists of 2 to 4 layers of round or elliptical, branched, loosely-packed cells with numerous, large air spaces, individual cells measuring about H 14 to 43 μ and Lev L and B 14 to 54 μ . Present throughout the mesophyll, and particularly abundant in regions near the veins, are rounded idioblasts each containing a well-defined cluster crystal of calcium oxalate measuring about 16 μ in diameter (Fig. 2, C).

* Cell measurements are recorded by symbols suggested by Moll and Janssonius (1923). For describing organs showing bilateral symmetry, i.e., leaf, stipule, sepal and petal, the symbols H, Lev L and Lev B are used. The symbol H = height, in a direction perpendicular to the surface of the organ; Lev = in the direction of the surface of the organ; Lev L and Lev B = parallel to the surface and at the same time in a longitudinal direction or transverse direction respectively. For describing the stem and hook the symbols R, T and L indicate the measurements made in the radial, transverse and longitudinal directions respectively.

UNCARIA GAMBIER ROXB.

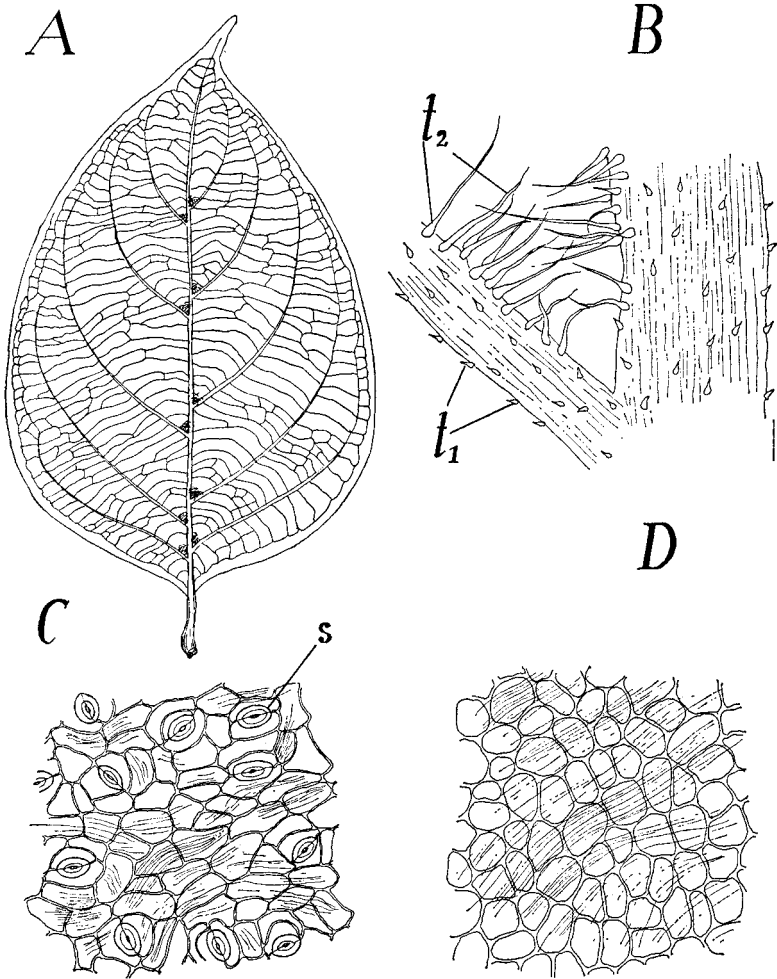


FIG. 1. Leaf of *Uncaria gambier* Roxb. A, entire leaf, $\times \frac{1}{2}$; B, diagram of part of the lower surface showing the distribution of the covering trichomes on the midrib and lateral veins, $\times 30$; t_1 , short, conical trichomes; t_2 , long covering trichomes; C, lower epidermis; D, upper epidermis; s, stoma; C and D, $\times 220$.

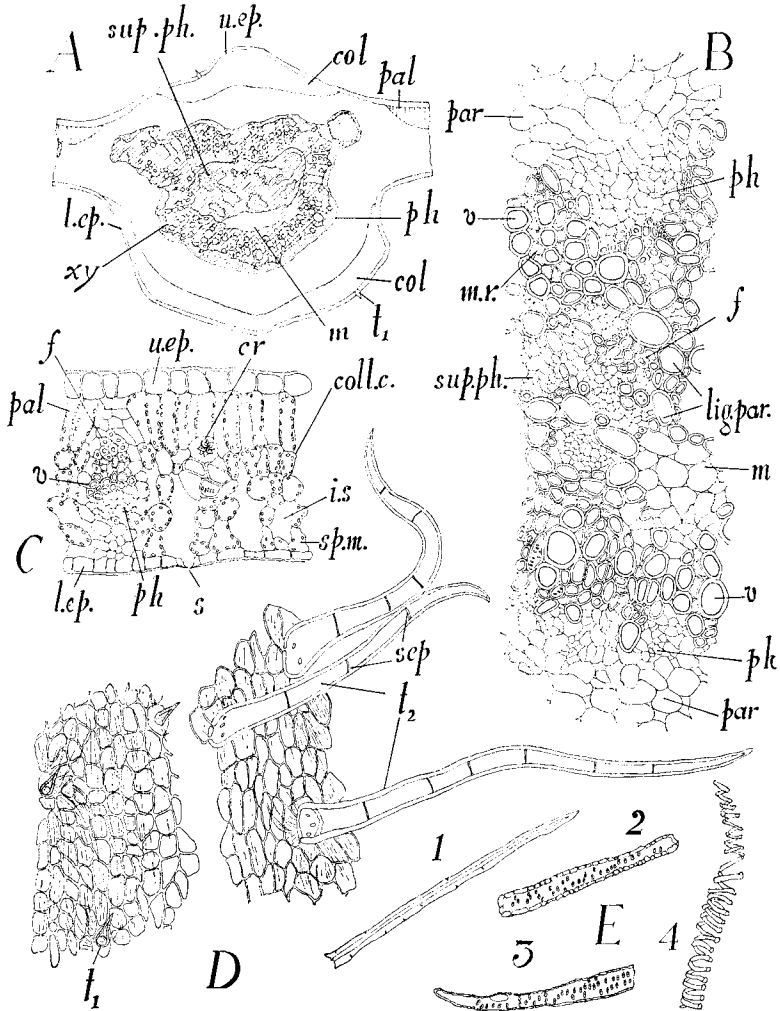


FIG. 2. Leaf of *Uncaria gambier* Roxb. *A*, diagram of a transverse section of the midrib, $\times 30$; *B*, details of a transverse section of the meristele; *C*, transverse section of the lamina; *D*, two regions of the lower epidermis of the midrib in surface view showing two different types of trichomes; *E*, isolated elements from the midrib; *B*, *C*, *D* and *E*, $\times 160$; *col*, collenchyma; *coll.c.*, collecting cells; *cr*, crystals of calcium oxalate; *f*, fibres; *i.s.*, intercellular space; *l.ep.*, lower epidermis; *lig.par.*, lignified parenchyma; *m*, medulla; *m.r.*, medullary rays; *pal*, palisade; *par*, parenchyma; *ph*, phloem; *s*, stoma; *sep*, septa; *sp.m.*, spongy mesophyll; *sup.ph.*, supernumerary phloem; *t₁*, short conical covering trichome; *t₂*, long covering trichomes; *u.ep.*, upper epidermis; *v*, vessels; *xy*, xylem; *1*, fibre; *2*, lignified parenchyma; *3*, tracheidal vessel; *4*, spiral vessel fragment.

The lower epidermis has a finely striated cuticle and consists of tabular cells measuring H 11 to 14 μ and Lev L and B 11 to 32 μ with straight or slightly sinuous anticlinal walls. Paracytic stomata are very numerous except over the lateral veins, where they are absent; they are slightly raised above the level of the epidermis, elliptical, measuring from 18 to 25 μ in length and about 10 μ in breadth (Fig. 1, C).

Midrib (Fig. 2, A and B). The upper epidermis, which is covered by a fairly thick and finely striated cuticle, consists of subrectangular or elongated cells with straight anticlinal walls; these cells are smaller than the epidermal cells of the lamina, measuring about H 13 μ , Lev B 11 to 18 μ and Lev L 18 to 39 μ ; stomata are absent. Covering trichomes are quite numerous; they are conical, small, measuring from 18–36–50 μ in length and 11 to 25 μ in diameter at the base; the walls are warty, thickened and unligified, and the lumen is wide at the base, narrowed in the limb and frequently occluded at the apex (Fig. 2, D, t_1).

The lower epidermis consists of tabular cells similar in size and appearance to those of the upper epidermis; stomata are absent; short, conical trichomes similar to those on the upper epidermis are abundant. Also present are larger, linear trichomes measuring 205–365–792 μ long and about 29 to 42 μ wide, which project from the midrib and lateral veins into the angle between them; these are unicellular but often contain 1 to 10 thin, transverse, lignified septa; limb straight or slightly curved, tapering, with an acute apex; walls evenly thickened, smooth and lignified and pitted at the base (Fig. 2, D, t_2).

A hypodermis is present beneath both epidermises and usually consists of a single layer of tetragonal to pentagonal thin-walled cells measuring about H 18 μ and Lev B 14 to 25 μ . The outer cortex consists of 3 to 5 layers of collenchyma situated immediately beneath each hypodermis; individual cells measure about H 18 to 32 μ and Lev B 11 to 43 μ . The inner cortex is composed of round, thin-walled parenchymatous cells measuring about H 18 to 50 μ and Lev B 36 to 54 μ with frequent and scattered idioblasts containing sandy crystals of calcium oxalate.

The *meristele* consists of a cylinder of xylem surrounded by a complete band of phloem; inside this cylinder are groups of supernumerary phloem intermixed with small groups of vessels, fibres and lignified parenchyma thus forming a kind of network replacing most of the central medulla. In some leaves pericyclic fibres are present; these form peripheral groups or, very occasionally, an almost complete cylinder surrounding the vascular tissue; individual fibres measure 324–648 μ long and 14 to 28 μ wide; the walls are fairly thick, pitted and slightly lignified. The *phloem* consists of groups of sieve tubes each measuring about 7 to 14 μ in diameter, frequently accompanied by large parenchymatous cells measuring H 11 to 25 μ and Lev B 14 to 21 μ and traversed by medullary rays which are usually one or two cells wide. The *xylem* consists of 3 to 4 rows of radially-arranged vessels measuring from 14 to 36 μ in diameter with spirally or annularly thickened walls, and groups of fibres and parenchyma; the medullary rays are usually lignified. The network of lignified elements inside the xylem cylinder consists of vessels, fibres and

lignified parenchyma; the parenchymatous cells are round to ovoid with fairly thick, pitted walls and measure H 14 to 54 μ and Lev B 18 to 54 μ ; the vessels are similar to those of the main xylem cylinder, but they are smaller, measuring 14 to 25 μ in diameter, and occur singly or in small groups; the fibres are scattered throughout but are particularly numerous in the regions bordering the supernumerary phloem; they are smaller than the pericyclic fibres, measuring only 7 to 14 μ in diameter. The *supernumerary phloem* is composed of elements similar to those of the phloem of the main cylinder, but frequently the cells are collapsed. The *medulla*, which is much reduced, consists of thin-walled parenchyma, the cells of which are fairly large, round to ovoid, measuring about 18 to 39 μ in diameter and occasionally containing sandy crystals of calcium oxalate.

Lateral veins and veinlets. The lateral veins and veinlets are transcurrent, the palisade tissue above and the spongy mesophyll below being replaced by a few rows of small, thin-walled parenchymatous cells measuring about 14 to 22 μ in diameter; fibres occur singly or in small groups in the periphery of the bundle. Small, conical trichomes similar to those occurring on the midrib (Fig. 2, D, t_1) are present scattered on the lower epidermis of the lateral veins.

(ii) Stems

MACROSCOPICAL CHARACTERS

The young stems and branches of *Uncaria gambier*, which are used in the preparation of catechu, are somewhat angular and measure from 0.1 to 0.4 cm in diameter. The nodes, which occur at intervals of 3.5 to 6.5 cm, are slightly enlarged. The surface varies from light to reddish brown in colour and is smooth or very finely striated longitudinally; the phyllotaxis is opposite and decussate.

The transversely cut surface of the internode is square or oblong in outline with rounded corners, and slightly concave on each side. The opposing sides, which bear the hooks and leaves at the next node up the stem, usually show a deeper concavity than the other two sides, which bear the scars of the interpetiolar stipules. Since the arrangement of the leaves is opposite and decussate, this arrangement of the concavities alternates by 90 degrees at each node.

The transverse section shows a layer of brown cork externally and in the centre a large, whitish-yellow pith, which occupies about half to two-thirds of the diameter. The pith is separated from the narrow secondary phloem and cortex by a band of secondary xylem which is brown in colour (see Fig. 3, A).

HISTOLOGICAL CHARACTERS

The *epidermis*, which is covered by a thin, finely striated cuticle, is composed of polygonal cells measuring about R 7 to 14 μ , T 10 to 21 μ and L 18 to 58 μ , with straight, evenly thickened anticlinal walls; stomata are few and paracytic; small, conical covering trichomes, similar to those found on the midrib, are fairly numerous (Fig. 3, C; Fig. 2, D). *Cork*

UNCARIA GAMBIE ROXB.

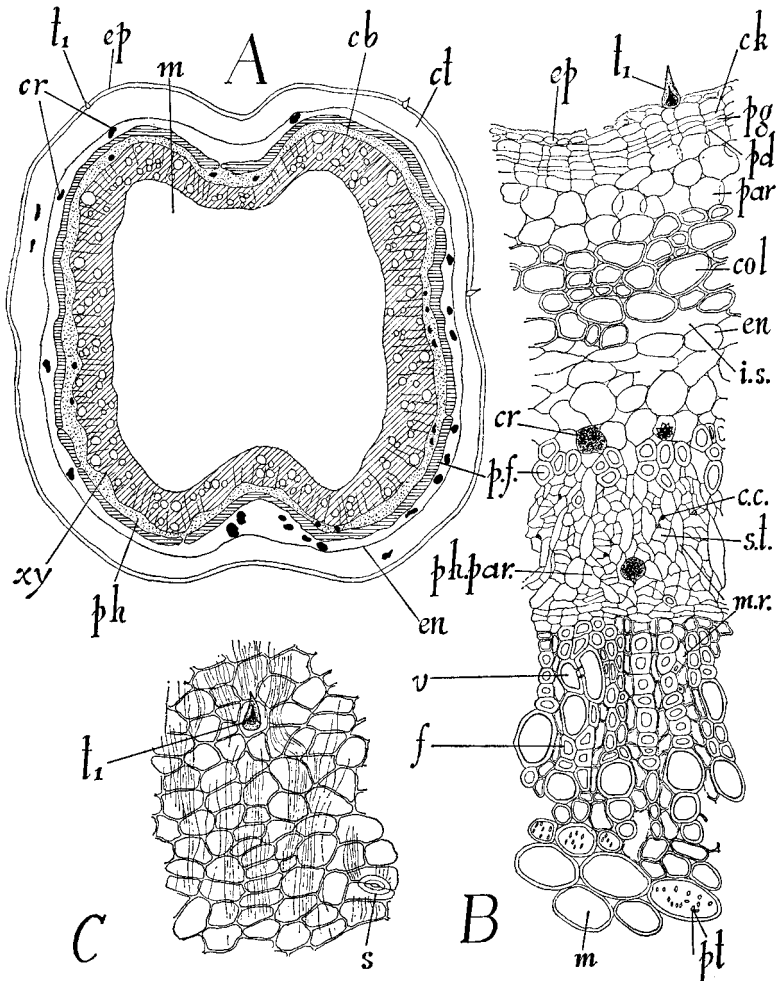


FIG. 3. Stem of *Uncaria gambier* Roxb. *A*, diagram of a transverse section of a young stem, $\times 40$; *B*, details of a transverse section of an older stem; *C*, epidermis in surface view; *B* and *C*, $\times 200$; *cb*, cambium; *c.c.*, companion cell; *ck*, cork; *col*, collenchyma; *cr*, crystals of calcium oxalate; *ct*, cortex; *en*, endodermis; *ep*, epidermis; *f*, fibres; *i.s.*, intercellular space; *m*, medulla; *m.r.*, medullary rays; *par*, parenchyma; *pd*, phelloderm; *p.f.*, pericyclic fibres; *pg*, phellogen; *ph*, phloem; *ph.par.*, phloem parenchyma; *pt*, pits; *s*, stoma; *s.t.*, sieve tube; *t₁*, covering trichomes; *v*, vessel; *xy*, xylem.

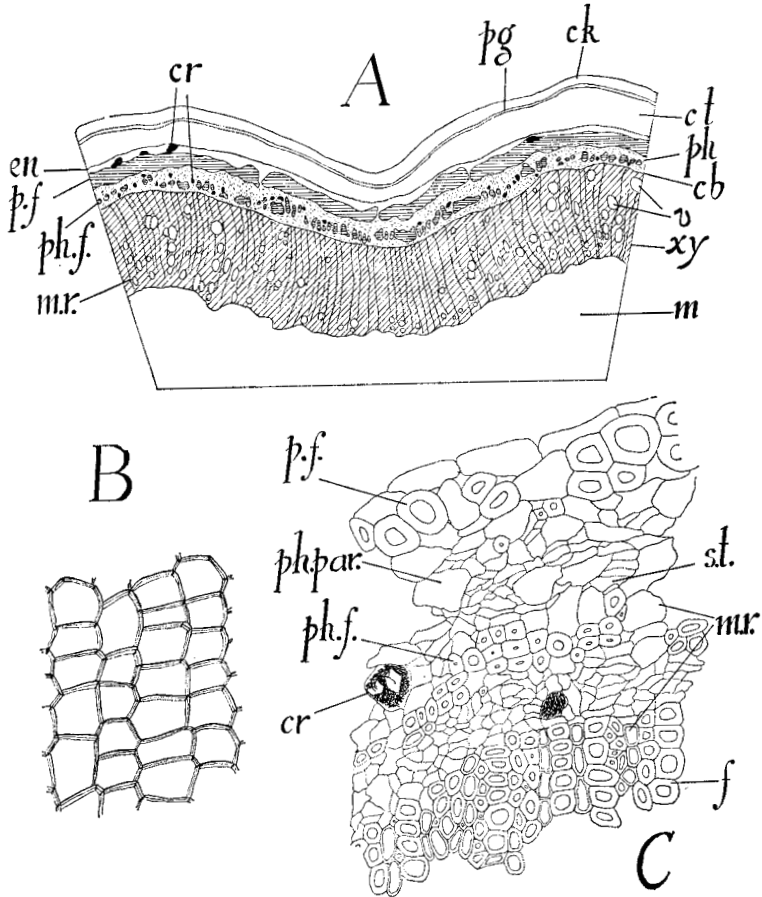


FIG. 4. Stem of *Uncaria gambier* Roxb. *A*, diagram of part of a transverse section of a mature stem showing the presence of phloem fibres, $\times 40$; *B*, cork in surface view; *C*, details of a transverse section in the phloem region, $\times 200$. *cb*, cambium; *ck*, cork; *cr*, crystals of calcium oxalate; *ct*, cortex; *en*, endodermis; *f*, fibres; *m*, medulla; *m.r.*, medullary rays; *p.f.*, pericyclic fibres; *pg*, phellogen; *ph*, phloem; *ph.par.*, phloem parenchyma; *s.t.*, sieve tube; *v*, vessels; *xy*, xylem.

is present in older stems, developed from a phellogen which arises in the hypodermis; it consists of 2 to 4 layers of polygonal cells measuring R 7 to 14 μ , T 15 to 46 μ and L 18 to 54 μ with dark brown contents and thin, suberised and occasionally lignified walls (Fig. 3, B; Fig. 4, B). Phelloderm is not well developed and forms the outer *cortex*, consisting of 2 to 4 layers of thin-walled, rounded or tangentially elongated parenchymatous cells with small intercellular spaces; the remainder of the cortex is collenchymatous and consists of 3 to 4 layers of cells measuring about R 14 to 25 μ , T 14 to 36 μ , with occasional large, intercellular spaces and scattered idioblasts containing sandy crystals of calcium oxalate. The endodermis is composed of a layer of thin-walled cells somewhat compressed radially, with no intercellular spaces; starch is absent.

The outer part of the *pericycle* is composed of 1 or 2 layers (increasing to about 4 in the concavities) of parenchymatous cells with large intercellular spaces; calcium oxalate occurs in some of the larger cells in the form of cluster crystals measuring about 16 μ in diameter or small sandy crystals or, occasionally, single cluster crystals embedded in a mass of sandy crystals. The inner part of the pericycle consists of an almost continuous band of from 1 to 3 layers of thick-walled, slightly lignified fibres; individual fibres measure from 10 to 36 μ in diameter and are very long, measuring 792 to 2,700 to 4,640 μ , with a few reaching a length of 5,000 μ (Fig. 5, D).

The primary phloem is not clearly distinguishable. The *secondary phloem* is well developed and from 6 to 9 rows in depth, or up to 12 rows at the concavities; the tissue is extremely soft and the cells are frequently broken or collapsed; some ceratenchyma is also present. The functional phloem is composed of sieve tubes and phloem parenchyma, traversed by numerous medullary rays (Fig. 3, B; Fig. 5, C). The sieve tubes measure about 6 to 14 μ in diameter and are accompanied by very small companion cells; the parenchymatous cells measure 14 to 25 μ in diameter and frequently contain crystals of calcium oxalate similar to those in the pericycle; the medullary rays are from 1 to 2 cells wide and are composed of large thin-walled parenchymatous cells which, in the outer part of the phloem, are radially elongated; individual cells measure about R 14 to 43 μ , T 7 to 29 μ and L 55 to 108 μ . Phloem fibres are only present in older stems in which cork formation has taken place (Fig. 4, A and C); they occur singly or in groups of up to 6 or in discontinuous bands of up to 4 layers, in the inner region of the phloem adjacent to the cambium; they are shorter and narrower than the pericyclic fibres, measuring 7 to 21 μ in diameter and up to 1,536 μ in length, and the walls are thicker and bear numerous, conspicuous slit-shaped pits (Fig. 4, C; Fig. 5, D).

The *cambiform tissue* consists of 2 to 3 layers of thin-walled, somewhat radially-compressed cells measuring R 4 to 7 μ and T 14 to 18 μ .

The *secondary xylem* consists of scattered vessels and tracheidal vessels and large amounts of fibres and xylem parenchyma. The vessel elements (Fig. 3, B; Fig. 5, A) measure about 28 to 72 μ in diameter and 390 to 972 μ in length; the side walls bear numerous small, spirally-arranged bordered pits and the end walls are oblique. The tracheidal vessels (Fig. 5, A)

are narrower, measuring about 14 to 29 μ in diameter and 432 to 936 μ in length; the walls bear numerous small, bordered pits and the perforations appear as oval or rounded openings near the ends, which are tapering and occasionally forked. The fibres are numerous and are arranged in radial rows of from 8 to 20 cells; they are identical in structure to the phloem fibres (Fig. 5, D).

The xylem parenchyma is lignified and consists of rectangular cells measuring R 7 to 29 μ , T 4 to 14 μ , arranged in radial rows of 8 to 20 cells between the groups of fibres and also accompanying the vessels; the walls are only slightly thickened and bear numerous bordered or simple pits (Fig. 5, B). The secondary medullary rays are also lignified and in transverse section the structure and arrangement of the constituent cells are very similar to those of the xylem parenchyma; they are, however, readily distinguished by their reddish-brown colour.

The *pith* is composed of parenchymatous cells with fairly thick, slightly lignified and pitted walls; the cells vary in size and shape depending on their position, those towards the periphery being round or ovoid measuring about 36 to 60 μ in diameter, whereas those in the central region are polygonal and measure up to 240 μ wide (Fig. 3, B).

Calcium oxalate is absent from all tissues internal to the cambium.

(iii) Hooks

MACROSCOPICAL CHARACTERS (Fig. 6, A)

One of the most characteristic features of *Uncaria gambier* and other tropical climbers of the same genus is the presence of a "hook" in the leaf axis after the inflorescence has fallen off; this is formed from the remnant of the axillary peduncle and is used by the plant for climbing. It is woody, about 1 to 2 cm long, curved downwards towards the stem axis, tapering towards the apex and laterally compressed; the surface is reddish-brown to dark brown and longitudinally furrowed; the basal region appears glabrous, but towards the apex the surface becomes densely pubescent and the hook very often terminates with a tuft of fine, silky hairs.

HISTOLOGICAL CHARACTERS

The epidermal cells are similar in shape, size and structure to those of the stem, except in the apical region where they are thinner-walled and smaller, measuring R 7 to 11 μ , T 7 to 25 μ and L 11 to 36 μ (Fig. 6, C₂); paracytic stomata occur infrequently. In the basal region the covering trichomes are similar in form and distribution to those on the stem epidermis (Fig. 6, C₃), but as the apex is approached they become longer, thinner walled, more tortuous in shape and progressively greater in number until, at the extreme apex, nearly every epidermal cell is developed as a covering trichome (Fig. 6, C₁).

The structure and arrangement of the remainder of the tissues are essentially the same as those of the stem. Larger vessels, however, are not found in the secondary xylem, and pericyclic fibres do not form a

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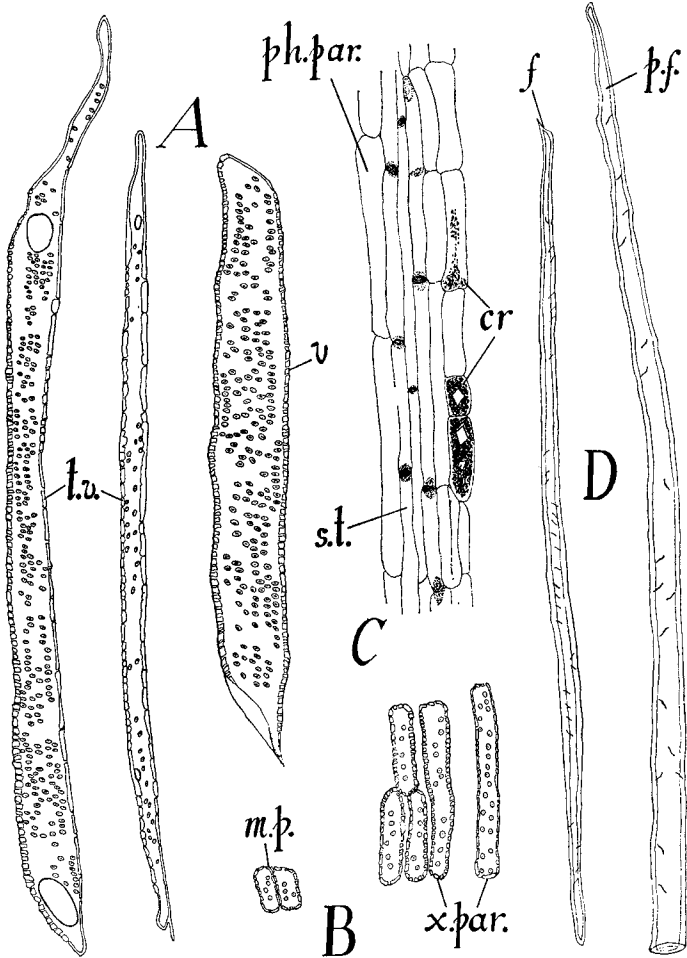


FIG. 5. Stem of *Uncaria gambier* Roxb. A, isolated vessel (v) and tracheid vessels (t.v.) from the xylem; B, xylem parenchyma (x.par.) and medullary ray parenchyma (m.p.); C, part of the phloem in longitudinal section; s.t., sieve tube; cr, calcium oxalate crystals; ph.par., phloem parenchyma; D, isolated fibres from the xylem or phloem (f) and pericycle (p.f.). All $\times 200$.

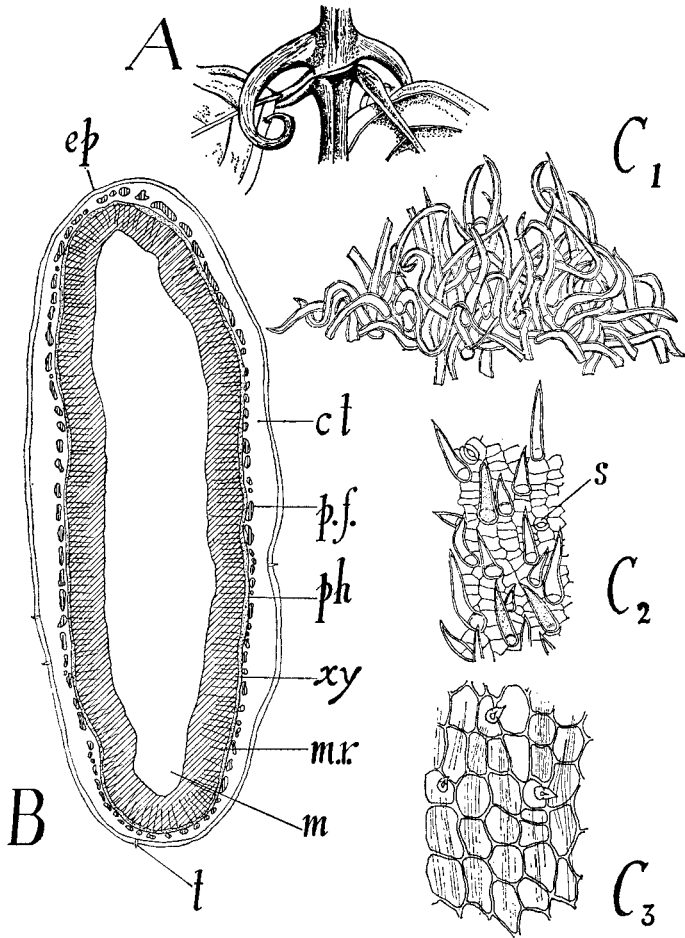


FIG. 6. Hook of *Uncaria gambier* Roxb. *A*, drawing of a node, showing the arrangement of the leaves and hooks, $\times 1.5$; *B*, diagram of a transverse section cut near the base, $\times 25$; *C*₁, *C*₂ and *C*₃, portions of the epidermis in surface view, all $\times 200$; *C*₁, from the apex showing details of part of the tuft of hairs; *C*₂, from near the apical region and *C*₃, from near the base; *ct*, cortex; *ep*, epidermis; *m*, medulla; *m.r.*, medullary rays; *p.f.*, pericyclic fibres; *ph*, phloem; *s*, stoma; *t*, covering trichome; *xy*, xylem. (*A*, after Bentley and Trimen, modified.)

complete band surrounding the vascular tissues but occur in groups, separated by thin-walled parenchyma; the cortex is also narrower and its constituent cells are somewhat radially-compressed (Fig. 6, B).

(iv) Stipules

MACROSCOPICAL CHARACTERS (Fig. 7, A and B)

The paired interpetiolar stipules are generally only found intact on the apical buds and the nodes in the upper region of the young twigs as they fall off early, leaving two linear scars at each node. They are ovate, about 6 to 10 mm long and 4 to 6 mm wide; vascular strands, of which there are about 15 to 20, run almost parallel to one another from the base to the apex, and these are joined by a fine network of smaller veins; the upper surface (Fig. 7, A) is densely pubescent, particularly near the margin, but only scattered hairs occur on the lower surface.

HISTOLOGICAL CHARACTERS

The *upper epidermis* is covered with a thin, faintly striated cuticle and consists of thin-walled cells measuring Lev L and B 10 to 43 μ and H 7 to 11 μ , with very occasional, paracytic stomata. Covering trichomes are very numerous, particularly near the margins; they are unicellular, conical to linear measuring about 54 to 144 μ in length and 7 to 18 μ in diameter at the base; the walls are thin and may be warty or smooth (Fig. 7, E). The *lower epidermis* is also covered with a finely striated cuticle but the cells are smaller, measuring Lev L and B 9 to 32 μ and H 7 to 11 μ ; paracytic stomata occur frequently and a few covering trichomes are present, similar to those on the upper epidermis (Fig. 7, D). The *mesophyll* is, in the main part, undifferentiated, and is composed of rounded or slightly elongated thin-walled cells measuring about 14 to 43 μ in diameter, with intercellular spaces; some differentiation occurs near the margins where the cells of the hypodermis and one or two adjacent layers are collenchymatous. Crystal-idioblasts are absent (Fig. 7, C). There is no midrib, and in transverse section the nearly parallel veins are seen at intervals cut transversely or somewhat obliquely; each vascular strand consists of from 7 to 10 xylem vessels with a small amount of sieve tissue and a few fibres (Fig. 7, F).

(v) Calyx

MACROSCOPICAL CHARACTERS (Fig. 8, A)

The calyx is green in colour and measures about 0.7 cm long and about 0.3 cm wide; sepals 5, joined, forming a tube at the base which is united with the inferior ovary, and at the top forming 5 triangular lobes which are somewhat thickened at the apex; outer surface densely pubescent with a ridge along the midrib of each sepal; inner surface glabrous except on the lobes, which are covered with silky hairs.

HISTOLOGICAL CHARACTERS

The *outer epidermis* is covered by a thin, very faintly striated cuticle; the cells on the lobes polygonal, measuring about Lev L and B 11 to 36 μ , with straight or slightly sinuous anticlinal walls, those on the tube smaller with slightly more sinuous anticlinal walls; paracytic stomata numerous; unicellular covering trichomes very numerous, those on the lobes and the upper part of the tube conical, somewhat sinuous, measuring about 72 to 180 μ long and 10 to 25 μ wide with thin, unligified walls and occasionally containing a single septum (Fig. 8, C); those near the base of the tube longer, conical to linear, measuring about 198 to 414 μ long and 10 to 18 μ wide with fairly thin, usually lignified walls and with the limb bent at right angles to the finely pitted base.

The cells of the *inner epidermis* are similar to those of the outer but they are larger, measuring Lev B 14 to 36 μ and Lev L 18 to 50 μ ; stomata are absent. Covering trichomes are present on the apex of the lobes only and they are similar to those occurring on the outer epidermis in this region.

(vi) Corolla

MACROSCOPICAL CHARACTERS (Fig. 8, A and B)

The corolla is pale purple in colour and measures about 1.5 cm long and 0.8 cm wide at the distal end, and 0.1 cm wide at the proximal end; petals 5, united for the greater part of their length to form a narrow tube and opening out at the top into 5 ovate, spreading lobes (Fig. 8, A); outer surface densely pubescent, inner surface glabrous except for a small tuft of long silky hairs at the base of each lobe; 5 epipetalous stamens alternating with the lobes of the corolla (Fig. 8, B).

HISTOLOGICAL CHARACTERS

The *outer epidermis* is covered by a thin, smooth cuticle; the cells on the lobes polygonal, fairly large, measuring Lev L and B 18 to 46 μ , those on the tube somewhat rectangular and elongated longitudinally measuring Lev B 8 to 22 μ and Lev L 40 to 126 μ ; stomata paracytic, rare, present only on the lobes. Covering trichomes, similar to those found at the base of the calyx tube, are very numerous on the lobes (Fig. 8, G) but only occur scattered on the tube (Fig. 8, E), those on the lobes measuring 144 to 270 to 432 μ long and 10 to 18 μ wide at the mid-part of the limb, but those on the tube shorter, measuring 90 to 234 μ long and 10 to 14 μ wide at the mid-part of the limb. The cells of the *inner epidermis* are similar to those of the outer in the tubular region, but differ on the lobes, those on the basal region being larger than those on the corresponding part of the outer surface, measuring Lev L and B 18 to 54 μ while those on the central and marginal regions are much smaller, measuring Lev L and B 18 to 25 μ , and have unevenly thickened walls; stomata are absent. Covering trichomes only occur at the base of the lobes; they are unicellular, long and stout, measuring 252 to 576 μ long,

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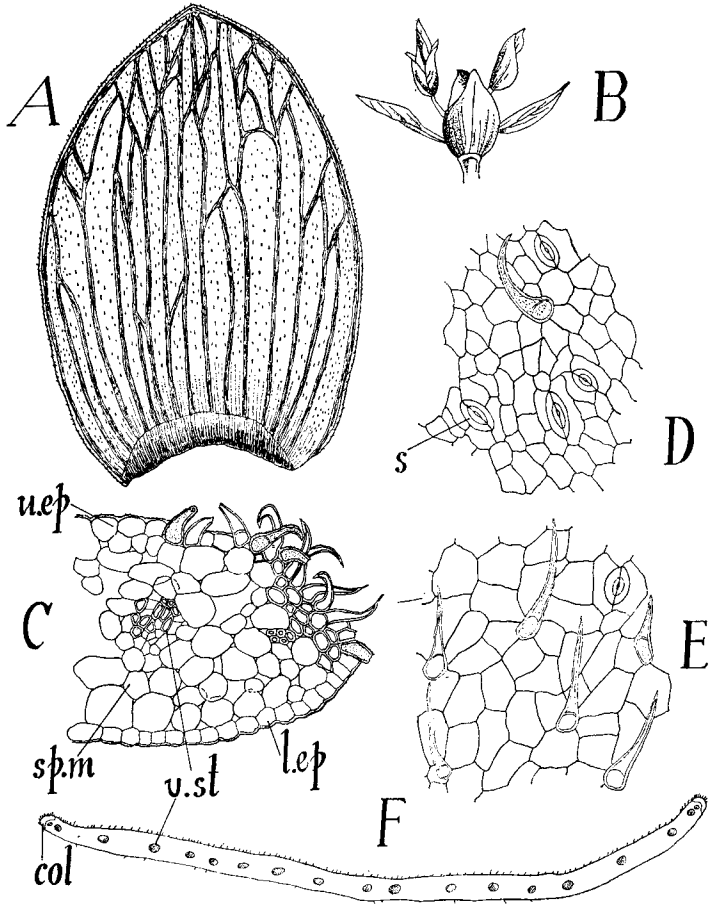


FIG. 7. Stipule of *Uncaria gambier* Roxb. *A*, an entire stipule, $\times 4$; *B*, the extremity of a young twig to show the position of the stipules, $\times 1.5$; *C*, details of part of a transverse section cut to include the margin; *D*, lower epidermis in surface view; *E*, upper epidermis in surface view; *C*, *D* and *E*, $\times 200$; *F*, diagram of a transverse section, $\times 8$; *col*, collenchyma; *l.ep*, lower epidermis; *s*, stoma; *sp.m.*, spongy mesophyll; *u.ep.*, upper epidermis; *v.st.*, vascular strands. (*B*, after Bentley and Trimen.)

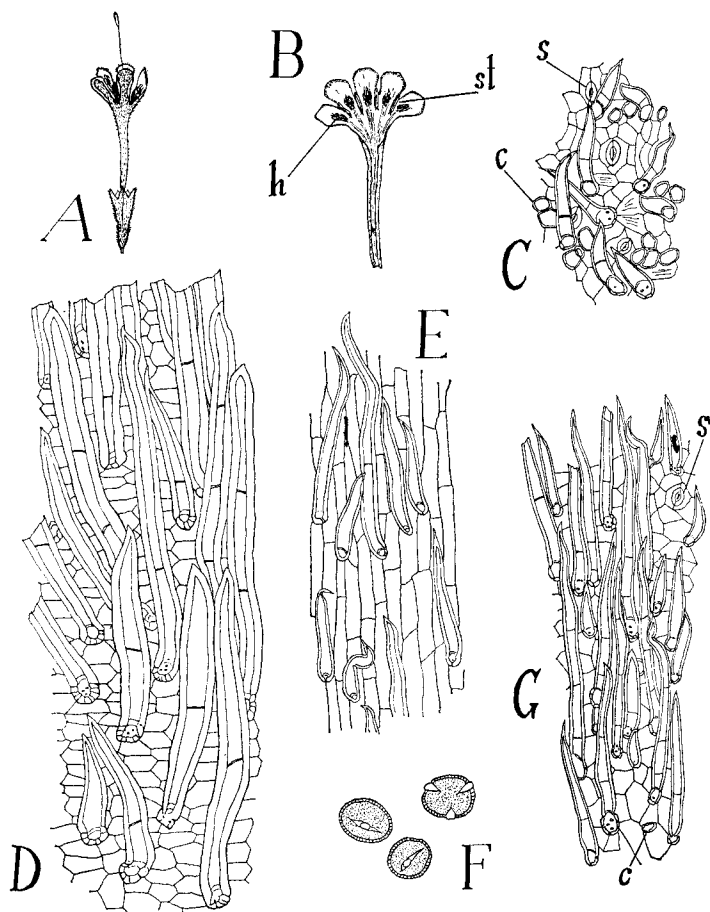


FIG. 8. Calyx and corolla of *Uncaria gambier* Roxb. *A*, entire flower, $\times 1.5$; *B*, corolla, opened out to show the epipetalous stamens (*st*), and the tuft of hairs (*h*) at the base of each corolla lobe, $\times 2$; *C*, outer epidermis from the lobe of the calyx; *D*, inner epidermis from the basal region of the lobe of the petal; *E*, outer epidermis of the corolla tube; *F*, pollen grains; *G*, outer epidermis from the lobe of the petal; *D* and *G*, $\times 130$; *C* and *E*, $\times 180$; *F*, $\times 350$; *c*, cicatrix; *s*, stoma.

UNCARIA GAMBIER ROXB.

21 to 39 μ wide at the base and up to 43 μ wide in the limb; walls thick and lignified, pitted at the base; the limb frequently bent at right angles to the base and containing 1 to 3 thin, transverse, lignified septa (Fig. 8, D).

POLLEN GRAINS

Owing to the presence of epipetalous stamens, numerous pollen grains are found on the lobes of the corolla; they are sub-spherical, very small, measuring 11 to 18 μ in diameter with 3 furrows, each furrow having a central pore; exine covered with minute pits in a scattered arrangement (Fig. 8, F).

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