

**ANATOMICAL STUDIES IN THE GENUS *RUBUS*\***  
**PART III. THE ANATOMY OF THE LEAF OF *Rubus loganobaccus***  
**L. H. BAILEY**

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The anatomy of the leaf of *Rubus loganobaccus* L. H. Bailey, in the whole and powdered condition, is described and illustrated. A summary of the anatomical characters is given, and the anatomical features which distinguish leaves of *R. loganobaccus* from those of *R. idaeus* L. and *R. fruticosus* L.<sup>1,2</sup> are briefly discussed.

No reference has appeared to date concerning the use of loganberry leaves in medicine, but the plant is closely allied to the raspberry and blackberry, and its leaves resemble those of these plants. Moreover, loganberries have become a well-known article of commerce, and the plants are frequently cultivated near to raspberry and blackberry crops. The present investigation was therefore undertaken to show the anatomical characters by which loganberry leaves may be distinguished.

The loganberry plant originated in 1881 by hybridisation between *R. idaeus* ssp. *strigosus* (Michx.) Focke, an American species of red raspberry, and *R. vitifolius* Cham. & Schlecht, the Californian dewberry<sup>3,4</sup>. It is a hexaploid, now behaving as a species, and was introduced into this country about 1900. Warburg<sup>4</sup> includes it, with *R. idaeus* L., in the subgenus IDEOBATUS.

#### MATERIAL

The material investigated consisted of the leaves of *R. loganobaccus* cultivated at the Gardens of the Royal Horticultural Society, Wisley, Surrey.

#### METHODS OF INVESTIGATION

A brief treatment with warm chloral hydrate solution sufficed to show the epidermises in surface view, but it was profitable to shave off the hairs before examining the lower epidermis, and also to soak the pieces of lamina in ether for several hours before testing for lignin with phloroglucin and hydrochloric acid or aniline sulphate solution. The hairs of the upper epidermis gave a positive reaction for lignin, but some of the hairs forming the tomentum on the lower epidermis of the lamina gave a positive reaction only after the above treatment, or alternatively, after preliminary heating in chloral hydrate solution. Other histological methods used were similar to those described earlier<sup>2</sup>.

\* The subject matter of this communication forms part of a thesis by one of us (K.R.F.) accepted by the University of London for the degree of Doctor of Philosophy.

## ANATOMICAL STRUCTURE

The leaf of *R. loganobaccus* is imparipinnately compound; there are usually five leaflets, lateral leaflets being sessile on the rachis. Paired linear stipules are adnate at the lower end of the rachis (Fig. 1, *A*; Fig. 5, *A* and Fig. 6, *A*).

## (a) LEAFLETS

No anatomical differences were detected between lateral and terminal leaflets; the following description, therefore, applies to either of these.

(i) *Lamina, interneural region* (Fig. 1, *C* and *D*; Fig. 2, *A*, *B*, *C* and *D*; Fig. 3, *C*; Fig. 4, *A*).

The UPPER EPIDERMIS is covered with a fairly thick, smooth cuticle and consists of a layer of polygonal cells having wavy, well-beaded, anticlinal walls; they measure\* about H 20 to 24 $\mu$  and Lev L and B 16 to 68  $\mu$ . Stomata are absent, but numerous, prominent, oval *hydathodes*, about 22 to 30  $\mu$  long and 14 to 20  $\mu$  wide, are present on each of the marginal teeth (Fig. 1, *C*). *Covering trichomes* occur frequently; they arise over or in close proximity to the veins and around the edges of the marginal teeth (Fig. 1, *B*; Fig. 2, *C*). They are unicellular, with thick, lignified walls, tapering and acutely pointed, with heavily thickened bases exhibiting well-marked linear pits; they measure about 180 to 1,400  $\mu$  long and 15 to 42  $\mu$  wide at the base. The lumen is wide in the basal part of the trichome, but narrows gradually, often becoming obliterated about one-third of the way along the trichome. The bases are surrounded by about 8 to 10 radiating epidermal cells; these radiating cells frequently show a striated cuticle.

The MESOPHYLL is well differentiated. The *palisade* is double, with the upper layer very slightly more well-formed than the lower. Both layers are continuous when seen in thin transverse sections, and consist of cylindrical cells measuring about H 20 to 35  $\mu$ , Lev 4 to 10  $\mu$  in the upper layer, and H 16 to 30  $\mu$ , Lev 4 to 10  $\mu$  in the lower. The cells of both layers contain chloroplasts, about 4 to 6  $\mu$  in diameter. Scattered irregularly in both the palisade and the spongy mesophyll (more commonly in the latter) are occasional rounded idioblasts containing well-defined cluster crystals of *calcium oxalate*, about 14 to 36  $\mu$  in diameter; there is no well-defined crystal layer between the palisade and the spongy mesophyll. The *spongy mesophyll* consists of about 2 to 4 layers of cells, which in surface view are rounded, elongated, triangular or trabeculate and measure about H 8 to 16  $\mu$  and Lev 10 to 30  $\mu$ ; they contain chloroplasts, about 4 to 6  $\mu$  in diameter; numerous air-spaces occur (Fig. 3, *C*; Fig. 4, *A*).

The LOWER EPIDERMIS has a smooth, thin cuticle. Its cells have wavy, slightly beaded walls about H 8 to 14  $\mu$ , Lev L and B 20 to 60  $\mu$ . *Stomata* are very numerous, and, when the hairs are shaved off, are seen to be of

\* The symbols H, Lev, Lev L and Lev B are suggested for the purpose of describing organs showing bilateral symmetry by Moll and Janssonius. 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 or transverse direction respectively.

*Rubus loganobaccus* L.H.Bailey

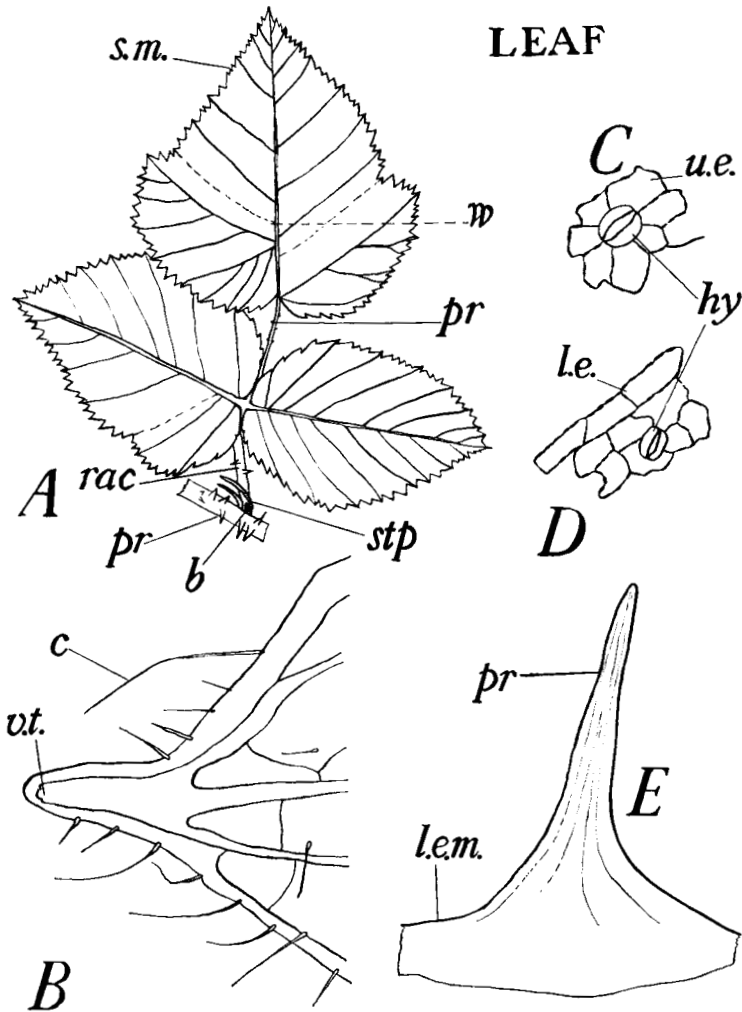


FIG. 1. Leaf of *Rubus loganobaccus* L. H. Bailey. A, complete, compound leaf with terminal and two lateral leaflets and paired stipules adnate to the rachis. B, marginal tooth of leaflet. C, hydathode on upper epidermis of marginal tooth of leaflet. D, hydathode on lower epidermis of marginal tooth of leaflet. E, prickle. A,  $\times \frac{1}{3}$ ; B,  $\times 33$ ; C and D,  $\times 200$ ; E,  $\times 18$ . b, bud; c, covering trichome; hy, hydathode; l.e., lower epidermis of marginal tooth; l.e.m., lower epidermis of midrib; pr, prickle; rac, rachis; s.m., serrate margin; stp, stipule; u.e., upper epidermis of marginal tooth; vt., vein termination; w, position at which transverse section in Fig. 3, A was made.

the anomocytic type and raised very slightly above the level of the epidermis; they exhibit prominent ostioles, are oval in outline and measure about 23 to 30  $\mu$  long and 18 to 22  $\mu$  wide (Fig. 2, *B*). Occasional oval *hydrathodes*, about 24 to 30  $\mu$  long and 18 to 22  $\mu$  wide, occur on the lower epidermis of the marginal teeth (Fig. 1, *D*). Long *covering trichomes* are present in great numbers; they form a virtual tomentum which is not so dense, however, as that observed on the leaf of *R. idaeus*. They are unicellular, lignified (but only stain satisfactorily after preliminary treatment of the lamina with ether or chloral hydrate solution), are commonly 300 to 700  $\mu$  long and 12 to 30  $\mu$  wide at the base, the lumen is sometimes obliterated in the upper two-thirds of the hair and they are curled, and to some extent, intertwined with each other; the bases are thickened and slightly pitted and the apices are bluntly pointed; spiral markings were not observed (Fig. 2, *B* and *D*).

The lamina has a coarsely dentate-serrate margin, individual teeth being acutely pointed. The minute ends of the secondary and tertiary veins extend to within about 60  $\mu$  of the teeth apices and terminate in a few, very small, spiral elements. Two fine veinlets, one on either side, converge towards the central veinlet and unite with it about 0.6 mm. from the tip of the tooth (Fig. 1, *A* and *B*).

(ii) *Midrib* (Fig. 2, *E* and *F*; Fig. 3, *A*, *B* and *D*; Fig. 4, *B* and *C*).

The midrib has a typically dicotyledonous structure; one significant variation was noted in transverse sections cut serially from apex to base in most (but not all) leaflets examined, namely that groups of pericyclic fibres appear in sections cut between the base of the leaflet and a point which varied from about one-quarter to about one-third of the way up the midrib (Fig. 3, *A* and *B*).

The UPPER EPIDERMIS consists of a single layer of elongated, slightly beaded, well-cuticularised, straight-walled cells measuring about H 14 to 24  $\mu$ , Lev B 8 to 30  $\mu$ , and Lev L 16 to 60  $\mu$ ; stomata are absent (Fig. 2, *E*; Fig. 3, *D*). *Covering trichomes* are present in moderate numbers, and are similar to those of the interneural epidermis. Occasional *glandular trichomes* about 100 to 180  $\mu$  long occur on the upper epidermis of both midrib and secondary veins; they comprise a multicellular, biseriate stalk about 6 cells long, and a multicellular, subspherical, glandular head about 60 to 70  $\mu$  in diameter (Fig. 2, *E*).

The LOWER EPIDERMIS consists of strongly cuticularised, longitudinally elongated, beaded, straight-walled cells, measuring about H 14 to 28  $\mu$ , Lev B 8 to 28  $\mu$  and Lev L 25 to 90  $\mu$ ; occasional anomocytic stomata are present (Fig. 2, *F*; Fig. 3, *D*). *Covering trichomes* arise frequently and are in general of similar structure to those of the upper interneural epidermis.

Laterally compressed, slightly curved, elongated-conical *prickles* occur frequently on the lower surface of the midrib. They are commonly 2 to 5 mm. high and 1 to 2 mm. long at the base, and consist of lignified, fibre-like sclerotic cells, about 140 to 900  $\mu$  long and 14 to 30  $\mu$  wide, their walls, in general, are thin, with oblique pits; the lumen is wide (Fig. 1, *A* and *E*; Fig. 3, *A*; Fig. 4, *B*).

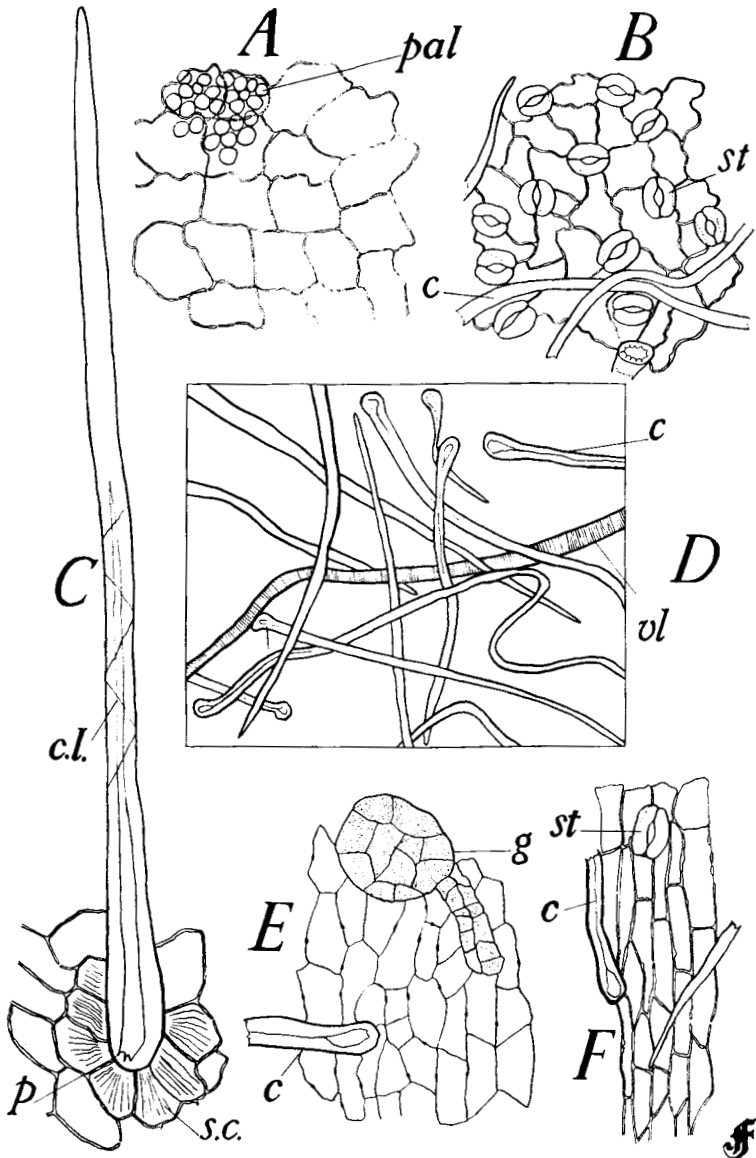
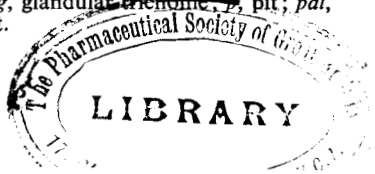


FIG. 2. Leaflet of *Rubus loganobaccus* L. H. Bailey. *A*, upper epidermis of leaflet; *B*, lower epidermis of leaflet; *C*, covering trichome on upper epidermis of lamina; *D*, covering trichomes forming partial tomentum on lower epidermis of lamina; *E*, upper epidermis of midrib; *F*, lower epidermis of midrib. All x 200. *c*, covering trichome (or portion of); *c.l.*, crossed-line effect; *g*, glandular trichome; *p*, pit; *pal*, palisade; *s.c.*, striated cuticle; *st*, stoma; *vl*, veinlet.



The CORTEX contains a few rows of supporting hypodermal *collenchyma* beneath both surfaces of the midrib, that towards the lower surface being the greater in extent. The cells are normally very heavily thickened, particularly in the angles, and measure about L 26 to 120  $\mu$ , R and T 14 to 40  $\mu$ ; chloroplasts are present, measuring about 6  $\mu$  in diameter. The interior of the cortex is of *parenchyma* which is often slightly collenchymatous, the cells being sometimes thickened at the corners and occasionally exhibiting small pits in their walls; individual cells measure about L 30 to 150  $\mu$ , R and T 14 to 64  $\mu$ . Idioblasts occur fairly frequently in this tissue, each containing a cluster or rosette crystal of *calcium oxalate* about 10 to 40  $\mu$  in diameter.

*Endodermal tissue* could be detected only with the aid of chloral-iodine solution—minute starch grains like those described in the analogous tissue of the leaves of *R. idaeus* and *R. fruticosus*<sup>1,2</sup> were observed in about half of the leaflets examined—in the innermost layers of the cortex. In none of the sections examined, however, did this layer continue over the upper side of the meristele. No lignified endodermal tissue could be demonstrated (Fig. 3, D).

PERICYCLIC FIBRES, in those leaflets where they occur, are arranged in small groups (Fig. 3, B) and commonly measure about 800  $\mu$  long and 20  $\mu$  in diameter; they exhibit thin, lignified walls with occasional small, oblique pits, a wide lumen and pointed apices (Fig. 4, C).

The MERISTELE is crescent-shaped and well-defined.

The PHLOEM consists of strands of sieve-tissue and small-celled parenchyma, alternating with medullary rays. The sieve-tubes are small, individual segments being about 70  $\mu$  long and about 2 to 6  $\mu$  in diameter, with transverse or oblique sieve-plates. The medullary rays are clearly defined and are usually one or two cells wide (Fig. 3, D).

The XYLEM is well-developed and the conducting elements are radially arranged. The component elements resemble those found in the midrib of *R. fruticosus*<sup>2</sup> to a marked extent. *Tracheids*, *fibre-like tracheids* and *vessels* are present, which exhibit annular, spiral, reticulate and pitted thickenings; they are all lignified, and measure about 8 to 50  $\mu$  in diameter (Fig. 3, A, B and D; Fig. 4, C).

In longitudinal sections, files of microclusters of *calcium oxalate* crystals about 3 to 10  $\mu$  in diameter are frequently seen in the parenchyma of the meristele.

The *lateral veins* exhibit similar anatomy to that of the midrib, all features progressively diminishing towards the margin.

Transverse sections mounted in ferric chloride solution exhibit a dark greenish-black coloration in the phloem and medullary rays of the meristele; the parenchyma below the meristele and the cortical collenchyma show a weak reaction. The mesophyll of the lamina reacts strongly, but there is no reaction in the epidermis.

#### (b) RACHIS

The rachis is about 6 to 14 cm. long and 2 to 5 mm. wide; prickles are prominent throughout the length of the lateral and abaxial surfaces

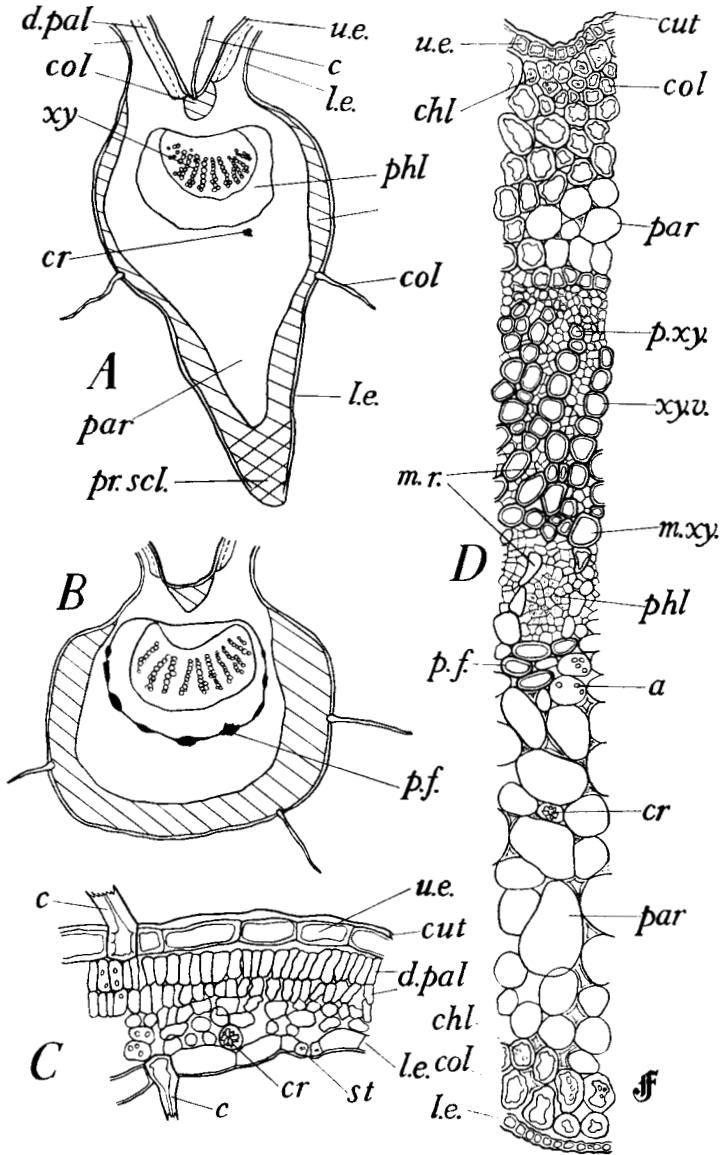


FIG. 3. Leaflet of *Rubus loganobaccus* L. H. Bailey. A, transverse section of midrib of terminal leaflet, cut at the position *w* (see Fig. 1, A) showing absence of pericyclic fibres; this section is cut through a prickle. B, a similar section cut from another leaflet, showing pericyclic fibres. C, transverse section of lamina, inter-neural region. D, central region of Fig. B. A and B x 20; C and D, x 100. a, starch; c, covering trichome; chl, chloroplast; col, collenchyma; cr, cluster crystal of calcium oxalate; cut, cuticle; d. pal., double palisade; l.e., lower epidermis; m.r., medullary ray; m.xy., metaxylem; par, parenchyma; p.f., pericyclic fibre; phl, phloem; pr. scl., area of prickle sclereids; p.xy., protoxylem; st, stoma; u.e., upper epidermis; xy, xylem; xy.v., xylem vessel.

(Fig. 1, *A*; Fig. 5, *A*). It is grooved along the adaxial surface, particularly in the part between the lateral and terminal leaflets. Transverse sections cut in the upper part present an almost oval outline apart from the groove (Fig. 5, *B*) whereas those cut in the lower part are nearly circular (Fig. 5, *C*). The arrangement of the vascular system in the upper part resembles that found in *R. idaeus*<sup>1</sup>, but simple variations from this were observed in transverse sections cut in the lower part; usually, 4 to

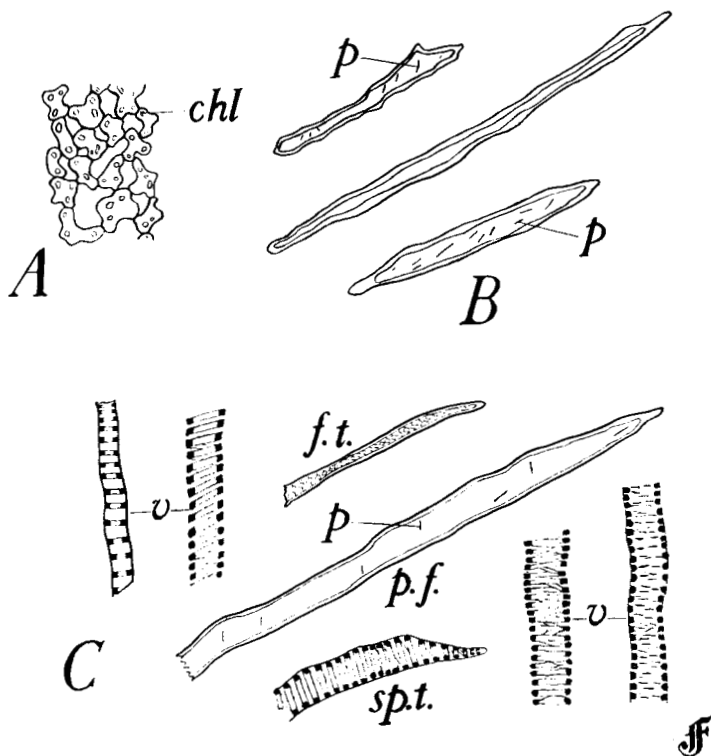


FIG. 4. Leaflet of *Rubus loganobaccus* L. H. Bailey. *A*, spongy mesophyll in surface view. *B*, elongated sclereids isolated by maceration of prickles. *C*, isolated elements obtained by maceration of the midrib. All  $\times 200$ . *chl.*, chloroplast; *f.t.*, fibre-like tracheid; *p.*, pit; *p.f.*, pericyclic fibre; *sp.t.*, end-portion of a spiral tracheid; *v.*, fragments of annular, spiral, reticulate and pitted vessels.

6 small meristemes, 2 or 3 on each side, occur above the central arc (Fig. 5, *C*). Pericyclic fibres are generally abundant below the phloem of all meristemes (Fig. 5, *B*, *C* and *H*).

The EPIDERMIS consists of cells having similar structure to those of the epidermis of the midrib. They are heavily cuticularised, elongated longitudinally, and measure about H 12 to 20  $\mu$ , Lev B 16 to 40  $\mu$  and Lev L 20 to 140  $\mu$  (Fig. 5, *D*, *E* and *H*); stomata of the anomocytic type are present; they are elliptical in shape and measure about 40  $\mu$  in length and 24  $\mu$  in width (Fig. 5, *D* and *E*). Covering trichomes, generally similar in detailed structure to those on the lower surface of the midrib, occur



## RACHIS

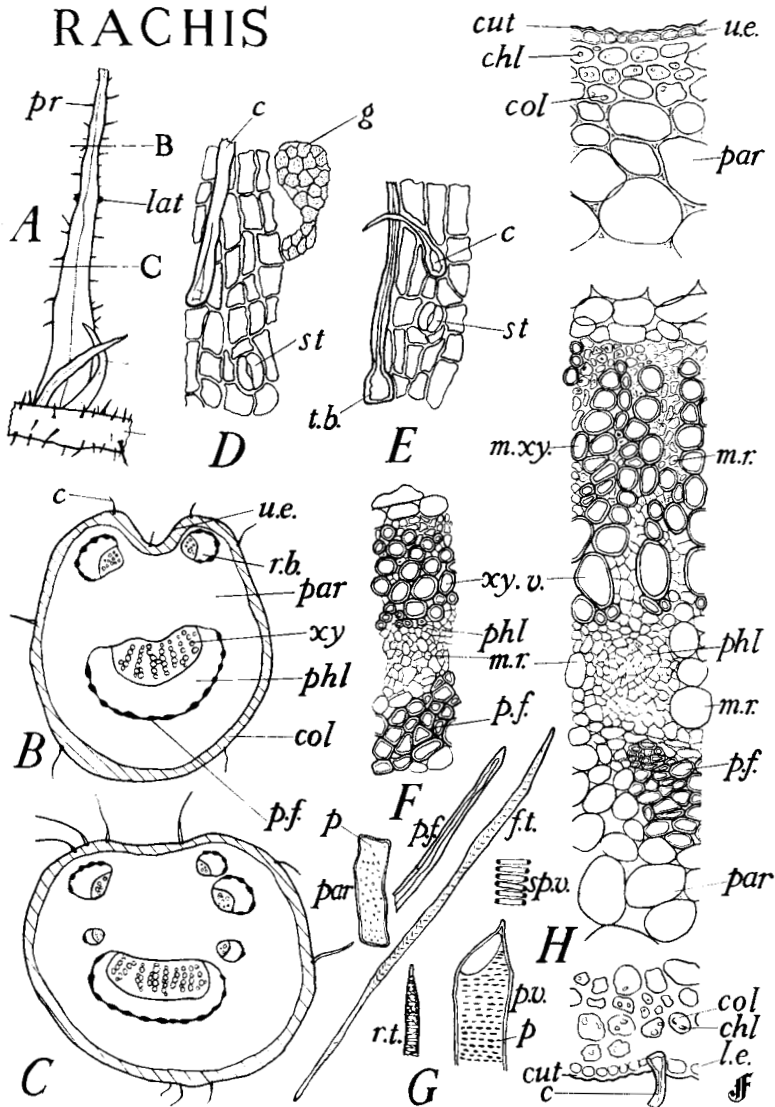


FIG. 5. Rachis of *Rubus loganobaccus* L. H. Bailey. *A*, rachis, denuded of leaflets. *B* and *C*, transverse sections cut at the positions indicated in Fig. *A*. *D*, upper epidermis of rachis with glandular trichome and stoma. *E*, lower epidermis of rachis with covering trichome and stoma. *F*, transverse section of a ridge bundle. *G*, isolated elements obtained by maceration. *H*, transverse section through central region of rachis at the point *B*, Fig. *A*. *A*,  $\times \frac{1}{2}$ ; *B*,  $\times 20$ ; *C*,  $\times 12$ ; *D*–*H*,  $\times 150$ . *c*, covering trichome; *chl*, chloroplast; *col*, collenchyma; *cut*, cuticle; *f.t.*, fibre-like tracheid; *g*, glandular trichome; *lat*, point of attachment of lateral leaflet; *l.e.*, lower epidermis; *m.r.*, medullary ray; *m.xy.*, metaxylem; *p*, pit; *par*, parenchyma; *p.f.*, pericyclic fibre; *phl*, phloem; *pr*, prickle; *p.v.*, portion of a segment of a pitted vessel; *r.b.*, ridge bundle; *sp.v.*, fragment of spiral vessel; *st*, stoma; *r.t.*, end-fragment of reticulated tracheid; *t.b.*, trichome base; *u.e.*, upper epidermis; *xy*, xylem; *xy. v.*, xylem vessel.

frequently, and those of the bi-cellular type occur occasionally; they vary enormously in size—from about  $120\ \mu$  to well over  $1,500\ \mu$  in length, and 10 to  $26\ \mu$  wide at their bases. Some trichomes are curled (Fig. 5, *E*). *Glandular trichomes* occur frequently on the upper epidermis and resemble very closely those seen on the upper epidermis of the midrib (Fig. 5, *D*). The *prickles* are generally larger than, but have similar structure to those on the lower surface of the midrib (Fig. 5, *A*).

The CORTEX, like that of the midrib, consists of two layers of tissue. There is an outer hypodermal layer of *collencyhyma*, several cells wide, similar in character to the corresponding layer of the midrib; the cells measure about L 40 to  $140\ \mu$ , R and T 12 to  $46\ \mu$ , and contain chloroplasts, about  $5\ \mu$  in diameter (Fig. 5, *B*, *C* and *H*). The inner cortex is *parenchymatous*, consisting of cells measuring about L 30 to  $150\ \mu$ , R and T 40 to  $120\ \mu$ ; they frequently possess finely pitted walls; occasional idioblasts occur containing small cluster crystals of *calcium oxalate*, about 10 to  $30\ \mu$  in diameter.

PERICYCLIC FIBRES occur below the arc of the meristele; they measure up to several mm. in length and 10 to  $25\ \mu$  in diameter; they exhibit thick, smooth walls, a variable lumen, and pointed apices (Fig. 5, *G*).

The vascular tissue of the central MERISTELE is arranged in a crescent and in general the structure of the vascular elements approximates closely to those of the midrib, except that those of the rachis are all somewhat larger. The PHLOEM consists of groups of sieve-tubes about  $80\ \mu$  long and 4 to  $10\ \mu$  wide, frequently accompanied by small rectangular or cubical parenchymatous cells arranged in longitudinal files, many of which contain microclusters of *calcium oxalate* about 8 to  $10\ \mu$  in diameter. Medullary rays traverse the phloem; they are usually one or two cells wide and their cells often contain minute starch grains about  $4\ \mu$  in diameter. The XYLEM is well-defined, the elements being arranged in radial rows. Its general structure resembles that of the xylem of the midrib; both tracheids and vessels are present, exhibiting annular, spiral, reticulate and pitted thickenings (Fig. 5, *B*, *C*, *G* and *H*).

The fibrovascular bundles on the adaxial side each exhibit similar structure to that shown by the main meristele.

Transverse sections mounted in ferric chloride solution show a marked greenish-black coloration in the cortical collenchyma and the parenchyma of the meristeles, due to tannin.

### (c) STIPULES

The paired stipules are adnate to either side of the base of the rachis. They are about 10 to 20 mm. long and 1 to 2 mm. wide, subulate or linear, and hairy (Fig. 1, *A*, Fig. 5, *A* and Fig. 6, *A*).

EPIDERMAL CELLS of both upper and lower surfaces are small, elongated or polygonal, and sometimes with slightly wavy and slightly beaded anticlinal walls, measuring about H 12 to  $30\ \mu$ , Lev B 12 to  $26\ \mu$  and L 20 to  $80\ \mu$ . *Stomata* are present on both surfaces; they are elliptical in outline and measure about  $30\ \mu$  in length and  $20\ \mu$  in width (Fig. 6, *D*, *E* and *F*). Very numerous covering trichomes occur, especially on the midrib

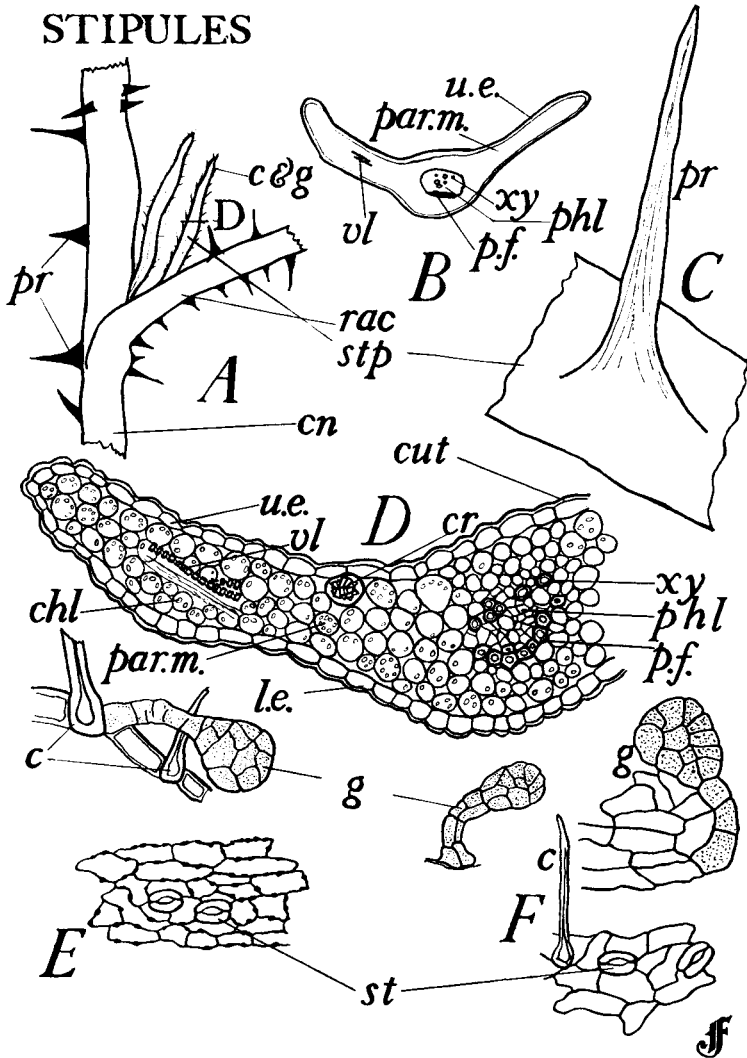


FIG. 6. Stipules of *Rubus loganobaccus* L. H. Bailey. *A*, paired stipules at base of rachis. *B* and *D*, transverse sections cut at the position *D*, Fig. *A*. *C*, prickle arising from lower surface of stipule. *E*, upper epidermis, showing stomata, also covering and glandular trichomes at the edge of the epidermis. *F*, lower epidermis, showing stomata, also covering and glandular trichomes, one of the latter from the edge of the stipule. *A*, x 1; *B* and *C*, x 40; *D*, *E* and *F*, x 200. *c*, covering trichome; *chl*, chloroplast; *cn*, cane; *cr*, cluster crystal of calcium oxalate; *cut*, cuticle; *g*, glandular trichome; *l.e.*, lower epidermis; *par.m.*, parenchymatous mesophyll; *p.f.*, pericyclic fibres; *phl*, phloem; *pr*, prickle; *rac*, rachis; *st*, stoma; *stp*, stipule; *u.e.*, upper epidermis; *vl*, veinlet seen in longitudinal section; *xy*, xylem.

and around the edges of the stipules; they possess the general characters of those of the upper epidermis of the leaflets, but vary greatly in size, measuring from about  $90\ \mu$  to about  $1,100\ \mu$  in length, and about 10 to  $28\ \mu$  wide at the bases (Fig. 6, *E* and *F*). Occasional *glandular trichomes* are present, often occurring around the edges; they have the general character of those found on the rachis and leaflets, but their stalks are sometimes uniseriate (Fig. 6, *E* and *F*).

Very small, slender, elongated pointed *prickles* were observed on the upper and lower surfaces of the midrib of some of the stipules examined; they were from 0.5 to 1.25 mm. in length (Fig. 6, *C*).

The MESOPHYLL has very simple structure, is undifferentiated and consists of rounded cells about 8 to  $26\ \mu$  in diameter; almost all of these cells contain chloroplasts, about  $4\ \mu$  in diameter. Many widely distributed idioblasts occur, containing cluster or rosette crystals of *calcium oxalate* about 10 to  $30\ \mu$  in diameter (Fig. 6, *D*).

The VENATION is simple, consisting of a central midrib and very minute, pinnate, secondary veinlets. The midrib consists of a very few lignified, mainly spirally thickened xylem elements about 8 to  $10\ \mu$  in diameter; there is but little phloem. The pericycle is evident, and here consists of a few, lignified, smooth-walled fibres, usually about  $280\ \mu$  in length and  $8\ \mu$  in diameter; these fibres are evident throughout the length of the stipule (Fig. 6, *D*).

#### POWDER

A No. 60 powder is green in colour; it has but little odour and a slightly astringent taste. When some of the powder is mixed with ferric chloride solution, a greenish-black colour is observed.

To examine the powder for structural features, it should be mounted in either 50 per cent glycerol solution, solution of chloral hydrate, or phloroglucin and hydrochloric acid. The diagnostic characters of the powder (Fig. 7) are as follows.

Numerous straight, or slightly curved, lignified fragments of *covering trichomes from the upper surface of the lamina*, up to about  $45\ \mu$  wide, apical fragments being solid, whilst basal fragments are hollow and pitted with simple pits; spiral markings are visible on some of these hairs but are not particularly prominent; curled fragments of *covering trichomes from the lower surface of the lamina*, up to about  $30\ \mu$  wide, which stain only feebly, or not at all, in mounts made with phloroglucin and hydrochloric acid (unless the powder is previously treated with ether); numerous *fragments of the lamina*, showing a transverse sectional view, about  $100\ \mu$  thick, with a *double palisade layer* in which there are rounded idioblasts, each containing a cluster crystal of calcium oxalate about 14 to  $36\ \mu$  in diameter; particles showing in surface view the slightly wavy-walled, beaded cells of the *upper interneural epidermis* of the lamina and usually, immediately beneath it, the palisade with its idioblasts; fragments showing the *lower interneural epidermis* consisting of wavy-walled, often slightly beaded cells with scattered anomocytic stomata and cicatrices of trichomes; fragments of the *veins* showing small, lignified vascular elements showing

annular, spiral, reticulate and pitted thickenings, and occasional files of small parenchymatous cells containing microclusters of *calcium oxalate*; fragments of the *prickles* consisting of elongated, *lignified sclereids* with simple, linear pits; infrequent fragments of *glandular trichomes* consisting of a multicellular, biserial stalk, and a multicellular, subspherical, glandular head about 60 to 70  $\mu$  in diameter.

POWDER

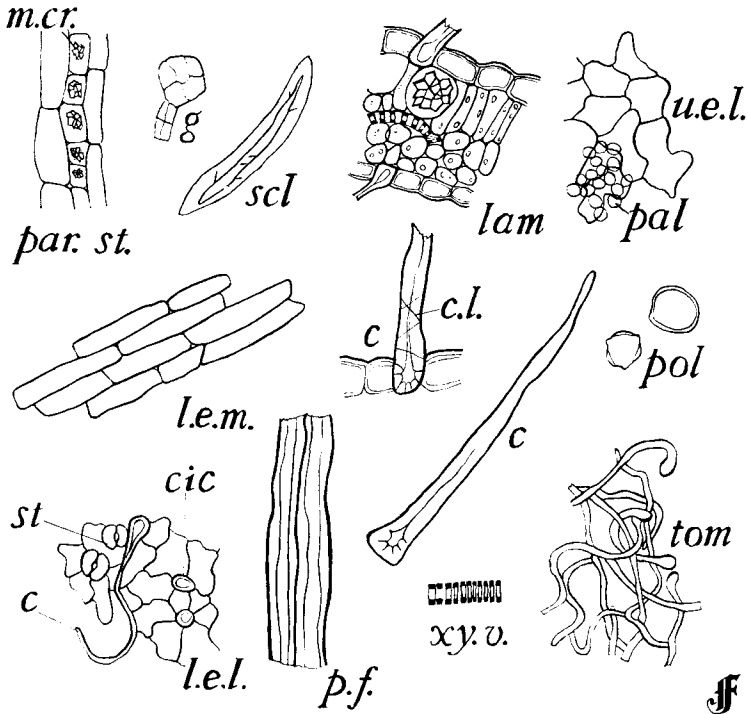


FIG. 7. Powder of the leaf of *Rubus loganobaccus* L. H. Bailey. All x 200. *c*, covering trichome; *g*, isolated head of a glandular trichome; *lam*, fragment of lamina in transverse section, showing upper and lower epidermises, idioblasts with cluster crystal of calcium oxalate, double palisade and spongy mesophyll; *l.e.l.*, lower epidermis of lamina; *l.e.m.*, lower epidermis of midrib; *m.cr.*, files of microcluster crystals of calcium oxalate, adjacent to phloem tissue; *pal*, palisade; *p.f.*, fragments of pericyclic fibres; *phl*, phloem; *scl*, sclereid of prickle; *sp.t.*, fragment of spiral tracheid; *st*, stoma; *t.b.*, trichome base; *tom*, fragment of curled, covering trichome from tomentum of lower epidermis of lamina; *u.e.l.*, upper epidermis of lamina.

SUMMARY OF THE ANATOMICAL CHARACTERS OF THE LEAF

1. The epidermises of the leaflets are characteristic. The *upper epidermis* consists of cells with slightly wavy, beaded anticlinal walls, and bears scattered, unicellular, lignified *covering trichomes* with acute, solid apices and thickened, pitted bases. The *lower epidermis* consists of cells with slightly beaded, wavy anticlinal walls, and bears curled, *covering trichomes* in sufficiently large numbers that they form a virtual tomentum;

these trichomes can be shown to be lignified only by first soaking in ether for several hours, before testing with phloroglucinol and hydrochloric acid. *Glandular trichomes* are present on the upper epidermises of midribs and secondary veins; they consist of a multicellular, biseriate stalk of about 5 to 8 cells in length, and a multicellular, subspherical, glandular head about 60 to 70  $\mu$  in diameter. *Stomata*, of the anomocytic type, occur in the lower epidermis only, and are oval in outline.

2. The *lamina* of the leaflet is thin and dorsiventral, with a well-developed, *double* palisade in which are rounded idioblasts, each containing a cluster crystal of *calcium oxalate*.

3. The midrib of the leaflet contains a meristele consisting of a *xylem* composed of lignified *tracheids* and *vessels* which exhibit annular, spiral, reticulate and pitted thickenings, a *phloem* consisting of simple sieve tubes with transverse or oblique sieve-plates, and rows of parenchymatous cells arranged in longitudinal files, each cell containing a microcluster of *calcium oxalate*.

4. *Prickles* of the midrib and rachis are composed of lignified, elongated sclereids with thick walls exhibiting linear pits.

5. Lignified pericyclic fibres are abundant, always occur in the rachis, but occasionally occur also in the midribs of leaflets.

6. The arrangement of the vascular bundles in the rachis is somewhat intermediate between that observed in the case of *R. idaeus* and that in *R. fruticosus*<sup>2</sup>. There are usually two small ridge meristeles in the upper part of the rachis, and usually from 4 to 6 in the lower part.

#### DISCUSSION

It is seen that the morphological and anatomical characteristics of the leaves of *R. idaeus* L., *R. fruticosus* L. and *R. loganobaccus* L. H. Bailey are similar in most general respects, but there are differences in detailed structures, some of which are diagnostic pharmacognostically. A fuller discussion of the common and differential characters of these leaves, also leaves of (a) other species of bramble and (b) cultivated varieties of *R. idaeus* and *R. loganobaccus* will be presented in a later communication; the following characters serve to distinguish leaves of *R. loganobaccus* from those of the two species described earlier<sup>1,2</sup>:—

1. Most diagnostic are the *covering trichomes of the lower epidermis of the lamina*, which are somewhat intermediate in character between those on the lower epidermises of the leaves of *R. idaeus* and *R. fruticosus*. They are 300 to 400  $\mu$  long and form a virtual tomentum which is, however, by no means as dense as that found in the case of *R. idaeus*. Lignification can be demonstrated only with phloroglucin and hydrochloric acid after preliminary treatment with ether or chloral hydrate solution; this fact affords further differentiation from leaves of *R. idaeus*, where the corresponding trichomes are unlignified, also from those of *R. fruticosus*, where they give a positive reaction for lignin without difficulty.

2. The *covering trichomes of the upper epidermis of the lamina* resemble, in general, those in the analogous position in the other two species, but

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frequently show a greater maximal length—up to 1,400  $\mu$  in specimens examined, compared with a maximum of about 500  $\mu$  in the case of *R. idaeus*, and 1,000  $\mu$  in the case of *R. fruticosus*.

3. The *epidermal cells of the interneural lamina* (both upper and lower) show a very well-marked beaded effect; this is not seen on leaves of *R. idaeus*, and only slightly on those of *R. fruticosus*.

REFERENCES

1. Fell and Rowson, *J. Pharm. Pharmacol.*, 1956, 8, 334.
2. Fell and Rowson, *ibid.*, 1957, 9, 293.
3. The Loganberry. *Advisory Leaflet No. 129*, The Ministry of Agriculture and Fisheries, H.M.S.O., London, 1952.
4. Clapham, Tutin and Warburg, *Flora of the British Isles*, Cambridge University Press, 1952, p. 463.