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**Autor:** Oteng-Yeboah, A.A.  
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## Morphology, anatomy and taxonomy of the genus *Remirea* Aublet (Cyperaceae)

A. A. OTENG-YEBOAH

### SUMMARY

The morphology and anatomy of the monotypic genus *Remirea* Aublet has been re-investigated. New observations on the vegetative and floral structures were made. The "corky organ" forming part of the spikelet structure is interpreted as the uppermost internode of the rachilla.

The taxon is considered as a distinct genus, closely related to *Mariscus* Gaertner. A subtribal grouping within the tribe *Cypereae* (Cyperaceae) is proposed.

This sub-tribe, *Kyllingeeae*, would embrace the following genera: *Courtoisia*, *Kyllinga*, *Queenslandiella*, *Remirea*, and *Torulinium*.

### RÉSUMÉ

La morphologie et l'anatomie du genre monotypique de *Remirea* Aublet ont été étudiées. De nouvelles particularités des organes végétatifs et floraux sont signalées. La structure charnue de l'épillet est interprétée comme étant l'entre-nœud supérieur de la rachille. *Remirea* est considéré comme un genre distinct, voisin de *Mariscus* Gaertner. L'auteur propose une subdivision de la tribu des *Cypereae* (Cyperaceae). Ainsi la sous-tribu des *Kyllingeeae* grouperait les genres suivants: *Courtoisia*, *Kyllinga*, *Mariscus*, *Queenslandiella*, *Remirea* et *Torulinium*.

The affinities of the monotypic genus *Remirea* Aublet within the family Cyperaceae has been in doubt for some time now. Some authors e.g. Kükenthal (1935) included it in the tribe *Rhynchosporae*, while others e.g. Chermeson (1922) put it in the tribe *Cypereae*. Even with the latter group, there are some authors e.g. Koyama (1961) who preferred to treat it as a species of the complex genus *Cyperus*.

The main feature that has brought *Remirea* into this dispute is to be found in the spikelet. It is that distinct "corky organ" which is found tightly clasping the fruit from the adaxial side. The homology of this organ has been discussed by many authors e.g. by Brown (1810: 236), Nees (1835, 1854), Kunth (1837: 138 f.), Böckeler (1868: 435 f.), Bentham (1883), Clarke (1883), Chermeson (1922), Kükenthal (1935: 30), Ohwi (1944), Holttum (1948), Kern (1958: 795-798), and Koyama (1961).

Up to the present, there is no unanimous agreement on its interpretation. One group of authors pioneered by Brown and including Nees, Böckeler, Bentham, Clarke, Kükenthal, Ohwi and Holttum agree that it is an incrassate flower-bearing glume; therefore the genus is a member of the *Rhynchosporae*. Another group pioneered by Kunth and including Chermeson, Kern and Koyama agree that it is an

incrassate upper internode of the rachilla, thus claiming it to belong to the tribe *Cypereae*.

Recent evidence from embryo morphology (Van der Veken, 1965) and leaf anatomy (Metcalf, 1971) shows a strong affinity of the genus *Remirea* to the *Cypereae*.

The aim of the current investigation into the morphology and anatomy of the taxon is to contribute to the present knowledge of the genus *Remirea* and to assess its relationships with the rest of the *Cypereae* in the light of available information.

### Material and methods

Three voucher specimens from India and Singapore and a number of specimens collected along the coastal areas of the Central and Western Regions of Ghana were studied. The three voucher specimens were *Tenasserim & Andamana* 6239 (Herb. E) collected in 1862 from India, *J. Sinclair* 38907 and 39042 (E) collected 1950 from Singapore.

The methods used in the anatomical studies were those described by Metcalf (1971).

### Observations

*Habit*: perennial with long, slender, branched, creeping rhizome.

*Rhizome*: with elongated internodes, rooting at the nodes (Fig. 1a). Transverse section (Fig. 1b-c) circular in outline. Epidermis cells small, equal in size, supported at intervals by rounded, hypodermal sclerenchyma strands. Cortex; outer, consisting of 2-3 layers of slightly lignified, parenchymatous cells with small intercellular spaces; inner, consisting of 3-5 layers of parenchymatous cells, sometimes with intercellular spaces. Rounded sclerenchyma fibres, 13-15 arranged in a ring, occur inside the inner cortical layers and sometimes at the boundary between the inner and outer cortical layers. Endodermoid layer well differentiated, composed of cells with strong, U-shaped thickenings, the outer tangential walls of which sometimes conspicuously thickened. Pericycle composed of 1-2 layers of strongly thickened, sclerified cells. Pericycle in the nodal region 3-4 layers, well differentiated except at an area where there is an apparent endogenous outgrowth of the stele. Vascular bundles collateral, mostly with 2, occasionally 3-4 conspicuous metaxylem elements, evenly scattered throughout the stele; smaller vascular bundles, often with only one metaxylem element, occur at the periphery of the stele attached to the pericycle. Pith consisting of thin-walled parenchymatous cells, with abundant secretory cells. The vascular bundles in the nodal region appear crowded towards one side, and the parenchyma cells between them are reduced to about 1-2 layers of sometimes sclerified cells.

*Shoots*: are given off singly from the nodes of the rhizomes; the basal and sub-basal parts often indistinguishable from the rhizome, in that they have elongated internodes which are sometimes shortened especially in the upper parts and covered with scales which gradually differentiate as bladeless sheaths and then bladed sheaths, upwards ensheathing the internodes; roots at the nodes, and sometimes branched shoots.

Outline circular in transverse section (Fig. 1d-e). The following tissues are distinguished: Epidermis, cortex, endodermoid layer, and a stele. Epidermis as in the rhizome. Cortex differentiated into a 3-layered outer and a 3-layered inner cortical zone as in the rhizome, with a ring of rounded sclerenchyma fibres distributed

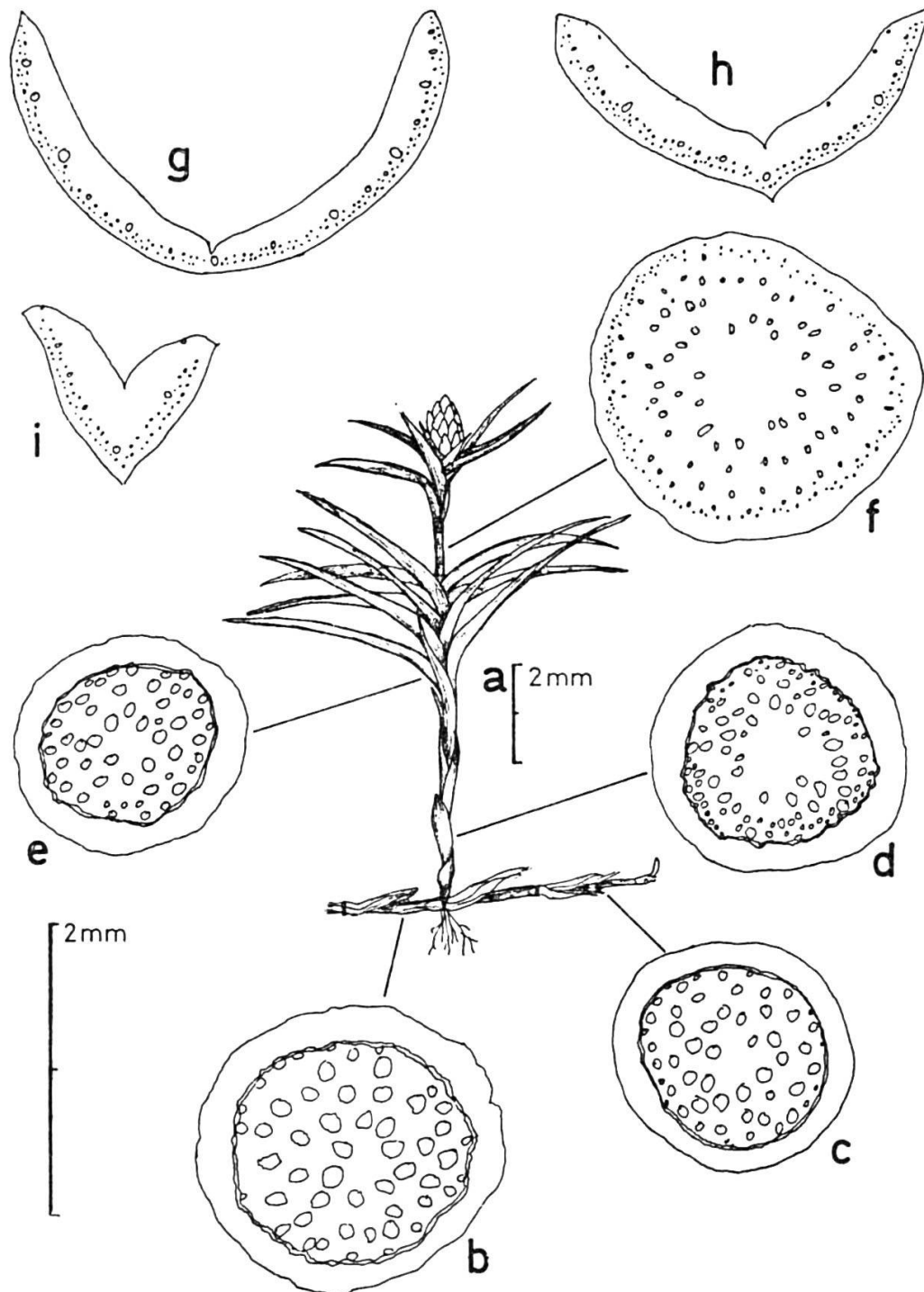


Fig. 1. — *Remirea maritima*. Anatomical sections.

a: General habit. b — i: Transverse sections of different organs. b: Old rhizome; c: young rhizome; d: basal part of aerial stem; e: upper part of aerial stem; f: culm; g: basal portion of leaf and involucre bract; h: middle portion of leaf and involucre bract; i: tip portion of leaf and involucre bract.

between the outer and inner cortex. Endodermoid layer differentiated as in the rhizome. Stele: pericycle consisting of 3-4 layers, uniting with smaller vascular bundles at the periphery of the stele. Vascular bundles collateral, congested, gradually becoming less congested towards the centre. Cells between the vascular bundles small, thin-walled, rounded, parenchymatous. Pith differentiated, cells thin-walled, much larger, with numerous small, often triangular intercellular spaces between them.

The upper part of the shoot is distinguished as the *culm* which bears the inflorescence at its summit. It is nodeless, cylindrical to trigonous, often very short, sometimes elongated. Transverse section of culm sub-circular in outline (Fig. 1f). Central ground tissue solid, composed of rounded to polygonal, large parenchyma cells with small, rounded triangular to rectangular intercellular spaces between them. Secretory cells present. Epidermis composed of small cells, uniformly shaped, cutinized at their outer tangential walls, minutely papillose. Epidermis supported at regular intervals in the hypodermal region by small angular to rectangular sclerenchymatous strands. Assimilatory tissue composed of chlorenchyma which is conspicuously radiate, especially around the smaller peripheral vascular bundles; cell-form otherwise similar to that of the central ground tissue. Vascular bundles numerous, minor ones embedded in chlorenchyma with much less differentiated elements, larger ones extending towards but not quite reaching the centre of the culm. Bundle sheath 2-layered; inner sheath parenchymatous, more obvious in the vascular bundles near the inner periphery of the assimilatory tissue; outer sheath fibrous, uniformly thick-walled, often 2 layers thick.

*Leaves*: sub-basal to cauline, lower ones bladeless, upper ones bladed, channelled, liguleless; leaf sheath open or appearing split due to the crowding of leaves on the shoot.

Outline in transverse section: basal part of leaf shows a thinly crescentiform outline without a keel (Fig. 1g). Middle portion also shows a thinly crescentiform outline but with a prominent keel (Fig. 1h). Distal (tip) portion shows a thickly crescentiform to V-shaped outline with a prominent keel (Fig. 1i). A shallow and narrow U-shaped adaxial groove occurs, and the margins taper or round off to a point. Epidermis: adaxial and abaxial epidermal cells uniformly sized. Single epidermal cells over minor sclerenchyma strands in the abaxial region much smaller. Sometimes 2-4 epidermal cells, also smaller, next to some minor, adaxial sclerenchyma strands. Cells in the adaxial groove  $\pm$  inflated, translucent. The outer tangential walls cutinized, showing minute papillae. Stomata are confined to abaxial surface only. Mesophyll consisting of: adaxially 3-5 layers of inflated, translucent cells, and abaxially chlorenchyma which radiate around all the vascular bundles. Chlorenchyma consists of slightly lobed cells. Occasionally, in between the radiate chlorenchyma, solitary translucent cells occur. Vascular bundles arranged in 2 distinct rows parallel to the leaf surface, all embedded in the chlorenchyma. About 6-12 principal bundles, oval to oblong in outline, are embedded in chlorenchyma near the boundary with translucent tissue. The principal vascular bundle below the adaxial groove with abaxial, winged, thinly crescentiform or abaxial, pulviniform girder, and a small adaxial cap. Remaining vascular bundles numerous, much smaller, subcircular in outline and with much reduced or less differentiated conducting

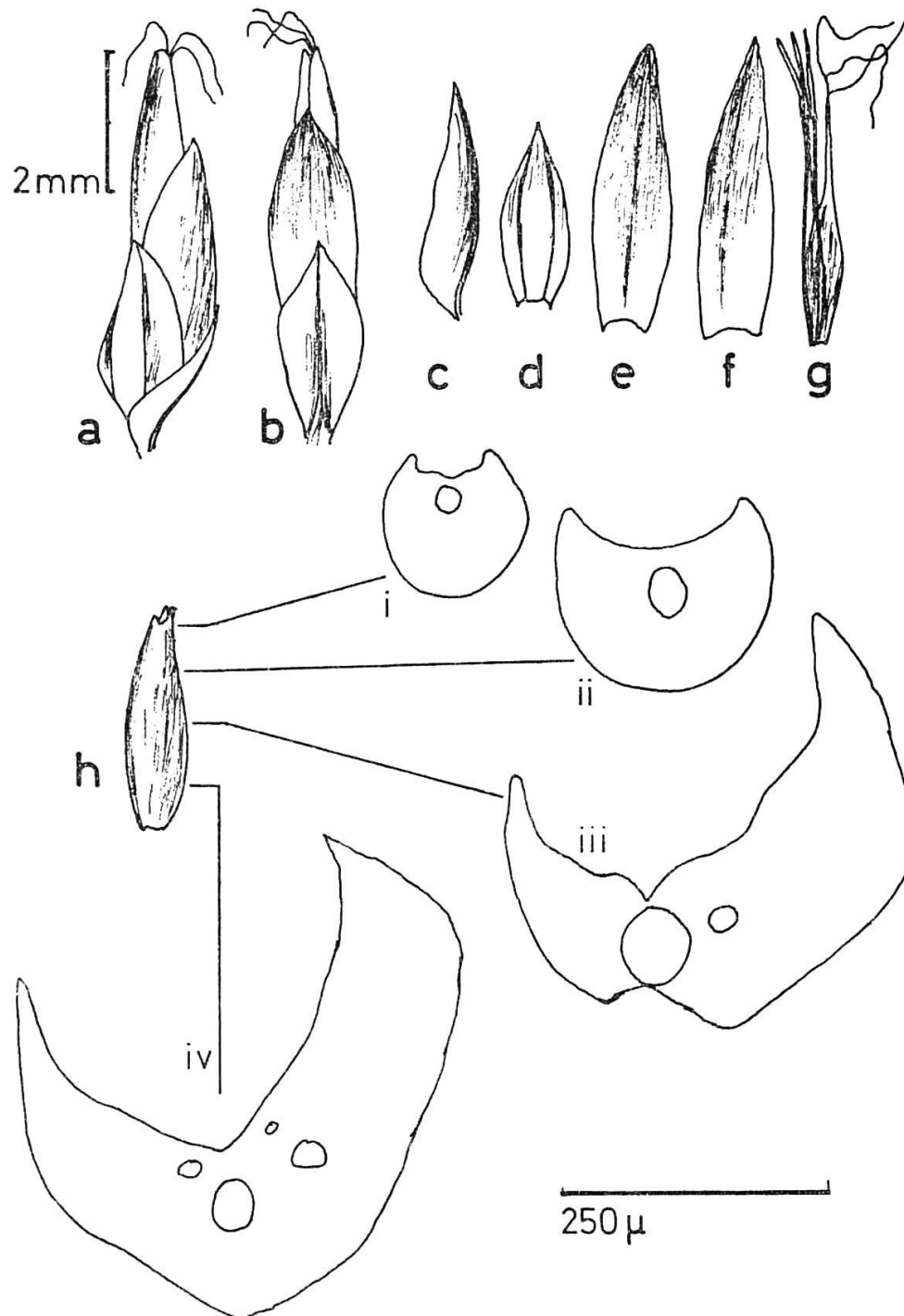


Fig. 2. — *Remirea maritima*. External spikelet structure.

a—b: Whole spikelet, a side-view, b front-view. c: Bract. d: Spicular prophyll. e—f: Glumes. g: Flower. h: "Corky organ", the incrassate uppermost internode of the rachilla; i—iv show the outlines of transverse sections in various parts of the "corky organ".

elements. Bundle sheath 2-layered; inner sheath parenchymatous; outer sheath of thick-walled, fibrous cells. Secretory cells abaxially located in the radiate chlorenchyma.

*Inflorescence*: terminal, often with one to few contracted heads, each head containing numerous spikelets. Inflorescence subtended by few to many channelled, leaf-like *involucral bracts*, longer ones below.

In transverse section, the involucral bracts show an internal structure similar to that of the leaf described above.

*Spikelets*: sessile, oneflowered, deciduous. The spikelet consists of a bract, a spicular prophyll, two glumes, and a flower. The rachilla is incrassate at its uppermost internode, whose wings are involute, thus embracing the flower. It often disarticulates above the bract and the spicular prophyll.

The morphology of the spikelet and the anatomy of the distinct corky organ, referred to here as the uppermost internode of the rachilla, and found clasping the flower/fruit from the adaxial side of the spikelet are illustrated in Fig. 2a-h. The spikelet is composed of a basal bract (Fig. 2c), a spicular prophyll (Fig. 2d), i.e. the glumelike organ following a reduced bract in the sessile spikelets of the tribe *Cypereae* (Oteng-Yeboah, 1972), two glumes (Fig. 2e & f, respectively), the first one being empty and situated at the back of the corky organ, the latter fertile, facing and sheathing the corky organ, one flower (Fig. 2g) whose three stamens are placed between the

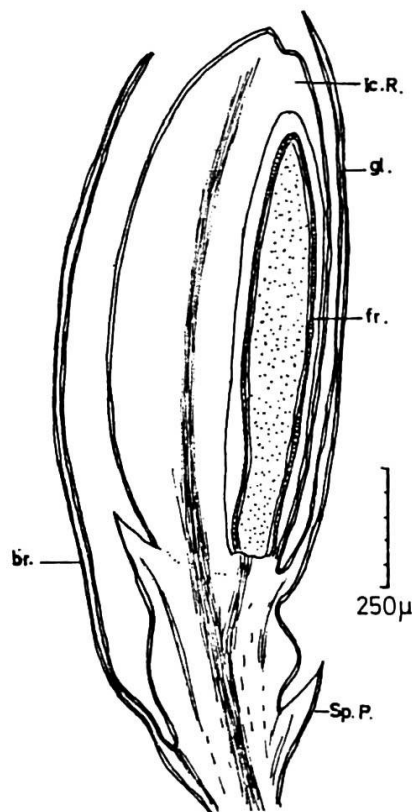


Fig. 3. — *Remirea maritima*. Spikelet, longitudinal section.

lc. R. = incrassate rachilla (the "corky organ"), Sp. P. = spicular prophyll, br. = bract, fr = fruit, gl. = glume.



second, fertile glume (Fig. 2f) and the fruit, and the "corky organ" (Fig. 2h) which partially clasps the fruit, bearing a small cucullate appendage at its apex.

Fig. 3 shows a longitudinal section through the entire spikelet. This section portrays the spikelet as having one main nerve or vasculature in the "real" rachilla, with traces to the spicular prophyll and the glumes. Below the point of insertion of the corky organ, the main nerve appears bifurcating or branching, with one nerve leading straight into the corky organ, the other one into the flower to give traces to the stamens and the pistil. In Fig. 4 transverse sections of the corky organ are illustrated. It has one predominant and distinct nerve which may or may not subdivide from the base upwards. These vasculatures have very distinct cells with thickened cell walls (Fig. 4a), sometimes occupying the whole height of the centre of the organ, or situated more towards the adaxial part. The winged lamina-like part of the organ and the area around the vasculatures are filled with rounded to polygonal, sometimes spongy cells with secretory cells irregularly distributed in them (Fig. 4b). Bordering the outside of the organ (Fig. 4c) adaxially and abaxially, there is a slightly lignified epidermal layer.

*Glumes*: 2, distichous, elliptic, apex obtuse, midnerve extending to the apex, often excurrent, awnless, smooth on the margins and on the back of the keel.

*Stamens*: 3, anthers linear, with obtuse smooth crests.

*Pistil*: Stigmas 3, weak and delicate, smooth. Style smooth. Ovary oblong, trigonous, 2 mm long, shortly apiculate, minutely dotted, reddish brown.

In transverse section, the outline of the ovary is convex at the abaxial surface and slightly concave at the adaxial surface (Fig. 2h, i—iv). Pericarp 63–84 $\mu$  thick, differentiated into exocarp, mesocarp and endocarp layers. Exocarp one-layered, ca. 15 $\mu$  high; cells isodiametrical with thin anticlinal and outer tangential walls. Inner tangential walls have finger-like ornamentations and bear silica bodies. Mesocarp 2-layered, ca. 21 $\mu$  high, uniformly thickened, the cell lumen small < 2 $\mu$  in diameter, cell walls very thick. Number of vasculatures 3, corresponding to the number of carpels. Endocarp one-layered, c. 15 $\mu$  high, consisting of radially elongated cells with thickened cell walls.

### Discussion and conclusions

Recent information from literature and the author's observations on the morphology and anatomy presented above leave no doubt about the relationship of the genus *Remirea* to the tribe *Cypereae*, and its distinctness as a genus.

Van der Veken (1965) showed that the structure of the embryo of *Remirea* fall into his "Cyperus type", in which the general form is ellipsoidal with a basal coleoptile and a lateral root cap. This type of embryo has been observed in all genera belonging to the tribe *Cypereae*.

Metcalf (1971) mentions the markedly radiate chlorenchyma around the vascular bundles in the leaf, involucre bracts and culm; the development of adaxial translucent cells in the leaves and the involucre bracts; and the 2-rowed arrangement of the vascular bundles in the leaves and the involucre bracts as features which support the affinity of *Remirea* to the *Cypereae*.



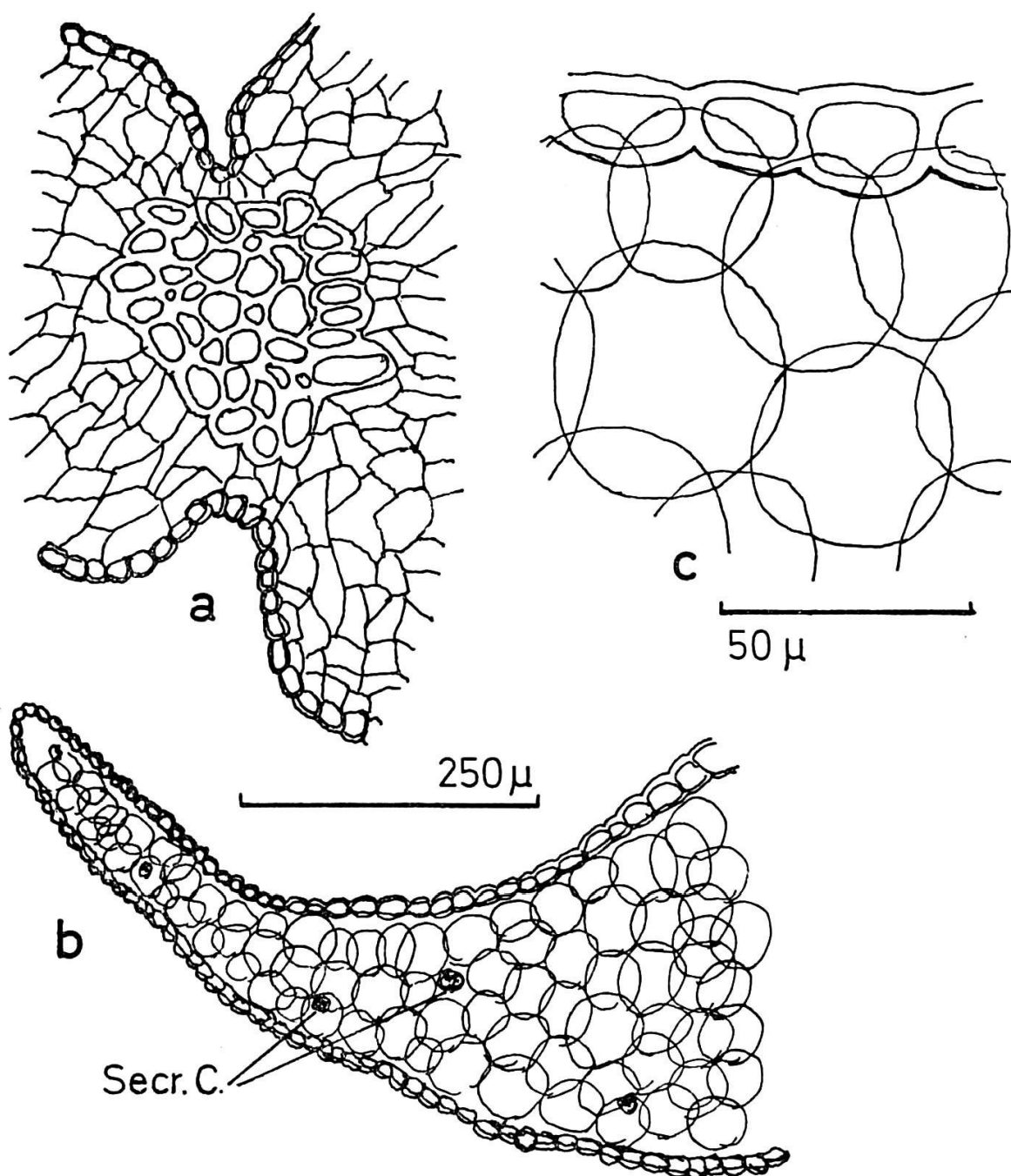


Fig. 4. — *Remirea maritima*. The "corky organ" (cf. Fig. 2). Transverse sections.  
 a: Midnerve region. b: Winged lateral region. c: Epidermal and cortical tissues. — Secr. C. = secretory cells.

The 2-layered bundle sheath of the vascular bundles, the inner sheath of which being parenchymatous, the outer one fibrous; the sessile, one-flowered, deciduous spikelet consisting of a bract, a spicular prophyll and two glumes which are distichously arranged; and the articulate rachilla, which disarticulates above the bract and sometimes also above the spicular prophyll; all these features also support the

affinity of *Remirea* to the *Cypereae*, notably *Mariscus*, *Kyllinga*, *Torulinum*, *Queenslandiella* and *Courtoisia*.

The incrassate "corky organ" in the spikelet has now been confirmed to be part of the rachilla and represents apparently its uppermost internode, by way of the relatively terminal position of the nerve trace going from the base of the spikelet into the "corky organ", and the lateral position of the traces going into the spicular prophyll, glumes and the flower. Furthermore, this organ is considered as an example of adaptation for dissemination within *Cypereae*.

The general habit of the plant—a long, slender, branched, creeping rhizome whose nodes give off single vertical shoots, the basal and subbasal parts of which are indistinguishable from the rhizome proper in their internal structure—also appears to be of some adaptive significance. On the basis of these two features, *Remirea* can be considered as a distinct genus, in much the same way as other genera of the family *Cyperaceae*.

With *Remirea* now confirmed as a distinct monotypic genus, belonging to the tribe *Cypereae*, a sub-tribal grouping of the latter can be suggested. The sub-tribe *Kyllingeeae* is thus proposed to comprise the following genera: *Remirea*, *Mariscus*, *Kyllinga*, *Torulinum*, *Queenslandiella* and *Courtoisia*. This sub-tribe is characterised as follows: markedly radiate chlorenchyma around the vascular bundles in leaf, involucre bract and culm; 2-layered bundle-sheath of the vascular bundles, with the inner sheath parenchymatous, the outer sheath fibrous; sessile, one- to few-flowered, deciduous spikelets, consisting of a bract, a spicular prophyll and distichously arranged glumes; rachilla articulate, disarticulating above the bract and sometimes above the spicular prophyll.

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