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II. *Notes on the Structure and Measurements of Cells of Hepaticæ.* By JAMES WILLIAMSON EDMOND, M.B., C.M.

The following notes were made by me last summer, while measuring the leaf-cells, spores, and elaters of some species of the Hepaticæ for Dr Carrington of Eccles. The size as well as character of the cells is sometimes important. Of course, when measurements are given they must be *average* measurements.

The order followed is that given by Cooke in his "British Hepaticæ," with some modifications by Dr Carrington.

1. *Mniopsis Hookeri*.—Cell-wall not thickened, the outline of each cell distinct. Those near the apex of the leaf irregularly quadrangular, and measure 1-700 in. long, and 1-1170 in. broad. Cells at base of leaf more elongated, measuring 1-700 to 1-583 long, and 1-1750 broad. The cells contain numerous granules of chlorophyll near the walls.

2. *Gymnomitrium concinnatum*.—Cell-wall thickened. After boiling the leaves in weak liq. potassæ, and adding tinct. of iodine and sulphuric acid, the cells are clearly defined. At the apex and margins of the leaves the cells are hexagonal, and often the angles are rounded. Towards the centre of the leaf they become oval, and near the base they are irregularly quadrangular. The margins of the cells present a double outline or contour, but there is no thickenings or "trigones" at the angles.

Cells at edge and apex measure 1-2300 in length and breadth; somewhat more to the interior of the leaf they are 1-1750 in length and breadth. The oval ones near the centre 1-1170 long and 1-1750 broad. Elongated quadrangular ones at base 1-500 to 1-580 long, and 1-1750 broad.

Elaters consist of a double spiral mahogany coloured fibre, somewhat flattened in appearance; length varies from 1-350 to 1-200; breadth at widest part varies from 1-4700 to 1-3500.

Spores also of a dark-brown colour, and of an irregularly rounded shape; average diameter 1-1750.

3. *Gymnomitrium crenulatum*.—Cell-wall much thickened. After applying the reagents mentioned above, the

outlines of the cells are clearly defined. Cells at the margin near apex of the leaf form crenations, and, as far as I observed in the specimens sent to me, they were destitute of colouring matter. Below the apex, and towards the base of the leaf, the marginal cells are flattened and form an even edge. Cells in the upper third of the leaf are elongated and hexagonal; those at the base are larger and have their angles rounded. They contain granules of colouring matter in their interior. Marginal cells at apex measure 1-850 long, and 1-1250 broad. Flattened marginal cells are 1-1170 long, and 1-1250 broad. Cells in upper third of leaf 1-875 long, and 1-1170 broad. Cells in lower third of leaf 1-700 long, and 1-1170 broad.

Elaters are similar to those of the previous species. They measure 1-350 to 1-175 long, and 1-4700 to 1-3600 broad.

Spores oval, and pretty regular in outline. They measure 1-1400 long, and 1-1750 broad.

4. *G. coralloides*.—Cell-wall thickened. Outlines are clearly defined by use of re-agents.

The margin of the leaf consists of a row of elongated quadrangular cells. The cells in the interior of the leaf are larger and polygonal.

Marginal cells are 1-1250 to 1-1400 long, and 1-2333 broad.

Cells at upper part of leaf are 1-1000 to 1-875 long, and 1-1400 to 1-1170 broad.

Cells at base of leaf 1-800 to 1-700 long, and 1-500 broad.

5. *Nardia emarginata*.—Cell-wall thickened; after application of re-agent outlines become clear. Margin of the leaf is formed by a distinct row of quadrangular cells placed side by side. They measure 1-875 long, and 1-1170 broad. The cells in the upper third of the leaf are hexagonal, with distinct "trigones" at their angles. Those near the apex measure 1-1170 in diameter; those lower down are 1-700 to 1-600 long, and 1-875 to 1-777 broad. The cells at the lower part of the leaf gradually elongate till they lose the hexagonal form, and the "trigones" also become less distinct. These cells measure 1-438 long, and 1-1000 to 1-875 broad. In this part of the leaf often a "trigone" may be seen, not at an angle between two cells, but on some intermediate point of the wall between two cells.

The *trigones* measure 1-1750 in diameter.

Elaters are similar to those already described, and measure 1-140 to 1-100 long, and 1-1750 broad.

Spores are round, and measure 1-1400 in diameter.

Variety robusta very similar to typical specimen, only that the cells are somewhat smaller.

The marginal cells measuring 1-1400 long, and 1-1750 broad.

Cells in upper third of leaf 1-1170 in diameter.

Cells at the base of the leaf 1-580 to 1-500 long, and 1-1750 to 1-1170 broad.

Variety minor.—Marginal cells not so regular as in typical *N. emarginata*, and measure 1-1170 long, and 1-1750 broad.

Cells in upper third of leaf 1-875 long, and 1-1170 broad, and similar in appearance to the type.

Cells at lower third 1-700 long, and 1-1170 broad.

Elaters, 1-180 to 1-140 long, and 1-3500 broad.

Spores, 1-1170 in diameter.

6. *N. Funckii*.—Cell-wall greatly thickened. After application of the re-agent the wall is well defined. Marginal cells do not differ from cells in the interior of the leaf. Cells are hexagonal in shape, with rounded angles. There are no trigones. They contain numerous chlorophyll granules in their interior near the centre. Cells at the apex measure 1-1400 to 1-1170 in diameter. Those in the middle of the leaf are more angular than those at the apex and margin, and measure 1-875 long, and 1-1000 broad. The angles between the cells are slightly thickened, but do not form trigones. The cells at the base are like those of the middle of the leaf, and measure 1-700 long, by 1-1750 broad.

G. adustum, considered by Dr Carrington a variety of *N. Funckii*, does not differ from *N. Funckii* in the microscopic character of the leaf cells. The marginal cells are arranged regularly, although they do not differ in shape from those of the interior of the leaf.

Marginal cells measure 1-1750 to 1-1400 long, and 1-2333 to 1-1750 broad.

Cells in upper third 1-1400 to 1-1000 long, and 1-1750 broad.

Cells at base 1-700 to 1-580 long, and 1-1400 to 1-1170 broad.

Variety α.—Cells at apex measure 1-1750 long, and 1-2333 broad; at base, 1-875 to 1-700 long, and 1-1750 broad.

Variety β.—Cells at apex, 1-1750 in diameter; at base, 1-1170 long, and 1-1750 broad.

7. *Nardia Mulleri.*—Cell-wall thickened, requiring the use of re-agents. Leaves and cells are very like *G. concinnatum*. A series of six or eight rows of elongated cells run up the middle of the leaf almost to the apex, forming a kind of midrib. These cells measure 1-300 long, and 1-1750 broad. Towards the upper part of the leaf they gradually get shorter, and are lost in the other cells near the apex. The marginal cells do not differ from those in the interior of the leaf; they form slight crenulations at the margin of the leaf, and measure 1-2333 to 1-1750 across. In the upper third of the leaf the cells are more or less hexagonal, and measure 1-1750 to 1-1400 long, and 1-2300 broad. At the base the cells have the same character, only they are proportionately longer, being 1-700 long, and 1-1400 broad.

8. *N. sphacelata.*—Cell-wall thickened. Margin of leaf composed of small quadrangular cells placed side by side; length, 1-1750 to 1-1170; breadth, 1-2300 to 1-1750.

Cells of upper part of leaf hexagonal, and are 1-1170 to 1-875 long, and 1-1400 to 1-1170 broad.

Cells at base 1-700 to 1-600 long, and 1-1170 broad. These cells are somewhat oval in shape. The outlines of the cells are double, and there are distinct trigones at the angles measuring 1-3500 to 1-5000.

9. *N. scalaris.*—Cell-wall only slightly thickened. Trigones faintly visible before application of re-agent. Margin of leaf composed of a distinct row of superior cells placed side by side. The interior of the leaf is made up of hexagonal cells. They contain three to five or more granules in their interior.

Marginal cells measure 1-636 long, and 1-875 broad.

Cells in upper third of leaf 1-700 to 1-583 long, and 1-875 broad.

Cells at base elongated and hexagonal, 1-435 to 1-380 long, and 1-700 broad.

Trigones, 1-2600 across.

Spores irregularly round, and measure 1-1500 to 1-1400 across.

Elaters 1-175 to 1-100 long, and 1-2300 to 1-1750 broad.

10. *N. compressa*.—Cell-wall thickened, but not very much. After applying re-agent, cells are well defined, and trigones are seen at their angles.

Marginal cells squarish, and measure 1-875 across.

Interior cells are polygonal or irregularly hexagonal, near the base they are elongated, and somewhat oval.

Cells near apex are 1-500 to 1-700 long, and 1-700 to 1-800 broad.

Cells at base 1-350 to 1-270 long, and 1-875 to 1-580 broad.

Trigones, 1-3500 to 1-3000 across.

Spores, 1-1400 to 1-1160 across.

Elaters, 1-150 to 1-100 long, 1-2300 to 1-1750 broad.

11. *Trichocolea tomentilla*.—Leaves composed of elongated cells joined end to end. The cell-wall is not thickened. The length of cells at the apex is 1-350, somewhat lower down they are 1-250; breadth at apex 1-1750, while lower down it is 1-1160.

Spores nearly round, 1-2300 in diameter.

Elaters, 1-230 to 1-170 or more long, and 1-1750 broad.

12. *Odontoschisma (Adelanthus) decipiens*.—Cell-wall greatly thickened. The leaves are tridenticulate. After applying the re-agent the cell-wall is clearly defined. It has a double contour, and there are trigones at the angles.

Cells at the end of the spines triangular, 1-400 long, and 1-700 broad at the base.

Cells at margin quadrangular, 1-780 to 1-700 broad, and 1-600 long.

Cells in the interior of leaf hexagonal, and 1-700 to 1-500 in diameter.

Cells at base the same as those in the upper part.

Trigones, 1-300 across.

13. *Odontoschisma Sphagni*.—Cell-wall thickened. After using the re-agent the walls have a double outline which is very delicate. Marginal cells are polygonal, the free edge is even. There are slight spaces at the angles of the cells, but no trigones.

Length of marginal cells 1-875, breadth 1-1400.

Cells in upper third 1-780 long, and 1-1170 broad.

Cells in lower third 1-580 long, and 1-875 to 1-700 broad, and of an oval shape.

Stipules consist of cells more or less oval, terminating in points in which the cells become more or less triangular. These cells measure 1-500 long, and 1-1170 broad.

Spores round, 1-1750 across.

Elaters, 1-70 long, and 1-1750 broad.

14. *Odontoschisma Carringtonii*.—Cell-wall very much thickened (guttate areolation). After the re-agents are employed the double outline and trigones are very clearly seen.

Marginal cells are quadrangular, placed end to end along the edge of the leaf. They measure 1-1160 long, and 1-1760 broad.

Cells in upper third hexagonal, and are 1-1160 to 1-1000 each way.

Cells about the middle of leaf are 1-780 in diameter.

Cells near the base are elongated, and nearly quadrangular. They vary from 1-580 to 1-390 long, and 1-1160 to 1-875 broad.

Trigones at the angles are large, and the portion belonging to each cell is distinct; they measure 1-1750 across.

15. *Plagiochila spinulosa*.—Cell-wall greatly thickened (guttate areolation). Re-agent defines cell-wall, and shows the trigones. Cells at the edge of leaf have their free margin straight, otherwise they look like those of the interior, which are hexagonal. Cells in the spines along the margin elongated or triangular. Trigones distinct and large.

Cells in spines measure 1-780 to 1-700 long, and 1-1170 to 1-1000 broad.

Cells near apex 1-1400 to 1-1170 long, and 1-1750 to 1-1400 broad.

Cells at margin 1-875 long, 1-1170 broad.

Cells at base 1-580 to 1-470 long, and 1-1170 broad.

Trigones, 1-1750 in diameter.

16. *P. tridenticulata*.—Cells distinct without preparation, more or less rounded in form, containing numerous chlorophyll granules filling up the interior. There are slight swellings at the angles of the cells, but no distinct trigones.

Cells at apex are 1-1170 by 1-1000.

Cells in upper third 1-875 to 1-780 long, and 1-1170 to 1-1000 broad.

Cells at base 1-700 to 1-580 long, and 1-1170 to 1-1000 broad.

Trigones, 1-4700 in diameter.

17. *P. interrupta*.—Cells distinct without preparation. They contain granules of chlorophyll near their margin. Marginal cells quadrangular, those inside hexagonal.

Marginal cells measure 1-875 to 1-700 long, and 1-1170 broad.

Cells near apex 1-1170 across, to 1-700 long, and 1-875 broad.

Cells at base 1-700 to 1-580 long, and 1-1170 to 1-1000 broad.

There are swellings at the angles which, after application of the re-agent, appear as trigones, measuring 1-4700. In a variety with purple leaves, after preparation with the re-agent, the trigones measure 1-3500 to 1-2300 across. The cells also are slightly larger than those of the typical specimen, those at apex being 1-1000 each way. At the base they are 1-700 to 1-440 long, and 1-1170 to 1-700 broad.

18. *P. asplenoides*.—Cells well defined without preparation. Those at the margin are quadrangular, and those towards the interior hexagonal. Contain chlorophyll granules round the edge of the cells. No trigones.

Cells at margin are 1-1170 each way.

Cells in upper third of leaf 1-875 to 1-700 long, and 1-1000 to 1-875 broad.

Cells at base of leaf 1-440 to 1-350 long, and 1-1000 to 1-700 broad.

Spores round, 1-1400 to 1-1170 in diameter

Elaters, 1-175 to 1-117 long, and 1-2800 to 1-2300 broad.

19. *P. exigua*.—Areolation guttate. After preparation the cells are well defined. Marginal cells do not differ from those of the rest of the leaf except that they are slightly flattened. Cells of the interior of the leaf more or less hexagonal in form.

Marginal cells measure 1-1170 long, and 1-1750 broad.

Cells in upper third of leaf 1-875 to 1-700 long, and 1-1170 broad.

Cells in lower third of leaf 1-700 to 1-500 long, and 1-1750 broad.

20. *Scapania compacta*.—Cell-wall thickened. After preparation with the re-agent the outlines become distinct.

Marginal cells flattened, and are 1-1750 to 1-1170 in diameter.

Cells near apex hexagonal, and are 1-1170 to 1-875 long, and 1-1170 to 1-1000 broad.

Cells near base, 1-875 to 1-500 long, and 1-1170 broad.

Spores, 1-1400 in diameter.

Elaters, 1-140 to 1-90 long, and 1-1400 to 1-1170 broad.

21. *Scapania æquiloba*.—Leaves slightly papillose (areolation guttate). Margins of the leaves spiny. Cells hexagonal, with a double outline. No special marginal cells. Basal cells elongated, and oval or quadrangular.

Cells near apex measure 1-1750 to 1-1170 across.

Cells at base 1-1170 to 1-700 long, and 1-1750 to 1-1400 broad.

Spores, 1-1400 in diameter.

Elaters, 1-175 to 1-90 long, and 1-2300 broad.

Specimen agreeing with *S. æquiloba* in character, only not papillose; agrees also in microscopic character.

Cells near apex 1-1750 to 1-1400, by 1-1400 to 1-1170; those near base 1-875 to 1-500 long, and 1-1750 to 1-1400 broad.

22. *S. subalpina*.—Leaves spiny at the edges. Cell-wall slightly thickened. Chlorophyll granules arranged round the cell-wall. After preparation the appearance is very like that of *S. æquiloba*.

Cells near apex are 1-1170 long, and 1-1750 to 1-1170.

Cells at base are 1-875 to 1-583 long, and 1-1750 broad.

Spores, 1-1750 to 1-1400 in diameter.

Elaters, 1-230 to 1-140 long, and 1-3500 broad.

23. *Scapania undulata*.—Margin of leaf even, no spines. Cell-walls slightly thickened. Chlorophyll granules arranged round the margin of the cell, very like *S. subalpina*. After application of re-agent it is also very like *S. subalpina*.

Cells at apex measure 1-1750 long, and 1-2330 broad.

Cells at base 1-700 to 1-500, and 1-1170 broad.

Spores, 1-1750 to 1-1170 in diameter; common size, 1-1400.

Elaters, 1-140 to 1-70 long, and 1-3500 to 1-2330 broad.

24. *Scapania uliginosa*.—Cells well defined without preparation, although the cell-wall is somewhat thick, and of a reddish brown colour. Granules of chlorophyll arranged round the wall. Marginal cells similar to the cells of the interior, and placed end to end. The cells are irregularly hexagonal.

Marginal cells measure 1-1170 to 1-875 long, and 1-1750 broad.

Cells in upper third 1-875 across.

Cells at base elongated, 1-350 long, and 1-580 to 1-438 broad. Application of re-agent scarcely alters the appearance of the cells; imperfect trigones are, however, seen at the angles, measuring 1-3500 across.

Spores, 1-1750 to 1-1170 across.

Elaters, 1-230 to 1-140 long, and 1-2330 broad.

25. *Scapania nimbosa*.—Leaves of a rich crimson; margin of leaf spiny. Cell-wall much thickened, forming guttate areolation. Boiling with KHO removes the colour. The cell-wall is defined, and of a dark-brown colour, while the interior of the cell is light, and contains two or three large oval or rounded granules from 1-3500 to 1-2330 in diameter. Spines at edges of leaves are composed of several elongated cells joined together, which measure 1-580 to 440 long, and 1-1750 broad.

Margin composed of a row of squarish cells 1-1750 in diameter.

Cells near apex regularly hexagonal, 1-1170 in diameter, with trigones at the angles, measuring 1-2330 across.

Cells near base 1-700 long, and 1-875 broad.

26. *S. irrigua*.—Cell-wall not thickened, and of a pale green colour. Cells contain numerous chlorophyll granules arranged round near the wall. Margin of leaf even; no special marginal cells; an occasional cell, however, projects beyond the rest, forming a slight irregularity.

Cells near apex almost square, 1-1170 to 1-875 across.

Cells at base oval, 1-580 to 1-440 long, and 1-1170 broad.

Small thickenings at some of the angles less than 1-3500 across.

Spores, 1-2330 across, and yellowish brown in colour.

Elaters, 1-230 to 1-140 long, rarely 1-70 long, and 1-3500 broad.