

§ 1.—GENERAL CONCLUSIONS.

From the results of the microscopical studies which I have made of the *Phormium tenax*, I conclude—

1. That the best fibres are those which have the smallest cavity, and the greatest thickness of wall.
2. That the fibres at different parts of the leaf are of very different values. As the leaf develops from above downwards, the fibres at the apex will be much older than those at the base. Microscopical examination also shows that the fibres at the base (lower part of the butt) and apex (last inch or two of the leaf) ought to be rejected. The leaves themselves ought also to be very carefully selected.
3. That the fibres situated near the under surface of the leaf are often inferior in quality, and that the microscopic structure of the leaf shows that these bundles can only be separated from the tissues with the greatest difficulty.
4. That no cement exists binding the cells together; the so-called cement of Captain Hutton being the primary cell wall, consisting of cellulose, and easily soluble in chlorate of potash and nitric acid.
5. That the gum existing on the epidermis of the upper surface is not likely to damage the fibres in any way, and can be easily got rid of along with the epidermis.
6. That the differences, chemical and microscopical, between New Zealand flax, and Russian hemp, and Irish flax, render it improbable that the New Zealand flax can ever be profitably applied to the same uses.
7. That the resemblances, chemical and microscopical, between New Zealand flax and Manilla hemp show that New Zealand flax ought to furnish valuable material for the manufacture of ropes, &c. For this end, I would urge that the fibro-vascular bundles be extracted from the leaf as nearly entire as possible, and with care, taking advantage of the cellular sheath surrounding them, this ought to be practicable; but the fibres close to the inferior epidermis ought not to be removed.
8. That as the Natives have overcome all the difficulties, a process as simple as possible ought to be employed, and while the bundles are not broken up into their ultimate cells, every care ought to be taken to preserve the natural oily and fatty matters in the fibre.

§ 2.—STRUCTURE OF THE BUTT OF THE FRESH LEAF.

A.—Lower portion.

The butt, or lower portion of the leaf, may be more accurately described as the *sheath*. Microscopically it presents two very different kinds of structure, the basal portion having the tissues arranged in a very different manner from those at the upper portion of the butt or sheath of the leaf.

The basal portion of the butt is generally of a reddish brown colour, and contains a peculiar coloured substance in many of the cells. Besides this colouring matter, very large crystals of *calcium oxalate* were also observed. On section the basal portion exhibits (with a power of about 50 diameters) an upper and a lower epidermis, with a quantity of cellular tissue, while scattered up and down in the cellular tissue the fibro-vascular bundles are seen. The upper superior, or inner epidermis, is composed of minute cells, the outer or free wall not being greatly thickened. Beneath is the cellular tissue of the leaf, the cells of which for a short distance are small and densely packed together. More towards the central portion of the leaf, the cells show well marked intercellular spaces (air spaces or lacunæ) which give a peculiar appearance to the section. The cells are, more or less, regularly arranged in bead-like rows, the spaces or lacunæ between these rows. The intercellular spaces are not equally well marked at every part of the section, in many places the tissue being dense. Towards the inferior lower, or outer epidermis of the leaf, the tissue becomes dense, the cells not presenting evident intercellular spaces. Below the epidermis the cells are small and densely packed together, while the epidermis consists of small cells, with the free surface greatly thickened, and forming a well marked cuticle.

The fibro-vascular bundles are scattered in the cellular tissue between the upper and lower epidermis. These fibro-vascular bundles present two very well marked varieties. Those near the inner or superior epidermis are complete, and made up of numerous tissues, while those near the lower or inferior epidermis are composed exclusively of the *elongated prosenchymatous wood-cells*, which form the fibres of the New Zealand flax. The intermediate bundles sometimes show a kind of transition from the one form to the other, a small inner portion of the bundle being left unchanged into wood-cells.

The different forms of cells making up the fibro-vascular bundle from the inner side of the leaf, can be easily made out by examination with a higher power (250 diameters.) Numerous large openings can be observed in the middle of the bundle, which are the spiral and pitted vessels cut across. On each side of the large openings very small cells are to be seen, the cambiform cells of the bundle; while the thickened prosenchymatous cells of the flax are well developed on the outer or lower side—those on the inner side being only slightly developed. The cells are large, and the walls thin and only slightly thickened.

One of the intermediate bundles shows that the large openings, spiral vessels, &c., are wanting, that the portion of pro-cambium left is very small, the outer prosenchymatous cells being well developed, and forming about 18-20ths of the whole bundle, while the inner prosenchymatous cells are only slightly developed, being represented by only about five or six cells. In the bundles near the outer or inferior epidermis all the procambium has been converted into prosenchymatous cells, each bundle being thus quite homogeneous in structure; no trace of spiral or other vessels being observable. The most characteristic feature of the bundles from the outer or inferior side of the leaf is the large size of the cavity of the cell. The walls are thin, and the size of the cavity shows that the fibres will have comparatively little strength; and also, that owing to the thinness of the walls of the ultimate cells, it will be very difficult to separate them one from the other. The prosenchymatous cells from the