Runciman, about sixteen years ago. It is singular that until last year the precise knowledge of the locality was lost to botanists; neither has the plant been discovered elsewhere in the colony.

Dr. Hooker entertained doubts as to its being indigenous, founded chiefly on its supposed extreme rarity here, compared with its abundance in some parts of Australia, where it is a common plant. *Leucopogon Richei*, Br., affords a similar instance, of a common Australian plant being confined to a small area in these islands. Our plant, however, must be considered as local, rather than rare, since it is found in abundance over several miles of low Tea-tree ground, near Papakura, usually occurring in large isolated patches; sometimes, when sheltered by a large Tea-tree, it attains a stature of nine feet, and is much branched, but more commonly it is from two to four feet high, with long straight shoots, abundantly clothed with attractive rose-coloured, or white flowers.

It is readily distinguished from the other species of Epacris, found in New Zealand, by its constantly recurved, pungent, coriaceous leaves, with long subulate points, the large size of its flowers, and the linear-lanceolate sepals. Small sparsely-branched specimens of *Epacris pauciflora*, with pungent leaves, have been erroneously referred to this species, by New Zealand botanists, and it has been said that *E. purpurascens*, *E. pauciflora*, and *E. Sinclairii*, are but forms of the same plant. The differences between *E. purpurascens* and *E. pauciflora*, are, however, far too wide to admit of their being united (if New Zealand forms *alone* are to be considered, at least); although it will be difficult to maintain *E. Sinclairii* as a species apart from *E. pauciflora*. *E. pauciflora* occurs on open Tea-tree land, and occasionally amongst other shrubs, up to 2000 feet of altitude, at various places between the North Cape and Nelson, but can hardly be considered a common plant. Flowering specimens may be seen a few inches in height, although from four to six feet is a common height, and the plant sometimes forms a large, much-branched, twiggy shrub, thirteen feet high. In the young state, the leaves are sometimes very broad, highly developed, pungent, and more or less recurved, but these characteristics disappear as the plant grows larger. A striking variety found near the North Cape, is sparingly, or not at all branched, with the leaves approaching those of *E. purpurascens*, but always green, never brown; it produces flowers freely, near the tips of the long straight branches; but the flowers are strictly those of the typical form, and the plant becomes gradually branched and twiggy with age, at the same time developing leaves of the ordinary type.

Art. XXI.—*On the Structure and Colour of the Fibre of* Phormium tenax.

By T. Nottidge.

[*Read before the Philosophical Institute of Canterbury, September* 1, 1869.]

As the preparation of the fibre of New Zealand Flax has now become one of the staple industries of this province, I thought that the following account of certain observations and experiments that I have made on the structure of the leaf, and colour of the fibre, of *Phormium tenax*, might not prove uninteresting to the members of the Institute.

As is well known to all botanists, the fibre of the *Phormium tenax* is the woody tissue or pleurenchyma of the leaf. This woody tissue consists of cells very much elongated, and tapering at each end, arranged side by side in bundles, the ends of the proximate cells overlapping.

When the carefully-cleaned fibre is teased out with a needle, and examined under a microscope by reflected light, with a power of 120 linear, it appears

to be white and transparent, like filaments of spun glass, and where it lies in bundles it has a lustre like satin.

When mounted in "Deane's gelatine," and examined by transmitted light with a power of 225 linear, the ultimate fibres appear to be cylindrical tubes of considerable length (probably one and a half to two inches, but I have not succeeded in tracing any one cell through its whole length), the margins extremely smooth and regular, the finest of the fibres quite as fine as the silk of the *Bombyx Mori*, or mulberry silkworm. The cells taper gradually to each end, and are slightly rounded at the point. A central canal of considerable size is plainly visible. I observed no transverse or longitudinal markings on the fibre. The central canal appeared to be filled with air only, when I examined the fibre in August, but this may not be the case at all seasons of the year.

Transverse sections of the upper part of the leaf, mounted in "Deane's gelatine," and examined by transmitted light with a power of 225 linear, show that the fibres are not round, but roughly hexagonal, with slightly-rounded angles packed closely together in bundles, but so that small interspaces are left at the rounded angles. The central canal is marked by a well-defined spot on each ultimate fibre; and around this spot are slight indications of concentric lines, showing how the cell has been built up by successive deposits of cellulose.

The ultimate fibres vary considerably in diameter, those near the green or upper-surface of the leaf being much finer than those near the dull under-surface of the leaf.

When the ultimate fibres are broken, they break transversely, and the fracture has a ragged edge. I could not discover any tendency to tear longitudinally into finer filaments.

The bundles of fibre are in the form of flattened bands, arranged with tolerable regularity, parallel to each other, lengthwise in the leaf, one edge of the band being close to the green or upper-surface of the leaf, the other edge close to the dull or under-surface. Some of the bands appear to be incomplete, and extend only to a short distance from the surfaces of the leaf.

In the centre of each complete bundle of fibres is a brown bundle of spiral or vascular tissue, the central canals in this tissue are larger than the central canals in the fibre. This spiral tissue appears to break up very easily and to separate readily from the woody tissue or fibre.

The bundles of fibre are imbedded in the cellular tissue, known as the parenchyma, or more accurately as the merenchyma, of the leaf, and are immediately surrounded by a layer of cylindrical cells very similar to the cells just beneath the cuticle of the leaf.

The cells of the cellular tissue are, for the most part, filled with the greenish fluid juices of the plant: the grains of chlorophyll—the waxy, green colouring matter of the leaf—being very conspicuous in the cells near the upper surface.

In the lower or butt ends of the leaf, the ultimate fibres are much coarser, the bundles are cylindrical or oval, there is a great thickness of cellular tissue in which the bundles of fibre are imbedded, and the cells surrounding each bundle are filled with some reddish colouring matter, which, in some cases, seems to pervade the whole cellular tissue.

The fibre appears to be quite white and colourless in every part of the leaf, until the cells in its neighbourhood are ruptured.

From the above microscopic examination of the leaf and fibre, I have come to the conclusion that an erroneous opinion is prevalent on the following points, which are important:—

1. There is no woody matter to be separated from the fibre; the spiral

tissue cannot, I think, be considered as woody matter; and from direct examination of the so-called woody matter, on imperfectly cleaned fibre, I have found it to consist of cellular tissue, and portions of the cuticle or skin of the leaf, stiffened and glued to the fibre by the dried sticky juices of the plant.

2. The fibre cannot be indefinitely divided, the cells of the pleurenchyma or woody tissue showing no tendency to tear longitudinally into filaments.

3. The ultimate fibres are shorter than is commonly supposed—probably not more than two inches in length, but on this point I am unable at present to speak definitely.

I have observed that in most of the returns of the sale of New Zealand Flax in England, the discoloration of the fibre is alluded to as an objection, and cause of a diminution in price.

From the above microscopic examination of the fibre, and certain other experiments to which I shall allude, I think I have discovered the chief cause of the discoloration of the fibre, as now prepared, and also a means by which that discoloration may be, to a great extent, avoided.

I have formed this opinion from the following considerations.

The fibre, as it exists in the uninjured leaf, is white, and this is the case, even in the thick butt ends of the leaves. Any person may satisfy himself on this point by carefully dissecting out a bundle of fibre, with as little injury as possible to the surrounding cellular tissue.

The fibre consists of elongated tubular cells containing air, or perhaps a colourless liquid.

In each bundle of fibre, very minute canals are formed by the interspaces between the separate fibres.

The bundles of fibre are imbedded in, and surrounded by, the cellular tissue of the leaf.

The cells of the cellular tissue are for the most part filled with sticky juices of the plant, containing chlorophyll, albumen, fibrin, pectine, starch, gluten, sugar, all that is popularly called gum, and in the butt ends of the leaf, the cells immediately surrounding the fibres, contain a red fluid (probably altered chlorophyll).

In the process of manufacture, the leaf is beaten or bruised, the cellular tissue is completely broken up, the fluid contents of the cells are set free, and, by the same cause, openings would be forced in the tubular cells of the fibre, whether those cells contained fluid or air, and if they contained fluid some of that fluid would be pressed out.

The result is obvious, the fluid juices would be drawn into the tubular fibres and into the minute canals between the ultimate fibres, by capillary attraction, and the tubes being so minute, the capillary attraction would act very rapidly, and with great force.

The remedy that I would suggest is simple. It is to dilute the juices of the plant with water the very instant they are set free, so that the tubes may absorb a mixture of juice and water, the more dilute the better, instead of the pure juice.

The following facts tend to show that the above views are to a great extent correct.

The fibre as it leaves the beating or stripping machines is green in colour, and this green colour cannot be removed by mere washing.

When the moist fibre, washed so as no longer to tinge water green, is passed between powerful rollers, a large quantity of green fluid is expressed.

The colour is improved by passing the moist fibre between rollers, or through a beating machine, under a stream of water, and the sooner the water is applied after the fibre has passed through the stripping machine the greater

is the improvement in the colour. For this last statement I am indebted to the manager of the Selwyn Flax Company, who has been making experiments on the washing of the fibre.

If the beating of the green leaf is effected under water, the resulting fibre is quite white.

If the green leaf is half dried, so that the juices may not flow freely in very minute tubes, and the fibre is then prepared by beating and subsequent washing, the fibre is much whiter than if prepared from the fresh-cut leaf in the ordinary manner, but the difficulty of separating the fibre from the cellular tissue is greatly increased.

Such are my views on the above subject, and the chief reasons which have led me to adopt them. It will be seen that the question goes far beyond the mere discoloration of the fibre. The green colour of the juices, if absorbed as I have suggested, might, no doubt, be removed by bleaching, so as to stain the fibre a light brown colour only; but the juices could not be washed out, and when dried up would leave a residuum by which the interior of each tubular cell would be coated, and thereby to some extent rendered harsh and brittle, the ultimate fibres of each bundle would be glued together so as greatly to increase the difficulty of adapting the fibre for textile purposes, and this residuum, when exposed to air and moisture, would probably be subject to chemical changes which might have a most injurious effect on the fibre.

I have alluded to the spiral vessels found in the centre of each bundle of fibre, in the leaf of the *Phormium tenax*. This spiral tissue is found in all phœnogamous plants and ferns, and from the careful manner in which it is generally protected, I suspect that it serves some very important purpose in the economy of the plant, but physiologists do not agree as to its precise function. It is found most abundantly on the inner bark, in the veins of the leaves, and immediately round the pith in the centre of the stem of exogenous trees. It is very abundant in the *Musa textilis*, a species of banana, from which the Manilla fibre is obtained, and it is from the uncoiled spiral threads of this vascular tissue that textile fabrics are manufactured, not from the true fibre known as Manilla, and used for rope. I mention this, because from ignorance of this fact it has been suggested that the process, by which fibre from the *Musa textilis* is prepared for fine textile fabrics, might be applicable to the fibre of the *Phormium tenax*.

My principal object in writing this paper was to give publicity to my views. Even if my theory is shown to be erroneous, I hope that it may lead to further experiments, and provoke discussions tending to the improvement of the manufacture of New Zealand Flax.

Art. XXII.—*On the Structure of the Leaf of* Phormium Tenax. By Captain F. W. Hutton, F.G.S.

(With Illustrations.)

(*Read before the Auckland Institute, October* 18, 1869.)

In the present paper an attempt has been made to describe the structure of the leaf of our native Flax, so as to form a basis for the examination and comparison of the manufactured fibre, as dressed by different machines, and prepared by different processes, on which subject I hope we shall receive communications from many of our members. I have also added some observations on the gum secreted by the leaf, and which is generally looked upon as the *bête noire* of the manufacturer, but which I believe not to be so black as it is painted. While it was in progress, I saw in the newspapers a short abstract