

*sytha paniculata*. This latter plant consists of cord-like, pale-yellow stems, which wind the one round the other and round the various shrubs which they attack, making veritable entanglements so that one can easily trip over these horizontal cords. The sign of the coast is twofold—namely, the prostrate habit of *Leptospermum scoparium*, *Styphelia fasciculata*, and other shrubs, owing to the increase of wind and sandiness of the substratum; and, secondly, the appearance of *Cassinia retorta*. All stages of burning and of reproduction of the heath are present, and it is clear that perhaps there is nothing left of the original vegetation. On flat ground and in gullies are swamps and bogs, distinguished at once by their greener colour, which is owing to the presence of the *Schœnus*. Where such swamps are of larger size, *Phormium tenax* and *Cordyline australis* enter in. The soil is very wet during the winter and spring months, but in the summer it becomes extremely dry and hard, and suitable only for xerophytes. It consists of a stiff yellow or whitish clay, with a more or less deep covering of peaty humus. So peaty is the ground indeed that the water filling the numerous holes made by the gum-diggers has the colour of strong tea. On the burnt ground *Drosera auriculata* is one of the first plants to commence recolonisation. *Gleichenia dicarpa* and *Lycopodium laterale* are the characteristic plants of the bogs, where also is more or less *Blechnum capense*."

The special ecology of the heath-plants must be passed over with but a few words. They are for the most part strongly xerophytic, a condition demanded by the extremely dry ground of summer and the peaty water of other seasons. Small leaves of the ericoid habit, isolateral stems and leaves, prostrate growth, and coriaceous, hard leaves, are among some of the principal adaptations.

An interesting fact is the occurrence occasionally of very stunted examples of the kauri on the heath itself.

### PART III.—ECOLOGY OF THE FOREST AND ITS MEMBERS.

#### A. GENERAL ECOLOGY OF THE FOREST.

The Waipoua Forest, as has been clearly shown, varies much in the combination of its species in different parts, in their relative proportion, their density, and so on. In some places it is open, in others there is a close undergrowth; this tree is dominant here, and that one there; in fact there is no uniformity.

Although it is quite impossible to explain in any manner approaching definiteness this state of affairs, certain general principles seem to govern the matter. The heavy rainfall and large number of rainy days sufficiently account for the presence of the forest as a whole—in fact, it is rather hard to see why a shrub-formation such as the heath should be present. Leaving this matter aside for the time being, variation in altitude accounts for the zonal arrangement of the forest, certain of the northern plants, like those of New Zealand in general, being very close to their cold-enduring capacity, and with the absence of special members, others, originally or elsewhere kept in check, can increase in number. Thus, at a low level and with certain soil-conditions the tarairi can overcome the tawa or the rimu. These soil-conditions are inextricably bound up with the water-holding capacity of the soil, and in the forest as elsewhere change of water-content, and that but slight, means change of vegetation, the presence of *Schefflera digitata* or the special abundance of palms in the moist hollows being excellent examples. But in such places the greater richness of the soil comes in, and so on river-flats certain plants—e.g., the puriri (*Vitex lucens*) and the titoki (*Alectryon excelsum*)—appear which are absent elsewhere.

The direct action of light is very plainly manifest in many parts of the forest. Where through death of the trees or damage to the forest-roof a more than average degree of light is present, a quite different floor-covering or undergrowth may enter in. Thus we have the acres of tree-ferns before mentioned in the upland forest, and there, too, on small, well-illuminated areas there is, for instance—instead of the usual undergrowth of trees, ferns, and shrubs—the grass *Microlana avenacea* knee-deep, the wineberry (*Aristotelia racemosa*) and *Histiopteris incisa*, the two latter most rare plants of this forest, also a few distant tree-ferns (*Dicksonia squarrosa*), a nikau palm, and a straggling-branched example of *Beilschmiedia tawa*. In short, the density of the undergrowth is in large measure a reflection of the intensity of the illumination.

Leaving out of consideration its transpiration-effect, wind exerts a powerful influence on the forest by damaging the forest-roof through breaking of branches, thus not only letting in light, but exposing the trees to the attacks of fungi. This natural damage to the trees is astonishing. Apical branches just broken off are constantly met with on the forest-floor, and so are epiphytes of various kinds, especially the immense "bough-gardens" of *Astelia Solandri*. The weight of these on the branches must be very great, and add materially to their danger of breaking. The branches are simply adapted to bear their own weight, and addition thereto much increases their chance of damage by the wind.

Apart from the changes brought about by moisture, light, heat, wind, and soil, there are always the reactions of one plant upon another to be considered. The struggle for existence constantly going on favours the increase of one species and the decrease of another. Where ground-conditions lead to close groups of tree-ferns, the floor-covering reaches its minimum, or where the *Gahnia-Astelia* tussock gets a footing the shrubby undergrowth is doomed to partial extinction. The age of different parts of the forest evidently varies very considerably—that is, so far as the taller trees are concerned. These may be in a state of decay, while beneath, owing to the increase of light, is a vigorous host of saplings ready to take their place and whose presence depends on many years' struggle and change in the undergrowth. All these struggles and changes doubtless are to be seen in the forest, but they are most difficult of recognition and their import very hard to decipher. At the best, without exact information as to the ecological factors and much more knowledge of the physiology of the living plant than is at present available, the best observations can only pave the way for suggestive guesses.