are ripped to the foundations by the dissipation of energy in the bad conducting walls; trees are torn open, and denuded of bark down the path of the electricity to earth; men and animals are killed.

In the absence of buildings, trees, bushes, even the blades of grass provide "discharge points" for passing thunderclouds. As an example, Schonland, in South Africa, took a small tree 13 feet high, cut it off at the base, and mounted it on insulators, so that current would pass between it and earth through a current-measuring instrument (a galvanometer). When the field reached 16,000 volts per metre, for example, the silent discharge was 4 microamperes (4×10^{-6} amps.). He calculated that the combined effect of all exposed natural conductors in the area within the influence of the cloud would be quietly discharging it at the rate of 2 amperes, in an upward direction.

This article will serve to give you some idea of the mechanism of thunderstorms, and of lightning; and should also suggest to you the magnitude of the energy involved. Nothing was known of it prior to the time of Franklin; he in 1737 believed it to be caused by "the inflammable breath of the pyrites, which is a subtle sulphur and takes fire of itself"—but advanced to the correct ideas, associating it with electricity, by 1749.

We have yet a lot to learn about atmospheric electricity.

THE INDO-MALAYAN (INCLUDING PAPUAN) ELEMENT IN AUSTRALIAN FLORA.

By THISTLE Y. HARRIS, B.Sc.

OVER a vast continent such as Australia one expects to find a great variety of plant life, since the climatic conditions and geological formations differ so markedly in different regions. Broadly speaking, however, the flora of the whole of Australia may be classified into two great groups :

(*a*) Endemic types, which are predominant and which, according to Bentham, either originated in Australia or were differentiated here in direct response to the

environment and never spread much out of it. This group is quite unique among the world's flora, though plants with similar ecological modifications are to be found in regions of the earth where the environmental conditions are somewhat similar, as they are in South Africa.

(*b*) Indo-Malayan and Papuan types, which in Australia are confined to the Eastern Coast District from Cape York to Cape Otway, and rarely extend for more than one hundred miles inland.

This latter element is well developed in Queensland and northern New South Wales ; but occurs in isolated patches further south along watercourses or sheltered moist valleys, damp mountain gorges, and on basalt-capped mountain tops and plateaux with high rainfall. Such types characterise the rain forest or " brush " of the Tweed River, Dorrigo, Barrington Tops (outside Maitland), Cambewarra, while patches occur throughout the Illawarra district as at Bulli and Otford. In addition to this, in coastal regions of New South Wales where the endemic element predominates, a small stand of brush trees frequently occurs. While a great many of the species belonging to this group are confined to Australia, others occur in the Pacific islands east of Wallace's line—in Papua, Celebes, Gilolo, Ceram, as well as in Malaya, India, and south-eastern Asia ; and all belong to genera which are represented or have allies found in these regions. This connection of the flora with that of neighbouring islands, coupled with what is known of the geological history of our continent, provides an interesting clue to the origin of our present day plants.

Geological records tell us that Australia and Tasmania have been squeezed inwards by thrusts from the Pacific and Tasman Seas, and that great changes have taken place along the eastern shoreline. These changes have involved the rising and falling of the shore line, with intermittent laval flows, and at other times glaciation has occurred, until, in cretaceous times, Australia was flooded by huge seas spreading from the Gulf of Carpentaria to the Great Australian Bight, and forming two islands, a small one to the east, a larger one to the west, and the land connection with New Zealand was severed. Subsequent peneplanation, great basaltic flows on the east coast, the falling of the coastline and the uplift of the huge peneplain, then another vast glaciation followed by desiccation in inland and western areas left Australia as she is today. Remembering that at some very much earlier period there

must have been some connection through New Guinea between Australia and the more northern lands, and that the climate during and after this connection must have been much hotter than it is at present, we may consider the important part played by the Indo-Malayan types of vegetation.

It appears that these large-leafed mesophytic types, developing into large straight trees with few laterals, found the east coast of Australia sufficiently similar to their previous environment to enable them to grow practically without modification, forming the dense tropical and sub-tropical forests which still prevail in Northern Queensland. The rich soil and tropical conditions enabled such a number of species to become adapted to this environment that the area became occupied—and still is—by a great variety of mesophytic trees, with a consequent development of epiphytes and an almost complete lack of undergrowth. Gradually these plants crept southwards, probably modifying themselves in accordance with the changing conditions, the less readily adaptable ones remaining in the more northern regions, so that the southern rain forests became poorer in numbers of species ; and this is still true of the remnants of these forests today. This left the fewer species more room for expansion, and in many of the brush forests of today we find great stands of one type of mesophyte, such as the coachwood (*Ceratopetalum apetalum*). It is probable that, in these earlier geological times, the whole of the eastern coast of Australia was covered with a vegetation which closely resembled not only the present jungles of Northern Queensland but also those of India, Malaya and Papua.

Gradually, as the climate changed and desiccation set in, these mesophytes, accustomed as they were to an abundance of water and sunshine, and not having had to adapt themselves to unfavourable conditions to any extent, gave way before the developing endemic Australian vegetation which had been developing slowly for some time, and which had been advancing from the barren soils of the western edge of the continent. Under these unfavourable western conditions plants had either to modify themselves rapidly or to be annihilated. No doubt many of them were completely wiped out, but others survived in a form in which they could survive in arid regions. Such was probably the origin of what is known as the endemic element in our flora. This modified flora was quite helpless against a Malayan flora developed under favourable conditions, so that, for a long time it was probably confined

to the western and central areas. When, however, lower rainfall and lower temperatures began to prevail on the eastern side, the rain forests became less luxuriant until, in many regions, they were subdued or completely expelled by the xerophytes from the west. At first this must have occurred in isolated patches along the coast—on the higher regions where lack of rainfall would be most keenly felt by plants accustomed to abundance, and where the nature of the soil did not permit of retention of much of the water which it did receive. Consequently the river courses and the mountain gullies where evaporation would be lower, and the rich basalt-capped plateaux and highlands where the moisture retention would be greater, were the last to be invaded. Indeed, many of these still retain the essential characteristics of a tropical rain forest. More frequently, however, we find today that the brush of the more southerly regions is intermixed with endemic Australian species; so we find Messmate (*Eucalyptus considiniana*) intermixed with the Sassafras (*Doryphora sassafras*), Coachwood (*Ceratopetalum apetalum*), Rosewood (*Dysoxylum Fraseranum*), and others on Cambewarra—Tallow Wood (*Eucalyptus microcorys*) entering much of the southern brush, while the more northern forests retain their Indo-Malayan nature much more nearly.

In many cases it is to be noted that where the true Australian element appears to have completely subdued the Malayan it has not done so entirely, and one may find isolated trees—or more frequently isolated groups of trees—which exhibit mesophytic tendencies most markedly and are undoubtedly hardy survivors of a one-time tropical forest. Both of our common coastal palms, the Cabbage Tree palm (*Livistona australis*) and the Bangalow (*Archontophœnix Cunninghamii*), the Blueberry Ash (*Elæocarpus reticulatus*), *Notelœa longifolia* and many others provide evidence of this.

The rain forest trees which have managed to survive in southern regions where the climate is not altogether suitable for their development show none of the modification to the changed conditions that are exhibited by their hardier xerophytic neighbours, and their survival is largely due to the protection which they afford one another, and to the absence of bush fires which, of course, is due to the greater degree of humidity produced. That such trees cannot stand exposure may be shown by clearing portion of the forest away—the remaining trees soon succumb to the unusual exposure. They are rapidly affected by fire, also, showing no tendency to put forth fresh growth,

as Eucalypts will do after a fire has passed through; consequently brush land is easier to clear than open forest land. The Indo-Malayan types are essentially unmodified. They are usually straight-stemmed, producing few laterals, since their object is rapidly to reach the light above their towering brethren; they produce an abundance of dark green, bilateral, large, soft foliage which transpires freely and forms a dense mass of sombre green through which little light can filter. The flowering is usually irregular, and flowers are produced for the first time only after some years. This is consequent upon the fact that the plant is so much in harmony with its environment that the chances of its elimination are small—therefore it can delay the flowering period for an almost indefinite time. Xerophytes, which live a much more precarious life, and which are in danger of being wiped out of existence by unfavourable environmental conditions, produce flowers as rapidly as possible—hence the greater floriferousness of such poor areas. The greater security of the brush types, however, makes them very unadaptable—hence the rapidity with which many of them must have been wiped out when climatic conditions became unfavourable. There are two striking exceptions to this, at least under cultivation: the White Cedar (*Melia Azedarach*) and the Silky Oak (*Grevillea robusta*) show remarkable adaptability to the arid conditions which prevail in western New South Wales.

That two genera usually regarded as typically Australian (namely *Eucalyptus* and *Acacia*), may possibly be modifications of plants which survived under earlier mesophytic conditions is suggested in their ontogeny. The Eucalypts possess isobilateral leaves which twist on their petioles to expose a minimum surface to the sun when its heat, and consequent evaporating power, is great. The juvenile foliage of this genus, however, is not isobilateral, nor does it possess the power of twisting—more frequently it is sessile, and of a soft texture, indicating no modification in relation to arid conditions. The second great genus which shows atavistic tendencies in the development of its juvenile foliage is *Acacia*. I refer here to the phyllodinous types, which are developed only in Australia. The juvenile foliage of this genus is invariably of the pinnate type similar to the adult foliage of some Australian types and of all the northern types. Soon, however, in the development of the individual there is a flattening of the petiole until, after a short time, the mesophytic pinnate leaf with its large number of stomata

is replaced by a phyllode with a much lesser number, and consequently a much more effective chlorophyll bearing organ for a xerophytic type. If, then, as is probably the case, this genus found its way from northern lands to Australia, it probably entered as a mesophyte, found conditions suitable to its growth, and modified its foliage later in response to changing climatic conditions. Having developed a method of water conservation which proved so satisfactory, it then was able to occupy many of the most arid regions of Australia.

We might, then, add a third group of plants to the two with which we started—namely a group consisting of modified mesophytic types acting as a connecting link between the Indo-Malayan types and the true endemic species.

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ON OBTAINING RESULTS FROM EXPERIMENTS.

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IN most experiments two or more quantities have to be measured and a series of readings is obtained for each of them. Curves are then drawn showing how the various values so obtained vary under various changes of conditions and, very often, results have to be worked out from these curves, and it may be that further curves are then plotted.

In measuring the quantities, certain possibilities of error are always present ; among these are :