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The southern California Ferns¹

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While California is a narrow state, measured across from east to west, it is a very long one, measured from north to south. On the Pacific coast it occupies the same degrees of latitude as does the whole row of states between Boston and Charleston on the Atlantic seaboard. And there is no other tract of equal size on the North American continent which can compare with it in topographical and physical diversity. All altitudes, from 14,000 feet above sea level to nearly 300 feet below it; a wide range of temperature, from many degrees below zero to 140 degrees above; all amounts of precipitation, from at least 80 inches per annum to none at all. Such a diversity of environment would lead one to expect an extensive fern-flora, but the fact is that the combinations are not suited to produce such a development. If the redwood belt, the part of the state which is soaked in rain and blanketed with fogs, had the temperatures of the Colorado and Mojave deserts, or if the transfer were reversed, and the northern rains and fogs were brought down to the hot, but arid south, what a land of ferns California would be! Even if the total moisture were evenly distributed over the whole state, and the varied temperatures averaged throughout its whole

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extent, a much larger fern-flora might reasonably be expected. For heat combined with moisture forms the combination which the fern family finds best suited to its requirements. It is where such conditions exist that "fern paradises" are found. If ferns make their homes where other conditions prevail, there is required, or rather, to speak more correctly, there is developed a modification of form and habit.

The result of actual conditions is the development in the cool fog-belt of a luxuriant growth of *Polystichum munitum* and *Pteris aquilina*, which prevail abundantly from one end of it to the other, and of a very limited number of other species. At the other geographical extreme, the arid south, there is a greater number of species, but the abundance of individuals admits of no comparison with the fecundity of the northern coast. The open pine intervals of the forests support an undergrowth of the same *Pteris* that abounds in the north, but in stature, in the structure of its contracted fronds, its aspect is very unlike the robust and tall coast form. *Pteris aquilina* is the only fern that forms a growth over extended areas in the south. The others grow in the select places to which their specialized structure and habits of life fit them. They seek the shelter of boulders, of shrubs, and of rock crevices, and are thus able to exist under very unfavorable conditions. As there are only special places in which they are able to grow, and these limited in respect of the whole area, there is a comparative scarcity of individuals; in some cases more than a comparative, a positive, scarcity. I have in mind a species (*Cheilanthes fibrillosa*) of which the type collection is the only one known, yet its validity has never been questioned by fern students. Of another (*C. Parishii*) there have been but two scanty collections, made at an interval of 20 years, and both in the same canyon. These two are, at least so far as this slender knowledge indicates, endemics, but there are two other

ferns (*Notholaena tenera* and *Cheilanthes Feei*) of wider distribution beyond the limits of the state, one of which is known within it by a single collection, the other by only four or five. The rain belt exhibits nothing of this; its ferns are of wide-spread species, and its most prominent one is of cosmopolitan distribution.

The arid regions are the homes of *Pellaea*, of *Notholaena* and of *Cheilanthes*, all ferns modified by the conditions under which they exist. These modifications are two-fold, and affect the structure of the plant, and its manner of life, and I do not recall a southern California species of these genera which does not exhibit both of these characteristics in some degree. In structure, in addition to histological modification, there are the external adaptations manifested in the small size of the frond and the multiplication of its divisions into contracted pinnae which are often broken up into bead-like tessellations. The fronds are thick, the opposite extreme in fern structure from the filmy ferns, which grow at the opposite extreme of conditions, but with which they are connected by a long series of ferns of intermediate structure, the results of adaptations to all the intermediate conditions. All but one of these ferns have evolved organs which serve to protect them in some degree from too great transpiration, to which they are exposed by the excessive insolation, the arid air and the drying winds of their habitat. *Cheilanthes viscida* has a coating indicated by its specific name; *Notholaena cretacea* and *Gymnogramme triangularis* a powdering of yellow or white grains; *Notholaena Parryi* is densely woolly, and *Notholaena Newberryi* has a close cottony tomentum; *Cheilanthes Fendleri* is clad in scale armor, and *Cheilanthes fibrillosa* has fibers mingled with its scales.

The other adaptation affects the habits of these ferns; their life-histories. Ferns, I take it, are normally evergreens, enjoying an uninterrupted growth, each leaf

continuing its active functions for the whole period of its life. In the different regions to which ferns have become acclimated other habits of life have become necessary. In cold climates the low temperature may destroy the aerial parts, or may suspend their functions, so that all the operations of life,—growth and the reproductive processes—must be carried out in the summer months. In our region this is the case with *Pteris*, which is cut down by the first frost. But the ferns we are now considering have an opposite life-problem to solve. They have at all seasons sufficient heat and sunlight, and for half the year an excess. Their greatest need is water. Our arid ferns meet the situation by making their growth in the winter, at which period of the year the rains occur, and by passing the summer in dormancy. But these rains are small in amount at any one time, they are uncertain, and the moisture is liable to be speedily evaporated by drying winds. Their fronds, therefore, unfold at once as soon as moistened by the first shower and resume life at the point where they dropped its functions, perhaps months ago. How long this active life may continue depends wholly upon the meteorological conditions. So long as moisture is attainable there is no cessation; but as soon as it fails active life is suspended. In this condition the fern appears dead; the frond is dry and crumbles in the fingers, the stipe and rhizome are brittle and break up in handling. These resting fronds assume various forms. Many curl up into more or less compact balls, exposing to the air the back of the frond, which is the most heavily protected. A study of the mechanics by which this rolling up is effected would be of interest. Perhaps it has been made, but, if so, I have never happened to read of it. If not, it is well worth making. The same phenomenon is familiar in the Mexican *Selaginellas*, which are sold under the name of "resurrection ferns,"

but *Notholaena cretacea* would be an excellent subject for investigation, for its fronds roll up into very compact balls. The same intermittent manner of growth is universal among the rock lichens of arid countries, and some of the mosses possess it.

I do not know how often this alternation of active and suspended life may be repeated before a frond exhausts its ability to respond; nor whether the duration of the life of a frond is measured by a definite number of months, or by the number of days of active growth, so that in one good season a frond might complete the cycle of its existence in a single winter, but in a less favorable one might require a longer period. Again, the habit is possessed by species which differ in several respects, and appears to be more fully developed in some than in others, but the degree and nature of these differences are not known. These are subjects worthy of investigation, and information concerning them would add much to our knowledge of fern-life.

I am recalling to your attention the characteristics of the arid Californian ferns, not as peculiar to them, but as examples of the phenomena shown, as you are aware, by ferns of all similar regions; nor is it to ferns alone that the question of life under the condition of too much sunshine and heat, and too little moisture is presented. It confronts the whole desert flora, and every plant must find a solution of the problem under penalty of death. How they severally and variously do it is one of the most interesting studies in plant ecology.

Although I have dwelt at such length on the arid ferns, if I may so call them, it is not to be inferred that there are no others in southern California. They are to me the most interesting, because they differ in so many ways from the ideal fern, and because, since this region has an unfortunate deficiency of precipitation and excess of heat, it is the arid ferns which most abound in it. But as there are places in which there is a sufficiency,

or an abundance of moisture, and some shelter from the sun's too-powerful rays, there are a number of semi-arid and of moisture-loving species.

By a semi-arid fern I mean one that has some of the physical or habital characteristics of the arid species, or has developed independent methods of meeting the same necessity, namely, of retaining life through the heat and drought of summer. Such a fern is *Cheilanthes Californica*. This has the small and exceedingly divided frond of an arid fern, but it is entirely without any protective indument. It grows at the foot of cliffs, where it obtains shelter from sun and wind, and where it is reasonably sure of a supply of moisture for a considerable period. When that fails it remains dormant until the next winter. *Adiantum emarginatum* is without protection to its fronds, which have broader and less divided pinnae, consequently it also seeks the protection of cliffs, or other shelter, and reliable water for its roots, and when at length moisture dries up the fronds wither and die, and only the root remains alive. I am inclined to put *Polypodium Californicum* also in this class, although its only claim to inclusion is the fact of its summer dormancy. Its rhizomes creep along the crevices of shady cliffs in canyons. It starts into growth very early in the winter, unless the season is unusually dry and late, and in the most favorable places it is able to put in a long working period, but sooner or later the rocks become dry, and its foliage withers and dies. Apparently it needs a summer rest, for it does not grow where there is permanent moisture, although such places are available. There is another form of this species, seldom seen, which grows on open grassy banks. There the effect of the exposure is seen in the thick texture of its much smaller fronds, but its habit is like that of the common thin-textured form of the rock crevices, winter growth and summer dormancy.

A third class of the southern California ferns includes those with perennial foliage and a continuous period of growth. Of necessity they are confined to situations which afford them a reliable supply of water throughout the entire year, and where the extremes of seasonal variations do not, at any period, entirely prevent growth. These conditions may vary within certain limits, so that the activity of life may be accelerated or diminished at certain periods for some of these ferns; and in this respect these vary among themselves, but they must at no time prevent the verdancy of the foliage, or suspend the activity of the vital functions.

Two ferns which are at the outer limits of this class are *Nephrodium rigidum argutum* and *Polystichum munitum*. These ferns, which are found throughout the whole length of the state, and northward to British Columbia, and even one of them, to Alaska, in the southern part of the state grow on lightly shaded canyon slopes, and have a range of altitude which does not expose them either to the intense heat of the lower hills, or to the great cold of the higher mountains. Their water supply is greatest in late spring and early summer; and it is at this period that they make their most vigorous growth; in the late summer their growth is checked by the diminished moisture in the soil, and in winter by the lower temperature. They, therefore, at least for a part of the annual cycle, require a degree of economy in the conservation of their water content. This results in fronds intermediate in form and texture between those of ferns which must live on the scantiest allowance of water, and those which have it in abundance.

Adiantum capillus-veneris illustrates the other extreme in this class. It affects the face of well-shaded cliffs, over which drips water from a perennial source, and being more sensitive to cold, it is limited to a much narrower altitudinal range than the two species last

mentioned, and in more exposed positions its fronds are killed in unusually cold winters; otherwise it retains continuous verdancy and maintains continual growth. The thin pinnae reflect the moist conditions under which it grows.

Our last class of ferns are those which grow during the summer, and in winter lose their fronds and retain vitality only in their roots. The most abundant of these ferns are *Adiantum pedatum*, *Cystopteris fragilis* and *Athyrium filix-foemina*. It will be noticed that these are species which are common over a large part of the country, and with us they occur in that part of our territory which differs little in physical character from their habitats elsewhere. The precise stations which they inhabit here are probably more restricted than in regions where the rainfall is more abundant and better distributed. Here, their requirement of abundant and unfailing moisture at their roots, confines them very closely to the margins of streams and springs, and to bogs.

I have, in this imperfect outline, endeavoured to place before you a general idea of the southern California fern-flora, and to indicate the effects of external factors in determining the distribution, the habits of life, and the structural forms of the various members which constitute it. The ferns are not an exceptional family of plants, nor is California an exceptional region, in respect to the conditions which determine plant life. These laws are universal in their application to all vegetation, and to all parts of the world. The study of the results of their decisions upon the life of the plant-kingdom where they rule the court of last resort, is a study fruitful and interesting, and there is no place where it cannot be prosecuted.

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