# THE ORIGIN OF LAND PLANTS

BY J. ARTHUR THOMSON

From *The New Statesman, April* 23
(LIBERAL LABOR WEEKLY)

THE more one thinks about the conquest of the dry land by adventurous animals of aquatic ancestry, the more convinced one becomes of the impossibility of success if plants had not led the way. Plants ensured the food, the moisture, the shelter without which the dry land would have been altogether too inhospitable for animals. Thus, the problem of the origin of land plants has an enhanced interest.

It seems quite certain that many ages passed before there were any land plants at all. In Cambrian, Ordovician, and Silurian strata there are plenty of traces of seaweeds, but there are no known fossil land-plants before the Devonian. Among the earliest are the very interesting Devonian fossils discovered a few years ago at Rhynie in Aberdeenshire by Dr. Mackie of Elgin. Of course, it is quite possible that there may have been pioneer land plants long before the Devonian, but of a type too simple to admit of definite fossilization.

If there were any orthodox view or majority report in regard to the origin of terrestrial plants, we suppose it would be something like this: the simplest plants began in the sea and flourished there for ages; but some of them, obedient to the universal impulse to explore empty corners, made their way from shore to estuary, from estuary to river, from river to lake, from lake to swamp and marsh, and thence, at last, began to colonize the dry land. At each station in their ascent some would no doubt settle down and specialize as best they could in relation to the immediate environment, while others would push on, trying as it were to find something better. Whether some may not have passed directly from the sea-shore to the shore-marsh and thus on to dry land, without serving an apprenticeship in the freshwaters, is a question in detail which may be waived for the present. But the general idea of the theory sketched is that relatively simple plants, endowed with considerable traveling power, like many of the unicellular algæ, did the exploring, and that structural evolution began afresh, as it were, in the successive stations where they established themselves. One must remember that detached propagative parts of plants would not readily migrate up-stream, though spores might be borne by the wind. Fishes may have helped in transport, but there were no plant-distributing birds in those early days. Moreover, there were no true seeds before the Devonian. The general idea seems to be that very simple plants did the traveling, and that when they reached a suitable resting-place they proceeded to evolve into organisms like our liverworts, mosses, and ferns, building up structural complexities somewhat similiar to those that had already been achieved among seaweeds in salt water, similar yet different, being adapted to the quite novel conditions of terrestrial life. In his very able book, *The Origin of a Land Flora* (1908), Professor F. O. Bower has sought to show how the ex-

aggeration of the spore-bearing (sporophyte) generation and the suppression of the sex-cell-bearing (gametophyte) generation, which is characteristic of all flowering plants, would follow as a natural outcome of becoming terrestrial. But the prior question is how the transition from aquatic to terrestrial (or subaërial) conditions may have been effected.

To this question a new answer has been recently given by the distinguished Oxford botanist, Dr. A. H. Church, in an essay entitled 'Thalassiophyta and the Subaërial Transmigration' (Oxford University Press, 1919), an essay as full of suggestive ideas as it is of repellent terms. We have seldom come across a book so gratuitously discouraging to the reader, and yet such good sport from cover to cover. Dr. Church's general idea is that terrestrial plants arose by the gradual transformation of highly evolved marine plants on a slowly rising beach. Transmigration seems to mean 'transition *in situ*.' 'When the first land gradually lifted above the primal sea, bearing all forms of marine life on it, the successful transmigrant algæ of the first land-migration combined the best and highest factors of marine equipment.' What had been gained in the sea in the course of ages was not lost, to be invented *de novo* a second time, it was adapted. It was not in the reproductive part of the plant that the profoundest changes were necessary; it was the body that required to be readjusted from life in an aqueous food-solution to life in an atmospheric medium with no external food-solution beyond that bathing the roots.

After the gradual cooling of the earth there were, according to Dr. Church's picture, three great epochs of world-construction, with associated vegetations. There was the time of the condensation of water-vapor to form the sea, which he supposes to have covered the earth; and the surface-waters of that sea were peopled by miscroscopic plants sufficient unto themselves. This was the Plankton Epoch. Second, the folding of the earth's crust raised parts of the floor of the sea into the reach of light, and minute plants began to settle there, anchoring themselves and proceeding to build up fronds and other forms of body. But anchoring on a substratum made it necessary to have some new arrangements to secure dispersal — a return to the plankton phase for processes of reproduction, much in the same way as we see in sponges which liberate free-swimming embryos, or in zoöphytes which liberate swimming-bells or medusoids. A new note was struck: the types that survived were those whose individual members had moved in the direction of race-continuance — the most fundamental of all biological truisms. To the plankton law of self-preservation was added the benthic law of race-continuance. 'The fact that any race still exists implies that the individuals collectively have done their bit.' This was the Benthos Epoch. Third, there was the gradual emergence of dry plant and the gradual transformation of aquatic vegetation — seaweeds for short — into a land-flora, able to absorb gases from the air and salts in solution from the substratum. The Benthos introduced the new factor of substratum, but the emergence of the land introduced the new factor of atmosphere. This was the Xerophyte Epoch. In other words, we must think: (1) of the primal Open Sea, with its free-swimming minute green plants; (2) of the floor of the illumined shallow sea with its anchored fronds all intent on experiments in body-making on the one hand and in reproductive dispersal on the other; and (3) of the beach slowly rising, foot by foot, millennium after millennium, with

its highly evolved sea-weeds slowly transforming themselves into land-plants.

'The energy of growth, at bottom a phase of chemical (ionic) activity, supplies the driving-power of life, and such "life" beats against the sieve of Natural Selection; but this alone does not account for all the manifestations of plant-organization. *Twice* in the history of the world the sieve itself has been changed: the "hidden hand" which did this, and so determined the path to be taken as a sequence of progression, was not "Nature" or "Divine Guidance," except in so far as such expressions may be utilized to cover an inevitable march of events, in this case merely the expression of the cooling of the earth, which (1) lifted the sea-bottom by tectonic changes, and (2) ultimately lifted the "land" above the surface of the water, to be subjected to subaërial denudation to form "soil."' Of course, only a few of the plankton creatures got through the sieve to become anchored seaweeds on the substratum, and only a few of the benthic plants got through the new sieve to become the pioneers of a land-flora. The idea of an evolution of sieves as well as an evolution of the sifted material is useful, but we should not be inclined to restrict the operations of the 'hidden hand' to *twice*.

It is very impressive to visit a rocky foreshore at the lowest tide, to wade out among the Laminarian and other seaweeds, not usually exposed at all, to observe the vigor and manifoldness of their growth and the complexities of their structure, and to realize that one is moving amid an antique vegetation, some members of which may be much older than the hills. The conventional view is that these seaweeds represent a gorgeous blind alley, but Dr. Church asks us to consider the possibility that from among such highly evolved creatures the land flora may have emerged by gradual transformation as the foreshore slowly rose. The transformation cannot be thought of in any easy-going way. It meant that the seaweeds' gripping structures, mere hold-fasts, not true roots at all, became provided with rootlets and root-hairs suited for the absorption of water and dissolved salts from the soil. It meant that a frond-surface adapted for the absorption of watery food-solution became fit for the absorption of the dry gases of the air. It meant the elaboration of a complicated vascular system for conveying the raw materials and the elaborated materials from part to part. These are among the more readily stated of the difficulties which are faced and ingeniously countered by Dr. Church.

Many a plant is a very plastic or modifiable creature, and even such a stable structure as a tree can adapt itself almost out of recognition to unusual conditions of life. It may be that individually acquired modifications hammered on each successive generation of seaweeds on the rising shore, but never taking hereditary grip (for that would be Lamarckism!), served as life-saving screens until germinal variations in the same direction had time to establish themselves as appropriate somatic adaptations.

The migration theory of the origin of land-plants, with which we started, is not an easy theory. Fresh-water algæ are rather of the nature of 'depauperated relics.' 'To pass from the sea to fresh water implies starvation and deterioration of the output of reproductive cells, and hence failure to compensate the wastage of the race, and extinction.' Perhaps this smacks a little of *ex parte* judgment, but there is the further difficulty of thinking of simple imigrants from pond and swamp beginning *de novo* the elaboration of structural equipments which many of the seaweeds had already achieved. In

place of this theory Dr. Church offers us 'the epic of the stupendous epoch of a world-transmigration.' 'The cells and somatic organization of all land-plants, as also all their reproductive cycles and mechanism, are but the continuation of the mechanisms evolved in the sea, to suit the conditions of life in the sea, as the best response possible under such conditions; and though the mechanism may be emended, modified, or superseded in innumerable details, the primary plan of the architecture and the entire range of general principles of organization remain essentially marine.'

Such a view is in harmony with what we learn so often in the study of animal evolution, that apparent novelties are only very old structures transformed. New lamps out of old has been one of the great methods of evolution. And as to the maternal sea, why, its tides still echo in the chemical composition of our blood!

## SONNET

BY ROY MELDRUM

[*The Nation*]

HERE are the woods, in whose soft echoing trees
The birds sing sweeter; here the rounded hill
Where sunning in the wild flowers merry bees
Pack full their wallet for the fragrant still.
Here, as I lie and down the valley gaze,
Seven spires across the dappled fields peep out,
Chaste with a medley of serener days,
And with their lingering incense girt about.
Like as a spirit pensive on the air
Makes poetry spring immortal, so thy love
Exhales a beauty fair as earth is fair,
And yet in element the earth above.
Lips, eyes, and all love's instruments soon perish;
But what thy love is, earth and heaven cherish.