

to the metallic surface. Local corrosion (pitting) then sets in. Moreover, this film is much more liable to crack when subjected to alternate wetting and drying, particularly at an air-liquid interface. Probably the interfacial tensions of metal, air, and water operate in producing this result. The practical problem therefore consists in finding a method of forming a strong and tightly adherent film of oxide or hydroxide instead of the thin film. Mott<sup>8</sup> showed that such a hydroxide film could be formed by making the metal the anode in a bath of sodium hydrogen phosphate, and recommended this treatment as a protection against corrosion. Working for the Corrosion Research Committee of the Institute of Metals, and with the aid of financial assistance from the Department of Scientific and Industrial Research, Dr. Bengough and Mr. J. M. Stuart, during the years 1921-24, carried out a series of investigations starting from this point, and found that the film produced by 'anodic oxidation' in a bath containing a chromate, bichromate or, best of all, chromic acid, protects the metal much more effectively against corrosion.

The process is carried out as follows: "After

<sup>8</sup> Mott, "Electrochemical Industry," 1904, 2, p. 129.

thoroughly cleaning the surface of the aluminium or its alloy, it is immersed in a suitable bath, e.g. dilute chromic acid, along with a carbon rod; a small external electromotive force is applied so as to make the aluminium the anode and the carbon the cathode. The applied electromotive force is gradually raised to a value depending on the nature of the alloy and on the composition of the bath. Thus with duralumin in a chromic bath the voltage may be safely raised to 50 volts. After treating for some time in this manner, the surface of the metal becomes covered with a semi-opaque uniform white coating. This seems to consist almost entirely of aluminium hydroxide in a glassy adherent form. The hydroxide is possibly hydrated to some extent, but the hydration cannot be much, since the coating can be heated to at least 350° C. without changing in appearance or density."

The laboratory investigations were followed by successful experiments on a larger scale at the Royal Aircraft Establishment at Farnborough, by agreement with the Air Ministry, and the process, which is protected by patent, is now being worked in Great Britain by several firms on non-exclusive licences from the Department of Scientific and Industrial Research.

### Organography of Plants.<sup>1</sup>

A 'FESTSCHRIFT' celebrating the seventieth birthday of Dr. Karl von Goebel, professor of botany in the University of Munich, was published in 1925 as a special volume of *Flora*. It was initiated by an international committee including many of his colleagues, pupils, and friends: it comprises thirty-eight memoirs on the most varied botanical topics, and these themselves bear witness to the catholicity of the interests of the veteran whose birthday they celebrate. His election in 1926 as a foreign member of the Royal Society has marked the recognition in Great Britain of his great scientific career, happily by no means ended, though it has reached the prescribed span of life. These events followed closely upon the completion of the second and greatly enlarged edition of his "Organographie der Pflanzen." The interest which they have aroused among botanists is readily understood, for the name of von Goebel is intimately associated with an essential change of scientific outlook upon the organisation of plants. This has lately been made more than ever apparent in a volume from his own pen, written in celebration of the centenary of the birth of his teacher, Hofmeister, a translation of which into English was lately published by the Ray Society, and reviewed in *NATURE* (Oct. 2, 1926, p. 473). This essay reveals with a truly philosophic touch the genius of the master, while it serves also as a natural guide to any appre-

ciation of the life-work of the pupil, von Goebel himself.

In the early part of the nineteenth century a stiff and artificial nature-philosophy was still dominant. This was clearly incompatible with those evolutionary views which were then forming themselves in men's minds. Even before "The Origin of Species" was published, a change of outlook had been initiated. Hofmeister's keen insight had tracked down, and his pencil had recorded in detail, facts relating to Archegoniate plants, which more than any others were at that time essential for any consecutive evolutionary scheme for the plant kingdom as a whole. These facts were stated by Hofmeister with a breadth of view which allowed of their ready application later in terms of adaptation to environment. He was not merely an observer of stark structure, but he broached the subject of causal morphology, a branch of study then only nascent, but great with the promise of the future.

It has been the happy lot of von Goebel as his pupil to carry on the torch which Hofmeister had thus placed in his hands, and to deliver it with ever-increasing glow to a later generation. Morphology in his hands has taken a more rational place than was possible before. Under the title of "Organography,"—a word already used by Sachs in 1882, from whom also von Goebel will have drawn stimulus and guidance in the years of his assistantship in Würzburg—he has embodied in two stately volumes a wealth of fact treated comparatively, experimentally and developmentally, and related throughout to function. While maintaining the Hofmeisterian tradition of exactitude, he has promoted the living aspect already so

<sup>1</sup> 1. "Organographie der Pflanzen," Dr. K. Goebel. Zweite Auflage. (Jena: Fischer, 1913-1923.)

<sup>2</sup> 2. "Die Entfaltungsbewegungen der Pflanzen." Ergänzungsband zur Organographie der Pflanzen. (Jena: Fischer, 1924.)

<sup>3</sup> 3. "Festschrift zum siebenzigsten Geburtstag von Karl von Goebel, in München." (Jena: Fischer, 1925.)

<sup>4</sup> 4. "Morphologische und biologische Studien." Von Prof. Dr. K. von Goebel. *Ann. Jard. Bot. de Buitenzorg*, 36. (Leyden, 1926.)

prominent a feature in Hofmeister's later writings. The first edition of von Goebel's great work was translated into English, and published as one of the botanical series issued by the Oxford Press (1900-1905). The second German edition, completed in 1923, may be held as embodying the mature views of its author: at the same time it reflects the attitude of modern morphology, in which form is not divorced from the study of function as it used to be.

The closing volume, styled "Ergänzungsband zur Organographie der Pflanzen," was published in 1924: it relates to the movements of development of plants, and their teleological meaning. While the author at once notes that erroneous teleological interpretations have frequently been enunciated in the past, and points out how movements may exist to which no useful end can be ascribed, he boldly accepts legitimate teleological interpretations. He asserts that organography is in itself the discussion of the relations that exist between morphology and teleology, and he quotes from Asa Gray the passage: "Let us recognise Darwin's great service to natural science in bringing back to it Teleology: so that instead of Morphology versus Teleology we shall have Morphology wedded to Teleology." The broad sweep of this volume, the variety of the facts adduced, and the wide quotations of literature, often varied in origin and remote in time, impress the mind with the catholicity of interest of its author. It fully justifies an incident that occurred long ago at an international meeting of botanists, where an unusual plant presented a puzzle to us all, and some one said, "Ask Goebel." The question was not put to him in vain.

To British students of botany the name of Goebel will have first become familiar through the publication of a translation of his "Systematik" under the title "Outlines of Classification and Special Morphology of Plants" (Oxford Press, 1887). It was in fact a new edition of Book II. of Sachs' text-book. But, earlier still, the young professor of Rostock had profoundly impressed those of us who followed the German botanical literature by his writings in the *Botanische Zeitung*, and elsewhere. Much of this early work was summed up in his "Vergleichende Entwicklungsgeschichte der Pflanzenorgane," included in Schenck's "Handbuch der Botanik" (vol. 3, 1884). Here, with the true Hofmeisterian touch, he uses ontogenetic details as an avenue to comparative conclusions. In his hands the story of floral development, traced in skilfully selected examples, furnished a living commentary upon the dryer facts of Eichler, and rendered them into terms more closely related to the life of the organism. On the other hand, his comparative studies of the development of the sporangium might at first sight appear as mere *tours de force* of developmental observation. But they worked out naturally into questions of the widest evolutionary interest. In the 'eighties we soon found ourselves reaching out towards some ultimate point of view as to the real nature of the sporangium of land-living

plants: whether it is a part *sui generis*, or the result of some transformation of a pre-existent part, as the older morphologists had held. Or we entered deeply into the cell-cleavages which precede the definition of the sporogenous cells, in a study which lent precision to knowledge of development, but left us there in a manner stranded. In either case we were brought face to face with far-reaching questions of ancestry and origin, which even the subsequent disclosure of the fossils of the Rhynie Chert have not fully resolved.

As an administrator von Goebel has taken his full share of duty. The head of a large institute and garden, he has passed through his hands a stream of pupils drawn from many nations. Since 1889 he has edited *Flora*; and the pages of that great journal not only witness to his own activity, but also show the variety and quality of the work of his school. But it would be vain to attempt here to follow this indefatigable worker through all the activities of a long and busy life. The mere list of his publications as given in the 'Festschrift' runs to nearly two hundred titles, many of them books. It is more to the point here to refer to one of his latest works, published since his seventieth birthday. Travelling recently to Java, as he wrote in a private letter "once more to see the tropics," he did not go as a mere spectator, but as a worker. A volume of two hundred pages with sixteen plates, entitled "Morphologische und biologische Studien," is the result. In it he canvasses questions ranging from the lichens to the flowering plants. Specially characteristic is the memoir on the relations of certain Javanese ferns; for here von Goebel selects some which are well known as presenting systematic problems, and helps materially towards their solution. It is inevitable in such work that differences of opinion should arise. But here there need be no apprehension; for when von Goebel differs, he lays all his cards upon the table, and after expressing his own opinion he will adorn the difference with a quotation from the classics, or it may be with a humorous touch which leaves the social field unscathed, while the scientific arena is as open as before for friendly rejoinder.

It will be gathered by those who know von Goebel only by name that we see in him a very impressive figure: the bearer of a great tradition from the past, who through a long life has amplified and extended it. More than any other writer of the time he has saved plant-morphology from itself, by diverting its higher pursuit from formal and scholastic channels, and leading its adherents by preference towards middle lines of thought. This tends to promote the general advance much more effectively than any narrow specialism. Unfortunately the mental effort involved in the pursuit of some circumscribed theme is much less than that entailed by more generalised study. It is this that is apt to exercise an undue influence on those who desire to achieve immediate results, an attraction always resisted by von Goebel.

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