SCIENCE

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CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Prof. J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ON THE UNTECHNICAL TERMINOLOGY OF THE SEX-RELATION IN PLANTS.

THE modern conception of the sex-relation and the alternation of generations in plants has so changed our point of view respecting the morphologies of various members that an entirely new terminology has recently come into use to express the new-found homologies. At the same time, there is an attempt to restrict or to specialize the use of such age-long words as male and female, sex and the like, when applying them to plants. This part of the new terminology which touches common language is not above criticism, and I wish briefly to advert to it.

It should be said, in the first place, that the original conceptions of sexuality in plants, from Camerarius down to the middle of this century, were borrowed and adapted very largely from analogy with the animal kingdom. The stamens were considered to be male organs of sex and the pistils to be female organs, the idea of the necessity of a conformed sex-member being evidently borrowed from a knowledge of animal morphology. At the present time, however, our conception of the sex-relation of the higher plants is borrowed from a study of the flowerless plants, which, with every reason, are believed to represent a more primitive stage of evolution than the flowering plants. The true significance of the sex-process in plants was first clearly conceived by Hofmeister in 1849, when he propounded the hypothesis that certain great groups of plants undergo an alternation of generations, a sex-bearing generation being followed by a sexless generation. In certain plants, as the ferns, the sex-generation soon disappears and the sexless generation leads a wholly independent life; this sex-generation is the prothallus of the fern, and the sexless generation is the foliaceous fern-plant. But in certain other plants, as the mosses, the sexless generation remains attached to or incorporated with the sex-generation. Many of these flowerless plants produce a prothallus from the spore, and upon this prothallus are two minute unlike organs, one female in function because it develops the succeeding generation, and the other male in function because it produces the cells which fertilize the female cells. Recent morphological studies have shown that in the flowering plants the asexual generation is enormously developed and is 'the plant,' whilst the sex-generation is reduced to the minimum and is represented by a female organ developed within the ovule and a male organ developed in the pollen grain. The prothallus within the ovule encloses the germ of the asexual generation in its fertilized sexual cell, and this germ becomes the embryo of the seed; and the prothallus is absorbed, or else it remains as the albumen —or endosperm or perisperm—of the seed.

This very brief and imperfect outline is sufficient to bring the point which I have in mind before the reader, namely, how far can we use the terms 'male' and 'female,' and what must be the common language of the sex-relation in plants? Some morphologists now object to calling a stamen a male organ, or a pistil a female organ; and they base their reform upon the undisputed morphological fact that the male sex-phase of the plant is comprised within the short span and function of the generative cell developing from the pollen grain, and that the female phase is associated only with the development of the prothallus in the ovule. It should be pointed out, however, that the discovery of these morphological facts does not in the least shift the old-time attribute of maleness as applied to the stamen or of femaleness as applied to the pistil; for whether the pollen grain is sperm, as older naturalists supposed, or whether it is a spore and gives rise to a secondary generation which discharges the office of sperm, it is still all contained in the stamen; and the stamen is, in the broad sense of common language, a sexual member because its entire office is the discharge of the paternal relation. It is as much a member or organ of sex as the root is an organ of nutrition. The meaning of the sex-process has not been materially changed by the recent studies. 'Male' and 'female' never did and never can be made to express strict morphological homologies. An organ of an animal or a plant is male if it exercises the functions of paternity and not of maternity. The stamen is such an organ. Its entire office is that of maleness. The attempt to restrict the terms male and female to the ultimate sexual process seems to me to be unwarranted and hypercritical. It is interesting to observe that the morphologists fall into the very pit which they have digged, when they talk of male and female prothalli. Surely the prothallus is no more sexual than a stamen or a leaf. The egg cell and the male cell are the sexual organs, unless we choose to carry the purism to the physiological units; and since these organs soon disappear, as such, it follows that we cannot apply the terms 'male,' 'female,' 'sex,' and the like, to plants, save in the very brief period during which impregnation is taking place. This practically means that we must eliminate any reference to sexuality in all untechnical speech about plants, and the result would contribute to anything but clearness.

The common language of sex has always dealt in analogies. There are perfectly good and sufficient technical terms to designate the homologies and the ultimate physiological processes. If the hypercriticism of the plant morphologists were to be accepted for the animal creation, pandemonium would come of it. One could not speak of the members of generation as sex organs, nor of any animal as male or female. I insist that it is perfectly proper to speak of a staminate willow as male, because its ultimate function is paternity; if I cannot speak of it as a male plant, then I cannot call a bull a male animal.

L. H. BAILEY.

ON THE DIFFUSION OF METALS.*

PART I.—DIFFUSION OF MOLTEN METALS.

IN the first part of the paper the author alludes to some earlier experiments he made in 1883 on the diffusion of gold, silver and platinum in molten led. He points out that, although the action of osmotic pressure in lowering the freezing point of metals has been carefully examined, very little attention has been devoted to the measurement, or even to the consideration, of the molecular movements which enable two or more metals to form a truly homogeneous fluid mass. The absence of direct experiments on the diffusion of molten metals is probably explained by the want of a sufficiently accurate method. Ostwald had stated, moreover, with reference to the diffusion of salts, that "to make accurate experiments in diffusion is one of the most difficult problems in practical physics," and the difficulties are obviously increased when molten metals diffusing into each other take the place of salts diffusing into water.

The continuation of the research was mainly due to the interest Lord Kelvin had always taken in these experiments. The want of a ready method for the measurement of comparatively high temperatures, which led to the abandonment of the earlier work, was overcome when the author arranged his recording pyrometer, and the use of thermo-junctions in connection with this instrument rendered it possible to measure and record the temperature at which diffusion occurred. Thermo-junctions were placed in three or more positions in either a bath of fluid metal or an oven carefully kept hotter at the top than at the bottom. In the bath or oven, tubes filled with lead were placed, and in this lead, gold, or a rich alloy of gold, or of the metal under examination, was allowed to diffuse upwards against gravity. The amount of metal diffusing in a given time was ascertained by allowing the lead in the tubes to solidify; the solid metal was then cut into sections, and the amount of metal in the respective sections determined by analysis.

The movement in linear diffusion is expressed, in accordance with Fick's law, by the differential equation

$$\frac{dv}{dt} = k\frac{d^2v}{dx^2}.$$

In this equation x represents distance in the direction in which diffusion takes place; v is the degree of concentration of the diffusing metal, and t is the time; k is the diffusion constant, that is, the number which expresses the quantity of the metal in grams diffusing through unit area (1 sq. cm.) in unit time (one day) when unit difference of concentration (in grams per c. c.) is maintained between the two sides of a layer 1 cm. thick. The author's experiments have shown that metals diffuse in one another just as salts do in water, and the results were ultimately calculated by the aid of tables prepared by Stefan for the calculation of Graham's experiments on the diffusion of salts.

The necessary precautions to be observed

*Abstract of the Bakerian lecture given by Professor W. C. Roberts-Austen before the Royal Society and printed in the Proceedings of the Society.