into range in doing so. This may sound easy, but if so, the reader is likely to alter his opinion after reading Herr Schillings's interesting narrative. We should have omitted all the illustrations of "failures" of one kind or another, as quite unnecessary to the description of the methods.

The translation seems to be well done, and but few and trifling errors have been noticed. The moral of the work, like the matter of it is admirable, and may be expressed in brief—avoid all ruthless and unnecessary destruction of the beauties of nature wherever found!

Francis H. Herrick

Aposporie et Sexualité chez les Mousses. El. and Em. Marchal. Bull. Ac. roy. Belg. Cl. Sciences, No. 7, pp. 765–789.

In a paper already reviewed in Science, the Marchals have shown that the individual capsules of certain diœcious mosses contain both male and female spores and that regenerations from the leaves, protonemata or from other parts of the gametophyte give rise to the same sex as the plant from which they were derived. In the present paper they give the results of a careful investigation by means of pure cultures of the sexual condition in the sporophytes of the diœcious mosses—*Bryum cæspiticium, Mnium hornum* and *Bryum argenteum.* They find that regenerations from the capsule or from its stalk, *i. e.*, from any part of the sporophyte, give rise to bisexual protonemata from each of which are developed three types of leafy axes: (1) Those apparently male containing only antheridia, (2) those obviously hermaphroditic containing both antheridia and archegonia, (3) those apparently female containing only archegonia. Shoots with only antheridia were most common, those with both antheridia and archegonia were considerably less abundant while those with only archegonia were distinctly rare. That the three different types of shoots were potentially hermaphroditic was shown by regenerations from their leaves. These gave in repeated cultures of *Bryum cæspiticium* approximately the same ratio of shoots apparently male, hermaphroditic and female as were obtained directly by regeneration from the sporophyte and it is concluded that the hermaphroditic condition can be thus indefinitely propagated by vegetative means.

It may be pointed out that this transformation of a dioecious species of the mosses into an hermaphroditic growth brought about by the Marchals is similar to what the reviewer has already accomplished in essentially the same manner with the mould *Phycomyces nitens.* The hermaphroditic growth obtained from this species when propagated by cuttings retains its bisexual character often to a dozen or more vegetative generations but eventually the bisexual character is lost and with the disappearance of one sex, the growth is not to be distinguished from a pure unisexual race, male or female as the case may be. The hermaphroditic growths of the mosses resemble those of *Phycomyces* in that they differ in their sexual polarity. Thus while one regeneration from the sporophyte of *Bryum cæspiticium* showed a marked male polarity and produced one shoot with antheridia and archegonia to 51 with only antheridia, a second regeneration from the sporophyte of this same species showed an equality of the sexes and of 21 shoots, produced 17 with archegonia and antheridia, 2 with only antheridia and 2 with only archegonia. In view of the behavior of *Phycomyces,* the Marchals seem hardly justified in concluding from an examination of only two generations that the hermaphroditic condition obtained in the mosses can be propagated for an indefinite period.

A determination of the chromosome number and the sexual conditions which result from the union of gametes arising from their artificially produced hermaphrodites is promised by the Marchals in the near future.

Mention of some unpublished work on the zygospores of *Phycomyces* may not be out of place in this connection. Zygospores formed by hermaphroditic growths of this species, which the reviewer has recently brought to germination, do not differ, in the sexual relations of the offspring to which they give rise, from zygospores formed between diœcious growths. It seems impossible therefore to fix

the hermaphroditic condition since a complete return to the dioecious condition normal to the species results in the first sexual generation.

It will be of interest to see how closely the further discoveries in the mosses follow the conditions worked out in such an unrelated form as *Phycomyces*.

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A STUDY OF VISUAL FIXATION

PROFESSOR RAYMOND DODGE begins a series of "Studies from the Psychological Laboratory of Wesleyan University" with "An Experimental Study of Visual Fixation." The *Psychological Review* prints the number as its Monograph Supplement for November, 1907.

Professor Dodge finds that the involuntary movements of the eyes during supposed fixation are, in part, compensatory to head and body movements; in part, however, they are "normal and physical disturbances" of fixation, due to irregular head and body movements for which compensation is inadequate. The compensatory eye movements are united with the movements of head and body "into a thoroughly organized motor system," furnishing a coordinating mechanism capable of "explaining the intimate correspondence between tactual and visual space." Visual motives for the fixation movements are found in retinal fatigue and in the correction of inadequate binocular coordination.

In studying control of fixation movements, Professor Dodge remeasured the ocular reaction time, using Professor Holt's method with the alternating arc light, the fall of the exposure screen giving the stimulus simultaneously with the actinic beam, the latter being reflected from the cornea to the falling plate of the camera. The alternations of the current thus gave a time record in a series of dots. Interruptions by a tuning-fork would give greater accuracy. Plates of pot blue glass "stopped down" the arc light to a comfortable glow without materially reducing the effect on the camera plate. The slow reaction time determined by earlier experimenters was confirmed, but a minimum of 130 σ was reached. The head reaction was quicker than that of the eye.

Successive fixations of the same word were found to vary widely in location of the point of regard, but were called "perfect fixations" when the object of interest was "brought to a retinal area of clear vision." The functional center of the retina is larger or smaller according to the character of the object and according to the corresponding extent of the area of clear vision.

Fixation is called "adequate" when it is sufficiently long and accurate to condition a "cleared-up" perception of the object of regard. Renewing his criticism of the short exposure-times of Zeitler and Messmer, Professor Dodge measures the exposure-time needed for the "clearing up" of words presented upon various pre- and post-exposure fields, and concludes that "the shortest adequate fixation pauses in reading are between 70 σ and 100 σ."

In further experiments he measured the effect of peripheral factors, such as words seen peripherally in reading, in modifying the total consciousness without properly "clearing up." The movement is from general to special effects, phrase, sentence and paragraph, episode and plot, forming "a dynamic background" for each new word-complex as it clears up.

Professor Dodge raises the question whether the spatial relations of the total visual field are determined by its relations to the fovea, or whether the object of regard is not "rather determined in its spatial relations by its apparent position in the total visual field"; and after criticism of the theory of retinal local signs, he proposes a substitute theory of "genetic organization of the retinal elements." While the argument here is not wholly satisfying, the new facts that are being brought forward in this field make it certain that a better theory is to shake out eventually, and Professor Dodge's view is worth a careful reading.

The appendix to the article reviews the technique of recording the eye-movements by photographic registration, and describes the apparatus used in the Wesleyan experiments.