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*On the Nature and Causes of Variation in Plants.\**

By PATRICK GEDDES, F.R.S.E. (Plate XIV.)

(Read 8th July 1886.)

While the fact of the origin of species by evolution is no longer disputed, nor the operation of natural selection upon organic forms any longer denied, the absence of any general theory or rationale of variation in either the animal or the vegetable world is not only generally admitted, but often regarded as inevitable or even hopeless: variation to some writers being simply "spontaneous" or "accidental"; to others, if not fortuitous, at least dependent upon causes lying as yet wholly, and perhaps hopelessly, beyond our present powers of analysis.

A theory of variation must deal alike with the origin of specific distinctions and with those vaster differences which characterise the larger groups. To commence, then, with the latter, we may pose such questions as—

1. How comes an axis to be arrested to form a flower?
2. How is the evolution of the forms of inflorescence to be accounted for?
3. How does perigyny or epigyny arise from hypogyny?
4. How is the reduction of the oophore and differentiation of the sporophore to be explained among cryptogams and phanerogams, and why should the moss type be so aberrant and so comparatively arrested?
5. How did angiosperms arise from gymnosperms?
6. How did wind-fertilised flowers arise?
7. How are the forms of fungi, algæ, &c., to be explained?

Does the explanation of such questions really lie merely in the operation of natural selection upon innumerable "accidental" variations requiring separate explanation in every case, or is any constant law of variation discoverable?

Let us note the parallelism of form exhibited in many of these cases of unrelated organisms, and inquire whether this does not give us some other clue to their origin.

1. In phanerogams we find the raceme modified into the

\* A preliminary outline of a more extended analysis, underlying the writer's essay on "Variation and Selection," in preparation for a forthcoming volume of the *Encyclopædia Britannica*.

umbel and the spike by arrest of the main axis or of the flower stalks respectively. Suppression of both gives the capitulum, and, as specialisation goes on, the convex flower-bearing surface of the composite becomes flattened, as in *Dorstenia*, and finally deeply hollowed, as in the fig. (Plate XIV. fig. A, 1-6).

2. In simple flowers an indefinite number of modified leaves is arranged round the axis, whose internodes are suppressed. The first advance is to a definite number of sepals, petals, stamens, and carpels in the arrangement called hypogynous. A carrying on of the outer parts of the axis gives the perigynous position to the stamens, and the final form is the epigynous, where stamens, petals, and sepals are all carried past the ovary, the carpels occupying the inside of a pit instead of the outside of a cone (see fig. B).

Both these cases are clearly explicable by reference to the familiar antagonism between reproduction and vegetative growth (further analysed in the writer's recent paper on "The Theory of Sex and Reproduction"—cf. *Encyclopædia Britannica*, article "Sex"—to its basis in the constructive and destructive metabolism of protoplasm). We may view in the same light the concave form of the spore-bearing surfaces in many Fungi and Algæ—for instance, *Peziza* or *Fucus* (see fig. C)—and the emarginate form of the fern *Prothallus*, where the sexual organs appear (fig. E).

Note also that the shortening and reduction in the inflorescence of the Coniferæ from fir-cone to yew-"berry" is parallel to that of the phanerogams. The reduction of indefinite to the various forms of definite inflorescence is another change in the economy of the phanerogam. Similar to this is the reduction and even loss of bracts, and usually of petioles and stipules in the sepals. The complete or partial loss of the calyx and petals is usually considered degenerate; but from the present economy point of view, it seems a more complete specialisation for reproduction. In getting rid of coloured and merely attractive organs, and assuming wind fertilisation, the vegetative system is still further reduced.

The lessening in the number of stamens, carpels, and ovules in all the more evolved orders of plants is a parallel

case, which the reader will readily develop. A wider consideration shows the gradual shortening of the sexual generation from the Mosses onwards through the Lycopods, Equisetaceæ, Ferns, Cycads, and Coniferæ, to the phanerogams, where it is represented by pollen grain and embryo-sac alone. The comparative failure of the moss type seems thus due to an inevitably unsuccessful attempt at vegetative life on the part of the reproductive generation.

It is seen from cases such as the above-mentioned, that the reproductive axis, organ, tissue, in every case tends to become more and more shortened, depressed, or hollowed in proportion to the vegetative. In wider terms, whenever destructive changes in protoplasm predominate over constructive, the tendency is thus to produce a concave surface, as seen, for example, in the hollows of nectaries, or in the invagination of the blastosphere to form the gastrula (see fig. D).

This conception may be further developed, and shown to apply alike to the construction of the general genealogical tree, and, in particular, to the affinities of the flowering plants, and even frequently to the interpretation of the minute details of floral structure usually regarded as the product of natural selection acting on "spontaneous" local variations, nor need its application be restricted to the vegetable kingdom only.

*The Botanico-Geographical Exhibition at Copenhagen in 1885, instituted by M. CARL HANSEN, Professor of Agriculture at the Royal Academy, Copenhagen. By ANDREW TAYLOR.*

When delivering a course of lectures on Botanical Geography early in April 1885, it occurred to Professor Hansen that his work needed more thorough and popular illustration than that afforded by diagrams and tables when exhibiting orographic distribution, or plant migration, caused by atmospheric or oceanic currents, as well as the influence of man. The Professor accordingly instituted a small exhibition of 2000 live plants in pots, arranged so as to demonstrate to the eye the recognised

