Dynamic Forces

By E. Pfeiffer

In studying the construction of a living thing, we first observe its purely material side, its weight, its shape, its chemical constituents, its structure. These material elements are combined, are quickened; it grows, reproduces itself, takes definite forms, temporary or constant, undergoes change of substance: in short, it shows biological formation, it has a living development and order.

But knowledge of its chemical formula is of itself insufficient to enable us to understand its physiological reactions. We deem ourselves nearer comprehension when we speak of its wholeness, its entelechy, when we regard it as a higher unity of organic differences.

The question, "Why does a given reaction take place just here and now?", leads beyond consideration of the purely static condition to the recognition of organized, directed processes—*i.e.*, dynamic happenings. Dynamic, from the Greek word "dynamis" meaning power, is applicable to everything in the interior of a life-process which gives this a definite direction, activity and order; that is to say, everything which causes this life-process to be influenced, assisted or checked. Over and above the material, static existence we see the life-condition with its possibilities of development or decay. That which promotes or impedes this condition, above all that which first renders it possible, we call "dynamic activity."

Light, warmth must be named as the first promoters and awakeners of life. Without heat, there can be no life. Light assists growth, furthers assimilation and—as we shall see later—has an appreciable influence on form. Chemical forces work in and through physiological reactions. In the living organism these are directed to an end, they do not proceed at random. The organism makes a selection between possible reactions and thereby proves the existence of wise laws to which it conforms.

Already in the inorganic we see directing, helping or retarding processes. In chemistry these are known by the generic term "catalysis." A catalytic substance aids a chemical change but remains unchanged itself in the process: that is to say its *presence* is sufficient for the effect.*

In life development we find a number of such catalytic, *i.e.*, directed processes: we therefore speak of "bio-catalytic" substances. It is not only inorganic compounds, such as metal, hydrogen, etc., which can release dynamic activity, but also organic, often very complicated, substances. Their presence is shown in the physiological course of events, in the quickening or slowing down of growth, in the assimilation of nutriment and in respiration. It can also be discerned in alteration of form, in one-sided development of height or thickness, of root formation, of ripening, etc.. Substances producing such

* "The catalytic substance as the simplest directing factor is and in the modern dynamic —no longer mechanistic—view of the world remains a Cause, not productive of energy it is true, but nevertheless an important cause. . . ." Alwin Mittasch.

effects are called by different names, according to the "dynamic tendency" they display: growth-promoting, *i.e.*, auxine, hormones, growth hormones, ferments, enzymes, vitamins. "The determining factors of form, however, include more than catalysis. Catalytic substances ensure that something happens but have no share in deciding *when* it happens." (Mittasch.)

In what follows we aim at giving a summary review of the most important "dynamic activities" in the plant world. In our view, the most striking quality common to all those substances which exercise influence upon their surroundings is the fact that all such bodies as come into question are present in a highly rarefied form and that this rarity is frequently a necessary condition for the effect produced. This indicates that the chemical reaction is unimportant in itself and soon vanishes, that through it, however, a whole set of phenomena is initiated. The change from tadpole into frog is influenced by applying extract of thyroid gland; a rapid transformation into very tiny frogs results, the hormone producing this result when in a dilution of one to one thousand millions.

Fundamental in the study of this subject was the observed fact that the "air exhaled by apples" affected the growth of neighbouring plants. In this exhalation ethylene is found. True the quantity is small. An apple generates in some months of ripening only 1.26 mg. of ethylene. Nevertheless the effect is powerful. Molisch* noticed amongst other things that plants in its vicinity reached maturity earlier and lost their leaves sooner, and that the exhalation was injurious to the growth of blossom and of root.

Boas** writes: "If, for example, broad beans, sunflowers or pumpkins are left to germinate in earth or in damp sawdust under glass near apples, the exhalation of ethylene causes strange transformations. The pumpkin shoot resembles a little kohl-rabi. The sunflower bud is like a diminutive sow's tail. The broad bean sprouts (*Vicia Faba*) let their normally upright shoots creep along the ground. Thus the normal response to gravity, the upright position in space, is destroyed."

The germination of rye is hindered by apple aroma in the dark, but furthered in the light. (This fact leads the writer to wonder whether, if apples were laid near potatoes in a cellar, the latter would be kept from sprouting, if for example the apples and potatoes were laid one above the other and the smell of the apples was shut in. This of course presupposes apples of a good keeping variety, of a sort to last until spring, a sort which is increasingly rare.) Dandelions also exhale ethylene and thereby further ripening.

These dynamic activities are put to technical use in the artificial ripening of fruits plucked unripe, such as oranges, lemons, grape fruit and bananas, which are "gassed" to make them appear ripe.

Following upon his countless observations of the most delicate mutual effects amongst plants, Boas insists on the need for a dynamic Botany, which in addition to the static descriptions (Morphology, Physiology, especially Physiological Chemistry, Anatomy, etc.) shall treat of these effects.

"If we deal with the plant world from the point of view of effects," he writes, "there emerges a new behaviour of plants. Influences are everywhere at

* A famous Vienna plant physiologist.

** Dr. Friedrich Boas, *Dynamische Botanik*. Verlag J. F. Lehman: München, 1937.

work, all affect each other. Life in its circulation produces an invisible entanglement of effects. To throw light upon this is the task of dynamic Botany" (Boas, S. 11-12). "There is no doubt that our present day Botany fails to grasp the entire plant. . . . Inadequate dynamic knowledge of the plant world means in every case biological uncertainty. Because this state of uncertainty has in fact existed for centuries it does not follow that we must continue to submit to it" (S. 10).

The growth of yeast can be influenced by dynamic substances. There are yeasts which do not sprout even in favourable media. Only when certain plant juices (or humus) are added, even if only a trace, do they begin to grow.

The presence or absence of a bit of filter paper may, under certain circumstances, influence a process. The addition of filter paper, for instance, will promote the rate of cell transformation. This is related to the fact that through the presence of the filter paper a higher degree of acidity is reached and speedy changes follow. Insight into the chemical details of this process is still lacking.

The agricultural chemist is wont to refer to potassium as an important foodstuff, and to demand that it shall be present in such and such percentages or, if not, that its absence be made good. Unfortunately, he tells us less about the dynamic activities of this potassium. For example, reduction of (not yet lack of) potassium tends to heighten assimilation and transpiration, *i.e.*, tends to an increase of leaf green (chlorophyll) content. An excess of potassium makes the assimilation decrease. The ratio between the nitrogen in the form of albumen and the nitrogen in the form of nitrates is controlled in the plant by the potash content. The same applies to the formation of starch.

An experiment in manuring a certain kind of pear tree showed that the content of malic acid in the fruits was greatest when well manured, least when potassium was absent or when the ground was left unmanured.

Boas writes (S. 40): "It is clear from the figures given that hundredweight does not equal hundredweight, that albumen is not the same as albumen. The physiological-dynamic values cannot be supplied from statements of the water, sugar, albumen, fat and ash-content. They require special research with new methods . . . then, together with the old tried methods of analytical chemistry (sugar, albumen, fat, ash) we may arrive at a real delineation of plants and their ever changing life processes."

A dynamically interesting plant is the crowfoot or buttercup. In its green condition it contains a substance which checks growth. This crowfoot poison (Anemonin), extracted in small quantities from a fluid secreted by the plant, prevents putrefaction and kills fungus and bacteria. Crowfoot juices remain for weeks unfermented; added to other juices they check fermentation. Their effect in a dilution of 1:60,000 and 1:250,000 can be clearly observed: in fact they were effective in a yeast culture at a dilution of 1:33 thousand millions, and that was not necessarily the limit of their effectiveness. In a dried condition, however, this growth-checking substance is not found. Instead there is observed a growth-promoting substance.

What does this signify in practice? Take a meadow containing a quantity of crowfoot. Its active substance will through rain and through decay percolate into the soil; there it checks the life in the soil, "sterilises" it, checks the forma-

tion of humus. The meadow becomes sour, other plants die, especially clover, and next year there is an even more favourable soil for the crowfoot. Curiously enough, kaolin and clayey soil absorb this harmful stuff. Therefore thorough manuring with clay compost, together with a good aerating (harrowing), is an excellent counter measure. In this connection it is important to note that the crowfoot action already appears in highly diluted form.

Camomile has the effect of expediting growth in yeast cultures and also in the life of the soil. An extract of 0.0012 mg. of camomile applied to a yeast culture increased its growth about 4½ times above that of a similarly grown culture without the camomile. An extract of 0.003 g. increased it 110 times. The limit of the active power of camomile was worked out by Boas at 1:125 milliards. A decade ago such activities would have been decried as mystical; today there are thousands of scientific writings embodying the results of countless observations of them.

In stable manure the same kinds of powerfully active substances may be found, whose presence or absence may be decisive for physiological development. So may the presence or absence of retarding substances. Amongst other things these affect root formation. "Hence it arises that the growth of roots may be actively promoted by a bath of plant-extracts. This proved valid in the case of bean-roots which were steeped for a short time in a decoction of camomile (10 g. in 500 cc. water). Individual plants and parts of plants produce different blends of active substances" (Boas, S. 73).

The writer has demonstrated the value of bio-dynamic preparations added to manure and their effect upon the growth of roots by countless experiments,* and further demonstrations will shortly be published. In these preparations it is partly a matter of plants like camomile, dandelion, yarrow, etc., which have been subjected to slow fermentation. The growth-promoting substances thus set free in them can be applied to the soil in a compost or a manure or directly by dilution. They increase fermentation and augment the life of the soil. Knowledge of their chemical formula is of minor importance; it tells us nothing concerning their activities. For more than a decade these preparations have met with criticism. But I believe that no one who follows the new studies concerning the so-called active substances can keep his mind closed to the effects of the bio-dynamic preparations. An objection frequently made to these preparations was founded on the high degree of dilution in which they were applied. As compared with the very high dilution of the growth stimulating substances, auxines, etc., the bio-dynamic preparations appear rather "concentrated" when applied, e.g. in a 0.005 per cent solution. According to Professor Kögl, Utrecht, the well-known auxine expert, the yeast extract biotin works in a dilution of 1:400,000,000,000.

To return to the effect of camomile, on which the writer proffers an observation of his own. The active parts of the plant naturally make themselves felt wherever the plants grow and through root secretions or through fall of leaves influence the soil and the roots of other plants. In his book *Bio-Dynamic Farming and Gardening*, he therefore writes of "dynamic" plants. Only those

* See E. Pfeiffer: "Bio-Dynamic Farming and Gardening": Anthroposophic Press, New York City, 1938.

who ignore the new plant physiology can disapprove of this conception. It has been observed that camomile deliberately sown as "weed" amongst wheat or other cereals influences their growth. For instance, a large quantity—20 camomile to 100 wheat plants—when sown together results in the production of small and light seed. But a smaller quantity, for instance 1 camomile to 100 wheat plants, results in a large and heavy grain. Only in the greater "dynamic" dilution can the substances do their work.

A similar substance, related to yeast extract, is found in the sap of the birch tree. It specially affects fungus. This substance may also be secreted in the roots of the birch or be washed by rain from its trunk into the soil. This explains, first, R. Steiner's statement (1921) that the soil surrounding birches is found to invigorate growth, and secondly, the fact that composts under birches rot into finer earth with less smell than elsewhere. For these reasons, we recommend the planting of birches on or near compost and manure yards. These and elder trees, which have a similar effect, will send their roots into the compost soil, exercising their beneficent influence. Experiment will show that such composts rot more quickly. Of the same order are the important effects of couch-grass, blackberries, elders, nettles, which play so great a part in the afforestation of unfavorable regions. If some day the effects of the root secretions of these plants are more closely studied, much material for research will be found therein.

We are here moving in the sphere of purely dynamic events, which were strange to us fourteen years ago but now are familiar through numerous scientists and hundreds of experiments. Whether by attributing "dynamic" processes to special substances we have solved the problem of their activity is another matter. To refer an activity back to a chemical, perhaps precisely defined, substance is no real explanation, for the formula throws no light upon the activity. We only know that the substance functions as its bearer. Through it, effects are wrought which, for example, resemble an increased, diminished or one-sided effect of light, warmth, gravity or chemical affinity. Further study will be devoted to this problem, which is but a section of a wide new field of research.

We end with these words of Boas: "At all events, the great dynamic importance of the substances which impart growth-influences will persist, whatever individual knowledge may yet be gained concerning them. And this importance will remain valid for the course of their activities. For they are chemically constant—and remain effective in nature when they are detached from the plant and, for instance, penetrate the soil. Perhaps they also carry elements of fruitfulness."