$$x^u \cdot y^v = z$$

can be put in the logarithmic form

$$u \log x + v \log y = \log z,$$

and charted immediately.

It is even possible to combine two or more charts of the general type we have considered, enabling us to solve equations containing four or more terms. The method is thus almost one capable of handling algebraic equations in general; but further development of the subject would be out of place here.

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THE COORDINATION OF CHROMATOPHORES BY HORMONES[1]

THE melanophores of the horned toad, *Phrynosoma cornutum* Harlan, become contracted during states of nervous excitement. All attempts to prevent this reaction locally by cutting various nerves have failed. It is thus suggested that the melanophores may be coordinated, in part, by a hormone produced during nervous excitation and carried to all parts of the skin by the circulation.

The skin of one leg may be isolated from the general circulation, without blocking its nerve supply, by tying a ligature snugly about the leg. When this is done the melanophores of the isolated leg remain expanded after the animal is thrown into a state of nervous excitement. The leg appears much darker than its mate. Upon removing the ligature the melanophores contract and the leg becomes pale. The effect is not due to a shortage of oxygen or the accumulation of metabolic products in the leg, for such effects do not influence the melanophores of a ligatured leg until much later and then they produce a *contraction* of the pigment cells. If blood drawn from a horned toad which is in a state of nervous excitement is injected into one of the subcutaneous lymph-spaces of a second animal, the skin above the lymph-space will become very much paler than that of the rest of the body. The injection of blood from a horned toad which has not been thrown into a state of nervous excitement does not have this effect. During states of nervous excitement the blood contains a substance which causes the pigment cells to contract.

What is this substance and where is it produced? The conception of a hormone coordinating melanophore activity is not altogether novel, for Fuchs (1914, pp. 1546–1547, 1651–1652) has attempted to explain the behavior of pigment cells in amphibian larvæ and reptiles by assuming that substances, perhaps internal secretions, which contract the melanophores, are produced in the body under the regulation of the pineal organ. Laurens (1916) has recently shown this hypothesis to be inapplicable to the phenomena observed by him in *Amblystoma punctatum*. That the pineal organ is not concerned, primarily at least, in the reaction in the horned toad is proved by the fact that removal of the entire brain anterior to the cerebellum does not prevent the melanophores from contracting during states of nervous excitation.

The studies of Cannon and his collaborators upon the physiology of the major emotions present a more promising clue to the nature of this hormone. Cannon and de la Paz (1911) have shown that during states of emotional excitement the adrenal glands are activated to such an extent that an increase in the adrenin content of the blood from the adrenal vein may be detected. Spaeth (1916) has amassed a formidable array of facts to prove that the melanophore is "a disguised type of smooth muscle cell." If Spaeth's contention be accepted, it would appear most probable that the melanophores should be controlled by adrenin, which occupies a particularly significant position in the physiology of smooth muscle (compare Elliott, 1905).

Adrenin has been shown to produce a contraction of the melanophores of the frog (Lieben, 1906) and of *Fundulus* (Spaeth, 1916). Very minute quantities have this effect upon the melanophores of the horned toad. Removal of the adrenal glands does not prevent

[1] Contributions from the Zoological Laboratory of the Museum of Comparative Zoology at Harvard College, No. 273.

the reaction which follows nervous excitement. This fact, however, merely indicates that there are other mechanisms capable of bringing about the reaction. By stimulating the adrenal glands electrically the melanophores of the entire skin may be contracted. If one leg is ligatured during this procedure, it will remain much darker than its mate; if the ligature be removed several minutes after stimulation has been discontinued, the leg will quickly become as pale as the rest of the body. If the gland be isolated from the general circulation by a ligature, no contraction of the melanophores will follow the stimulation of its surface.

From the foregoing it is clear that the melanophores of the horned toad are coordinated, in part, through the action of a hormone. There is some circumstantial evidence that this hormone is adrenin. Experiments are in progress designed to give more direct evidence concerning the latter point.

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SOCIETIES AND ACADEMIES

THE AMERICAN PHILOSOPHICAL SOCIETY

ON March 3, Dr. Caroline Rumbold, University of Pennsylvania, spoke before the American Philosophical Society of Philadelphia on the "Pathological Anatomy of Injected Chestnut Trees."

While working on tree injection in connection with the chestnut-tree blight, about 50 different substances: hydrocarbons, alkali metals and metals were injected in solutions of varying dilution into the trunks of chestnut trees. So far, an examination of the trunks and branches of the trees shows that the reaction of the tree to the injections was alike in kind though not in intensity. This reaction varied with the distance from the point of injection. The affected region extended up and down the trunk from the point of injection in a line, whose width usually was but little more than the injection hole. As the distance from this point increased the tissues appeared more normal and the area of disturbance decreased. Occasionally all stages of reaction to an injection could be seen in a tree: death—at the point of injection—retarded growth, stimulated growth and no reaction.

The regions that showed response were the cambium and the phlœm. The cambium as such ceases growth and is wholly converted into wood-tissue. Small isolated groups of xylem cells develop on the outside of the rows of normal bast-fiber, through proliferation of the already formed phlœm cells. Large and very numerous stone-cells appear in the phlœm, which increase in number until rows of them are formed. An increased number of calcium oxylate crystals form. The isolated groups of xylem, developed in above-mentioned manner in the phlœm, grow in area and coalesce. In this conversion the cells of the phlœm take part with the exception of the bast-fibers and the stone-cells. They are frequently found embedded in xylem. This conversion proceeds irregularly, leaving areas of phlœm surrounded by xylem, or groups of cells of an undecided appearance, apparently partly phlœm, partly xylem. No specimens have been found in which all the phlœm cells in the injected region of the bark had been entirely converted into xylem.

The conversion of the cells of the phlœm into xylem cells is not unknown, but it is believed that this is the first instance in which by injected chemicals this phenomenon has been produced and it may prove a help in the future histological study of the cells of the phlœm.

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 552d regular meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, March 11, 1916, called to order by President Hay at 8 P.M., with 28 persons present.