funnel-shaped and white. The immediate progeny from such a mating is uniform and exhibits the dominant traits, color and the salver shape. The generation of the grandchildren, derived as in the simple Phlox case, is a mixture. In every 16 individuals there are *on the average*

- 9 colored and salver-shaped,
- 3 colored and funnel-shaped,
- 3 white and salver-shaped, and
- 1 white and funnel-shaped.

As an aid in visualizing the processes that underlie this ratio, let us refer again to the diagram. Each of the chromosomes in the male gamete has a black mark in it. Suppose the dot in the straight chromosome is the gene determining salver shape and the dot in the curved chromosome is the gene for colored flowers. The homologous chromosomes in the female gamete are shown without marks in the corresponding places or "loci." This signifies that they are carrying the recessive genes conditioning funnel shape and non-colored flowers, respectively. (See Figure 1 in the diagram.) Fertilization gives a cell (Figure 2 of diagram) hybrid

in respect to two pairs of characters. The adult built up (Figure 3 of diagram) forms colored salver-shaped flowers and does not betray the latent genes for white and funnel shape carried in its constitution. With the formation of gametes by the adult (Figure 4, diagram) the usual reduction in chromosomes occurs. It is important to note that while rod chromosome always separates from rod chromosome (the two entering different gametes) and likewise curved chromosome separates from curved, it seems to be a matter of indifference whether the black-dotted rod passes into a gamete with the black-dotted or the non-dotted curved chromosome.

The same holds good for the non-dotted rod. Accordingly four kinds of gametes are possible (Figure 4 of diagram), and the first hybrid generation forms these in equal numbers. Now suppose a lot of eggs of these four sorts are mixed with a lot of male gametes of the same sorts and the unions are left to chance. The laws of probability will lead us to the four combinations already mentioned as found among the grandchildren and in the stated proportions.

The second of the chief Mendelian principles is exemplified in this more complex Phlox example, *i.e.*, the principle of the independent reassortment of traits or of the genes that condition them. If the colored salver-flowered strain and the white funnel-flowered strain were the only kinds of Phlox in existence, then our crossing would have enabled us to secure two entirely new creations, namely, colored funnel-shaped flowers and white salver-shaped. All organisms may be viewed as a collection of traits (dependent on a collection of genes in the chromosomes) dissociable at time of gamete formation and capable of being put together into new combinations at times of fertilization. It is this principle which caused the botanist Baur to boast that with a little time he could make Snapdragons to order.

A large part of the success of Luther Burbank is dependent on securing new combinations of characters resulting from hybridizations. There are limitations or refinements to the principle of reassortment, but all these are nicely interpretable in terms of chromosome behavior.

Quantity Production of Relief Maps

A New Process Whereby These May Be Had Quickly and in Large Numbers

By Dr. Alfred Gradenwitz

INASMUCH as ordinary maps fail to convey any adequate idea of the ground they are intended to show, endeavors have long been made to provide plastic maps, representing all three dimensions, the heights as well as the lengths and widths. Those so far produced, however, were anything but satisfactory. If made of plaster of Paris, they would, in fact, be too schematic, of dimensions hardly ever true to scale and colors only seldom agreeing with natural conditions. Though these reliefs could be manifolded, two copies of the same original hardly ever agreed with one another, while each had to be separately painted and written on. Other plastic maps were made up of a superposition of pasteboard (or wooden) sheets arranged in stair fashion; unless the stairs were smoothed over with some plastic material, these would produce a wrong impression. Moreover, all these maps were much too expensive to lend themselves to any more general use.

A Munich sculptor, Karl Wenschow, has designed a radically new process for providing relief maps of surprising perfection and remarkable cheapness; in fact, any ordinary level map can by this process be converted into an excellent plastic map.

The map to be operated on is fixed in a frame providing the proper tension, after which it is placed above some plastic material and, by moistening with some special liquid, made ductile at any places corresponding to elevations or depressions of the ground. The map having then been pressed against the plastic mass, the heights and depths are worked out with special instruments in accordance with the altitude data of the map. The ductility of the map varies from one point to the other, any tearing or other damage being effectively prevented. Ingeniously constructed apparatus allow the variable height of relief to be checked, ascertaining even the slightest inaccuracies. In fact, the level map is thus converted into a faithful model of the ground, true to scale with regard to all its dimensions and angles.

The plastic mass above referred to enables even the most minute details, such as stone bridges, railroad lines, cuttings, to be worked out.

From this primitive mold, there is produced a counter-mold, destined to be used as matrix in stamping any desired number of replicas. Special stamping machines, working under high pressure, are used in this connection.

For each plastic map to be stamped with this matrix, a level map is made ductile in the same manner as

A flat original (left) and the relief map into which it is transformed by the new process

in connection with the primitive mold and is by the matrix pressed against an immediately hardening plastic mass. Stampings follow upon one another so rapidly that every five minutes a relief map is ready to leave the machine. The latter is so designed that, while one mold is in the press, another can be prepared, in order on withdrawing the former, to be inserted without delay.

Thanks to the stamping process, each relief leaving the machine is a perfect replica of the primitive mold, the surface of each being a pressed-on, previously level map. It is immediately ready for use and, as an improved map, it is suitable for a multitude of applications.

The inscriptions, colors and original proportions of the map are in no way altered by the treatment. The relief map is hard as wood and of unlimited durability, neither its dimensions nor its volume undergoing any change in the course of time.

The process above described and the possibility of manifolding open up an enormous field of application, the extent of which cannot yet be adequately gaged.

Schools—elementary schools in the first place, but even secondary and high schools, universities and technical colleges—will derive much advantage from the new type of map. While the ordinary flat map frequently conveys no adequate idea of the conformation of the soil, plastic maps give a most vivid and impressive idea of everything pertaining to geography and lend a new and unexpected interest to a doctrine generally appealing to few pupils. Inasmuch as the plastic map is a perfect replica of the ground on a reduced scale, it is the most efficient means of studying it, even before proceeding to an inspection of local surroundings, enabling pupils to check and complete the knowledge derived from the plastic map.

Water, mining and harbor engineers will work much more quickly when planning and demonstrating their

schemes with the aid of accurate reliefs. In fact, no better means of advertising a given scheme, or schemes of a given kind, can be imagined. While engineering diagrams with their calculations, ground-plans and elevations, profiles and financial estimates will always form the basis of any project, plastic maps are bound even to interest the man in the street in things so far reserved to a narrow circle of experts. Unfortunately, as is the case of most inventions, even military circles are likely to be interested in the process above described.

In the opening up of new countries, the new process will lend invaluable

help, the more so as a combination of aerial surveying with the wholesale production of plastic maps has been attempted. In fact, the company exploiting the process has associated itself with the Aerial Picture, Ltd., the Zeiss Works and the International Stereographic Central Station, with a view to combining their endeavors in the interests of culture and scientific investigation.

Whereas many decades would be necessary to survey (at an enormous cost) by terrestrial methods such countries as, *e.g.*, the interior of Africa, South America and Asia, the combination of aerial photography, photogrammetry and plastic map production will enable the greater part of the surface of our earth, which had so far been unknown, to be made accessible to mankind for the benefit of science and the progress of human civilization, thus utilizing values which it might otherwise have taken centuries to open up. Even before the colonist's foot shall have trodden the soil to be cultivated by him, he will be supplied with an accurate picture in relief of the area that is to be the scene of his future field of activity.

Gas-Burner Design

TECHNOLOGIC Paper of the Bureau of Standards, No. 193, entitled, "Design of Atmospheric Gas Burners," describes the apparatus and methods used for the investigation of burner operation. Several types of gas orifices were investigated and the coefficients of discharge determined. The principles governing air injection are discussed, and examples and curves are shown to illustrate the effect of a change in the gas pressure, specific gravity and volume of gas. The design of injecting tubes that produced the greatest injection of air was determined. Characteristics of a satisfactory burner are described. The relation between total port area of burners and the capacity of burners is fully discussed.