COLOR CONTRAST.

BY PROF. OGDEN N. ROOD, OF COLUMBIA COLLEGE, ASSISTED BY THOMAS EWING.

At the recent meeting of the National Academy of Sciences, Professor Rood gave some account of the experiments on color contrast now in progress at Columbia College. Previous experiments have been altogether qualitative; the present ones are the first quantitative experiments ever undertaken.

Colors of all objects are altered by their surroundings. An instance cited was that of a house which the Professor supposed to be of an orange yellow brown color, until he saw it in winter, when it was evident that there was not a particle of red in the color. The apparent red was caused by contrast with the green grass.

There are two kinds of contrast, simultaneous and successive. These investigations were of simultaneous contrast, which is very difficult. Successive contrast would be still more so, on account of the inability of the memory to recall slight shades of color.

The investigation was conducted by causing colored disks to revolve in such a way as to blend the colors.

The simplest case is that of uniform color all around the circle, as in the case of a disk of green surrounded with a gray ring, and that again with another green ring, Fig. 1.

The interposed gray appears rosy by contrast with the green.

In order to measure the intensity of the apparent redness of the gray ring, two methods were adopted—first by comparing it with a revolving disk of the color complementary of the green, but partly covered with black and white, and varying the amount of the disk thus covered till the color appeared to be of the same intensity as that of the gray ring, Fig. 2.

The second method of measuring was by extinguishing the induced red by partly covering with green, Fig. 3.

Still another method resorted to was copying.

The degree of lightness of the gray disk is not material unless it is made very dark indeed.

It is found that the induced sensation produced by a red disk is extinguished by 8 per cent of the complementary green; that of a green disk, however, requires 33 per cent of the complementary red; and that of a blue disk, 50 per cent of the complementary yellow. No reason is known for this physiological effect.

It is found also that in passing from the red to the violet end of the spectrum, the induced colors vary more and more from the true complementary.

With a green disk, the induced color appears more pink than the complementary; and with a blue disk, the induced color differs widely from the true complementary.

If the coefficient of a red disk be taken as 1, that of the emerald green disk which just balances it and produces white light is 1·7, Fig. 4.

Green when darkened looks bluish; but if you diminish the brightness more than one-half, you only diminish the subjective effect one-third.

With blue, one-third the brightness produces fully one-half the subjective effect. Bluish colors are more effective than others subjectively.

A more difficult problem is to find the most neutral point in comparing colors not strictly complementary, as in the case of emerald green and vermilion. In this combination the most neutral tint is not gray, but yellow. To illustrate this combination of colors, an inner disk of black and white may be introduced, Fig. 5.

In order to aid the memory, an inner disk may be used of the same colors as the outer ring, which is set at the point of the previous experiments, while the outer ring is slid a little one way or the other till the vertical point is reached, Fig. 6.

It should be understood that in all these experiments, the disks are compounded of two capable of sliding one above the other, so as to expose a greater or a less proportion of each color, the individual colored disks having each a slit, which enables them to be adjusted; each color covering a disk of this construction, Fig. 7.

The second part of the investigation was to ascertain the quality of colors that are not true complementaries.

Two colors, A and B, were taken, nearly, but not absolutely, complementary, A being used as the standard.

The value of B having been determined, as in the first experiments, it was combined with a third color, C, which was a little further up the spectrum than A. C would be combined with D, which was still a little further from the starting point. Thus all the colors of the spectrum were compared through a gradation of fifty colors. This is an entirely new process.

As a result of these and other experiments, he claims that Newton's diagram of colors should be arranged in a circle, not in straight lines, as Newton had it. Instead of Fig. 8, we have Fig. 9.

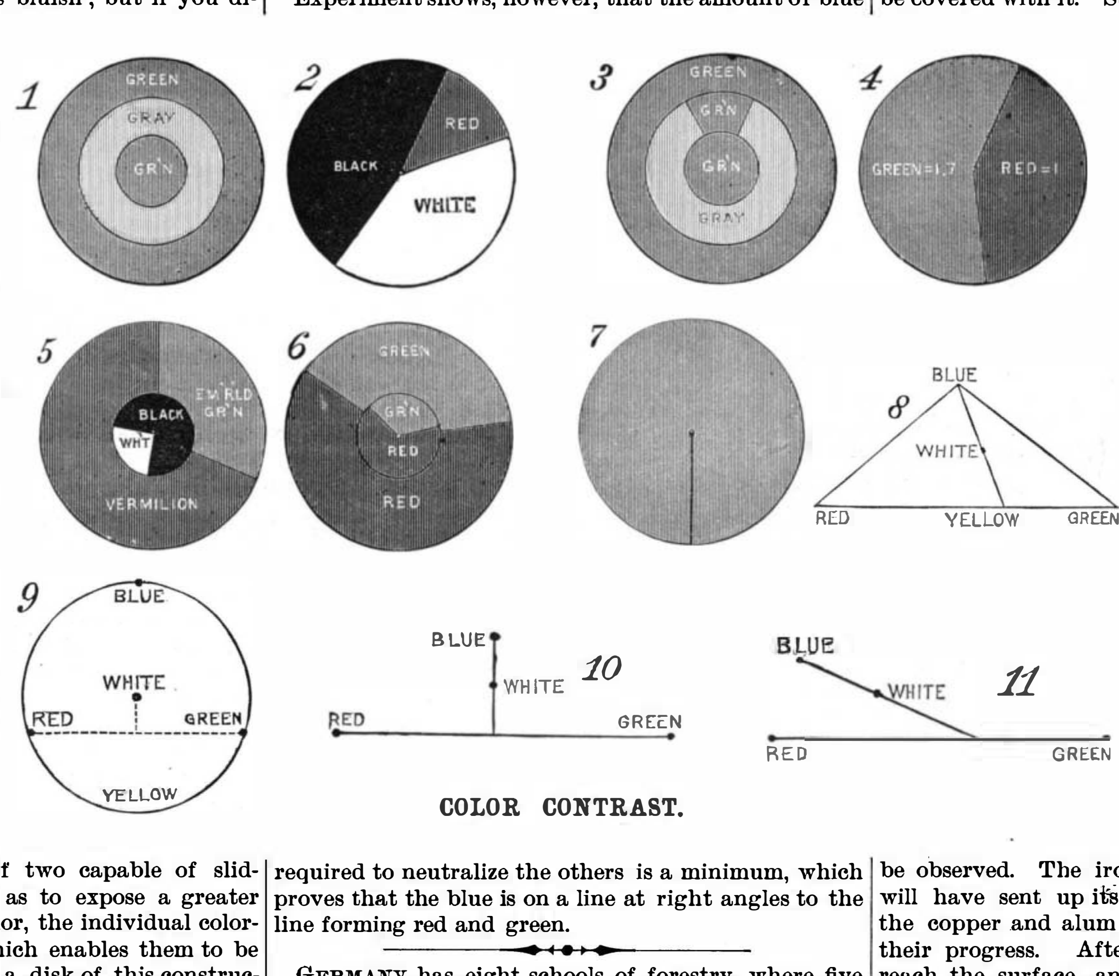
White occupies the center of the circle, and lies on a line drawn at right angles to the palest tint. Some of the experiments in corroboration of this are of the following nature:

Let the three fundamental colors be supposed to represent weights at the end of a system of bars, Fig. 10.

Then white represents the center of gravity.

If the system were arranged as follows, with the blue off at one side, white would still represent the center of gravity; but the amount of blue necessary to counterpoise the system would be much greater, Fig. 11.

Experiment shows, however, that the amount of blue required to neutralize the others is a minimum, which proves that the blue is on a line at right angles to the line forming red and green.



COLOR CONTRAST.

GERMANY has eight schools of forestry, where five years' training is required of those who seek positions under the Government, although a course of study half as long may be taken by amateurs. France supports a single school at Nancy.


CHEMICAL VEGETATION.

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T. O'CONOR SLOANE, PH.D.

Many of our readers have tried the old time classic experiments with solutions of different metallic salts, in which tin trees, lead trees, or silver trees were produced. A bar of zinc suspended in a dilute solution of acetate of lead precipitates metallic lead very beautifully, producing the effect of an inverted tree. This was the *Arbor Saturni*, or Saturn's tree of the old school. A silver tree is produced by an analogous method, and was called *Arbor Dianæ*, or Diana's tree. By the battery, aborescent growths of metal may be produced on an electrode, which, exhibited in the magic lantern especially, produce very striking effects.

By the use of silicate of soda, chemical precipitations can be brought about that still more closely resemble vegetation, in some cases corresponding in color with their model. Crystals of metallic salts immersed in a moderately dilute solution of this silicate, or water glass, as it is often called, send out shoots of precipitates varying from stalagmitic formations to the finest threads. Each of the available salts produces a highly characteristic appearance. In some cases the resemblance to the lower forms of plant life is remarkable.

Silicate of soda is made by combining silica with soda. Some form of silica is heated under pressure in a solution of caustic soda, when combination takes place, and a thick solution is obtained.

It is thus prepared in large quantities for commercial use, and can be purchased by the experimenter cheaper than he can make it. In composition it is precisely analogous to glass, but is soluble to almost any extent in water. Notwithstanding this, when once in the solid condition, its solution is only effected with difficulty. This gives it a certain value as a cement. Broken glass and china can be mended by it quite satisfactorily.

As sold, it is a very thick fluid, resembling strong starch solution. For the experiment in question, it must be diluted. A clear glass bottle or any suitable vessel may be used. It is about one-third filled with silicate of soda solution, and the remainder is filled with water. By shaking and stirring, the two must be mixed perfectly. In doing this, a good opportunity is afforded for observing the action of a liquid of low diffusive power. The silicate solution mixes with much difficulty with the water, gathering into a lump or drawing out into threads. It gives a good illustration of the difficulty we should be placed in, were there no power of diffusion in liquids. Without this power to help us, it would require a long time and prolonged stirring to mix a cup of tea or coffee containing sugar and milk.

When the silicate solution has been thus diluted and mixed, a layer of sand, half or a quarter of an inch thick, is introduced into the bottle. It is best to pour it through a wide tube, reaching nearly to the bottom to avoid discoloration of the fluid. Then crystals of different salts are embedded in the sand. The object of the sand is to hold the crystals in place. It plays no active part in the experiment. The crystals must not be covered with it. Sulphate of alumina, potash alum, protosulphate of iron, or "copperas," sulphate of copper, or "blue vitriol," are good salts to start with. Clear crystals, the size of a pea, should be selected, dropped into the bottle, and by a rod pressed down into the sand until half embedded.

The bottle is then put aside in a quiet place, where it will not be shaken. In a few hours the crystals will begin to sprout to a perceptible extent. The finest possible green filaments, resembling seaweed, will start up from the iron crystals in a nearly vertical direction. More slowly, similar filaments appear with the copper crystals as nuclei, while the alum sends up a most characteristic growth of pure white stalagmites. These three forms are represented in the cut. They can be identified by the description. The iron growth is greenish; the copper, light blue.

A curious difference in rapidity of growth will next be observed. The iron in the course of a few hours will have sent up its filaments several inches, while the copper and alum will be much more gradual in their progress. After a while the iron filaments reach the surface, and another phenomenon shows itself. Where each filament touches the surface, it spreads out, and, as the iron oxidizes, loses its green color. After a while, it becomes too large for the floatative powers of the solution, and sinks until it is caught and sustained by some of the neighboring filaments. In this way the filaments become terminated with expansions, several of which are shown in the drawing.

Many other salts can be tried, and separate growths produced in different bottles. In addition to the salts already named, sulphates of chromium, nickel, cobalt, and combinations of other acids and bases might be tried. To those who have never used silicate of soda, the behavior of this curious solution will in itself be an interesting phase of the experiment.

To arrest the growths, the silicate solution may be displaced with clear water. To do this, water must be poured in very gently through a tube reaching nearly to the bottom of the bottle. As the liquid overflows, the silicate will be carried away and water will take its place. Where it is not desired to preserve the growths, it is preferable to dispense with sand, as the process can be more closely watched without it. The only object of using it is to hold the crystals in place where the bottle is subjected to movement.

Ships' Boats.

The lifeboats of the British National Lifeboat Association have iron keels, a very extensive provision of air cases, and valves for discharging water through the bottom; they have a flat laid in them, and have so much inclosed buoyancy that if a sea breaks over them they are able to discharge through the bottom all the water as far down as the flat. They have further so much stability that if capsized they will soon right themselves. Of course, boats so completely *lifeboats* as these could not be made practical use of as ships' boats, they would be so very heavy and cumbersome. The official standard of the Board of Trade as regards lifeboats is that one and a half cubic feet of airtight compartment shall be provided for every person carried in the boat, and the number of persons carried is assumed to be one for every ten cubic feet of the boat's content. It will be seen that this is a purely arbitrary scale, and is prescribed because some quantitative regulation is necessary.

Of course, other things being the same, the more airtight space the better in a lifeboat; and, on the other hand, any boat is the better fitted for saving life by having ever so little either of airtight space or of space filled with cork. The specific gravity of cork is 0·24, consequently, a compartment filled with cork is for every cubic foot of its content equal in efficiency to three-quarters of a cubic foot of air space. A cork-filled compartment has, however, the advantage that if damaged or leaky but little harm is done, as water cannot get into the space occupied by the cork. It has been found necessary to specify the material of which air cases for lifeboats may be made in order to insure their being and remaining efficiently watertight. Thus zinc cases are not allowed, and copper cases are not admitted in a boat the shell of which is iron. Even copper cases have sometimes been found to be defective through having been fraudulently constructed of material little thicker than tin foil. The material most commonly employed in the construction of air cases is well seasoned yellow pine coated with waterproof canvas. It is also required that lifeboats shall be built both ends alike, similar to whaleboats; that they be fully and completely equipped; that the equipments, including a supply of fresh water, be always in them ready for use; and that they can by means of davits be readily lowered into the water.

Ships' boats are constructed in as diverse fashion and of as many or more kinds of material than ships themselves. The clincher built boat is that which probably has the greatest strength for its weight. The material most frequently used in its construction at the present day is larch. The diagonal built boat is also very strong, and is a good type of boat when it is desired to use very thin hard wood plank; this system of construction is often adopted in boats of the largest size. For the heavy longboats of sailing vessels, which have to be seldom got out except at ports, where they are required to be used in transporting cargo, in which service the boat should be able to put up with some rough usage, the old fashioned carvel construction presents many advantages. Iron, or rather iron coated with zinc, known usually as galvanized iron, has for many years been employed in the construction of boats, but has not made its way into very common use. A well known type of iron boat is one in which the metal is corrugated in such a manner that the boat's bottom looks very much like that of a clincher built wood boat. The consequence of this arrangement is that the boat is locally, and indeed altogether, much stronger than if constructed with plain sheets of metal.

A very efficient and strong composite boat is carried by the American mail steamers which run regularly between Liverpool and Philadelphia. The skin of this boat is iron, but the frame is of live oak, and consists of bent planks arranged longitudinally at intervals. In these boats there is no necessity for the metal skin to be corrugated. Metal boats have two important advantages over others: they may be carried near the funnel or in hot climates without liability to shrinkage and consequent leakiness, and the outer skin of the boat can be made to form the sides of the air cases, thus saving both weight and space. The disadvantage is that these boats cannot be very easily repaired; in fact, cannot usually be repaired by the carpenter of the ship.

Canvas and similar materials are, and have been for many years, used in the construction of boats, although their use is chiefly associated with one important type, which we propose to notice at some length. From the earliest times the skins of animals stretched over bent osiers or branches of trees have formed a convenient and easily transported boat, and on certain parts of the Irish coast boats in which painted canvas takes the place of plank have been employed from time immemorial, and are even now used for fishing purposes.

The portable folding boat of the Berthon Boat Company depends for its flotation upon canvas made watertight by a special paint. The framework consists of a number of longitudinal frames which are broad and flat, having their edges to the curve of the shape of the boat, and are jointed together at the upper part of the stem and stern post. They lie in parallel planes side by side when the boat is collapsed, like the leaves of a closed book, and they stand out at different but definite angles, radiating from their common center, when open. The upper one on each side, when the boat is open, forms the gunwale. The boat has two skins of waterproof canvas, one attached to the inside of all the frames, the other to the outside. She thus has a double bottom and sides, and the space between is divided into separate compartments by the wood frames. The wood frames, upon which, with the keel and stern post, the boat depends for longitudinal strength, are of American elm. The boat is carried in the ship in its folded condition, with all the oars and gear, including water breakers, in position, and all wrapped up in a canvas cover. When it is required, the canvas cover is cast off, and the boat is lifted by hooking on the davit tackles to two slings, one near each end, which are attached to the gunwale.

As the weight is taken, the boat opens, then two men jump in her and place the struts which keep her open, and she is then ready for lowering into the water and for use. It is claimed that the boats when folded only occupy one-fifth of their width when open, and that one of them can be stored between the ordinary wooden boat and the ship's bulwarks. The folding boat is also much lighter, and is said to cost less than an ordinary boat of the same size. It is obvious that if the Berthon boat is thoroughly reliable, it affords a means of carrying sufficient boats to take all the passengers and crew of an emigrant ship. One objection which readily suggests itself is that holes would be soon eaten in them by rats, but we are told that the Admiralty experience of them is proof to the contrary. The store where they are kept in Portsmouth dockyard abounds with rats; and although nests have been found in the canvas boats, in no other case have the rats eaten the canvas coated with the composition, one of whose special merits appears to be that rats do not relish it. These boats have been used by the Admiralty for the last ten years in the Indian troop ships, the only ships in the Royal Navy which are unable to take sufficient ordinary boats to carry all hands on board. They are not employed to do ordinary boat work (probably if they were they would soon wear out), and they are not considered to be nearly as durable as ordinary wooden boats, but they afford a ready means of carrying a sufficient number of boats for any emergency.

They have been used for landing troops, and we believe that on the occasion of one of the troop ships being aground in the Suez Canal, all her Berthon boats were put out in the water and used to lighten the ship. The Admiralty have also used canvas boats in connection with small torpedo craft, which had not room to carry an ordinary boat. We should not think that folding canvas boats are likely to come into use for ordinary purposes in the mercantile marine, although they may be, and we believe are often carried in yachts; but they certainly do afford a means of almost indefinitely multiplying the boat accommodation of a large ship, without taking up very much deck room.—*Nautical Magazine.*

Fatal Trichiniasis.

Eugene A. Rau, of Bethlehem, Pa., gives an account of recent cases of fatal trichiniasis arising from imperfectly cooked measly pork which had been eaten for a week from January 6, 1886. The family consisted of a man and wife and two daughters, aged five and thirteen years. The older daughter and the mother, aged thirty-seven years, have died; the other members of the family, although affected, are recovering. In the mother, who died March 8, the deltoid muscles showed under the microscope three to nine, the rectus femoris two to six, and the diaphragm one to three, trichinæ in a field view about one-fifth of an inch in diameter. In the daughter, who died February 19, trichinæ were found embedded in the deltoid muscle, in some portions as many as forty-two being counted on the field of view under the microscope.

No other portions of the daughter were examined; but the lungs, heart, liver, spleen, and kidneys in the mother were found to be unaffected. The pork used was home-raised, and, according to the owner, the animal did not at any time show signs of ill health. An examination of two other hogs raised on the premises was made, but no trichinæ were found. As usual in such cases, the meat was imperfectly cooked or fried, the tenderloin, sausage meat, spare ribs, etc., all being freely used. For several days while in water, the human trichinæ showed signs of life, coiling and uncoiling when freed from the muscular fiber; but the stage of development found in the pork showed no activity under the same conditions.

Eggs by Weight.

It is annoying to the breeder of blooded and fine fowls to find, when he offers for sale eggs nearly twice as large as his neighbors', that they bring no more per dozen than do the smaller ones. Also, the consumer is often vexed to find that he must pay the same price today for a dozen eggs weighing a pound that he yesterday paid for a dozen weighing a pound and a half. Besides, an egg from a well fed fowl is heavier and richer than one from a common fowl that is only half fed, so that weight compared to size is an indication of richness. Thus, eggs of which eight will weigh a pound are better and richer than those of apparently the same size, of which ten are required for a pound. Of course, with eggs at four and five cents a dozen (and hundreds of dozens have been sold in past years at these figures), it is not much matter as to the size; but when the price ranges from twenty-five to fifty cents per dozen, it is a matter worth looking after. It is high time that this old style of selling and buying eggs were discontinued. It is a relic of the past, and reminds us of the time when dressed hogs sold for a dollar each without regard to size, and were dull sale at that. Insist upon it, then, you who raise poultry and eggs for market, that the price for eggs shall be so much per pound, and then it will be some inducement to farmers to raise a better class of fowls, and all will get what is their just due.—*American Rural Home.*

Manufacture of Aluminum.

We have heretofore described the electrical process of obtaining aluminum. Another, and the more common, method of producing aluminum is by heating substances that contain the chloride of aluminum in connection with the metal sodium. The chlorine combines with the sodium and leaves the aluminum in the metallic state. The process is easy and simple, but very expensive, owing to the high cost of the sodium. Three pounds of sodium, which now sells at retail for from $4 to $5 per pound, are required to obtain one pound of aluminum.

Any mode by which sodium can be more cheaply obtained will, as a matter of course, lessen the cost of making aluminum. Mr. H. Y. Castner, a chemist of this city, has discovered a new process of distilling sodium, by which it is said the metal can be produced at the extremely low cost of 25 cents per pound. With sodium at this low price the problem of cheap aluminum seems solved, and with it magnesium, silicon, and boron, all of which depend upon sodium for their manufacture. The production of sodium at this low figure means far more than cheap aluminum. Who can state the future of either magnesium, silicon, or boron, as each may be prove to be of as great value in the arts and sciences as aluminum? When sodium can be had for 25 cents a pound, aluminum should not cost over $2 a pound. Of course, this seems a rather high price for any metal that may be extensively used, but in reality it is but slightly more expensive than tin at 50 cents a pound.

A cubic foot of aluminum weighs 166 pounds, while the same bulk of tin will weigh 445 pounds. The uses of aluminum are indeed unlimited, even when it is produced at $2 a pound, as may be easily conceived from its many valuable properties. It is unaltered in air even when heated, and is not tarnished when exposed to an atmosphere contaminated with sulphurous gases, which would affect almost every other metal. It is ductile, and may be drawn out in extremely fine wire. It may be cast in moulds of either sand or iron. As a conductor of electricity it ranks equal with silver, which is the best known conductor. The vegetable acids are without action on it; and when all these properties are taken in connection with its extreme lightness, it may indeed be termed one of the most valuable of metals. Above all other metals, aluminum possesses the property of forming alloys of great variety and extreme usefulness, and owing to its cost formerly it has been confined in its uses almost exclusively to these purposes. The alloy known as "aluminum bronze," consisting of copper 90 per cent and aluminum 10 per cent, has been somewhat extensively used of late, and with the production of cheap aluminum it will undoubtedly largely take the place of brass and ordinary bronze, as it possesses all their varied properties in a far more valuable degree.