to one class or the other. So far success seems to favor us. Doubt is the mainspring of progress, and this doubting of a fact which has long been maintained to be of *no importance* may be the key to open up unknown vistas of research.

It will, however, be conceded in a matter of no importportance that this dual classification may be incorrect. This we believe to be the case, for one very important element—hydrogen—is given in every classification among the non-metallic elements, while the element itself is admitted to be metallic; a strange and incomprehensible misplacement. Whether the others are right or not only extensive experiments will determine. With this rectification, however, they are so far correct that the movements of Nature are opened to us as by a miracle. The lock cleared of this obstruction opens readily to the key, and Materialism rules triumphant. We seem premature; how does the duality of the elements solve all mysteries?

The object of this paper was to prove the materialistic origin of the sexes—that sex had its origin in matter. That matter is dual is part confirmation of it, but, like its antitype, we must also prove dual matter to be productive. Two females will not produce, neither will two males. If a production can be formed from the nonmetallic elements only, or metallic only, then our theory is false; production should only ensue from the connection or interaction of opposite sexes and elements. Chemical analysis in this particular shows that we are right. *No natural production can be found containing the elements of only one class;* both metallic and nonmetallic are essential to a formation. In simple laboratory experiments the opposite elements will combine readily with one another, while combination cannot be produced among the elements of either class alone. Even the simplest natural productions, such as air and water, are of dual combinations. Air composed of oxygen, nitrogen, carbonic acid gas, *hydrogen*, etc. Water, composed of oxygen and *hydrogen*, is the great medium also of life and production. Even the old *element*, fire or combustion, can only be produced from oxygen and *hydrogen*, with other opposing dual elements. All rock formations, crystals, stratas, are produced from combinations of the dual elements. All plants and vegetation are of dual formation and dual in sex, while all animals are undoubtedly male and female.

Our premises being thus clear and true regarding the elements of the matter, it follows that—as all plants and animals are composed of the same elements, of oxygen, hydrogen, etc., in different proportions and combinations —the conclusion we have been seeking is inevitable, namely, *sex in either animal or vegetable life is derived from and had its origin in the duality of matter*.

What causes dual matter to combine and be productive would lead us into another inquiry as to the origin of life from matter; but this we reserve for future consideration.—*Journal of Science, England.*

THE MECHANICS OF BIRD-FLIGHT.

The mechanics of the flight of birds have been much studied, and considerable space has been recently given to the subject in the columns of the *English Mechanic.* A new contribution has been recently made to a Silesian Society by MM. Legal and Reichel, whose researches deal with the relations of the size of the muscles of flight. and the size and form of a wing-surface, to the power of flight, and a short account may be of interest. (An abstract of the authors' observations appears in a recent number of *Naturforscher*.)

The authors begin by considering the question, whether the absolute size of a bird is of importance with regard to its flying power, *i. e.*, whether two birds, which considerably differ in size from each other, but are geometrically similar in their whole bodily structure, fly equally well. The final answer to this is (as we shall see) a distinct negative. The authors have measured in a great number of birds, the weight of the muscles of flight, especially the most important of these, the great breast muscle, as also its antagonist, the wing raising *musculus subclavius*, and compared it with the body-weight. The ratio of weight of the right and left large breast-muscle to the body-weight varied in the different bird species that were examined, from 1 : 3.4 in the pigeon, to 1 : 10.5 in the gull. But if the bird-species are arranged according to the amount of this quotient, neither the equally good flyers come together, nor birds of equal absolute size; *e. g.*, the partridge stands pretty well forward in the series with 1 : 4.8, near and before the hawk 1 : 5; while the sparrow, stork, and eagle, stand with about 1 : 6 near one another. Certainly, with increasing body-weight, the muscular system concerned in flight does not become relatively greater. The size of the muscles of flight is only one factor in flying-power.

A second, and very important factor is the surface presented by the outspread wing (the wing-surface); and here, again, it is not immaterial in which direction the surface extends. With equal wing-surface, a long narrow surface has more effect than a short and broad one, as a long rudder is more powerful than a short one. The authors have therefore given drawings of the form of the outspread wings for 37 different bird species, and indicated in figures the surface and length (wing configuration). A calculation of the mechanical action showed that where the ratio of the surface and length of the wing to the size of the bird remained the same, the angle of the wing motion and the angular velocity of the wing also remain the same; also that with the absolute size of the bird the air-resistance against the wings increases in the fourth power, but the body-weight only in the third. In order to compare the significance of wing-configuration for flight in large and small birds, one must therefore introduce into the numbers, expressing wing-configuration, a correction according to the absolute size of the bird, and the result of this correction the authors name the wing-number. Now, if the various birds be arranged in series according to wing-number, *i. e.*, according to wing-configuration, with comparative preference of the smaller, the good flyers are found to be at one end of the series, the bad at the other, *e. g.*, partridge 4, wild duck 10, jackdaw 20, sparrow hawk 24, sea-swallow 50. If we now multiply this wing-number with the ratio of the weight of the breast-muscle to the body-weight, *i. e.*, combine the consideration of the actual wing-configuration with that of the relative size of the muscles of flight, which are related to the effectiveness and velocity of wing-beat, we obtain the flight number as measure of the flying power, and this appears, *e. g.*, as follows: Sparrow 0.43, partridge 0.48, wild duck 0.98, jackdaw, 1.72, gull 2.15, kibits 2 92, eagle 2.95, stork 2.97, sea-swallow 3.28.

A comparison of the series thus obtained with the actual flying power, shows that the flight-number in general rises and falls with the flying power and in particular corresponds the better where birds of equal body-size are considered; and less well, the more different the size of the birds compared, so that in larger birds the actual flying power falls behind the comparative flight-number; that even appears, *e. g.*, from a comparison of the partridge with the sparrow. Or conversely, when we compare birds of equal flying power, but different size, *e. g.*, larger and smaller, but adult examples of a species, or species of a genus, the flight-number increases with the body-size. It is indeed difficult and always somewhat erroneous, to measure the actual flying powers of different birds together, one bird accomplishes more in dexterous and quick movements, another in rapid flight in a short time, a third in duration of flight. Still, the result may in general (says the reporter), be regarded as correct. Now, as the flight-numbers express the combined mechanically measurable factors of flight, it follows tha.

with the absolute size of the bird, some flight-hindering element not yet therein contained, increases. We might therefore put the question, whether equally rapid, and (comparatively) equally great contraction in a small bird. In fact, too, it is chiefly the larger birds that present the phenomenon of soaring, a condition in which, the body being maintained at the same height for a certain time, muscular work is saved by special arrangements. If soaring be an advantage, it must, in alternation with periods of active rise by means of rudder-like mechanism, be extensively utilized for the problem of a flying machine.

COLOR RELATIONS OF METALS.

In a paper on the color relations of copper, nickel, cobalt, iron, manganese, and chromium, lately read before the Chemical Society, Mr. T. Bayley records some remarkable relations between solutions of these metals. It appears that iron, cobalt, and copper form a natural color group, for if solutions of their sulphates are mixed together in the proportions of 20 parts of copper, 7 of iron, and 6 of cobalt, the resulting liquid is free from color, but is gray, and partially opaque. It follows from this that a mixture of any two of these elements is complementary to the third, if the above proportions are maintained. Thus a solution of cobalt (pink) is complementary to a mixture of iron and copper (bluish green); a solution of iron (yellow) to a mixture of copper and cobalt (violet); and a solution of copper (blue) to a mixture of iron and cobalt (red). But, as Mr. Bayley shows, a solution of copper is exactly complementary to the red reflection from copper, and a polished plate of this metal, viewed through a solution of copper salt of a certain thickness, is silver-white. As a further consequence, it follows that a mixture of iron (7 parts) and cobalt (6 parts) is identical in color with a plate of copper. The resemblance is so striking that a silver or platinum vessel covered to the proper depth with such a solution is indistinguishable from copper.

There is a curious fact regarding nickel also worthy of attention. This metal forms solutions, which can be exactly simulated by a mixture of iron and copper solutions; but this mixture contains more iron than that which is complementary to cobalt. Nickel solutions are almost complementary to cobalt solutions; but they transmit an excess of very yellow light. Now, the atomic weight of nickel is nearly the mean of the atomic weight of iron and copper; but it is a little lower, that is, nearer to iron. There is thus a perfect analogy between the atomic weights and the color properties in this case. This analogy is even more general, for Mr. Bayley states that in the case of iron, cobalt, and copper, the mean wave length of the light absorbed is proportional to the atomic weight. The specific chromatic power of the metals varies, being least for copper. The specific chromatic power increases with the affinity of the metal for oxygen. Chromium forms three kinds of salts. Pink salts, identical in color with the cobalt salts; blue salts, identical in color with copper salts; and green salts, complementary to the red salts.

Manganese, in like manner, forms more than one kind of salt. The red salts of manganese are identical in color with the cobalt salts, and with the red chromium salts. The salts of chromium and manganese, according to the author, are with difficulty attainable in a state of chromatic purity. He thinks these properties of the metals lead up to some very interesting considerations.

FIRE AND WATER-PROOF PAPER.—A mixture is made of two-thirds ordinary paper pulp, and one-third asbestos. The whole is then steeped in a solution of common salt and alum, and after being made into paper is coated with an alcoholic solution of shellac.

DETECTION OF STARCH-SUGAR MECHANICALLY MIXED WITH COMMERCIAL CANE-SUGAR.*

By P. CASAMAJOR.

In a previous communication on the same subject,† read before the American Chemical Society at the meeting of March, 1880, I gave several processes for the detection of starch-sugar in commercial sugars. One of these consisted in adding to the suspected sugar a quantity of cold water, somewhat less than its own weight, and stirring the mixture for a few seconds. If starch-sugar is present, it will be seen in the shape of white chalky specks.

Quite lately a sample of yellow refined sugar was given to me which was supposed to be adulterated by being mixed with starch glucose. By applying the test just mentioned, there seemed to be left a few small chalky specks, which dissolved after standing a minute or two, making it very uncertain whether any starch glucose was present. Upon repeatedly trying the same test the result was always doubtful.

I was then lead to treat the suspected sugar by a liquid capable of dissolving sugar, but without any solvent action on starch-glucose. After many trials, I found that methylic alcohol of such density as to mark 50° by Gay-Lussac's alcohometer answered the purpose very well, if previously saturated with starch-sugar, as this solution dissolves cane-sugar, either white or yellow, very readily, but does not dissolve starch-glucose.

Methylic alcohol at 50°, saturated with starch-sugar, gives a solution of specific gravity = 1.25. 100 c.c. of methylic alcohol at 50° dissolves 57 grms. of dry starch-sugar, the volume of the solution being 133 c.c. A solution of starch-sugar in ethylic alcohol does not answer so well, because ethylic alcohol does not dissolve so readily the gummy matters found in soft sugars, which are those generally chosen for adulteration with glucose.

To test the presence of starch-sugar in a commercial cane-sugar, the suspected sugar should, in the first place, be thoroughly dried, as otherwise any water present will weaken the alcohol, and enable it to dissolve more starch-sugar. It should then be stirred for about two minutes with the saturated solution of starch-sugar in methylic alcohol. After this, the residue is allowed to settle, and the clear solution poured off. The residue may then be washed with a fresh quantity of the same solution. After stirring again and allowing the residue to settle, there will remain, if any starch-sugar is present, a certain quantity of chalky white specks, accompanied by a fine deposit, formed by the starch-sugar present in power of fine grains. These finer particles are never seen when water is used for detecting the presence of starch-sugar, as they dissolve in water very readily. It seems probable that by using this solution of starch-sugar in weak methylic alcohol, the starch-sugar in an adulterated sample could be estimated quantitatively by a process somewhat analogous to that of Payen for estimating cane-sugar.

Not having had any occasion for such a process I have not determined experimentally the degree of approximation obtainable in this way.

The methylic solution of starch-sugar should be poured on a filter, after it has dissolved all it can from a commercial sugar, and the residue should be washed out with the same solution, and everything poured on a weighed filter. After all the liquid has run off, the filter and the residue may be rapidly washed with the strongest methylic alcohol fuund in commerce, which tests 92½° by Guy-Lussac's alcohometer, and which dissolves starch-sugar with great difficulty.

By a dexterous use of this process it seems probable that very approximate results may be obtained, although what is said here is merely in the nature of a suggestion to those who may have use for quantitative results.

* A paper read before the American Chemical Society, Nov. 4, 1880.

† *Chemical News*, vol. xli., p. 221; *Journal of the American Chemical Society*, vol. ii., p. 111; *Sugar-Cane*, vol. xii., p. 283.