ently something not being instantaneous but taking long ages to accomplish and not concerned with any single character of a single species. If not defined in some such fashion, it has no reality. Mutation, as viewed by de Vries, is a sudden change within a species, which gives rise to a new one, closely akin, but with a break in heredity, the new species persisting, and at times replacing the old *within the same environment*. If the new and old are competing, selection may decide.

The conception of the origin of species by mutation, now accepted by many authors, especially botanists, rests on the slightest of foundations. In most groups are found "geminate" or twin species, closely related. Scarcely ever are these twins found in the same region, scarcely ever far apart, but always separated by some barrier, land, water, climate, food, space or enemies. Such separation saves variants, however originated, from being lost through interbreeding with the mass. Forms separated by barriers are subject to new selections; they have new gauntlets to run. They are not products of selection in competition with the old stock, for in no case as far as I know are their characters of survival value, as was supposed by Darwin. Nor is there any adequate evidence for presuming species to appear suddenly, "full-fledged," from germ cells of an old species. The belief in this process is, I think, one of the myths of science.

In Dr. Kyle's work, so complete and suggestive in most regards, I find no important account of the origins and relations of orders and families nor of the origins of species. The lower differences come first in nature and the higher problems are largely beyond our reach, in the realm of speculation. In the history of science guesses, however brilliant, have rarely proved true.

Taxonomy, with Cuvier, is primarily the systematic way of stating the known facts of comparative anatomy. Now that we recognize that comparative anatomy is itself a statement of the trend of evolution, classification has naturally become the expression of evolution. A complete biology of fishes should elucidate this.

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SPECIAL ARTICLES

ON THE EQUILIBRIUM BETWEEN THE ENAMEL OF THE TEETH AND THE SALIVA

IN studying the equilibrium between sea water and calcite[1] it was found that crystals of calcite had to be very clean in order to get an equilibrium by shaking with sea water in a thermostat in any practical length of time. If clean crystals of calcite (or aragonite) were shaken with sea water, an equilibrium was established in a few hours, but if ground-up shell or coral or limestone mud was shaken with sea water, an equilibrium was not even approached in three or four days. In studying the equilibrium of enamel of the teeth and the saliva at different pH values, it was thought that this factor complicated the results. Therefore studies on crystals of fluorapatite [$CaF\ Ca_4\ (PO_4)_3$] were made, using an artificial saliva containing no proteins or capillary active substances that would tend to deposit on the surface of the crystals.[2] At pH between 5.5 and 6.5, the apatite was practically at equilibrium with this artificial saliva containing the same quantity of calcium phosphate as in normal saliva. From this data and also from the fact that impure masses of calcium phosphate deposit on the teeth, it was concluded that at a pH between 6 and 7 the enamel of the teeth should not dissolve in the saliva.

It therefore seemed desirable to find a method of cleaning the surface of the enamel of the teeth so that an equilibrium with the saliva could be established. In this case, theoretically, the enamel should grow with increase in pH and dissolve with decrease in pH.

Since there is a general impression that gritty substances used on the teeth will wear away the enamel, the following observation was made using calcite crystals newly formed and therefore clean on their surfaces and sharp at their angles, to see whether such an abrasive would wear away the teeth. Calcite crystals, which were rhombohedral and of large enough size to feel gritty, did not perceptibly wear the enamel in a total of sixty hours polishing with the dry powder and dry brushes. Only one experiment was performed. During the five years from the age of thirty-five to forty, the teeth were brushed two minutes a day with a dry brush, and during this time hard deposits collected on the teeth, which were removed by the dentist. These deposits seem to collect on rough places. During the next five years, from the age of forty to forty-five, the teeth were polished for two minutes daily with the dry calcite crystals on a dry brush. The roughness gradually disappeared and no hard deposits occurred on exposed surfaces of teeth during this period.

Calcite crystals were formed by nearly filling a one hundred liter jar with water and allowing molecular solutions of sodium carbonate and calcium chloride to run in on opposite sides of the jar at the rate of

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[1] Proc. Nat. Acad. Sci., 3: 692, 1917.

[2] *Jour. Dent. Research*, 3: 50, 1921.

½ cc per second, while the water was vigorously stirred by a powerful stirrer placed eccentrically. The crystals were observed microscopically and the process continued until some spherules appeared when stirring was stopped, crystals collected, the jar was emptied and the process repeated.

Although these observations do not solve the problem of dental decay, they are offered in the present form because a solution of that problem does not seem immediately forthcoming, and yet it seems to be very important, owing to the fact that the enamel of the teeth is subject to the most frequent lesions which have not, so far, been repaired by regeneration of the tissue.

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FLUORIDES VS. FLUOSILICATES AS INSECTICIDES

MARCOVITCH[1] reported that sodium fluosilicate undiluted is effective against the cotton boll weevil (*Anthonomus grandis* Boh.), and when mixed with nine parts by volume of hydrated lime is effective against the Mexican bean beetle (*Epilachna corrupta* Muls.), the Colorado potato beetle, the potato flea beetle, the bean leaf beetle and the tobacco hornworm.

There is nothing new in the use of sodium fluosilicate as an insecticide. Its use for that purpose was described nearly thirty years ago by Higbee (English Patent No. 8236, May 23, 1896). More recently Wille[2] has reported tests with sodium fluosilicate against roaches, and Cobenzl[3] mentions it as a common ingredient of rat and insect poisons.

During the past year entomologists have shown much interest in sodium fluosilicate (also known as silicofluoride) and have made many tests with it, particularly against the Mexican bean beetle. The results obtained have varied greatly, however, and foliage injury has been produced by its use. These variable results are not surprising in view of the fact that commercial grades of sodium fluosilicate contain varying quantities of the fluosilicate of sodium and fluoride of sodium, and often carbonate of sodium. The occurrence of sodium carbonate in commercial sodium fluosilicate is of particular significance because an alkali in solution in water quantitatively decomposes a fluosilicate into a fluoride. In fact, one of the commercial processes of manufacturing sodium fluoride[4] is based on this reaction, which is represented by the following equation:

$$Na_2SiF_6 + 2Na_2CO_3 + H_2O = 6NaF + H_2SiO_3 + 2CO_2$$

Sodium fluosilicate may not only be partially decomposed into a fluoride, owing to the presence of sodium carbonate, but it may be broken down by alkaline water used in spraying. Most waters are more or less "hard," because of the presence of soluble calcium and magnesium salts. Sodium fluosilicate would react when added to such a water to form calcium and magnesium fluosilicates, which in turn would break down partially into calcium and magnesium fluorides. When mixed with a large excess of hydrated lime, sodium fluosilicate, in the presence of water, would be converted into calcium fluosilicate, and this in turn into calcium fluoride. When a mixture of sodium fluosilicate and an excess of hydrated lime is applied as a dust, as was done by Marcovitch, this conversion would not be immediate but would proceed as the mixture became moistened by rain, dew or even the water vapor in the air.

Power and Chesnut[5] have shown that ammonia and trimethylamine are present in emanations from the living cotton plant. Smith[6] has shown that the dew on the leaves of the cotton plant has an alkaline reaction to litmus, due in part at least to the presence of calcium and magnesium carbonates and bicarbonates and potassium carbonate. All these compounds would favor the decomposition of a soluble fluosilicate into a fluoride.

As used under practical conditions in the field, therefore, the sodium fluosilicate in a commercial grade of the material, before coming into contact with the insects, might be largely if not entirely converted into a fluoride, owing to the action of (1) sodium carbonate originally present, (2) alkaline or "hard" spray water if sprayed or hydrated lime if dusted, (3) alkaline emanations or exudations from the plants to which it is applied. Even pure sodium fluosilicate in solution in pure water is hydrolyzed to some extent into sodium fluoride and silicon fluoride.[7]

When sodium fluosilicate is mixed with lime preparatory to its application as an insecticide an interesting cycle is completed. By the action of sulfuric acid on fluorspar (calcium fluoride) the chemical manufacturer obtains hydrofluoric acid. This added to sand forms "sand" acid (hydrofluosilicic acid). By the interaction of this and soda ash (sodium carbonate) sodium fluosilicate is formed. When the entomologist adds hydrated lime to this compound the

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[1] *Ind. Eng. Chem.*, 16, 1249, 1924; SCIENCE, 61, 22, 1925; *J. Econ. Entomology*, 18, 122, 1925.

[2] Biologie und Bekämpfung der deutschen Schabe, *Phyllodromia germanica* L., Monographien zur angewandten Entomologie No. 5, Beiheft 1 zu Band 7, Ztschr. angew. Ent., Berlin, 1920, p. 126.

[3] Chem. Ztg., 45, 1116, 1921.

[4] Bishop, U. S. Patent No. 1,382,165, June 21, 1921.

[5] *J. Am. Chem. Soc.*, 47, 1751, 1925.

[6] *J. Agr. Research*, 26, 191, 1923; SCIENCE, 61, 572, 1925.

[7] Hudleston and Bassett, *J. Chem. Soc.*, 119, 403, 1921.