with incoming and outgoing vessels all adequately provided with valves to insure a one-way course of the blood (Jackson (2)). The third heart is the so-called caudal heart. This is a true pump supplied with valves and located at the beginning of the caudal vein. In fact, it is a bilaterally symmetrical or double heart, each half collecting blood and lymph from the subcutaneous sinuses of the corresponding side of the body (Greene (5)). The caudal heart varies from the systemic and the portal hearts in that the walls of the cavity itself are not contractile. The power that contributes the energy for the caudal pump is a pair of striated or skeletal muscles differentiated out of the great lateral muscles of the region. Like all skeletal muscles, these are controlled by spinal nerves and by a rhythm inherent in a definite spinal center (4, 5). In its coordinative nerve control the caudal heart of the hagfish is unique, for the portal heart and the systemic heart are both without nervous regulation (5).

There are still many facts of the biology and natural history of the hagfish to be determined. The living collections maintained at the Steinhart Aquarium of the Golden Gate Park in San Francisco may add to a fuller knowledge of facts. This blind primitive form is indeed replete with morphological, embryological and physiological interest to both student and investigator.

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CARBON MONOXIDE, A PRODUCT OF ELECTROLYSIS

Phosgene has for some reason always been regarded as a non-ionizing solvent, and this view was given support by the observation of Beckmann and Junker, in a study of the ebullioscopy of phosgene solutions, that organic acids dissolve in it as double molecules, while their anhydrides dissolve as simple molecules, a phenomenon that has been observed for non-ionizing solvents such as benzene.

The ease with which solutions of aluminium chloride in phosgene react with metals, metallic oxides, sulfides, carbonates, etc., however, led me to believe that these reactions were of the ionic type, and that the solutions contained ions and would therefore conduct electricity. The experiment verified the prediction, and conductivity measurements have shown that, while phosgene itself is a very poor conductor, the specific conductivity of the solution of aluminium chloride in phosgene increases with the concentration until the more concentrated solutions conduct nearly 100,000 times as well. Mr. Russell Timpany, working in this laboratory, has measured the conductivity of redistilled technical phosgene, and has obtained the value $.007 \times 10^{-6}$ for the specific conductivity at 25°.

The products of electrolysis were not collected separately, but the gases evolved from a cell connected in series with a copper voltameter were evolved under mercury, the surface of which became blackened, showing the presence of chlorine; a solution of sodium hydroxide, over the mercury, absorbed phosgene, which was present in the evolved gases by virtue of the vapor tension of the solution, and the unabsorbed residual gas was collected in a gas burette filled with sodium hydroxide. Analysis of this gas showed it to be carbon monoxide (characteristic combustion and absorption by cuprous chloride). The volume of the gas collected, however, was only 65 to 75 per cent. of the volume calculated according to Faraday's law from the weight of copper obtained.

This is undoubtedly due to the fact that carbon monoxide and chlorine in the light readily combine to form phosgene, so that under the experimental conditions employed a certain proportion of the gases evolved would inevitably recombine to form phosgene. Furthermore, Plotnikov has shown that when a mixture of these gases is bubbled through a solution of aluminium chloride in chloroform, the solution contains phosgene; it would seem reasonable to suppose that the same combination might occur in the presence of aluminium chloride in phosgene solution.

It has been shown, then, that phosgene is a weakly ionizing solvent and that when the solution of aluminium chloride in phosgene is electrolyzed, carbon monoxide and chlorine are evolved. The production of carbon monoxide by an electrolytic method is unique, as it has heretofore not been obtained by electrolysis.

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WHAT IS AN ACID?

IN terms of the theory of electrolytic dissociation, an acid is any substance which yields the hydrogen ion in water solution, and a base any substance capable of yielding the hydroxide ion under similar circumstances. But Franklin has shown that this definition of a base is too narrow, and that a comprehensive definition should include substances capable of yielding the amide ion in ammonia solution. The question may, then, be legitimately asked, if bases may include substances that do not yield the hydroxide ion, may there not exist acids that do not yield the hydrogen ion?

I have recently been forced to the conclusion that the answer to this question is in the affirmative. The evidence, which I shall discuss more fully in another paper, consists in the following facts. Aluminium chloride is very soluble in liquid phosgene, $COCl_2$, and several phosgenates of aluminium chloride have been described in the literature. I have shown that this solution conducts electricity and that the products of electrolysis are carbon monoxide and chlorine. I have also shown that this solution reacts with metals, with metallic chlorides, oxides, sulfides and carbonates to form compounds, containing the metal as chloride, and aluminium chloride, with phosgene of crystallization, and that carbon monoxide, carbon dioxide, carbon oxysulfide are split off.

These observations become intelligible if we assume that the active substance in the solution is a phosgenate of aluminium chloride, such as $2AlCl_3.COCl_2$, which may be compared with the behavior of $2SO_3.H_2O$, or with $SO_3.H_2O$ in water solution; it is customary to write $H_2S_2O_7$ or H_2SO_4 to represent the condition of the hydrates of sulfur trioxide, and in an analogous manner we are led to write $COAl_2Cl_8$ to represent the condition of the phosgenate of aluminium chloride in phosgene solution. This compound, carbonyl di-chloraluminate, reacts with metals to produce salts of the type $M^{II}Al_2Cl_8.xCOCl_2$ (using a bivalent metal as example), with liberation of carbon monoxide, in precisely the same manner as sulfuric acid produces, with metals, salts of the type $M^{II}SO_4.xH_2O$, with liberation of hydrogen. With metallic chlorides, carbonyl di-chloraluminate reacts to produce salts of the same type, splitting off phosgene, in precisely the same manner as sulfuric acid produces sulfates with the metallic oxides, splitting off water. The analogy may be carried on to the other reactions and to the electrolysis of the two solutions, and the conclusion becomes inevitable that these solutions have properties so precisely similar that we must classify them in the same group—in other words, carbonyl di-chloraluminate is an acid. But this acid contains no hydrogen; in its place, we have carbon monoxide. The metallic chlorides must be regarded as bases, and the chloride ion in these bases corresponds to the hydroxide ion among the aquo-bases, and to the amide ion among the ammono-bases.

What, then, is an acid?

First of all, an acid involves a solvent, and as far as we know an ionizing solvent—such as water, ammonia, phosgene, to mention only those we have referred to in this note. In the second place, an acid is a substance dissolved in the solvent, which is chemically combined with a portion of the solvent, as SO_3 is combined with water, as $AlCl_3$ is combined with phosgene, or as C_3N_4 is combined with ammonia (cyanamide, H_2CN_2, or di-cyanimide, $HN(CN)_2$). Finally, solutions of these acids in their respective solvents give certain definite reactions—they conduct electricity and the solvent is decomposed in the process; metals displace the ion common to the acid and the related solvent (H, CO, etc.) forming salts; they react with bases derived from the related solvent to form salts, splitting off a molecule of the solvent; etc.

In short, an acid is the substance formed when an ionizing solvent unites chemically with a suitable compound and is capable of forming salts with metals and with bases derived from the same solvent.

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MIOCENE MARINE VERTEBRATES IN KERN COUNTY, CALIFORNIA

PROBABLY the first vertebrate fossils collected in California were the teeth of sharks picked up by W. P. Blake, geologist of the Williamson contingent of the Pacific Railroad Survey, in 1853.

The original location was given as "Depot Camp" on the south side of Poso Creek (called Posé Creek in the original reports; also called Ocoya Creek and spelled Ocoga on the map) "Lat. 305° 30′ 27″, Long. 118° 53′ 02″," Kern County, California. The specimens were described and illustrated by L. Agassiz.[1]

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[1] *Am. Journ. Sci. Arts,* 1856, pp. 272–275; Pac. R. R. Reports, Vol. 5, 1857, pp. 313–316, plate 1, figs. 1–44; for a full account of the occurrence of the specimens see pp. 164–173.