are incapable of producing griping, nausea, or any of the mal effects above enumerated.

It appears that these ferments are distributed through a large number of vegetable substances, not being confined to unripe fruits only, but can also exist in the root, bark, leaf, or even in vegetable extracts, of which we have illustrations in various juices, liquid or inspissated. Of this latter class aloes will serve as an example. A familiar illustration of an unaltered vegetable would be the cucumber, the green apple (familiar to the school boy), and unripe fruit generally. In the case of the cucumber, experience has taught the means of removing this ferment by dialysis or osmosis. We sprinkle salt over it or surround it with a strong brine, which provokes an outward flow of the fluid containing the ferment, with the result that the ferment is to a large extent removed, and thus rendered incapable of producing the same conditions in the stomach, for which it was intended in the plant; that is, the creation of vegetable acids from other material previously existing, in the same manner that pepsin, likewise an unorganized and soluble ferment, provokes the solution of fibrin and albumen, forming peptone, or as diastase is capable of effecting the transformation of starch into soluble glucose and dextrin, both new bodies.

That these ferments all bear a direct quantitative proportion to the results accomplished, has been practically recognized. We are promised a satisfactory indication of the sources of the acids formed in the plant, which will enable us to corroborate the statements that identical processes go on in the stomach when the ferment is permitted to exert its action there.

THE PRESENT POSITION OF TOXICOLOGY.*

By J. O. ARNOLD, F.C.S.

In considering this subject it may be remarked at the outset that popularly the powers of the analyst with reference to the *post mortem* detection of poisons are much exaggerated, and the skill with which it is supposed he is always able to separate and estimate fabulously minute quantities of any poison exists only in the imagination of the ignorant. True it is that a limited number of poisons can be detected with certainty, when only mere traces are present, but the detection and estimation of the majority of vegetable poisons are envied respectively with great difficulty and doubt. It is proposed to deal only with those poisons (excluding corrosive substances) which, from their frequent use in medicine, are likely to be of interest to pharmacists. Such poisons may be divided into two groups: (a) poisons detected with difficulty, (b) poisons capable of easy separation and recognition.

Group A.—Colchicine, aconitine, digitalin, atropia, cantharidin, morphine (opium).

Group B.—Strychnine, prussic acid, arsenic.

First taking into consideration the members of group A, the initial step of the analyst is to endeavor to completely isolate the poison from the mass of organic matter with which it is usually associated. The process for the separation of alkaloids generally is as follows: The highly concentrated organic liquid or finely pulped solid is digested for many hours at a gentle heat with excess of rectified spirit containing a little acetic acid; the alcoholic filtrate is then highly concentrated on the water bath, and everything soluble dissolved out with water. To the aqueous filtrate a general test for alkaloids may be applied, such as sodium phosphomolybdate or the chloriodide of potassium and mercury, when, if any appreciable quantity of an organic base is present, a yellowish precipitate is obtained. But it must be remembered that albuminous and certain other organic substances give a similar result, to say nothing of the poisonous or non-poisonous organic bases, which are now known to develop spontaneously in a dead body, and which have been isolated in the pure crystalline state in such quantities that many elementary organic analyses have been made to determine their formulæ. In the face of these facts no analyst is justified in future in stating that extraneous alkaloidal poison exists in a dead body because he has obtained a precipitate with a general reagent. It is necessary that the alkaloid should be separated in such quantity, and in a sufficiently pure state, to answer decisively to individual tests. On the other hand, a negative result to the general test indicates that the alkaloids are absent, or only present in quantities so small as to baffle any further endeavor to isolate them. It is obvious that a study of the reactions of alkaloids of *post mortem* development is a subject of vital importance to the toxicologist. It is urgently required that these bases be exhaustively examined to find out if any of them are capable of giving tests coincident with those obtained from vegetable alkaloids likely to be used for criminal purposes; and perhaps, primarily, the most important step is to ascertain whether any of these animal alkaloids yield reactions resembling those of strychnine and morphine.

Returning to the alkaloids of group A (leaving morphine and opium for special consideration) the analyst is confronted by the unpleasant fact that no really decisive chemical tests exist for any members of the group. He may be able to obtain a crude alkaloid contaminated more or less with that brown extractive matter which from its power of obscuring color reactions is the *bête noir* of the toxicologist, but he can do little toward a conclusive settlement of its identity.

Starting with colchicine, we may liberate the alkaloid from the filtrate (to a portion of which a general test has been applied with positive results) by the addition of ammonia, and the crude alkaloid may be removed from the aqueous fluid by means of ether. The residue left after evaporating off the ether is treated with strong nitric acid, and a purplish coloration is supposed to indicate colchicine. But a coloration produced by nitric acid from an organic residue is not, in the speaker's opinion, a test upon which a decision, possibly involving life or death, should be arrived at.

Similarly in the case of aconitine. The crude alkaloid may be obtained by evaporating the ethereal solution, but it possesses no distinctive chemical properties; the only practical test is physiological, namely, that the extract produces a tingling and afterward a sensation of numbness when applied to the tongue. It may here be remarked that all physiological tests are now open to the objection that it has not yet been

proved that there are no *post mortem* alkaloids capable of producing similar effects.

Digitalin when isolated gives a few color reactions, e. g., a reddish tint with sulphuric, and a green color with hydrochloric acid; but such are at best only unsatisfactory indications.

For the detection of cantharidin, the vesicating properties of the ethereal extract containing the compound, or in the case of the powdered fly the presence of shining microscopic scales, are the only recognized tests.

The only test for atropine is its well known effect in dilating the pupil of the eye.

Coming now to the more interesting alkaloid morphine, and the opium in which it is contained, the first thought which strikes one on reading records of poisoning cases in which it has been criminally administered, and has afterward been the object of a *post mortem* search, is the fact that its detection is exceptional. Three causes, doubtless, operate to produce this effect. First, morphine is appreciably soluble in water and is not readily removable by immiscible solvents, such as ether or chloroform; secondly, its tests are much obscured by the brown extractive matter always more or less present, any attempt to remove which might be followed by loss of the alkaloid itself in the case of a small residue; thirdly, there is good reason to suppose that morphine is much more susceptible to constitutional alteration in the living body than most other alkaloids. If a small quantity of not very impure alkaloid can be extracted and made to yield the following tests, the presence of morphine is almost certain: (a) a moderately strong solution develops a red color on the addition of strong nitric acid; (b) the solution liberates iodine from iodic acid, and the former may be concentrated by agitation with bisulphide of carbon into a pink layer; (c) sulphomolybdic acid produces when applied to the solid substance a deep crimson tint, changing to dingy green and finally clear blue; (d) sulphuric acid and bichromate of potash produce with the solid or a strong solution a green color, owing to reduction of the chromic anhydride to oxide; (e) neutral perchloride of iron added to a strong solution of morphine produces a blue or green color.

It must be remembered that with the exception perhaps of the sulphomolybdic test none of these reactions is peculiar to morphine, but it may be safely stated that no other single substance produces all these effects.

The application of dialysis to the isolation of morphine from other organic admixture has been recommended by some toxicologists, but the speaker's experience of the process has been unsatisfactory.

In cases of opium poisoning the presence of meconic acid rather than morphine should be sought for. It may be precipitated as a lead salt; the plumbic meconate after washing is decomposed with dilute sulphuric acid, the filtrate from the sulphate of lead containing free meconic acid is concentrated, nearly neutralized with potash, and a drop or two of ferric chloride is added. Blood red meconate of iron is produced. It must be borne in mind that sulphocyanic and acetic acids give a similar result. In their case, however, the color is destroyed by the addition of dilute sulphuric acid; not so, however, with ferric meconate.

In concluding the consideration of group A, it may be remarked that only in cases where an appreciable quantity of such alkaloids is present in the original organic substance, say about half a grain, can the analyst hope to get decisive results, because these can be obtained only from a moderately pure substance, and the purification of alkaloids inevitably entails loss.

There are cases on record in which operators, mis-called analytical chemists, have certified to the finding of $\frac{1}{100}$ of a grain of morphine; indeed, one has gone so far as to swear to $\frac{1}{2000}$ part of a grain on data manifestly absurd. Such statements excite pain and disgust in the mind of the conscientious and experienced toxicologist.

We now come to group B, and here tread upon firmer ground. Of all the alkaloids, strychnine is the most easily separated, and when isolated is capable of decisive recognition. It may here be stated as a general principle that little reliance can be placed upon the crystalline forms obtained by evaporating on microscope slides the ethereal solutions of alkaloids, because the same base may be made to give several shapes dependent upon the rate of evaporation; neither can a bitter taste form more than a rough auxiliary guide.

In the case of strychnine the characteristic color reactions with sulphuric acid and dioxide of manganese (namely, the production of a play of tints, starting with deep purple and ending with reddish yellow) may be observed with advantage under the microscope with a low power when the base has been isolated in a pure state, but in very small quantity. When a fair amount of alkaloid has been separated, the characteristic chromate may be precipitated in faintly acid solution, washed and dried, when the addition of sulphuric acid alone produces the play of color.

Passing on to the next poison on our list, namely, prussic acid, experience shows that when present even in traces this compound is capable of easy recognition, but owing to its volatile nature (which makes its isolation from the organic matter containing it so easy) it is not often found after the lapse of two or three weeks between death and analysis. Its characteristic odor is often a valuable guide, but when this is not present the poison may be obtained by gentle distillation of the viscera, etc. But it is seldom necessary or advantageous to resort to distillation. If the organic matter containing the poison is placed in a wide-mouthed flask, three rapid tests may readily be made, which, taken together, are absolutely decisive. If a drop of nitrate of silver be caused to adhere to a watch glass and the latter is placed over a vessel containing the suspected matter, the application of a very gentle heat causes the vapor of the acid to act upon the silver salt with the production of a white film of cyanide of silver. This film might, of course, be due to other vapors, such as that of hydrochloric acid, and, therefore, this result must be confirmed by other tests. For the drop of nitrate of silver substitute a drop of a solution of potassium cyanide. Potassium cyanide is formed. After a few minutes add to the potash a drop of a mixed solution of ferrous and ferric chlorides. The respective hydrates are thrown down together with the well known cyanide of iron, Prussian blue; on dissolving

the former in one drop of hydrochloric acid, the blue flakes of the latter become distinctly visible. The final test should be made with a drop of yellow ammonium sulphide; ammonium sulphocyanide is produced, and on gently evaporating the spot of liquid to complete dryness, the addition of a drop of ferric chloride brings out the blood red color of the sulphocyanide of iron.

We finally reach arsenic, the poison above all others capable of the most certain detection, as its presence in the human body is fixed as the hills; but even with this element the accurate analyst should guard against exaggerated ideas as to his ability to swear to infinitesimally small amounts. It may be stated that the quantity of the metal present, say in half a pint of an organic liquid such as the *post mortem* contents of the stomach, from which decisive and confirmed tests can be obtained, is about 1 milligramme. Less can be detected, but who would care to swear away a life on the strength of the discoloration of a fragment of copper foil by the Reinsch process, or a glimmering speck in the neck of a Marsh apparatus? When, however, a milligramme of arsenic is present in a liquid of the volume and character before mentioned, it can be obtained, as will be shown later on, in an almost pure hydrochloric acid solution, which will yield with the Reinsch test a steel blue color, a decisive deposit in the Marsh tube, and several mirrors on porcelain; the latter are readily distinguished from an antimonial mirror by their instantaneous disappearance when treated with a solution of a hypochlorite. If both the Marsh and Reinsch deposits are sublimed in a tube open to the air, characteristic crystals of As_2O_3 are formed, which may be recognized under the microscope, under a power of about 300 diameters. No data short of the above are sufficient to positively swear to the presence of the poison. The speaker has, however, in a known mixture detected 0.1 milligramme of arsenic in 60 grammes of liver, or $\frac{1}{600}$ part.

The process by means of which this result was obtained will now be described. Suppose, for instance, we have a portion of the liver of an animal known to have died from arsenical poisoning. The first step is to cut the viscera into small pieces with a sharp knife; the mass is then thoroughly desiccated in the water bath, when it becomes sufficiently brittle to be finely powdered in a mortar, a process more easily said than done. About 15 grammes of the powder are placed in a 250 c. c. flask, provided with a long condensing tube wrapped round with a cloth constantly kept wet with cold water; the end of the condensing tube dips into a small vessel jacketed with cold water, and containing about 10 c. c. of distilled water. The dried liver is thoroughly saturated with pure fuming hydrochloric acid, the cork of the condensing tube is inserted, and the whole is gently distilled until about three fourths the volume of the hydrochloric acid originally added have passed over. The distillate is passed through a small filter, and is, if necessary, somewhat diluted. If arsenic were present in quantity approaching a milligramme, its presence may be decisively proved by both Reinsch and Marsh, and if only one-tenth of a milligramme was contained in the amount of liver taken, a deposit may be obtained in the Marsh tube.

To the student the study of toxicology is rendered difficult by the retention of antediluvian methods in modern works. Roscoe and Schorlemmer, for instance, in dealing with the toxicology of arsenic, reproduce the complicated and dangerous process of Fresenius and Von Babo, a method no analyst would ever dream of using now. The very nature of the process defeats its object from a toxicological point of view, as it is supposed to detect both soluble and insoluble arsenic, whereas the former only is of importance. There is little doubt that by this method traces of arsenic are liable to be found and reported as present in the viscera, which really had their origin in the large quantities of the various reagents used. In the process already described the only reagent used is hydrochloric acid (about 25 c. c.). Of course in cases where quantities of arsenic are present the lemon-yellow sulphide may be precipitated, and to this the various confirmatory tests may be applied. It is a matter of surprise that Roscoe and Schorlemmer should also reiterate the fable of Fresenius that the Marsh test must not be made in the presence of chlorides; a greater fallacy was never penned. As a matter of fact, hydrochloric acid is in all respects superior to sulphuric acid for use in the Marsh test, and the speaker has repeatedly proved that 0.1 milligramme of arsenic in 50 c. c. dilute HCl yields a deposit. Greater delicacy than this cannot be desired. It is not until the student becomes somewhat advanced in his studies that the fact dawns upon him that the beams of light emanating from stars of the first magnitude in the scientific firmaments are not always rich in chemically active rays.

To-night only the detection of poisons has been touched upon, and difficult as is this subject at times, it is easy compared with the unraveling of the mysterious chemical action of poisons on animal life; with effects we are fairly well acquainted, but the corresponding causes are wrapped in the outer darkness which environs the mass of empirics called by courtesy the science of medicine.

THE INFECTIOUS NATURE OF BOILS—CASE OF PNEUMONIA DUE TO THE PARASITE OF FURUNCULUS.

By Dr. ERNEST CHAMBERD, Paris.

THERE has always been a popular idea that boils are catching, and it has even given rise to the saying that "one boil means nine." The theory of the infectious nature of furuncles has now been proved. There are not only arguments of a clinical order in its favor, such as the reports of epidemics of the disease, and the cases of persons who undoubtedly get it after using basins or objects contaminated by others who had boils, but there are also the results of recent bacteriological researches. A distinct microbe has been found in the pus of boils, which is constant and can be cultivated. There is a good account of it in Cornil and Ranvier's recent book. They describe it as a staphylococcus pyogenes aureus of Rosenbach, consisting of cocci placed in twos, rarely in fours, and often found grouped in large masses. In gelatine and especially in agar-agar a fine orange-yellow cultivation can be produced. They do not look upon it as special to furuncles.

* A paper recently read before the Sheffield Pharmaceutical and Chemical Society.