

function which takes the form $\frac{0}{0}$; but the most interesting point in the details of this part of Hegel's work is his criticism of Princip. ii. lem. 2. Hegel accuses Newton of an error in elementary algebra, but in reality Newton's work is strictly accurate, and Hegel has merely failed to see the point of the problem. Hegel's own views of the calculus were got from Lagrange, whose treatise, with all its analytical skill, is yet a fruit of the very *Aufklärung* which in other matters Hegel especially opposes. Mistaking the abstract formalism of Lagrange's intrinsically erroneous and now quite abandoned method for superior generality, Hegel still thinks it possible to reject certain incumbrances that cling to Lagrange, and which are in fact inevitable concessions to the *physical* view of the calculus, without which the method could have no value.

Absolutely identifying analytical with algebraical method, and thus freed from all the difficulties about continuity which occur in the ordinary processes of algebra, Hegel, of course, cannot appreciate these parts of Lagrange's work. He gives a simplified theory, and applies it, among other things, to the problem of drawing tangents. Hegel professes to deduce the correct rule, but he does so only by adopting an utterly false definition of a tangent, which, in fact, gives an infinite number of tangents at every point of a curve. In short, in this and other cases, Hegel makes errors of a mathematical character sufficient to show that his knowledge of the calculus was absolutely worthless.

4. On the Connection between Chemical Constitution and Physiological Action:—On the Physiological Action of the Salts of Ammonia, of Tri-methylamine, and of Tetramethyl-ammonium; of the Salts of Tropia, and of the Ammonium Bases derived from it; and of Tropic, Atropic, and Isatropic Acids and their Salts. With further details on the Physiological Action of the Salts of Methyl-Strychnium and of Ethyl-Strychnium. By Professor A. Crum Brown and Dr Thomas R. Fraser.

(*Abstract.*)

In papers which the authors have already communicated to this Society, they have shown that there exists a very marked difference

between the action of bases containing nitrogen as a triad and those in which that element is pentad. This result was obtained from an examination of the physiological action of substances having an unknown and complex constitution. It appeared to be necessary to institute a series of experiments with bodies having a simpler and fully known constitution. For this purpose, the salts of ammonia, tri-methylamine, and tetra-methyl-ammonium were selected. A comparison of the structural formulæ of the hydrochlorates of these bases shows that tri-methylamine stands in the same relation to the salts of tetra-methyl-ammonium as strychnia to the salts of methyl-strychnium.

The iodide of tetra-methyl-ammonium was prepared by mixing iodide of methyl with an excess of ammonia dissolved in alcohol, and recrystallising the crystalline precipitate from hot water. From the iodide the hydrate was obtained by the action of oxide of silver; and by distilling the hydrate and conducting the vapours into hydrochloric acid, the hydrochlorate of tri-methylamine was obtained.

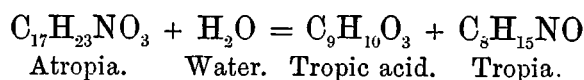
In their general physiological effects these substances very closely resemble each other. The most obvious symptoms which they produce are paralysis and slight muscular spasm; and when these symptoms were carefully analysed, by restricting the poisonous action to certain defined regions in frogs, it was ascertained that they are caused mainly by a direct action on the cerebro-spinal nervous system and on striated muscles. When large doses are given, the functional activity of these structures is first impaired and then destroyed; but during the stage of impairment, a slight degree of spasmodic action is produced, which may probably be referred, in frogs, to the stage of irritation which precedes the final action of the majority of muscular poisons, and, in mammals, to this action, aided by changes in the vascular condition of the central nerve organs, due to an influence on non-striated muscles.

The physiological effects of chloride of ammonium and of hydrochlorate of tri-methylamine were found to be extremely similar, both in degree and in kind, and to differ, in several important respects, from those of iodide of tetra-methyl-ammonium. The two former substances are comparatively feeble in their action; the latter is a poison of considerable energy. Chloride of ammonium

and hydrochlorate of tri-methylamine develop their full effects sluggishly; but the different structures which they influence have their activity destroyed nearly simultaneously, so that it is a matter of considerable difficulty to ascertain whether the muscles are paralysed before the motor nerves, or the latter before the sensory, or whether the nerve-trunks or periphery are first affected. Iodide of tetra-methyl-ammonium, however, very rapidly destroys the conductivity of the motor nerves by an action on their peripheral terminations, and an interval of several hours may elapse before its other effects are fully developed.

While the change of physiological action, produced by the addition of iodide of methyl to tri-methylamine, differs in some respects from that produced by the performance of the same operation upon strychnia, the observations now communicated tend to confirm the conclusion drawn from the previous experiments of the authors, that paralysis of the peripheral terminations of motor nerves is a characteristic effect of the salts of the ammonium bases.

The decomposition of atropia by means of acids and bases has lately been completely studied by Kraut* and by Lossen.† It appeared of interest to examine the physiological actions of the products of this decomposition, and to compare them with that of atropia. The reaction may be expressed by the equation—



The tropic acid is further changed by loss of water into two isomeric acids, atropic and isatropic ($\text{C}_9\text{H}_8\text{O}_2$), the former being produced most abundantly in the presence of alkalies, and the latter in the presence of acids. These substances were prepared by the methods given by Kraut and by Lossen; and, on account of the readiness with which the acids pass by oxidation into formic and α toluic acids, the action of the latter acid, prepared by the method which one of the authors communicated to this Society some years ago,‡ was also examined.

Each of these substances has been examined by the authors, and it was found that none of them possesses the well-known dilating

* *Annalen der Chem. u. Pharm.*, cxxviii. 280; cxxxiii. 87; cxlviii. 238.

† *Ibid.* cxxxi. 43; cxxxviii. 230.

‡ *Proceed. Roy. Soc. Edin.* v pp. 409, 455.

action of atropia on the pupil. The experiments were made with the hydrochlorate of tropia and with soda salts of each of the acids. Although, however, tropia differs so strikingly from atropia in being quite unable to influence the pupil, it resembles it in some of its other physiological effects. Like atropia, it is a powerful paralysing agent, and it produces paralysis in very much the same way as atropia does. In virtue of this action, tropia is an active poison.

Apart from the immediate object of these researches, some interest is attached to this portion of the investigation on account of its bearing on practical therapeutics. It has been shown by Professor Garrod, that when small quantities of caustic potash or soda are added to solutions of hyoscyamus, stramonium, belladonna, or atropia, the activity of these substances appears to be destroyed.* More recently, Dr John Harley, of London, has pointed out that the same effect is produced by caustic lime and by ammonia.† This conclusion was arrived at, principally, by observing that the pupil was not affected by preparations to which they had previously added one or other of these alkalies. The decomposition effected by potash, soda, lime, and ammonia, is the same as that which the authors have described; and by an examination of the separate products of this decomposition they are enabled to confirm the observation of Drs Garrod and Harley, and to add to it the additional fact that the products of this decomposition are not altogether inert.

The last portion of this paper, to which the authors think it advisable to draw attention, is that in which they describe some experiments with the salts of methyl- and of ethyl-strychnium, which were performed subsequently to their first communication. These additional experiments were made with the view to establish beyond the possibility of doubt, the truth of their statement, that these substances act as simple paralyzers of motor nerves. In a paper recently communicated to the French Academy of Sciences, two able observers, Messrs Jolyet and Cahours, have confirmed the result that these substances possess an action analogous to that of wourali (curara); but they have, besides, observed symptoms which

* *Medico-Chirurgical Transactions*, vol. xli. 1858, p. 53.

† *The Old Vegetable Neurotics*, 1869, p. 211.

induce them to believe that this analogy is not a very perfect one, as the methyl- and ethyl-derivatives of strychnia seem to retain a certain degree of the characteristic convulsant action of strychnia.* They found their opinion on the appearance of tetanic spasms in the limb of a frog, whose vessels had been ligatured before the poisoning, and on the production of coexisting paralysis and convulsions in mammals poisoned by these substances. Both of these effects are obviously explainable by the presence of a minute trace of strychnia. In the case of the frog with the vessels of one limb tied, the methyl- or ethyl-strychnium salt paralysed all the motor nerves to which it had access; but as strychnia was also administered, *by accident*, the excitability of the spinal cord was exaggerated, and tetanic spasms therefore occurred in the non-poisoned limb—its motor and sensory nerves being protected from the paralysing action of the methyl- or ethyl-derivative. The appearance of strychnic effects in mammals may likewise be explained by the presence of strychnia. One of the authors has shown, in a paper communicated to this Society, that when a sufficient dose of a substance that paralyses the terminations of motor nerves is administered to a frog along with a certain proportion of one that stimulates the spinal cord, the symptoms are those of paralysis alone; but when this combination is administered, in the same relative proportions, to a mammal, the symptoms are those of paralysis coexisting with convulsions.† This result is sufficient to account for the different symptoms observed by Messrs Jolyet and Cahours on frogs and on mammals, on the supposition that the methyl- and ethyl-strychnium salts they employed contained strychnia.

The authors have made a number of experiments which support this supposition. Several specimens of these salts, prepared by them, were found to produce such complicated effects as the French physiologists describe; but by carefully treating them a second time with iodide of methyl or of ethyl they succeeded in removing the convulsant action. They have also treated a specimen of iodide of ethyl-strychnium that produced strychnic effects, with iodide of methyl, and thus obtained a substance whose action was a purely

* Comptes Rendus, Nov. 2, 1868, p. 904.

† Proceed. Roy. Soc. Edin. vol. vi. p. 434.

paralysing one. They have, besides, added minute quantities of strychnia to specimens of salts of methyl and of ethyl-strychnium of perfect purity, and they found that the effects which were then produced were exactly the same as those described by Messrs Jolyet and Cahours. The correctness of the statements previously communicated to this Society by the authors was thus established in the most undoubted manner.

In their first experiments with these strychnia derivatives, and especially with that formed by iodide of ethyl, the authors obtained results similar to those described by Messrs Jolyet and Cahours; and they have been induced to enter thus fully into the subject from the knowledge, gained by their experience, of the importance as well as of the difficulty of obtaining these bodies in a state of absolute purity. This is apparent if it be recollected that the presence of 0.1 per cent. of strychnia is sufficient to vitiate the results of such experiments. It was only after the authors had adopted precautions, which seemed at first to be perfectly unnecessary, that they succeeded in eliminating this source of error, and in obtaining their substances in a state of *physiological* purity.

The following Gentleman was elected a Fellow of the Society :—

ROBERT HENRY BOW, Esq., C.F.

Monday, 31st May 1869.

DR CHRISTISON, President, in the Chair.

The following Communications were read :—

1. On the Annual Range of Temperature over the Globe.
By Mr Keith Johnston, jun. Communicated by Mr Buchan, Secretary of the Scottish Meteorological Society.
(With a Plate.)

The subject of range of temperature has been divided by meteorologists into the two main heads of *Diurnal* and *Annual* range, the former being measured by the variation of temperature between the warmest and coldest hours of the day, the latter by the differ-