

SEISMOLOGY AND ENGINEERING IN RELATION TO THE RECENT EARTHQUAKE IN JAPAN.

AT 6.38 a.m. on October 28, I was awakened at my house in Tokio by the long swinging motion of an earthquake. There was no noise of creaking timbers, and there were no shocks such as usually accompany earthquakes. It was an easy swing, which produced dizziness and nausea. As recorded by bracket seismographs this continued for ten or twelve minutes. During the interval there was ample time to study the movements of these instruments, and the conclusion that could not be avoided was that rather than acting as steady points these heavy masses were simply being swung from side to side—horizontal displacement was not being measured, but angles of tip were being recorded. That many of our seismographs are useless as recorders of horizontal motion whenever a vertical component of motion is recorded, is a view that I have held for many years, and therefore when these two have been recorded in conjunction I have been inclined to receive the records with caution.

Further, the measurement of vertical motion as recorded by a horizontal lever arrangement can only be trusted if we can assure ourselves that the advance of the waves has been at right angles to the direction of the lever. If this condition is not fulfilled, then the seismograph for vertical motion may also become a tip-recording instrument. As another indication that during this particular earthquake earth tips occurred, I may mention that the water in a tank with perpendicular sides which is about 25 feet deep, 60 feet long, and 30 feet broad, rose quickly, first on one side and then on the other, to a height of 3 or 4 feet—much in the same way that water would rise and fall in a basin that was being tipped from side to side.

Assuming what is said to be correct, it must not be concluded that modern seismographs are useless. For earthquakes where the motion is horizontal, they give records which practically are absolutely correct. When vertical motion occurs, in many cases if not in all, the records must be interpreted in a new light. The so-called horizontal displacements may be employed in determining the maximum slope of a wave, and if from an instrument recording vertical motion we are assured that we have measured the vertical height of a wave, we can at least approximate to the length of the same. The period of the waves being recorded, it follows that the velocity of propagation may be calculated.

Although it seems possible to use our present bracket seismographs as angle measurers, it is evident that there are other types of instruments, where swing due to inertia is minimized, which will act more satisfactorily. To obtain a true measure of vertical displacement, the most evident solution would be to use a number of lever arrangements in different azimuths. Other methods may, however, suggest themselves.

For the present our time is too much occupied with outside observations to attend to instruments or to reduce their records. Up to date it is known that nearly 8000 people have been killed, many having been consumed in the burning ruins where they were entombed. At least 41,000 houses are level with the plain, and engineering structures which have stood both typhoon and flood have been reduced to ruin. In the middle of the stricken district, which is near Gifu and Ōzaki, it is doubtful whether any ordinary building could have resisted the violence of the movement; but outside this, much destruction might have been obviated had attention been given to the ordinary rules of construction, and to the special rules formulated by those who have considered the question of building in earthquake countries. In many places so-called "foreign" buildings of brick and

stone—undoubtedly put up in the flimsiest manner—lie as heaps of ruin between Japanese buildings yet standing. Cotton mills have fallen in, whilst their tall brick chimneys have been whipped off at about half their height. Huge cast-iron columns, which, unlike chimneys, are uniform in section, acting as piers for railway bridges, have been cut in two near their base. In some instances these have been snapped into pieces much as we might snap a carrot, and the fragments thrown down upon the shingle beaches of the rivers. The greatest efforts appear to have been exerted where masonry piers carrying 200-foot girders over lengths of 1800 feet have been cut in two, and then danced and twisted over their solid foundations considerable distances from their true positions. These piers have a sectional area of 26 × 10 feet, and are from 30 to 50 feet in height. Embankments have been spread outwards or shot away, brick arches have fallen between their abutments, whilst the railway line itself has been bent into a series of snake-like folds and hummocked into waves. The greatest destruction has taken place on the Ōkazaki-Gifu plain, where we have all the phenomena—like the opening of crevasses, the spurting up of mud and water, the destruction of river banks, &c.—which usually accompany large earthquakes. At Ōkazaki and Nagoya the castles have survived. The reason for this may be partly attributable to the better class of timber employed in their construction, but principally to their pyramidal form and to the fact that they are surrounded by moats. Here and there a temple has escaped destruction, partly, perhaps, on account of the quality of materials employed in its construction, but also in consequence of the multiplicity of joints which come between the roof and the supporting columns. At these joints there has been a basket-like yielding, and the interstice of the roof has not, therefore, acted with its whole force in tending to rupture its supports. On the hills which surround the plain, although the motion has been severe, the destruction is not so great. These hills are granites, palæozoic schists, and other rocks. There is nothing volcanic. In the small cuttings where the railroad passes from the hills out into the plain, no effects of disturbance are observable, the surface motion probably having been discharged at the faces of the inclosing embankments. The general appearance outside the cuttings, however, is as if some giant hand had taken rails and sleepers and rubbed them back and forth until the ballast lying between them was formed into huge bolster-like ridges. Crossing the hills and proceeding to other plains, it is noticeable that there has been more movement on the alluvium than on the rocks.

Earthquakes yet continue, and in the Gifu plain each one is preceded by a boom as if a heavy gun had been fired in some subterranean chamber. Although the survivors, who may number, perhaps, two millions, are, for the most part, destitute, have witnessed the most terrible scenes, and are yet surrounded by the dead and the dying, yet there is no panic. They hear a "boomb," and run laughing to the middle of the street to escape the shock which the unaccountable noises herald. The Japanese have their feelings, but on occasions of this sort there is no helplessness in consequence of hysteria or mental prostration. As to what happens with Europeans under like circumstances, I must leave readers to consult history.

JOHN MILNE.

Tokio, November 7.

FURTHER RESEARCHES UPON AZOIMIDE, N₃H.

THE discovery of this remarkable compound of hydrogen and nitrogen by Prof. Curtius, in the chemical laboratory of the University of Kiel, formed one of the

most interesting chemical events of last year. The extraordinary nature of the compound—manifested by its fearfully explosive properties, together with its acid character, by virtue of which it forms salts with metals containing only metal and nitrogen—mark out for it a place among the most attractive of hitherto discovered substances. It was first obtained by Prof. Curtius in the form of a gas, by treating with soda a compound containing the organic radicle benzoyl in the place of the hydrogen atom, and subsequently warming the sodium salt thus produced with dilute sulphuric acid. The gas was described as possessing a frightfully penetrating odour, and as being absorbed by water with extreme avidity, forming a solution of strongly acid properties, which liberates hydrogen in contact with metals. So great, indeed, is the affinity of azoimide for water, that in these earlier experiments it was not found possible to collect the gas in the anhydrous state. Shortly after the publication of his first communication (see NATURE, vol. xlii. p. 615), an improved method of preparing the solution in water was devised by Prof. Curtius. It consisted in distilling a soda solution of a derivative containing the radicle of hippuric acid with dilute sulphuric acid. He was thus enabled to obtain a tolerably large quantity of the aqueous acid. By successive fractionation of this solution in water, and finally distilling the last product of the fractionation over fused calcium chloride, pure azoimide itself was eventually isolated, and found to be a volatile liquid, boiling at 37°.

Owing to the terribly explosive nature of both the free acid and its salts, the work has been attended with considerable danger, and has, unfortunately, been delayed by a lamentable accident which befell Prof. Curtius's assistant, Dr. Radenhausen, who was seriously injured by the explosion of a quantity of the anhydrous acid. At length, however, Prof. Curtius is able to publish some further particulars concerning the acid and its salts, and an important communication from him will be found in the current number of the *Berichte* of the German Chemical Society. The following is a brief account of these further researches, together with a *résumé* of the present state of our knowledge of this interesting compound and its derivatives.

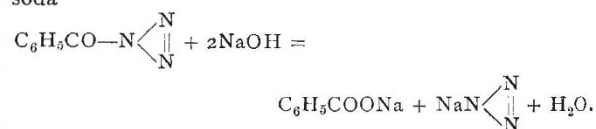
Sources of Azoimide and its Derivatives.

Azoimide and its salts have been obtained from two distinct sources, both organic. One source, the first employed by Prof. Curtius, is benzoyl-glycollic acid, $C_6H_5CO-O-CH_2COOH$; the second is hippuric acid, $C_6H_5CO-NH-CH_2COOH$. During the investigation of the reactions of his previously discovered compound of hydrogen and nitrogen, hydrazine, N_2H_4 , Prof. Curtius found that both benzoyl-glycollic and hippuric acids reacted with hydrazine hydrate, forming hydrazine derivatives.

Benzoyl-glycollic acid reacts with two molecules of hydrazine hydrate, forming benzoyl hydrazine, $C_6H_5CO-NH-NH_2$, and the hydrazine derivative of acetic acid, $NH_2-NH-CH_2COOH$, with elimination of water. When benzoyl hydrazine is treated with nitrous acid, it is converted into a nitroso derivative, $C_6H_5CO-N \begin{smallmatrix} \diagup NO \\ \diagdown NH_2 \end{smallmatrix}$.

This nitroso compound is a very unstable substance; it spontaneously parts with water, and becomes converted into the benzoyl derivative of azoimide, benzoyl-azo-imide, $C_6H_5CO-N \begin{smallmatrix} \diagup N \\ \diagdown N \end{smallmatrix}$. This latter compound forms a direct starting-point for the preparation of azoimide. Upon boiling with alkalis an alkaline salt of azoimide is

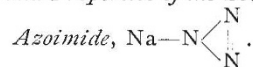
formed, together with benzoate of the alkali. Thus with soda



When the sodium salt of azoimide is distilled with dilute sulphuric acid, azoimide escapes as a gas, which condenses along with water in the form of an aqueous solution.

Hippuric acid reacts with one molecule of hydrazine with formation of hippuryl hydrazine, $C_6H_5CO-NH-CH_2CONH-NH_2$. When this substance is treated with nitrous acid, a compound is obtained which was at first considered to be a nitroso compound, but is now discovered to be in reality a diazo compound possessing the constitution $C_6H_5CO-NH-CH_2CONH-N=N-OH$. This substance may be isolated in quantity, and yields salts of azoimide directly upon treatment with alkalis. If soda is employed the sodium salt of azoimide is obtained, from which azoimide itself may, as before, be liberated by distilling with dilute sulphuric acid. It is more convenient, however, as will be described later, to employ it directly for the preparation of the ammonium salt of azoimide by saturating its alcoholic solution with ammonia gas; from the ammonia salt, if desired, azoimide itself may be obtained by converting it into the insoluble silver salt, and distilling the latter with sulphuric acid.

Preparation and Properties of the Sodium Salt of



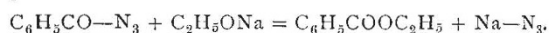
The method of preparing the sodium salt of azoimide, now adopted as most convenient by Prof. Curtius, is somewhat different from the earlier one just described, although based upon the same lines. Instead of benzoyl-glycollic acid, ethyl benzoate, $C_6H_5COOC_2H_5$, is employed. This substance is converted readily into benzoyl hydrazine by treatment with hydrazine hydrate:



The benzoyl hydrazine is next treated with sodium nitrite and glacial acetic acid, whereby it is quantitatively transformed into benzoyl azoimide, the benzoyl derivative of the new acid:



The benzoyl azoimide thus obtained is finally dissolved in an equal weight of absolute alcohol, and the equivalent of an atom of sodium is also dissolved in a little absolute alcohol, and the two solutions mixed; the mixture is then digested for several hours upon a water-bath, when the sodium replaces the benzoyl radicle, and ethyl benzoate is regenerated:

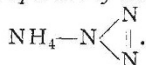


Upon cooling, the solution deposits crystals of the sodium salt, and the remainder may be precipitated from the mother-liquor by means of ether. The ethyl benzoate is recovered by distillation with very little loss, and may be employed again for the preparation of a further quantity of the sodium salt of azoimide.

The sodium salt, NaN_3 , obtained by this method is substantially pure. It is very soluble in water, but is, strangely enough, not hygroscopic. It is almost insoluble in ether and alcohol. It gives a feebly alkaline reaction, and possesses a briny taste. The crystals do not explode

by percussion, but do explode when heated to a temperature which is higher than in the case of most other salts of azoimide. The explosion is accompanied by the production of a brilliant yellow flame and a detonation which is less loud than in the case of other salts. The salt is not volatile, and is not changed by evaporation of its aqueous solution.

Preparation and Properties of the Ammonium Salt,



The ammonium salt, which is by far the most convenient salt to start with for the preparation of the free acid and its metallic salts, is best prepared from the curious diazo compound of the amide of hippuric acid, $\text{C}_6\text{H}_5\text{CO}-\text{NHCH}_2\text{CO}-\text{NH}-\text{N}=\text{N}-\text{OH}$, before mentioned. This substance is readily obtained in calculated quantity by first acting with hydrazine hydrate upon the ethyl ether of hippuric acid, and subsequently treating the hippuryl hydrazine thus produced with sodium nitrite and glacial acetic acid. Diazo-hippuramide appears to be most prolific in its reactions. Prof. Curtius states that it reacts with almost every class of organic and inorganic bodies with which he has brought it in contact, and generally without the application of external heat. Thus, when treated with water, alcohol, haloid ethers (alkyls), aldehydes, free halogens, or hydrazine derivatives of organic acids, it evolves free nitrogen gas, and forms compounds which are derived from hippuramide by replacement of a hydrogen atom in the NH_2 group by the radicle of the reacting substance. On the other hand, when acted upon by alkalis, ammonia or substituted ammonias (amines), or by diamide (hydrazine) and its derivatives, salts of azoimide are formed. Thus last reaction, when ammonia is employed, forms the most convenient mode of obtaining the ammonium salt of azoimide.

About a pound of diazo-hippuramide is placed in a flask of 2 litres capacity, and covered with 600 grams of 85 per cent. alcohol. The flask is then placed in a freezing mixture, and ammonia gas is led in until the liquid is saturated with it. The flask and contents are then allowed to stand twenty-four hours in order to complete the reaction, when the diazo compound is quantitatively converted into hippuramide and the ammonium salt of azoimide:



The liquid is then boiled, the flask being fitted with an upright condenser, until no more ammonia escapes, when the heat is removed, and the solution allowed to cool. After standing another twelve hours, the clear alcoholic solution is decanted from the mass of hippuramide crystals, and treated with four times its volume of ether, when 70 per cent. of the total yield of the ammonium salt is precipitated in the form of a white powder. The remaining 30 per cent. of the azoimide may be recovered by recrystallizing the hippuramide from water, adding the mother-liquor to the ethereal-alcoholic solution after removal of the precipitated ammonium salt, and treating the whole of the liquid with solutions of lead, silver, or mercurous salts, when the azoimide is precipitated in the form of the difficultly soluble lead, silver, or mercurous salts. The hippuramide is readily converted, by boiling with hydrazine hydrate, into hippuryl hydrazine, which may thus be used again for the preparation of more of the diazo compound.

The precipitated ammonium salt is washed with ether and dried in the air. The snow-white crystalline powder thus obtained, consisting of fine anisotropic needles, may be recrystallized from boiling alcohol. It is only

sparingly soluble in absolute alcohol, but on boiling for some time in a flask fitted with inverted condenser, the whole passes into solution. Upon cooling, the salt separates out in large colourless crystals, tabular in form, and frequently aggregated in step or fan-shaped forms. These aggregates often resemble those of ammonium chloride very closely, but the crystals do not belong to the cubic system. The crystals are readily soluble in water, and, upon allowing the aqueous solution to evaporate *in vacuo*, large transparent prisms are obtained, which, however, soon become turbid in air.

The ammonium salt of azoimide reacts in a feebly alkaline manner. It is not hygroscopic, although so readily soluble in water. It dissolves easily in 80 per cent. alcohol, but, as above described, with difficulty in absolute alcohol. It is insoluble in ether and benzene. It is distinguished by its great volatility. When the crystals are allowed to lie exposed to air, they gradually disappear, eventually passing away entirely in the form of vapour. Upon gently warming a small quantity of the salt in a test-tube to a temperature very slightly superior to 100° , it sublimates like ammonium chloride, condensing again, however, in brilliant little prisms. This operation requires great care, for if the heating proceeds too rapidly the substance explodes with great violence.

As may be expected, great difficulties were met with in obtaining an analysis of a substance so explosive. Upon attempting to determine its composition by combustion with copper oxide in a stream of dry air, the apparatus was destroyed upon each occasion with a fearful detonation. Only one-tenth of a gram of the salt was employed, placed in a small platinum boat. At first the compound sublimed out of the boat into the cooler portion of the combustion tube; the little sublimed crystals then commenced to fuse into yellow drops, and immediately this occurred, in each experiment, the tube was shattered to fragments with a frightful report. The platinum boat was in each case torn to fine splinters. Eventually, however, Prof. Curtius succeeded in obtaining a satisfactory analysis by performing the combustion with copper oxide in a stream of carbon dioxide.

The ammonium salt may be readily converted into the sodium salt by evaporation with caustic soda upon a water-bath.

Preparation and Properties of Free Azoimide, H—N $\begin{array}{l} \diagup \text{N} \\ | \\ \diagdown \text{N} \end{array}$

An aqueous solution of azoimide may be prepared by distilling any of its salts, preferably the sodium or silver salts, with dilute sulphuric acid. It is more conveniently obtained, however, by dissolving the crystals of diazo-hippuramide in dilute caustic soda, warming the solution for a short time upon a water-bath, so as to insure the formation of the sodium salt, and subsequently distilling the liquid with dilute sulphuric acid. The latter is allowed to drop slowly from a dropping funnel upon the soda solution contained in a flask and maintained at the temperature of ebullition. The flask is connected with a condenser, and the azoimide, as it escapes, is carried along with the steam, and condenses in the receiver in the form of an aqueous solution. This solution may be concentrated by precipitating it with silver nitrate, collecting the insoluble silver salt, and distilling it with sulphuric acid diluted with eight times its volume of water.

The aqueous solution of azoimide possesses a most intolerable odour.

Free azoimide itself may be obtained by the fractional distillation of the concentrated aqueous solution thus prepared. The first fraction is collected separately and refractioned. Upon repeating this process with four successive first fractions, an acid containing over 90 per cent. of azoimide is obtained, which distils at about 45° . The last 10 per cent. of water may be completely removed

by means of fused calcium chloride, after treatment with which pure anhydrous azoimide distils over.

Azoimide is a clear, colourless, mobile liquid, which boils without decomposition at 37°. It is endowed with the same intolerable odour as the solution. Its most characteristic property, however, is its frightful explosiveness. It explodes in a most erratic manner—sometimes, without the least apparent provocation, at the ordinary temperature. Its distillation is an operation attended with great danger; Prof. Curtius and his assistant *have* succeeded, as above described, in isolating it and determining its boiling-point several times; but upon other occasions, under apparently the same conditions, the experiment has ended with a disastrous explosion. When suddenly heated, or touched with a hot body, it always explodes. The explosion is accompanied by an intensely vivid blue flame. The damage wrought by the explosion of very minute quantities is most surprising. The thousandth part of a gram, placed upon an iron plate and touched by a hot glass rod, is sufficient to produce a loud detonation, and considerably distort the iron plate. The twentieth part of a gram was found sufficient to completely pulverize a Hofmann "density" apparatus, when an attempt was made to determine its vapour-density in the Torricellian vacuum at the ordinary temperature. Upon another occasion, seven-tenths of a gram, contained in a closed glass tube, upon removal from the freezing mixture in which it had been immersed exploded with such immense force as to shatter every piece of glass apparatus in the laboratory. It was upon this occasion that Prof. Curtius's assistant was so seriously injured as to cause the temporary abandonment of the work. The aqueous solution is almost as explosive as the anhydrous liquid, the explosion of two cubic centimetres of a 27 per cent. solution upon one occasion shattering the glass tube into dust so fine that Prof. Curtius, who was attempting to seal it, escaped uninjured.

The anhydrous liquid readily dissolves in water and alcohol. The aqueous solution is strongly acid to litmus. Magnesium, aluminium, zinc, iron, and even copper are rapidly attacked by it, hydrogen being evolved. Gold and silver are likewise attacked, although not so rapidly. In the case of gold a red solution of the gold salt is formed; the silver salt being insoluble soon prevents further action in the case of silver.

The anhydrous compound appears to be decomposed by concentrated sulphuric acid.

Other Metallic Salts of Azoimide.

The silver salt, $\text{Ag}-\text{N} \begin{array}{l} \diagup \text{N} \\ | \\ \diagdown \text{N} \end{array}$, is obtained in the form of

a white precipitate whenever a soluble silver salt is added to azoimide, its aqueous solution, or solutions of its salts. It resembles silver chloride very closely in appearance, but is not darkened by the action of light. There is very little difficulty in distinguishing between the two salts, however, inasmuch as the silver salt of azoimide partakes of the frightfully explosive properties of the free acid. It is the most dangerous of all the salts to handle. In spite, however, of this explosiveness, Prof. Curtius has *once*, and only once, succeeded in obtaining a determination of its nitrogen content, by combustion in a long layer of copper oxide. The number obtained was 27.65. The value calculated from the formula AgN_3 is 28.00. In every other experiment the tube was shattered into fragments, notwithstanding the finest subdivision and distribution among the copper oxide.

The precipitated silver salt is soluble, like silver chloride, in ammonia. Upon evaporation of the solution, however, instead of obtaining an ammoniacal double compound, the silver salt itself crystallizes out in almost colourless crystals half an inch long. These crystals, as may be

imagined, are most delicate objects to handle; they explode even upon breaking the prisms across. They are almost perfectly insoluble in water.

The mercurous salt, HgN_3 , is likewise insoluble in water, and may be readily obtained by precipitation of the free acid or its soluble salts with mercurous nitrate. It has the advantage of being more safely handled than the silver salt, and is less sensitive to percussion. It also requires a higher temperature to bring about explosion by heating. It is usually obtained by precipitation in the form of microcrystalline anisotropic needles. It becomes coloured yellow when exposed to light. Like mercurous chloride, it forms a black compound with ammonia.

The lead salt, PbN_3 , resembles lead chloride very closely. It is insoluble in cold water, but dissolves somewhat in boiling water, though not to such an extent as lead chloride, about half a gram dissolving in a litre of boiling water. Upon cooling, brilliant colourless needles, attaining sometimes the length of half an inch, separate out. It may be best obtained by precipitating the solution of the sodium or ammonium salt with lead acetate. The precipitate is soluble in excess of lead acetate. The crystals of the lead salt explode with fearful force when slightly warmed. By long boiling with water this lead salt appears to be decomposed, a non-explosive lead compound separating, and free azoimide escaping. Warm acetic acid also dissolves it, with gradual decomposition and liberation of azoimide.

The barium salt, BaN_3 , is readily obtained by neutralizing the acid with baryta, and crystallizes from solution in large lustrous crystals. It is likewise a highly explosive salt, and the explosion is accompanied by the production of a brilliant green flame.

Ethereal Salts of Azoimide.

The metallic salts of azoimide may be readily converted into ethereal salts by reacting upon them with haloid ethers. The phenyl ester has been prepared by Prof. Curtius, and is found to be identical in every respect with

the long known diazobenzene imide, $\text{C}_6\text{H}_5\text{N} \begin{array}{l} \diagup \text{N} \\ | \\ \diagdown \text{N} \end{array}$. The

aromatic esters are generally remarkably stable substances, and it was consequently found impossible to obtain azoimide by the direct saponification of diazobenzene imide with soda. Within the last few months, however, Drs. Noelting and Grandmougin, of Mülhausen, have succeeded in preparing azoimide indirectly from diazobenzene imide, by first diminishing somewhat the stability of the compound by introducing two nitro groups into it. Upon treating dinitro-diazobenzene imide with alcoholic potash, the potassium salt of azoimide was at once formed. Upon distilling this with dilute sulphuric acid, an aqueous solution of azoimide was obtained, and eventually anhydrous azoimide itself, identical in all respects with that obtained by Prof. Curtius.

Hydrazine Salt of Azoimide, $\text{N}_3\text{H} \cdot \text{N}_2\text{H}_4$.

This interesting substance, formed by the union of equal molecules of the two remarkable compounds, hydrazine and azoimide, whose isolation we owe to Prof. Curtius, is a solid substance forming large well-defined crystals. It is obtained when one molecular equivalent of hydrazine hydrate (the preparation and properties of which were described in NATURE, vol. xliii. p. 205) is added to the ammonium salt of azoimide, and the mixture, placed in a shallow dish, is allowed to evaporate in a desiccator. It is curious, also, that by adding a very concentrated aqueous solution of azoimide, obtained by distilling 60 grams of the lead salt with dilute sulphuric acid, to hydrazine hydrate, until litmus is turned strongly blue by the mix-

ture, one does not obtain, as might be expected, the salt $2N_3H \cdot N_2H_4$; on the contrary, the mono-salt, $N_3H \cdot N_2H_4$, is again formed; and if the mixture is placed in a desiccator containing solid caustic potash and oil of vitriol, crystals of the mono-salt are deposited, and the excess of azoimide escapes and is absorbed by the potash.

The mono-hydrazine salt crystallizes in lustrous, anisotropic prisms an inch long, which melt at 50° . They rapidly deliquesce in air. They are soluble with difficulty in boiling alcohol, and crystallize from the solution, on cooling, in brilliant leafy crystals. The crystals burn quietly with a smoky flame when brought in contact with a flame, leaving no trace of residue. Owing to the strong reducing power of the liberated glowing hydrogen, metallic surfaces upon which the crystals may be ignited become brightly cleaned, as if polished, being freed from the least trace of oxide. When the crystals, however, are rapidly heated, or touched with a white-hot wire, they explode with fearful violence. The explosion may also be brought about by detonating in the neighbourhood a little of one of the metallic salts of azoimide. Even in the deliquesced state the substance retains its fearfully explosive properties.

In conclusion, it may be remarked that Prof. Curtius has further succeeded in preparing a number of derivatives of the as yet unisolated compound of hydrogen and nitrogen, triamide, $NH_2-NH-NH_2$, by the action of the hydrazine compounds of several organic acids upon diazohippuramide. The organic radicles are so rigidly attached in these derivatives that he has not yet been fortunate in displacing them. It appears very probable, however, that before long some means of effecting this object will be discovered, and that Prof. Curtius will further add to his achievements by making us as familiar with triamide as we now are with hydrazine and azoimide.

A. E. TUTTON.

BEAST AND MAN IN INDIA.¹

THE natives of India have been described from many different points of view, but Mr. Kipling is the only writer to whom it has occurred to give a full account of their relations to animals. The task is one for which he is admirably fitted, and he has fulfilled it in a way that cannot fail to secure for the book an enduring place in the literature relating to Indian subjects. The work has considerable scientific value, not only because the author presents the people of India in a new light, but because he has much that is fresh to say about the animals to which he refers. Animals have a great attraction for him, and his notes on their habits have the brightness and charm that belong only to records of direct personal observation. The volume is enriched with many clever illustrations, the majority of which are from drawings by Mr. Kipling himself. Most of the others are from drawings by native artists. Several of these illustrations we are enabled to reproduce.²

There is a general impression in Europe that animals are treated kindly in India. This impression is only in part confirmed by Mr. Kipling. It is true that the Hindus, believing in the transmigration of souls, are reluctant to take animal life; but that, says Mr. Kipling, "does not preserve the ox, the horse, and the ass from being unmercifully beaten, over-driven, over-laden, underfed, and worked with sores under their harness; nor does it save them from abandonment to starvation when unfit for work, and to a lingering death which is made a long torture by birds of prey, whose beaks, powerless to kill

outright, inflict undeserved torment." Even the sacred cow is not so well treated as the milch cows of Europe. Mr. Kipling's statements on this subject are extremely unpleasant reading, but it is to be feared that they are only too well founded. With regard to free creatures, however, he is able to give a better report. The village school-boy does not stone frogs, or set dogs at cats, or tie kettles to dogs' tails, or go bird-nesting, or annoy squirrels; and "the sparrow, the crow, the maina, and the hoopoe move from his path without a flutter of fear." The farmer, too, endures with extraordinary patience depredations on his crops by wild animals. The monkey, the nilghai, the black buck, the wild pig, and the parakeet fatten at his expense, and do not even reward him by killing a caterpillar or a weevil. There are bird-catchers in India, but the popular feeling about them is shown in a scornful proverb on their ragged and disreputable condition.

One of the brightest chapters in the book is on monkeys, which the author has had good opportunities of observing. The monkey most commonly seen both in the hills and plains is the Macaque (*Macacus rhesus*), which is not to be confounded with the tall, long-tailed, white-whiskered Langūr (*Presbytes illiger*). The latter is clad in an overcoat of silver-grey. He is, in his way, a king of the jungle, and is not so often met with in confinement as his brown brother. The Hooluck, or Black Gibbon (*Hylobates hooluck*), is most often found in Bengal and Assam, and, if a pair can be secured, easily reconciles itself to captivity; but it is "a depressing companion." An Assam monkey, known as "the shame-faced one," is "a gentle, bashful, large-eyed creature, with a quaint trick of hiding its face in its hands and hanging its head like a timid child."

The monkey is held in great respect in India, and Hanumān, the monkey-god, is one of the most widely-worshipped of Hindu deities. Sacred as the animal is, the people are thoroughly alive to the faults of its character, and in ordinary talk the monkey is used, as in Europe, "to point morals against wanton mischief, helplessness, and evil behaviour generally." For some months a number of wild monkeys were daily fed by Mr. Kipling and his family; and they soon learned to distinguish by smell between fresh and stale biscuits. Yet—as the natives have noted in proverbs—monkeys are not sharp enough to provide themselves with shelter against the heavy rains of the country. In the Simla region they may be seen in troops sitting shivering for hours within a few yards of covered spaces. The scheme of their life, according to Mr. Kipling, seems to be patriarchal, with a touch of military organization, the patriarch being "at once commander-in-chief and effective fighting force." The natives call him "Maharajah," and the name is well chosen, as he is "the very type and incarnation of savage and sensual despotism." Monkey mothers treat their little ones with a tenderness "that endears them to the child-loving Oriental"; and the young, when the sun shines, often contrive to have a good time. Says Mr. Kipling:—

"They have a game like the English boys' cock of the dung-hill or king of the castle, but instead of pushing each other from the top of a knoll or dust-heap, the castle is a pendent branch of a tree. The game is to keep a place on the bough, which swings with their weight as with a cluster of fruit, while the players struggle to dislodge one another, each, as he drops, running round and climbing up again to begin anew. This sport is kept up for an hour at a time with keen enjoyment, and when one is nimble as a monkey it must be splendid fun."

Mr. Kipling finds in cows and oxen the subject of another capital chapter. They seem to him to be the foremost figures in both the rustic and the urban scenery of the country. The cow is now "firmly enthroned in the Hindu pantheon," and the peculiar sanctity in which

¹ "Beast and Man in India." By John Lockwood Kipling. C.I.E. With Illustrations. (London: Macmillan and Co., 1891.)

² Figs. 1, 2, and 4, are by Mr. Kipling. Fig. 3 is by Mūnashi Sher Muhammad.