which will continue increasing their distance from each other, proportionately with the increase of the velocity. If one succeeds in determining micrometrically the distance of one of these lines from the original aperture, he will measure no longer the single deviation of Foucault, but as high a multiple of that deviation as may be desired. The distance of my two mirrors from each other being 5 m., and the velocity of the rotation of the mirror only 200 revolutions per second, the deviation will be five-eighths of that obtained by Foucault—*i.e.* five-eighths of 0·7 mm., or nearly 0·44 mm. The tenth image will consequently be at 4·4 mm. from the aperture.

To assure myself, above everything, of the existence of these multiple images, I employed Foucault's mode of observation, and placed before the luminous aperture, at a little distance from the fixed mirror, a plate of glass with parallel faces, inclined at an angle of 45° to the direction of the axis of the mirror. By this means there is thrown back laterally a portion sufficiently faint, it is true, but still a portion, of each of the deviated pencils which one receives in a microscope. There will then be seen, so soon as the velocity of rotation is great enough to give a continuous image, appearing on the rim of the image of the aperture a second, less distinct image, next a third at the rim of the second, increasing in breadth in proportion as the first is more and more deviated, and ending by separating from one another. With the electric light generated by a small gas-machine of half-horse power, or with the wan sun of these late days, I have managed to see as many as three images and catch a glimpse of the fourth. The actual result very well corresponded with my anticipations. What remains to be done is to improve the method of observation and increase the quantity of light.[1]

Suppose the tenth image is sufficiently intense to be observed, I cut away the silver of the mirror from a little rectangle with rims parallel to those of the aperture. The tenth image will come to be formed in this rectangle, all the following images will be suppressed, and the deviated pencil traversing the glass of the mirror, the posterior face of which is plain and polished, will be received behind on a prism of total reflection, which will transmit it into the micrometric microscope. The distance of the rim of the image from the rim of the rectangle will be measured; then, by an independent operation, the distance of this rim from that of the aperture; the sum of the two will give the line of magnitude of the deviation. It remains to ascertain the order m of this deviation. For this purpose the rotation of the mirror will be accelerated till the image of the order $m - 1$ comes to be substituted for that which was observed. Let n and n' represent the numbers of revolutions of the mirror per second, δ and δ' the lineal values of the simple corresponding deviations, then

$$\delta = kn, \qquad \delta' = kn' \qquad \text{and } m\delta = (m - 1)\delta',$$

thence

$$mn = (m - 1)n'.$$

whence

$$m = \frac{n'}{n' - n}.$$

The number of revolutions is measured electrically by the methods M. Cornu has so carefully discussed in his work on the velocity of light; I need not dwell on it. Finally, the measurement of the passage of the light is easily got at; it is that of the distance from each other of the centres of the surfaces of the two mirrors.

In order to observe a deviation of a rather high order, all that is needed is a sufficiency of light. Now, in this case, I manage to augment considerably the proportions of utilised light. In the first place the rotating mirror may be made to reflect on its two faces, care being only taken that both have exactly the same radius of curvature. In the second place, having suppressed every object-glass, I am able to utilise the pencil reflected by the rotating mirror throughout the whole space in which it gives a good image of the aperture, and this space is considerable, because the astigmatism resulting from the obliquity does not sensibly affect the rectilineal form of this image. It is, next, possible to tack on to the mirror of 0·20 m., of which I have spoken, a series of other identical mirrors placed at the same distance in the plane of rotation of the pencil. The condition of identity of the radius of curvature is, besides, much less rigorous for these mirrors than in the case of the two faces of the rotating mirror. It is, however, always indispensable that the movable image given by this latter is reflected exactly on to the surface of each of the fixed mirrors.

I have also to remark that it is necessary that the lineal distance of the image observed from the aperture is large enough to allow the observation to be made. For in the thickness of the glass of the mirror and on its two surfaces there will inevitably arise a diffusion, as also reflections of the incident light, to embarrass and even frustrate the exact vision of the deviated image when it is too near the aperture. I have just shown that the actual apparatus ought, under good conditions, to show an image of the sixteenth order, perhaps even one as high as the twentieth—that is to say, at 8·8 m. from the aperture. It would be useful, however, to have recourse to an apparatus of more considerable proportions.

If 20 m. is taken for the radius of curvature of the mirrors and for the length of the simple passage of the light, the movable mirror ought to have a diameter of 0·20 m. Let there be impressed on it a velocity of rotation of only fifty revolutions per second, the deviation calculated according to the experiment of Foucault will be:—

$$0{\cdot}7 \text{ mm.} \times \frac{40}{40} \times \frac{20}{1} \times \frac{50}{400} = 1{\cdot}75 \text{ mm.}$$

The displacement of the twentieth image will then be 35 mm., which, measured to the hundredth of a millimetre, will give an approximation of $\frac{1}{3500}$. Now I do not think it impossible to turn a mirror of 0·20 m. as many as fifty revolutions per second without causing deformation of its surfaces. The turbines and the movable pieces of the dynamo-electric machines of the present day frequently attain a similar velocity.

It is my duty to make known to the Academy that the funds necessary for my first and long experiments were generously supplied to me by M. de Romilly, to whom I am happy to make this public testimony of my gratitude.

[1] The quantity of light utilised by this mode of observation on a glass is hardly the tenth of the actual quantity. The ratio of the geometrically decreasing progression representing the intensities of the successive images being 0·656, allowing 0·90 for the reflecting power of the silver, the brightness of the third image seen by reflection from a plate of glass is inferior to that of the eighth image seen directly. The reflecting power of new silver being 0·96, it would be possible by its means to attain to the sixteenth image.

ACCIDENTAL EXPLOSIONS PRODUCED BY NON-EXPLOSIVE LIQUIDS[1]

III.

THE only real danger which may attend the use of the little sponge lamps arises from accidental spilling of spirit used for filling them in the neighbourhood of a flame, or from carrying out the operation of filling in the vicinity of a light. Indeed, such casualties as have been attendant upon the use of petroleum-spirit as an illuminant have been mainly connected with the keeping and handling of the supplies of this very volatile liquid, and are largely attributable to want of caution or to forgetfulness. The salutary regulation prescribed by law, that vessels containing the spirit shall bear a conspicuous label indicating its dangerous character, has undoubtedly operated very beneficially in diminishing the frequency of accidents with it, by constantly admonishing to caution. It is a matter for much surprise and regret that the manufacturers of a class of miners' safety lamps, consisting of modifications of well-known types, with the ordinary oil lamp replaced by the sponge lamp, in which petroleum-spirit is burned, should have allowed trade interests to induce them to mislead those who use these lamps with regard to the nature of the illuminant supplied with them, by devising a name for it which gives a false indication of its nature, being designed to create the belief that it is an article of special manufacture, allied in character to a comparatively very safe oil largely used in miners' lamps, while in reality it is a well-known article of commerce, the safe storage and use of which demand special precautions and vigilance.

The lecturer took occasion to point out here, ten years ago, that a large proportion of the accidents arising out of the employment of petroleum- or paraffin-lamps were not actually due to the occurrence of explosions. Thus the incautious carrying of a lamp, whereby the liquid is brought into contact with the warm portion of the lamp close to the burner, may give rise to a liberation of vapour which, in escaping from the lamp, may be

[1] Address delivered at the Royal Institution of Great Britain, Friday, March 13, 1885, by Sir Frederick Abel, C.B., D.C.L., F.R.S., M.R.I. Continued from p. 496.

ignited, causing an outburst of flame which may alarm a nervous person and cause the dropping or overturning of the lamp. The accident which occurred in some apartments in Hampton Court Palace, in December, 1882, and gave rise to a somewhat alarming fire, appeared almost beyond doubt to have originated from the employment by a domestic servant of a contrivance in which petroleum spirit was used for heating water; but, as petroleum-lamps were used in the particular residence where the fire actually occurred, public correspondence ensued regarding the dangers attending the use of such lamps, although all which were known to have been on the premises were forthcoming after the fire and found to be intact. There was, at any rate, no evidence whatever adduced in support of an assumption that the casualty was due to the explosion of a lamp, and other instances might be quoted in which the breaking out of a fire, or the destruction of or injury to life, which had evidently been caused by upsetting or allowing to fall a petroleum lamp, has been erroneously ascribed to an explosion.

There are, however, numerous casualties which have been unquestionably caused by the occurrence of explosions in lamps, and which have in many cases been followed by the ignition of the oil, and the consequent loss of life or serious injury to those in the immediate vicinity of the accident. Careful inquiries have of late been instituted into casualties of this kind, and in many instances the explosions have been distinctly traceable to some immediate cause. In the great majority of cases they occur some considerable time after the lamp was first kindled, and when the supply of oil remaining in the reservoir has been but small. Occasional examples of the reverse are, however, met with. Thus, last spring, a man and his young son were sitting at a table reading, his wife being also close at hand, when a paraffin lamp, which had just been lighted, exploded, and the room was at once set on fire by the burning oil which escaped. The husband and wife fled from the room, both being slightly injured, but the child was unable to escape from the flame, and was burned to death. The oil used in the lamp was of a well-known brand, having a flashing point ranging from 73° to 86° F., and assuming that the recently lighted lamp had been filled with oil, and was untouched at the time of the explosion, no satisfactory explanation can be given of the accident, unless, perhaps, the reservoir had been so completely filled with oil, that the expansion of the liquid, on its becoming slightly warm, exerted sufficient force to determine the fracture of the glass at some part where a flaw or crack existed.

A lamp accident which occurred last July at Barnsbury, causing the death of a woman and her husband, appears, on the other hand, distinctly traceable to the production of an explosion in the reservoir of the lamp. The latter was stated to have been alight but a short time, when, the husband being already in bed, the wife, in her night-dress, attempted to blow out the flame of the lamp; the man heard a report, and, looking towards the lamp, saw his wife in flames. He proceeded at once to her rescue, and was severely burned in extinguishing the flames in which she was enveloped. The woman died in a few hours, and the man succumbed three days later to the injuries received. There being no witness to the accident, there is no evidence against the supposition that, on the occurrence of a slight explosion in the reservoir in the lamp, the woman, having hold of it when attempting to blow it out, may have upset it, or tilted it so as to cause the oil to flow out and become inflamed. The lamp may have become fractured by the explosion; but whenever such a result has been produced, the lamp had always been burning some time, so that there was considerable air-space which could be filled by an explosive atmosphere, whereas, in this case, the evidence appears positive as to the lamp having been full of oil when lighted.

In another fatal case of a lamp explosion in the same month, at Mile End, the accident was also caused by the attempt on the part of a woman to blow out the lamp before going to bed. In this case the lamp had been burning for three hours; the husband of the sufferer was in bed asleep in the room at the time, and, the woman being unable to give any account of the occurrence, the only information elucidating it was furnished by the daughter, to the effect that the lamp had been burning for three hours, and that it was the habit of her mother to extinguish the lamp by first lowering the wick and then blowing down the chimney.

Another fatal accident, caused by the explosion of a lamp, took place at Camberwell last January, and was brought about, as in the two preceding cases, by attempts to extinguish the lamp by blowing down the chimney. The husband and two sons of the sufferer were witnesses of this accident; the lamp had been burning for six or seven hours, when the woman took it in her hand, and having partially turned it down, proceeded to blow down the chimney; an explosion at once occurred, the glass reservoir was broken, and the inflamed oil flowed upon her dress, burning her most severely.

A lamp explosion which occurred last December in a van used as a bedroom by an itinerant showman, at the so-called World's Fair held at the Agricultural Hall, Islington, and which caused the death of an infant, was of a somewhat different character to the foregoing. The lamp, which was of the duplex-form and was attached to a bracket, had been alight for some hours, when a woman went, from a neighbouring van used as the dwelling room, to extinguish it. She observed that while the lamp, or wick, was only burning faintly, the oil in the reservoir was alight. She placed her apron over the top of the chimney to extinguish the lamp, when it at once appeared to explode, and the burning oil set the interior of the van on fire. The woman ran out for help, and a lad, protecting his head with his coat, rushed in and brought out the infant which was lying upon the bed, and which died from injuries received. The oil used in the lamp was believed to be of high flashing point, being obtained by the retailer who supplied it, from a firm dealing in a Scotch shale oil manufactured by the Walkinshaw Company (known as the "electric light" brand). A sample of the oil, as supplied by the wholesale dealers, had a flashing point of 114° F., but a portion of the oil actually purchased by the owner of the lamp had a flashing-point of only 63° F., and evidently consisted of a mixture of the heavy oil and of benzoline. The oil in question would naturally become exhausted of the volatile spirit after the lamp had burned for some time, and the flame would then have burned low in consequence of the heavy character of the residual oil; the lamp and its contents would have thus become highly heated, and some accidental disturbance of the surrounding air must have caused vapour generated from the heated oil and contained in the air-space of the reservoir, to become inflamed, the oil itself being thereby ignited. By placing her apron hastily upon the top of the chimney, the woman forced air into the reservoir, and thus either caused a slight explosion to take place or determined the breaking of the glass by the sudden change of temperature. A lamp explosion, apparently due to the same cause, occurred quite recently in the cabin of a small steam-launch on the Medway, near Chatham.

Several cases of undoubted lamp explosions, fortunately unattended by serious consequences, have come to the lecturer's knowledge as having occurred in the billiard-rooms of barracks where petroleum or paraffin oil was employed as an illuminant. These lamps are fixed over the billiard-tables, and generally speaking the rooms have top- or sky-lights. In every instance the lamp had been burning for several hours, and had probably become more or less heated, especially as shades of sheet tin were placed over them as reflectors. In each case a portion of the glass reservoir was blown out by the explosion, and the oil, becoming ignited, burnt portions of the table on which it fell.

A careful investigation of accidents of which the foregoing are illustrations,[1] together with a critical examination of the construction of various lamps, and the results of many experiments have, up to the present time, led the lecturer and Mr. Redwood to arrive at several definite conclusions with respect to the immediate causes of lamp-explosions and to certain circumstances which may tend to favour the production of such explosions.

If the lamp of which the reservoir is only partly full of oil be carried, or rapidly moved from one place to another, so as to agitate the liquid, a mixture of vapour and air may make its escape from the lamp in close vicinity to the flame, and, by becoming ignited, determine the explosion of the mixture existing in the reservoir. This escape may occur through the burner itself, if the wick does not fit the holder properly, or through openings which exist in some lamps in the metal work, close to the burner, of sufficient size to allow flame to pass them readily. A sudden cooling of the lamp, by its exposure to a draught or by its being blown upon, may give rise to an inrush of air, thereby increasing the explosive properties of the mixture of vapour with a little air contained in the reservoir, and the flame of the lamp may at the same time be drawn or forced into the

[1] Mr. Alfred Spencer, of the Metropolitan Board of Works, has obligingly furnished me with the official details of several of the accidents above referred to.—F. A. A.

air-space filled with that mixture, especially if the flame has been turned down, as the latter is thereby brought nearer to the reservoir. The sudden cooling of the glass, if it had become heated by the burning of the lamp, may also cause it to crack if it is not well annealed, and this cracking, or fracture, which may allow the oil to escape, may convey the idea that an explosion has taken place. If the evidently common practice is resorted to of blowing down the chimney with a view to extinguish the lamp, the effects above indicated as producible by a sudden cooling may be combined with the sudden forcing of the flame into the air-space, and an explosion is thus pretty certain to ensue, especially if that air-space is considerable. If the flashing-point of the oil used be below the minimum (73° Abel) fixed by law, and even if it be about that point or a little above it, vapour will be given off comparatively freely if the oil in the lamp be agitated, by carrying the latter or moving it carelessly; the escape of a mixture of vapour with a little air from the lamp, and its ignition, will take place more readily, but on the other hand it will probably be feebly explosive, because the air will have been expelled in great measure by the generation of petroleum vapour. If the flashing-point of the oil be high, the vapour will be less readily or copiously produced, under the conditions above indicated, but, as a natural consequence, the mixture of vapour and air existing in the lamp may be more violently explosive, because the proportion of the former to the latter is likely to be lower and nearer that demanded for the production of a powerfully explosive mixture. If the quantity of oil in the lamp reservoir be but small, and the air-space consequently large, the ignition of an explosive mixture produced within the lamp will obviously exert more violent effects than if there be only space for a small quantity of vapour and air, because of the lamp being comparatively full. If the wick be lowered very much, or if for some other reason the flame becomes very low, so that it is burning beneath the metal work which surrounds and projects over the wick-holder, the lamp will become much heated at those parts, and the tendency to the production of an explosive mixture within the space of the lamp will be increased, while, at the same time, heat will be transmitted to the glass, and it will be correspondingly more susceptible to the effects described as being exerted by its sudden exposure to a draught. Experiments have demonstrated that a lamp containing an oil of high flashing point is more liable to become heated than a comparatively light and volatile oil, in consequence of the much higher temperature developed by the combustion, and of the comparative slowness with which the heavy oil is conveyed by the wick to the flame. It therefore follows that safety in the use of mineral oil lamps is not to be secured simply by the employment of oils of very high flashing point (or low volatility), and that the use of very heavy oils may even give rise to dangers which are small, if not entirely absent, with oils of comparatively low flashing points. The occurrence of such an accident as that in the training-ship *Goliath*, already referred to, which was brought about by a boy letting fall a lamp which had been alight all night, and which was so hot that he could no longer hold it, appears to be primarily ascribable to the use of an oil of very high flashing point; and the accident at the Agricultural Hall furnished another illustration of the kind of danger attending the use of such an oil.

The character of the wick very materially affects not only the burning quality of the lamp, but also its safety. A loosely plaited wick of long staple cotton draws up the oil to the flame regularly and freely, and so long as the oil be not very heavy or of very high flashing point, and therefore difficultly volatisable or convertible into vapour (by so-called destructive distillation), the flame will continue to burn brightly and uniformly, with but little charring effect upon the wick—that is to say, the extremity of the latter will only be darkened and eventually charred to a distance of much less than a quarter of an inch downwards, and it will not be until the partial exhaustion of the oil-supply diminishes the size of the flame and induces the user to raise the wick, that the latter will become more considerably charred. But, if the wick be very tightly plaited, and made, as is not unfrequently the case, of a short staple cotton of inferior capillary power, the oil will be less copiously drawn up to the flame; as a consequence, the length of exposed wick will be increased by the user of the lamp, and as the evaporation of the oil will take place more slowly from each portion of the wick which furnishes the flame, the heat to which the cotton is exposed will be greater, and the charring, which is fatal to the proper feeding of the flame by destroying the porosity of the end of the wick, will take place more rapidly and to a much greater extent.

Even with wicks of the higher qualities, considerable differences exist in the rapidity with which the oil is raised to the flame. In Mr. Redwood's experiments, conducted with a specimen of English wick of good quality and with a very superior American wick, of corresponding dimensions, the quantity of oil siphoned over by the latter in a given time, was from 35 to 47 per cent. greater (according to the nature of oil experimented with) than that carried over by the English wick.

If the wick be at all damp when taken into use, its power of conveying the oil to the flame will be decidedly diminished, the capillaries of the fibre being more or less filled with moisture, and similarly, if the oil accidentally contain any water, the latter, passing into the wick, will interfere with the proper feeding of the flame. As the oil is very thoroughly filtered or strained during its transmission through the body of the wick to the flame. it is obvious that any impurities suspended in the liquid will be deposited within the wick and will gradually diminish its porosity. For this reason the same wick should not be used for a great length of time, and it is decidedly objectionable to use a much greater length of wick than is necessary to reach to the bottom of the reservoir, and to continue its use until it has become too greatly shortened by successive trimmings. On the other hand, the wick should always be of sufficient length to be immersed to a considerable distance in the oil. It is evident that the copious supply of oil to the flame will become reduced as the column of liquid which covers the wick in the reservoir becomes reduced in height; hence the supply of oil in the lamp should never be allowed to get very low, not only because it is undesirable to have a large air-space which may be filled with vapour and air, but also because the burning of the lamp is injuriously affected thereby.

Some lamps of patterns first constructed in the United States are provided with what may be called a feeding wick, in addition to the wick or wicks which furnish the flame. This wick is generally simply suspended from the lower surface of the burner, and reaches nearly to the bottom of the reservoir, being so placed that it hangs against one flat side of the regular wick, and thus aids considerably the copious and uniform absorption of oil by the latter. In certain lamps of recent construction the reservoir which contains the main supply of oil is so arranged (upon the principle of the old study- or Queen's oil-lamp) that it regularly maintains at a uniform level the supply of oil, which surrounds the wick in a small central reservoir or cylinder, separated from the main reservoir (excepting as regards a small channel of communication) by an air-space, which presents the additional advantage of preventing the transmission of heat to the oil vessel. This kind of lamp is constructed entirely of metal; this is the case now with a very large proportion of the lamps in use, and unquestionably adds greatly to the safety of lamps, which, if constructed of glass or porcelain, are always liable to accidental fracture, quite apart from the question of possible explosion.

It has been proved experimentally that if the reservoir of a burning lamp be warmed, so as to favour the emission of vapour into the space above the oil, and a small opening in the top of the reservoir be then uncovered, air will be drawn into the latter and form an explosive mixture with the vapour, which, escaping from the lamp close to the wick-holder, will be fired, and produce an explosion in the lamp. It is an interesting illustration of the very imperfect appreciation, by some lamp-designers, of the conditions which, in the construction of a lamp, secure safety or determine danger, that the reservoirs of some petroleum-lamps are actually furnished with an opening in the upper surface, which is closed with a more or less badly-fitting metal cap, and is intended to be used for filling the lamp with oil. Independently of the great element of danger which this fitting presents, in consequence of the obvious temptation to the users to replenish the reservoir while the lamp is actually burning, it is very likely sooner or later to be the means of admitting to the reservoir, in the manner above indicated, the supply of air necessary to determine the explosion of vapour therein existing.

Another source of danger introduced in the construction of lamps which should be sufficiently obvious, and to which reference was made when first discussing the causes of lamp explosions, consists in the provision in many lamps, of openings of considerable size close to the burner, apparently with the object of affording a passage for the air or vapour in the reservoir, which may expand as the lamp becomes somewhat warm. Other devices with the same object in view, consisting of small channels or shafts brought up from the top of the reservoir to the seat of the lamp flame, are adopted in some American lamps. If these openings or channels were protected, in accordance with the well-known principles which govern the construction of miners' safety lamps, so as to preclude the possibility of flame passing them, they would obviously be unobjectionable, and indeed in one or two instances of modern lamps the openings which have been provided for the escape of expanding air or vapour are of such dimensions that flame could not pass. A simple arrangement which would effect the desired object with perfect safety, and would at the same time protect the lamp wicks from deterioration by the grosser impurities sometimes contained in portions of a supply of oil, is to attach to the bottom of the burner a cylinder of wire gauze of the requisite fineness (twenty-eight meshes to the inch) which would contain the wicks, and would allow the passage of air or vapour through it towards the burner, while it would effectually prevent the transmission of fire from the lamp-flame to the air-space of the reservoir.

Some of the more prominent points elicited by the inquiry in progress, as to the causes of explosions in petroleum lamps, and the conditions which regulate their efficiency and safety, having now been noticed, it remains to offer a few simple suggestions, attention to which cannot but serve to reduce the risks of accident which attend the use of petroleum and paraffin oil :—

1. It is desirable that the reservoir of the lamp should be of metal. It should have no opening or feeding place in the reservoir, nor should there be any opening or channel of communication to the reservoir at or near the burner, unless protected by fine wire gauze, or packed with wire, or unless it is of a diameter not exceeding 0·04 inch.

2. The wick used should be of soft texture and loosely plaited ; it should fill the entire space of the wick-holder, and should not be so broad as to be compressed within the latter ; it should always be thoroughly dried before the fire, when required for use. The fresh wick or wicks should be but little longer than sufficient to reach to the bottom of the reservoir, and should never be immersed to a less depth than about one-third the total depth of the reservoir.

3. The reservoir or lamp should always be almost filled before use.

4. If it be desired to lower the flame of the lamp for a time, this should be carefully done, so as not to lower it beneath the metal work deeper than is absolutely necessary ; but it should be borne in mind that even then the combustion of the oil will be imperfect, and that vapour of unconsumed petroleum will escape, and render the lamp very unpleasant in a room.

5. When the lamp is to be extinguished, and is not provided with an extinguishing arrangement (of which many excellent forms are now applied to lamps) the flame should be lowered until there is only a flicker ; the mouth should then be brought to a level with the top of the chimney, and a sharp puff of breath should be projected *across* the opening. The lamp should remain on a firm support when it is being extinguished.

The lecturer hopes that, pending the more thorough treatment of this subject by Mr. Redwood and himself when these investigations are completed, the points dealt with in this discourse which relate to accidents with petroleum lamps may, on the one hand, tend to dispel groundless alarm as to the dangerous nature of petroleum and paraffin oil as illuminants, and may, on the other hand, serve to convey some useful information respecting the causes which lead to accidents with lamps and the readiness with which they may be avoided.

DR. KLEIN ON CHOLERA

AT a recent meeting of the Abernethian Society of St. Bartholomew's Hospital, Dr. Klein briefly reviewed the accepted theories as to the ætiology of cholera, and stated the views concerning it which he had been led to adopt since his visit to India. His address is of importance as embodying the conclusions of the Indian Commission of Inquiry into this disease. Two main theories are held with regard to the cholera —the one, which is supported by a large section of the Indian medical staff, being that cholera is non-infectious and non-communicable ; the other, which is upheld by European authorities, being that it is both infectious and communicable. In support of the former theory may be quoted the numerous cases of sporadic cholera which occur, and the fact that when troops are attacked in a military cantonment and are at once marched out into camp, no new cases occur other than those which are already incubating. Lastly, in many places in India, in spite of all conditions favourable to a spread of cholera by the evacuations, it is rare for any but sporadic cases to occur. In support of its communicability and infectiousness it is unquestionable that when an outbreak of cholera has occurred, it has in most instances been introduced from a district where cholera was rife, as instanced by the late outbreak at Marseilles, which was shown to have been introduced from Egypt. Some have maintained that it may be conveyed by winds ; against this may be adduced the fact that epidemics have occurred in Malta without any occurring at the same time in Gozo. Now, Gozo is nearer to Egypt than Malta, and yet no epidemic at Malta has ever been preceded by an epidemic at Gozo. The upholders of the theory of infectiveness are divided into two schools—the contagionists, who consider that the disease is directly communicable from the sick to the healthy, and that the virus is contained in the discharges from the alimentary canal ; and the localists, who believe that the evacuations contain a germ which is capable of elaborating the virus under suitable conditions of climate and soil. Against the contagionists' view must be considered especially these facts—that it is very rare for attendants to be attacked early, and that they only succumb at a late period of the epidemic ; and that cholera patients are treated in the general wards of a large hospital in Calcutta, and yet no cases of contagion have occurred. Dr. Koch, in studying this disease, found that the lower parts of the small intestine of patients who died from cholera swarmed with peculiar bacilli (comma bacilli), which passed out with the evacuations, and which he considered were capable of manufacturing the cholera virus when introduced into the small intestine of an unhealthy patient. He also believes that this bacillus is destroyed by the acid secretion of the stomach of a healthy person, and, further, that this bacillus is destroyed by drying ; and hence that this disease could not be propagated by soiled linen after this had been dried. The German Commission believes these bacilli to be the cause of the disease. Dr. Klein, by a series of experiments, has proved that these comma bacilli are not destroyed by an acid solution of the same strength as that of the gastric juice ; but that, on the contrary, they thrive after having been immersed in such a solution. Further, that though these bacilli, in common with all germs (except spores of bacilli), are destroyed by thorough and scientific drying, still soiled linen never becomes thoroughly dry. Klein thinks that even the location of these bacilli in the lower part of the small intestine should of itself suggest suspicion, inasmuch as bacilli and micrococci in great numbers are contained in it even in health, and the more because this locality is not the exclusive seat of the disease. More conclusive evidence, however, was collected by him in India. For instance, three of the houses situate in a certain street in Calcutta contained in all eight cases of cholera. Leading out of the street was a narrow lane to a large water-tank, around which was built a squalid rookery. The water of this tank was used in the rookery for all purposes, and contained the comma-bacilli. Now, the houses in the street were not supplied with water from the tank, and yet eight cases of cholera occurred in the square, while none were found in the rookery, which was inhabited by about 200 families. The English Cholera Commission has also found a bacillus apparently similar with the cholera-bacillus in the intestines of children and adults suffering from diarrhœa. Dr. Lewis, of Netley, has found the same in the saliva of healthy persons. With regard to the evacuations containing the virus, Dr. Klein found that in India many of the public-built wells were contaminated by sewage, and that the water, though nominally not used for drinking purposes, for expediency was generally so used, and especially at night time. Again, at Benares a large sewer opens into the Ganges at a spot where the pilgrims and natives perform their religious ablutions, these including especially the washing out of the mouth with the river water. In spite of this only sporadic cases of cholera occur. Dr. Klein has been led to the conclusion with regard to the cholera—that Koch's bacillus cannot be the cholera germ.

SCIENTIFIC SERIALS

American Journal of Science, March.—Prof. Marsh's monograph on the Dinocerata, by L. P. B. This valuable contribution to American palæontology forms a sequel to the author's