have made in my travels of a zone of almost perpetual electrical discharge in the belt of the "doldrums" all round the world.

Anywhere in that belt, a more or less intermittent display of sheet lightning commences the moment the twilight of sunset has sufficiently faded away, and continues with varying intensity till the light of morning prevents further observation.

The localisation of this belt of lightning is very obvious as we run a section across the equator on board ship. There is very little electrical discharge in the high-pressure belt of anticyclones which encircle the earth approximately under the lines of the tropics; but as we approach the low-pressure band of the "doldrums," where the two trade-winds, or the two monsoons meet, then the display of lightning is of nightly occurrence, even if there are no actual thunderstorms.

This electric discharge has a diurnal period like every other meteorological element; for night after night, as I have slept on deck in Malaysia during the change of the monsoons, I have noticed a very marked diminution of the lightning after 1 or 2 a.m. If a total eclipse of the sun could last for twelve hours, I have no doubt that we should see more or less lightning all the time, with a regular set of diurnal variations.

Edlung and others have noticed the gradual decrease in the frequency of thunderstorms as we recede from the equator; but I wish to show now, not only that the discharge is of nightly occurrence, but that the locality of maximum effect is not so much on the equator as in the "doldrums." The sheet lightning may be the reflection of distant thunderstorms, or it may be the silent discharge of electricity. Meteorologists are much divided as to the possibility of the latter; but it is certain that the amount of sheet lightning is out of all proportion to the frequency of actual thunderstorms.

Is it not possible that we may find in this perpetual lightning, some clue to the origin of earth-currents everywhere? and in the diurnal variation in the discharge, some probable reason for the hourly variation of the aurora, and of some magnetic elements? No doubt it is at present difficult to connect the electricity of lightning with the electro-magnetic effects of terrestrial magnetism or the aurora; and though Edlung's theory is defective in this respect, I cannot help thinking that he is right in collating thunderstorms on the equator with the glow discharge of electricity on the Arctic circle; and it is in the hope that the discovery of the constancy of electrical discharge in the "doldrums" may perhaps assist in the evolution of a true theory of the aurora, that I have penned this short notice.

RALPH ABERCROMBY

21 Chapel Street, London, March 15

Scorpion Virus

PROF. BOURNE'S experiments, related in the Proceedings of the Royal Society of January 6, 1887, seem to establish the fact that although the scorpion may be provoked to strike and wound itself or another scorpion, it is incapable, in either case, of causing any toxic action, however active the virus may prove in respect of other creatures. That it is, in short, with the scorpion as it is with the cobra or viper: they poison other creatures, but not themselves or each other.

Some years ago an exhaustive series of experiments brought me to the conclusion that a cobra is not poisoned by cobra virus, whether inoculated by its own fangs, by those of another cobra, or by a hypodermic syringe. The same in the case of daboia and other viperine snakes.

It seemed, however, that the bungarus, a less deadly snake than the cobra, occasionally is affected, though slowly, by the cobra virus, but that it escapes more frequently than it suffers; and when it does suffer the effect of the poison is greatly diminished. On the other hand, non-venomous snakes, lizards, frogs, fish, mollusca, and other low forms of life, all rapidly succumb to snake poison.

The details of these experiments are to be found in the "Thanatophidia of India," published in 1872, and in referring to them Prof. Bourne remarks: "They show conclusively that the cobra poison will not affect a cobra, and will not even affect the viperine ptyas." I would correct the latter part of the quotation so far as to say that the ptyas is a colubrine harmless snake, not a viperine snake, and that it rapidly succumbs to the cobra virus.

Prof. Bourne has helped to dispel another of the popular delusions which cling round venomous creatures.

March 14 J. FAYRER

THE RELATION OF TABASHEER TO MINERAL SUBSTANCES

MR. THISELTON DYER has rendered a great service, not only to botanists, but also to physicists and mineralogists, by recalling attention to the very interesting substance known as "tabasheer" (NATURE, vol. xxxv. p. 396). As he truly states, very little fresh information has been published on the subject during recent years, a circumstance for which I can only account by the fact that botanists may justly feel some doubt as to whether it belongs to the vegetable kingdom, while mineralogists seem to have equal ground for hesitation in accepting it as a member of the mineral kingdom.

It is very interesting to hear that so able a physiologist as Prof. Cohn intends to investigate the conditions under which living plants separate this substance from their tissues. That unicellular Algæ, like the Diatomaceæ, living in a medium which may contain only one part in 10,000 by weight of dissolved silica, or even less than that amount, should be able to separate this substance to form their exquisitely ornamented frustules is one of the most striking facts in natural history, whether we regard it in its physiological or its chemical aspects.

Sir David Brewster long ago pointed out the remarkable physical characters presented by the curious product of the vegetable world known as "tabasheer," though so far as I can find out it has not in recent years received that attention from physicists which the experiments and observations of the great Scotch philosopher show it to be worthy of.

Tabasheer seems to stand in the same relation to the mineral kingdom as do ambers and pearls. It is in fact an *opal* formed under somewhat remarkable and anomalous conditions which we are able to study; and in this aspect I have for some time past been devoting a considerable amount of attention to the minute structure of the substance by making thin sections and examining them under the microscope. It may be as well, perhaps, to give a short sketch of the information upon the subject which I have up to the present time been able to obtain, and in this way to call attention to points upon which further research seems to be necessary.

From time immemorial tabasheer has enjoyed a very high reputation in Eastern countries as a drug. Its supposed medicinal virtues, like those of the fossil teeth of China and the belemnites ("thunderbolts") of this country, seem to have been suggested by the peculiarity of its mode of occurrence. A knowledge of the substance was introduced into Western Europe by the Arabian physicians, and the name by which the substance is generally known is said to be of Arabic origin. Much of the material which under the name of "tabasheer" finds its way to Syria and Turkey is said, however, to be fictitious or adulterated.

In 1788 Dr. Patrick Russell, F.R.S., then resident at Vizagapatam, wrote a letter to Sir Joseph Banks in which he gave an account of all the facts which he had been able to collect with respect to this curious substance and its mode of occurrence, and his interesting letter was published in the Philosophical Transactions for 1790 (vol. lxxx. p. 273).

Tabasheer is said to be sometimes found among the ashes of bamboos that have been set on fire (by mutual friction?). Ordinarily, however, it is sought for by splitting open those bamboo stems which give a rattling sound when shaken. Such rattling sounds do not, however, afford infallible criteria as to the presence or absence of tabasheer in a bamboo, for where the quantity is small it is often found to be closely adherent to the bottom and sides of the cavity. Tabasheer is by no means found in all stems or in all joints of the same stem of the bamboos. Whether certain species produce it in greater abundance than others, and what is the influence of soil, situation, and season upon the production of the substance are questions which do not seem as yet to have been accurately investigated.

Dr. Russell found that the bamboos which produce tabasheer often contain a fluid, usually clear, transparent, and colourless or of greenish tint, but sometimes thicker and of a white colour, and at other times darker and of the consistency of honey. Occasionally the thicker varieties were found passing into a solid state, and forming tabasheer.

Dr. Russell performed the interesting experiment of drawing off the liquid from the bamboo-stem and allowing it to stand in stoppered bottles. A "whitish, cottony sediment" was formed at the bottom with a thin film of the same kind at the top. When the whole was well shaken together and allowed to evaporate, it left a residue of a whitish-brown colour resembling the inferior kinds of tabasheer. By splitting up different joints of bamboo Dr. Russell was also able to satisfy himself of the gradual deposition within them of the solid tabasheer by the evaporation of the liquid solvent.

In 1791, Mr. James Louis Macie, F.R.S. (who afterwards took the name of Smithson), gave an account of his examination of the properties of the specimens of tabasheer sent home by Dr. Russell (Phil. Trans. vol. lxxxi., 1791, p 368). These specimens came from Vellore, Hydrabad, Masulipatam, and other localities in India. They were submitted to a number of tests which induced Mr. Macie to believe that they consisted principally of silica, but that before calcination some vegetable matter must have been present. A determination of the specific gravity of the substance by Mr. Macie gave 2·188 as the result; another determination by Mr. Cavendish gave 2·169.

In this same paper it is stated that a bamboo grown in a hot-house at Islington gave a rattling noise, and on being split open by Sir Joseph Banks yielded, not an ordinary tabasheer, but a small pebble about the size of half a pea, externally of a dark brown or black colour, and within of a reddish-brown tint. This stone is said to have been so hard as to cut glass, and to have been in parts of a crystalline structure. Its behaviour with reagents was found to be different in many respects from that of the ordinary tabasheer; and it was proved to contain silica and iron. The specimen is referred to in a letter to Berthollet published in the *Annales de Chimie* for the same year (October 1791). There may be some doubt as to whether this specimen was really of the nature of tabasheer; if such were the case, it would seem to have been a tabasheer in which a crystalline structure had begun to be set up.

In the year 1806, MM. Fourcroy and Vauquelin gave an account of a specimen of tabasheer brought from South America in 1804 by Humboldt and Bonpland (*Mém. de l'Inst.*, vol. vi. p. 382). It was procured from a species of bamboo growing on the west of Pichincha, and is described as being of a milk-white colour, in part apparently crystalline in structure, and in part semi-transparent and gelatinous. It was seen to contain traces of the vegetable structure of the plant from which it had been extracted. On ignition it became black, and emitted pungent fumes.

An analysis of this tabasheer from the Andes showed that it contained 70 per cent. of silica, and 30 per cent. of potash, lime, and water, with some organic matter. It would, perhaps, be rash to conclude from this single observation that the American bamboo produced tabasheer of different composition from that of the Old World; but the subject is evidently one worthy of careful investigation.

It was in the year 1819 that Sir David Brewster published the first account of his long and important series of observations upon the physical peculiarities of tabasheer (Phil. Trans., vol. cix., 1819, p. 283). The specimens which he first examined were obtained from India by Dr. Kennedy, by whom they were given to Brewster.

Brewster found the specimens which he examined to be perfectly *isotropic*, exercising no influence in depolarising light. When heated, however, it proved to be remarkably *phosphorescent*. The translucent varieties were found to transmit a yellowish and to reflect a bluish-white light—or, in other words, to exhibit the phenomenon of *opalescence*. When tabasheer is slightly wetted, it becomes white and opaque; but when thoroughly saturated with water, perfectly transparent.

By preparing prisms of different varieties of tabasheer, Brewster proceeded to determine its refractive index, arriving at the remarkable result that tabasheer "has a lower index of refraction than any other known solid or liquid, and that it actually holds an intermediate place between water and gaseous bodies!" This excessively low refractive power Brewster believes to afford a complete explanation of the extraordinary behaviour exhibited by tabasheer when wholly or partially saturated with fluids. A number of interesting experiments were performed by saturating the tabasheer with oils of different refractive powers, and by heating it in various ways and under different conditions, and also by introducing carbonaceous matter into the minute pores of the substance by setting fire to paper in which fragments were wrapped.

The mean of experiments undertaken by Mr. James Jardine, on behalf of Brewster, for determining the specific gravity of tabasheer, gave as a result 2·235. From these experiments Brewster concluded that the space occupied by the pores of the tabasheer is about two and a half times as great as that of the colloid silica itself!

From this time forward Brewster seems to have manifested the keenest interest in all questions connected with the origin and history of a substance possessing such singular physical properties. By the aid of Mr. Swinton, Secretary to the Government at Calcutta, he formed a large and interesting collection of all the different varieties of tabasheer from various parts of India. He also obtained specimens of the bamboo with the tabasheer *in situ*. In 1828 he published an interesting paper on "the Natural History and Properties of Tabasheer" (*Edinburgh Journal of Science*, vol. viii., 1828, p. 288), in which he discussed many of the important problems connected with the origin of the substance. From his inquiries and observations, Brewster was led to conclude that tabasheer was only produced in those joints of bamboos which are in an injured, unhealthy, or malformed condition, and that the siliceous fluid only finds its way into the hollow spaces between the joints of the stem when the membrane lining the cavities is destroyed or rent by disease.

Prof. Edward Turner, of the University of London, undertook an analysis of tabasheer, the specimens being supplied from Brewster's collection (*Edinburgh Journal of Science*, vol. viii., 1828, p. 335). His determinations of the specific gravities of different varieties were as follows:—

Chalky tabasheer	2·189
Translucent tabasheer	2·167
Transparent tabasheer	2·160

All the varieties lose air and hygroscopic water at 100° C., and a larger quantity of water and organic matter (indicated by faint smoke and an empyreumatic odour) at a red heat. The results obtained were as follows:—

	Loss at 100° C.	Loss at red heat
Chalky tabasheer	0·838 per cent.	1·277 per cent.
Translucent tabasheer	1·620 ,, ,,	3·840 ,, ,,
Transparent tabasheer	2·411 ,, ,,	4·518 ,, ,,

Dr. Turner found the ignited Indian tabasheer to consist almost entirely of pure silica with a minute quantity of lime and vegetable matter. He failed to find any trace of alkalies in it.

In 1855, Guibourt (*Journ. de Pharm.* [3], xxvii. 81, 161, 252; *Phil. Mag.* [4], x. 229) analysed a specimen of tabasheer having a specific gravity of 2·148. It gave the following result:—

Silica	=	96·94
Potash and lime	=	0·13
Water	=	2·93
Organic matter	=	trace

Guibourt criticised some of the conclusions arrived at by Brewster, and sought to explain the source of the silica by studying the composition of different parts of the bamboo. While the ashes of the wood contained 0·0612 of the whole weight of the wood, the pith was found to contain 0·448 per cent., the inner wood much less, and the greatest proportion occurred in the external wood. On these determinations Guibourt founded a theory of the mode of formation of tabasheer based on the suggestion that at certain periods of its growth the bamboo needed less silica than at other times, and that when not needed, the silica was carried inwards and deposited in the interior.

In the year 1857, D. W. Rost van Tonningen, of Buitenzorg, undertook an investigation of the tabasheer of Java, which is known to the natives of that island under the name of "singkara" (*Naturkundig Tijdschrift voor Nederlandsch Indie*, vol. xiii., 1857, p. 391). The specimens examined were obtained from the *Bambusa apus* growing in the Residency of Bantam; it is described as resembling in appearance the Indian tabasheers. Its analysis gave the following result:—

Silica	=	86·387
Iron oxide	=	0·424
Lime	=	0·244
Potash	=	4·806
Organic matter	=	0·507
Water	=	7·632
Total ...		100·000

Apart from the question of its singular mode of origin, however, and its remarkable and anomalous physical properties, tabasheer is of much interest to mineralogists and geologists. All the varieties hitherto examined, with the exception of the peculiar one from the Andes, are in composition and physical characters true opals; this is the case with all the Indian and Java varieties. They consist essentially of silica in its colloidal form, the water, lime, potash, and organic matter being as small and variable in amount as in the mineral opals; and, as in them, these substances must be regarded merely as mechanical impurities.

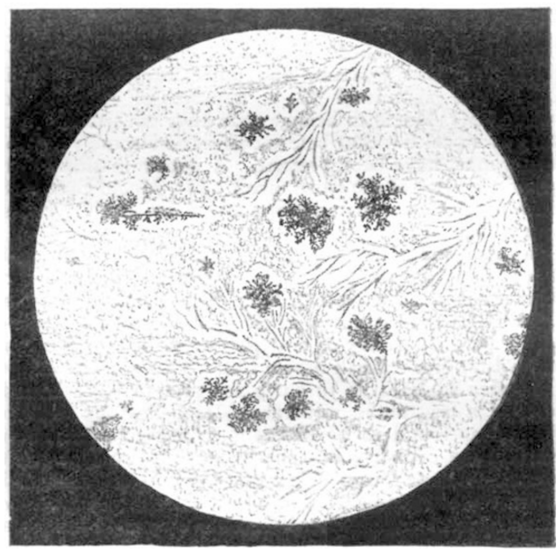
The tabasheers must be studied in their relations on the one hand with certain varieties of the natural semi-opals, hydrophanes, beekites, and floatstones, some of which they closely resemble in their physical characters, and on the other hand with specimens of artificially deposited colloid silica formed under different conditions. Prof. Church, who has so successfully studied the beekites, informs me that some of those remarkable bodies present singular points of analogy with tabasheer.

By the study of thin sections I have, during several years, been endeavouring to trace the minute structure of some of these substances. In no class of materials is it more necessary to guard one's self against errors of observation arising from changes induced in the substance during the operations which are necessary to the preparation of transparent sections of hard substances. Unfortunately, too, it is the custom of the natives to prepare the substance for the market by an imperfect calcination, and hitherto I have only been able to study specimens procured in the markets which have been subjected to this process. It is obviously desirable, before attempting to interpret the structures exhibited under the microscope, to compare the fresh and uncalcined materials with those that have been more or less altered by heat.

Tabasheer would seem, from Brewster's experiments, to be a very intimate admixture of two and a half parts of air with one part of colloidal silica. The interspaces filled with air appear, at all events in most cases, to be so minute that they cannot be detected by the highest powers of the microscope which I have been able to employ. It is this intimate admixture of a solid with a gas which probably gives rise to the curious and anomalous properties exhibited by this singular substance.

The ultra-microscopical vesicles filled with air in all probability give rise to the opalescence which is so marked a property of the substance. Their size is such as to scatter and throw back the rays at the blue end of the spectrum and to transmit those at the red end.

When the vesicles of the substance are filled with Canada balsam, and a thin slice is cut from it, this opalescence comes out in the most striking manner; very thin sections are of a rich orange-yellow by transmitted light, and a delicate blue tint by reflected light.



Section of Indian tabasheer, seen with a magnifying power of 250 diameters.

I do not know of any substance which in such thin films displays such striking opalescence.

That the excessively low refractive power of tabasheer is connected with the mechanical admixture of the colloidal silica with air seems to be proved by the experiments of Brewster, showing that with increase of density there was an increase in the refractive index, from 1·111 in specimens of the lowest specific gravity, to 1·182 in those of the highest specific gravity. Where the surface was hard and dense, Brewster found the refractive index to approach that of semi-opal. The wonderful thing is that a substance so full of cavities containing gas should nevertheless be transparent.

By the kindness of Mr. F. Rutley, F.G.S., I am able to supply a drawing taken from one of my sections of tabasheer.

The accompanying woodcut gives some idea of the interesting structures exhibited in some sections of tabasheer, though much of the delicacy and fidelity of the original drawing has been lost in transferring it to the wood.

In this particular case, the faint punctation of the surface may possibly indicate the presence of air-vesicles of a size sufficiently great to be visible under the microscope. But in many other instances I have failed to detect any such indication, even with much higher powers. The small ramifying tubules might at first sight be taken for some traces of a vegetable tissue, but my colleague Dr. Scott assures me that they do not in the least resemble any tissue found in the bamboo. I have myself no doubt that it is an inorganic structure. It is not improbably analogous to the peculiar ramifying tubules formed in a solution of water-glass when a crystal of copper sulphate is suspended in it, as shown by Dr. Heaton (Proc. Brit. Assoc., 1869, p. 127). Similar forms also occur on a larger scale in some agates, and the artificial cells of Traube may probably be regarded as analogous phenomena.

The aggregates of globular bodies seen in the section so greatly resemble the globulites of slags and natural glasses, and in their arrangement so forcibly recall the structures seen in the well-known pitchstone of Corriegills in Arran, that one is tempted to regard them as indicating the beginnings of the development of crystalline structure in the tabasheer. But I have good grounds for believing the structure to have a totally different origin. They seem in fact to be the portions of the mass which the fluid Canada balsam has not succeeded in penetrating. By heating they may be made to grow outwards, and as more balsam is imbibed they gradually diminish, and finally disappear.

I must postpone till a future occasion a discussion of all the structures of this remarkable substance and of the resemblances and differences which they present to the mineral opals on the one hand, and to those of the opals of animal origin found in sponge spicules, radiolarians, and the rocks formed from them, some of which have recently been admirably investigated by Dr. G. J. Hinde (Phil. Trans., 1885, pp. 425–33).

I cannot, however, but think that it would be of the greatest service to botanists, physicists, and mineralogists alike, if some resident in India would resume the investigations so admirably commenced by Dr. Patrick Russell nearly a century ago; and it is in the hope of inducing someone to undertake this task that I have put together these notes. There are certain problems with regard to the mode of occurrence of this singular substance which could only be solved by an investigator in the country where it is found.

Most parcels of the commercial tabasheer appear to contain different varieties, from the white, opaque, chalk-like forms, through the translucent kinds to those that are perfectly transparent. It would be of much interest if the exact relation and modes of origin of these different varieties could be traced. It would also be important to determine if Brewster was right in his conclusion that the particular internodes of a bamboo which contain tabasheer always have their inner lining tissue rent or injured. The repetition of Dr. Russell's experiment of drawing off the liquids from the joints of bamboos and allowing them to evaporate is also greatly to be desired. My colleague Prof. Rücker, F.R.S., has kindly undertaken to re-examine the results arrived at by Brewster in the light of more recent physical investigations, and I doubt not that some of the curious problems suggested by this very remarkable substance may ere long find a solution.

JOHN W. JUDD

EXHIBITION OF MARINE METEOROLOGICAL INSTRUMENTS

THE eighth Annual Exhibition of the Royal Meteorological Society was held in the Library of the Institution of Civil Engineers, 25 Great George Street, Westminster, from Tuesday, March 15th, to Friday, the 18th. The exhibition was specially devoted to marine meteorological instruments and apparatus, and such new instruments as have been invented and first constructed during the past twelve months.

A very interesting and valuable collection of instruments from the *Challenger* Commission, the Scottish Marine Station at Granton, the Scottish Meteorological Society, and Mr. J. Y. Buchanan, were brought from Edinburgh under the charge of Dr. H. R. Mill, who showed several in action. This set included various forms of deep-sea thermometers, from the early pattern of the Miller-Casella to the Scottish frame for Negretti and Zambra's reversing thermometer, which has been adapted from Magnaghi's by Dr. Mill. Two specimens of the Miller-Casella thermometer, after four months' immersion in brackish water, were shown, with the following results: in No. 1, which was placed at the surface, the copper case was clean, but the scale figures were entirely obliterated from the porcelain; in No. 2, which was suspended in 9 fathoms, and at 1 foot above the bottom, the copper was entirely covered with a green crust, but the scale figures were not rendered illegible. Various forms of piezometers for ascertaining the depth when the temperature is known, or the temperature when the depth is known, were also exhibited. These were nearly all constructed by Mr. Buchanan on board the *Challenger*. Water-bottles for obtaining samples of water at the bottom, or any required depth below the surface, were suspended from the gallery to show their action when in use. The most interesting were Buchanan's sounding-rod and water-bottle for great depths, and Mill's self-locking slip water-bottle for moderate depths.

The Meteorological Council contributed sets of instruments as supplied to merchant ships and the Royal navy; the Royal Meteorological Institute of the Netherlands exhibited a set as supplied to the Dutch navy; and the Deutsche Seewarte sent a set as issued to the German navy.

The Rev. C. J. Steward exhibited a set of instruments as used at the Lochbuie Marine Institute, Isle of Mull, which, among others, included a dimenuion thermometer in a box for river temperatures, the box being suitable for the bottoms of pools, or rough stony bottoms; and a large disk for ascertaining the transparency of the sea.

In connexion with the deep-sea thermometers Mr. Casella showed some apparatus originally employed in testing these instruments for the Admiralty and the Royal Society, and damaged during the experiments; viz., a bottle broken at a pressure corresponding to $2\frac{1}{2}$ miles of sea-water, a steel bar bent at 3 miles, and an iron plug broken at 4 miles. Specimens of almost every pattern of deep-sea thermometer were exhibited, including Johnson's registering metallic, the records of which are obtained by the varying expansion of brass and steel bars acting upon indices; Miller-Casella maximum and minimum; and Negretti and Zambra's turnover thermometer.

The barometers exhibited included patterns used in the British, Dutch, French, and German navies. The English marine barometer has an iron cistern and contracted scale, and the gun barometer is mounted with india-rubber packing to prevent breakage caused by gun-firing. MM. Richard Frères, of Paris, sent one of their self-recording aneroids, for use on board ship; and Mr. Abercromby showed several curves taken at sea by one of these instruments in various parts of the world.

The anemometers shown were: Sir Snow Harris's, which is an improved form of Lind's; Hagemann's, Robinson's, Black's pressure, and Whipple's maximum pressure, the latter being quite a new instrument. Dr. Black exhibited his marine rain-gauge and evaporator. Among the miscellaneous instruments were various forms of patent logs, current meters, clinometers, and a model of a section of a vessel fitted with lightning conductor.

In addition to the instruments, a number of charts