VI. Experiments and observations on certain stony and metalline substances which at different times are said to have fallen on the earth; also on various kinds of native iron

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* * Repeated experiments of the above invention were made by the committee; from the result of which it appeared to possess some advantages over the common wheel, and to have a greater power of action.

Description of the late Mr. Besant's Water-wheel. (Plate I. fig. 2 and 3)

A, (fig. 2.) the body of the water-wheel, which is hollow in the form of a drum, and is so constructed as to be proof against the admission of water within it.

B, the axis on which it turns.

C, the float-boards, placed on the periphery of the wheel. Each board is obliquely fixed firm to the rim of it, and to the body of the drum.

D, the reservoir, containing the water.

E, the penstock, which regulates the quantity of water running to the wheel.

F, the current of water which has passed the wheel.

Fig. 3 is a front view of the water-wheel, showing the oblique direction in which the float-boards, C, are placed on the face of the wheel.

VI. *Experiments and Observations on certain Stony and Metalline Substances which at different Times are said to have fallen on the Earth; also on various Kinds of Native Iron.* By EDWARD HOWARD, Esq. F.R.S.*

THE concordance of a variety of facts seems to render it most indisputable, that certain stony and metalline substances have, at different periods, fallen on the earth. Whence their origin, or whence they came, is yet, in my judgment, involved in complete obscurity.

The accounts of these peculiar substances, in the early annals, even of the Royal Society, have unfortunately been blended with relations which we now consider as fabulous; and the more antient histories of stones fallen from heaven, from Jupiter, or from the clouds, have evidently confounded such substances with what have been termed *ceraunia*, *bætilia*, *ombria*, *brontia*, &c. names altogether unappropriate to substances fallen on our globe. Indeed some mislead, and others are inexpressive.

The term *ceraunia*, by a misnomer, deduced from its supposed origin, seems, as well as *bætilia* †, to have been an-

* From the *Transactions of the Royal Society of London* for 1802.

† Mercati, *Metallotheca Vaticana*, p. 241.

tiently used to denote many species of stones, which were polished and shaped into various forms, though mostly wedge-like or triangular, sometimes as instruments, sometimes as oracles, and sometimes as deities. The import of the names *ombria*, *brontia*, &c. seems subject to the same uncertainty.

In very early ages it was believed that stones did in reality fall, as it was said, from heaven, or from the gods; these, either from ignorance, or perhaps from superstitious views, were confounded with other stones, which, by their compact aggregation, were better calculated to be shaped into different instruments, and to which it was convenient to attach a species of mysterious veneration. In modern days, because explosion and report have generally accompanied the descent of such substances, the name of thunderbolt, or thunderstone, has ignorantly attached itself to them; and because a variety of substances accidentally present near buildings and trees struck with lightning have, with the same ignorance, been collected as thunderbolts, the thunderbolt and the fallen metalline substance have been ranked in the same class of absurdity. Certainly, since the phenomena of lightning and electricity have been so well identified, the idea of a thunderbolt is ridiculous. But the existence of peculiar substances fallen on the earth, I cannot hesitate to assert; and on the concordance of remote and authenticated facts I shall rest the assertion.

Mr. King, the learned author of "Remarks concerning Stones said to have fallen from the Clouds, in these Days, and in antient Times," has adduced quotations of the greatest antiquity, descriptive of the descent of fallen stones; and, could it be thought necessary to add antique testimonies to those instanced by so profound an antiquarian, the quotations of Monf. Falconet, in his papers upon *œtilia*, inserted in the *Histoire des Inscriptions et Belles-Lettres**; the quotations in Zahn's *Specula Physico-mathematica Historiana*†: the *Fisica Sotterranea* of Giacinto Gemma; the works of Pliny, and others, might be referred to.

Dr. Chladni, in his "Observations on the Masses of Iron found in Siberia, and on other Masses of the like Kind," as well as in his "Observations on Fire-balls and hard Bodies fallen from the Atmosphere," has collected almost every modern instance of phenomena of this nature.

Mr. Southey relates an account, juridically authenticated, of a stone weighing ten pounds which was heard to fall in

* Tom. vi. p. 319, et tom. xxiii. p. 228.

† Fol. 1696, vol. i. p. 385, where a long enumeration of stones fallen from the sky is given.

Portugal Feb. 19, 1796, and was taken, still warm, from the ground †.

The first of these peculiar substances with which chemistry has interfered, was the stone presented by the abbe Bachelay to the Royal French Academy. It was found on the 13th of Sept. 1768, yet hot, by persons who saw it fall. It is described as follows †:

“ The substance of this stone is of a pale ash-gray colour; when examined with a magnifying glass, it is found to be interspersed with a multitude of small brilliant metallic points of a pale yellow colour; its exterior surface, that which, according to the abbé Bachelay, was not engaged in the earth, was covered with a small and very thin stratum of a blackish matter, puffed up in some places, and which appeared to have been fused. This stone, when the interior of it was struck with steel, produced no sparks: on the other hand, when struck on the thin external stratum, which appeared to have been attacked by fire, some few sparks were elicited.”

The specific gravity of this stone was as 3535 to 1000.

The academicians analysed the stone, and found it to contain

Sulphur	-	-	8 $\frac{1}{2}$
Iron	-	-	36
Vitrifiable earth	-	-	55 $\frac{1}{2}$
			100

Of their mode of analysis, I shall have occasion to speak hereafter. They were induced to conclude, that the stone, presented to the academy by the abbé Bachelay, did not owe its origin to thunder; that it did not fall from heaven; that it was not formed by mineral substances, fused by lightning; and that it was nothing but a species of pyrites, without peculiarity, except as to the hepatic smell disengaged from it by marine acid. “ That this stone, which was, perhaps, covered by a small stratum of earth or turf, may have been struck with lightning, and thus uncovered: the heat may have been sufficiently great to fuse the surface of the part struck, but it may not have been long enough continued to be able to penetrate to the inside: on this account, the stone has not been decomposed. The quantity of metallic matters it contains, opposing less resistance than another body to the current of the electric matter, may perhaps have contributed to determine the direction of the lightning.”

The memoir is however concluded, by observing it to be

* Letters written during a short Residence in Spain and Portugal, page 239.

† Here, and in the two following quotations, Mr. Howard gives the original words of the author: we have substituted faithful translations.—
EDIT.

sufficiently

sufficiently singular, that M. Morand le fils had presented a fragment of a stone, from the environs of Coutances, also said to have fallen from heaven, which only differed from that of the abbé Bachelay because it did not exhale the hepatic smell with spirit of salt. Yet the academicians did not think any conclusion could be drawn from this resemblance, unless that the lightning had fallen by preference on pyritical matter*.

Monf. Barthold, professeur à l'école centrale du Haut-Rhin, gave, I believe, the next, and last †, analytical account of what he also denominates *pierre de tonnerre*. He describes it thus:—"The mass of stone known under the name of *pierre de tonnerre d'Ensisheim*, weighing about two quintals, has its exterior form rounded, almost oval, is rugged, and of a dull earthy appearance.

"The ground of the stone is of a blueish gray colour interperfered with insulated crystals of pyrites, the crystallization of which is confused, in some places scaly, accumulated, forming nodes and small veins, which traverse it in every direction: the pyrites is of a golden colour: polishing gives it the splendour of steel, and, when exposed to the atmosphere, it becomes tarnished and brown. One may distinguish also with the naked eye gray scaly iron ore, not sulphureous, susceptible of being attracted by the magnet, little oxidated, or approaching much to the metallic state.

"The fracture is irregular, granulated, of a grain somewhat compact: in the inside very small fissures are seen. It does not strike fire with steel: its texture is so soft, that it readily suffers itself to be attacked by a knife. By pounding, it is easily reduced to a blueish gray powder of an earthy odour. Sometimes there are found small crystals of iron ore, which present a greater resistance to the blows of the stamper."

The specific gravity of the piece in professor Barthold's possession was 3233, distilled water being taken at 1000.

The analysis of M. Barthold, of which I shall also have occasion to speak hereafter, gave in the 100,

Sulphur	-	-	2
Iron	-	-	20
Magnesia	-	-	14
Alumina	-	-	17
Lime	-	-	2
Silica	-	-	42

97.

* See *Journal de Physique*, tom. ii. p. 251.

† A very interesting detail of a meteor, and of stones fallen in July 1790, was given by professeur Baudin in the *Magazin für das Neue aus der Physik*, by professeur Voigt.

From

From the external characters, and from his analysis, the professor considers the stone of Ensisheim to be argillo-ferruginous; and is of opinion, that ignorance and superstition have attributed to it a miraculous existence, at variance with the first notions of natural philosophy*.

The account next in succession is already printed in the Transactions of the Royal Society; but cannot be omitted, as it immediately relates to one of the substances I have examined. I allude to the letter received by Sir William Hamilton from the earl of Bristol, dated from Sienna, July 12, 1794:—"In the midst of a most violent thunder-storm, about a dozen stones, of various weights and dimensions, fell at the feet of different persons, men, women, and children. The stones are of a quality not found in any part of the Siennese territory: they fell about eighteen hours after the enormous eruption of mount Vesuvius; which circumstance leaves a choice of difficulties in the solution of this extraordinary phenomenon. Either these stones have been generated in this igneous mass of clouds, which produced such unusual thunder; or, which is equally incredible, they were thrown from Vesuvius, at a distance of at least 250 miles; judge then of its parabola. The philosophers here incline to the first solution. I wish much, Sir, to know your sentiments. My first objection was to the fact itself; but of this there are so many eye witnesses, it seems impossible to withstand their evidence." (Phil. Trans. for 1795, p. 103.) Sir William Hamilton, it seems, also received a piece of one of the largest stones, which weighed upwards of five pounds; and had seen another which weighed about one. He likewise observed, that the outside of every stone which had been found, and had been ascertained to have fallen from the clouds near Sienna, was evidently freshly vitrified, and was black, having every sign of having passed through an extreme heat; the inside was of a light gray colour, mixed with black spots and some shining particles, which the learned there had decided to be pyrites.

In 1796 a stone weighing 56 pounds was exhibited in London, with several attestations of persons who, on the 13th of December 1795, saw it fall, near Wold Cottage, in Yorkshire, at about three o'clock in the afternoon. It had penetrated through twelve inches of soil and six inches of solid chalk rock; and, in burying itself, had thrown up an immense quantity of earth to a great distance: as it fell, a number of explosions were heard, about as loud as pistols.

* See *Journal de Physique*, Ventose, an. 8, p. 169.

In the adjacent villages, the sounds heard were taken for guns at sea; but, at two adjoining villages, were so distinct of something singular passing through the air, towards the habitation of Mr. Topham, that five or six people came up to see if any thing extraordinary had happened to his house or grounds. When the stone was extracted, it was warm, smoked, and smelt very strong of sulphur. Its course, as far as could be collected from different accounts, was from the south-west. The day was mild and hazy, a sort of weather very frequent in the Wold hills, when there are no winds or storms; but there was not any thunder or lightning the whole day. No such stone is known in the country. There was no eruption in the earth; and, from its form, it could not come from any building; and, as the day was not tempestuous, it did not seem probable that it could have been forced from any rocks, the nearest of which are those of Flamborough Head, at a distance of twelve miles*. The nearest volcano I believe to be Hecla in Iceland.

The exhibition of this stone as a sort of show, did not tend to accredit the account of its descent, delivered in a hand-bill at the place of exhibition; much less could it contribute to remove the objections made to the fall of the stones presented to the Royal French Academy. But the right hon. President of the Royal Society, ever alive to the interest and promotion of science, observing the stone so exhibited to resemble a stone sent to him as one of those fallen at Sienna, could not be misled by prejudice: he obtained a piece of this extraordinary mass, and collected many references to descriptions of similar phenomena. At length, in 1799, an account of stones fallen in the East Indies was sent to the president by John Lloyd Williams, esq. which, by its unquestionable authenticity, and by the striking resemblance it bears to other accounts of fallen stones, must remove all prejudice. Mr. Williams has since drawn up the following more detailed narrative of facts.

Account of the Explosion of a Meteor near Benares, in the East Indies; and of the Falling of some Stones at the same Time, about 14 Miles from that City. By John Lloyd Williams, Esq. F. R. S.

A circumstance of so extraordinary a nature as the fall of stones from the heavens could not fail to excite the wonder and attract the attention of every inquisitive mind.

Among a superstitious people, any preternatural appearance is viewed with silent awe and reverence: attributing the

* Extracted from the printed paper delivered at the place of exhibition.
causes

causes to the will of the Supreme Being, they do not presume to judge the means by which they were produced, nor the purposes for which they were ordered; and we are naturally led to suspect the influence of prejudice and superstition in their descriptions of such phænomena: my inquiries were therefore chiefly directed to the Europeans, who were but thinly dispersed about that part of the country.

The information I obtained was, that on the 19th of December 1798, about eight o'clock in the evening, a very luminous meteor was observed in the heavens, by the inhabitants of Benares and the parts adjacent, in the form of a large ball of fire; that it was accompanied by a loud noise resembling thunder; and that a number of stones were said to have fallen from it near Krakhut, a village on the north side of the river Goomty, about 14 miles from the city of Benares.

The meteor appeared in the western part of the hemisphere, and was but a short time visible: it was observed by several Europeans, as well as natives, in different parts of the country.

In the neighbourhood of Juanpoor, about twelve miles from the spot where the stones are said to have fallen, it was very distinctly observed by several European gentlemen and ladies; who described it as a large ball of fire, accompanied with a loud rumbling noise, not unlike an ill-discharged platoon of musketry. It was also seen, and the noise heard, by various persons at Benares. Mr. Davis observed the light come into the room where he was, through a glass window, so strongly as to project shadows from the bars between the panes, on a dark coloured carpet, very distinctly; and it appeared to him as luminous as the brightest moonlight.

When an account of the fall of the stones reached Benares, Mr. Davis, the judge and magistrate of the district, sent an intelligent person to make inquiry on the spot. When the person arrived at the village near which the stones were said to have fallen, the natives, in answer to his inquiries, told him, that they had either broken to pieces, or given away to the *teffeldar* (native collector) and others, all that they had picked up; but that he might easily find some in the adjacent fields, where they would be readily discovered (the crops being then not above two or three inches above the ground) by observing where the earth appeared recently turned up. Following these directions, he found four, which he brought to Mr. Davis: most of these the force of the fall had buried, according to a measure he produced, about six inches deep, in fields which seemed to have been recently watered; and
it

it appeared, from the man's description, that they must have lain at the distance of about a hundred yards from each other.

What he further learnt from the inhabitants of the village concerning the phænomenon was, that about eight o'clock in the evening, when retired to their habitations, they observed a very bright light, proceeding as from the sky, accompanied with a loud clap of thunder, which was immediately followed by the noise of heavy bodies falling in the vicinity. Uncertain whether some of their deities might not have been concerned in this occurrence, they did not venture out to inquire into it until the next morning; when the first circumstance which attracted their attention was the appearance of the earth being turned up in different parts of their fields as before mentioned, where, on examining, they found the stones.

The assistant to the collector of the district, Mr. Erskine, a very intelligent young gentleman, on seeing one of the stones, brought to him by the native superintendant of the collections, was also induced to send a person to that part of the country to make inquiry; who returned with several of the stones, and brought an account similar to that given by the person sent by Mr. Davis, together with a confirmation of it from the cauzy, (who had been directed to make the inquiry,) under his hand and seal.

Mr. Maclane, a gentleman who resided very near the village of Krakhut, gave me part of a stone that had been brought to him the morning after the appearance of the phænomenon, by the watchman who was on duty at his house; this, he said, had fallen through the top of his hut, which was close by, and buried itself several inches in the floor, which was of consolidated earth. The stone must, by his account, previous to its having been broken, have weighed upwards of two pounds.

At the time the meteor appeared, the sky was perfectly serene; not the smallest vestige of a cloud had been seen since the 11th of the month, nor were any observed for many days after.

Of these stones, I have seen eight, nearly perfect, besides parts of several others, which had been broken by the possessors to distribute among their friends. The form of the more perfect ones appeared to be that of an irregular cube, rounded off at the edges; but the angles were to be observed on most of them. They were of various sizes, from about three to upwards of four inches in their largest diameter; one of them, measuring four inches and a quarter, weighed two pounds twelve ounces. In appearance, they were exactly

actly similar: externally they were covered with a hard black coat or incrustation, which in some parts had the appearance of varnish, or bitumen; and on most of them were fractures, which, from their being covered with a matter similar to that of the coat, seemed to have been made in the fall, by the stones striking against each other, and to have passed through some medium, probably an intense heat, previous to their reaching the earth. Internally, they consisted of a number of small spherical bodies, of a slate colour, embedded in a whitish gritty substance, interspersed with bright shining spiculæ, of a metallic or pyritical nature. The spherical bodies were much harder than the rest of the stone: the white gritty part readily crumbled, on being rubbed with a hard body; and, on being broken, a quantity of it attached itself to the magnet, but more particularly the outside coat or crust, which appeared almost wholly attractable by it.

As two of the more perfect stones which I had obtained, as well as parts of some others, have been examined by several gentlemen well versed in mineralogy and chemistry, I shall not attempt any further description of their constituent parts; nor shall I offer any conjecture respecting the formation of such singular productions, or even record those which I have heard of others, but leave the world to draw their own inferences from the facts above related. I shall only observe, that it is well known there are no volcanos on the continent of India; and, as far as I can learn, no stones have been met with in the earth, in that part of the world, which bear the smallest resemblance to those above described.

[To be continued.]

VII. *Mineralogical Notice respecting two great Peculiarities lately found in Iron-stone from Hachenburg and Ischenburg. By Mr. CRAMER, Counsellor of Mines at Altenkirchen*.*

THE first mineral I shall here mention is native iron. It is well known that a dispute has long existed among mineralogists respecting the actual existence of this substance; that by some it has always been doubted; and that, besides the monstrous mass of which professor Pallas has given a circumstantial description, few specimens have ever been produced to give support to the assertion, that this mineral is found in a natural state. The certainty of its existence has

* From *Der Gesellschaft Naturforschender Freunde zu Berlin Neue Schriften*, vol. ii.