"induction," as used in reference to the investigation of the causes of phenomena. The mistake which he makes is a very frequent one, and is due to the ambiguity of the words themselves, and to the inaccessibility of a treatise on modern logic.

The "deductive method," as formulated by John Mill, is one method by which the mental process known as induction—"the operation of discovering and proving general propositions"—is accomplished. An "induction" may be a simple inference from an observation; it must be an inference in which the conclusion is *wider or more general* than the premises from which it is drawn. A "deduction" (as the term is commonly used) is a result of ratiocination solely, or, in other words, of a "train of reasoning," by which from a general proposition (not alone, but by combining it with other propositions), we infer a proposition of the *same* degree of generality with itself, or a *less* general proposition. The "deductive method" receives its name from the fact that ratiocination is combined in it with induction.

"In order to discover the cause of any phenomenon by the deductive method, the process must consist of three parts:—(1) Induction; (2) Ratiocination; (3) Verification;" or in common language: (1) A generalisation from observed facts [or a deduction from a previous generalisation]; (2) A deduction from this generalisation [or from an initial deduction]; (3) The testing or verification of the final deduction.

The "hypothetical method" is a special and very usual form of the deductive method in which in place of an induction or primary deduction we have substituted a hypothesis. Under proper safeguards this is the most valuable and fertile method of investigating the causes of complex phenomena. Hypotheses are legitimate or illegitimate. The cause suggested by the hypothesis, if not already known as existing, ought to be capable of being known, and, until the cause suggested is shown to exist, the hypothesis, although verified, constitutes only a plausible conjecture. Further, the hypothesis must be such that no other hypothesis substituted for it would lead to verification.

A hypothesis, as distinguished from a proposition resulting from a complete induction or a correctly formulated deduction, is "a supposition without actual evidence or with evidence avowedly insufficient." The whole value of a hypothesis lies in the final carrying through with it of the deductive method. It must be made the starting-point of deductions, and these must be (one or more) brought to the test of observation or experiment—the final process of verification.

So much by way of preliminary.

The objection which my friend Mr. Thielton Dyer has made to the essay of Mr. Grant Allen upon the forms of leaves does not, it appears to me, consist in a depreciation of the "deductive method" as Mr. William White is led to believe. Nothing can be further from the real state of the case.

What Mr. Dyer objects to is that the method is *not carried out* by Mr. Allen. Mr. Allen gives us hypotheses—suppositions with insufficient evidence—and deductions from the generalisation of evolution, but he is relatively deficient in "verification." He also fails in the condition insisted on by Mill, who holds that the hypothetical method is valueless (or relatively so) unless it be proved that no other hypothesis than that formulated can be similarly verified. He further, in the case of the supposed exhaustion of the carbonic acid in atmospheric air, appears to fail in another respect indicated by Mill, in so far as he does not demonstrate the actual existence of the cause which he assumes in his hypothesis. His proposition on this head is no more than "a plausible conjecture" at the best, and is not a legitimate conclusion arrived at by the deductive method.

I do not think that there is any ground for discountenancing either a "purely deductive" or a "purely inductive" method in the treatment of biological topics, so long as the method is soundly and thoroughly carried out and its logical results truly and clearly stated. Still less is there any shadow of reason for not fully accepting the "deductive method" (so named) as the method of biological research. What we have to deprecate in some modern speculative essays is the tendency to put forward suppositions as though they were propositions which have been demonstrated, and to employ the printing press in launching hypotheses which are neither legitimate inductions nor deductions, and should be kept unpublished until their originator has thoroughly examined them by the accepted "deductive method."

E. RAY LANKESTER

11, Wellington Mansions, North Bank, N.W.

The Peak of Teneriffe *not* very Active again

WITH reference to my notice in NATURE, vol. xxvii. p. 315, stating, on the authority of a native lady in Santa Cruz, that the Peak of Teneriffe was active again, even to the extent of exuding a red-hot lava stream from near its summit, I am informed now from a higher scientific authority, viz. a Cambridge man, and high Wrangler there in his day, but since then resident in Teneriffe, near Puerto Oratava, for fifty years, that that view was exaggerated. I hasten, therefore, to present to your readers exactly what this venerable and experienced man has to say, without altering a word, so far as the extract goes:—

"The facts of the case," says he, "are simply these. On a clear day of south weather, about the latter end of December or the beginning of January last, I happened to be looking at the Peak (as I often do) and observed several distinct and very copious gushes of steam issuing from the summit. In similar weather I had often seen a similar phenomenon, but never to anything like the same extent. I watched these steam gushes several times that day, and very remarkable they were. On going down to Port the following day, I found they had been seen by several people there, who declared that the peak was pouring forth volumes of smoke and flames. The so-called smoke was simply the steam gushes I have mentioned, and what were mistaken for flames I am convinced were nothing but the same steam gushes illumined by the rays of the setting sun. All agreed that after dark nothing was to be seen there, which certainly would not have been the case had there been fire or flames. As for the lava stream, *that* was a pure fiction of an excited brain. I have looked carefully at the Peak through my telescope, and see nothing but the old, black lava streams that I have known for the last fifty years, and I have spoken with one of the guides who has been lately with a party to the summit, and he declares he saw no trace of any eruption, or of anything different from what he has always seen there."

Then follow some other topics to the end of the letter proper; but to that there is appended the following P.S., which may be interesting to intending travellers this summer:—

"Last night (May 27), about an hour and a quarter after midnight, we had a smart shock of an earthquake which woke me out of a sound sleep and rather frightened us all. However, no damage was done, but here people say that eruptions of the volcano are always preceded by earthquakes; so who knows but that our eccentric friend's vision of the three bonfires and the lava stream may come to be verified after all. If the Peak has any intention of erupting again, I should be personally obliged to it if it would do so while I am still in the body. It would be a grand sight from our Sitio."

To any of the previously mentioned intending visitors to the island I would beg to recommend that they carry Dr. Marcet's recent neat little book on "Southern and Swiss Health Resorts." His descriptions of Teneriffe, and especially of Guajara on the great crater, and Alta Vista on the high peak, are graphic, and true though terse. Indeed the only point of difference I have with him is his reason for there not being forthwith erected a grand hotel on the elevated Canadas, high above the summer cloud level, in the driest air, strongest sunshine, and most curative conditions for the moist kinds of consumptive disease, which the whole of this planet would have to offer. The reason he gives is, that there is nothing to interest the invalids, or ordinary lady and gentleman travellers up there.

Yet there have long been mineralogy, geology, a peculiar, though scanty, botany, meteorology of a most commanding type, and astronomy under special advantages, inviting all the readers of NATURE to go there and participate in the mental feast; while now the probabilities each morning of witnessing from a distance a little real eruption, will add an exciting topic to the breakfast conversation and the noonday ramble.

C. PIAZZI SMYTH,

Astronomer-Royal for Scotland

15, Royal Terrace, Edinburgh, June 19

"Devil on Two Sticks"

WHY a game at once so graceful and attractive should have received such a christening I do not know, and I am equally at a loss to imagine how an outdoor sport like this, requiring skill and promoting a healthful exercise of the muscles, should have passed out of sight and become almost forgotten. Like Clerk Maxwell, I have played the game many a time some twenty years since, and hasten without further preliminary to describe it.

Imagine two cones joined together at their small ends like an hourglass, and that a solid of such a shape and size is turned out of walnut or cherry or boxwood or of ebony or ivory: this is the devil. Now take the last half-yard from the taper ends of two billiard-sticks, and let them be connected from these ends by a limp silken cord or string half a yard long—these are the sticks.

To play the game hold the thick ends of the sticks one in each hand, bring the cord under the narrow neck of the solid and try to elevate it in the air: it drops directly on the grass. If a brisk rotary motion is given to it however, it will not only remain on the cord, but several dexterous manœuvres may be accomplished with it: the variety of which and the skill displayed in performing them constitute the game. To produce the revolutions the sticks are moved rapidly up and down alternately, and when the spinning is once established, "Diabolus" may be allowed to run up and down the stick, or he may be projected high up in the air, and, still spinning all the while, be caught on the cord again and again in rapid succession. Two may be engaged in the same game. It was fashionable many years since in these parts, and I recollect seeing a picture in a Tunbridge-ware shop in this place of the lords and ladies engaged in playing this game on the Pantiles at Tunbridge Wells more than half a century ago.

JOHN GORHAM

Bordyke Lodge, Tunbridge, June 4

[This is a nearly complete answer to our correspondent's query. The behaviour of the "devil" is an excellent example of that property of the axis of greatest or least moment of inertia of a body which is utilised in a well-thrown quoit or an elongated rifle-bullet. The mode of producing the rotation is easy to learn by trial, but not very easy to describe. The sticks are kept moving so that one end of the cord is always at a greater tension than the other.—ED.]

Channel Ballooning

As I have shown in my pamphlet, "Les Grands Ascensions Maritimes," the British Channel is the proper field for trying maritime ascents and determining which are the best means for rendering balloons serviceable on sea as well as on land. I have had several conversations with Lhoste, my aeronautical pupil, on the circumstances of his audacious trip. I will confine myself to the scientific teaching of this expedition.

The cone anchor was lowered by Lhoste when he saw that the *Noëmi* was running after the balloon, and diminished so much the velocity of the run that it was possible to catch him with a rowing boat. But although the wind was rather mild, the balloon inclined so much that the car was plunged into the water, and the waves drenched the occupant. It is evident that in stormy weather the lowering of the cone anchor would lead to the destruction of the balloon by pressure of the wind. To avoid this it is necessary to reserve the cone anchor for ordinary winds, and to use in other circumstances guide-ropes with wooden nuts passed through them in order to increase friction as much as possible.

The balloon went to the great altitude of 15,000 feet through the activity of the sun, which can be resisted very easily by taking some litres of water out of the sea, when nearing it, with a very simple apparatus that Lhoste has invented.

Any balloon attempting to cross the Channel should be bound to take on board half a dozen carrier pigeons to indicate the place where it has anchored, or has been rescued or landed, so that help could be sent to it without any delay. With such easy precautions, and the throwing out of a sufficient number of pilot balloons, the experiments can be conducted on scientific principles, and exert the most useful influence on the study of aerial currents on these seas, where several such currents combine, and where the constitution of the air is so peculiar that mirages of every description have been frequently seen even at the present season.

Lhoste, on the morning of June 9, saw at an altitude of 1200 feet a regular halo, which surrounded the sun. The fog was so heavy that he could not see the sea, except when it was almost ready to send him to a watery grave. The steam whistling from vessels in different seaports, reached him at every altitude; but he did not know what was the cause of the extraordinary noise.

If it had not been for the fog, Lhoste would have succeeded in a scientific sport which will become fashionable, and ultimately

lead astronomy to try the air, and to trust to the winds in spite of Shakespeare.

Lhoste's audacity seems to have given rise to a competition in the Mediterranean from Marseilles, but I believe that the Mediterranean must only be tried when the British Channel has been traversed without difficulty in every direction, and that this part of the ocean will play an important part in the development of aerial navigation in the second century of its existence.

Boulogne, June 17

W. DE FONVIELLE

Geology of Cephalonia

CAN any of your readers kindly inform me whether geological investigations were ever made in the island of Cephalonia, one of the Ionian Islands that were under British protection up to the year 1863?

The following are the names of the fossils that I have been able to determine out of those that were given to me and brought last year from Climatias, Thermanti, and Leacas, localities in the neighbourhood of Mount Cephalos, in the island of Cephalonia:—

Mitra fusiformis, Brocc.*M. Bronni*, Mich.*M. Michelotii*, Hörnes.*Buccinum costulatum*, Brocc.*B. prismaticum*, Brocc.*Chenopus pes pelecani*, Phil.*Triton Tarbellianum*, Grat.*T. corrugatum*, Lam.*Murex spinicosta*, Bronn.*Murex* —*Murex* —*Fusus mitraformis*, Brocc.*F. virgineus*, Grat.*F. longirostris*, Brocc.*Turbinella subreticulata*, d'Orb.*Cerithium* —*Turritella turris*, Bast.*Turritella* —*Turritella subangulata*, Brocc.*Vermetus intortus*, Lam.*Natica millepunctata*, Lam.*Natica* —*Dentalium* —*Venus multilamella*, Lam.*V. plicata*, Gmel.*Chama gryphoides*, Linn.*Cardita Jouanneti*, Bast.*Pectunculus pilosus*, Linn.*Limopsis calabra*, Seguenza.

Bucuresti (Roumania), June 2

J. P. LICHERDOPOL

Lightning Phenomenon

WHILE watching the incessant play of vivid lightning during the progress of a thunderstorm which was raging close by in the country towards Novara, Arona being just on the northern limit, my wife observed the following curious spectacle, the account of which she wrote down immediately afterwards:—At 9.35 p.m. on Sunday, June 3, a meteor-like object was seen to pass apparently from south to north (window facing due east), coming from the side of the storm and disappearing behind a mass of cloud which capped the high hill of Monte Val Grande above Lago Varese. It was oblately spheroid in form and apparently about the size of a fire-balloon, and with the velocity of a rocket was travelling slowly, for it left no visible track. It was of a bright, clear, whitish yellow, with a bright, pale green colour showing on the northern side when it passed behind the dark cloud. It was about three times as high above the horizon as the low hills opposite Arona, and traversed an angle of 45° horizontally from the point where first seen to its disappearance. The next day (June 4) when visiting friends at the Villa Frauzosine, near Tura, we ascertained that this meteor-like body had also been seen by two or three persons who were sitting on a terrace watching the brilliant lightning to the south; they observed it moving also from south to north, disappearing behind the mountains to the northward. W. H. GODWIN-AUSTEN

Waterspout

ON April 28 last the Cunard steamship *Servia*, in making her outward voyage to New York, fell in with several small waterspouts. Being on deck at the time I made a rough sketch and some notes of the occurrence, which I now venture to send you, having learned that many officers of these steamers have sailed the North Atlantic for years without having witnessed any similar phenomenon there. The ship's position may be easily deduced from the fact that her latitude was 42° 24' and longitude 51° 3' at noon on the 27th, while these were 41° 42' and 59° 53' respectively at noon on the 28th, at 8.30 a.m. of which day we met the waterspouts. There was hardly any wind at the time, and