

are immediate and evident; it is believed that special cases of proportionality are involved in the general relation, and hence that Newton's Second Law is an *à priori* cognition.

But the cognition which his opponents affirm is a very different cognition, though this is an odd name to give to a mathematical doctrine. What his opponents affirm is that in certain cases forces measured in a certain way are proportional to their effects measured in a certain way; and by proportional they mean proportional and not something else. They affirm that experiment and observation are necessary to ascertain this proportionality; and that experiment and observation, and the method of verification, furnish overwhelming evidence in favour of the truth of Newton's laws. Their best proof is the *Nautical Almanac*, to those who can understand it and them.

I believe the *à priori* method to be as utterly barren in the future as it has been in the past. When a new truth has been discovered it is easy to say that it is evident *à priori*. Some day the laws of the actions of molecules and their relations to heat and electricity will be discovered by physicists; but I imagine they will be physicists of the type of Rumford and Faraday and Thomson and Maxwell. Meantime it is open to any *à priori* philosopher to anticipate the future.

And now, as far as I am concerned, this correspondence will cease. Mr. Collier is polite enough to say that my letter would have confirmed Sir W. Hamilton in his conviction that the narrow discipline of mathematics produces an incapacity for general reasoning; and he therefore cannot be anxious to continue a correspondence with one so contemptible, so stupid, and so ignorant as he plainly believes me to be.

A SENIOR WRANGLER

I SHALL be obliged if you will permit me to correct a verbal error, of some importance, in my letter (*NATURE*, vol. x. p. 84). The words "*finished conception*," in col. 2, line 26, should be "*finished pre-conception*."

J. COLLIER

#### The Glacial Period

BOTH Mr. Belt and Mr. Bonney, have, I think, missed the one point on which the question under discussion turns. The shell-bearing drift-gravels are *well stratified*. I can speak to those in the neighbourhood of Macclesfield, which run up to 1,100 ft. above the sea, being also very delicately current-laminated. I am puzzled to imagine how this structure could be obtained if the gravels were brought to their present position in the way Mr. Belt supposes; indeed its presence seems to me fatal to his hypothesis. It is not the case moreover that all the shells are smashed and scratched. At Macclesfield most of the shells are broken, as one would expect to be the case if they had been tossed about on a shingle-beach; but entire specimens were not very rare. As for scratches, I never saw one on either the shells or the pebbles of these gravels; in the boulder clay, where the included stones are scratched, scratches are occasionally seen on the shells as well.

A. H. GREEN

Cockermouth, June 6

#### VENUS'S FLY-TRAP (*Dionaea muscipula*)\*

THERE are two ways of studying a plant or an animal. One of these consists in the mere contemplation and description of its external aspects and behaviour. Persons who occupy themselves with this sort of study are commonly called naturalists; for it is by them that by far the greater proportion of the facts we possess relating to natural objects has been gained.

But there is another and a much better sense in which a man may be said to be a naturalist. The true naturalist does not content himself with standing at one side and watching the proceedings of nature as a mere spectator. Animated by that insatiable scientific curiosity from which some shrink, in the fear lest it should carry them too far, while the greater part are indifferent, he occupies his whole life in seeking to lift the veil from all that is hidden in nature and in discovering and exposing the springs of every secret process. His restless spirit cannot content itself with contemplation of the mere external aspects of living beings nor even with the most minute and searching study of the forms and structure of organic life. For even if he begin

as a botanist or zoographist, a mere describer of plants or animals, he is forced by the perception of that general adaptation of means to ends and ends to means which he sees everywhere, to become first an anatomist then a physiologist. The study of these external aspects leads him, if possessed of that curiosity which is his characteristic attribute, to study their minute structure, and this, the further he goes into it, stirs up in him the desire to penetrate further into the mysteries of their being. For the delight and interest with which the forms, colours, and structure of animals and plants fill us is derived from the conscious or unconscious perception by our minds of their *adaptation*—their fitness for the place they are intended to occupy. I would go further even than this, and maintain that our artistic perception of beauty in nature is, I believe, in great measure derived from the same source.

But to understand nature in the sense of the naturalist we must know not only those aspects which she is willing to present to us but those she is determined to hide. For this end, when we cannot get at what we want by persuasion, we are often obliged to use compulsion.

It is constantly happening to the naturalist, that he has a process, a contrivance before him, a series of phenomena the connection or evolution of which he cannot understand. He stands at one side and watches and learns but little, for nature refuses to tell *why* she does this, or *how* that. Under these circumstances, which recur, not once in a way, but daily and hourly in the study of plant and animal life, what is he to do? Is it his duty to sit down respectfully and wait, in the hope that what is now difficult and obscure may, by the light thrown upon it from right or left, become more or less clear and intelligible? No. This is not the spirit of the naturalist. If nature conceals the truth, we frankly deny her right to do so, and wrest it from her by force. If circumstances are unfavourable, we alter them to suit our ends. If, as repeatedly happens, a number of antecedents are seen to lead to one event, if a number of apparent causes conspire to one result, we proceed in our investigation by taking away first one, then others of these antecedents, until by a succession of trials (or as they are commonly called experiments) we find the true one, viz. that of which the removal or modification abolishes or alters the event. It is thus, and thus alone, that we compel nature to tell "that wherein her great strength lies."

It is my purpose in this lecture to illustrate to you if I can, by an example, that the systematic application of the method of experiment is the only method by which it is possible to become so acquainted with the forces of nature as eventually to be able to convert them to useful purposes (and this is one, though by no means the highest, end of natural knowledge). More particularly is it true of that branch of natural knowledge which *par excellence* we call physiology, that it is by experiment alone that progress has been or can be made; the whole subject being in its present state but a system of experimental results.

A while ago I applied the term forcible to this method because it is the plan by which, as Bacon said, we torture nature. But let us remember that this is a mere figure of speech. In disciplining nature to our ends, in forcing her to give up her secrets, we use no violence, but utmost gentleness. Plant or animal, to be made to tell its story, must be delicately handled, so delicately that, by association, the very care which the naturalist, for scientific ends, bestows on animals and plants, unavoidably engenders a love for them. However right and necessary it may be that we should to-night destroy and mangle these beautiful leaves for our own pleasure and instruction, let us not do so recklessly, for the life and beauty we destroy we cannot with all our science bring back again or imitate.

The name *Dionaea muscipula* was given to the plant when it was first imported from America. It belongs to the family Droseraceæ, a very natural one, *i.e.* one in

\*Lecture by Dr. Burdon Sanderson, F.R.S., at the Royal Institution, Friday evening, June 5, 1874.