there is not the same stimulus to the salivary glands, not the full healthy amount of secretion, whereby digestion suffers; there is not the same exercise of the teeth whereby they are strengthened and uniformly worn, as we see in ancient skulls. It seems not improbable that their premature decay in civilized nations is due to the want of their normal exercise by the substitution of the knife and fork and stew-pan. According to the evolution theory, our organs have grown into what they are, or ought to be, by long use, and the remission of this tends to irregular development, or atrophy. Every artificial appliance renders nugatory some pre-existing mode of action, either voluntary or involuntary; and as the parts of the whole organism have become correlated, each part being modified by the functions and actions of the others, every part suffers more or less when the mode of action of any one part is changed. So with the social structure, the same correlation of its constituent parts is a necessary consequence of its growth, and the change of one part affects the well-being of other parts. All change, to be healthy, must be extremely slow, the defect struggling with the remedy through countless but infinitesimally minute gradations.

Lastly, so the forms of government give us any firm ground to rest upon as to there being less undue antagonism in one than in another form. Whether it is better to run a risk of, say, one chance in a thousand or more of being decapitated unjustly by a despot, or to have what one may eat or drink, or whom one may marry, decided by a majority of parish voters, is a question on which opinions may differ, but there is abundant antagonism in either case.

Communism, the dream of enthusiasts, offers little prospect of ease. It involves an unstable equilibrium, *i.e.* it consists of a chain of connection where a defect in one link can destroy the working of the whole system, and why the executive in that system should be more perfect than in others I never have been able to see. Antagonism, on the other hand, tends to stability. Each man working for his own interests helps to supply the wants of others, thus ministering to public convenience and order, and if one or more fail the general weal is not imperilled.

You may ask, Why this universal antagonism? My answer is, I don't know; Science deals only with the How? not with the Why? Why does matter gravitate to other matter, with a force inversely as the square of the distance? Why does oxygen unite with hydrogen? All I can say is that antagonism is, to my mind, universal, and will, I believe, some day be considered as much a law, as the law of gravitation. If matter is, as we believe, everywhere, even in the interplanetary spaces, and if it attracts and moves other matter, which it apparently must do, there must be friction or antagonism of some kind. So with organized beings, Nature only recognizes the right, or rather the power, of the strongest. If twenty men be wrecked on a secluded island which will only support ten, which ten have a right to the produce of the island? Nature gives no voice, and the strongest take it. You may further ask me, *Cui bono?* what is the use of this disquisition? I should answer, If the views be true, it is always useful to know the truth. The greatest discoveries have appeared useless at the time. Kepler's discovery of the relations of the planetary movements appeared of no use at the time; no one would now pronounce it useless. I can, however, see much probable utility in the doctrine I have advocated. The conviction of the necessity of antagonism, and that without it there would be no light, heat, electricity, or life, may teach us (assuming free will) to measure effort by the probable result and to estimate the degree of probability. It may teach us not to waste our powers on fruitless objects, but to utilize and regulate this necessity of existence; for, if my views are correct, too much or too little is bad, and a due proportion is good (like many other useful things, it is best in moderation), to accept it rather as a boon than a bane, and to know that we cannot do good without effort—that is, without some suffering.

I have spoken of antagonism as pervading the universe. Is there, you may ask, any limit in point of time or space to force? If there be so, there must be a limit to antagonism. It is said that heat tends to dissipate itself, and all things necessarily to acquire a uniform temperature. This would in time tend practically, though not absolutely, to the annihilation of force and to universal death; but if there be evidence of this in our solar system and what we know of some parts of the universe, which probably is but little, is there no conceivable means of reaction or regeneration of active heat? There is some evidence of a probable zero of temperature for gases as we know them, *i.e.* a temperature so low that at it matter could not exist in a gaseous form; but passing over gases and liquids, if matter becomes solid by loss of heat, such solid matter would coalesce, masses would be formed, these would gravitate to each other, and come into collision. It would be the nebular hypothesis over again. Condensation and collisions would again generate heat; and so on *ad infinitum*.

Collisions in the visible universe are probably more frequent than is usually supposed. New nebulæ appear where there were none before, as recently in the constellation of Andromeda. Mr. Lockyer, as I have said, considers that they are constant in the nebulæ; and if there be such a number of meteorites as are stated to fall daily into the atmosphere of this insignificant planet, what numbers must there be in the universe? There must be a sort of fog of meteorites, and this may account, coupled with possibly some dissipation of light or change of it into other forces, for the smaller degree of light than would be expected if the universe of stellar bodies were infinite. For if so, and the stars are assumed to be of an equal average brightness, then if no loss or obstruction, as light decreases as the square of the distance and stars increase in the same ratio, the night would be as brightly illuminated as the day. We are told that there are stars of different ages—nascent, adolescent, mature, decaying, and dying; and when some of them, like nations at war, are broken up by collision into fragments or resolved into vapour, the particles fight as individuals do, and like them end by coalescing and forming new suns and planets. As the comparatively few people who die in London to-night do not affect us here, so in the visible universe one sun or planet in a billion or more may die every century and not be missed, while another is being slowly born out of a nebula. Thus worlds may be regenerated by antagonism without having for the time more effect upon the Kosmos than the people now dying in London have upon us. I do not venture to say that these collisions are in themselves sufficient to renew solar life; time may give us more information. There may be other modes of regeneration or renewed activity of the dissipated force, and some of a molecular character. The conversion of heat into atomic force has been suggested by Mr. Crookes. I give no opinion on that, but I humbly venture to doubt the mortality of the universe.

Again, is the universe limited? and if so, by what? Not, I presume, by a stone wall! or if so, where does the wall end? Is space limited, and how? If space be unlimited and the universe of suns, planets, &c., limited, then the visible universe becomes a luminous speck in an infinity of dark vacuous space, and the gases, or at all events the so-called ether, unless limited in elasticity, would expand into this vacuum—a limited quantity of ether into an infinite vacuum! If the universe of matter be unlimited in space, then the cooling down may be unlimited in time. But these are perhaps fruitless speculations. We cannot comprehend infinity, neither can we conceive a limitation to it. I must once more quote Shakespeare, and say in his words, "It is past the infinite of thought." But whatever be the case with some stars and planets, I cannot bring myself to believe in a dead universe surrounded by a dark ocean of frozen ether.

Most of you have read "Wonderland," and may recollect that after the Duchess has uttered some ponderous and enigmatical apophthegms, Alice says, "Oh!" "Ah," says the Duchess, "I could say a good deal more if I chose." So could I; but my relentless antagonist opposite (the clock) warns me, and I will only add one more word, which you will be glad to hear, and that word is—Finis.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The list of Physical Science lectures this term includes Prof. Liveing on Spectroscopic Chemistry, Mr. Robinson on Agricultural Chemistry, Mr. Ruhemann on Gas Analysis and on Aromatic Compounds, Mr. Shaw on Electrolysis, Mr. Wilberforce on Dynamo-electric Machines, Mr. Lyon on Machine Construction.

Prof. Stokes lectures on Hydrodynamics, Dr. Besant on Differential Equations and Solid Geometry, Dr. Glaisher on Theory of Errors, Mr. Stearn on Attractions and Theory of Potential.

In Biology, Mr. Langley is lecturing on the Central Nervous System, Prof. Macalister on the Rudimental Structures of the Human Body, Mr. Gadow on the Morphology of Mammalia recent and extinct, Mr. F. Darwin on the Physiology of Plants (advanced demonstrations).

In Geology, Prof. Hughes lectures on the geology of the

neighbourhood of Cambridge, Mr. Marr on Advanced Physical Geology, Mr. Roberts on the Crinoidea.

The above are only a selection out of a long list.

Mr. J. G. Adams, of Christ's College, has been appointed Demonstrator of Pathology on Mr. Rolleston's resignation.

SCIENTIFIC SERIALS.

American Journal of Science, April.—The absolute wave-length of light, by Louis Bell. The final results are here given of the research partially reported in the *Journal* for March 1886. Owing to the wide discrepancies in the value of this constant as determined by various observers and methods, the author gives a brief historical summary of the subject, with a critical discussion of the standards of length, methods, and apparatus employed in the present investigation. The details of the experimental work, together with some remarks on the final results, and some questions of theoretical and practical interest connected with the work of recent experimenters in this field, are reserved for a future number.—History of the changes in the Mount Loa craters; Part I, Kilauea (continued), by James D Dana. Here are discussed questions connected with the ascensive action in the conduit lavas, the effects of heat, the hydrostatic and other gravitational pressure.—The electromotive force of magnetization, by Edward L. Nichols and William S. Franklin. At the Ann Arbor meeting of the American Association for the Advancement of Science the authors described some singular modifications in the relation of iron to acids which occur when the reaction takes place within the magnetic field. In the present paper, which was read at the New York meeting of the Association in 1887, they deal with the behaviour of iron when that metal acts as one electrode in a voltaic circuit, and is at the same time subjected to magnetization.—Notes on certain rare copper minerals from Utah, by W. F. Hillebrand. A series of rare copper ores, including olivenite, erinite, tyrolite (?), chalcophyllite, clinoclasite, mixite (?), and bronchantite, are here subjected to careful chemical and physical examination.—The Taconic system of Emmons, and the use of the name Taconic in geological nomenclature (continued), by Chas. D. Walcott. The main subject of this paper is the geology of the Taconic area as known to Dr. Emmous, with a comparison of its area as now known. As a result of this comparative study, the author finds that the Lower Taconic is essentially a repetition of the Lower Silurian (Ordovician) of the Champlain Valley, while the Upper Taconic appears to be conformably subjacent to the Stockbridge Limestone of the Lower Taconic, and to include the Potsdam horizon at or near its upper portion.—Three formations of the Middle Atlantic Slope (continued), by W. J. McGee. This paper is occupied with the Appomattox formation, its character, and distribution.—W. Le Conte Stevens describes a new lecture apparatus of an extremely simple character for the demonstration of reflection and refraction phenomena.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 8.—"Further Observations on the Electromotive Properties of the Electrical Organ of *Torpedo marmorata*." By Francis Gotch, Hon. M.A. Oxon., B.A., B.Sc. London, M.R.C.S. Communicated by Prof. J. Burdon Sanderson, F.R.S.

In the present treatise the author details the results of further observations as to the electromotive properties of the electrical organ of Torpedo, the experiments being carried out in October, 1887, at the laboratory of the Société Scientifique d'Arcachon.

I. The first part of the work deals entirely with the phenomena of "irreciprocal conduction" in the organ of Torpedo, as described by du Bois-Reymond.

From du Bois-Reymond's experiments it would appear that the organ possesses the remarkable property of conducting an intense current of short duration, led lengthwise through its columns, better when the current is directed from its ventral to its dorsal surface than when directed the reverse way. The former direction coincides with that of the current of the shock of the organ, and is therefore termed by him "homodromous," the latter, being opposite in direction, is termed "heterodromous." The evidence rests upon the value of the galvanometric deflections obtained when both currents are allowed to traverse a strip of organ and a galvanometric circuit. The deflections are markedly unequal, particularly when induced currents are used, the homodromous effect being always much greater than the heterodromous. The homodromous current must therefore either encounter less resistance than the heterodromous, or its electromotive force must be suddenly strengthened, and that of the heterodromous current weakened, by the sudden establishment in the tissue of a new source of electromotive energy. The first is the view taken by Prof. du Bois-Reymond.

(1) The present rheotome experiments reveal (*a*) the new fact that the passage of such intense currents of short duration is always followed by an excitatory response (shock) in the tissue; (*b*) that if the intense current due to this response is allowed to affect the galvanometer as well as the induced or other exciting current, then by obvious algebraic summation the homodromous deflection must be much larger than the heterodromous; (*c*) and that when by means of a fast-moving rheotome the induction shock only is allowed to affect the instrument, no irreciprocity is found.

The author therefore assumes that the phenomena of irreciprocal conduction are in reality excitatory phenomena, the nature of which, from the methods of investigation used, have not been recognized.

(2) The time relations of this response of the isolated strip of the organ to direct stimulation by the traversing induction shock are now for the first time investigated, by means of the rheotome, and the influence of temperature and other conditions upon these is shown by experimental evidence.

II. The second part deals with entirely novel phenomena—namely, the excitation of the organ by the current of its own excitatory state. It is shown that in vigorous summer fish every response of the whole or part of the organ to a single excitation of its nerves is followed by a second response, due to the passage through its own substance of the intense current of the first response. In other words, the shock of the organ excites its own nerve fibres and nerve endings, producing a feebler second shock, which in a similar manner evolves a feebler third shock; this a fourth, and so on.

The response of the isolated organ to nerve excitation is thus multiple; a primary, secondary, tertiary response following the application to the nerve of a single stimulus. Since all these responses produce currents similarly directed through the columns of the organ, each column during its activity must reinforce by its echoes the force of the primary explosion, both in its own substance and also in that of its neighbours.

Linnean Society, April 5.—Mr. W. Carruthers, F.R.S., President, in the chair.—Amongst the exhibitions of the evening Mr. D. Morris (Kew) showed a curious native bracelet from Martinique. Although formed apparently of seeds, or beads of wood, or bone, its real composition had puzzled both botanists and zoologists, and until microscopically examined could not be determined.—Mr. J. G. Baker, F.R.S., exhibited a series of specimens of *Adiantum Fergusoni* and *Capillis Veneris*, and offered some remarks upon their specific and varietal characters.—Mr. J. E. Harting exhibited a specimen of a rare British animal, the pine-marten, which had been trapped in Cumberland; and made some observations on the present distribution of the species in the British Islands.—Mr. Clement Reid exhibited a series of fruits and seeds obtained by Mr. J. Bennie from interglacial deposits near Edinburgh, affording evidence of a colder climate formerly than that now prevailing in the Lowlands of Scotland.—Mr. F. Crisp exhibited some fragmentary remains of a wild goose shot in Somersetshire, which had been reported as the lesser whitefronted goose (*Anser erythropus*, Linn.), but which was apparently an immature specimen of *Anser albifrons*, Scopoli.—In the absence of the author, a paper by Mr. A. W. Waters, on some ovicells of the Cyclostomatous Bryozoa, was read by the Zoological Secretary, Mr. W. Percy Sladen; and after an interesting discussion, the meeting adjourned.

Chemical Society, March 28.—Annual General Meeting.—Mr. W. Crookes, F.R.S., in the chair.—The President delivered an address on which we have already commented.—The following Officers and Council were elected for the ensuing session:—President: Mr. W. Crookes, F.R.S. Vice-Presidents who have filled the office of President: Sir F. A. Abel, F.R.S.; Dr. Warren de la Rue, F.R.S.; Dr. E. Frankland, F.R.S.; Dr. J. H. Gilbert, F.R.S.; Dr. J. H. Gladstone, F.R.S.; Dr. A. W. Hofmann, F.R.S.; Dr. H. Müller, F.R.S.; Prof. Odling, F.R.S.; Dr. W. H. Perkin, F.R.S.; Sir Lyon Playfair, F.R.S.; Sir H. E. Roscoe,