Plate 1.

Carl Achilles, lith.

Reeve Benham & Reeve imp.

1. 2. 4. 5. 6. 7. 8. 9. 10. 11. 13. 14. 15. 16. 17. 18. 19. 20. 22. 23. 24. 26.

INSTINCT AND REASON:

DEDUCED FROM

ELECTRO-BIOLOGY.

BY

ALFRED SMEE, F.R.S.

"Vainly the philosopher avers
That Reason guides our deed, and Instinct theirs.
Instinct and Reason how can we divide?"

PRIOR.

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PREFACE.

During the latter part of last year, circumstances beyond human control subjected me to so much bodily fatigue and mental anxiety, that at their unfavourable termination I felt indisposed to prosecute the study of those subjects which my former investigations would have led me to follow.

Under these circumstances, I rather desired amusement than labour, and from this cause I determined to comply with the suggestions of several scientific friends, who strongly recommended me to demonstrate the bearings of Electro-biology on the various matters which are comprised within the range of Electro-biological research.

I feel bound to return my most grateful acknowledgments for the valuable aid which I have invariably received in the prosecution of my investigations, and have only to add, that my previous writings and inventions have, upon the whole, met with a kind consideration, both at home and in the translations abroad, far beyond that which I could possibly have anticipated.

It would be in vain to conceal, and useless to deny, that the system of Electro-biology, upon which this work is based, required intense labour in the laboratory and dissecting-room, to learn the facts; and even then, the subsequent labour required for their arrangement was so great, that it cost me many years of anxious toil for the development of the system.

Electro-biology can still only be regarded as the first stone of a noble edifice. Fresh minds will bring fresh facts and fresh talents to the task; and those who first cultivate this delightful science may rest assured, that they may earn an abundant reward, as at every step we take, fresh fields present themselves to our notice, which only require cultivation, to produce an abundant harvest.

The subject of this volume, as a whole, would require for its perfect exemplification a knowledge of a range of subjects more than that which falls to the lot of a single individual to be thoroughly acquainted with. On this account, I must entreat the kind consideration of my reader, should any error be found in the various details which I have given. With regard, however, to the principles of the subject, I can but desire that they should be thoroughly sifted, and purged of every error and imperfection, that Electro-biology may triumph, and that truth may confer its blessings on man.

In the selection of illustrations for this work, I have invariably, as far as possible, taken examples from subjects which circumstances have brought prominently before my notice, and hence, throughout the book, I have chosen facts, even of a trifling character, which I have myself observed, in preference to those which, although more remarkable, have been observed by others.

To myself the reminiscence of by-gone events, the examination of various facts in natural history, and the exemplification of former principles which I developed, have afforded to me unmixed delight, and thence I have already received abundant reward for my labour; but should this treatise be found to be beneficial to others, the retrospective consideration of the subject will, indeed, in future years, be the source of a higher gratification.

I must record my grateful acknowledgments to Mr. Gray, and the other gentlemen of the Natural History department of the British Museum, for affording me every facility for figuring the specimens contained in our national establishment. I have to acknowledge the invaluable assistance of a talented member of my own profession, when I was engaged upon the anatomical part of the subject; for I am almost ashamed to record, that we frequently conducted our operations till the rising sun declared that we were purchasing knowledge at the risk of health. I must return my obligations to those friends who have lent me specimens and communicated facts for this little treatise; and lastly, to my most esteemed friend, Mr. John Beadnell, my best thanks are due, for revising the proof sheets.

7, Finsbury Circus,
April 18, 1850.

CONTENTS.

CHAPTER I.

RELATION OF MIND TO LIFE.

CHAPTER II.

ON THE ORGANS OF SENSATION IN MEN AND ANIMALS.

CHAPTER III.

PLEASURE AND PAIN.

CHAPTER IV.

ON MEMORY.

CHAPTER V.

ON REASON.

CHAPTER VI.

OPERATIONS OF MAN SUPERIOR TO THOSE OF ANIMALS.

CHAPTER VII

ON INSTINCT.

CHAPTER VIII.

INTUITIONS.

CHAPTER IX.

ON WORDS AND LANGUAGE.

CHAPTER X.

ON THE WORKS OF MAN, AS COMPARED WITH THE WORKS OF NATURE.

CHAPTER XI.

THEORY OF INSTINCT AND REASON.

CHAPTER XII.

ON REASON AND FAITH.

CHAPTER XIII.

PERVERTED REASON.

CHAPTER XIV.

VARIOUS FAMILIES OF MEN.

CHAPTER XV.

NATURAL CLASSIFICATION OF ANIMALS.

DESCRIPTION OF THE PLATES.

PLATE I.

This plate is intended to illustrate the chapter on the various families of Man, of which the specimens have been selected from the most authentic sources. (Page 276.)

1, Arab; 2, Persian; 3, Turk; 4, Hindoo; 5, Greek; 6, Cossack; 7, Chinese; 8, Englishman; 9, Japanese; 10, Calmuck; 11, Beloochee; 12, Corean; 13, Papuan; 14, Esquimaux; 15, Kamtschatkadale; 16, Negro; 17, Bornean; 18, Chilian; 19, Hottentot; 20, Australian; 21, Bosjesman; 22, Polynesian; 23, New Zealander; 24, Kaffir; 25, North American Indian; 26, Patagonian.

PLATE II.

Fig. 1. Nest of a honey-making wasp from Rio Nancay, presented to the British Museum by Mr. Walter Hawkins. The insect has been named by Mr. White the *Myrapetra scutellaris.* The aperture is at the inferior part, concealed by the protuberances. Mr. White's paper on this nest is in the 'Annals and Magazine of Natural History' for 1841. *Par.* 332.

Fig. 2. Curious wasps' nest, with the cells in two axes, belonging to Mr. Bowerbank. It will be seen that six layers of cells are parallel to the bough on which it is supported. Probably the weight of the nest caused the bough to fall, when the insects made three layers of cells at right angles to the first cells. *Par.* 335.

Fig. 3. Edible nests of the swallow, *Calocalia esculenta,* and bird of ditto. *Par.* 303. A portion of a very beautiful white sample of the nest, given to me by Mr. Hawkins, was carefully broken up, and all foreign matter, such as parts of feathers or earthy material, was removed. These fragments I then sent to Mr. E. C. Nicholson, at the College of Chemistry, who kindly made an ultimate analysis of the material, and has obtained for himself the credit of having first shown the real nature of these nests. The entire substance was dried at 212°, and lost 12 per cent. of water. The composition of the substance, dried at 212°, he found to be as follows :—

		Or, deducting the Ash,	
Carbon	49·06	Carbon	51·70
Hydrogen	6·23	Hydrogen	6·56
Nitrogen	14·76	Nitrogen	15·55
Oxygen	24·85	Oxygen	26·19
Ash	5·10		
	100·00		100·00

It was also examined for sulphur, but was found to contain a mere trace, and, in this respect, it differs from albumen and fibrin. From the general appearance of the nest I entertained no doubt that it was the secretion of the bird, and this analysis indicates that its composition is so close to the Protein compounds as at once to cause us to class it amongst the animal products; for, although vegetable gluten and albumen would have a similar composition, yet it is always mixed with ligneous and starchy matters in plants.

Fig. 4. Nest of the *Ploceus pensilis*. It is composed of grass suspended to a bough, and the bird enters at the bottom. From my own specimen. *Par.* 300.

Fig. 5. Nest of snail, *Bulimus Mindoroensis*, the eggs of which have a calcareous covering like a bird's egg, from a specimen belonging to Mr. Cuming. *Par.* 351.*

Fig. 6. Nest of water ousel, *Cinclus aquaticus*, from a specimen which I purchased of Gardner, the naturalist, of Oxford-street, which he procured from the gamekeeper of the Duke of Leeds (*Pl.* 2, *Fig.* 6). *Par.* 291.

Fig. 7. Column of the cells of the electric battery of the torpedo, from

* The reference in the text is erroneously given as *Fig.* 8.

the model in the College of Surgeons, presented to that institution by Professor Owen, who received it as a present from the Grand Duke of Tuscany. *Par.* 210.

Fig. 8. Surface of one of the cells, showing the distribution of blood-vessels. *Par.* 210.

Fig. 9. Portion of the bone of the Mastodon, being one of the specimens which led me first to the discovery that those parts which were supposed to contain the earthy matter were only cellules. The dark holes are the Haversian canals, which contain the blood-vessels, whilst the cells are arranged around them, and communicate by very fine tubes. From my own specimen. *Par.* 36.

Fig. 10. The West Indian fire-fly, *Pyrophorus noctilucus*. The two spots from whence the light emanates may be seen one on each side the thorax. *Par.* 224.

Fig. 11. The common glowworm, female (*Lampyris noctilucus*). The light is emitted from the two or three last segments of the tail. *Par.* 223.

Fig. 12. *Dionæa muscipula*, or Venus's fly-trap. The traps are seen at the end of the leaf, and close up when irritated. It is very difficult to keep this plant, and I have had the ill luck to lose my specimens during the dull weather of a London winter. *Par.* 125.

Fig. 13. *Mimosa sensitiva*, or sensitive plant. When this plant is kept in a house of sufficient temperature, the leaflets close, and the leaf drops from its stalk upon the slightest irritation. *Par.* 124.

PLATE III.

Fig. 1. Nest and eggs of chaffinch, *Fringilla cœlebs*. From my own specimen.

Fig. 2. Nest of oriole, *Cassicus Persicus* (*Par.* 299). The entrance is below the figure of the bird. From my own specimen.

Fig. 3. Bird belonging to the above nest (*Par.* 299). From my own specimen.

Fig. 4. Nest of reed-warbler (*Par.* 294), built into the reeds whilst growing. From my own specimen.

Fig. 5. Very curious basket-nest, with a handle, made by the *Euplectes flaviceps* (*Par.* 296). From my own specimen.

Fig. 6. Bird belonging to the above. From my own specimen.

Fig. 7. Nest made of leaves sewn together by the sun-bird, *Dicæum concolor* (*Par.* 301). From my own specimen.

Fig. 8. Bird belonging to above. From my own specimen.

Fig. 9. Nest of humming-bird, *Trochilus glaucopsis* (*Par.* 293). From my own specimen.

Fig. 10. Bird of above. From my own specimen.

Fig. 11. Nest of humming-bird, with egg, *Trochilus moschitus* (*Par.* 293). From my own specimen.

Fig. 12. Bird of above. From my own specimen.

Fig. 13. Nest of long-tailed titmouse, *Mecistura caudata* (*Par.* 290). From my own specimen.

Fig. 14. Bower of satin bower-bird, *Ptilonorhynchus holosericeus*. From the Zoological Gardens. *Par.* 309 *et seq.*

Fig. 15. Bird of above, from same place.

Fig. 16. Nest and eggs of song-thrush, *Turdus musicus* (*Par.* 281). From my own specimen. The nest of the blackbird is not figured, although a reference has been given in *Par.* 281.

PLATE IV.

Fig. 1. Nest of a spider. *Par.* 347.

Fig. 2. Case of the larva of a species of *Phryganea*, or caddis-worm. From my own collection. *Par.* 350.

Fig. 3. Nest of the wasp of the *Vespa holsatica*, formed upon a growing bough. It is constructed of a delicate paper, and the aperture is on the under surface (*Par.* 323). From my own specimen.

Fig. 4. Web of the common spider, *Epeira diadema*. *Par.* 344.

Fig. 5. Case of a species of *Fumea*, slightly magnified, in which the caterpillar resides, from a specimen belonging to Mr. Wing. *Par.* 342.

Fig. 6. Case of the caterpillar of a species of *Argyromyges* (*Par.* 342). The reference has been erroneously inserted, as it should have been placed after the word *larvæ*, last line but one from the bottom.

Fig. 7. Case of the caterpillar of the *Porrectaria leucapennella*, which feeds upon the sloe. *Par.* 342.

Fig. 8. Hinged habitation of the *Mygale Ionica*, a sort of spider, from a specimen in the British Museum. *Par.* 348.

Fig. 9. Nest of common wasp, *Vespa vulgaris* (*Par.* 317 *et seq.*) It shows the imbricated layers of paper, which cover all the cells, from my own specimen.

Fig. 10. Nest of pasteboard wasp, *Chartergus nidulans*, from my own specimen. *Par.* 330.

Fig. 11. Case of one of the house-building caterpillars, a species of *Oiketicus* (*Par.* 342), from the British Museum.

Fig. 12. Nest of the common hornet (*Vespa crabro*), from a beautiful specimen in the British Museum. *Par.* 324.

Fig. 13. Web of a species of spider which commonly builds in corners of rooms. By a misunderstanding the artist has figured this species from nature instead of that of the *Agelena labyrinthica*, which is to be found in hedges and fields (*Par.* 346). There is, however, much similarity between the two webs.

PLATE V.

This plate contains specimens of some beautiful nests from Brazil.

Fig. 1. This nest is that of a very minute wasp, with yellow lined thorax, and transversely banded abdomen. This figure is from a nest in my own possession, and is composed of a very fine card, or rather, perhaps, coarse paper. In this kind of nest little pedicles are thrown out, by which the entire mass is affixed to the leaf or leaves. Upon applying to Mr. White, a talented assistant at the British Museum, for information upon this nest, he told me that he was preparing a paper on the subject, and showed me various figures which were intended to illustrate the subject. The wasp which made this nest he called the *Polistes Smeei.*

The cells are arranged in layers, and are exceedingly minute. The whole is covered with a paper case. When the wasp desires to enlarge its habitation, it makes another series of cells over the first covering, and thus it proceeds from layer to layer. The aperture in the specimen is at the inferior margin of the nest, and at the right-hand corner. From my own specimen.

Fig. 2. The nest of a small Brazilian *Polistes,* with yellow-banded abdomen, allied to *Polistes pedunculata.* The material of which it is composed is far stronger and coarser than that of the last-described species, and, as will be perceived, it is constructed upon a stalk. From my own specimen.

Fig. 3. Curious paper case, formed by a species of Brazilian ant. The paper is of grey colour, much resembling that used for making *papier mâché* ornaments, and completely covers three large leaves. From my own specimen.

Fig. 4. Another specimen of the nest of *Polistes Smeei*. From my own collection.

Fig. 5. A very interesting nest, with a carved entrance, about as large as a pint bottle, formed of a thin delicate paper case, in the interior of which is contained the cells. The insect which forms this very remarkable production has been called by Mr. White the *Polistes Doubledayii*. The insect is of a brownish-yellow colour, with yellow lined thorax. From my own specimen.

Fig. 6. A third species of nest, similar to *fig.* 1 and *fig.* 4. From my own specimen.

Fig. 7. Brazilian ants' covering. This specimen is particularly interesting, inasmuch as it differs from *fig.* 3 by its including two leaves, and fixing them together. From my own specimen.

Fig. 8. Nest of a Brazilian *Polistes*, attached to the centre of a leaf. It is composed of a very coarse paper, and in the interior may be seen the layer of cells. From my own specimen.

Fig. 9. This nest is a very beautiful and marvellous production. The inferior surface of about half of a large leaf is covered, over its greatest extent, with a very delicate paper; and even in some specimens this covering extends over the entire under-surface. Under this case, in the specimen figured, are three groups of cells. In another specimen I have counted six groups, each group containing nearly sixty cells. On the cover ants were placed; but as they could not have constructed it, they were probably placed in that situation by some busy hand. From a specimen in my own collection.

Fig. 10. Nest of *Polistes*, from Brazil. It is curious in being attached to a stalk by a very slender pedicle. The insect has a silky brown abdomen, dusky wing, thorax with silky yellowish pubescence. The nest of this species has no covering. From my own specimen.

Fig. 11. A beautiful little nest, of another species of *Polistes*. It is a globular nest, about an inch across, formed of coarse-grained thin cardboard. In the interior is arranged a series of layers of cells. In this a new layer of cells is being formed, which indicates well the manner in which the insects add to their domicile. From my own specimen.

Fig. 12. A fourth specimen of the nest of *Polistes Smeei* (from my own collection), showing how the insect adapts itself to circumstances; for, by comparing the figures 1, 4, 6, 12, it will be noticed that in the first case the nest is covered entirely with leaves; in the second, it is hardly so much covered with leaves; in the third, it is partially covered with leaves; and in the present specimen it is placed on the under surface of a single leaf. A person can never look upon these specimens without great gratification; and we can only regret that we have not the means of observing these creatures in the act of constructing the fabric.

PLATE VI.

The figures in this plate represent the distribution of the blood-vessels in the brain and spinal chord. These beautiful injections are exceedingly difficult to prepare; but they are made by using a solution of carmine in ammonia mixed with size, a process which I communicated to the Microscopical Society, but the Society has contrived to lose my paper.* The preparations are dried and placed in balsam, so that they are permanent, and, being transparent, constitute the most lovely microscopical specimens which can possibly be conceived. I really know no object calculated to fill the mind with wonder and amazement so much as these carmine injections, which will bear a very high magnifying power. All the figures are from my own preparations.

Fig. 1. A complete longitudinal section of the brain of the cat, a little on one side of the median line. It shows how intensely vascular the brain is, and, also, that this vascularity is not equally distributed, as the white fibrous portion is almost destitute of vessels. In the cerebellum this condition is more especially marked, as it will be observed that the centre of the section of that part is quite white. By this mode of injection the relation of the white to the grey matter is better shown than by any other process which can be followed.

Fig. 2. A portion of the cerebellum of *Fig.* 1 more highly magnified. The white part only indicates a few vessels, while the vascular portion is most intensely supplied with blood-vessels. The large dark vessels in the centre of each compartment is the *pia mater* dipping down between each convolution.

* If any gentleman now has it, I should feel extremely obliged if he would return it to me, as its loss has caused me much inconvenience.

Fig. 3. A portion of cerebrum of *Fig.* 1. It shows how the vessels dip down from the *pia mater* into the grey matter of the brain, and there break up into a network of fine capillaries.

Fig. 4. Portion of the cerebrum of a pigeon, showing a similar complicated network of capillaries.

Fig. 5. Injected spinal chord. Here it will be observed that only the grey matter in the centre possesses any considerable number of vessels, although the white part has a few ramifying through its substance. The section is transverse to the axis of the chord.

Fig. 6. Section of inferior part of *pons Varolii*, partaking partly of the characters of the spinal chord, partly of the brain.

Fig. 7. Vertical section of the spinal chord. In both these specimens of the chord it may be seen that the vessels are but very few comparatively with the fine capillaries of the brain, and the few vessels are very much coarser in size. In these specimens there is not the slightest extravasation, and the delicate red tinting between the vessels, which my artist has faithfully delineated, arises from other vessels being placed deeper and out of focus.

PLATE VII.

This plate illustrates some of the principal vascular tissues of which I have had occasion to speak in this work.

Fig. 1. A portion of voluntary muscle (*panniculus carnosus*) of the cat, highly magnified. It will be seen that the ultimate capillaries are arranged parallel to the primitive muscular fibre. From my own specimen.

Fig. 2. This figure represents the vessels distributed to the interior of the ear. It is very difficult to make a good injection of this part; and though it is the best specimen which I have seen, yet it is by no means satisfactory. From my own specimen.

Fig. 3. Vessels of the membrane lining the nose. The drawing hardly gives a fair idea of its intense vascularity. From my own specimen.

Fig. 4. Vessels of the skin, slightly magnified, showing that the skin contains a wonderful network of capillaries. From my own specimen.

Fig. 5. Blood-vessels of the papillæ of the tongue; after Arnold.

Fig. 6. Artery of the retina, with its capillaries. From my own specimen.

Fig. 7. Posterior surface of the iris, or curtain, of a fœtus, showing its blood-vessels, together with the ciliary processes. This drawing shows well the number of vessels in these structures. These, according to the quantity of blood which they contain, I have supposed to act upon the position of the lens, to adjust the focus of the eye to various distances. From my own preparations.

Fig. 8. A more magnified view of the ciliary processes, choroid, and iris, showing the distribution of the blood-vessels. This drawing has been made from my own preparations, after the design of a figure in Arnold's 'Icones Organorum Sensuum.'

PLATE VIII.

Fig. 1. Brain of man, showing the large size and extent of convolutions of the cerebral lobes viewed from above.

Fig. 2. Brain of the dog, showing the less extent of the cerebral lobes, which do not sufficiently cover the cerebellum to hide it from sight.

Fig. 3. Nervous system of one of the molluscous animals, which well demonstrates the imperfect character of its nervous centre.

Fig. 4. Nervous centre of the centipede, showing the character of the Articulate animals.

Fig. 5. Nervous centre of the star-fish, which well shows the inferior character of the Radiate departments of the animal kingdom.

Fig. 6 & 7. These two figures are theoretical arrangements of the fibres of the nervous system according to my system of electro-biology; *fig.* 6 being that of man, *fig.* 7 of an animal.

The three lines from each organ of sensation represent three nerve-fibres. At 1, they are supposed to form the aisthenic battery of the brain. At 2, they enter into the combinations or permutations to give to animals or mankind simple ideas. In the animal (*fig.* 7) the motor nerves are assumed directly to be opposed to the syndramic vesicles, which are continued to the muscles, where their terminations are opposed to the origins of the nerves in the organs of sensation. In man, however, it is assumed that the vesicles of the combined impressions of each organ of sense are combined into unity, constituting the noemic battery (3). The vesicles of each organ of sensation are again combined, forming the syndramic noemic battery (4), which are finally combined into one, constituting the pneuma-noemic battery (5). From this the motor nerves spring, which are continued to the muscular substance, as in the animal.

If in place of the three fibres of each organ of sensation we had one hundred, then we should form some idea of the complexity of the brain under such a system, and then, indeed, it would much resemble the natural structure of *Plate* 9.

By a careful study of such a circuit, we perceive that a voltaic circuit might originate at the organ of sensation by some new impression, or, in the brain, by an action determined by some antecedent impression.

Thoroughly to realize to our minds the properties of a contrivance of this class, great study is required; but, be it remembered that this is the only system which in any way explains how the most minute action is determined by every event which has previously been known to the individual, and how the impression is carried to the brain, and determines its line of action with the rapidity of lightning, for, under this system, we learn that lightning and thought are the result of the same force acting under different circumstances.

PLATE IX.

Fig. 1. Plate of the brain, after my former distinguished teacher, Professor Mayo, showing the general course of the fibres. I cannot here lose this opportunity of bearing my feeble testimony to the value of his beautiful plates, engraved by Finden, which are, perhaps, the finest anatomical plates of their class which have ever been executed in this or in any other country. A, the spinal chord; *f*, posterior columns of spinal chord, into which the sensor nerves are implanted, which form part of the restiform bodies, and are continued into the cerebellum, B. From the cerebellum a band of fibres springs, which are continued to the *corpora quadrigemina*, *k*, *l*. Other bands of fibres are continued upwards, from the spinal chord, through the olivary bodies, *e*, by the olivary fasciculus, *h*, which, with bands from the *corpus geniculatum*, are continued to the cerebrum, C C C. From the cerebrum fibres converge to the *pons Varolii*, *n*, and from this point the fibres of the anterior fasciculus of the spinal chord springs, *d*, from which bundles the motor nerves arise. I would venture, as a matter of theory, to place the pneuma-noemic battery of my electro-biological system at *n*, the *pons Varolii*. I should also be disposed to suppose that the aisthenic and syndramic batteries of common and bodily sensation exist in the cerebellum, B. Moreover, we may infer that the syndramic batteries of the other senses exist in the cerebrum, C, in which situation, in all probability, the syndramic batteries of the other senses exist, together with the syndramic-noemic battery; but of course this must ever remain a matter of pure theory, although based upon a careful consideration of all the facts of the case.

Fig. 2. Diagram showing the ultimate vesicles of the brain, with the nerve-tubes in contact with them, which are placed in the grey matter, amongst the blood-vessels. After Todd and Bowman; highly magnified.

Fig. 3. Ultimate structure of the nerve-fibre, which appears to consist of a membranous tube, lined with fatty matter, and containing an aqueous fluid in its centre. Highly magnified.

PLATE X.

Fig. 1. Hoe, from one of the South Sea Islands. It consists of a piece of bone firmly strapped on to a piece of wood, which is attached at an acute angle to a second piece. From my own specimen. *Par.* 566.

Fig. 2. Boomerang, from Australia. From my own specimen. *Par.* 566.

Fig. 3. War instrument, made by a series of sharks' teeth fastened upon a piece of wood. From my own specimen. *Par.* 566.

Fig. 4. Polynesian chisel, formed of a piece of a stone firmly tied on a wooden handle. From specimen in British Museum. *Par.* 566.

Fig. 5. Reticule, from the interior of Australia, very neatly constructed. From the specimen given to the British Museum by Sir T. Mitchell. *Par.* 566.

Fig. 6. Foulah musical instrument, from Africa. From British Museum. *Par.* 561.

Fig. 7. Hatchet from Nootka Sound, made of a piece of flint inserted in a grotesque handle. From British Museum. *Par.* 566.

Fig. 8. Polynesian chisel. From British Museum. *Par.* 566.

Fig. 9. File made of shark-skin tied round a piece of wood; given to the British Museum by Sir Ev. Home, Bart. *Par.* 566.

Fig. 10. Celtic arrow-head, of flint. British Museum. *Par.* 566.

Fig. 11. Fish-hook. From British Museum. *Par.* 566.

Fig. 12. Artificial fish, similar to the "kill-devils" of the English fisherman, made of shell and bone; from my own collection. *Par.* 566.

Fig. 13. A contrivance made of the shells of cowries, and attached to a cord, said to be used for catching cuttle-fish. From the British Museum. *Par.* 566.

Fig. 14. New Zealand saws, made of sharks' teeth, fixed to a piece of wood, to cut up the bodies of slain enemies. From the British Museum. *Par.* 566.

Fig. 15. Arrow, to be thrown through a blow-pipe. British Museum. *Par.* 562.

Fig. 16. Harpoon, from Nootka Sound. British Museum. *Par.* 566.

Fig. 17. Polynesian hatchet, made of a flint blade attached to a piece of wood. From British Museum. *Par.* 566.

Fig. 18. Excellent hammer, made of stone, attached to a handle. From British Museum. *Par.* 566.

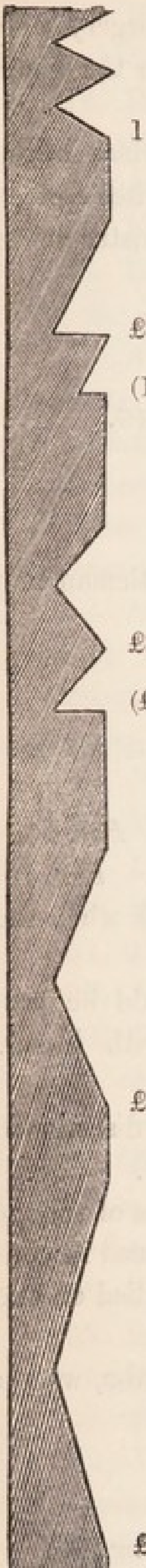
Fig. 19. Figure of an Exchequer Tally, from my own collection (*Par.* 375). By the kind and valuable assistance of my former neighbour, Mr. Walter Hawkins, and other authentic sources, I am enabled to illustrate this subject with a description of the method of recording the receipt of moneys paid into the Exchequer, by scores or notches cut upon the sticks called *tallies.* I am the more gratified at having it in my power to preserve this curious information, because I believe that it is not elsewhere so particularly or accurately detailed; and, curiously enough, I have ascertained that no gentleman in the Bank of England recollects the mode of reading them.

The tally-sticks were made of hazel, willow, or alder wood, differing in length according to the sum required to be expressed upon them. They were roughly squared, and one end was pointed; and on two sides of that extremity, the proper notches, showing the sum for which the tally was a receipt, were cut across the wood. All these operations were performed by the officer called "the maker of the tallies." On the other two sides of the instrument were written, also in duplicate, the name of the party paying the money, the account for which it was paid, the part of the United Kingdom to which it referred, and the date of payment; recorded with ink upon the wood, by an officer called "the writer of the tallies." The inscription, on the specimen figured, is taken from a tally given in acknowledgment for certain conscience-money remitted from a person unknown, for some former evasion of the payment of government duties.—"Pr. Hen. Hase pecun. ei remiss. de person. incog. pro causâ conscient. Mag. Brit. 19 Feb. 1824."

When the tally was complete, the stick was cleft lengthwise by the maker of the tallies, nearly throughout the whole extent, in such a manner that both pieces retained a copy of the inscription, and one half of every notch cut at the pointed end. One piece was then given to the party who had paid the money, for which it was a sufficient discharge; and the other was preserved in the Exchequer. The latter piece, however, was the smaller part; since there were about five or six inches left of the original thickness of the wood, cut off in a sloping direction, on the counter-tally, at the end opposite to that where the scores were made.

Like the court to which these records were peculiar, the time when they were originally used is unknown; since Madox states only that they were "very ancient, coeval, for aught I know, with the Exchequer itself in England." The system of reckoning by them was, however, completely understood so early as the twenty-third year of Henry II., 1177, when it is described in a very curious work, entitled, 'The Ancient Dialogue of the Exchequer,' attributed to Richard Fitznigell, bishop of London. The following extract from this record, illustrated by the annexed diagram and explanation, will, I hope, convey a complete notion of the practice of counting by tallies.—"The cutting," says the principal speaker, "is after this manner. At the top they place a thousand pounds; so that a cut of that thickness was about as wide as the palm of the hand; one hundred pounds as the little finger: the cut of one pound about a grain; that of a shilling less, but in such a manner that the vacancy might appear as deep as a small slit: a penny is distinguished by making a cut, and not taking the piece out."

It will be observed, by the annexed diagram, that the ancient proportions of the notches to their relative values, remained but little altered down to the time of the abolition of tallies. The width of



the score for £1000 was, however, reduced from a hand-breadth to one inch and a half; for £100 it was an inch, and for £20 half an inch; which are but little different from the old measurements. It will be perceived that the third notch for £10 shows that a notch of such a form and width, immediately preceding the £20 scores, would be reckoned as £10, but it must be in this position. The fourth notch is a £20 score, and is half an inch in width. The same arrangement is to be understood of the fifth and sixth scores, which are one quarter and half an inch in width, but cut diagonally, with one straight side; hence the half diagonal notch, preceding the entire spaces, would be expressive of ten shillings. As in the ancient time of the Exchequer, a penny was indicated by a short cut only, without removing any of the wood; and a halfpenny by a dot pierced on the tally. The character for a farthing was somewhat like a musical minim 𝅗𝅥, which was doubtless the initial letter of the word *quadrans*.

Rude and simple as was this very ancient method of keeping accounts, it appears to have been completely effectual in preventing both fraud and forgery for a space of seven hundred years. No two sticks could be found so exactly similar, as to admit of being identically matched with each other, when split in the coarse manner of cutting tallies; and certainly no alteration of the particulars expressed by the notches and inscription could remain undiscovered when the two parts were again brought together. And, as if it had been further to prove the superiority of these instruments over writing, two attempts at forgery were reported to have been made on the Exchequer, soon after the disuse of the ancient wooden tallies in 1834.*

Fig. 20. Part of a basso-relievo of one of the Nineveh marbles in the British Museum, showing the manner in which the Ninevites crossed the rivers on bags of air, also in boats, with warlike instruments. *Par*. 559.

DESCRIPTION OF THE WOOD ENGRAVINGS.

1. *Acarus* of Weekes, from a specimen which that gentleman sent me some years since; drawn by Mr. Ingall. *Par*. 38.

2. *Acarus* of Crosse. *Par*. 38.

3. Section of the Eye, a diagram. *Par*. 45.

4. Camera Obscura. *Par*. 46. A, B, C, D, E, F, stops for preventing the admission of extraneous light.

5. Diagram showing an image formed before the retina. *Par*. 46.

6. Diagram showing the image formed behind the retina. *Par*. 46.

7. Diagram showing how the lens would be carried back when the ciliary processes were emptied of blood. *Par*. 46.

8. Diagram showing the manner in which the lens would be projected forward when the ciliary processes were filled with blood. *Par*. 46.

9. Figure of the Optometer, which I have contrived, to distinguish disease and accurately adjust optical contrivances. *Par*. 48.

10. Diagram of an artificial nose. It consists of two pieces of sponge separated by a porous diaphragm. A piece of metal is placed in contact with each piece of sponge, and when the odour is applied on one side a voltaic circuit is produced. *Par*. 75.

11. Artificial organ of taste. It consists of a V-shaped tube, with a piece of platinum in each leg. *Par*. 85.

12. Thermo-voltaic circuit. *Par*. 103.

13. Artificial blood corpuscule. *Par*. 103.

14. Diagram of combinations of nervous impressions. *Par*. 147.

* 'Gentleman's Magazine,' Nov. 1834, p. 480, note.

44. Figure of *Fusisporium Solani*, after Martius. *Par.* 517.

45. Portion more highly magnified. *Par.* 517.

46. Fungus from diseased potato tubers. *a*, young sprout; *b b b*, full grown; *c*, thoroughly ripe, throwing its sporules; *d*, stalk. *Par.* 517.

47. Fungus. *Par.* 517.

48. Another species of fungus. *Par.* 517.

49. Figure of leaflet of potato-plant from Walthamstow, 1846, showing the *Aphis vastator* on the under surface. The specimen is placed in balsam of Canada, exactly as it was taken from the plant. *Par.* 517.

50. Potato leaf of 1847, showing the mode of its destruction by the *Aphis vastator*, from a specimen procured at Deptford. *Par.* 518.

51. Potato tuber, showing the fibre broken down, and the particles of starch free, after Martius. *Par.* 516.

52. Aphis of the hop plant in its first stage, from my own specimen. One of its most prominent characteristics is the presence of two little tubercles on the head. *Par.* 519.

53. Underground stem of potato-plant, showing the gangrene on its stem at various parts. *Par.* 519.

54. Hop leaf, natural size. *a*, winged hop fly, or hop aphis; *b*, hop lice; *c*, ladybird; *d*, larvæ, *e*, pupa, *f*, egg, of ladybird. *Par.* 519.

55. Cabbage aphis (larva). *Par.* 519.

56. Apple leaf damaged by an aphis. *Par.* 519.

57. Aphis (larva) of the bean, which frequently causes the total destruction of the crop. *Par.* 519.

58. Aphis (larva) of the melon and cucumber, which frequently destroys those plants. *Par.* 519.

59. One of the species of aphides (larva) which infest the oak. This tree is infested by five or six species. *Par.* 519.

60. Oat aphis (larva), which occasionally causes a total loss of the crop. *Par.* 519.

61. Rose-tree aphis (larva): lives upon the young shoots. *Par.* 519.

62. Cottony blight, which infests the apple-tree: *Aphis lanigera* (larva). *Par.* 519.

63. Aphis (larva) which sometimes destroys couch-grass. *Par.* 519.

64. Aphis (larva) of the cherry-tree. *Par.* 519.

65. Aphis which lives underground on the artichoke. It has a very long rostrum, though not nearly so long as that of another species which pierces the oak bark. *Par.* 519.

INSTINCT AND REASON:

DEDUCED FROM

ELECTRO-BIOLOGY.

CHAPTER I.

RELATION OF MIND TO LIFE.

Comparison between Man, Animals, Plants, Stones, and Pieces of Mechanism, 1.—Dogs: Passions and Affections of, compared with those of Man, 2; their capability and their end, 2, 3; their similarity to Beasts, Birds, Fishes, and Reptiles, 3.—The Daisy and other Plants, compared with Man and the Dog, 4.—Stone, 5.—Ice: its nature, 7.—Organic Bodies continually undergo Changes, 8.—Distinction between Organic and Inorganic Bodies, 9; changes not entirely dependent upon their own forces, 11.—The Daisy a piece of mechanism, 12.—External matter necessary to organic bodies for vital action, 13.—Wood: its composition, 14.—The Dog an example of Animal Existence, 17, 18; its career, 19; its volition, 20.—Volition of Animals regulated by Experience, 21.—The Mouse, 22.—Power of hunger over volition, 24.—Volition governed by two powers, 25.—Volition of the dog regulated by its peculiar mechanism, 28.—The Mind dependent upon the Brain and Nervous System, 29, 30.—Mechanism of the Dog compared with the Steam Engine, 31.—Steam Engine employed in the Bank of England, 32.—Perpetuation of Organized Beings, 34.—Structures of Bodies of Antiquity, compared with those of the Present Time, 35.—Microscopical Observations on Bones, 36; on Vegetable Structure, 37.—Organic Beings formed from Inorganic Matter, 38.—The Mind part of the Vital Actions, 14.

1. A MAN can hardly journey through the path of life without pausing to consider in what respect he differs from a dog, a daisy, a common stone, or a piece of mechanism, like a steam-engine.

Let us, then, now pause for a short time from our every-day pursuits, withdraw our attention from the excitement of this money-making city, and calmly and quietly consider the power by which we traverse the seas in ships, annihilate, as it were, time and space by telegraphs and railroads, descend into the depths of the ocean in the diving-bell, ascend to the clouds in balloons, turn night into day by lights, subjugate animals to our use, cultivate plants for food or raiment, predict the courses of the planets in the firmament, and know that all things in heaven and in earth are the work of an Infinite Cause, the Creator of man and of all things, animate and inanimate.

2. The dog, on observation, is found, in some degree, to have similar passions and affections to mankind. He exhibits hope and fear. He shows his love to his master, and will even risk his life to protect him. If irritated, he growls, snaps, and indicates his rage. Endowed with a keen perception of odour, he hunts out coveted objects, and, in this respect, even surpasses his master. His body is subject to disease. In process of time he becomes old and worn out, and finally dies, turning again to the dust of which he is made.

3. The dog, however, is but an example of thousands and tens of thousands of beings, which, though they differ strangely from him, yet possess, to a certain extent, similar qualities. If the dog be compared with the horse or elephant, many points of similarity occur. If we extend this comparison to birds, fish, insects, or reptiles, yet similarities may still be noticed; for all come into the world, live for a certain time, exhibit certain powers, and finally pass away, to be succeeded by other structures.

4. On examining the daisy, moreover, it, like the dog and like ourselves, comes into existence, continues but a short time,

and then ceases to live. The dead parts decay, and the elements of which they are composed revert to their original state, to be used again for some other purpose. My daisy, however, is but taken as an illustration of the great class of plants, some of which, with noble trunk, tower upwards, defy the tempest, and stretch their stately limbs to afford shelter to the wearied traveller or scorched beast. Other plants are, again, so diminutive (as some of the *fungi*), that they are enabled to live within the cells of other plants, and their parts are scarcely visible under the highest powers of modern microscopes.

5. When, however, we turn to the stone, we find that it began a stone, it continues a stone, and a stone it will remain, for ages and ages, unless some force acts upon it, and either crushes it into powder, or separates it into its component parts. This stone is an example of a large class of bodies, which are called lifeless things, and which exhibit neither affections nor passions.

6. The circumstances possessed in common by man, the dog, and the daisy, cause them to have the appellation of organic bodies, or bodies which have life, in contradistinction to stones, which are called inorganic, or lifeless bodies: and we have to study the relation of life to matter, and of mind to life.

7. To consider the qualities of a lifeless thing, we may perhaps substitute a piece of ice for the stone before mentioned. Now, chemistry teaches us that ice is a compound of oxygen and hydrogen—in fact, an oxide of hydrogen,—the two elements being held together by the force of attraction. No change is taking place between these elements, but it possesses its individual characteristic by virtue of that attraction. As long as that attraction exists, it is still oxide of hydrogen; but a destruction of that attraction, or a supervention of a new one, would cause it to be

no longer an oxide of hydrogen, but some other body. I may act upon this compound by external forces, and cause it to assume either the liquid or gaseous states, but it is still an oxide of hydrogen; and unless I destroy the attraction existing between the oxygen and hydrogen, it remains the same body. I can, in the same way, make this body hot, luminous, electrical, or vibrating, without any alteration in its composition. I might divide it to its finite particle, or increase its bulk indefinitely, but still its characteristic as an oxide of hydrogen would not be impaired.

The inorganic body, then, (a lump of ice or other matter,) consists of particles of matter, held together by attraction, the force being only exerted between its own particles. Other matter, indeed, may act upon this matter, though it would not contribute in any way to produce its individual existence. To express these facts in the fewest words and most comprehensive manner, we may state, that an inorganic body is a body which maintains its quality by forces which are exerted between the particles of matter of which the mass is made up.

8. In the whole range of organic bodies, or bodies which exhibit life, the particles of which they are composed are continually undergoing some change of arrangement, which change serves to effect some definite end. If we examine the daisy, we find that the whole plant has form, and the particles of which it is built up are held together by internal forces, like the particles of stone. In this respect the daisy is similar to the stone, both consisting of particles of matter held together by the force of attraction.

9. But if I further examine the daisy, I find that is built of a solid part, which consists of a series of cells, which give to it tenacity and form, and which, in fact, form the skeleton of the plant. This skeleton contains a fluid, which is termed sap; and

if we could either take away all the solid or fluid portion, the daisy would no longer exist as a plant, but would be entirely destroyed. In this respect we have a condition in the nature of a body with life, which serves to distinguish it from the lifeless or inorganic body; for, although an inorganic body may be either in the solid, liquid, or gaseous state, yet a lifeless body is never in the two states at one time. In contradistinction, an organic body can only exist by possessing both a solid portion, or structure, and a fluid, which is the sap.

10. On examining the daisy more attentively, we find that some change is constantly occurring, and this change serves to a definite end. The sap continually rises from the roots to the stalk, and thence to the leaves. In the leaves the quality of the sap is altered. New matter is drawn from the carbonic acid in the air, and a flower sprouts out, which is, in its turn, followed by seed. These seeds, in process of time, become new plants, and the original plant perishes.

11. These changes do not depend alone upon forces generated within its own structure, for we find it to be essential that certain external forces should act upon the whole plant, to enable these alterations in the arrangement of the particles to ensue. If I keep my daisy in too hot or too cold a temperature, I should certainly destroy it; and if I kept it in darkness, I should kill it. When, however, the temperature is properly regulated, and the sun's rays act upon it, this plant grows, and exhibits its lovely flower.

12. We thus find that our daisy is an elaborate piece of mechanism, made up of structure and sap; and that this mechanism requires the assistance of heat and light to maintain its action. If I were to destroy the mechanism of the plant, by stamping upon

it, or interfere with its action, by placing it too near the fire, in an ice-house, or in a dark cellar, then this mechanism would cease to act, and the plant would be destroyed.

13. Bodies manifesting life require food, or some external matter from which they derive their nourishment, which enables them to maintain their form, and to carry on their vital actions. In this climate, where spring suddenly bursts upon us in May, and warm weather succeeds to a protracted spring, the growth of trees and shrubs is so rapid, that, as we walk by the hedgerows, we hear the buds crackle, as though the shoots were determined to burst through the bond by which they have been so long imprisoned. This first growth is maintained by the sap which has been stored up through the winter, and which is now augmented by water drawn from the roots. This first growth is made in a few days; but afterwards the soft shoots require the entire summer before a sufficient quantity of ligneous matter is deposited to give them the character of wood.

14. The woody matter is derived from the atmosphere, through the medium of the leaves, which, when acted upon by light, decompose the carbonic acid, set free the oxygen of which it is composed, and take to themselves charcoal, in union with water. Chemistry has demonstrated to us that the wood of plants is composed of charcoal in combination with water; and hence they are enabled to draw the material from the carbonic acid which nature has placed in the atmosphere for that purpose.

15. My daisy is but a sample of a plant; but every other plant is equally an elaborate piece of mechanism, made up in a similar manner of structure and fluid, and requires a certain amount of temperature and light to enable it to serve the end for which it is destined.

16. As long as this mechanism acts, the plant is said to be alive, or to have life. When the action of the mechanism ceases, theplant is dead. *Life*, then, is the word which we assign to the capacity of an organized being to perform its functions; and a living body is an elaborate piece of mechanism, destined to act in a particular manner, through the medium of external forces. Upon this view, my daisy has life so long as it sends its roots downwards to absorb moisture;—so long as its leaves change the sap, to enable the flower-shoot to sprout, the lovely flower to appear, and the seed to ripen. The life of the plant is the term given to the performance of the functions of the structure, or, in other words, to the action of the mechanism.

17. Heretofore, I have taken the daisy as an example of an organic body, which, in common with all other plants, consists of sap and structure, requires to be acted upon by heat and light, and demands a supply of food to be constantly furnished for its nourishment. But we find that the dog is strictly similar in many respects. He also consists of fluid and solid parts, although, in animals, we call the fluid part blood, instead of sap, and the solid part structure, or parenchyma. The dog requires a certain temperature to be enabled to exist. He would die, whether he were either frozen or roasted; and, moreover, he must have a constant supply of food to keep him alive. When the dog is first born, he sucks, and derives nourishment from his mother's milk. He then grows, and gradually acquires strength to eat. The food which he selects is changed in his body, and renovates the wasted parts, which parts are continually thrown off from the body. After a time, the dog brings forth other puppies, he grows old, and finishes his career.

18. The dog may be taken as a good example of animal

existence; and whether we ascend in the scale to proud man himself, or descend to the lowest polyp, yet one, each, and all consist of blood and solids, and require certain conditions of temperature and light. Moreover, each animal must be supplied with proper food, and must throw off the wasted matter. Each, in its turn, brings forth young, becomes old, wears out, and passes away.

19. The career of the dog manifests life as completely as that of the daisy, and there is no difference in the kind of life. The word which we give to the action of the mechanism of the daisy in its appointed course, is also given to the action of the mechanism of the dog. The term used in both cases is *life*, the use of which implies nothing more than that the mechanism in both cases performs its appointed duties.

20. Although the dog is built up in a somewhat similar manner to the daisy, yet we cannot fail to observe a considerable difference between them. Two daisy-plants, placed under similar circumstances, would act alike: the roots would always tend to the dark; the leaves and flowers would tend upwards to the light. Two dogs, however, under similar circumstances, would act very differently, according to the education which they had respectively received from their master. The staghound, in chase after a stag, allows hares to cross his path without notice, whilst the harrier would follow the hare to seek its destruction. The action of the dog, in a particular course, is called volition, or will. The animal is said to will when he bites a stranger, or licks the hand of his master,—when he takes the food offered to him, and touches not other food till leave is given him to eat it.

21. If we examine carefully this power of volition, we find that the act willed is determined by the immediate stimulus which

incites the dog to act, modified by his education or experience. For instance, the excitement occasioned by a piece of meat being placed before his nostrils, so that the savoury odour might make him long for the dainty morsel, would act as a strong inducement to cause him to seize the food. But if, by experience, he found that, when he took the meat before his master gave him leave, the act would be followed by pain, in the shape of punishment, he would not take the meat when first offered, but would wait patiently till it was given to him. This statement is not a mere hypothesis: it occurs daily in every kennel, among well-trained dogs, as they do not touch the food until leave is given by their keeper. When, however, the pangs of hunger increase, the fear of punishment lessens, and, sooner or later, the meat is inevitably seized.

22. Many years ago, I caught a common mouse in a trap, and, instead of consigning it to the usual watery grave or to the unmerciful claws of the cat, I determined to keep it a prisoner. After a short time, the little mouse made its escape in a room attached to my father's residence in the Bank of England. I did not desire the presence of a wild mouse in this room, and therefore adopted means to secure him. The room was paved with stone, and enclosed with solid walls. There was no hope for him that he would ultimately escape, although there were abundant opportunities for hiding. I set the trap, and baited it with a savoury morsel, but day after day no mouse entered. The poor little thing gave unequivocal signs of extreme hunger, by gnawing the bladder from some of my chemical bottles. I gradually removed everything from the room that he could possibly eat, but still the old proverb of "Once caught, twice shy," so far applied, that he would not enter my trap. After

many days, on visiting the apartment one morning, the trap was down, the mouse was caught;—the pangs of hunger were more intolerable than the terrors of imprisonment. He did not, however, will the unpleasant alternative of entering the trap, until he was so nearly starved that his bones almost protruded through his skin; and he freely took bits of food from my fingers, through the wires of the cage.

23. In illustration of the effect of education or experience in regulating volition, I may tell the story of a favourite puppy which my children possessed. One morning, as soon as I had left the room, he deliberately got upon the table and carried off a chicken destined for my breakfast. When I returned I scolded, and exhibited unmistakeable evidence of disapprobation at his conduct in appropriating without leave that which was destined for my own particular use. The puppy thus learnt that it was not altogether commensurate with his personal convenience to take without leave that which belonged to his master, and, since then, he has willed to wait for the food which is in due course supplied to him.

24. Most lawgivers mercifully hold that, under the extreme pangs of hunger, a human being should not be punished for stealing food. Doubtless our lawmakers have humanely reasoned, that although the party knows the error of taking another man's goods, yet the preservation of his own life would cause him to will an evil act to maintain his existence; and, if a prosecutor should be found so hard-hearted as to seek to punish under such awful circumstances, mercy steps in, and declares that the act, although it cannot be justified, shall nevertheless be excused.

25. If we examine these cases of volition, we find that the creature acts according to two circumstances: firstly, according to the immediate stimulus; secondly, from the experience which he has

received of former acts. From these and other observations, I have defined volition to be the resultant between the force of an immediate stimulus and of all former ideas existing in the individual.

26. When we compare the dog with the daisy, we find that this action upon experience does not appertain to the latter; its action is in no degree modified by former impressions. Under the influence of light, the leaves stretch upwards and the roots enter the ground. It is true that the roots may stretch more in one direction than another, but that would entirely depend upon the soil being more favourable to growth in the one direction than the other. Under the influence of light and heat, it must come into flower, and perform its various functions.

27. As far as concerns also the growth of the dog, it increases in bulk whether it will or not, in a similar manner to the plant; but there are certain actions in the dog which are regulated by former events, which have no such influence on the animal.

28. If we examine the dog, we find a peculiar mechanism by which the acts of volition are regulated. We observe that he has eyes to see with, a nose to smell with, ears to hear with, a tongue to taste with: and, further, if pinched, he shows evidence by a growl that he feels. Moreover, on dissecting the dog, we find in its interior white chords called nerves, which run ultimately to a large organ placed in the head and in the centre of the vertebral column, which is termed the brain and spinal chord. These peculiar structures are not to be found in any plant, though to a greater or less degree they exist throughout the whole animal kingdom. As a general rule, the more brain, the more nerves, the more spinal chord, which are possessed by any animal, the more extensive are the evidences of volition in the creature.

29. We moreover find, that, to exercise the functions of the mind,

all parts of the nervous system must be entire: the eye alone cannot see, nor the ear hear, without nerves to carry the impression to the brain, and the brain to receive those impressions. But whenever the dog or any other animal sees, hears, or remembers, he is properly said to evince mental action; and mind is thus the term which we assign to the action of the brain and nervous system.

30. For the brain and organs of sensation to act, it is absolutely necessary that the animal should be alive, or that the actions which appertain to its growth and nutrition should be carried on in their proper manner: in fact, that the food should be digested, that the heart should beat, that the blood should circulate, and that the creature should preserve its form and character. From these facts we perceive that the dog possesses a higher organization, or a more complicated structure, by which he evinces the power of mind; and thus, in common language, he is a more complicated machine.

31. If we compare the elaborate mechanism of the dog with that of a steam-engine, we find many points of similarity. The steam-engine cannot act unless its mechanism is entire; and, amongst other parts, it must have a boiler to hold water, and a fire-place to supply the heat necessary to convert the water into steam. Moreover, the steam-engine cannot act without a due supply of food in the shape of coals, coke, or wood, which are consumed in the fire, and, by their combustion, evolve the necessary heat. As the water is converted into steam, fresh water must be continually supplied to the boiler. When all these things are duly supplied, the steam can move the piston up and down. This communicates its motion to the other parts of the contrivance; and thus, the whole forms one machine, the action of which tends to a defined purpose.

32. Well contrived steam-engines, as that in the Bank, supply

themselves with food or fuel exactly in proportion to the wants of the fire. They moreover pump water into the boiler as fast as it evaporates. In witnessing such a circumstance as this, we are astonished to perceive so much done for hours without a man, or even a boy, to regulate the machine. The machine almost seems to possess judgment, in furnishing its supplies exactly according to the demand. In time of danger it can be made to ring a bell, blow a whistle, or sound an alarm, to warn the engineer that his attendance is required.

33. Here the analogy stops, for no machine has ever been contrived which has the power of repairing its various solid parts. No steam-engine can make a new boiler, a new piston, or other part of the apparatus, nor, when worn out and decayed, can give rise to other little steam-engines which may take its place. These, however, are differences in degree rather than in kind, for, as far as the action of the steam-engine goes, it is similar to the action of an organized being.

34. The capacity of an organized being to be perpetuated by the construction of other organized beings is truly wonderful, for the essential peculiarities are transmitted for thousands and thousands of years. When we inspect the interesting remains of Egyptian antiquity in the British Museum, we are struck with the similarity of the various animals which are represented in the drawings, or which are preserved by the process of embalming. Upon this point the illustrious Cuvier observes, "I have carefully examined the figures of animals and birds engraven on the numerous obelisks brought from Egypt to ancient Rome. In the general character, which is all that can have been preserved, these representations perfectly resemble the originals as we now see them. My learned colleague, M. Geoffrey St. Hilaire, col-

lected numerous mummies of animals from the sepulchres and temples of Upper and Lower Egypt. He brought away cats, ibises, birds of prey, dogs, monkeys, crocodiles, and an ox's head, embalmed. There is no more difference between these relics and the animals we are now acquainted with, than between human mummies and the skeletons of the present day."

35. In reference to the same subject, Lawrence, in his valuable work on man, observes, that animals are just the same now as at any, even the remotest, period of our acquaintance with them. The zoological descriptions of Aristotle, composed twenty-two centuries ago, apply in all points to the individuals of the present time; and every incidental mention of animals, or allusion to their characters and properties in the writings of historians, poets, fabulists, confirms this identity of form and endowments.

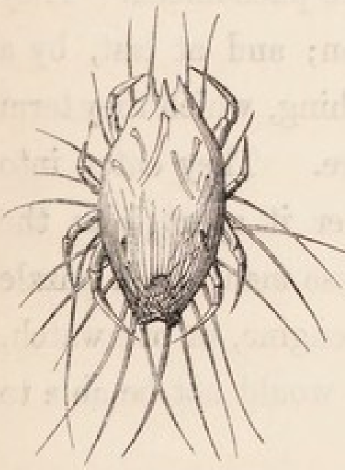
36. I have confirmed these general remarks by microscopical anatomy. Some years ago, I investigated the structure of bone, and, I believe, had the pleasure of first demonstrating that the parts of bone which were supposed to contain the earthy matter are really little cells or cavities, communicating together by fine tubes. I found the same structure in Roman bones. I even traced up the investigations to the bones of the mummy, and observed that these little cavities still existed, filled with a sort of bituminous matter used in the mummifying process. I still further extended my inquiries to the bones of the former tenants of the globe. I there found that the mighty Icthyosaurus, the tyrant of the water, and the vast Mastodon, the giant of the land, still possessed these cellules; so that I proved that bone in its structure is made upon the same plan from the primeval epochs of creation.

37. If we carry on our investigations into the structure of vege-

table productions, we find that, as in animals, a similar structure exists throughout all ages. The cellular structure of woods is found in the fossilized remains of former states of the earth's surface. Fossil woods and vegetable structures are now preserved, which exhibit the structures peculiar to the genus; and I have in my own cabinet a few beautiful specimens of fossil woods, and in one or two the remains of starchy or gummy matter are clearly discernible in the cells of the texture.

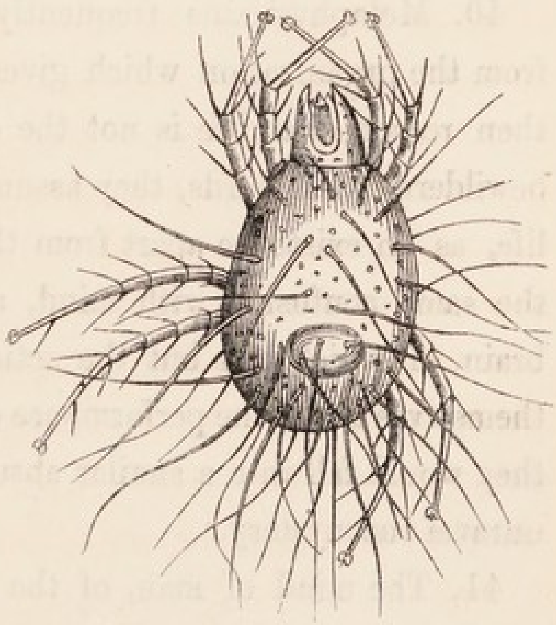
38. As to how far one organic body may be modified to form a second, remains an unsettled question, except that we know that mules may be produced as a cross of two different species. With respect to the remarkable results supposed to have been obtained by Crosse and Weekes, who consider that new animals have arisen under electrical excitement, a mystery still hangs. Mr. Weekes, during his experiments, has observed several different species; and Mr. Crosse tells me, that he believes that many creatures have appeared, during his experiments, from purely inorganic matter.

Fig. 1.



ACARUS OF WEEKES.

Fig. 2.



ACARUS OF CROSSE.

As far as appertains to this subject, I am of opinion, that the facts should be neither believed nor disbelieved, but kept in abeyance for fresh experiments. The subject has been taken up with much ill-judged acrimony; for the question really resolves itself into this proposition—Has, or has not, the Creator endowed inorganic matter with the power of assuming, under the influence of certain forces, an organic form?

39. A savage, when he viewed a watch for the first time, is said to have exclaimed that it was alive; but *life* is not the term which is assigned to the action of any piece of human mechanism. The watchmaker would stare if a customer asked whether a chronometer was either alive or in health, but he would ask whether it performed properly. The engineer would be equally surprised if he were asked whether his steam-engine exhibited a good judgment. The action of any engine, watch, or other mechanical arrangement, is called its performance; and, therefore, the word *performance* is used in relation to such action, in a sense similar to that in which the term *life* is employed to denote the action of organic structures.

40. Metaphysicians frequently consider the term life apart from the organization which gives rise to the phenomena. They then reason that life is not the organization; and at last, by a bewilderment in words, they assume a something, which they term life, as an existence apart from the structure. They enter into the same confusion with mind, and consider it apart from the brain, of which it is but the action. If these men would puzzle themselves about the performance of a steam-engine, or of a watch, they would fall into a similar absurdity, and would not be able to unravel the mystery.

41. The mind of man, of the dog, and of all other animals, is part of the vital actions. It is the result of the elaborate

mechanism perfected by nature. The performance of the machine is the action of a more simple mechanism devised by a human being. What, therefore, is the difference? The performance of the machine is the result of the mechanism which was first formed by the mechanism of man, which in its turn has been created. Life is the result of the mechanism immediately constructed by the Great Creator Himself. Life, therefore, differs not in kind, but in degree, from the performance of the engine; but as much as the power of man is inferior to the power of the Creator, so is the performance of machines which we construct inferior to the mind of man, emanating as it does from the master-work of God.

CHAPTER II.

ON THE ORGANS OF SENSATION IN MAN AND ANIMALS.

General Remarks, 42, 43.—Vision, 44.—The Eye, a Camera Obscura, 45; adjustment, 46.—Optic Nerve, 47.—Optometer, 48.—Vision in Animals, 49; in the Parrot, 50; in Pigeons, 51; in the Eagle, 52.—Structure of the Eye in Birds, 53. —Estimate of distance in Birds, 54; in Pigeons, 55; instance in a Pheasant, 55.—Nictitating Membrane, 56.—Dogs often near-sighted, 57.—Hyena quick-sighted, 58.—Mole, blind, 59.—Reptiles, quick-sighted, 60.—Chameleon, 61.—Vision in Fish, 62; in the Tortoise, 63; in Insects, 64; in the Dragon-fly, 65. —Vision common to many animals, 66.—Artificial Eye, 67–69.—Nose, 70.—Nasal Organ of Man imperfect, 71; in the Dog more perfect, 72.—Odour useful in choice of food, 73.—Nasal Organ in Insects, 74.—The Organ of Scent a voltaic battery, 75.—General consideration, 76.—Range of Hearing, 77; in the Dog, 78, 79; in various animals, 80; in Tortoises, 81; in Serpents and Lizards, 82; in Fishes, 83.—Intimate Structure of the Ear, 84.—Taste, 85.—Feeling, 86; of the Skin, 87; to estimate heat and cold, 88.—Death from cold, 89.—Feeling in Fish, 90.—Skin acted upon by Light, 91.—Temperature influences Plants and Stones, 92.—Tact, 93, 94; in the Elephant, 95; in Monkeys, 96; in Ducks, Geese, &c., 97; in Animalcules, 98; in Fish, 99; in the Snake, 100.—Man's superiority not dependent upon tact, 101.—Tact derived from Nerves of Skin, 102.—Mechanism of Feeling and Tact voltaic, 103.—Primitive nervous fibre, 104.—Compound Nerve, 105.—Organs of Sensation pieces of Physical Mechanism, 106.

42. We have now found that man is an organized being, who, during his life, exhibits a certain amount of mental power by virtue of the mechanism of his nervous system, and it is now requisite that we should compare the result of its operations with that of other organized beings.

43. And first, in making our comparisons, we must observe how far the organs of sensation in the human being surpass, or are inferior to, those of other portions of the animal kingdom, and how far the peculiar qualities of the mind, which give to man his superiority, depend in any manner upon a difference in the organs of sensation. In making this comparison, we must study the power of sight, hearing, smelling, tasting, and feeling, in the various members of the animal kingdom.

44. Of all our senses, that of vision gives us by far the most extensive knowledge of natural objects, as by means of the eye we obtain our ideas of light, colour, and form. By means of the eye we estimate magnitude, height, and also the relative position of bodies to each other. Man values his eye above every organ of sensation, as that sense which is most useful to him. How painfully and graphically does Milton picture the value of the eye, and the severity of the affliction which attends its loss!

> "Thus with the year
> Seasons return; but not to me returns
> Day, or the sweet approach of eve or morn,
> Or sight of vernal bloom, or summer's rose,
> Or flocks, or herds, or human face divine;
> But cloud instead, and ever during dark
> Surround me, from the cheerful ways of men
> Cut off, and, for the book of knowledge fair,
> Presented with an universal blank
> Of Nature's work, to me expunged and rased;
> And wisdom at one entrance quite shut out."

45. If we take a section of the human eye (*fig.* 3), we find that it is a camera obscura, an optical contrivance by which a perfect image of any object is formed at the back part of the eye. Any of my readers, curious to prove this point, may procure a sheep's eye at the butcher's, and carefully scrape away the white

part at the back, when, on holding the eye towards the candle, a beautiful inverted image of the flame is depicted upon the part scraped.

Fig. 3.

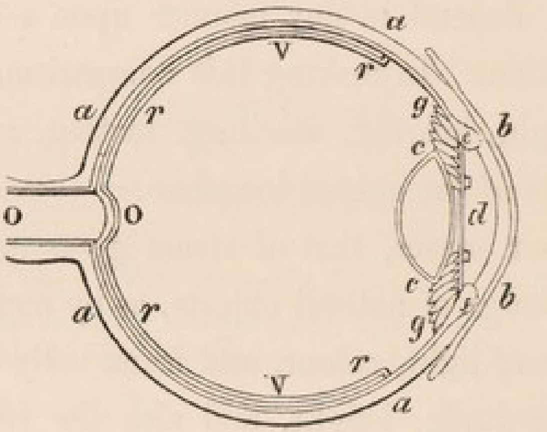
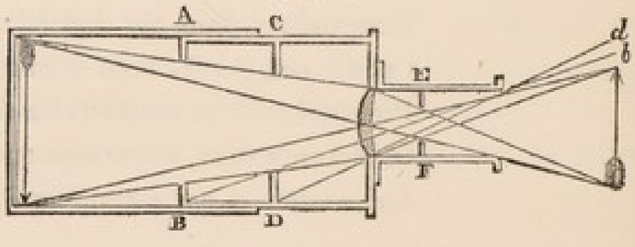


Fig. 3.—Vertical section of the eye.—*a a a*, Sclerotic coat, or white of the eye. *b b*, Cornea, or glassy part through which we see. *r r r r*, Retina, or nervous expanse: the choroid lies between the retina and sclerotic. *o*, Optic Nerve. In the diagram it appears to be in the axis of the eye, but in reality it is about the $\frac{1}{10}$ of an inch from the axis on its inner side, and a little above the median line. In the axis is a spot called the foramen of Sömmering, which is in fact the point of most distinct vision. *e, f*, Iris, or curtain. *d*, Anterior chamber, or aqueous humour. *c*, Lens. *g g*, Ciliary processes, for the adjustment of the eye to distance. *v v*, Vitreous humour.

46. A camera obscura (*fig.* 4), however, requires the lens to be adjusted to suit different distances. In all instru-

Fig. 4.



ments of this character a contrivance exists by which the lens can be moved backwards and forwards to suit different distances; otherwise, the image might be formed behind or before the medium placed to receive it, as in the subjoined wood-cuts (*fig.* 5, 6). There is much difference of opinion as to how this operation is performed in the human eye; but I have ventured as a theory of the process, that the lens of the human eye moves backwards and forwards as the resultant of forces which would arise from blood entering the ciliary processes, as shown in the subjoined diagrams.

Fig. 5.

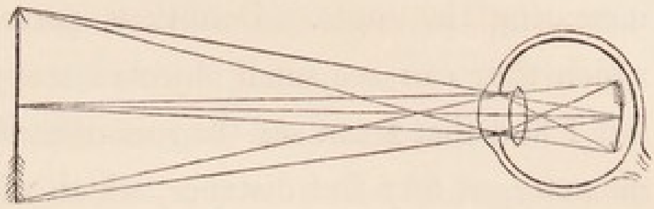


Fig. 6.

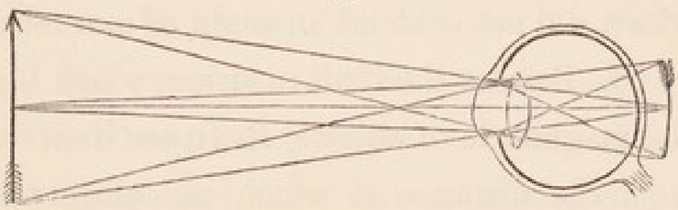


Fig. 7.

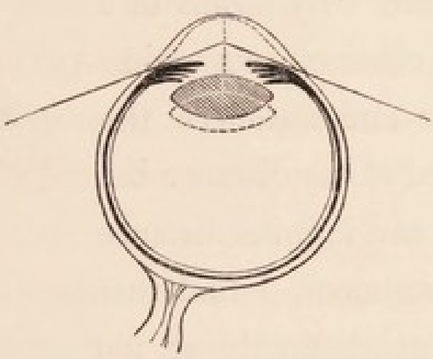
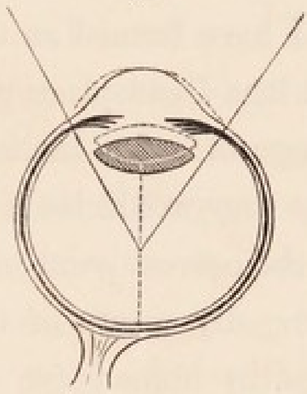


Fig. 8.



47. The human eye is a piece of optical mechanism by which a perfect image, as I have before explained, is formed at the back part of the eye. The perfection of vision, however, must depend upon the number of nervous fibres which carry the impression to the brain. Upon this principle, there is a limit to the extent of vision. We cannot see objects which are below a certain size, or, rather, which do not subtend a certain angle; thus, the largest object may be rendered invisible by removing it to a sufficient distance, and conversely, the smallest may be rendered visible by increasing the visual angle. The inverted telescope will render objects invisible by diminishing the angle; and the microscope

renders objects apparent which were previously invisible, by increasing the angle. Doubtless, persons differ in the extent to which they can see small objects: many cannot see below 40″, but I find that I can see the round head of a pin $\frac{1}{20}$ of an inch in diameter, at fifty feet distance, which will only afford an angle of 17″. I have even seen a fine platinum wire under circumstances which did not subtend an angle of more than 4″.

Fig. 9.

48. Besides the limit to vision, which is afforded by the magnitude of objects, there are limits which arise from the distance at which the objects are placed. For the purpose of examining the eye more particularly in this matter, I have contrived an instrument which I have termed an Optometer. By means of a convex lens I can place print or other objects within the range of a few inches under circumstances the same as they would be if situated at any distance between the nearest point of sight and infinite distance (*fig.* 9). By means of this instrument, I find that the healthy human eye sees most distinctly at ten inches' distance, and can adjust itself so that man can view objects placed from $2\frac{1}{2}$ inches' distance to the immeasurable distance of a fixed star. For the purpose of determining disease and adjusting glasses this instrument has proved to be of the utmost possible value.

49. It is quite true that I cannot subject the eyes of other animals to experiment, so as to obtain as clear a knowledge of their powers of sight as I can that of the eye of the human being. Nevertheless, by diligent observation, I am enabled to arrive at a somewhat similar knowledge, and find out the distances at which they can view objects, and the size of those objects which are visible to each particular creature.

50. I have observed the powers of vision in a parrot, and I have noticed that he can see minute seeds close to his beak with perfect clearness. He also recognizes persons at a considerable distance. He flutters and calls, to attract the attention of those to whom he is partial. It is thus apparent that the powers of adjustment are as perfect as those of man, and, moreover, as minute objects can be detected by him.

51. Some time since, I had some pigeons behind my house in Finsbury Circus. They used to spy me out from the tops of the neighbouring roofs and chimneys as I sat in my consulting room, and fly upon the window to be allowed admittance. I always found, that from great heights and considerable distances they could instantly recognize me from others. When I went into the garden they came down from all quarters, and settled most unceremoniously upon my head, shoulders, and arms, in such numbers, that the projecting parts of my body would no longer hold any more, when they would fight amongst themselves to determine which should remain. The sight of these pigeons must have been excellent; and it requires a very keen sight to tell one person from another at a distance, especially when you look into an apartment through the window.

52. These facts are cases of ordinary observation; but we observe the eagle to soar at such an altitude that the eye can scarcely detect it, and then to pounce upon his prey. We are compelled to admit that their power of sight is better than that of man; by which I mean, that they see smaller objects, or objects under a smaller visual angle.

53. There is a considerable peculiarity in the structure of the eye of many birds. In the centre, or part of most perfect vision, the retina is thrown into folds, probably to allow a greater number

of nerves to be there supplied, and thus to render the power of vision more minute.

54. Not only do birds adjust the eye to distances as extensively as man, and see as minute objects, or more minute objects; but, through the medium of the eye, they judge of the distances of bodies. If they had not this power, they would not be enabled to settle with that precision from a great height upon any definite object, but they would dash against masses of matter and be destroyed. With respect to clear glass, birds require some experience, as they are not aware that it is a solid body, and will fly against the windows with such great force as to pass completely through them.

55. I once desired to have some wild rock-pigeons, to note their habits, but the person to whom I applied to procure them particularly cautioned me about the damage which they were likely to commit upon glass; and this caution brought to my mind a singular circumstance which occurred at the Bank of England when I was a little boy. The parlour of this establishment is a most beautiful room, from which emanate those edicts of the Directors which are, in times of distress, as terrible and fearful to speculators of the mercantile community as the bulls of the pope are to believers in the potency of his holiness. The windows of this room are double, to exclude sound and to preserve the temperature of the room. One day, great was the astonishment of the gentlemen assembled, to observe a hen-pheasant dash completely through the two panes of glass and alight upon the carpet, a little shaken by the concussion, but not killed. I saw the bird the same afternoon, and she seemed to be but little the worse for the damage which she received in the course of her unceremonious intrusion.

56. The eyes of birds are, then, of the highest importance to

them. They are large in proportion to the size of the animal, and even the skull is so formed as to receive large eyeballs. Nature has also provided a special contrivance, called the nictitating membrane, by which the creature can wipe the glassy part of the eye.

57. Animals have generally very good eyes, and can see at certain distances, and can distinguish minute objects. As a rule, perhaps, the eye of the dog is very inferior to that of birds, and I can call to mind no instance of a dog seeing at any very extraordinary distance; nevertheless, greyhounds invariably hunt by sight, and not by scent. My own impression, from observation, is, that most dogs are short-sighted. I yesterday saw a good example of this apparent imperfection of vision. A child visited a house where there was a dog. From frequently visiting at the house, a mutual attachment existed between the dog and the child. When the child arrived, the dog barked violently at him, and did not seem to recognize its friend till it had applied its nose, when immediately it jumped upon him, and seemed to feel such unbounded joy that it could hardly express it.

58. Some animals are very quick-sighted. A friend of mine was present at a wild beast show, at which an hyena was making his accustomed laughing howl. A boy, amused with its liveliness, pushed his fingers through the cage at him, but the hyena was too sharp for the boy. It saw the fingers, and, before the boy could withdraw them, snapped them off, swallowed them, and then repeated his singular laughing song.

59. There is a common animal, however, in the fields, which, living almost exclusively in the dark, in subterraneous passages, has no eye: this creature is the sleek-skinned mole. It is a common proverb to speak of a person as blind as a mole, but it is

equally common to hear the casual observer speak of the error of the proverb, because, on turning aside the hairs on each side of the head, a little black tubercle appears, which is called an eye. These black tubercles have no optical contrivance, and a distinguished physiologist has shown that the little tubercle is not supplied by the optic nerve. In consequence of this creature having no eyeballs, there are no sockets in the skull to receive the eyeballs. I have tried once or twice to keep the creatures, to observe their habits, but they proved restless in confinement and speedily perished.

60. Some reptiles have quick and ample powers of sight, which enable them to see over a considerable range of distances. I kept one of the beautiful Guernsey lizards in a Ward's case in my dining-room, and he soon became very tame, and would take food from my fingers. He preferred for breakfast a dish of black beetles, and my servant used diligently to set traps at night that he might not go without his usual repast in the morning. As soon as the food was brought into the room, he came to the door of the case, ready to seize the beetles as soon as they were offered to him; and his powers of sight, both for near and distant objects, could certainly not be doubted by any reasonable being.

61. The eyes of the chameleon are very peculiar: one eye can look forwards, and the other can be directed backwards at the same moment; a manœuvre which no doubt is well contrived to enable the creature to spy an insect. These curious reptiles are not often brought to this country, but I am informed that they will live a long time upon meal-worms.

62. Fish are well known to possess a keen sight. An angler has no chance to hook many of the finny tribe unless he keeps himself carefully from sight. It is curious to come upon a shoal

suddenly, and observe how rapidly the fish dart off as soon as they perceive any signs of movements on shore. When the angler seeks to kill the chub while basking on the top of the water, he must drop the bait unseen, and he will surely kill the fish. If the fish first sees the angler, the disciple of Isaac Walton might as well have stopped at home and angled in his water-butt.

63. For some years I had a pet tortoise, who was sufficiently inactive during the winter season; but, when the warm weather set in, he was lively and sprightly enough. It used to amuse me to watch him upon the lawn, for he was especially partial to yellow flowers. He would begin to munch a buttercup, and, before he had half finished, he would spy out another a long way off. Hardly waiting to swallow the last mouthful of the first flower, away he would toddle to secure the precious morsel, and he would thus proceed from flower to flower for some considerable time. After he had cleared away all the buttercups from the lawn, he would proceed to the flower-beds, and devour the yellow flowers, to the great horror of the gardener, who wished his sight was not quite so acute.

64. Whilst considering the powers of sight, we should not omit the sight of insects; as it is a most remarkable circumstance that, instead of having an eyeball which can move about as ours do, they have an eye which multiplies objects like the many-faceted glasses shown by the pensioners in Greenwich Park. Insects are, nevertheless, by no means deficient in sight, and every person must have remarked how the common house-fly can perceive the slightest movement of the hand.

65. It is a marvellous sight to watch the dragon-fly hawk up and down the groves in a summer's day after flies. It evidently judges of distances with the greatest nicety. It perceives another insect, it follows it and catches it. When the insect is secured, it

is carried off to the top of some bare branch to be eaten at leisure; the whole operation being conducted in a manner which clearly shows that the dragon-fly estimates distance to the greatest nicety; for, if it were in error but the fractional part of an inch, it would either never catch its prey or dash itself to pieces against the trees.

66. These instances, which I have quoted abundantly, show that sight is not peculiar to man; and that, amongst organized beings, according to their wants and exigencies, some are to be found with a power of mind superior to man, and some inferior. We may, therefore, fairly assume that the superiority of the mind of man cannot depend either upon the existence or upon the quality of his eye. In all cases, where animals possess an eye, they are made acquainted with visible objects by virtue of their being illuminated with light.

67. We are naturally led to inquire if any difference exists between the eye of an animal and a piece of mechanism which man can construct. As far as regards the optical part of the apparatus, the contrivance used daily in his camera obscura exactly corresponds with the structure of the eye. Even here we find a perfection in the work of nature which we cannot obtain in any work of man.

68. For instance, the lens in the camera obscura is of the same density throughout, because we cannot make it otherwise. By mathematics we can calculate that the lens ought to increase in density towards the centre, and we even find that nature has so constructed the organic lenses. This, however, is rather a difference in the workman-like manner in which the camera and eye are constructed, than in the essential character of the organ itself.

69. The optical part of the eye would exist in vain were there not nerves to carry the images to the brain. From my experi-

ments I believe that it is sufficiently demonstrated that the light falling upon the nerve determines a voltaic current which passes through the nerves to the brain. From this fact we might make an artificial eye, if we did but take the labour to aggregate a number of tubes communicating with photo-voltaic circuits. As far as a single fibre is concerned, I have not the slightest difficulty in imitating the arrangement ; but these fibres must be enormously magnified to suit the capacity of my fingers to manufacture them. Having one nervous element, it is but a repetition to make an eye ; and, apart from the mere trouble of manipulation which belongs to this as well as to every other process, there is no reason why a view of St. Paul's in London should not be carried to Edinburgh through tubes like the nerves which carry the impression to the brain. The difference between the real and artificial eye is the difference between the work of the created being and that of the Creator.

70. I have now to take a short review of the differences manifested between the nasal organs of man and those of animals. We find that odours in all creatures possessing the organ of scent must come in contact with a membrane. From the superiority of our sight and hearing, we use this organ but to a limited extent compared with many animals. The perfection of any organ always follows its extent of organization, and in this case we find that the mechanism of the nose of man is more simple than the elaborate convoluted ethnoid bones which are to be found in the cat, dog, hare, and in many other animals.

71. Man uses the nasal organ but very little, and I never remember to have seen, amongst the thousands of books now published, any work upon the science of odours. Yet, unfortunate creatures who have been born deaf, dumb, and blind, have used their nasal organ to make them acquainted with persons and

things; and it is recorded that a poor boy, under such circumstances, used to take likes and dislikes against persons who called at the house entirely by their peculiar odour.

72. When we place the nose of man in comparison with that of the dog, the discrepancy is sufficiently apparent. When the sportsman hunts the hare in an open country like the Brighton downs, where the poor thing can get a fair start, the hare will run for miles and miles, and then return to the spot from whence she started. During the whole of that period, perhaps, the dogs have never once seen her, but tracked her course entirely by appreciating the odour which she has left in the grass by her footsteps as she ran.

73. If we carefully and attentively observe animals, I think we shall conclude that they select their food in great measure by the knowledge which they obtain through its odour. Whether we throw a cabbage, carrot, or anything else to a horse, cow, pig, or any other animal, he always gives a goodly sniff before he ventures to eat; and, therefore, there is fair reason to suppose that the curious choice which different animals exhibit in the food which they eat is in great measure regulated by this organ.

74. There is one fact with respect to the nasal organs of insects which I have often observed, but which is extremely curious, as it seems to indicate that these creatures have an extraordinary faculty of scent. In summer, when wasps and flies are troublesome, it is usual to place arsenic and syrup mixed together, which they freely eat, and are extensively destroyed. If, however, corrosive sublimate be substituted for the arsenic, though the mixture to the human nose is quite inodorous, yet the creatures detect the villany, and leave the vessel with mingled feelings of desire and fear, but not one will touch the compound. These creatures wave

their antennæ over the poisonous mixture, as though they smelt at the poison by these organs.

75. The nasal organ is probably excited by the various odours being absorbed, and, when excited, a series of nerves carries the impression to the brain. I have found that the voltaic force is set in motion in the cat and rabbit when the organ is stimulated. An artificial nose may be easily constructed, which shall be acted upon by odours on a similar principle (*fig.* 10). The artificial nose will carry a knowledge of the presence of odour to an adjoining room, and differs solely from the natural nose in its being a less perfect piece of mechanism.

Fig. 10.

76. From the few facts which I have now enumerated, it must be apparent that, as the nasal organ of man is greatly inferior to that of most other animals, his mental superiority cannot depend upon possessing that organ of sensation.

77. Considerable difficulties present themselves in the comparison between the faculty of hearing in man and animals, and it requires much patient observation to judge accurately of the power which other creatures possess. Sound is collected by the external ear, and impinges upon the membrane of the tympanum, which is thereby thrown into vibrations. From this membrane it is continued to the inner ear, partly through a series of bones and partly through the air. The inner ear, to which the auditory nerve is distributed, comprises three semicircular canals, and a curious structure called the cochlea. To these parts the blood-vessels and nerves are distributed. Without entering into long disquisitions, or probable or possible modes of action, we may assume that the arrangement is of such a character as to be suit-

able to allow the vibrations, according to the pitch, to act upon particular nerves, or, according to the direction from whence the sound originates, to influence particular localities. Man is capable of appreciating the sounds of a range of about 12½ octaves; and, according to a calculation which I have made, it would require about 3,200 nerves to carry these sounds to the brain.

78. All quadrupeds have the power of hearing. In the stillness of the summer's evening the chorus of dogs, each barking with his peculiar voice, is striking. The large dog barks with his deep bass voice, and the little one in a note higher, in the treble. The noise extends from cottage to cottage, from village to village; and as far as the human ear can reach the creatures answer each other. There are instances in which we may fairly presume that the dog hears the note of a companion, and answers him, before man can appreciate the sound.

79. Dogs exhibit signs of being peculiarly affected by sounds. They will constantly howl at music. We had a dog which had a great objection to the sound of the bell at Lothbury church which tolled at eight o'clock on Sunday morning. This proceeding seemed much to displease the dog, for, no matter where he was, he would contrive to get out of doors and howl in the most hideous manner during the entire time of the unmeaning performance. In this case we can but admire the taste of the dog in testifying its disapprobation at the barbarous custom; although the bell-toller did assure me that his bells were charming ringers.

80. If we judge of the powers of hearing from the perfection of the mechanism of the external ear, many creatures may be supposed to have powers of hearing far superior to those of man. Man has very little power over the muscles of the external ear; and in only one instance do I remember to have seen a

gentleman who could extensively move these parts, or, in other words, could prick up his ears like a donkey. It is a curious fact, that this gentleman is a first-rate musician as an amateur.

81. With respect to the lower animals, I have observed that tortoises can not only hear, but can distinguish people by the voice. I knew a lady who had a pet tortoise, and when she called "toitoi" in a peculiar manner, the little creature used to turn its head and look as if it would have smiled, had it but the soft part of the face by which it could thus have expressed the gratification at the friendly voice.

82. Serpents and lizards are said to delight in music, and raise their heads in ecstasy at the concord of sweet sounds. If we believe the accounts rendered by travellers, the most deadly serpents are quiet under so soothing an influence. There is, however, reason to suppose that in the majority of cases the serpent-charmers extract the poisonous fangs before they exhibit their feats.

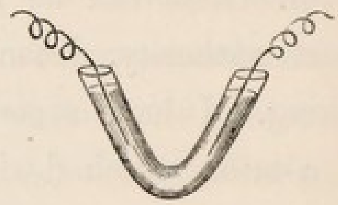
83. There can be no question but that fishes hear. The great authority, Isaac Walton, enjoins the strictest silence in fishing. I have some gold-fish at my residence, which I keep in a tank, which during summer-time is completely covered by the leaves of an aquatic plant, except a small space, which is properly kept vacant. When I am about to feed them I whistle; and as soon as they hear this sound they are all in commotion, and swim as fast as they can to the open space. With mouths out of water, they are all activity to receive the food. In a similar way, carp may be taught to come and be fed at the ring of a bell.

84. As to the essential character of the organ of hearing, we labour under the disadvantage of not being able to submit it to

experiment; but from analogy I apprehend that the impression is carried by the voltaic force acting through the medium of nerves. Upon the whole, we cannot say that man possesses an organ of hearing superior to that of any other creature; and certainly our superiority of mind can hardly depend upon the ear.

85. Man rather uses his tongue as an organ for determining the choice of food, than for obtaining any extensive knowledge of external objects. Every animal which has the power of exhibiting any choice in food doubtless has the faculty of taste to a greater or less degree; and as all animals appear to select particular kinds of food, we may infer that all have taste. The nerves of taste carry the impressions to the brain, and probably the voltaic force is set in motion when taste is excited. An artificial tongue, composed of one or more sets of nerves, may easily be made, which shall carry the impression produced by a little sugar or meat into an adjoining apartment, and there render itself evident. The one figured consists of a V-tube, containing salt and water, and a platinum wire on each side. The voltaic current is determined when the savour is placed on one side the tube.

Fig. 11.



86. There are two kinds of feeling possessed by man. By one kind man estimates heat and cold, and the action of external forces; by the second he estimates the changes which take place in his own body.

87. The estimate of heat and cold is highly important, and man possesses this feeling to a great extent. Whilst I am writing, a blazing fire is casting its radiant heat upon my body, and comforts it; but were I to cross my threshold, a cold biting north-east

wind would chill my skin, and make me sensible of the change of temperature. There are curious instances where persons do not seem to be damaged by exposing certain parts of the body to great heat. Now nature has so contrived, that a man can exist in a room intensely heated, by exhaling a great amount of perspiration, which, by evaporation, cools his body; and thus he will not suffer as long as he freely exhales water. A Frenchman has lately tried experiments by which he has shown that a man may dip his finger into molten lead or molten brass with impunity, as the perspiration about the finger forms a covering which protects the structures of the finger.

88. The skin is endowed with nerves for the purpose of estimating heat and cold. In this respect the human species is not singular, for, as far as I can observe, all other creatures are sensible to heat and cold; and whilst I write, my cat is lying before the fire, and the dog is standing with his feet on the fender, the better to warm his chest. All creatures are careful to select a warm place before they go to rest; and it is a curious sight to observe a string of love-birds preparing for roost. They nestle on one perch, huddled together in a row. The two outer ones get only one shoulder warmed by their neighbours, and they fly upwards and settle in the middle. The two left on the outer side, feeling their shoulders grow cold, do the same, and this process is repeated till darkness and drowsiness make them settle down fairly for the night.

89. Like the love-birds, human beings exposed to cold huddle together for warmth; and on visiting the Convent of St. Bernard, the horrid spectacle presented itself of a mother and child, who, caught in a snow-storm in that inhospitable climate, and

worn down by fatigue, had sat down for rest. They cuddled together to give each other mutual warmth, but both perished, became as dry as mummies, and both remain, a sad spectacle, to be seen by travellers who visit the pass.

90. Even cold-blooded animals are sensible of heat and cold. The slow tortoise delights in radiant heat. The snake revels in warmth, and lies extended at full length to enjoy the genial rays of the sun; and even salamanders in my dining-room, during the cold weather, mount the stalk of a fern to get a little warmth, when the sun shines through the canopy of clouds so frequent at this (the winter) season. Fish come to the top of the water and bask in the sunshine; and, to the lowest animalcule, all creatures seem possessed of the faculty of feeling warmth and cold.

91. The skin of animals is more or less sensible to light, independently of heat. On two or three occasions I have had the opportunity of inspecting that curious creature, the proteus, which inhabits the dark caves of Italy. If the creature is brought suddenly to the light, the blood rushes to the skin, and thus shows the influence of that agent. But even the skin of man himself is endowed with the property of being acted upon by light. One year I formed one of a party of tourists who visited Switzerland, and we crossed the Furca Pass on the first or second day it was open to travellers. From little difficulties which we experienced in the passage, we were exposed to the influence of the sun's rays from six in the morning till eight at night, in one of those brilliant days which distinguish the month of June. Of the whole party which crossed the pass, I alone escaped from having the skin of the face blistered over its entire surface. The next morning, the blistered faces of the various

voyagers, when we all met at breakfast, formed a curious spectacle, and showed well the influence of the sun's rays on the human skin.

92. The mere appreciation of the influence of heat and cold, of light or darkness, is not peculiar to man. Plants are influenced in a similar manner, and even stones and inorganic bodies are changed and acted upon by similar agents. This day, as I entered one of the offices of the Bank, a pane of glass broke to pieces, from the contraction of the iron frame from cold. The difference between animals and plants in this matter depends not upon the animals being acted upon by these forces, but on their possessing a nervous mechanism which transmits that action to the brain or other centre of the nervous system, where the event is registered or remembered.

93. The sense of tact, or touch, gives to man a considerable knowledge of external objects. This power more especially resides in our fingers and lips; and the extent to which the sense may be improved is very extraordinary. If we carefully attend to the manner in which we use this sense, we find that we obtain our knowledge by moving the fingers; and I apprehend that the sensation depends upon the change of form which occurs from the motion of the part.

94. In my book on vision I have demonstrated the value of this bodily feeling for estimating distance, magnitude, or position. We thus convert the eyeball into a measuring instrument, by virtue of the faculty we possess of knowing the extent to which we move that organ. We can only judge of the nature of bodies through the medium of our fingers, by moving them over the object which we desire to examine. Persons deprived of sight acquire great dexterity in using their fingers; and I

hardly know a more interesting sight than to see the poor blind child read the Scriptures, by the aid of his fingers, from a book not printed in the ordinary manner, but with the letters embossed, or raised. Children taught at the school for teaching the blind are enabled to read aloud the embossed book as quickly as a clergyman can read to a congregation. Their little fingers are in full motion as they read, proving that tact is acquired by the movement of the part rather than by immediate pressure.

95. Man, in this power of tact, holds a very high position in the scale of creation, if he does not really exceed most other creatures. This power, however, is also possessed by various other animals. The elephant is remarkable for the delicacy of touch which he possesses in the prolongation of the nose, which is called his trunk. By it he can seize minute objects; and it is very interesting to observe how he turns the instrument to the best account. In the truly national establishment belonging to the Zoological Society, this stupendous beast is allowed to perambulate the walks of the garden, with several visitors on his back, not only to keep himself in health, but to amuse the spectators and gratify the riders. Whilst he is being loaded or unloaded, or even as he is trotting up the path, his trunk is thrust out, to feel, first on one side and then on the other; and if he can but touch a dandelion or piece of grass, so certain is his tact and so firm is his grasp, that he immediately breaks it off and conveys it to his mouth. He never stops for this manœuvre, nor relaxes from the rapidity of his gait; but he seizes the delicious morsel as he is walking along, and thus procures what he desires without incurring the censure of the keeper.

96. Monkeys have the faculty of tact in their tails. From that circumstance, they can hold to objects in the most surprising manner, by twisting their tails firmly round them. Monkeys have also the sense of touch in all their feet. From the exquisite contrivance of the thumb, however, in the human being, man possesses in the hand an instrument of touch perhaps superior to that of any other creature.

97. Ducks, geese, and similar birds, have a very keen perception of objects with their bill, which is highly supplied with nerves for that purpose. These creatures may be frequently seen in a shallow pond, with their heads completely under water, groping with their bills in the mud; and when they feel anything good to eat, they are enabled to seize it.

98. The faculty of touch extends even to many microscopical animalcules. By means of their feelers they are conscious of an insect coming within their grasp, when in an instant they seize it, and finish by thrusting it into their stomach.

99. Fish seem to have this faculty in their lips. You may frequently observe them take hold of something gently, and thrust it away the moment it is touched. In sniggling for eels, a worm with a needle in it is held before the domicile of the creature. The eel, however, frequently detects something in the worm which it does not understand, and will thrust it with anger from its abode. In fly-fishing with an artificial fly, the unhappy fish is deceived by appearances, and hooked before he can spit out the bait; otherwise, he would surely thrust it away.

100. A German has said of the serpent, that his whole body is a hand; and really there is some foundation for the

metaphor. A snake evidently has a most acute sense of tact at every part of its body, although it is covered by hard scales. Our English snakes are certainly most untameable creatures in confinement. I am sure that I have had nearly a hundred, at one time or another, but never could make friends with any of them. It is a gratifying spectacle to witness their beautiful and graceful movements. At one time they support themselves by holding with the tips of their tails; at another they hold by the centre; and then will glide down plants, by management and contrivance, which at first sight would appear totally unable to support them. All this is evidently effected by the sense of tact, which enables them to judge of the strength of every stalk and leaf.

101. From the consideration of these various facts, it appears that man does not differ materially from other animals in the sense of tact; and even should we decide that, upon the whole, he does surpass other creatures in this faculty, yet that superiority would not account for the superiority of his mental power.

102. The sense of tact, as I have before stated, is a sense of bodily changes; but the nerves which carry the knowledge are probably placed close to the skin. On very carefully examining human beings who have injured their skin, I find that the sense of tact is defective, and defective to a great extent.

103. There is no experiment more easy in electro-biology than to prove that the mechanism for this transmission of impressions is voltaic. I have ascertained the fact in cats, rabbits, eels, birds, and other creatures, over and over again. A physical mechanism may be readily made, (upon

voltaic principles,) which shall be excited by variations of temperature, and which shall convey the impression to a distance. For instance, if we place into each side of a V-tube, containing a solution of sulphate of copper, a copper wire, and apply the heat of a spirit-lamp to one side, a strong voltaic current is immediately determined. We may imitate a voltaic circuit, the current of which is set in motion by simply disturbing the blood-corpuscule. If we take two plates of iron, and suspend a little bag containing pernitrate of iron against each plate, no current will occur; but if either bag be removed, a very powerful voltaic current is excited.

Fig. 12

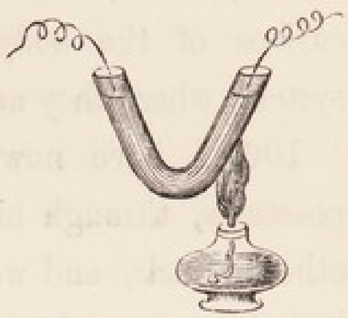
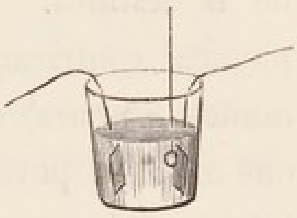


Fig. 13.



104. In all these cases of sensation the impression is carried to the brain through the nervous fibres, by means of a voltaic current. The nervous fibres consist of tubes, like those of gutta percha, containing a fluid. The mode by which insulation is accomplished is somewhat curious. The nerve-tubes consist of a membrane which is of itself a conductor of electricity. The inside of this membrane, however, is lined with a layer of fat, which is an absolute non-conductor of electricity. In the interior of the fat there is a fluid through which the electricity passes. (*Plate* 2.)

105. An entire nerve consists of a number of these primitive fibrils arranged together; and the whole forms a series of communication precisely similar to the wires which are placed along the lines of railroads, to convey intelligence from station to

station, as the nervous fibres carry the intelligence from the surface of the body to the brain, or centre of the nervous system, where they are registered.

106. I have now examined the relative power which man possesses, through his organs of sensation, in comparison with other animals, and we find that man excels some animals, and is inferior to others, in the knowledge which he can obtain through each organ of sensation. In every case, however, there is an exquisite adaptation of these organs to the wants of the creature; and no animal can be said to possess more or less than he absolutely requires for the particular purpose for which he is destined. We have found that these organs are purely physical contrivances: some of the parts of which are (as in the camera obscura) continually used by mankind. Each and every one of these physical contrivances exhibits a structure far more intricate, far more minute, and far more perfect, than any mechanism which man can manufacture; for, whilst the organs of sensation have been constructed directly by the Creator, the machines of man have been constructed by the mechanism which the Almighty has bestowed upon us.

CHAPTER III.

PLEASURE AND PAIN.

107. In the last chapter I have considered the mechanism by which the animal creation is made cognizant of that which is going on around it; and I have now to consider a very curious effect which is produced when these impressions are carried to the brain, or central nervous organ. Now it appears that any impression upon a nerve produces either the sensation of pleasure or pain, according to the intensity of that impression; and a right understanding of the important results which accrue from these two sensations is quite necessary to the proper estimate of all questions appertaining to reason and instinct.

108. When a man exposes his hand to the fire, a genial warmth excites the nerves of the part, and produces a most pleasurable sensation; but if it be placed too close, the impression is stronger, and a sensation of pain arises; and what

is true of this mode, is true of every other mode of excitement. Gentle friction of the skin produces an agreeable sensation; severe pressure, or a pinch, considerable annoyance. Gratification is produced by looking at objects illuminated by the sun's rays, although distress is caused by regarding the full blaze of the sun. Delightful to the ear are the effects of gentle sounds; horrible are the sensations produced by piercing shrieks. In these cases, and in all similar ones, there is no half-way or medium sensation: an impression is either of the first class or of the second; it is either pleasurable or painful.

109. As every action is pleasurable which is not painful, we are enabled to estimate the great preponderance of our feelings of pleasure over our feelings of pain. It has been asked by some men why pain has been allowed; but if we interrogate nature, we find that pain is necessary for our preservation in the present scheme of the construction of the universe. By pleasure and pain we regulate our actions; as, in truth, man seeks those actions which are pleasurable, and eschews those which are likely to be painful.

110. Let us picture to our mind a man who felt no pain. He would not be able to tell whether he sat upon a red-hot iron plate or upon his chair, and thus would run the chance of being destroyed. In cases of insensibility, where there is no pain, this result actually happens. I remember a man who fell during a fit, in the boiler-room of a steam-engine. His comrades, anxious to assist him, placed him upon the top of the boiler. The man did not feel the effect of the heat, and a most dangerous wound resulted.

111. A man without the power of feeling might walk upon nails or other sharp instruments, and inflict serious mischief

upon himself. Under such want of power he might thrust his limbs into machines, and be totally unconscious of it; he might have disease, and not be warned to take care of it. There are some diseases which proceed usually without much pain, as consumption. I have several times detected, on some accidental examination, that fatal disease existed when the party himself was quite unconscious of illness.

112. One case now comes to my mind which painfully illustrates this position, and which made a great impression upon me at the time of its occurrence. A gentleman was continually absent from his duties; and when he was asked the reason, he said that he did not feel strong. Upon this answer I was requested to make a report upon his case. When he came before me he at once frankly stated that he did not think that there was anything the matter with him; but sometimes, when he started to his office, he did not feel quite in spirits, and upon that feeling he went back, knowing well that he perilled his situation by such a course. The moment he came before me I was responsible for his state; and, notwithstanding his assertion, I gave him a thorough examination, when, to my horror, I found the upper part of one of his lungs so much diseased that I could not doubt a fatal issue. I recommended at once that he should apply to his medical adviser. I explained the circumstances to his employers, and exculpated him from the suspicion of idleness. The gentleman, at my instigation, immediately procured the best medical aid; but ultimately he fell a prey to the insidious, death-seeking phthisis. Had this gentleman but felt as much sensation of pain as would have been caused by the prick of a needle, he would have earlier sought medical aid, and might possibly have been saved.

In this case the painless character of the disease was probably the source of the greatest danger.

113. Little children are always in motion. Up and down, backwards and forwards, they cannot be quiet for a single instant. If they fracture a bone, it might be supposed that the two ends of the bone would never be kept in apposition; but every time they move pain is caused, and this keeps the injured limb so perfectly quiet that it heals up with precision, and causes the anxious mother to rejoice in the existence of pain. I lately saw a little child which had broken his arm. Nobody knew the fact till the parents observed that the child never performed the slightest movement with it all day long, and he cried bitterly if it was touched. As it recovered, it was curious to observe how cautiously the child began to use it. He took the greatest care not to suffer the slightest pain.

114. It has been argued that an Infinite Power might have constructed an animal in such a manner that he should neither have had pain, nor have suffered inconvenience from being devoid of that phenomenon. Upon considering the consequences of such an arrangement, it would be found to be impossible, as long as we exist in a material world. If we neither felt pain from excessive action in our body, nor suffered any ill consequence from its absence, then a man would be enabled to live unhurt in the hottest furnace, or walk at the bottom of the ocean with impunity. He might be crushed with heavy weights, or torn to pieces by machinery, and still preserve his integrity. This view is manifestly impossible; and nature declares, that so long as man exists in the world, he must, for his own security, be subject to the necessity of pain.

115. Man does not alone feel pleasure nor suffer pain; all

classes of animal beings are subject to these necessities. With respect to the pleasure which animals enjoy, what a lovely world is this! How many myriads of creatures come forth and perform their allotted duties in delight! In spring the groves resound with the melodious notes of happy birds, the fields with lowing beasts. The waters abound in sprightly, playful fish. The air is filled with the joyous insects, all busy in their respective callings. Who can observe all these things, and not be surfeited with delight? Who can inquire into the source of such continuous joy without exclaiming, "Such knowledge is too wonderful and excellent for me; I cannot attain unto it"?

116. If we turn from an almost endless amount of pleasure, we find that the joy of the animal creation is still alloyed with pain. Witness the agonies of the writhing worm, cut in two by the gardener's spade; and yet these two portions will each become a worm, and thus two worms will be made from one. The dog which basks on our hearth occasionally suffers from a painful pinch. It is true that pleasurable sensations, in every creature, far exceed those of pain; but, nevertheless, pain is still felt by every member of the animal creation.

117. Nature has wonderfully ordained that useless pain should not be inflicted. That which utterly destroys, occasions but little uncomfortable sensation. I have talked frequently with persons who have been saved from apparent death from drowning, and they said that they felt no pain, but only an uneasy sensation. In like manner, when a limb is entirely crushed, the patient does not feel. When a severe burn takes place, the part is destroyed, and no pain ensues. When the surgeon is summoned to a severe accident, his countenance betokens

much anxiety when his patient feels no pain. The surgeon knows, from experience, that when there is no pain the accident is too severe for the body to repair, and he fears the worst.

118. With regard to animals, it has always struck me as a beautiful provision of Providence that things should be so arranged that the instant an animal falls ill, or takes on a weakly state, then there are other creatures always on the look-out to pounce upon him and destroy him in an instant,—which is the most merciful end which can happen to creatures which cannot be nursed or otherwise attended to in their affliction. This principle extends throughout the entire creation, even to the most minute animal. Upon this head it has been facetiously observed that

> "Great fleas and little fleas have lesser fleas to bite 'em;
> The lesser fleas have smaller fleas—so on *ad infinitum*."

119. Although nature has been careful to avoid the infliction of unnecessary pain upon animated beings, man is not always so thoughtful. In the heart of this great metropolis there is a market for cattle and sheep; and the scenes which are witnessed in this place are truly dreadful to behold. I have myself seen the feet of sheep to be cut off by cart-wheels, and the poor creatures to be left in the streets with the arteries pouring out their contents. I have seen oxen to be mutilated by falling in the slippery streets, or by running against carts. In frosty and snowy weather the streets are so slippery that the poor beasts cannot stand. At every step which they have attempted to make, when urged on by the infernal shouts of the fiendish drovers, they have dropped down, and will only rise when urged on by the stick and spike. I quote the case of the

Smithfield abomination simply to show that beasts suffer pain as well as man; and fearfully do the agonies which they are thus compelled to bear support my argument.

120. A gentleman of my acquaintance was so horrified, on passing through Smithfield, at the brutality with which a man was behaving to a sheep, that, on the spur of the moment, he seized the man by both his ears and shook him violently, till the man let go the animal, which he was treating in a similar manner. The man was so astonished that he offered no retaliation, especially as the bystanders declared that he was served quite rightly for his cruelty. It is confidently believed that the City authorities will not long consider that any revenue can compensate for the pain inflicted upon the millions of animals which are tormented in consequence of Smithfield being placed in the heart of London.

121. It is difficult to form an opinion of the exact nature of pleasure and pain,—or rather, I may say, of the effect of these impressions on the brain. A painful impression seems not only to damage the nerves implanted in the body, but also their terminations in the brain;—a result which may be easily imitated by voltaic arrangements. These considerations have been fully discussed in my 'Electro-biology,' and need not, therefore, be repeated in this place.

122. The consideration of pleasure and pain enforces upon our minds conclusions of the most important character. It shows that God has ordained that his creatures should alone suffer pain for their own benefit and protection, and that every other act of their lives should tend to a pleasurable existence. If man follows out the same principle, he will perform the

duties so specially enforced by Christianity;—he will be kind and merciful to all organic creatures; he will do unto all men as he would they should do unto him; and he will, in all respects, do everything that will alleviate pain, and tend to the happiness and welfare of his fellow-creatures.

CHAPTER IV.

ON MEMORY.

Organs of Sensation in Man and Animals, 123; compared with Sensitive Plant, 124. —Venus's Fly-trap, 125.—Memory, 126; extraordinary instances of, 127; other instances, 128.—Lost Memory, 129.—Memory in the Dog, 130, 131; in the Mouse and Elephant, 132; in Parrots, 133; in Tortoises, Toads, Lizards, Wasps, &c., 134.—Memory dependent upon Organization, 135.—Proof thereof, 136.—Strong impressions most remembered, 137-139.—Artificial Memory, 140. —Registration of printing of Bank Notes, 141; of Magnetic Needle, 142.— Conclusion, 143.

123. We have now found that both man and the dog possess organs of sensation to be acted upon by external agents. We have also observed that all other animals agree to a certain extent in having similar organs. We have discovered, moreover, that both man and the dog agree in possessing nerves to convey these impressions to the brain. And, lastly, we have found that they still further agree in experiencing either pleasure or pain as the result of these impressions, according to their intensity.

124. But, up to this point, no advantage would be gained by the various arrangements which we have already described; for, unless something else occurred, no result would take place beyond the effect of the immediate impression, and animals would be in no better position than certain plants, as sensitive plants. (*Plate* 2.) These plants, in hot weather, when they are perfectly healthy, from

the slightest motion, as a breath of air, close up their leaflets and drop their leaves. I love to watch a sensitive plant in perfect health; nor am I singular in this respect, for a gentleman well known in mechanical science, who resides in the neighbourhood of London, and possesses splendid hothouses, greenhouses, and every horticultural luxury, is said only to ask his gardener, on hiring him, whether he can grow sensitive plants, and the gardener, well knowing his master's peculiar whim, takes care to have an abundance in his conservatories.

125. There is another plant called Venus's Fly-trap, (*plate* 2,) which apparently shows the sense of feeling. At the top of each leaf an apparatus exists like an open trap, but, when a fly enters, it closes, and retains the creature in that situation; but, as to the use of this singular structure, no person has ever been able to divine.

126. The impressions in man, the dog, and in all other animals, are not transient; they are carried to the brain, where they are registered, and may rise again to produce or to modify an action at any future period. When this effect takes place, the man is said to exhibit memory.

127. I need hardly quote examples of the effects of memory in man; they must be sufficiently well known to every individual. Extraordinary instances have been recorded of the power of memory in man. For instance, Justus Lipinus told a prince of Germany that he had Tacitus by heart. It is also recorded that Joseph Scaliger committed all Homer to heart in one-and-twenty days, although his Iliads have 31,670 verses, and Odysseys have no less.

128. I was once at an important meeting where no reporter was present, and it was considered desirable for a report to appear. Upon application two or three days afterwards, I wrote out such

Plate II.

W. Wing, del et lith.

Reeve Benham & Reeve imp.

of the speeches as were required, in such a manner that the substance was so correctly given that no person found out that his very words had not been taken down in the room by a short-hand writer. Those proceedings happened to interest the public, and have been copied from paper to paper, and from newspapers to standard works. When I have seen the extracts, I have often smiled at the utility of memory which could thus accurately have given the result.

129. To estimate the value of memory in regulating our proceedings, we should compare examples of powerful memories with other instances in which that faculty is lost. Last week I examined a poor fellow who could not tell me what he had done the day before, or even on the same morning up to the time when I examined him, and I was informed that he would totally forget anything which was told him, even after a few minutes. Where memory is lost, all the properties of the mind dependent upon it are also lost. The man without memory cannot compare a present event with a past event, or judge in any way of the difference. He cannot exercise the powers of reflection or imagination, and is said to be fatuous, or foolish,—a state which destroys all that ennobles the man, and lowers him almost to the condition of a plant.

130. My dog, when I return home, shows unequivocal signs of memory by jumping about and wagging his tail. He also, by little artifices, seeks to attract my attention and induce me to caress him. After a longer absence memory still remains; for what can exceed the unbounded joy which a dog manifests when his master returns after a long absence? This memory extends to persons, places, and things, and the dog knows whether any object has given it pleasure or pain.

131. I had once a dog which we used to take out of town with us every year. Upon taking him a second year to the same place, he exhibited signs of unequivocal joy when he arrived near the house: he could no longer be restrained in the carriage, and he suddenly leaped out of the window. From these and other facts, we see that memory in the dog is as perfect as in the human species.

132. All other animals in like manner exhibit memory. The little mouse, in the anecdote before quoted, remembered having been caught in the trap. His remembrance of his former capture decided him not to venture again till hunger compelled him. In Knight's accounts of elephants it is stated that "Warren Hastings, the Governor-general of India, possessed an elephant which had been ten years absent from the rule of man. His keeper being dismissed, he was refractory to all others who attempted to control him, and at length escaped to the wild herd. After the long interval we have mentioned, his old keeper recognized him in a Keddah, and the elephant immediately submitted himself to his former master." In this case we have a clear manifestation of memory after the lapse of ten years, as the creature brought to mind all the acts which it had learnt at that by-gone period.

133. Birds are amply endowed with memory. My brother has taught a parrot to whistle the beautiful and popular chant in A, composed by Dr. Chard. This parrot, after an absence of many weeks, shows unspeakable joy upon the return of his master. He flutters his wings, whistles, calls, and leaves nothing undone to show his love for his master and his desire to be recognized.

134. Tortoises remember persons and places. My lizard always knew me. Toads also clearly manifest memory. As we descend lower in the scale, it is more difficult to detect the presence of this faculty. Nevertheless, bees and other insects clearly remember

the situation of their abode, as they fly away great distances and return home. When a wasps' nest is destroyed, there are generally some stragglers who, perhaps, are feasting in a grocer's window. These do not return till the next morning, and they seem much astonished at the demolition of their abode. On several occasions I have destroyed a nest very late at night; I have very carefully dug out the nest and burnt it, using, during the whole process, so much of the sulphur, saltpetre, and charcoal as utterly to destroy the whole brood. After filling up the hole, I watched the next morning to see how many stragglers were from home, and generally some half dozen would visit the spot. These stragglers would exhibit the greatest perplexity, and would alight exactly where the hole existed before my operations were conducted. They would then crawl about rapidly for a few minutes, take a short fly round and reconnoitre, then settle upon precisely the same place. Some of these unfortunates would continue to search in vain for the hole for several days, after which I have generally lost sight of them altogether.

135. I have quoted quite enough facts to show that, although man exhibits a powerful memory, yet animals possess in a very high degree this faculty. Memory depends upon organization, and the state of the organ in which it is manifested. A person under the influence of chloroform, ether, or spirituous liquors, remembers nothing which has occurred; hence the two former fluids are frequently used during the performance of surgical operations. A leg may now be removed, a new nose made, or any other tedious operation may be performed, without the patient being in the least degree cognizant of the process. Surgeons now constantly employ these remedies. When chloroform is employed in sufficient quantity, it induces a state of perfect insensibility.

During this state the surgeon performs the operation, and the patient neither winces nor shows the slightest sign of pain, but remains with a placid countenance, as though he were thrown into a gentle sleep. After a short time he suddenly wakes up, rubs his eyes, and stares around him. The interval is a blank upon his existence. When all is over, I have frequently heard the patient ask when the surgeon will begin, and he is delighted when he is told that the whole has been completed without his knowledge. The memory of the event is lost from the action of the ether or chloroform on the blood preventing it from acting properly on the brain.

136. When the brain is acted upon by various other causes, memory is interfered with. A blow on the head, which shakes the brain and produces a pressure upon that organ, interferes with memory; and persons labouring under severe fever have no memory of their state for days or even weeks.

137. As a general rule, the power of memory is proportionate to the intensity of the impression. Any very horrible circumstance will appear continually, and should, therefore, as far as possible, be avoided. It is said that a noble lord saw an execution in France, and the bloody head appeared frequently before his eyes as long as he lived; and even when delivering important speeches in the House of Lords the event would appear.

138. At various times I have myself seen accidents and events of great moment, such as persons falling from the tops of houses, persons killed close by me by being crushed to death by carts. I have also been present at very extensive fires, such as that of the Royal Exchange, and various others which I need not specify. Such events, from their magnitude and importance, it would almost be impossible for me to forget to the latest period of my life.

139. After a person has been the subject of any severe accident, the circumstances of the accident are very prone to re-appear to the mind, and the party will even dream of it. Yesterday a clergyman slipped down in the City, and dislocated his shoulder. I reduced the dislocation in the ordinary manner. The gentleman passed a somewhat disturbed night, and, in answer to my inquiries this morning, told me that he had, in imagination, slipped down several times in the night, and had awoke in kicking about to save himself. I explained how this result, in my opinion, occurred, and told him that it would be a pretty instance to detail in my book.

140. From these facts we know that memory entirely depends upon organization, which is the word used for mechanism contrived by the Infinite Cause. It is, therefore, a physical property arising from that mechanism. It ultimately resolves itself into an action, determined by some previous impression on the body, and, as such, can be obtained by human contrivances. Now here a difficulty arises; for if I pass a voltaic current through a solution, and so alter it that it ever afterwards shows that phenomenon, I have obtained the same effect which is produced in the brain by memory. Yet, as the term memory is only assigned to organized beings, quibblers and twaddlers, who are apt to make words their masters instead of their servants, declare that the one effect is not like the other, because we call it by a different word.

141. As far as the mere registration is concerned, it may be imitated by mechanical means. At the Bank of England there are many presses for printing Bank-notes, and of course it is of much consequence that no man should print one too many. Every time the press acts, a communication is made

to a series of numbers, and the event is registered. The clerk, who sits in an adjoining apartment, has only to look to the numbers, when he can tell how many times the press has acted at any given moment of the day. It would neither be impossible, nor even very difficult, to print these numbers, with the corresponding time of the day; and thus a permanent registration would be preserved of the exact action of every press.

142. The registration of impressions is also used, in a very curious manner, by Mr. Brooke for noting every variation of the magnetic needle, at every given moment. The apparatus is so contrived that the light from a camphine lamp, or from the naphthalized gas, acts upon photographic paper, which is carried forward by clock-work, and the part of the paper which is acted upon is determined by the variation in the needle. These papers are carefully preserved, and at any future time the variation of the needle, for any given moment, can be learnt. These last two cases form instances of registration, not of memory. Memory involves a new tendency to act, while registration is a passive result; and we thus find that registration may exist without memory, although memory cannot act without registration.

143. We find that memory is a property of the mind of extreme importance. It is the basis of its other more noble qualities. It is a property that is possessed by man, the dog, and, perhaps, to a greater or less extent, by all other animal beings. The daisy and other plants manifest no signs of it, though it can be imitated to a slight extent by human contrivances. In the instance of memory, as man possesses it, we are again compelled to admit that it requires a mechanism so extensive as only to be exemplified in the glorious works of God.

CHAPTER V.

ON REASON.

144. Up to the present time we have studied how man obtains knowledge through the mechanism of his senses,—how that knowledge is conveyed to the central organ of thought, or brain, through the medium of the nerves. We have also found that in possessing this mechanism he does not differ from the dog, or, in fact, from other animal bodies; and we have now to examine the character of that knowledge, so obtained, and the effect which it has upon his proceedings.

145. In each organ of sensation the knowledge of any object or action is obtained by the peculiar combination of nervous

fibres excited. If we take, for example, the retina of the eye, it may be likened to a design printed for ladies, to serve them as a pattern from which to execute needlework. Now, inasmuch as there is only a certain number of nervous fibres in the eye, there can be only a certain number of different objects which can be possibly seen at one moment without moving the eye. This number consists of all the possible combinations which can occur; and if we estimate the nervous fibres of the eye at 5,000, the combinations of the eye alone, and therefore of all the possible images which might be represented to us, are so numerous as almost to defy calculation.

146. Mr. Walker, the talented actuary of the English Widows' Fund Life Office, has kindly made a calculation of the number of images which may thus be represented. I will not go into the process by which he arrived at the result, but I will state generally that, for the expression of the total number of pictures, 1,505 figures would be required. As a million only requires seven figures for its expression, it follows that the number of figures required to express the possible combinations would be 215 times greater—a finite number of which the human mind cannot form the slightest conception. Besides the number of impressions which may be made by the simple action of light, we have every possible variation of colour, and every possible degree of intensity;—which would render the number of pictures capable of being represented almost infinitely more numerous.

147. If I exemplify this view by taking nine squares, it will be seen that an action on the squares marked 1, 2, 3, 6, 9, would represent L; an action on 1, 4, 5, 6, 7, would represent T; a combination of 1, 3, 4, 5, 6, 7, 9, would represent

Fig. 14.

1	4	7
2	5	8
3	6	9

I. Supposing, however, we have a much larger number of squares, then an entire page of print might be represented. By this method views might be described; and, although the course would be somewhat laborious, I can conceive it possible that, were it desired to have a copy of any work of art, it might, in this manner, be so described by figures as to render it possible to make an accurate fac-simile.

148. It must be apparent that, vast as is the mechanism of the brain, it cannot contain a separate structure for each combination; and I have no doubt but that some curious contrivance may be ultimately pointed out by the mathematician, by which the number of these combinations may be materially reduced. It is quite certain that any action on the nervous expanse, or any combination of actions, is impressed on the brain, and is liable to recur at some future time.

149. But the fact to which I now desire to draw my reader's attention is, that every definite combination signifies a particular thing. One combination gives us the idea of a dog, a second of a cat, a third of a house, and so for every object and for every view which can be possibly represented to our eye.

150. This impression is either attended with a pleasurable or a painful feeling. The disc of the sun excites a painful impression; a green tree a pleasurable one. The disc of the sun also recurs as a painful impression whenever it is represented to the eye. If a man is told to look at the sun, the former painful impression is remembered, and he acts not alone upon the immediate stimulus, but also upon the impression which was before recorded. This determination, or selection between two lines of action, is called judgment, and requires an action upon the organs of sensation, and a remembrance of the character of that action.

151. I have chosen the eye as an organ of sensation which was convenient to illustrate my argument; but the eye is similar to the ear, nose, mouth, and other organs of sensation; for whenever two or more nervous fibres are excited at the same moment, it produces the action which makes us cognizant of that which gives rise to the idea.

152. It is, perhaps, hardly necessary to point out that man, in every action of his life, is regulated by judgment; and so universal is this exercise of mental power, that we are hardly conscious of using it on all occasions, but rather assign the term to the solution of very difficult problems, requiring much thought. If, however, we regard a man who has to a great extent lost his memory, we find at once how judgment, in even the most trifling matter, is lost. The poor fellow whom I examined last week, and quoted in my last chapter, forgot, when he was told to go to dinner, where he usually dined, and, instead of walking to his dining-room in the City, so ill-judged as actually to start off over London Bridge to his own residence. Had he also forgotten where his residence was, it is manifest that he never could have judged between the right and wrong direction, but might have started up the City-road, Fleet-street, Holborn, and wandered about without any definite plan.

153. This error in judgment actually happens constantly in practice. I knew one man who was suddenly missed from his office, and on inquiry it was found that he did not go home. After two or three days he was found insensible in a lane in the middle of Kent; but how he got there, and for what he went there, he could never assign the slightest reason, the whole affair being a blank in his existence.

154. Animals, like man, act not only upon the immediate,

but upon the antecedent idea, and in that respect exhibit judgment. A dog finds his way home, and goes from place to place, with as much precision as a human being. A dog who usually had his dinner in the City would never make the mistake of going over London Bridge, instead of going to the kitchen, for his dinner. About a month ago, I had a pretty illustration of that fact in a cat. In a large establishment, which is perambulated every Sunday to prevent fire, I took the round with the gentleman on duty. A cat was locked up, and as soon as she heard our voices she made sounds which showed her desire to be released from the room in which she was confined. The moment the door was opened, out she rushed, and ran away at the top of her speed. I was curious to know where she was going, and on watching her found that she ran to her feeding-place, where the porter had placed the meat the day before.

155. The exercise of judgment in acting upon the remembrance of locality is well shown in birds, who fly (according to some authors) hundreds of miles, and return with certainty to their abodes. The facts upon this head are so curious, that some philosophers have thought that birds possessed a peculiar sense, which they have called a sense of direction. But this assumption will be found to have no foundation if we carefully examine the facts. It is true that pigeons will fly straight home from long distances, but they must be trained for that purpose. Before the electric telegraph came into operation, and surpassed in rapidity all other modes of communicating knowledge, expresses were sent by pigeons; and one eminent merchant is said to have kept up a series of pigeon establishments, at a very large annual cost.

156. For a pigeon to obtain any excellence in carrying

despatches, he must be regularly trained. The training is commenced by catching the bird and throwing it up a few yards from the dove-cot. The distance is regularly increased daily, so that the creature is by degrees made familiar with the neighbouring districts. Few persons can fail to have observed basketfuls of the birds at the tops of omnibuses, or on board the river steamboats, who are let off one by one at different distances, and which are, in fact, in process of training. Bird-fanciers train the birds, and then sell them at a small rate, as they know full well that if the bird is shut up for two or three years, yet it is sure to fly straight home when let loose; and by these means they make much money, by selling the same birds over and over again.

157. The use of training is but to make the birds acquainted with the appearance of the country, inasmuch as, in a state of domestication, they have no reason to make excursions. Their food, water, materials for building their nests, &c., are carefully supplied to the birds by the owners, and therefore they have no occasion to fly about and seek them. When I was a schoolboy, I kept some pigeons at the Bank, and once, on leaving town, the birds were left in charge of a servant. Upon returning, the first question naturally asked was as to the health of the favourite birds; but I received the startling answer, "Lor! indeed, sir, I never once thought of them." Their fate seemed inevitable; and up I ran to the dove-cot, to confirm, as I thought, my worst fears. To my astonishment, however, all the birds were in good health. The young ones looked fat, and the old ones had built new nests, although not a particle of food nor a drop of water was to be found. As the birds had done so long without food and water, I thought they

could not hurt by waiting a little longer, and therefore I determined to see what they did. After a little time the birds became uneasy, and, after pluming their feathers, they all flew off. I watched them as far as the eye could reach, and I could trace them beyond Shoreditch Church; and after an hour and a half they came back. There is no doubt but that they had flown off to the fields for food, and thus were not the least the worse for the servant's inattention.

158. To show that this knowledge of the locality of habitation is a matter of experience, derived from their senses and remembered, I may mention that I have once or twice tried the experiment of throwing up untrained birds within a very short distance of the house. They exhibited no sense of direction, otherwise they would have flown straight home. The birds rose in the air higher and higher, till they obtained such an altitude as to be enabled to see known objects, when they flew in a straight line towards home. On repeating, however, the experiment, they did not rise so high in the air, but flew at once to their abode. In fact, the birds judge of the direction of their home as we judge of the road through the London streets, by noticing the various objects in their course.

159. Cats and other animals traverse great distances in their natural state. As we walk about London at night, and see the cat skulking from one house to another, we are apt to think that they belong to the immediate neighbourhood. Cats have their regular runs, and traverse the country for miles and miles, and thus become well acquainted with the country, which sufficiently accounts for the manner in which they return home when moved from one place to another. To my great annoy-

ance, the cats from all districts meet at the top of my hothouse, because they find the glass warm to their feet.

160. There are some extraordinary instances given of animals having found their way home under circumstances which would seem to render it impossible that this knowledge of the road could have been obtained by experience. In these instances it is difficult to come to a direct conclusion, unless we know all the facts in the history of the animal; but I see no reason why animals, like man, should not in some instances be guided by the motion of the sun. I shall, hereafter, when I speak of instinct, again have to call attention to the migration of birds, and even of some animals.

161. Some years ago we had a little dog, which had never left the Bank. We took the dog out, and left it at a house at Chelsea, whilst we went some distance further to make a call. As soon as the dog found itself in a stranger's house, he made such a yelling that the master went to see what was the matter. The moment the door was opened, the dog ran away, and was no more seen. On the third day, in walked the poor animal, covered with mud, and nearly exhausted. Now, there are many modes in which the dog might have found its way home, and in a complex case of this sort it is difficult to trace the exact operations of the mind. The dog, for instance, might have tracked, by the nose, the footsteps of some person whom he knew. He might have run about till he noticed the path by which he went; but certain it is, however, that, from the exhaustion of the dog, the time occupied in the journey, and the muddy state of the poor creature, the method by which he regained his habitation was not very simple.

162. The extent to which experience may be carried, to regulate the action of animals, is truly extraordinary. A short time since, I lent a presentation copy of a book to a near relative, who kept a parrot. This book was left upon the table; and upon entering the room I found Polly sitting upon the table, and I observed that she had torn the cover of my book to pieces. I was first inclined to be very angry; but on ringing the bell, the servants stated that they believed Poll had been shut up, and that she had opened the spring, as lately she had found out the way to let herself out whenever she pleased. We agreed that this process must be stopped, and therefore it was determined to place a padlock upon the cage, which opened by pressing upon the spring. The next day she again was found outside the cage, with the padlock at the bottom, although she had been duly fastened up. She was again put back in her cage, and the door padlocked; but she walked deliberately down, took hold of the padlock, opened it, and walked in triumph out of the cage, with the padlock in her beak. When I saw the proceeding, I was so delighted with the feat, that I thought it more than compensated for the injury done to my book.

163. Some years ago I was stopping at a farm-house in Wales during harvest-time, and I wanted a pony, in order that I might take a ride. All the men were in the fields, some distance off, and the females declared that it would be impossible to catch the pony, because it was so uncommonly cunning. However, I thought that I would make an attempt myself, and was surprised to find how easily I could drive it into a close place. To my astonishment, the pony went coolly to the gate, pressed its mouth against the spring, pushed the gate open, and away it ran, with several horses after it, into a field, kicking up its

heels and frisking about, as much as to say, "Catch me if you can." However, I fastened the springs of all the gates but one, tried the manœuvre over again, and captured the little rascal by his opening the gate and entering into the farm-yard, intending to go out on the opposite side.

164. In these cases the animal showed memory, and also evinced judgment in determining its line of action. I can quote examples of this character to an almost unlimited extent. A servant at a cottage by the side of the river Lea was washing her cap in the water, when she tumbled head foremost into the stream. A dog, being present, and witnessing the circumstance, set up immediately a most singular howl, and ran backwards and forwards to his master, who was in the house. On noticing the strange conduct of the dog, he went out to see what was the matter, and saw the woman in the river. He jumped in, and, with the assistance of his sister, rescued the female from a watery grave.

165. Humboldt gives a picture of the South American mules. He states that "when the mules feel themselves in danger, they stop, turning their heads to the right and to the left. The motion of their ears seems to indicate that they reflect on the decision they ought to take. Their resolution is slow, but always just, if it be free,—that is to say, if it be not crossed nor hastened by the imprudence of the traveller. It is on the frightful roads of the Andes, during journeys of six or seven months, across mountains furrowed with torrents, that the intelligence of horses and beasts of burden displays itself in an astonishing manner. Thus, the mountaineers are heard to say, 'I will not give you the mule whose step is the easiest, but him who reasons best.'"

166. Dogs who frequent the streets are much exposed to be

tormented by having stones thrown at them. In this respect they remember the event, and act *instanter* when they see any person who stoops to pick up a stone, by running away as fast as they can,—showing that the action in this case is regulated by former as well as by immediate impressions. This exercise of judgment or determination, between an immediate or bygone impression, appears to be common to the whole animal creation, to a greater or less extent.

167. In the neighbourhood of London, sparrows are extremely numerous; and a friend of mine, who is fond of feeding various birds, had so many visiters of that class amongst the others, that he was very desirous of lessening their number. Upon consultation we determined to poison them by prussic acid, and for that purpose we placed food in the accustomed place, taking care to drive away other birds. The sparrows came in their accustomed formidable numbers; but the curious fact which I have now to notice is, that when a fresh sparrow came and found a dead bird, it looked alarmed at the fate of its companion. Its attentive observation was very remarkable; and after looking earnestly for a minute or two, it flew away without touching the deadly food; and for this reason we were compelled to remove the birds as fast as killed, the number of which, as far as I can remember, amounted to near a hundred.

168. The faculty of judging between an immediate and a former impression is only found in the animal kingdom. On a superficial view, plants, under such circumstances, may be thought to exhibit that phenomenon. For instance, the daisy will grow better in long grass than in short grass. If its roots are exposed to two different soils, the one suitable, the other unsuitable, they will penetrate the mould which is most suitable

to the whole plant, to the exclusion of the other. This selection or choice, however, is not the result of any knowledge which the plant has acquired, but is due—entirely due—to the immediate stimulus of light, heat, moisture, &c.

169. The determination between two lines of action is perhaps best exemplified by Mr. Cotton's weighing-machine. This machine is destined to separate light sovereigns from those which are heavy, the light ones being thrown into one till, the heavy ones into the opposite. So perfect is this contrivance, that the mechanism will weigh accurately sovereigns to $\frac{1}{100}$ of a grain; and, of course, more rapidly and more correctly than could be possibly effected by the ordinary process. When Professor De la Rive saw the mechanism at work, he said that it was the perfection of mechanics; and truly it is a most wonderful sight to witness the series of these machines at work in the Bank of England. When the sovereign is light, the scale-beam rises, and the coin is thrown by a contrivance into one till, made to receive it; if the sovereign is heavy, the beam descends, and the coin is thrown into an opposite box. By this mechanism a selection is made between the heavy and the lighter coin. The machine decides between these two states; and in that way its action is analogous to judgment in the animal kingdom.

170. Man, however, when he solves problems by his brain, has not to decide simply between two things; his determination is formed upon all the knowledge he possesses. If we compare the judgment exhibited by the weighing-machines with the judgment exercised by a medical man in the exercise of his profession, what a remarkable contrast do the two states present! The medical man's opinion is based upon a vast variety of circumstances, all of which have their bearing upon the solution of the case, whilst

the action of the machine is regulated simply by the circumstance of the rise or fall of the beam. Although the weighing-machine has been well said to be the perfection of human mechanism, yet the brain is the structure devised by an Infinite Power. The comparison between the two well illustrates the relative capacity between the mechanism of man and the structure of nature.

171. Ideas formed in the mind of human beings at different times are remembered together, and thus produce a new idea made up of the two former ideas. Thus, a man can have the idea of a house and a tree separately, and, if these two objects appear to the mind at the same moment, the two will form an ideal picture differing from either separately. This power, in all its various forms, is called imagination, and absolutely requires memory for its manifestation. The painter extensively uses the power of imagination, as he constantly combines various ideas received at different times into one complete harmonious picture.

172. If we compare man with the dog in this particular, we find that it is extremely difficult to ascertain how far the latter possesses this power. Dogs, during sleep, appear to dream, which is a property of the mind akin to imagination. If we attempt to mew like a cat, we find that any dog, who hears the sound, immediately appears excited; he wags his tail, he looks about, and he runs to and fro to seek the object which he has imagined to be the cause of the sound.

173. As far as curiosity is concerned, man does not surpass the dog. I this day observed the action of a little dog who heard some strange noise. He went to the door, scratched, and barked to be let out. He went to the spot from whence the noise emanated, and, after having satisfied himself, returned with complacency to the hearthrug, and again basked before the fire. As far as this

little feat was concerned he was equal to man, for man would have done no more. Not only the dog, but other creatures exhibit much curiosity at any new object.

174. The various images impressed upon the mind of man and animals, according to their pleasurable or painful character, regulate, as I have before observed, their subsequent operations. By a pleasurable impression the most obdurate beast may, to some extent, be tamed, and led to perform various acts. In man, as a rule, kindness is more potential than harshness—love, than fear,—and this rule seems to be maintained throughout the whole of animated nature. By kindness and gentleness the very tiger has, to a certain degree, been tamed; and at fairs it is customary for persons to enter into their cages. The natural tendency of these beasts to kill animals renders this experiment in the highest degree dangerous, and the papers of last week contain the account of the inquest held upon the Lion Queen, who used to perform at such exhibitions. The tiger in an instant, without warning, seized her head, and bit it so dreadfully that she instantly expired.

175. I am told that, whenever the tiger used to show any symptoms of a desire to spring at Van Amburgh, it was beaten with an iron bar till it was cowed and much frightened; but Van Amburgh never seemed to me to take his eyes off the tiger whilst he was playing with the more tameable animals. It appears to me that such exhibitions should not be permitted, and I once expressed very strongly an opinion upon that point to a man who exhibited boa constrictors. His answer was significant enough. He said that people would have it, and that they could get no money without such a dangerous display. He, moreover, went on to state that, when in America, they were not satisfied with the exhibition of even very large boa constrictors, but they used to taunt him with

not being able to handle their own little country snakes. To amuse the people, he was actually obliged to procure rattlesnakes, and, by stroking them gently, he would get them into a good humour, so that he could quietly lift up the lips and show the fangs. This manœuvre showed well the effect of gentleness upon the reptiles. Still, the exhibition was at the risk of the man's life, and such, in my opinion, should not be allowed.

176. The manner in which horses and dogs are taught is upon this principle. The horse-breakers are now much more kind than they used to be; they encourage and fondle the animals instead of beating them violently as heretofore; they rather show them the way by giving them a pleasurable impression than by giving them a painful feeling.

177. Pigeons may be readily taught to go through a bolting wire by gently pushing them through a few times and then supplying them with food. Goldfinches, redpolls, and some other species of the charming finch kind, may be taught to draw up their water in a little bucket by accustoming the bird to go to one spot for the water. The water is then placed barely within their reach, and then a trifle beyond it, taking care that they do not perish for want of water before they have learnt the trick. I had a bird for many years which used to draw his water daily. Sometimes I used, for one or two hauls, to play him a trick by lengthening the string of his bucket till it was a yard long, which used to embarrass him much, though he generally succeeded by pulling the string with his beak and then holding it with his claw.

178. When animals are gregarious, they not only have regard to themselves, but they extend their operations to the benefit of the whole community. "Three dogs belonging, two to M. G. and the other to M. P., of Saint-Bonnet sur Galaune (canton de

St. Valier, department of the Drôme), went to the chase without their masters. Having pursued a rabbit almost to an extremity, which took refuge in a burrow, one of the dogs of M. G., carried forward by eagerness, shoved himself so deeply into this subterraneous asylum that retreat became utterly impossible. After having scratched to no purpose in the hope of extricating him, the two companions returned home in such a state of sadness and dejection as to be noticed by their masters, who knew not to what to attribute the cause. The next day came a fresh disappearance of the two dogs, which had found the means of joining each other. They were seen to return in the evening to their respective domiciles harassed with fatigue; to refuse every sort of nourishment, their paws bloody, and their bodies covered with earth and sweat. At first, no attention was paid to what took place; but the same procedure being repeated the next and on succeeding days, and M. G. not finding his dog return, the absence of which began to make him uneasy,—surprised, moreover, at the daily disappearance of his second dog, which only came back at night, and that in the most frightful state,—mentioned the circumstance to M. P., who declared to him that his dog had done the same thing for a week. Finally, the day following, M. G. was awakened early in the morning by the cries of several dogs, who scratched at his door; he came down to see what was the matter, and what was his astonishment when he saw his dog, which he thought lost, feeble, languid, and like a mere skeleton, escorted by its two liberators to the residence of its master, and which, seeing it in his care, went to sleep tranquilly on a bundle of straw, scarcely able to move their stiffened limbs. M. G. made researches to discover the place where this touching scene occurred. He found, in fact, that the narrow opening into which his poor dog had forced itself was transformed into a large cavity, the working out of which was evidently due to the intelligence of the two other dogs."

179. But, perhaps, a more curious example is to be found in those cases in which an animal forms a partiality with an animal of a different kind. In cases where an attachment exists between man and animals, the animal will protect his master, and defend him to the best of his ability. I knew a boy who had a favourite dog, and who also kept a number of silkworms. The dog used to sit quietly by the boy when he was cleaning and feeding the worms. To-day, however, the wind blew down the boxes containing the worms. The dog saw the accident, and, by barking and manœuvring, he attracted the attention of his master, and thus the worms were reinstated in their former position. In this instance the dog clearly knew that something had happened which required the immediate attention of his friend and master.

180. I have seen other instances in which the dog and his master have been actuated by the same idea. Two boys were very fond of taking a dog to bed with them, although it was strictly forbidden for them to do so. The mamma was determined to stop the practice, went at night into the room, and turned the dog out, and he was compelled to sneak down stairs with tail between his legs. On the next night, however, the boys put the dog into one of the drawers and shut him up, so that, when the mamma came, no dog was found, and the boys afterwards took him to bed. The dog seemed fully to appreciate the boys' movements, and used perfectly to fall in with their plans. Some nights, indeed, the dog was discovered, but generally he was hid up in such an ingenious manner that he was not discovered. If the dog was called or whistled he took no notice, but used to lie perfectly quiet till the

boys took him out of his hiding-place. In this case we are compelled to admit that the actions of the boys and their canine companion were determined with the view to obtain the same end.

181. I have often noticed on the Sussex downs, with great interest, large flocks of sheep during the month of June, when the lambs still require the aid of their mothers. The young ones frisk about, and amuse themselves with other lambs of their own age. But, after a time, they require their mother to supply them with nature's food, and they begin to baa most piteously. The mother, although a long way off, instantly recognizes the cry of her offspring, answers the lamb, and runs off at full speed to attend to its wants. The other mothers, who heedlessly noticed the cry of the first lamb, are on the alert when each is called by its respective offspring. This calling of the lamb, this answering of the mother, each in its own particular tone of voice, certainly adds much to the animation of the scene. No sooner is the lamb fed than they again separate; and this alternate losing and seeking continues till the shepherd gathers the flock into the fold for the night. As far as all these actions are concerned, a sheep cannot be said to exhibit less mind, or a different kind of mind, from man, who, under such circumstances, could do no more.

182. Where animals are trained to perform any act, they are apt to carry out that act blindly, without reference to all the circumstances of the case. A gentleman of my acquaintance had a large Newfoundland dog, which used to fetch sticks and other objects when thrown into the water, and was fond of the sport. One day the dog came suddenly upon a pond where many boys were bathing. He rushed instantly into the water, seized one of the lads by the fleshy part of the back, and forthwith dragged him to land. The poor boy was dreadfully alarmed, and cried for pro-

tection. The owner of the dog begged the boy to be quiet, but the lad rejoined, "Oh, Sir, he is biting such a big hole in my back;" and no doubt felt his teeth uncommonly disagreeable. I have read of cases where dogs have drowned their masters in attempting to pull them on shore; so we must take with some qualification the title which the talented Landseer has bestowed upon a dog, when he describes the beautiful picture of a Newfoundland dog as that of "A distinguished member of the Royal Humane Society."

183. We have all heard, and we have all read, of the wonderful doings of the dogs of St. Bernard. When I visited that hospice I fancied that it was the realization of a romance; and when, as we approached the house, two or three noble dogs came out, I thought that I should have all my previous ideas confirmed. However, I was sadly disappointed by one of them setting up an angry growl, and seeming rather to forbid our entrance than to exhibit any preternatural love for the human race. However, he got a hearty kick from one of the lay brethren, which seemed to teach him more becoming manners. I could not learn that the monks attached any very extraordinary value to the dogs, though they stated that they were very useful to carry flasks of brandy, food, or clothing to travellers in places where the snow was not sufficiently hard to bear the footsteps of a man.

184. At any one given moment of our existence we are receiving impressions from all our senses; but these impressions do not endure equally long. Some are continued but for a few seconds, others for a few minutes, and many for a long period. The relation of the changes to each other is termed the time of their occurrence.

185. Man, by practice, can estimate the relation of these

changes. The old lecturer well knows when he has reached the hour; the practised physician can estimate the pulse without his watch; and I really think that there is but little difficulty in estimating how long we have been about any operation. This power is not alone obtained by man. Pigeons, when they have eggs, divide the day, one bird sitting all day, the other all night; though occasionally I have known birds which could not be happy if they did not each take charge of an egg during the night. The one bird sits all day, leaves the nest about four o'clock, and the process of changing is interesting. The bird, whose turn it is to sit, is generally close at hand, and, the moment the first bird leaves the nest, occupies its position, and the first bird takes a fly round, trims its feathers, and takes food and water for its subsistence. The point now to be noticed is the constancy with which the change is made in point of time, although these creatures have neither watch, clock, nor hourglass. One pair which I attentively noticed used to change daily at a quarter past four, and the time varied in different days but to a very few minutes.

186. We had a dog to which the former clerk of the works took a great fancy. He used to dine at one o'clock, and then he invariably gave the dog a bit of biscuit, of which it was particularly fond. The dog would frequently go out and wait upon the top of the opposite steps till it thought that the time had arrived, when it would walk deliberately over to the office and bark for its accustomed food. The constancy of the time of the visit was very curious, and used to attract the attention of the bystanders.

187. A gentleman of my acquaintance kept a toad, and used to give it something to eat at dinner-time, and it always knew the time regularly, and was always ready at the window to receive his dinner. From family circumstances the time of dining was

changed from four till two, and the toad was not there to receive its food. The next day the toad kept a sharp look-out, and ever afterwards came down at the new time; so that, in point of fact, the creature judges of the interval which existed between one day and another.

188. In this chapter I have shown how we obtain our simple ideas of everything we either see, hear, feel, smell, or taste, and couple with these ideas the notion of pleasure and pain. We have found that these ideas are possessed in common by man and the whole of the animal kingdom, but that each animal differs in his capacity to form these ideas. Man is inferior to the bird in point of ideas which he derives from the eye. He is inferior to the dog in the ideas which he can derive from the nose. He is superior to the mole, who can derive no ideas from the eye. Upon the whole, he can neither be considered superior nor inferior to other creatures in the knowledge which they have of these simple ideas.

These simple ideas, derived from the direct impressions of the senses, I have termed units of knowledge, and the parent should always take care that the child should have his mind well stored. There are four great establishments about London which children should periodically visit, namely, the British Museum, Kew Gardens, the Zoological Gardens, and the Polytechnic Institution. At a very early age they should visit these places, in order that accurate notions of the various things there exhibited should be firmly impressed. Every additional unit of knowledge fixed in the mind enlarges the sphere of mental power, and, as the child grows up, will afford him a further means of exciting the higher powers of thought.

189. In the cases which have been quoted throughout this chapter, a man has no superiority over the brute beast. It is not in

these respects that he excels all living beings, and we must, therefore, look hereafter for some further cause for his superiority. Up to this point, man only manifests the phenomenon of a structure superior to the mechanism which he can construct, from his powers being inferior to those of the Great Architect of the universe.

CHAPTER VI.

OPERATIONS OF MAN SUPERIOR TO THOSE OF ANIMALS.

190. Up to this time we have found that man, in respect to

the powers of mind which he possesses, is similar to animals; and yet we know that man far exceeds all living creatures in the faculties of the mind. If mankind possessed no further faculties than what I have already enumerated, he would be no whit better than the beast; and therefore we have now to consider those other faculties which entitle him to hold the first place in the scale of creation.

191. If we examine the results which man can effect, we find that he can use the various forces of matter, and apply those forces to obtain any given end. Newton observed that the apple fell to the ground, and, from bringing all the facts of the case to his mind, deduced the law that bodies naturally attract each other,—and hence arrived at the idea of gravity.

192. As the bulk of the whole earth attracts to it every lesser body, so it causes the apple invariably to fall to it instead of tumbling to the sky. From a knowledge of the law, every child knows that whether the piece of matter be an orange, an apple, a stone, or any other body, it will fall to the earth. Man, in practice, instead of acting upon the simple idea of an apple falling to the ground, acts upon the general law, and thus applies the fact to any small piece of matter, as he knows that it will be attracted to the larger mass.

193. We practically use this law to give motion to the mechanism of our clocks: we elevate a weight, which falls slowly to the ground, and communicates its action to the wheels. We use this law when we let the railway train glide gently down the incline, and also when our water-wheels are made to turn from the weight of water which is attracted to the earth.

194. If we turn to the various members of the animal kingdom, we find that not one shows any indication of acting upon the idea

of attraction, or weight. At once we perceive that, in this instance, we have a result obtained by man which is above that which can be obtained by any other created being.

195. In examining the earth, we find that it is made up of about sixty-one undecomposed bodies or elements, grouped together in various ways. Moreover, we find that bodies are attracted together in definite proportions, and hence we arrive at the laws of chemical affinity. Upon a knowledge of chemical affinity the whole science of chemistry depends, which gives to man the power of either forming new bodies or of decomposing old bodies at will. This knowledge alone confers a great superiority upon man above all other animal beings.

196. Not only with regard to the idea of attraction and chemical affinity does man excel animals, but also in his capacity to understand form, volume, number, he holds the pre-eminence; as for the knowledge of these principles he has constructed the sciences of arithmetic and geometry. If we compare this knowledge with that of the animal, we at once find that no brute could ever be made to comprehend that two and two make four, that twice four make eight; and I apprehend that the keeper of a menagerie would be greatly surprised if any person asked him to teach his elephant that the three angles of a triangle are equal to two right angles.

197. Man, by applying this knowledge, can map the globe with tolerable precision; he can ascertain the distance of celestial bodies from each other, and their relative size to this great globe, or any definite object amongst those of which it is composed. By the application of this knowledge he can circumnavigate the earth with certainty and precision, and, when in unknown seas or

untrodden lands, he can ascertain his relative position on the earth's surface, and the distance from his native country, provided he can add to his natural resources the exact time by the clock in his own climate.*

198. Electricity is another force of matter with which man is acquainted and uses for his own purposes. It is a more mysterious force than many other forces which man employs, and only within the last few years has been used in the arts. In the working of metals it now takes its proper place; and so well are the processes of electro-metallurgy now understood, that I regret to state that even the false coiners are in the habit of silver-plating their spurious productions, to give them the appearance and feel of silver.

199. Electro-metallurgy is principally employed for the working of gold, silver, and copper. To illustrate this process with regard to copper, let us suppose that we desire to make a cast in that metal. A solution of a salt of copper is to be placed in a convenient vessel, and the object on which the precipitation is to take place (N) is to be connected with the zinc of the battery (Z), whilst a piece of sheet copper is connected with the silver (B). As soon as action commences, water is decomposed, oxygen passes to the copper pole and oxidizes it, and the hydrogen passes to the negative plate. Whilst the decomposition is taking place, oxide of copper is passing to the negative pole, and the acid to the positive pole; the hydrogen reduces the oxide of copper at the negative plate, whilst the acid combines with oxide of copper at the positive end, and thus the saturation is continued. (*Fig.* 15, 16.)

200. Electro-metallurgy is now extensively employed for surface

* Smee's 'Sources of Physics.'

Fig. 15.

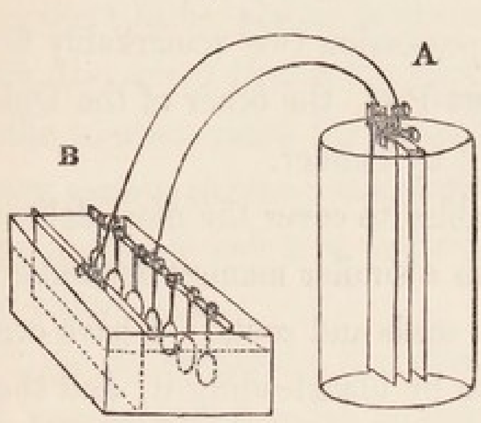
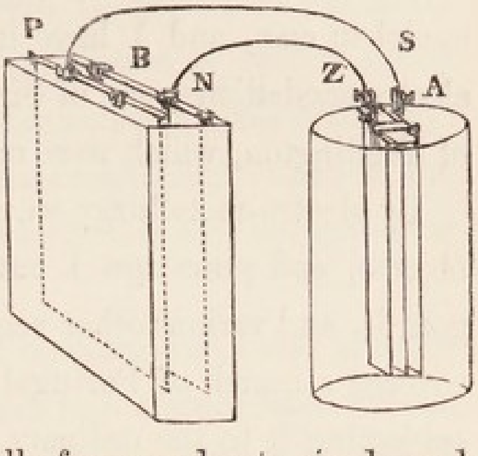


Fig. 16.



printing. In these instances, especially from moderate-sized wood-cuts, a clichée reverse is frequently at once taken from the cut. From this clichée an electrotype duplicate is procured, which is found especially adapted for printing; and the annexed beautiful cut, designed by Landseer, well shows how excellent a device it is for the purposes of the arts. Electro-metallurgy is also employed

Fig. 17.

by the Art Union to multiply their disreputable engravings, and by Government for the more meritorious purpose of copying the original plates of the Ordnance survey of England, a process which, from the large size of the plates, is extremely difficult to carry on.

It is used occasionally by the sculptor to obtain a fac-simile of his model in clay, and I have in my possession two remarkably fine electro-medallions, one of Sir Robert Peel, the other of the Duke of Wellington, which were modelled by Palmer.

By electro-metallurgy we are enabled to cover the most delicate objects, and years ago I covered in a similar manner cucumbers, gourds, and various other vegetable seeds and roots. I have even covered a bunch of Portugal grapes by blackleading it, and then subjecting it to the ordinary process for the deposition of copper.

201. For all cases of electro-gilding the aurocyanide of potassium makes by far the best solution. It is scarcely decomposed by any metal. It may be prepared by digesting oxide of gold in a strong solution of cyanide of potassium. For gilding, a strong solution of the salt is to be preferred, and from its corrosive nature it should always be placed in a glass vessel. The size of the battery need never exceed the size of the object to be gilded. The positive pole in the precipitating trough should consist of a piece of pure gold flattened, and the part exposed to the solution should not exceed the size of the object to receive the deposit.

202. It is a curious fact that, over a series of years, I have received numerous letters stating that more gold was reduced than was dissolved at the positive pole, and that, therefore, gold was probably made in the process. However, in these cases, the solution takes oxygen instead of the gold being dissolved, and thus its apparent manufacture is accounted for.

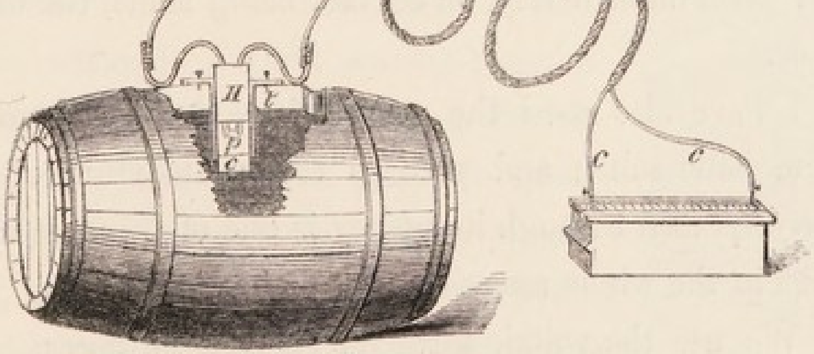
203. There is no process at the present time more readily conducted than electro-plating. The best solution which can be used is without doubt the argentocyanide of potassium. It is generally made by boiling the oxide of silver in a strong solution of cyanuret of potassium. The solution is placed in a glass vessel;

a silver pole is connected with the silver plate of a battery, whilst the object to be plated is conected with the zinc. It has lately been discovered that a few drops of bisulphuret of carbon added to the solution cause the metal to be deposited in great brilliancy. These various electro-metallurgic processes have much improved the arts, and show well how electricity can be beneficially employed for the wants of man.

204. By electricity the process of blasting rocks and blowing up vessels under water is now carried to a considerable extent. When Sir Harry Smith desired to astonish the natives of Africa, having previously arranged the contrivances required for voltaic blasting, he told them that, as an example of his power, he would show that he could, at any definite moment, command the waggon to go to pieces. The word of command was given, the circuit was was completed, and, to the astonishment of the Africans, the whole blown into the air.

205. In this country it has been used for the removal of the wreck of the Royal George off Spithead. Captain Fisher, the harbour-master of London, has constantly employed it for removing shoals and wrecks of vessels. By his process (*fig.* 18) he placed

Fig. 18.



the gunpowder in a barrel which had a hole bored in it so that it might admit a copper tube (t). This copper tube had a plate soldered to it at the upper part, by which it might be fastened by copper nails to the cask; a plug (h) was fixed in the tube, through which two copper wires were inserted, and round the ends of the wires was wound a fine piece of platinum wire (p), so that but a single filament extended from wire to wire; the rest of the tube was filled with fine powder, and a piece of cork (c) was placed in the other end This copper tube was then carefully secured water-tight by smearing pitch round the copper. For securing the tube and wires in their places, the ends of the two copper wires were bent and nailed to the tub. The next thing was to fill the tub with blasting powder by another hole, and then secure the aperture water-tight with a wooden plug, which was afterwards smeared over with pitch. The cask was then lowered to the bottom of the vessel and placed in the situation where it was destined to act. A rope, previously made by procuring two wires, first covered with cotton and varnished, and twisting them with the texture of the rope, was then lowered to the bottom of the sea, and the ends of the two wires communicating with the tube were tightly lashed to the two wires in the rope. All these things being ready, the ends of two wires at the other extremity of the rope were connected with the two extremities of one of my small compound batteries, when immediately, on contact being made, the explosion took place.

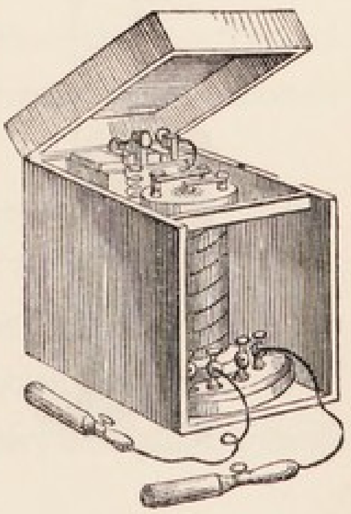
206. I have also used the voltaic force for the formation of various metallic salts; and perhaps the manufacture of the red prussiate of potash through its agency is one of the most recondite operations in the whole range of electro-chemistry.

207. We use the voltaic force for medical purposes. It con-

tracts the muscles and stimulates the nerves of sensation. From my experiments it is proved that the action of the nervous system is a voltaic circle, which passes by the sensor and motor nerves. The terminations of the sensor nerves form one pole, those of the motor nerves the opposite pole; hence the voltaic force is competent to excite their action.

208. An amusing account is given by Dr. M'William, in his important work on the medical history of the ill-fated Niger expedition, in which he details the manner in which the galvanic shock startled the African king, Obi, when he first felt the sensation which it excites. "An instance of his firmness was shown one day on board of the Albert. While he was engaged with the commissioners, I was amusing his brother and some of the boatmen by performing some experiments with Smee's galvanic battery. Obi came up to us just as the instrument was fitted for giving shocks. Amorama, the judge, a little man, touched the cylinders at the end of the conductors, and, as the battery was at the moment acting rather powerfully, he dropped them and would not again come near. Most of the others looked upon this new and extraordinary agent with suspicion and awe; even Obi himself stooped somewhat doubtingly to take the shock, but he seemed determined to show no signs of irresolution or fear before his people. He took a firm grasp of the cylinders and held them upwards of a minute, although I could see the muscles of the shoulder and chest in strong electric excitation." For medical purposes generally, the electro-magnetic machine is preferred, as giving a more powerful shock, and not requiring a series of batteries. (*Fig.* 19.)

Fig. 19.



209. For all these purposes the voltaic battery is employed, of which three principal forms are now in use, namely, that devised by my distinguished master Professor Daniell, the nitric acid battery, and the platinized silver battery. Professor Daniell's battery (*fig.* 20) is constructed of an outer copper cylinder (C) to form the negative pole. Into this is placed a solution of sulphate of copper (S). The zinc (Z), or positive pole, is placed in an inner porous pot (P) holding dilute sulphuric acid (A). For the nitric acid battery (*fig.* 21) platinum (P) is employed as the negative pole. Zinc (Z) is placed in the porous pot (P) with dilute sulphuric or muriatic acid (A), and nitric (N) is placed in contact with the platinum. This battery is the most powerful, but the nitrous fumes exhaled are extremely destructive to the lungs. My own form of battery (*fig.* 22) is by far the cheapest in its operation. It consists of platinized silver (S) for the negative metal, zinc (Z) for the positive, and it requires no porous pot. The battery is charged by using one part of sulphuric acid to eight of water (A). When we require a compound battery, it is conveniently arranged in a many-celled porcelain trough (*fig.* 23).

Fig. 20.

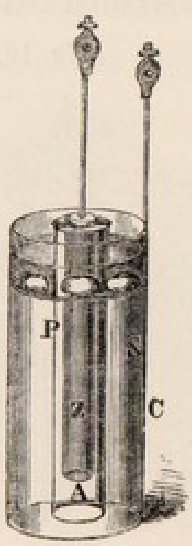


Fig. 21.

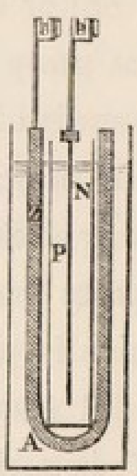


Fig. 22.

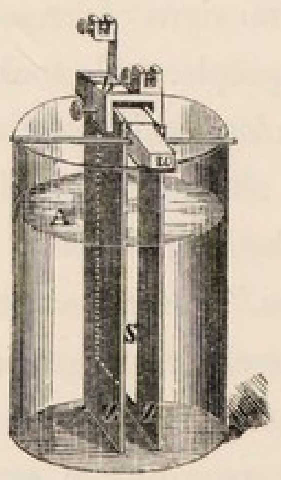
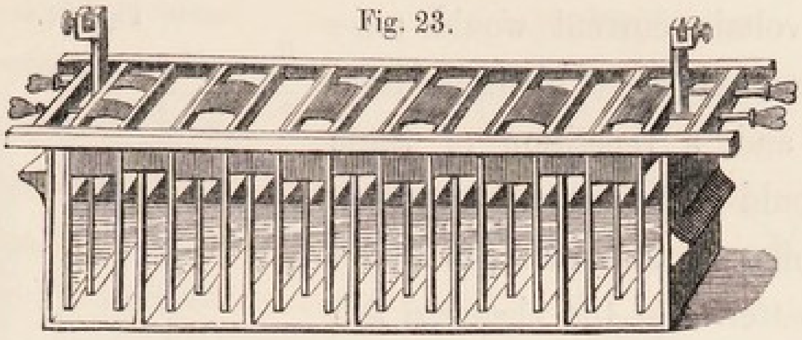


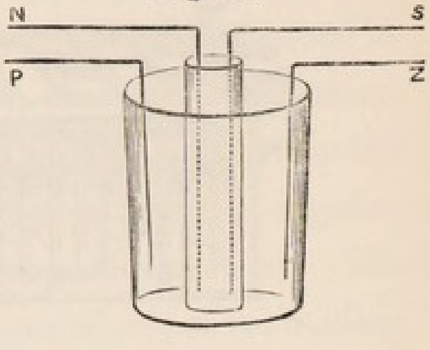
Fig. 23.



210. We boast of our voltaic batteries. I should hardly be believed if I were to say that I did not feel pride in having constructed my own, especially when I consider the extensive operations which it has conducted. But, when I compare my battery with the battery which nature has given to the electrical eel and torpedo, how insignificant are human operations compared with those of the Architect of living beings! The stupendous electric eel in the Polytechnic Institution, when he seeks to kill his prey, encloses him in a circle; then, by volition, causes the voltaic force to be produced, and the hapless creature is instantly killed. It would probably require ten thousand of my artificial batteries to effect the same object, as the creature is killed *instanter* on receiving the shock. As much, however, as my battery is inferior to that of the electric fish, so is man superior to the same animal. Man is endowed with a power of mind competent to appreciate the force of matter, and thus is enabled to make the battery. The eel can but use the specific apparatus which nature has bestowed upon it.

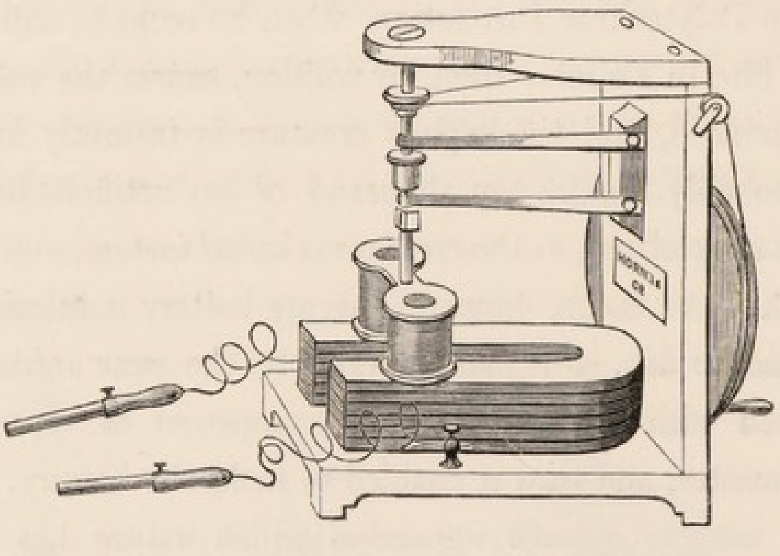
I have contrived two or three arrangements which appear to me to be similar to the electrical organs of these fishes. In the natural battery the nerves are distributed at right angles to the batteries. Following this hint, I took a solution of prussiate of potash, and transmitted a current of electricity at right angles to it. A voltaic current would arise from a second pair of platinum electrodes; and a repetition of these cells would form an arrangement very similar to that which is found in the batteries of the electrical fish (*fig.* 24).

Fig. 24.



211. The electric current, which has all the properties of that produced by the voltaic battery, may be obtained by the magneto-electric machine, and the one which I have figured is one which has been lately made by Messrs. Horne and Thornthwaite to supply the place of the battery in medicine, and to be used for various chemical purposes.

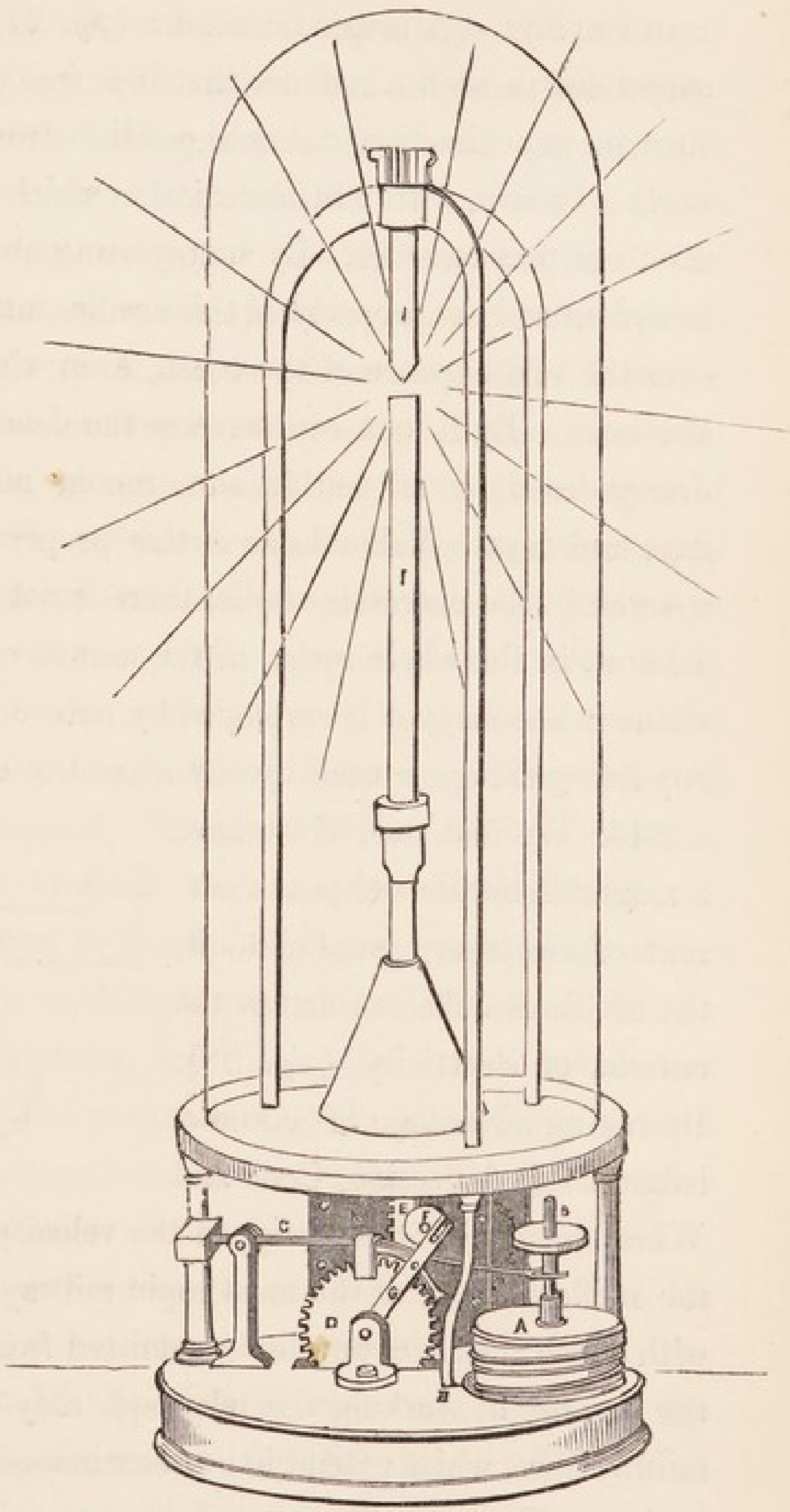
Fig. 25.



212. Man can employ the voltaic force for the production of the electric light (*fig.* 26); and some time since, Mr. Staite amused the inhabitants of London by illuminating the Nelson Monument from the front of the National Gallery. There is, however, one serious drawback against the use of voltaic electricity for the purpose of illumination, and that is, its serious expense. It is a

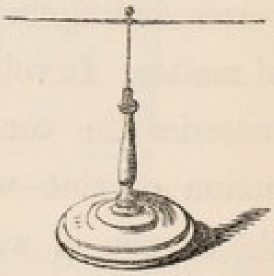
Fig. 26.

STAITE'S APPARATUS.



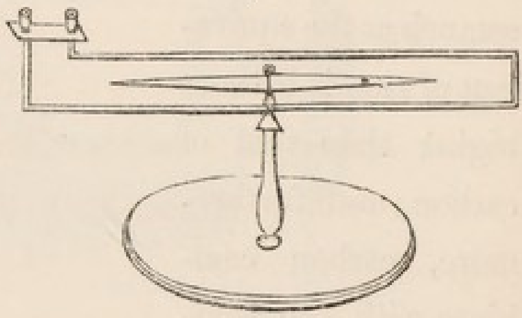
primary law of nature, that no power can be obtained without a corresponding change of matter. In voltaic batteries the combination of zinc with the oxygen of water constitutes the change of matter which gives rise to electricity. As much dearer as zinc is than coal gas, so is the cost of the voltaic light over the ordinary mode of illumination. But the expense is even still greater, inasmuch as the equivalent of zinc is 5 times higher than that of carbon; and, furthermore, carbon combines with two equivalents of oxygen to form carbonic acid. For this reason the electric light will probably for ever remain a pretty scientific toy, unless, indeed, some person shall have the good fortune to discover a battery with a carbon positive pole.

Fig. 27.



213. Magnetism is another force which man employs. A magnetic needle (*fig.* 27), suspended in such a manner that it is free to turn in any direction, takes a position from north to south, with a little deviation which I need not now consider. By simply being able to understand the property of this needle, man can steer his course over the vast expanse of the ocean, even when he is unable to see the land. By it man can traverse the densest forest or the most dreary desert, when neither sun, moon, nor stars are visible for days and days. Valuable as is this property which man has discovered in the magnetic needle, there is not one instance, as far as I know, in the whole range of the animal creation, in which this virtue in the magnet is employed by nature in the organization of any living thing, or used by any animal to effect any definite end.

Fig. 28.



214. We find that, if we have a magnetic needle and pass a current of electricity parallel to it, the needle is deflected across the current of electricity (*fig.* 28). By taking advantage of a knowledge of this deflection, Cook and Wheatstone have far outstripped the velocity of the carrier-pigeon, the swiftest horse, or the most rapid railway-train, in the rapidity with which messages may be transmitted from place to place. For the purpose of working the telegraph they place wires along the railway lines, which extend in one continuous length from station to station. Whenever the voltaic force passes, it acts upon the needles

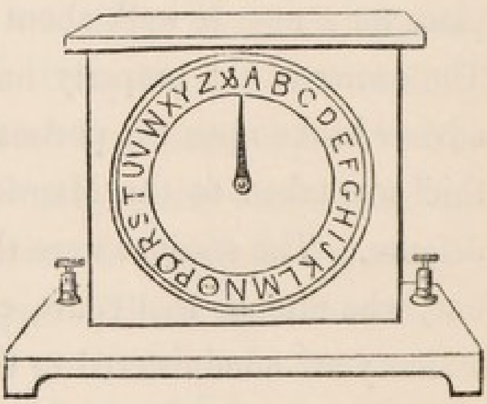
at the opposite end. This action represents a sign, and, by using these signs upon a preconcerted plan, the messages are sent.

215. To show the influence of the electric telegraph upon our operations, and the superiority which a knowledge of the laws of nature practically bestows upon mankind, I may mention a story which Mr. Marshall, the chief cashier of the Bank, tells upon the subject. One Friday night, at ten o'clock, he received a notice from Liverpool by electric telegraph to stop certain notes. The next morning the descriptions were placed upon a card and given to the proper officer, to watch that no person exchanged them for gold. Within ten minutes they were presented at the counter by an apparent foreigner, who pretended not to speak a word of English. A clerk in the office, who spoke German, interrogated him, when he declared that he had received them on the Exchange at Antwerp six weeks before. Upon reference to the books, however, it appeared that the notes had only been issued from the Bank about fourteen days, and, therefore, he was at once detected as the utterer of a falsehood. The terrible Forrester was sent for, who forthwith locked him up, and the notes were detained. A letter was at once written to Liverpool, and the real owner of the notes came up to town on Monday morning. He stated that he was about to sail for America, and that, whilst at an hotel, he had exhibited the notes. The person in custody advised him to stow the valuables in his portmanteau, as Liverpool was a very dangerous place for a man to walk about with so much money in his pocket. The owner of the property had no sooner left the house than his adviser broke open the portmanteau and stole the property. The thief was taken to the Mansion-house, and could not make any defence. The sessions were then at the Old Bailey. Though no one, who attends that court, can doubt that impartial justice and leniency are administered to the prisoners, yet there is no one who

does not marvel at the truly railway speed with which the trials are conducted. By a little after ten the next morning,—such was the speed,—not only was a true bill found, but the trial by petty jury was concluded, and the thief sentenced to expiate his offence by ten years' exile from his native country. The next morning the account appeared in the newspapers. A sergeant at the Tower, on reading it, exclaimed, "That man answers the description of a person who deserted our regiment, and we have not been able to find him." He posted off to Euston-square, sent a man to Rugby, where the telegraph to Liverpool then commenced; a message was sent to stop a man with his description. As the prisoner alighted from the carriage, he was taken into custody, and the next morning he was placed in confinement at the Tower as a deserter.

216. But, in America, the Anglo-Saxon race far surpasses us in electro-telegraphing. In former times, if any person had pretended that he could have sent a message so fast, that if posted at eight it would arrive at its destination by seven, he would certainly have been set down either as a madman or a fool. Yet the Americans, from having an extensive telegraphic communication, have actually attained this extraordinary result. Messages would be sent instantaneously round the world if we could but gird it with a wire; and, in America, the wires are of such great length that I have heard it stated that they can actually forestal the time by the sun for nearly an hour!

Fig. 29.

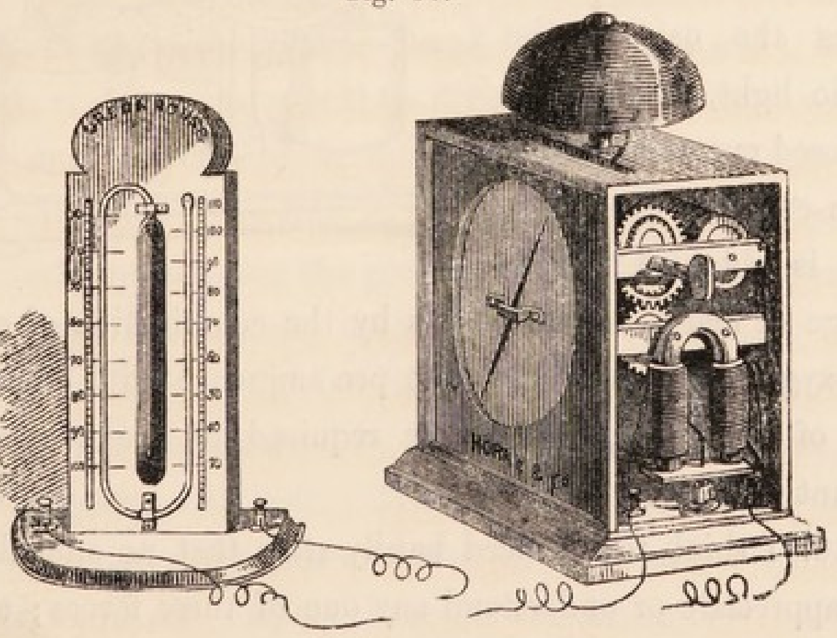


217. There are many varieties of electric telegraph which now exist. In some forms letters are thrown up as desired (*fig.* 29); in others, certain actions represent certain words; in some the word is printed; but, upon the whole,

the simple needle telegraph appears preferable to all others for most purposes. In animal bodies we really have electro-telegraphic communication in the nervous system. That which is seen, or felt, or heard, is telegraphed to the brain *instanter*; and, from the whole of our previous ideas being included in the circuit, the act determined takes place momentarily.

218. I have a little trifle at my own house of a somewhat similar character, as it communicates intelligence from one spot to another. Behind my house is a small hothouse, and I conceived the idea of constructing a simple telegraph which should inform me of the temperature. Now, my plants would be injured if the heat fell below 50° or rose above 90°, and I therefore wished to have some contrivance which should inform me in my own study whether the temperature were remaining or not within these limits. For this purpose a thermometer was made for me by Messrs. Horne and Thornthwaite, into which two platinum wires were inserted, which came in contact respectively with the mercury at those two points (*fig.* 30). By this contrivance, when

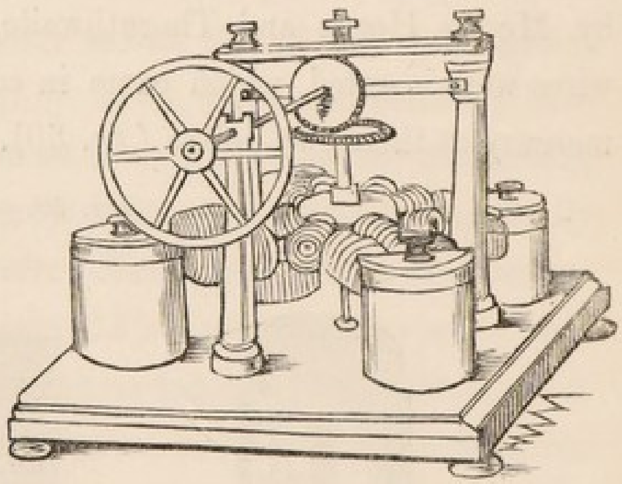
Fig. 30.



the heat either fell below or rose above these two points, the mercury and platinum were not in contact, and a voltaic current could not be maintained. Telegraphic communications were laid down from these two platinum wires to my dwelling-house, and a large pair of zinc and copper plates were sunk into the ground for a battery. By attaching the wires to a galvanometer we can always ask how the temperature is; and, by attaching an alarum, a gardener might be warned of any accident at any time of the night. I must say, that had I the care of so valuable a collection of plants as that of Kew, I should never be easy till I had such an apparatus in my bedroom to tell me if any of my plants were under unfavourable circumstances.

219. By a knowledge of the action of the voltaic force on the magnet we can obtain a motive power; there are several varieties of arrangements for this purpose (*fig.* 31). Now, the only reason why this motive power is not employed is that which precludes the use of the voltaic light, namely, its increased expense; for the steam-engine, where the force is obtained by the change of matter which ensues by the combination of coals with the oxygen of the air, holds the pre-eminence with respect to the cost of the change of matter required to produce any given amount of force.

Fig. 31.



220. I think that I need hardly state that no animal but man can appreciate or understand any one of these forces; and, thus,

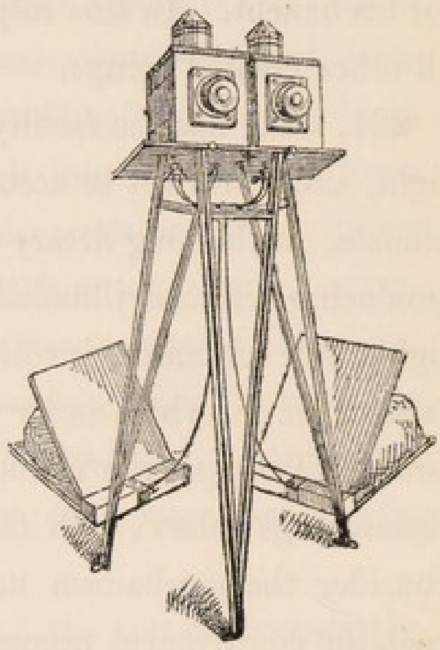
that no creature but man can employ any of these physical forces for his benefit. In this respect man thus shows a superiority over all other created beings.

221. Man has the faculty to understand the force which we call light, and to turn it to account. What could we do, even in this climate, in the long dreary winter evenings, without the power of producing artificial illumination? and yet our candles, our gas-lights, our oil-lamps, involve a mental capacity to understand the laws of matter which is far before that which is exhibited by any brute. Perhaps the artificial illumination which we obtain by means of gas shows well the effect of mental power. When we consider the mechanism necessary to obtain that product from coal, the contrivances necessary to ensure an equable and constant supply under the varied circumstances of the wants of the people, the appliances necessary to carry it from the factory and distribute it to all parts of the metropolis, the devices by which it is measured, and, finally, the contrivances through which we are ultimately enabled to burn it, the use of gas does appear to be a noble practical effort of mental power. At present, gas is obtained by the distillation of coal in retorts placed in large furnaces; but I suspect that, ere long, water will be decomposed into its elements by carbon, and transmitted in the form of carbonic oxide and hydrogen. The only objection to this plan is the pale colour of the flame; but, by adopting the process of Mr. Lowe, and naphthalizing the gas, the difficulty might be readily overcome.

222. The most intense light, with the exception of the electrical light, is that which is obtained by the combustion of oxygen and hydrogen in contact with lime. These gases are generally placed in two bags, so that their amount may be accurately regulated. This light is frequently employed for the dissolving views, which

are thus contrived:—Two cameræ obscuræ (*fig.* 32) are used, and before the aperture of each is placed a slide so arranged that as one aperture is closed the other is opened. Of course, when the process is only half finished, the two views are both imperfectly represented at the same moment; but directly one aperture is perfectly closed and the other is widely opened, the views appear in their artistic beauty.

Fig. 32.



223. It might be urged that the glowworm gives off light, and, therefore, using light, it was similar to man. The glowworm does, in truth, give off light at will, and there scarcely can be a more lovely object than the glowworm when it shines forth at the top of a blade of grass in a summer's evening. In this case, however, the glowworm cannot make the candle,—does not make the apparatus by which light is exhibited; but nature has contrived some adaptation in the last two segments of the tail, by which the creature is enabled to evolve the light. This apparatus is not understood by the physiologist; and if the mystery should ever be unravelled, it might possibly indicate to us a new mode of lighting now unknown.

224. In this country, amongst moderate-sized creatures, the glowworm alone has an apparatus for evolving light, though many animalcules are luminous. There is a species of centipede called Electrica, which exhales large quantities of luminous matter, especially in the autumn. In this case the creature excretes the matter which is luminous, and which is left upon the ground as

the creature moves. The luminous matter may be taken in the hand; and then the fingers, and other parts which have touched it, will appear powerfully luminous. I have never been able to procure a sufficient quantity of either of these creatures to subject them to a very rigorous scrutiny. In foreign countries there are several remarkable light-generating animals. There are several beetles called fire-flies, common in the West Indies and neighbouring coast, which have on each side of the thorax a small organ, from which they evolve light as they fly along, lighting their way like a carriage with its candle on each side. Dr. Baird, the eminent naturalist, told me that he had read by the aid of the light emitted by these creatures, and narrated a curious circumstance which well illustrates the amount of light which they produce. The Spanish gentlemen are extremely jealous of the other sex, and, to prevent the latter from using these creatures to afford them light sufficient to enable them to see to write amorous epistles, a law was formerly enacted rendering the use of these insects an offence. It is said that the fair damsels, before retiring to their apartments, used to collect three or four of the creatures, when the light which they emitted was sufficient to enable them to indite their letters. In all these instances the light comes from some special contrivance given by nature to the animal, and is not in any instance obtained through the mind of the insect; and thus we find an important difference between man and the insect in this respect, for man makes the candle subservient to his use by a knowledge which he possesses of the force of light.

225. Light is not peculiar to animals, for there is a mineral called chlorofane, which emits much light. In a very fine specimen belonging to my friend Mr. Terry, I have been enabled to read the dial of a watch in a dark cellar, after waiting a few

minutes to accustom my eyes to the dim light. The mineral, however, when it is acted upon by light, seems to take on that state, by which it is enabled to evolve it for a considerable period.

226. But the contrast between man and animals is still more remarkable if we examine the effects which man can produce by light in the production of daguerreotypes, calotypes, cyanotypes, and a variety of other types of an analogous character. When it was first announced that pictures could be taken by light, the public were in a state of great excitement, and each person was trying his best to clear up the mystery in the interval which elapsed between the announcement and the publication of the process. At that time I happened to be absent from my usual occupation, from some trifling indisposition, and also turned my attention to the matter; and the results of the experiments were published in the 'Literary Gazette' for 1839.

227. At that time I obtained a fair representation of Lothbury Church from the top of the Bank; but my readers will no doubt smile when I state, that I arranged my apparatus at eight in the morning, and removed the picture at seven in the evening. At the present time the picture, which required eleven hours to be formed, even as a feeble impression, would be effectually produced in as many seconds under the improved processes now known. I am now writing with a few specimens of these exquisite pictures before me, which I have received from various kind friends. In one instance I have not only a faithful representation of the building, with every brick and every mark delineated, but I have even the shadow of all these things upon a pond of water. As an illustration of the perfection to which this beautiful type can be brought, I may state that I have seen a fac-simile of the 'Times' newspaper, made by Mr. Knight, represented word for word

and dot for dot on a space occupying about an inch and a half square.

228. These lovely pictures are so admired and appreciated, that an amateur calotype club has been founded by Mr. Fry, amongst the more eminent amateurs of this branch of art, who meet periodically to compare their various productions and to exchange copies. At their social parties the collective exhibitions of all the members are displayed, and the pictures which have been produced by Sir Thomas Wilson, Mr. Cundell, Mr. Myall, and others, are of surpassing beauty.

229. The production of calotype pictures is somewhat complex, as three processes are required before a negative picture is obtained; and the negative has to be rendered insensible to the further action of light before the reverse or perfect picture can be obtained, resembling nature in the various details of light and shade. For the calotype the finest paper which the talent of Whatman or Turner can produce is required. This paper is then coated with iodide of silver by the following process. A solution of iodide of silver in iodide of potassium is prepared, by dissolving twenty-seven grains of dry iodide of silver in distilled water by the addition of as much of the iodide of potassium as is necessary for that result. The paper is now stretched on a board, and inclined at an angle of 25°. Some of the dissolved silver is placed upon it by drawing a perfectly clean glass rod, which has been immersed in the solution, slowly from the upper to the lower edge of the paper. The paper is then dried, when the iodide of potassium is dissolved by placing it in perfectly clean water till it acquires an uniform primrose-colour. The iodized paper must then be rendered sensitive by a second coating. For this purpose a solution is prepared by adding four drops of a solution of nitrate of silver of fifty grains to the

ounce, to one drachm of distilled water, and still further adding three drops of a saturated solution of glacial acetic acid, and three drops of a saturated solution of gallic acid. This mixture is to be applied to the paper in the same manner as in the last process, taking care to perform the process in a room where no daylight is admitted. When dry, the paper is fit for exposure in the camera, to receive the impression of light; after which the dormant picture is rendered visible by treating it with a saturated solution of gallic acid; and, finally, the proper tone is produced by employing the sensitive solution. When the picture is distinct it is washed in water, and any remains of the sensitive coating removed by a solution of the hyposulphate of soda. The picture is then dried, and by these means we have a negative picture, or a picture in which the lights are reversed, the dark parts appearing light, and the light parts appearing dark. The negative picture is used as a plate from which the positive pictures are printed by placing it in close contact with photographic paper between two pieces of plate glass, when the new picture is the reverse of the first. The photographic paper may be prepared by washing the paper with a solution of twenty grains of salt to the ounce of water, and afterwards with a solution of ammonio-nitrate of silver, twenty grains to the ounce.

230. I have thus detailed the best process, as given to me by Mr. Bland, to show how complete the operation is in itself, and how many facts connected with chemical and optical laws must be understood before it can be practised. I once was requested to examine a Bank of England note for the Great Western Railway Company, to ascertain whether an erasure had not been made; but, before I subjected it to my experiments, I took a photographic copy, and thus can at any time not only swear, but prove, that the writing which I reproduced had some faint appearance before the tests were applied.

231. As we sit by the evening's fire-side, we are apt to take for granted that the production of heat from the combustion of coals is a matter of course, and we are apt to forget the mind which is requisite even to appreciate the idea of heat. It nevertheless affords to man much comfort, and shows power above brutes; for, howsoever much the animal may shiver in the woods, he never lights the fire nor adds fuel to the dying embers. What a contrast does this present to the knowledge of heat which we possess! We trace its effects upon matter under all circumstances, and regulate the heat of our rooms or hothouses to the greatest nicety under all the variations of external temperature. Behind my house I have a small experimental hothouse, which I heat by a common close stove. I have so placed it that the warm air passes into the house, is equally distributed, and, when again cooled, returns to the stove to acquire new warmth. When any system of warming is pursued by the circulation of air, the direction of the current may be predicted, inasmuch as the hot air is lighter, and consequently rises, whilst the cold air is chilled, and has a tendency to fall.

232. At an institution to which I am medical officer, it was desirable to have a strong room, in which documents of importance might be placed. When built, however, this room was found to be extremely damp, and unfit for its purpose, unless it could be efficiently ventilated. In this dilemma I proposed to Mr. Brass, the eminent City builder, to circulate the air, and render the whole slightly warm by means of a gas-burner. For this purpose I caused to be constructed a copper tube, which communicates with the bottom of the safe, and in the interior of which is placed a simple gas-burner. Over the copper tube is placed a galvanized iron jacket, which communicates with the upper part of the safe; and thus the air is kept continually in motion, and the

water is removed from the walls of the safe by the fixed and immutable laws of nature.

233. I need hardly remind my readers that, of all created beings, man alone cooks his food, or, in other words, alters its properties by heat to render it more suitable for his nutriment or digestion. The qualities of a cooked potato differ from those of a raw one in consequence of a certain material being removed, and the particles of starch being broken and rendered more digestible. A biscuit is a very different article from new wheat, and yet the change is simply effected by heat. When famine visited the country, I tried various experiments to ascertain how far other kinds of bread might be employed, and, as no record exists except in the newspapers of the day, I have copied the observations of the reporters upon the specimens which I exhibited at a *soirée* at my house, on February 6th, 1847. I believe that none of the breads, except the cereal breads, could compete with wheat in nutritive power or price, so that, besides being inferior in quality, they could never be brought into use from their additional cost.

234. The *Morning Herald* states that a very interesting collection of bread, in fourteen varieties, was exhibited under the title of "Famine Food." The rye, barley, and Indian corn breads require no comment from their want of novelty. The root breads were respectively made of half of the root previously boiled and reduced to a fine pulp, with half its weight of wheaten flour. The yam bread was good, and much resembled potato bread. It is a mere scientific curiosity in this country, though we are informed that it is employed in the West Indies. The turnip bread had a very agreeable flavour, but the loaf was very small. The relative price was not stated, but we should think it would not be an economic food. It might, perhaps, be used as a luxury. Bread

made with the sugar-beet was good and palatable, so was also that made with mangold wurzel. There was a good sample manufactured from the red beet by Mr. Farnes, which had the colour removed by repeated boilings. Parsnip bread was one of the best breads shown, and was moreover a large loaf. Bread made with the white carrot in the same manner had no peculiar flavour, which of course is a great advantage for food which is to be used constantly. Artichoke bread has the flavour of that root: it makes a good bread. Perhaps the root breads can hardly be called famine food, because the materials of which they are formed are articles of food under any circumstances, and they will be just as available for human food when cooked in the usual manner as when made into bread. There were, however, two decided novelties exhibited, namely, Iceland moss bread and hay bread, which will strictly bear the name of famine bread. Half Iceland moss and half wheaten flour make a dark-coloured bread of great weight and probably highly nutritious. It, however, possesses a peculiar bitter flavour, agreeable to those who like bitters, and disagreeable to those who dislike that taste. The hay food attracted great attention; it was shown in two forms—as hay bread and hay biscuits. The colour was very dark and repulsive, but the odour was agreeable. In taste it was sweet and high-flavoured, somewhat resembling that of strong and high-flavoured tea. The greater part of the company agreed as to its palatable character; some even thought it delicious, though others thought it disagreeable. To prepare it, the hay was ground into an impalpable powder and mixed with half flour, to hold the particles together. The hay food is probably highly nutritious, and might form a valuable famine food; but, being quite a novelty, experience is wanted upon the subject.

235. The *Morning Advertiser* observes, with reference to the hay bread:—"The hay biscuits and bread are most singular compounds; they are of a deep brown colour, approaching almost to black, possessing all the fragrance of hay, and are nutritious in a high degree. Of the nutritive powers, indeed, there seems to be no question,—the grand point to be ascertained is their susceptibility of yielding to the action of the digestive organs."

236. The *Sun* states that "the hay bread was a sweet-smelling and not unpalatable food. The Iceland moss bread alone was nauseous; all the other varieties were well tasted, and presenting the appearance of an ordinary loaf, and indicating by the smell the vegetable from which it was prepared."

237. The *Morning Post* states, "The most interesting objects, and those which excited the greatest attention, were specimens of famine food. About a dozen different kinds were submitted for examination, consisting of rye, barley, Indian meal, parsnip, yam, beet-root, artichoke, carrot, Iceland moss, and hay. With the exception of the two last, these breads seem to be well adapted for use, not only in times of scarcity but also when no such dire exigency exists. The Iceland moss and hay breads are black, and fit only to be used as human food when terrors similar to those described by Josephus of the last siege of Jerusalem shall fall upon us. At that dreadful extremity 'the tender and delicate woman ate her own child, and the son tore the bread from the mouth of the mother, and the father fed upon his daughter's portion.' This wonderful fulfilment of the prophecy, with all the circumstantial details of the event, occur, not unnaturally, to the mind at this season, more particularly when we already see human ingenuity at work to provide against the worst, and the productions of the earth, heretofore the food of beasts, converted into an-

other form for the exclusive use of man. May God forbid that so fearful a necessity should fall upon this hitherto highly favoured land."

238. Man appreciates and uses sound. He has discovered its laws and has measured the velocity of its progression. From a knowledge of these laws he has constructed multifarious instruments, each varying in tone and quality. When we hear the band of Exeter-hall, with all its varied instruments, playing the almost divine compositions of the Messiah or Elijah, we are prone to exclaim, What an excellent power does man possess, to enable him to accomplish these things! But when we walk in the groves and hear the chorus of birds in spring, are not the tones and qualities of the nightingale, thrush, lark, and other birds surpassingly fine, and do they not equal those of any instrument made by man? To my taste, they incomparably surpass them; and I am free to admit that I should leave the stupendous compositions of Mendelssohn and Handel for a walk, in the month of May, by the hedgerows of Kent.

239. The notes of the organ, the flute, the fiddle, and those of all other instruments, are obtained from a knowledge of the properties of sound, whilst the nightingale warbles with an instrument given to it by nature; so that, whether man or the bird excels in the capacity to produce melodious sounds, yet man exhibits a vast superiority in being able to make the instrument. In the use of the charming tones of the human voice even Jenny Lind is not one whit above the bird, as, in this respect, she uses but the instrument bestowed upon her by Providence. One bird excels another as much as one human being excels another in the quality of its voice. Mr. Fox, a neighbour of mine, in Finsbury-circus, has some birds which,

among the skylarks, may fairly pass for Jenny Linds; and the quality of their singing is so superior, that when we compare them with the ordinary standard, the difference is quite remarkable. Birds of such quality fetch a great price, as much as about £5 each. The human voice may be imitated by mechanism; and the talking doll, or the speaking machine of Wheatstone, will call, "plum," "papa," "mamma," &c.

240. Mr. Whishaw has lately taken advantage of a certain property of sound to construct a telegraph, or telekouphanon. The instrument consists of a long gutta-percha tube, communicating from one room to another, to each end of which is fixed a whistle, with a mouth-piece. When a party desires to communicate with another, he blows the whistle to attract attention, when the hearer goes to the end of the tube, and a conversation is kept up between them.

241. A near relative of mine excels as a musical amateur, and greatly delights to perform on the organ; but an organ with any degree of range occupies too much space for an ordinary dwelling-house. However, by substituting vibrating tongues for pipes, Mr. Willis, the eminent organ-builder, has contrived a charming instrument, which he terms an Organicon, containing fourteen stops, three rows of keys, with notes ranging from C C to F, swell throughout, and the instrument, moreover, has $2\frac{1}{2}$ octaves of pedals. The whole is arranged in a space comprised within two feet in depth, ten feet in height, and five feet in width. The construction of this instrument, to meet the particular wants of the owner, is a good example of the appreciation of the laws of sound.

242. There is no animal which shows any appreciation of the laws of sound: and whether we regard the melodious night-

ingale, the merry cricket, the hoarse raven, or the croaking frog, we find they make no instrument for themselves, but simply use the designs given to them by Providence.

243. Man, to conduct his operations, could, unaided, effect but little with his own natural organs, as they are manifestly inferior in themselves to those possessed by various other creatures. As a compensation for this defect, he is supplied with an organization which renders him competent to construct and to employ tools and instruments, by which he is enabled to obtain his end. Man contrives the saw to cut the wood, the centre-bit to bore holes, the plane to smooth, the hammer to strike; and with these he assists his natural organs, and is enabled thereby to surpass all other creatures. Some animals are naturally endowed with chisels, made precisely upon the same principle as those of the carpenter—as, for instance, the rat, the rabbit, the hare, all of which have teeth which consist of two parts of unequal hardness: the softer part, by the ordinary operation of biting, wears away, and thus the form of the chisel is perpetually maintained.

244. In constructing our tunnels we use spades and pick-axes; yet we find, by the organization of the mole, that it is so contrived that it can burrow extensively underground, form numerous galleries, and traverse considerable distances. To effect this object, its fore legs are very curiously constructed, so that it has great power to turn aside the earth; and in fact, we find that although animals may effect similar operations to those of men, yet no living creature except the human being ever uses a tool for any purpose, but simply confines its operations to what it can effect with its own organs. A dog will never take a piece of wood to assist him to reach anything placed

beyond the distance to which its foot will extend, although a child, at a very early age, would adopt the manœuvre. A monkey will never use a stick to inflict punishment upon another, but would be contented to endeavour to wreak its vengeance with its claws and teeth.

245. In the monkey there are, indeed, occasional examples of apparent use of tools. A captain told me that he had a monkey which had its usual share of mischievous propensities. Once, when his ship was in the river Thames, he ordered the figurehead to be painted, and paint for that purpose was procured. When the artist went to dinner, the paints were left on deck, when the monkey descended and mixed all together;—but this was action which did not tend to any definite end. From what I have already adduced, I believe that I shall be safe in stating that no animal, under any circumstances, ever makes a tool of any kind to effect any definite purpose.

246. Gilbert White has given us a pretty illustration of the manner in which three creatures effect the same object in a different manner, by using the mechanism with which nature has endowed them. "There are three creatures—the squirrel, the field-mouse, and the nut-hatch (*Sitta Europæa*)—which live much on hazel-nuts, and yet they open them each in a different way. The first, after rasping off the small end, splits the shell into two with his long fore teeth, as a man does with his knife; the second nibbles a hole with his teeth, as regular as if drilled with a wimble, and yet so small that one would wonder how the kernel can be extracted through it; while the last picks an irregular, ragged hole with his bill; but as this artist has no paws to hold the nut firm while he pierces it, like an adroit workman he fixes it, as it were, in a vice, in some

cleft of a tree, or in some crevice, when, standing over it, he perforates the stubborn shell. We have often placed nuts in the chink of a gate-post, where nut-hatches have been known to haunt, and have always found that the birds have readily penetrated them. While at work they make a rapping noise, which may be heard at a considerable distance."

247. If we take an example of any mechanical arrangement, such as that of a ladder, we find that man makes a ladder by which he can ascend to various heights. But if he attempts to ascend by his own powers, he is inferior to the monkey or other creatures, which have limbs specially designed for that purpose. His superiority, however, consists in being able to make the ladder, which shall suit all cases, and enable him to overcome obstacles which neither he nor the monkey unaided could possibly have surmounted.

248. But when we substitute for the ladder a mechanical hoist, the contrast between the power of man and animals is more striking. For instance, at Mr. De la Rue's a hoist is contrived which passes from the top of the building to the bottom, and by the use of which the workman with heavy weights can save himself the labour and fatigue of walking upstairs; as, by simply walking into a room and pulling a rope, the steam-engine will raise him even to the uppermost story of the building. The various methods by which the same end may be accomplished form other examples of the extent of the mental power of the human being. In the splendid room used for the drawing office in the Bank of England, there is a portion of the floor which descends at pleasure to the vaults below, and ascends again to its former situation. In this instance the steam-engine was too far from the spot to effect

the object, and the same result was therefore obtained by hydrostatic pressure. By turning one cock, water presses upon a large piston, and raises the floor and weight; and by turning a second, the supply is carried off, and the floor is thus allowed to descend by its own weight.

249. As an example of other contrivances produced by man, I may instance the railway systems now in vogue. By railroads the friction incidental to an uneven surface is removed, and other impediments, caused by going over hills, avoided, by the construction of tunnels and viaducts; but the formation of a railroad to cross an arm of the sea is one of the most astonishing instances of human labour and knowledge which has ever been undertaken. It is accomplished by the use of great tubes, which are strengthened by a series of cells. Now, the moment I saw the design, I could not help exclaiming that the device was virtually an artificial bone. Nature obtains strength and firmness by placing all the material at the circumference; hence a marrow-bone is hollow in the centre, but the bony tissue forms the outside of the tube—by which arrangement nature obtains the same strength with a far less amount of material. The bony tissue is even still further lightened by the presence of numerous little cavities throughout its entire structure. The astounding work has been raised to its destination, and will remain a monument to the mental power of Stephenson, who designed it, and to Englishmen, who are honoured by being enabled to number him amongst themselves.

250. After these instances of mental power, who will now be bold enough to assert that man does not differ in a remarkable manner from the most enlightened animal that has ever been witnessed? Nevertheless, animals make roads; and if we ob-

serve the sides of the mountains, we observe the regular track of the sheep to consist of little paths about four inches wide. Nor is the making of paths peculiar to sheep, for, as far as I can observe, all animals prefer to run in one road, and thus form a track. The track of sheep, oxen, and rabbits is precisely similar to the rough tracks which man forms through forests or wild places. Our railroads, however, differ from these primitive tracks, in being made, according to a knowledge of the properties of matter, to overcome natural obstacles.

251. Our knowledge of the properties of matter is not confined to matter in a solid form, as we are enabled also to employ fluids. The Britannia Bridge was hoisted to its great elevation by means of what is called an hydraulic press—a contrivance which is used for the hoist in the Bank, and which is employed in many instances where great pressure is required. For instance, gutta-percha ornaments are made by the great pressure which the hydraulic press affords. The hydraulic press is employed to squeeze out the surplus paste in the preparation of pasteboard; and there is no doubt but this book will have a squeeze before it goes to the binder, to flatten the surface, and probably it will have another squeeze before it leaves the binder. The hydraulic press is formed upon the principle that fluids press equally in all directions. By using a small pump to force the water into the piston, only a small resistance is offered to the entry of the fluid, while the force which is produced against a piston of large area is enormous.

252. By a knowledge of the properties of fluids, towns are supplied with water. London is supplied by the New River, which is brought, upon a level, from its source to Islington. Now, all parts of London which are below this level can be

supplied by simply carrying a pipe to the various houses, when the water, by its own weight, finds its level, and enters our cisterns. The water-supply of London is a reproach to its inhabitants. They have allowed private companies to pay the most enormous, unparalleled, and usurious dividends, and yet the poor have been allowed to remain without even a tithe of what they require of that necessary of life. I hope that some future commentators upon the powers of man will be enabled to say that the Londoners not only know the properties of water, but have obtained such an abundant supply from some distant source, that fountains may exist in every street, and that no man may be deprived of his proper supply. No animal ever makes a rill to bring the water to his habitation; no animal has his aqueduct or waterworks:—and here again is exemplified the superiority which man derives from his appreciation of the laws of nature.

253. A knowledge of the properties of air and gases is more recondite than that of solids and fluids. Man has found that air and all gases, although invisible, have weight. He proves this by taking a copper flask and carefully noticing the weight (*fig.* 33). When the air or gas has been exhausted by an air-

Fig. 33.

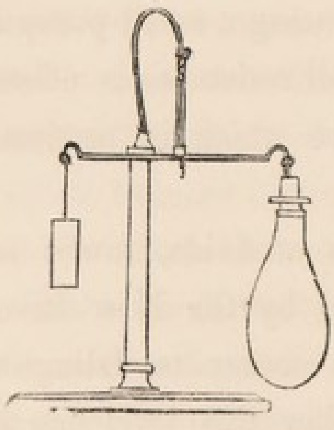
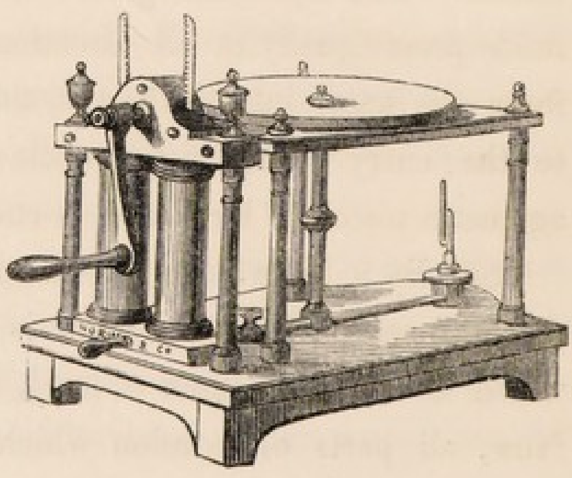


Fig. 34.



pump (*fig.* 34), he finds that the vessel is, to a certain amount, lighter, and the difference expresses the weight of that bulk of air or gas. Man also estimates the pressure of the atmosphere by the barometer. By a knowledge of the various weights of different gases, man is enabled to use a gas so much lighter than atmospheric air that a large balloon filled with it rises in the air as a piece of cork does in water; and by this application of a knowledge of the properties of matter, man has been enabled to elevate himself to a higher altitude than probably any bird or other creature has ever attained.

254. Man can, indeed, rise to great altitudes in balloons, but, at the present moment, has not been enabled to guide the apparatus; hence, in this respect, he is far inferior in practice to the most minute bird, which can not only soar aloft, but can guide its course in any direction it pleases. The bird, however, uses the apparatus which nature has bestowed upon it, and constructs no instrument by which it attains its end. Man has always looked wistfully at the wings of birds, but has never been able to make himself wings and fly in the air.

255. In the expedition which has lately left for the north pole, in search of Sir John Franklin, a number of balloons, constructed of four layers of gold-beater's skin, have also been sent, with a supply of zinc and sulphuric acid, with which to generate hydrogen gas. The object of the balloon is to carry a series of coloured papers, attached to a slow match; so that, as the match burns, printed papers, containing a notice of places where provisions have been deposited, will be scattered abroad in the progress of the balloon, and thus those who search for Sir John are expected to communicate intelligence over a large tract of country.

256. Man, moreover, finds that compressed air is heavier than

air at ordinary pressure; and Mr. Thornthwaite received a medal from the Society of Arts for a contrivance by which he could raise or depress a diving-bell or other weight under water, by compressing the air. Now, in this particular he has copied (perhaps without leave) the air-bladder of fish; for it is supposed that, by compressing this organ, they are enabled to sink to great depths;—by relaxing the pressure, to raise themselves to the surface. It has been conjectured by Dr. Buckland that the numerous chambers of the nautilus are for the purpose of enabling it to be counterpoised at various depths of the ocean, by an adjustment of the density of the air; but our distinguished geologist, Dr. Mantell, tells me that some facts have lately seemed to disprove this hypothesis, both in the nautilus and the analogous primeval type, the ammonites.

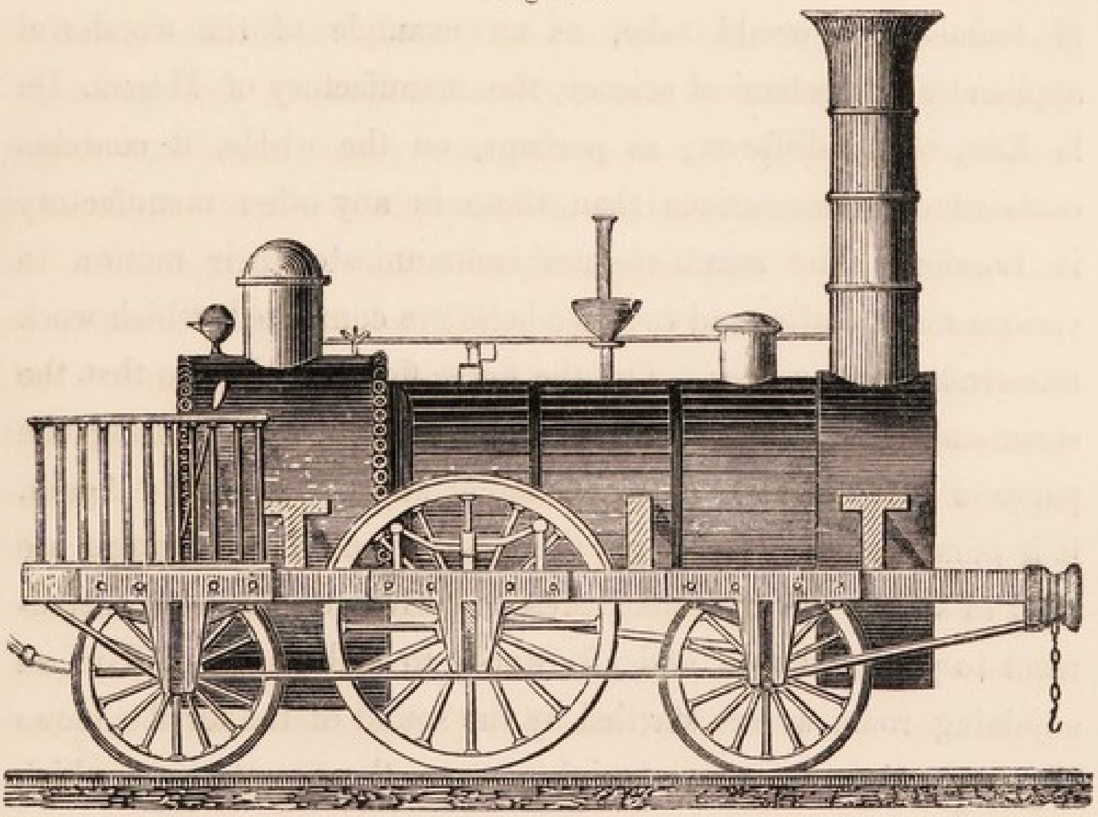
257. Moreover, hot air is lighter than cold air; and from a knowledge upon this principle all the contrivances for ventilation are conducted. If a stream of cold air be allowed to enter a warm apartment, no matter from what part of the room, it instantly subsides to the bottom of the room, and the hot air collects at the top. The hot air cannot escape unless an opening be made for that purpose at the upper part of the room, and this opening be made into a warm chimney. The difficulty has at length been overcome by the talents of Dr. Arnott. He uses a flat valve, so exactly counterpoised that the slightest downward current of air closes the valve, and effectively stops the smoke from entering the apartment, although it allows the foul air to escape up the chimney. This mode of ventilation is now so extensively in use in public institutions, and even in private houses, that it requires no further comment. In the practical adaptation of ventilation, the superior density of cold air is the fact particularly to be remembered; for wherever there

are any cooling surfaces, such as a window or an outer wall, the air will there become denser, and will subside to the bottom.

258. As a general principle, everything placed in the air has a portion adherent to itself, and upon this account resists wetting by water. Now, before the Bank-notes are printed, it is necessary that the paper should be damped. To damp 10,000 pieces of paper every day much labour was required, and the late Mr. Oldham contrived a pretty apparatus to remedy the evil. The paper is placed in the receiver of an air-pump, and the air is then pumped out. When the air is removed, the water is allowed to rise, and thus it thoroughly wets the paper. The wetted paper is then passed through rollers to expel the surplus water, when it is ready to be printed for the Bank purposes.

259. One of the most important and complex pieces of mechanism used by man is the steam-engine (*fig.* 35); for here a

Fig. 35.



variety of principles are brought into operation to obtain the desired end. In the first place, we require a knowledge of combustion to produce the heat. Then we must know that heat converts water into steam, which is amazingly more bulky than that fluid. Again: by obtaining this increase of bulk, we are enabled to move the piston backwards and forwards. By the motion of the piston the wheels are carried round, and this motion is extended to the driving-wheel of the locomotive, or to the paddle-wheel of the steam-boat. Now, in this complex arrangement of machinery, produced by a knowledge of various physical powers, we find that no animal can appreciate even a single force. The dog can neither light the fire, convert water into steam, use steam to produce motion, or connect one movement with another to produce any desired result.

260. If we look to the application of the steam-engine, then does the mind of man stand forth in strong contrast with that of animals. I would take, as an example of the wonderful appliances of mechanical science, the manufactory of Messrs. De la Rue, of Bunhill-row, as perhaps, on the whole, it contains contrivances more curious than those in any other manufactory in London. The steam-engines communicate their motion to various main shafts, and to these belts are connected, which work numerous contrivances. On the lower floor we observe that the steam-engine is guiding the ink. Further on, it is printing the paper or card, by two or three different kinds of presses. Again, it is pumping water to supply the factory, and lesser pumps are used to supply the hydraulic presses. Here we have an instrument to print a device, and afterwards to emboss it; and in an adjoining room we are startled by the sound of the terrific blows which are given by a huge coining press, the operations of which

no one can witness without an instinctive shudder. In another part of the factory the engine is raising the workmen, accompanied with heavy weights, from one floor to another; and, again, it is driving vast currents of air, by means of a revolving fan, through a room, to dry paper and pasteboard. As we proceed, we find that it is turning a grindstone to sharpen the workmen's tools; and, further, we observe that millstones are revolving to grind various pigments. When we enter the smith's shop, we find that it is boring holes at one place, planing iron at another, preparing wheels at a third, and at a fourth, perhaps, cutting a screw. Leaving the smith's shop, we walk upstairs, and we find that the same engines are cutting reams of paper at once by a sort of guillotine, and the next machine is cutting out corners to give the necessary shape to the envelopes. These pieces of paper are then supplied to a machine, where they are first folded on one side, and then on the opposite, and finally thrown out as perfect envelopes. In an adjoining room are various contrivances to emboss and to mill paper; and in an upper room there is a complicated machine, with air-pumps and other contrivances, to colour paper. Besides all these contrivances, are carpenters' shops, laboratories, and other mechanism; so that this one firm alone uses, for the purposes of its trade, most of the appliances which can be deduced from a knowledge of mechanics, hydrostatics, pneumatics, and chemistry; and yet there is not one article, throughout this entire manufactory, which could not, without any very great inconvenience, be dispensed with; so that all this mental power, all this labour, requiring hundreds of hands daily to maintain it, is brought to bear simply to contribute to the luxuries and conveniences of man.

261. One of the most extraordinary pieces of mechanism which I have ever witnessed has been lately devised by Count Emilian de Dunin, as a present to his Majesty the Emperor of Russia. It represents a man, five feet high, in the proportions of the Apollo Belvidere, and from that size the figure can be proportionably increased to six feet eight inches; and, as it is intended to facilitate the clothing of an army, it is so constructed as to be capable of adjustment to the particular proportions of each individual person. In fact, if an individual is once accurately measured, no further reference to him is required, but a fac-simile can be produced, upon which any garment can be exactly fitted. I need hardly state, that, for any piece of mechanism to fulfil such conditions, most elaborate contrivances are required; the number of springs, screws, and other movements is very great. The whole combination very forcibly proved to my mind that Englishmen must not fancy that they have peculiar inventive powers, as in this case the Polish count has, in his invention, fully equalled our most perfect mechanical contrivances.

262. There are various other special properties of matter of which man takes cognizance, and which he employs for his purposes. We find that if we mix 75 parts of saltpetre, 15 of charcoal, and 10 of sulphur, we have a mixture which, when lighted, will burn under water, with the evolution of much gas. If this mixture be wetted, and then granulated, when inflamed it will explode;—in fact, it is gunpowder. I remember well that one of my earlier chemical experiments was an attempt to make gunpowder; but as I did not understand how to granulate it, I made a sort of quick fire instead of powder. By the use of gunpowder, man acquires a great power over all other animals; and doubtless its invention will finally contribute more to promote the prin-

ciples of universal peace than the ravings of half-witted fanatics. The use of gunpowder is bringing the science of warfare to be rather a mathematical problem than an effect of bravery; and therefore, when nations find that no place can be rendered impregnable, but that every place must yield to the devastating power of powder, they will be less disposed to fight, but will endeavour to settle their differences amicably.

263. Professor Schönbein discovered the remarkable fact that cotton could be rendered explosive by soaking it in nitric acid. If we take a mixture of equal parts, by measure, of the strongest sulphuric acid and nitric acid (sp. gr. 1,500), and suddenly, by a glass rod, immerse in it 100 grains of cotton wool, and after a few minutes thoroughly wash out the acid by a stream of water, the wool, when dry, will be found to have all the properties of gunpowder, but in a far more active degree. The manufacture of this material was undertaken by Mr. Hall; and I am informed, upon the best authority, that its preparation was brought to such perfection, that two samples hardly varied the least in their power of propelling a ball. However, just as the machinery was about to be brought into play, the entire place was blown up, and all the inmates perished, from some cause not accurately explained; though it is a curious fact that in the ruins were found lucifer-boxes and German tinder, so careless were the workpeople of risking their lives by their heedlessness. This accident was as likely to have happened to the powder-mills as to the gun-cotton manufactory; in fact, an account of a terrible explosion at Hounslow is contained in this day's paper; and therefore there hardly seem to me to be sufficient grounds for abandoning this curious manufacture.

264. Man has observed that certain substances destroy the

animal organization, or, in other words, act poisonously. By the knowledge of this property of matter, he is enabled to make poisoned arrows, and thus destroy his victim. As far as this destruction of another animal by poison is concerned, he does not surpass, or even equal, the reptile. The bite of the rattle-snake kills with great certainty; and I was told by a gentle-man well qualified to pass an opinion, that the hooded snake invariably proved fatal to those who were bitten by it; in fact, that he never saw one person recover from the injury. In this country we have, fortunately, but one poisonous reptile, which is called, in some places, the viper, in others, the adder (*f.* 36). We have also certain poisonous insects, as the wasp, bee, and hornet, (*fig.* 37,) and which sting by an apparatus placed

Fig. 36.

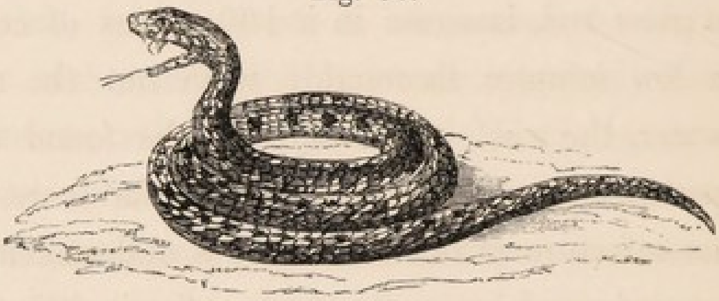
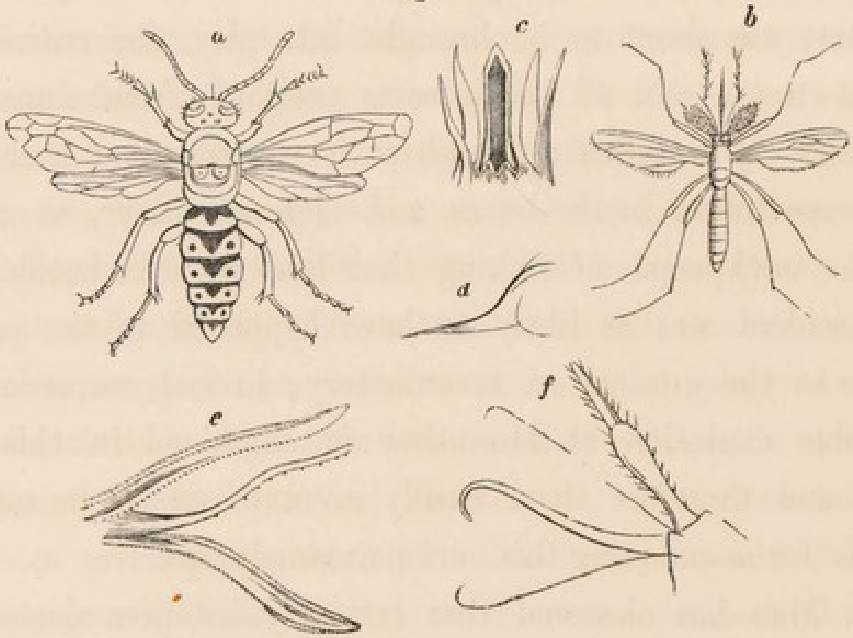


Fig. 37.



at their tail; and we have some other insects which bite, as the gnat, flea, and bug, by organs existing in the mouth. Man differs from the rattlesnake, &c., by making the poison, and using some instrument with which it is introduced into the body of his enemy; whilst the snake kills by a special contrivance given to it by nature. It has two teeth, in the upper part of the jaw, which are pierced with a hole passing down to a gland which secretes the poison; so that in this case the animal uses a direct mechanism given to it, and man uses a contrivance formed on his knowledge of the laws of matter.

265. Last summer I was walking with my children in a lane near Tottenham, and we were accompanied by a small spaniel dog. A wasp's nest had been dug out on one side of the road, and the parties who disturbed it had not destroyed the creatures, but left the comb exposed. A young gentleman who accompanied us threw a stone at the wasps, and the dog, who delighted to run after a stone, dashed headlong after it into the enemy's camp. The wasps rose in a cloud, and the screams of the dog soon indicated that he had been stung. I called and whistled, and at last induced the dog to run; but still numbers of the irritated creatures kept about him. After he had run about fifty yards, he dropped down, apparently lifeless; and after we had beaten off the wasps, and killed those still adhering to the skin, I could neither feel nor hear the heart's action. The New River was at hand, and it occurred to me that a sudden plunge into the water might rouse him. I dipped him suddenly twice, and we were well pleased to witness signs of returning animation. We carried him home, rubbed him dry, and placed him before the fire, but it was several days before he recovered.

266. Some years ago I tried to press some colonies of wasps into my service, to make skeletons for me. I placed the animal at the hole of their nest, when they used to come out and carry it away; but their jaws were so strong, that they not only took the flesh, but even the bones also of small animals. I had been teazing, as long as I dared, a mass of wasps who were feeding upon a mouse, when I thought it prudent to retire. Immediately afterwards, a little, short, peculiar-looking man came by, with a female upon each arm. As soon as he saw the wasps he seemed much astounded, and took his stick and stirred them all up. They instantly rose about him, when the two females ran away as fast as they could, shrieking violently; but the man stood still, waving his hat and giving a great shout every time he received a fresh sting. I became very much alarmed for the consequences; but, as it was before I commenced my medical studies, I did not know in the least what to do; nevertheless, I kept hallooing, as loud as I could, "Run, you fool! run, or you will be stung to death!" and after some little time he followed the course of his fair friends, and took to his heels. I never can think of the incident without apprehension as to whether serious consequences might have ensued, but had no means of ascertaining the fact. I heard both himself and the females declare that they would never walk in country places again, to be subjected to such terrible perils. It is a curious fact, that ammonia, or hartshorn, acts as a perfect specific to either a wasp's or a bee's sting. Every person living in the country should have a bottle of ammonia, to apply directly to wounds.

267. Of the various properties of matter, the last novelty of any importance is that which man has lately discovered in gutta percha. It is insoluble in water, highly elastic, but little

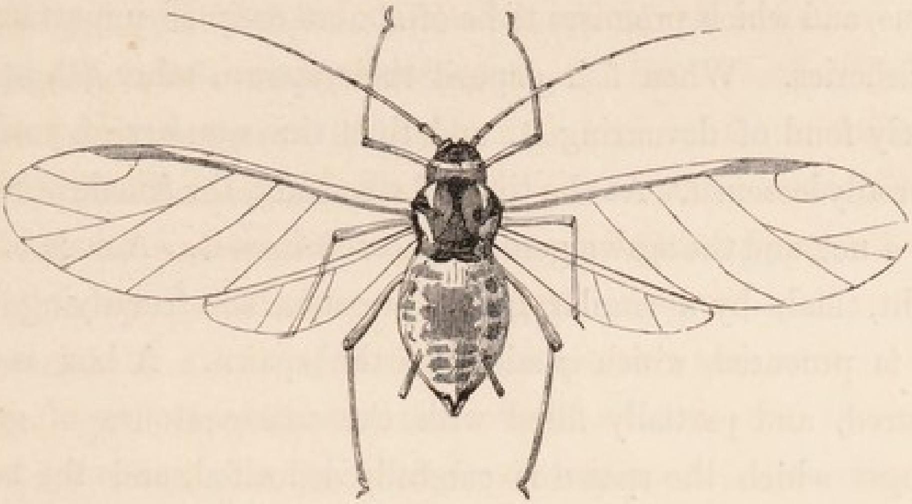
extensile; and from these combined qualities it has been turned to most excellent account. From its power of resisting moisture, and its low conducting power of heat, it is extensively employed for the soles of boots and shoes. I was fortunate enough to obtain some of the first of the material imported into this country, and turned it to good account for surgical purposes. From its moulding properties I adapted it to fractured limbs, divided tendons, and sprains; and even were its use confined to those purposes alone, its discovery would confer a great boon on mankind. It is impossible to enumerate even a tithe of the multifarious properties which man has observed to exist in various bodies; but I have selected one example to show that man can find out and understand the properties of various bodies, and then apply them, according to their properties, to his own peculiar wants. In no one instance does an animal exhibit this power.

268. From this appreciation of the properties of various bodies, man, who comes into the world naked, is enabled to clothe himself according to the circumstances under which he is placed. In summer he clothes himself with the cool garment made from the cotton-tree; in winter with warm ones, constructed from the wool of the sheep. He makes the warm bed from the feathers of birds, and shuts out the light and heat by blinds stretched across the windows. Although he effects all these things, he is no better off than the animal; for where nature has not bestowed the mind necessary to direct the animal to construct these objects, there it has given to the creature such a covering of hair, wool, or feathers, as not to require such adventitious aid.

269. Man is not only acquainted with the forces of mat-

ter, but he learns the peculiar properties of animal and vegetable bodies. Man subdues the powerful elephant, catches the swift horse, snares the timorous bird,—tames them, and turns them to his purposes. Dogs never keep a colony of rats to hunt, nor do cats keep their aviaries, from which to make a dainty meal at pleasure. By a knowledge of the habits of animals, we train the horse so perfectly, that in our London streets, where the carriages and horses are so numerous that thousands pass up Cheapside or over London Bridge daily, accidents are, comparatively speaking, of rare occurrence. Mankind not only keep many animals for food, or for other purposes, but breed them exactly to suit their purpose. Man can breed the ox so fat that he is a very burden to himself, and can neither walk, run, nor even rise from his bed. We can breed the horse for the brewer so strong, that he can move with ease enormous weights; and we can also breed him to have the properties of swiftness to such an extent that he surpasses all other beasts in the velocity of his pace. There is no instance of anything among animals at all approaching to this power. It is stated that aphides are taken by ants to their nests, and kept for the sugar which they void, in the same way as we keep cows. Now, I apprehend that there must be a mistake about this observation, because aphides have an apparatus to pierce the living plant, and thus are enabled to suck their juices. From an examination of the structure of the creature, I think the fact is completely answered. I have here given a figure of the *Aphis vastator* (*fig.* 38), which my observations have led me to suppose to be the cause of the potato disease, which gave rise, in 1847, to so dire a famine. I have also given various figures of the piercing apparatus of

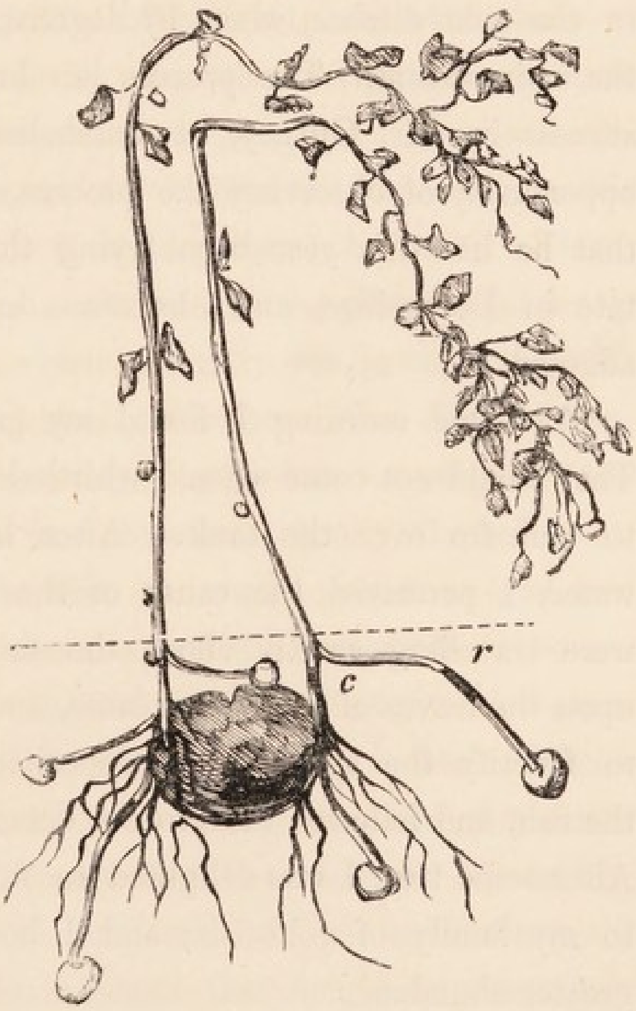
Fig. 38.



several of these creatures in the 'Gardeners' and Land Stewards' Journal;' and the figure of the drooping plant shows well the damage they effect. I placed several plants in a green-house, and on one I placed a number of the *Aphis vastator*. This little plant was soon reduced to the state here accurately represented, while all the rest remained perfectly healthy (*fig.* 39).

270. There is a very curious plan now in use

Fig. 39.



with regard to fish, which I believe was commenced by Mr. Boxius, and which promises to be of almost national importance to our fisheries. When fish deposit their spawn, other fish are extremely fond of devouring it, and thus the number of young is materially lessened. At the time of spawning, the female is caught with a net, and the spawn gently squeezed from it. A male is then caught, and, by a similar gentle pressure, the fructifying principle is procured, which is added to the spawn. A box is then procured, and partially filled with the coarse stones of gravel, amongst which the spawn is carefully deposited, and the box is then placed in such a situation that a rill of water can pass over it. When the spawn is hatched, the young fry are placed in the side ditches, when, by degrees, they make their way into the main stream. The process has been followed with the best success by Mr. Gurney, at Carshalton, where I have had an opportunity of observing the process. Mr. Allcard informs me that he has this year been trying the experiment on his estate in Derbyshire, and I have no doubt it will be universally adopted.

271. One morning I found my gold-fish all in commotion. They would not come when I whistled to them, but were darting to and fro over the tank. After looking carefully into the water, I perceived the cause of the disturbance. The females were travelling swiftly about the tank, depositing the spawn upon the leaves of the water-plants, and the males were following to fructify the spawn when deposited. I immediately caught the fish, and followed the process detailed in the last paragraph. After some time I was delighted to find that I had an addition to my family of gold-fish; and I hope this year to obtain a greater abundance.

272. By a knowledge of the functions of eggs, man can artificially hatch them;—a process which, under certain circumstances, is of considerable advantage. He finds that the eggs of each species require a different time for incubation, and hence he can apply the requisite temperature for a suitable time. The heat can be applied by a gas-lamp or oil-lamp; and I have myself an apparatus which consists of simply a double vessel, to be made at a cost of a few shillings, and with which I have hatched eggs. In this case man employs the heat of the candle or gas, by virtue of a knowledge of its properties; but the hen simply applies the heat which is evolved by its ordinary natural processes.

273. As we learn the habits of animals, and turn them to account, so do we also learn the properties of vegetables, and, in like manner, adapt them to our own purposes. From a knowledge of these peculiarities, we are enabled to accumulate in one spot, as Kew Gardens, plants from all parts of the world. There, the stately palm, requiring a saturated atmosphere, luxuriantly thrives; there, the plants which naturally live in the arid plains of Australia are in the highest perfection. The delicate fern, the bristly cactus—in fact, every plant—has its proper treatment and culture, and lives in a climate artificially adapted for it.

274. In this vast metropolis, so much poisonous gas and smoke is exhaled from the chimneys of the thousands of houses and manufactories here accumulated together, that the sulphurous acid poisons the plants, and the absence of light is fatal. Under such circumstances, horticulture seems futile; and yet, when I say that, despite these difficulties, I have now, in the middle of January, lilacs, azaleas, an oncidium, and an epidendrum, in full bloom, it must be acknowledged that even here plants may

be grown not altogether in vain, although in less perfection than in the horticultural gardens surrounding London.

275. As far as appertains to the foul sulphurous acid and smoke, Ward has taught us that by simply covering the plants with a glass shade they may be effectually grown. In my dining-room I have had two of these cases for nine years; and the plants, which I first purchased from Loddige's, are still alive. In fact, the luxuriance of their growth is so great, that I am periodically compelled to remove large quantities of the plants. Besides ferns, I attempt the growth of a few flowering plants. I commence with crocuses; I go on with hyacinths, and an occasional tulip or narcissus. Later in the year the common cereus is generally covered with flowers, affording a gorgeous display. However, this plant generally blooms itself to death. In July my *Hoya carnosa,* or wax-plant, gives rise to a dozen or a dozen and half of fine flowers; and I am now venturing to try the charming *Stephanotis floribunda.* During the fall of the year I obtain a fine display of achimenes, and my ferns and lycopodiums form an elegant green covering all the year.

276. Now, from observation and experiment, I think that I can communicate a great secret as to the plants which will do well in a London atmosphere; for I find that the tropical plants, as a general rule, flourish nearly as well as in the country. We read that the lights of tropical countries are apt to be yellow, like the dismal yellow lights of London. Palms, bananas, and many plants of this description, will thrive. Some orchids, although they do not like the sun, require much light, and they do not thrive, though others may be grown satisfactorily.

I have lately constructed a portable hothouse, which can be heated by a candle, oil, or coal gas. The one which I have is like a Ward's case, but has a compartment to hold water at the bottom, through which is inserted a copper tube, to carry the heated air and warm the water. I hope to be enabled, by this contrivance, to obtain the more beautiful orchids and tropical plants in ordinary dwelling-rooms; and I question, if I can fully succeed, whether the largest conservatory or the most extensive orchideous house, when cultivated by the hired gardener, can give half as much pleasure as this little portable hothouse.

277. But we not only grow various plants from being acquainted with their properties, we are also able to raise varieties in the same manner, which are of much value to man. If we compare the delicious filbert or cobnut with nuts which grow in the hedgerows, the difference is sufficiently striking; so the comparison between the Ribstone or Newtown pippin with the wild crab is equally remarkable: and yet they are but varieties obtained by man from the same plant. So the florist only received the dahlia as a single flower, and now how splendid have its varieties become! Again, how various are the varieties of the fuchsia! and even the common pansy, by cultivation, quite loses its original type as we find it growing in wild situations.

278. We have now had abundant examples of the faculty which man possesses of learning the properties of matter, and of arranging this knowledge into general laws, to be afterwards employed for his amusement or advantage. Upon a rigorous investigation of the faculties of animals, we find that no other living creature but man has the capacity to obtain this result. By virtue of a knowledge of the laws of nature, we find that man has dominion "over the fish of the sea, and over the fowl

of the air, and over the cattle, and over all the earth, and over every creeping thing which creepeth upon the earth." I must apologize to my reader for using this quotation; but on considering the summary which should be appended to this chapter, the quotation presented itself to my mind. How beautifully does it apply to my present subject! It is, in fact, such an epitome as I could not have found words of my own to express so truthfully and accurately.

CHAPTER VII.

ON INSTINCT.

Works of Animals, 279.—Birds' Nests, 280.—Nest of Blackbird, 281; of Song-thrush, 282.—Its inner coat, 282.—Different specimens alike, 283.—Nest of an Australian Bird, 284; of the House Marten, 285; of the Flamingo, 286.—Mason-birds and Masons compared, 287.—Woodpecker, 288.—Sand Marten, Kingfisher, 289.—Nest of Long-tailed Titmouse, 290; of Water Ousel, 291; of Chaffinch, 292; of Humming-birds, 293; of Reed Warbler, 294; of the Rook, 295.—Singular Basket-formed Nest, 296.—Basket-making Birds and Basket-makers compared, 297.—Pensile Nest of Golden-crested Wren, 298; of the Oriole, &c., 299; of other birds, 300.—Nest of Tailor and Sun-birds, 301.—Nest of the Lark, &c., 302.—Edible Swallows' Nests, 303.—Design of Nests, 304–308.—Bower-birds, 309.—Bowers, 309, 310.—Incubation, 311.—Migration of Birds, 312, 313.—Rabbits' Nests, 314, 315.—Instinct in Child, 316.—Wasps' Nests, 317: texture of, 318; comb of, 319; use of, 320; invariable design of, 321.—Anecdote, 322.—Pendulous Wasps' Nest, 323.—Hornet's Nest, 324; perfection of their construction, 325.—Paper of Wasps, 326.—Paper-making by Man, 327.—The two processes compared, 328.—Paper Double, 329.—Cardboard Nests, 330.—Cardboard Manufacture, 331.—Papier-mâché Nest, 332.—Papier-mâché Manufactory, 333.—Pasteboard Nest, 334.—Design of Nests, 335.—Bee-hive, 336; arrangement of Comb, 337.—Design of the Nest a Design of Nature, 338.—Solitary Wasps and Bees, 339, 340.—Other Instincts in Wasps, 341.—Habitations of Caterpillars, 342.—Cocoons, 342, 343.—Web of Spider, 344.—Nets of Fishermen, 345.—Other Nets, 346.—Nests of Spiders, 347.—Habitation of Spiders, 348; of Ants, 349.—Caddis-worms, 350.—General Remarks, 351, 352.

279. If we carefully regard the operations of the lower animals, we perceive that in some respects they are distinguished

for works of which even a Sir Christopher Wren, an Inigo Jones, or a Stephenson might justly be proud, as they exhibit in their construction a knowledge of laws and a perfection of design which man can hardly hope to obtain, and certainly, in many cases, if he had designed, he could not have executed. For an investigation into the source of this perfection of design, we must bring an unbiassed mind, to study the subject calmly and dispassionately. By tracing out the source, I doubt not but that we shall arrive at a satisfactory solution of the mystery.

280. I hardly know a more curious and interesting work than the nest of a bird. Every schoolboy marks its beauty and glories in its possession. Although hidden from view, he knows with certainty the situation likely to be chosen by any particular bird; and when

"Creeping, like snail, unwillingly to school,"

he too often digresses from the direct road to secure the coveted treasure. One of the first nests which can be procured in the spring is that of the blackbird. This bird is a visitor in every gentleman's garden round London; and, despite of the gardener's remonstrances, is usually considered, by the master of the domain, to give, by his delightful song, a full equivalent for the fruit he destroys.

281. The nest of the blackbird consists of a round structure, of which the outside is composed of an earthy material. On the inner side of this are arranged the stalks of various plants and long pieces of coarse hay. As the bird proceeds with the work, it selects a finer material, such as fine pieces of hay; and in the nest from which I am writing this description, a few of the fibrous skeletons of leaves are also placed. Now, the point to

W. Wing, del et lith. Reeve, Benham & Reeve imp.

which I am about to direct particular attention is, that the nest of the blackbird always partakes, more or less, of these characters; and two nests are always so far formed upon the same design, that no person can mistake the identity of the species to which it belongs. (*Plate* 3.)

282. If we take the nest of the song-thrush (a bird of the same genus as the blackbird, and therefore like it in most essential points), we find that the nest is differently built; and this difference of design is always as much maintained as that of the blackbird. The nest of the song-thrush is a neat production. Its foundation is composed of a good layer of moss. Over this moss little twigs are carefully interwoven, with fine roots of trees, and a few pieces of hay. The whole, however, is lined with a material which really very much resembles a coarse sort of pasteboard in appearance and texture. This inner lining is a very wonderful performance, for it has, in the first instance, to be stuck firmly to the roots and grass—an operation which of itself must be a work of no small difficulty. But our astonishment is perhaps even more increased when we observe how exquisitely its surface is smoothed and finished off. Naturalists appear to differ much as to the composition of this inner case. Some say that it is made of mud; others, of clay. Again, it is stated to be constructed of horse-dung or cow-dung; but I strongly suspect that it is made of earthy material, which is afterwards covered with small pieces of wood and other rotten fibres, aggregated together by some secretion, either from the mouth or the crop of the creature, and which thus forms a rude kind of pasteboard. I was so curious to know the composition of the inner case of the nest of the song-thrush, that I submitted it to the action of certain tests. Upon incinerating a

small portion, a certain amount of earthy material was left, which clearly shows that it is lined partly with earth. On subjecting the material, however, to the usual tests for bile, I did not discover any; and therefore I infer that the inner case is first lined with earth, and then with fine fibres of straw or wood. (*Plate* 3, *fig.* 16.)

283. If we examine various nests of different individuals, we find that they are all manifestly made upon the same design. Each is made with moss outside, and with twigs and grass in the middle; each is also lined with a perfectly smooth, hard case; so that no reasonable being can doubt but that the same plan is invariably pursued by every song-thrush.

284. There is, in the British Museum, a nest of an Australian bird, which in some degree resembles that of our common blackbird. On the outside it is composed of earthy material, which is again lined with dried grass, like the nest of the blackbird. Yet here, although the materials employed are nearly, if not entirely, identical, there is a difference in the form, independently of the size, which clearly marks a difference in the general design of the two birds.

285. Our favourite martens build their nest of dirt and loam mixed together, with little bits of broken straws, to render it tough and tenacious. They fix their nest under the eaves of houses, in chimney corners, or other similar situations; and when they have finished the outer crust, they line the interior with feathers, grasses, moss, or some other soft material. Last summer I was stopping near an extensive colony of these charming visitors, which have taken up their abode under the eaves of a farm-house for many years, to the no small delight of the farmers, who protect the birds from injury with religious care. When these birds make a new nest, they only perform a little bit

of the work daily, to allow it to dry before more is added; otherwise, all might tumble down. I think, from my own observation, that they are about a fortnight in constructing their nests; and, in fact, the accurate White allows for that process from ten to twelve days, which we can hardly doubt has been the time actually noticed by this distinguished naturalist. Last year, one pair of these birds commenced their nest in its accustomed place, but, finding the weather to be very cold, abandoned it, and commenced another in the roof, which they finished, and in which they reared their first brood of young, but their second nest was made outside in its accustomed locality. When we view a series of nests of the house-marten, placed side by side, as though specially designed for our comparison, we cannot fail to notice how like one is to the other; and although a strict scrutiny may detect some slight differences, yet all are manifestly made upon the same design, although actually constructed by different birds.

286. The flamingo is also said to build a very curious nest of earth, which it heaps up into little hillocks, which are raised about a foot and a half above the water. But the most curious part of the operation is the mode in which they are said to rest upon their nests; for it is stated that they actually sit astride their nests, as a man would a stool; but this process is so very different from that adopted by the heron and other long-legged birds, that its authenticity should be thoroughly established.

287. Those birds which build nests of mud are, by some writers, by a sort of false analogy, called mason-birds; but if a comparison be made between these birds and masons amongst human beings, a sufficient difference is exhibited. Really, a builder of a mud cabin would be hardly called a mason, though

the construction of such an apartment indicates a power of mind far superior to that possessed by any animal, inasmuch as the man builds the mud house with a knowledge of the properties of his material, which he can make subservient to his desires in any way he pleases, and can form upon any design he pleases. The bird, however, can only carry out one design; and we find that each bird of the same species carries out a similar design and no other. A man, in building a house, varies the design infinitely;—he makes it with one, two, or more rooms; he makes each room of a different size in each instance, and sometimes he gives the room a square form, at others an oval or circular form; but neither blackbird, nor marten, nor other bird which uses mud, ever varies the general design of its nest. If we examine a hundred nests of birds of the same species, they are always made upon the same design.

288. There are some species of woodpeckers which have the power of digging into the hardest wood, and, by excavating a suitable hole, form a large and commodious cavity in which they can deposit their eggs and safely rear their young. Now, the process of excavating a large hole in a tree is a feat in carpentering by no means easy to execute, though the testimony of the veracious Wilson must be considered as conclusive of their ability to perform such an operation. A man, by his own natural powers, would be quite incapable of executing such a work, and the carpenter must first contrive some tool before he is enabled to excavate a hole in timber. The bird literally digs a hole with his beak, which thus serves his purpose equally well as the chisel of the carpenter: the bird, however, only uses the tool which has been supplied to it by nature, and carries out one uniform design. The carpenter contrives his tool, and can execute any design which he desires.

Now, as far as the operation of the bird is concerned, it is as perfect as any work of man; but, inasmuch as man can, by carpentering, execute any desired design, man exhibits a vast superiority of mental power.

289. The different circumstances under which different birds construct their nests is certainly not one of the least interesting facts connected with the natural history of birds. It by no means is manifest why the blackbird should invariably make its nest as we have described it, nor why the woodpecker should bore the tree, or, furthermore, for what reason certain birds should invariably bore a hole in the earth. The sand-marten, the kingfisher, and some other birds, invariably make a nest in a hole constructed for that purpose. These birds only use the beak, an instrument given to them by nature to perform this operation. Now, man can build an apartment or a house by excavating the rock, but he is unable to effect his object by his organs unaided by some suitable tools. In the face of those stupendous cliffs at Beachy Head there is a flight of steps excavated in the solid cliff which communicate with three or four rooms, all of which are said to have been excavated by a clergyman, who quarrelled with his wife, and sought this lonely spot to hide from society. In eastern countries there are some wonderful excavations turned to account; and thus we find that man has the power of excavating an abode, not upon one design alone, but upon any plan which may best promote his interest or his purposes.

290. Amongst our English birds, perhaps the most exquisitely beautiful nest is constructed by the long-tailed tomtit, oven-bird, or barrel tomtit. The nest of this little bird is about the size of a common preserving-bottle, with a small hole to allow the bird to enter and emerge. The whole is formed of mosses and lichens

beautifully put together, with almost innumerable spiders' nests, pieces of grass, and other materials. The interior is lined with abundance of feathers, and the whole forms a very wonderful specimen of bird architecture. In this warm nest many eggs are deposited. If we examine nest after nest of this bird, but one design is manifested. Each nest is made upon the same type; and even the country lad, on finding the nest, immediately exultingly declares it to be the nest of the bottle tomtit. (*Plate* 3, *fig*. 13.)

291. A very singular nest is built by the water ousel, a small bird which lives upon the banks of unfrequented rivers in Wales and Scotland. The nest is rather difficult to procure, but I obtained one which was stated to have been found by the game-keeper to the Duke of Leeds. The nest is of very singular construction; it has evidently been built in a gap in the rock, and its general form is that of a brick, although it is very much larger in every direction. It is composed of a large quantity of green moss, so beautifully entwined and woven together as to form a texture of great solidity and strength. The lower part is the thickest, apparently to protect the young from the coldness of the rock. The aperture for ingress and egress is placed in front, is of oval form, slightly dilated at both extremities, and is apparently so arranged that the bird goes in at one extremity and escapes by the second. The interior, where the eggs are deposited, is lined with hair. That two such small birds should make so large a nest does seem astonishing; for, how great must be the labour of finding so large a quantity of materials; how great must be the burden of carrying the moss when found to its locality; and how tedious must be the process of entwining the materials together into so solid a mass! (*Plate* 2, *fig*. 6.)

292. To my mind, the nest of the common chaffinch is one of

the prettiest structures which are formed by birds living in this country. It is composed of moss carefully entwined with fine twigs, roots, and pieces of grass, and in the interior are frequently placed the softer part of the skeletons of decayed leaves. The bird covers the outside with beautiful lichens, so that the whole nest assumes, not only in form but in colour, a very beautiful appearance. Now, if we examine a number of chaffinches' nests, they are all so similar that it is perfectly manifest that they are invariably formed upon one design. (*Plate* 3, *fig.* 1.)

293. I have one or two most beautiful nests of humming-birds, which are certainly worthy of the exquisite little creatures which produced them. The one, of the *Trochilus Moschitus,* about an inch across, is formed of light materials, and is wound firmly round a leaf, to which it was suspended by abundance of spiders' webs. (*Plate* 3, *fig.* 10 *and* 11.) Whether we regard the exquisite form and colouring of the bird, or the extreme delicacy and beauty of the nest, we are compelled to admit that the whole has a poetical character which would fit it for some fairy land. I possess other little nests of the *Trochilus glaucopsis,* which are made of the softest down of some plant like our thistle, and which is also a most elegant little structure. (*Plate* 3, *fig.* 9 *and* 12.)

294. A very singular contrivance is adopted by the reed warbler. It makes its nest by enclosing three or four reeds in its structure, so that it has the appearance of being supported by several pillars. In the construction of its nest it selects long and wiry pieces of dry vegetable structure, and makes thereby a strong and firm nest. It lines the interior with a few pieces of dry hay. Wherever we find this nest, the general design of its construction is always the same,—there is no variation in plan to be observed. (*Plate* 3, *fig.* 4.)

295. There are some birds which make their nests like baskets, of which the rook may form a good example. A rook's nest is so familiar to all my readers, that I need hardly say that it is composed of twigs entwined in a curious manner, somewhat resembling a basket. We have these birds in the very heart of London, on a noble plane-tree, which grows at the corner of Wood-street, Cheapside. There are now signs of four nests on that tree; but, though I remember the first one being located upon that spot, and have passed the tree upon the lowest estimate twice a day for the last twenty years, I am unable to state whether they have reared their young in that locality,—a fact which well shows the merit which is due to accurate observation. Rooks, however, build in the crowns surmounting the highest pinnacles of the turrets in the Tower of London; and there is another rookery in Gray's Inn Gardens, which, some years ago, was threatened with destruction because the birds disturbed some aspirant to legal honours before he had sufficiently recruited his sleepy caput.*

296. I have lately purchased a nest made by a bird which is called the *Euplectes flaviceps*. It is so like a basket, that, curiously enough, it has a handle to it like the basket known by the sea-side by the name of a cobble. It is composed, not of twigs, but of a coarse grass, and the handle is so interwoven with the whole mass as to cause us to wonder at its construction. I cannot conceive for what purpose this handle can be made; but not the least curious part of the structure is the finish which is given to the handle by grass being wound round and round it.

* Pigeons have lately taken to build on the tops of the pillars of the Bank of England and Royal Exchange; so that London can now boast of three kinds of birds which rear their young, namely, sparrows, pigeons, and rooks. We have every year a robin or two at Finsbury-circus, but it does not build, and we are frequently favoured with a visit from starlings.

I have seen three such nests, but all were perfectly similar. (*Plate* 3, *fig*. 6.)

297. If we compare these baskets with those which man can make, there can be no question that, in the simple manufacture, man greatly surpasses the bird. Our commonest market basket is better made than the basket of the rook. But throwing out of consideration mere degrees of excellence in the manufacture, we find that these basket-birds always proceed upon one design, whereas the designs of the baskets of man are almost innumerable; and man can adapt them to all purposes,—can construct them of all degrees of coarseness, from the rough hamper to the elaborately finished textures which French skill supplies for the use of ladies in the elegant drawing-room.

298. In this country we have but one bird which suspends its nest, and even that, after all, is but a partial suspension. This bird is the smallest of all the birds which live in these islands, and is called the golden-crested wren. It delights to form its nest in a fir-tree, and constructs it of moss in such a manner that the nest is formed underneath the bough.

299. In foreign countries there are several remarkable instances of pendulous nests; and, first, I may call attention to that of the *Cassicus Persicus*, one of the orioles, a nest of which I happen to possess. The nest is suspended from a bough by a very slender pedicle. It is composed entirely of some of the grasses of the country; and really its construction is an enigma difficult to solve. The pedicle from which the nest hangs is very strong, and is made of grass woven together like a coarse plait, with the ends left free, in a manner which would lead us to suppose that even for this there is some reason. To this pedicle is plaited a nest of the same material, in which is contained the cavity to receive the eggs.

The nest has an entrance which is directed upwards, and is situated at the bottom of the structure. In the interior a ledge is formed, so that the circular form of the essential part of the nest is amply maintained. Taking the nest as a whole, it is a wonderful design for a bird to execute. (*Plate* 3, *fig*. 2, 3.)

300. But, remarkable as this nest is, it by no means equals the nest of a bird (the *Ploceus pensilis*) which I possess. It is suspended from a bough like that of the oriole, but the upper part is not supported from so slender a pedicle, but has a more extensive support. The nest is made of dry grass, and is plaited together with the most marvellous perfection. Like the nest of the oriole, the aperture is at the bottom, but a long neck, a foot long, depends from the true nest, and forms a passage through which the bird must pass on visiting or leaving its young. This remarkable contrivance is no doubt formed to prevent snakes or other animals from entering its dwelling; for, in the tropical countries, the snakes are said to inhabit the lower boughs, the monkeys the middle, whilst the birds for their own protection are compelled to take up their abode at the topmost branches. (*Plate* 2, *fig*. 4.)

301. There is another class of birds which are truly curious, inasmuch as they literally sew their nests to the leaves of trees. I have two nests of the *Dicæum concolor*, or sun-bird, which literally has pierced the leaves with regular holes, and then, with a little wool, has made an in-and-out stitch, precisely similar to that used by man. But the sewing of this bird and that of the tailor-bird differ from the same operation as practised by the human being, inasmuch as the bird uses its bill,—man uses a needle, by which this process is effected. Up to the present time no contrivance has practically superseded the needle, though I remember that a very curious machine for sewing was exhibited

at the *soirées* of Lord Northampton, which sewed very rapidly, by contrivances which were not exactly explained. (*Plate* 3, *fig*. 7, 8.)

302. From the above brief illustrations, we have found that some birds build their nests of mud; others mine for themselves holes underground; others, again, by a process of carpentering, excavate cavities in the hardest wood. Some make baskets, which are fixed aloft; others suspend their nests, by a narrow pedicle, to lofty branches. Some make nests of materials felted together. Thus we have found that different birds construct their nests in many different methods. It will be perceived that I have noticed no bird which builds its nest directly on the ground, though I may give, as an illustration of such a proceeding, the nest of the lark, of the partridge, of the pheasant, and of many other birds.

303. In every instance which I have yet quoted, the bird has used grass, sticks, mosses, or some other foreign matter; but there still remains to be noticed a class of nests which by some naturalists are supposed to be formed from a secretion of the animal itself. These nests are made by two or three species of swallows, and are so highly prized by the Chinese as a delicacy, that they are worth their weight in silver. Specimens of nests of these birds may be seen in the British Museum. I have tried to obtain these nests for experiments (*Plate* 2, *fig*. 3), and Mr. Hawkins has been so kind to bring me a small portion this day, the analysis of which I hope to be enabled to give in an appendix.

304. On taking a survey of my little collection of nests, I find that I have many others of great interest, which I can hardly spare space to describe; nor do I think there is any necessity for further illustrations, as, whether I take as my type the largest specimen of the feathered tribes, or descend to the most minute bird, which hardly equals in size the larger moths,

still a similar design for the construction of the nest is invariably manifested for the same species. We do not find that experience improves this design, nor, in a series of ages, has this design altered. The stork which built its nest on Trajan's column made a similar structure to those which we can to this day observe, in our summer's tour up the Rhine, on the roofs of houses, or on some contrivance placed for their convenience.

305. In all the cases which I have detailed, a fixed design, which is invariably maintained, is shown in the construction of the nest of each species. This permanence of plan is very remarkable, when compared with the versatile operations of human beings; for it is manifest, that if we compare the gypsy's tent with the palaces of the Queen, or the mud houses of the Irish and Welsh with the mansions of the nobility, that even in this country the designs of our habitations vary extremely. With us there is no fixity of design. It is perpetually changed, to suit either our wants or our caprice. It is certainly true that the bird, in the formation of its nest, shows a power of construction which man, with his superior knowledge, may marvel at; nevertheless, the bird shows no other capacity to design,—it can carry out this one idea and no other analogous one requiring a similar amount of mental capacity.

306. From these facts we find that birds clearly build their nests upon a principle different from that with which man conducts his operations; and we find that birds build their nests without any manner or kind of experience. We are, therefore, compelled to infer that the design of the nest is inherent in the organization, and that, under a certain stimulus, birds build nests upon a definite plan, which they did not originate, which they were not taught, but which they brought into the world with them.

307. As the organization of every animal, however apparently insignificant, bears the stamp of an Infinite Cause—the Creator of all things—every idea implanted in the organization of the animal is also derived from the same omnipotent power. Can we, therefore, marvel at the work of the little titmouse, when it makes its curious bottle-nest? Can we wonder that the nests of other birds should surpass even what man can devise, when we find that these little creatures build their nests instinctively upon a design implanted in their organization by God himself?

308. Although the general design is impressed upon the animal, and does not proceed by the ordinary operations of the mind, yet, as far as the faculties of its mind extend, they are brought to bear upon the question, and assist the bird to construct it. The bird, in this sense, is a builder which carries out an architect's design, as much as Grissell and Peto carry out the design of Mr. Barry in the construction of the houses of Parliament. In human operations one man designs, another constructs. With birds, however, the individual neither designs nor is taught, but carries out the plan given to it by the Creator.

309. Before I part with birds, I have yet other instinctive operations to notice, which are in themselves extremely curious. Some time since, Mr. Gould, the distinguished ornithologist, investigated certain structures which existed over a great portion of Australia, and he found that they were the work of birds, which built them for pastime, and hence they were called bower-birds. Mr. Gould informs me that now there are three bower-birds known, two of the bowers of which are now in the British Museum, and a third he has received lately from Australia.

These bowers are constructed of sticks, and the bowers of each species vary. The birds also place a great number of shells at the mouth of the orifices, so that they make a path round the outside. There are some minor differences in the construction of the bower of each species; but any of my readers who will take the trouble to visit the Zoological Gardens will have an opportunity of observing for themselves a real bower of the satin bower-bird; and for those who have not that opportunity, I have given a figure of it. (*Plate* 3, *fig*. 14, 15.)

310. Poets, doubtless, would be extremely eloquent upon the idea of bowers constructed for young gentlemen and young ladies to make love together, in the blooming month of May, when the birds are singing delightfully and nature is decked in all her beauty. Here we have bowers constructed by birds for a similar purpose; for here it is in the wilds of Australia that the birds make love before the time of nidification commences. They play with their bower, first pulling out one stick, then another; they beautify it with feathers, and then alter the arrangement to suit their fancy; then they chase each other round as fast as possible, the female, like a coy maiden, only running away for the pleasure of being caught by her favourite companion.

311. But birds not only show instinct in the construction of nests or bowers; they also act upon an idea, without experience, and without being taught, when they sit upon eggs; as, however great may be their desire for progeny, a pair of young birds can neither know from experience, nor can they have been taught, that, by sitting a certain number of days, a lump of white matter could turn to a young bird. My children have now a pair of young canaries, and the silly things are both sitting upon the nest, as though they were fully impressed with the importance of the proceeding.

312. The migration of birds is another operation of great

mystery. In this country Mr. White has described twenty different species as being summer birds of passage, which he found to have visited Selborne. He also details seventeen species of winter visitants. Now, birds like swallows, which are on the wing all day long, would certainly find it a work of no great difficulty to fly to any distance; but it has always puzzled me how a little bird like the white-throat, which simply twitters at the end of a bough, could possibly cross the sea to reach continental shores.

313. Of the instinct which guides birds in their extensive migrations but very little is known. We observe the same phenomenon, not only in birds, but in fish, who visit our coasts at certain set periods of the year; but up to the present time the annual migration of living creatures is very little understood.

314. The operation of forming a nest is also followed by animals as well as birds. The nest of the rabbit is a beautiful example of this character. The female leaves the warren and goes to some distance, perhaps over two or three fields. She then scratches a hole, two, three, four, five, or even more feet in length; but still it is a mere hole in the ground, and would be quite unfit to receive the little rabbits at birth. To make the bed suitable, she pulls off from her own body a good hatfull of down, which makes a nest as warm and snug as may be desired. She does not stop continually with the young ones, but lives in the warren. In the dusk of the evening she stealthily runs to the nest, to suckle the young. Before she returns, she carefully covers over the hole, leaving a very small space for the air to enter; and she has to remove the covering whenever she visits her offspring. I have often been delighted in watching

these precautionary measures; and on one occasion a rabbit wandered into the garden of a house where I was stopping, and so I had a capital opportunity of watching her proceedings, as she returned nightly to visit her nest. When I judged that the young ones were sufficiently strong, I took the nest. In the evening the old rabbit came as before, went into the hole, saw that all her little ones were gone, took one look round, and ran away, as fast as her legs would carry her, to the warren, and never returned again to the spot. If the rabbit's nest is the least disturbed, the old one finds it out on her next visit, and for ever deserts her progeny.

315. Now, whatever number of rabbits' nests we examine, they all exhibit the same design; and even in the domesticated state, where, from being confined in hutches, the rabbit cannot burrow, she makes her nest in a dark chamber, and still pulls off the down; so that we cannot doubt that the proceeding is a purely instinctive operation, and not in any way derived from experience.

316. There may be some doubt whether man, who is competent to do so much for himself, is actuated by any blind instincts; yet, I think, if carefully examined, it must be conceded that such is the case at least in one, if not in more than one, instance. The new-born baby comes into the world without the knowledge of anything to determine its line of action, and yet the tendency to suck so far exists that the moment it has the opportunity it performs that operation. Whatever explanation we may afford of the *modus operandi*, still the fact itself remains.

317. For an exhibition of purely instinctive operations perhaps insects far exceed either birds or animals, as the extremely beautiful edifices which they construct will testify. The nest of the common wasp is so plentiful that I have known five or six of them

in a single garden, and that within five miles of the Royal Exchange. This insect, from its omnivorous character and ferocious disposition, is no favourite with mankind, yet it associates with its fellows in large communities, and forms extensive habitations in the banks of hedges, and occasionally, as one I saw last year, in the centre of a corn-field. This latter would have been extremely dangerous to the horses or farmers in the operation of ploughing, and was obliged to be destroyed before that process could be undertaken. The nest of the wasp is entered by a long passage, generally about two feet in length, and thus it becomes a work of some trouble and labour to dig it out, especially as it is impossible to tell the direction the passage may take. The nest is globular, and as large as a human head, and therefore requires a large hole. I am very much puzzled to know how this hole could possibly be made by a wasp, because, in the usual soil, there must be some stones too large for the insects to carry away. This is a very curious fact to unravel, and I hope that some of my country friends will try to solve the problem, because, doubtless, this difficulty is overcome by a very simple process. It is generally known that wasps begin at the top and work to the bottom, so that I would venture a supposition that any stone found in the process of the work is undermined and let down gradually. If this supposition be true, on carefully excavating nests an accumulation of stones will be found at the bottom underneath the nest. (*Plate* 4, *fig*. 9.)

318. The whole of the nest is covered with a series of layers of very coarse paper, evidently made of woody fibre. These layers have a mottled, wavy appearance, from differences in the colour of the material of which they are composed, and are arranged one above the other to form a thick coating impervious to all moderate

quantities of water. Under this dome is arranged a series of cells, which are composed of paper. Each tier consists of numerous cells, about twenty-five to the square inch for the smaller cells, and sixteen to the inch for the larger cells. It is stated by Kirby and Spence that the number of cells in a wasps' nest occasionally amounts to 16,000, which, however, must be of an enormous size, as the one figured, which I took last summer, and which appeared to be a strong nest, does not contain above 5,000 cells.

319. The cells of the comb are hexagonal, and the tiers are so arranged that the mouths of the cells are turned downwards. Between the mouths of one tier of cells and the roof of a second a space of half an inch is left, so that the roof forms a platform over which the wasps run to attend to their young. Each tier is firmly attached to the sides of the entire nest; but further support is still required, otherwise the middle would give way. To obviate this difficulty, a series of pillars are made, which look somewhat like the iron supports frequently used in warehouses to carry the weight above. These supports are placed at irregular distances, so there can be no doubt but that they are placed as the creatures find that they may be required.

320. The nest of the wasp is destined for the protection of the grubs or young wasps, and, during the entire summer, the wasps continue to extend their nests. When the cold weather sets in they all perish, except a few females, which survive till the next year, when each forms a new brood for herself. Gilbert White says, "The great pests of a garden are wasps, which destroy all the finer fruits just as they are coming into perfection. In 1781, we had none; in 1783, there were myriads, which could have devoured all the produce of my garden, had we not set the boys to take the nests, and caught thousands with hazel-twigs

tipped with birdlime. We have since employed the boys to take and destroy the large breeding wasps in the spring. Such expedients have a great effect on these marauders, and will keep them under. Though wasps do not abound but in hot summers, yet they do not prevail in every hot summer, as I have instanced in the two years above mentioned."

321. The nest of the common wasp is always made upon the same invariable plan, and even the very texture of the paper but very slightly varies. Although it exhibits such skill in the construction of its nest, it exhibits no skill to construct any other contrivance. From the unity of design, we infer that it never learnt the design nor contrived it, but blindly carries out an idea which arises from its mode of organization.

322. An amusing circumstance is connected with the nest which my artist has figured. It was taken at Tottenham, and carefully placed in an ordinary hat-box, after the wasps had been exposed to sulphurous vapours to ensure their destruction. After a few weeks, on entering the room, a great number of wasps were observed; and, on examination, it was found that they had gnawed a hole through the box, and thus had effected their escape. This instructive circumstance shows clearly that creatures endowed with any special organs are not compelled to use them for any one set purpose. There is a story current amongst entomologists, that, once, the great entomologist, Mr. Stevens, had a stag-beetle, which he placed in a tinned iron box. Every evening he used to hear a grinding noise emanating from that spot, till suddenly the noise disappeared. He immediately examined the box, to ascertain the reason of its absence, and he discovered that the stag-beetle had actually made a hole through the tinned iron box, and had effected its escape.

323. There is another species of wasp (*Vespa Hobsatica*) which, though extremely uncommon round London, is nevertheless frequently found in the north of England, and I am indebted to one of my former pupils, Mr. Greatorex, for a beautiful example of this kind of architecture. The nest is somewhat of the form of an ostrich's egg, and, if anything, a trifle larger. One of the specimens before me was built on a bay-tree, another on the bough of an oak, and the boughs in both cases were in a growing state at the time of the construction of the nests. The nest is formed of layers of paper, far more beautiful than that of the common wasp, or hornet, and the layers of the outer case so envelope each other that the summer torrent may probably descend without in any way injuring the structure. The aperture is placed directly at the bottom of the nest, and in the interior are arranged a series of combs, in which the maggots are deposited. (*Plate* 4, *fig*. 3.)

324. The hornet is a larger species of insect, possessing characters like the common wasp in many essential points. We had a hornet's nest within a stone's throw of our door at Tottenham last summer; and on one occasion I remember a hornet's nest to be built in the roof of a farm-house at which I was stopping. Being a larger insect than the wasp, the cells and tiers, together with the intervals between them, are made upon a larger scale. The cells have their aperture placed downwards, like those of the two wasps already mentioned; but the entire structure is composed of paper, of a coarser kind. The hornet makes its paper of wood which is partially decayed. Last summer we had a garden seat in which the wood was in that condition, and the creatures used to excavate it for their purposes. I was much interested to observe how they excavated the wood

W. Wing del. et lith.

Reeve Benham & Reeve imp.

to the very verge of the outer coat, leaving it as thin, in that situation, as a piece of paper. (*Plate* 4, *fig*. 12.)

325. I hardly know a more admirable structure than the nests of these little insects. We can regard their operations with the same amazement as we do the elaborate mechanism displayed in animal bodies, and we can but exclaim that one is as perfect as the other. And why are we enabled to compare the work of a little insect with the work of the Creator of the universe? Because these little creatures erect structures not from a design originating from their own mental power, but upon a design given to them by the same Creator who designed organic structures.

326. I have already frequently observed that these wasps make paper by instinct; but man manufactures a similar material by reason. The wasp and hornet, with their powerful mandibles, break up the woody fibre, and, by a little saliva, which serves for glue, put together the separated fibres; but man has no mandibles, and is therefore compelled to use a more indirect process to obtain the same end. Man makes paper of various materials; but the strongest paper, such as that of which the Bank-notes are made, is constructed from the best unbleached linen rags, which have themselves been formed from the fibrous part of flax.

327. To make paper, the rags are cut into small pieces, and then torn by a revolving machine attached to a steam-engine, till at length a very fine pulp is obtained. All these contrivances are required as substitutes for the mandibles which these insects possess. By these means a very fine pulp is obtained, to which is added a little size, to take the place of the saliva. A certain amount of the floated pulp is distributed over a surface, so as

to form a mass of uniform thickness, when it is dried and becomes ready for use.

328. When we walk round the paper manufactory, we are surprised at the steam-engine and various contrivances and appliances necessary for the production of that material; but at length man, by working in obedience to the laws of matter, obtains that which he desires. The little wasp has neither steam-engine nor mechanical contrivances, nor does it understand the *rationale* of its operation; yet, by employing the mandibles with which nature has furnished it, the wasp is enabled to obtain the same object as man.

329. A French naturalist believes that the paper of the cells of the wasp's nest is double;—a fact not unlikely to be true. Nevertheless, an erroneous opinion may be formed upon this point, inasmuch as all kinds of paper may be split into two portions. Some time since, Mr. Baldwin exhibited at the Bank several remarkable specimens, in which the 'Times' newspaper and 'Illustrated London News' were split into two parts. Subsequently he exhibited a Bank-note, divided in a similar manner. The same evening I managed to split a portion of the 'Morning Post;' but I did not think it fair to him to detail the process. However, a paragraph appeared in those wonderful organs for disseminating knowledge, the newspapers, and at least a hundred aspirants for splitting paper immediately appeared; and now the process for splitting paper is known to many individuals. Paper may be readily split by glueing it on each side to calico. On pulling the two pieces of calico apart, the paper is split asunder. The paper is then soaked in water, to soften the isinglass or glue, when the paper is found to be separated into two divisions. The best antidote to fraud is, in my opinion, the promulgation of

the modes of conducting it; and I therefore particularly call the attention of commercial men to the possibility of documents being split and then put together feloniously.

330. Hitherto I have only described nests made by paper-making wasps; now I must consider the operations of those wasps which make cardboard. I have figured a wasps' nest in my possession, of this character, from Cayenne, which is about the size of a small basin. It is fixed upon a bough, and consists of a series of tiers of cells, arranged one above the other, like those of other wasps and the hornet. The whole is made of the finest cardboard, and nearly as white; and, what is most singular, the cardboard is really constructed of a series of layers. The cardboard is so perfect, that writing can be effected upon it; and in no other respect does it differ from ordinary white card. The whole nest has a single hole, through which the insects enter and emerge; and this single hole is to be found at the centre of each tier of cells; so that I have no doubt but that the bottom of the nest is used for the new layer of cells when the insects desire to increase the size of their habitation. (*Plate* 4, *fig*. 10.)

331. Now, man cannot make cardboard by so simple a process as that by which these wasps effect it. Man takes two, three, or more sheets of paper, and pastes them together, when the surplus paste is pressed out by hydraulic pressure, and the sheets are dried in rooms artificially warmed for that purpose. In a large manufactory, where they make this article very extensively, a steam-engine, an hydraulic press, a warming apparatus, and even other appliances, are required.

332. My former neighbour, Mr. Walter Hawkins, imported into this country a very remarkable nest of one of the honey-making wasps. It is as large as a three- or four-gallon bottle,

and is suspended by a very strong pedicle to a bough. It is formed of a material more resembling papier mâché than either card or paper. Its exterior is rough, and covered with a series of nodules, or protuberances, which are supposed to protect the nest from the jaguars, who, desiring to obtain the honey, jump at it, but, when their noses come in contact with the knobs, are frightened and retire. The entrance is on one side, and is covered with a series of imbrications, placed far enough apart to allow the creatures freely to pass in and out, but not so wide as to permit some of the larger moths to enter and steal the honey. The nest is of great density, and well calculated to resist those terrific rains of which we read as occurring in the torrid zones, but from which we are fortunately free in this more hospitable climate. (*Plate* 2, *fig.* 1.) I have not myself the good fortune to possess a specimen of this nest, and therefore have figured the one in the British Museum, to which Mr. White, the entomologist, kindly drew my attention. I intend, however, to solicit Mr. Hawkins to endeavour to procure me a specimen, and I venture to hope that he will be enabled to comply with my request.

333. I have seen the papier-mâché works of Jennings and Bettridge, in Birmingham, but they cannot conduct their operations so simply as these wasps. For the manufacture of papier mâché a peculiar kind of grey paper is first made. This is thoroughly pasted, and applied in layers over a mould, when the whole is dried, and afterwards varnished and painted, to form our tea-trays or other similar objects. The wasp carries out the design implanted within it when it forms papier mâché, directly by its own organs, from woody fibre; man, however, forms papier mâché by an extensive knowledge of the properties of matter, and then by adapting that knowledge to meet his wants.

334. In the collection of the British Museum, there is a nest made by a wasp which is a native of the West Indies, of a material closely resembling the coarsest pasteboard. It is suspended from boughs of trees, and consists of a series of tiers of cells, arranged vertically, the one over the other. I do not remember ever to have seen common pasteboard made, but it is so similar to cardboard that I doubt not it is manufactured in the same manner: it is formed apparently of brown paper, which is, of itself, made of far rougher and coarser fibres than the paper of cardboard.

335. In all these cases the wasps display organs directly furnished to them by Providence, and construct their habitations from external material according to some definite plan, always the same in the same species. As a proof of the identity of design with which these creatures carry on their operations, I have figured a most interesting nest, which has been lent to me by Mr. Bowerbank, with his accustomed liberality. The nest is one of the cardboard nests before described. After the wasps had built six tiers of cells, either from the weight, or from some unknown cause, the branch appears to have fallen, so that the tiers were no longer parallel to the ground. The creatures, however, carried out their instinctive design, and the next tier was made at right angles to the former tier, so that the entire nest has two different axes, as it has six tiers in one axis and three in another (*Plate* 2, *fig*. 2). When Mr. Bowerbank asks for this interesting specimen, I intend to use every persuasion to induce him to allow me to keep it, by offering him a substitute in some other department of natural history, in which he more delights.

I have been tempted to give an additional lithographic plate of figures of part of a large collection of wasps' nests which I have recently obtained (*Plate* 5), as I consider, in these matters, figures are much to be preferred to descriptions. All of these nests may be observed to be formed on branches or on the under surface of leaves, and the texture of the paper in each case presents some marked peculiarity. As far as the argument is concerned, which I am attempting to enforce, on the nature of instinct, I may observe that, in those cases where I have more than one nest, those of the same species are formed upon a similar design. I do not know anything more calculated to fill the mind with wonder and delight than the inspection of these operations of the animal creation. In this chapter I cannot spare further space to describe the interesting objects figured in the plate; and I must therefore refer my reader to the description of the plates at the termination of this volume.

336. I have yet to give an account of insect habitations which are not only formed by the organs of the creature, but the material for which is produced by the secretion of the insect itself. I need hardly state that the habitations to which I allude are the nests of bees, who build their combs, not of paper, pasteboard, or papier mâché, like wasps, but of wax. Here we possibly have an analogy between the insect and the bird, inasmuch as we have already stated that certain swallows are by some persons supposed to construct nests of a material which they secrete.

337. Hive-bees not only differ from wasps in building their comb with a material secreted by themselves, but they also differ in the mode in which they construct their cells. All the wasps which I have hitherto described have their tiers of cells single; now the honeycomb is invariably double; and, moreover, whilst all these wasps and hornets arrange their cells horizontally, the bee arranges its comb vertically. I think it needless to enter into very minute descriptions of the honeycomb, as all my readers are

Wing, del et lith.

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doubtless perfectly familiar with its appearance. Each cell, like that made by the wasp, is hexagonal, and the cells are put together in a manner which secures the greatest strength for the least possible material. Kirby and Spence state that "Maraldi found that the great angles were generally 10° 28′, and the smaller ones 70° 32′; and Mr. König, an eminent mathematician, calculated that they ought to be 109° 26′ and 70° 34′ to obtain the greatest strength with any given amount of material." Lord Brougham states that he has discovered that the bee is right and the mathematician was wrong, and that other mathematicians with whom he has communicated agree with him, and have detected the source of the error.

338. The habits of bees are extremely difficult to unravel, on account of their invariable determination to work in the dark. Kirby and Spence state that philosophers have, in all ages, devoted their lives to the subject, from Aristomachus of Soli, in Cilicia, who, we are told by Pliny, for fifty-eight years attended solely to bees; and Philiscus, the Thracian, who spent his whole time in forests investigating their manners; to Swammerdam, Réaumur, Hunter, and Huber, of modern times;—still the construction of a honey-comb is a miracle which overwhelms our faculties. The point, however, to which I have to draw attention is, that the hive from the earliest period has always been constructed upon the same design; and in whatever climate or under whatsoever circumstances we meet with the structure, we cannot fail to recognize the plan upon which it is built. When we see this design to be as universal as the manner in which the bee itself is constructed, can we any longer doubt that the impress of the Divine Power which constructed the bee also gave to the bee the design upon which it thus so marvellously constructs its habitation?

343. Caterpillars are not only remarkable as exhibiting instinct in the formation of their habitations, but they also afford to us examples of that faculty in the construction of their cocoons. The cocoon of the silkworm is of great utility to man, affording to us a material of much value for clothing. An eminent naturalist has stated that all the plants this insect feeds upon contain more or less india-rubber; and I am acquainted with a fact which is not generally known, namely, that worms fed upon mulberry-leaves from trees grown in very confined spots in the centre of London, either will not spin silk at all, or will spin it very sparingly—a result which probably arises from the juice not being properly eliminated, from a want of sun. In foreign countries the insect is fed upon the leaves of a shrub called the white mulberry, and not upon the edible mulberry common in our gardens. If we compare ten thousand cocoons, they are all clearly made upon the same design, which the insect carries out independently of any former knowledge which it has acquired itself or which it has learnt from others; as it is manifest that all silkworms are hatched the same year from the egg, and therefore could have had no benefit of any experience which their ancestors might have derived.

344. Many spiders are remarkable for the nets which they spread to catch the victims on which they prey. The common spider, who makes his geometric web, forms a good example of action from a fixed design. Towards autumn, when these creatures are on the alert to catch flies, benumbed and half stupid with the cold of the mornings and evenings, their webs may be seen, by hundreds of thousands, stretched between various boughs. If we compare web with web, the identity of design upon which each is formed is manifest, though slight variations may be de-

tected in the execution of the work. When the nest is completed, the spider patiently waits, either in the centre or lurking behind some leaf, apparently lifeless, for hours and hours, for his prey; but the moment the fly touches his web he is all alive; he rapidly covers him with another web, cuts him out of the net, and carries him off in triumph, to feed upon him at hs leisure (*Plate* 4, *fig.* 4).

345. This contrivance is similar to that employed by the fisherman, who makes his net with cord, and suspends it in the stream till the fish becomes entangled in the meshes, when he removes the creature, and makes use of it, as the spider does the insect, for food. The spider forms its web by cords which are formed by a secretion of its own body, whilst the fisherman forms his net from the fibres of a plant. The fisherman makes his net from knowing the properties of these fibres, and constructs the meshes upon a scale which he determines according to the size and peculiarities of the fish which he desires to catch; the spider, contrariwise, constructs its web upon a fixed design, implanted in its organization. Hence, the net is the result of the faculties of reason which man possesses, whilst the web is simply made upon an idea existing independently of experience, a knowledge of the laws of matter, the habits of the flies, or of any other knowledge derived from reasoning powers.

346. Other spiders make a totally different web. One species delights in a corner, and spreads out a very fine, delicate, close network, of a triangular form. At one extremity of the triangle it makes a circular hole to the ground, and in that hole it lurks till its prey touches its web, when it rushes out and seizes the fly. Although this web is totally different from the geometric web, nevertheless the general design, in the same species, is as

universally maintained; and under no circumstance is the geometric web substituted for this latter web, or the last-described form for the geometric web (*Plate* 4, *fig.* 4).

347. The nests of spiders are no less remarkable than their webs. Many are made of bags, supported by slender pedicles; others are flattened; but each species has its peculiar form, which is constantly maintained upon a definite design (*Plate* 4, *fig.* 1).

348. But of all specimens of the architecture of insects, the habitation constructed with a true door is by far the most curious. Those who are unacquainted with the production, I dare say, will think that I am drawing a forced or poetical analogy. But in this case no colouring is required; and if my reader will examine the figure given in Plate 4 (*fig.* 8), he will perceive that the habitation is built with a true door, having a hinge, which allows it to be open and shut, and which most accurately closes. I have not at present been able to procure a specimen for myself, though the spiders are abundant in Tangier. Specimens may, however, be seen in the British Museum, and the curator of the King's College Museum has lately presented that institution with several very beautiful specimens.

349. All these instances are but given as illustrations of instinct, and by no means comprise all the cases in which the faculty is exhibited; but in the lower animals this faculty is shown to a very great extent. In foreign countries the habitations of ants are of so vast a size, that instances are known of their reaching ten or twelve feet in height. Other species, again, do great destruction to timber, by tunnelling it in all directions; and doubtless all have observed the curious structures of our common wood-ants. In all cases the design of the habitation is always maintained in the same species, and

the insect appears to act as a mere builder to carry out that design.

350. The caddis-worms form a domicile, in which they reside, of a very remarkable character. Some species form it of little pieces of wood, which they arrange tangentially to the cavity, so that the whole forms a case, with numerous projections. Other species form their abode of little shells, which they agglutinate together; but perhaps the most remarkable specimens are those which are entirely formed of small stones, so that the worm literally forms a stone case. In this latter case we have an insect performing an operation which only very lately has been patented by Messrs. Ransome, of Ipswich. They consolidate stones by silicate of potash, and thus are enabled to make artificial stone, of various shapes; but at present I do not think that their patent has been very extensively used (*Plate* 4, *fig.* 2).

351. There are numerous other cases of instinct, where the design partakes of a more simple character. Mr. Lovell Reeve has called attention, in his 'Conchologia Iconica' (vol. v., *Bulimus*, plate 1), to a very interesting instance in a species of snail from the Philippine Islands, a specimen of the nest of which is in the collection of Mr. Cuming (*Plate* 2, *fig.* 8). The eggs are as large as those of a hedge-sparrow, and, what is most curious, they have a chalky incrustation, like the eggs of birds. There are only two or three other instances known of a similar character, though in one case the eggs are as large as those of a pigeon. The snails of the genus *Bulimus* deposit their eggs, some in the ground, some on the trees. Of the former, many are viviparous; but there is a species inhabiting Brazil, *B. oblongus*, which produces a calcareous egg, very similar to a pigeon's. The *Bulimi* of the Philippine Islands are mostly of

arboreal habit, and their eggs are all soft, like snakes' eggs, with the single exception above recorded, in the *B. Mindoroensis,* from the island of Mindoro.

352. In all the instances which I have detailed, the animals are only enabled to carry out a certain plan,—in fact, to execute a design given to them by Providence. As far as the design is concerned, it is as perfect as that of any other of nature's works, and therefore man may well marvel at their excellence. If we regard the bee, which makes its honeycomb—the wasp, its paper, cardboard, pasteboard, or papier mâché—the spider, its web,—we observe that although it has carried out a perfect design, yet no superior intelligence is exhibited by the creature in any other particular.

To man, however, neither tools are given, with which he may conduct his operations, nor weapons with which he may defend himself, nor a design, implanted in his organization, upon which he may erect any structure. Although none of these things are given, yet man is endowed with faculties to understand the properties of matter, and, by applying this knowledge, he has command over all things, animate and inanimate. Man, therefore, upon the whole, widely surpasses creatures endowed with instinct, or having the idea of a specific design implanted in the organization given to them by their Creator.

CHAPTER VIII.

INTUITIONS.

Instinctive Ideas, 353.—Ideas common to the whole Human Race, 354, 355.—Intuitive Ideas not deducible by Reason, 356.—Religions Dependent upon Intuitions, 357.—Laws of Society akin to Religion, 358.—Intuitions do not exist in Animals, 359.—Origin of Intuitions, 360.

353. In my last chapter I have shown that animals carry out certain designs, which we infer to originate in their organization, because we observe that, under all circumstances, the same species conduct these operations in a similar manner. I have also shown that man does not conduct any ordinary operation by instinct, but that he is guided by a knowledge of the properties of matter to obtain any given result.

354. Nevertheless, there are certain ideas which are possessed in common by all mankind. We find, under all circumstances, in every climate, in every region of the world, that they are held both by educated men and savages. In my treatise on 'Electro-biology,' I have considered these matters in detail, and shall, therefore, only briefly refer to them in this place. I have there shown how various combinations of ideas may give us other higher ideas. Thus, the ideas of personality and infinity give us the idea of the soul; pleasure and infinity, of good; pain and infinity, of evil; cause and infinity, of God; time and infinity,

of eternity; infinity, pleasure, and time, of heaven; infinity, pain, and time, of hell. Personality, and all the units of sensation, give us the idea of the body; personality, infinity, and time, of immortality; personality, and other totalities of senses, give us the idea of the mind; thought and infinity, of spirit; lastly, action, infinity, and pleasure, give us the idea of virtue; action, infinity, and pain, of vice.

355. Thus we perceive that we know, from the very organization of our bodies, that we are immortal;—that God exists;—that there is virtue and vice,—a heaven and a hell. Man, in every age, in every climate, is compelled by his very organization to believe these first principles. It is not within our power to define these ideas; and if we attempt to descend into particulars upon these mental conceptions, very different specific ideas are attached to the same point. That which is infinite must not be limited;—time must not be confounded with eternity, matter with space, the body with the soul, or material actions with God.

356. The possession of these ideas ennobles man above every brute beast, for it enables him to act upon the moral law. Many of these intuitive ideas cannot be deduced from the external world by any effort of reason. For instance, man knows that all mankind are mortal, but cannot deduce from experience that man has an immortal soul. It is, in like manner, impossible to prove by reason the existence of heaven and hell, of virtue and vice. But when man observes the insect deposit its egg blindly, to produce an offspring which it can never see, but which, nevertheless, comes to life and eats the food which has been instinctively supplied by its parent;—when man observes the bird to build its nest upon principles which never fail,—can he

suppose that when he himself aims at attaining a future reward in heaven, which he intuitively believes, that he will be deceived? Can he believe that these ideas have been implanted in him as a mockery by Providence? and can he doubt the reality of his soul, and that his soul will live for ever?

357. It is upon these intuitive ideas that religions are operative; for all religions, true or false, are assumed to come directly from the Almighty, and all religions qualify each specific action, and determine whether it be right or wrong. As religions give different rules for conduct, we find that an action which is right in one religion is wrong in another; but in either case the powerful effect which religion has upon the actions of man is alike. The Indian widow destroys her body under the influence of a debased religion, in the same manner as the Christian sacrifices his frame, and endures agonizing tortures. The influence of religion appears to be peculiar to man, as there seems to be no question but that the dog or other organized being is totally uninfluenced by its operation.

358. Akin to religion are those laws which man forms for the well-being and government of society. Man is a social animal, and finds it much to his advantage, if not absolutely necessary, to live in communities; and laws must be formed to govern these communities. Man, however, is not singular in living in communities, as the dog and other creatures live under similar circumstances. All gregarious animals do not alone consider their own advantage and pleasure, but they also consider the advantage and pleasure of the whole community. In a former part of this work (*Par.* 173) I have quoted a very remarkable instance of the association of dogs to help one of their companions. I must confess that these instances are some-

what puzzling to unravel; nevertheless, although, in point of fact, they clearly act upon the Christian principle of doing to others as they would that others should do to them, yet there appears to be no reason for supposing that their action is upon fixed laws. Many instances of the action of gregarious animals are clearly the result of pure instinct. For instance, in the construction of the nest of the wasp or the hive of the bee, all members of the community are carrying on the operations upon one set design, which they have instinctively learnt. I need hardly state, that neither the plant, the stone, nor the steam-engine can possibly exhibit these mental faculties.

359. I have already shown, that by these intuitions the actions of man are very powerfully controlled. I may also state, that, to obtain infinite pleasure for all eternity, he will subject himself to great immediate pain; and, contrariwise, that he will forego great immediate pleasure to prevent himself from suffering infinite pain for all eternity;—all of which results do not seem to occur in other animated beings. If we examine carefully the actions of a dog, we find that he can be taught that a certain act should not be done. Our dog this day jumped upon the table and stole a pen; but as soon as he caught my eye he skulked away, and hid himself under the table. Although, apparently, this dog was conscious that he had done wrong, and felt remorse, which caused him to hide himself from my sight, yet I am inclined to suggest another view of the case. The dog had been scolded or corrected for this behaviour on a former occasion, and had therefore registered in his brain the ideas of myself, his being on the table, and the pain of the correction: so that when all these were again conjoined, a memory of a painful character came into play, and he was afraid. This is a

very different view of the question from supposing that the dog appreciated the ideas of good and evil, and that he was conscious that the act was evil. From the former view, it was a simple case of an idea remembered as to its pleasurable or painful character; from the latter, it would have been a case requiring a knowledge of the profoundest laws.

360. In my 'Electro-biology,' I have pointed out a theoretical structure, deduced from voltaic laws, by means of which man possibly obtains these intuitive ideas. Up to this point, man only exhibits the result of physical structure; or, in other words, these faculties arise from the mechanism of the brain, which is contrived by the Creator. In this world, to us only is given a power to obtain a knowledge of matter and material forces, though we hold besides certain intuitive ideas which we are compelled to believe, though our finite minds cannot appreciate them. We believe intuitively that we shall exist infinitely in a spiritual state; but before we can learn the attributes of the spiritual state, we must shake off the earthly structure which now gives to man his faculties of reason.

CHAPTER IX.

ON WORDS AND LANGUAGE.

"To speak I tried, and forthwith spake;
My tongue obeyed, and readily could name
Whate'er I saw."—*Milton.*

361. Man has the faculty of expressing his ideas by sounds or marks. He is thus enabled to write to a friend, by using words, or to talk to him, by using sounds; he can, moreover, express how one thing acts upon another, and explain how the second was effected. The use of these sounds or marks to signify things or actions is called language; and from this faculty man derives a great superiority over all other animal bodies.

362. It seems hardly necessary to state that the same thing—or instance, a house—may be expressed by various sounds or

marks; and in the almost innumerable languages existing over the globe, the same thing is called by very different terms. Now, the use of language appears to involve a high power of organization, for perhaps no other animal has the power to use language in the manner in which we clearly possess it.

363. This want of power to use language does not depend necessarily upon any defect in the organs of voice in other members of the animal kingdom, for the parrot does certainly possess the faculty of speech, although destitute of the power of using words. The parrot will repeat short sentences if he be carefully taught, but it is quite amusing to hear how he will, in the frenzy of delight, mix up the words incorrectly. I am acquainted with a grey parrot, which cries out, 'pretty poll,' 'poor poll,' 'scratch a poll,' 'good morning,' 'you old rascal,' 'Elizabeth,' 'Betty, you old wretch.' She will also mew like a cat, bark like a dog, and imitate various strange noises, as the drawing of a cork from a bottle, &c. On a fine morning, when Polly feels lively, she will amuse herself by talking, and will then combine these words in every possible manner. She will begin, "Poor Poll; you old rascal, Poll; Betty, ras-" and forget to say the terminal "cal." She will then go on with "Elizabeth, pretty Poll, puss, puss, puss, puss, Betty, pretty rascal, you old wretch, Poll! don't bite." Then she will indulge her hearers with part of a chant; then mew, then bark, and then proceed, for an hour or more together, apparently thoroughly satisfied with herself, and appearing to be in the highest ecstasy of delight.

364. Sometimes she will take part in the conversation, and some of these words cause shouts of laughter amongst her audience. At other times she will laugh most heartily herself,

exactly at the right time, and add much to the merriment. Yet these cases appear to be quite accidental. There is an amusing story, of a somewhat analogous character, detailed in the 'Percy Anecdotes.' "A Persian, who kept a parrot, taught it, in his own language, to answer every question with 'What doubt is there of that?' One day the man carried the parrot to market for sale, and fixed the price at one hundred rupees. A Mogul asked the parrot, 'Are you worth a hundred rupees?' It answered, 'What doubt is there of that?' The Mogul was delighted, bought the parrot, and carried it home. Whatever he said, he received for answer, 'What doubt is there of that?' He then began to repent of his bargain, and said, 'What a fool I was to buy this bird!' The parrot said, 'What doubt is there of that?' The Mogul smiled, and gave the bird its liberty."

I need hardly mention, that if a man were to use words as indiscriminately as a parrot, he would be set down as a lunatic at once. Whilst I write this, a case comes to my mind upon which I had to bestow my most anxious consideration, to determine whether a very trifling incoherence in the use of words was not attributable to incipient insanity; and the supposition proved to be but too true.

365. A friend of mine had another Poll, who would call out, whenever she saw food on the table, "Give Poll a piece; give Poll a piece:" but after a short time, if not attended to, she used to get angry, and would use such obnoxious language as is too frequently used by the sailors on board ship. The use of these words could hardly be likened to the use of words as we employ them. There never appeared to be the slightest evidence to show that she understood fully the meaning of either of the

words "give" or "piece," but merely associated the sound of the whole sentence with food.

366. The keeper of the elephant at the Zoological Gardens used to make the beast perform various evolutions; and if the man had a piece of money for his trouble, he used to cause the elephant to make a noise, which he interpreted into "I thank you;" but this strange sound falls under the same class as the Poll Parrot's vociferations.

367. Nevertheless, animals certainly have a power, to some extent, of communicating ideas to each other. In a former chapter I called attention to the manner in which lambs call their dams; and the same thing is observed with other beasts. I remember once to have been in a large field with a friend, where two calves and two cows were grazing. It so happened that the calves were at one side of the field, the cows at the other. We commenced playing with the calves. At first they seemed well pleased with the sport; but I suppose that at length we were too rough, as they made a peculiar cry, when the mothers instantly, with tails erect, ran as fast as they could, to take such steps as they might deem necessary to punish the delinquents; when I need hardly record that, for our own safety, we deemed it prudent instantly to decamp, and scamper over the hedge into the adjoining field.

368. Birds have a peculiar call-note, which attracts others of the same species. A parrot caught the note of a chaffinch so accurately, that it was impossible to tell the one from the other. In summer-time Polly used to be indulged by being placed in a tree, where she took much delight in climbing about the branches. At these times she would frequently repeat the chaffinch's note, when the birds would come from all quarters

and settle upon the tree. It was then highly amusing to hear the parrot and chaffinches mutually call each other. After a short time, however, Polly, in the exuberance of delight at the sight of so many winged creatures around her, would suddenly call out, "Pretty Poll!" when the chaffinches, startled at so human a sound, as much as Robinson Crusoe in his uninhabited island, instantly took flight, and made their escape from so terrible a sound as rapidly as possible, when Polly looked wofully astonished to find that all her visiters had so suddenly deserted her. Bird-catchers are in the habit of imitating the call-notes of birds, to decoy them into their nets; and some of them are very clever in catching the exact note of the bird which they desire to entrap.

369. From the above instances, and others of a similar character, I think that no person can hesitate to admit that animals attach a particular meaning to particular sounds; and therefore we must try to ascertain to what extent animals can understand sounds for things. Dogs which are brought up with little children from their earliest infancy are generally more humanized, and therefore form the best subjects to ascertain how far they can appreciate language under the most favourable circumstances. In the first place, dogs know their names; and if we call them when they are wanted, they instantly come. They also clearly know whether you are speaking to them in anger or in pleasure. If in anger, with tail between their legs, they slink out of the room to some hiding-place; if in pleasure, they will jump about, wag their tail, and show other signs of delight. Moreover, they know the meaning of many different words. Call out, to a terrier, "Cat! cat!" or, "Rat! rat!" and immediately, with ears erect, he is all alive, and ready for the fight; and there

can be no question but that he knows what is meant. If the lock of a gun is clicked when a pointer is basking before the fire, he will be up in a minute, and show that he is ready for the sport. If we trace the subject still further, we find that dogs can understand simple sentences and simple ideas. If we call to the educated dog, "Go down stairs," "go to bed," "fetch it," "catch him," "bite it," "let go," "don't bite," the dog understands the meaning, and acts upon it. In Wales the sheep-dogs from two walks will go to the boundary and appear to relieve the monotony of their employment by a little conversation; but neither dog will allow his master's sheep to cross the boundary line, and if the shepherd orders him to do a certain thing, such as turning back a particular sheep, he is off in an instant to effect the desired object.

370. Moreover, when dogs are basking by the fire, and conversation turns up about themselves, I am inclined to believe that in some cases they appear, to a certain extent, to understand what is said. If it is complimentary, they will remain quiet, with their eyes open, and ears a little raised; if it is disparaging, they will generally slink away. It is difficult to ascertain accurately how far this capacity exists; but as far as my own observations are concerned, it appears hardly so great as incautious observers might assume.

371. As far as I can observe, any simple idea with which an animal is acquainted may, as a general rule, be so associated by education with a certain sound, that it may be brought into action by it. In a former part of this work, I have already shown that animals only act upon simple impressions, and no one animal, under any circumstance, appears to have the slightest idea of a physical force, of a general law, or of a moral law. In

confirmation of these observations, we find that no member of the animal creation but man appears to be able either to express or to receive any idea of this character by sounds or marks. Now man expresses any act of matter by a part of speech, which is called a verb. On this account the verb is a most important kind of word in the use of language, second only to the noun, which expresses either the object which acts, or the object which is acted upon. As no animal understands force, it is manifest that it cannot use the verb in the sense in which we employ it.

372. As far as a mere association of a sound with an object is concerned, I have, within the last few minutes, observed a pretty example. I thought a parrot desired some water, and got up for the purpose of pouring some from a bottle. The quick-eyed Polly soon detected my intention, and made a noise so resembling the pouring of water that it would have been impossible to have detected the difference. This parrot invariably says 'Good morning' when I enter the room, because I am in the habit of using these words. I have also known a parrot which, the moment he saw the gardener, would call out, 'Gardener, ahoy!' or, if told to call the maid, would call 'Caroline! Caroline!' and thus would evidence a knowledge of the connection between certain sounds and objects.

373. Some of the lower animals appear to impart knowledge to each other without either sounds or marks. For instance, ants, if their nests are disturbed, run about in great trouble and commotion, and we might fancy that each is running to his neighbour to inquire what can be the matter. They cross their antennæ, but whether it be for communication must be rather a matter for conjecture than for absolute belief. With regard to the elaborate accounts which have been written of the proceedings of bees, I have no hesitation in stating that the

belief requires more faith than I possess, as these and other creatures most obstinately and pertinaciously work in the dark, and will hardly allow you to peep in for a moment, so that a glass hive is transparent rather in imagination than in fact.

374. Up to the present time I have more particularly considered the use of sounds to represent things, as in the ordinary process of conversation; but that is by no means the only mode by which knowledge is conveyed from one person to another. In written documents certain marks are used, for the same purpose as the peculiar marks which are used for printing.

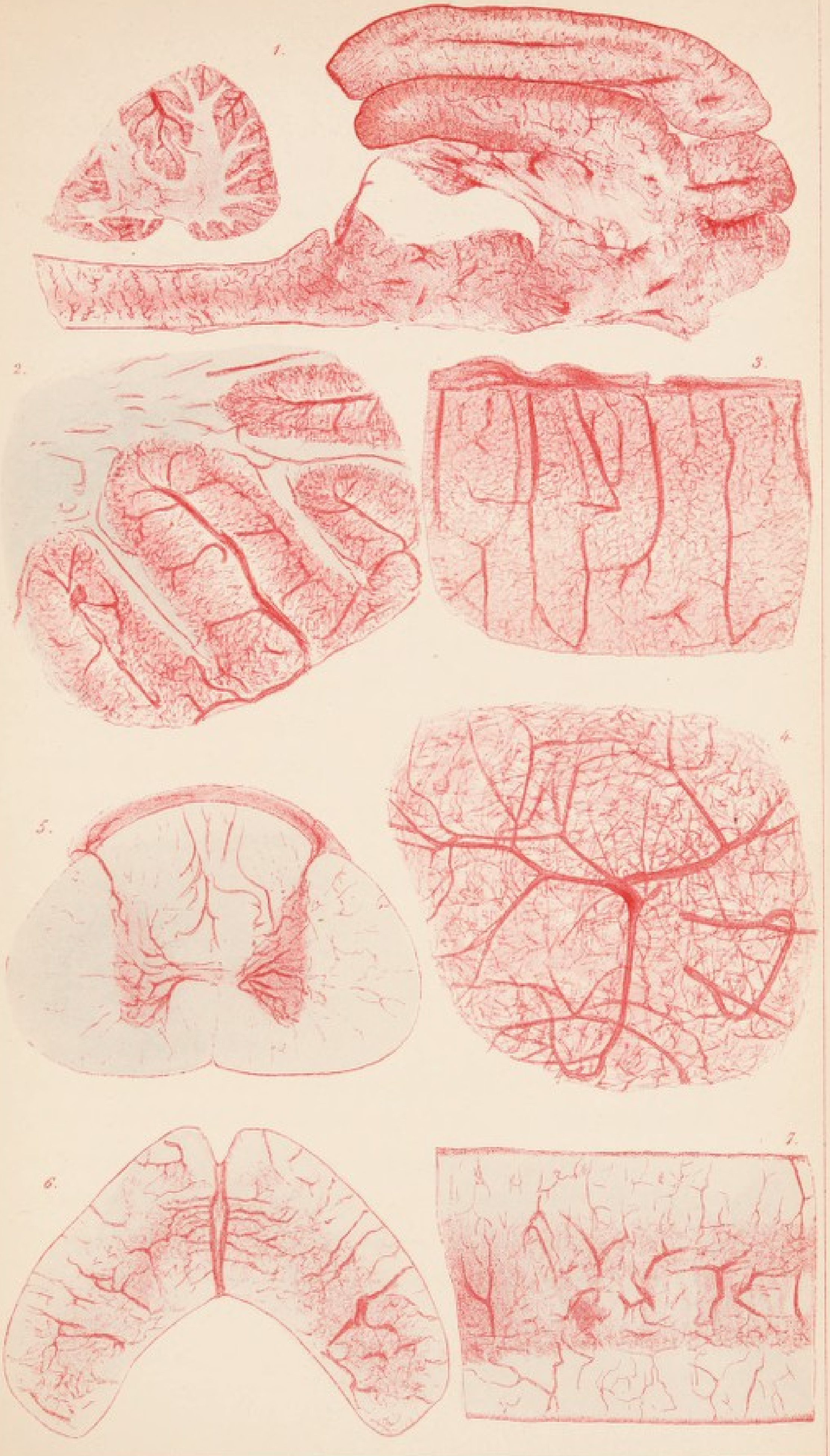
375. The modes of writing words, or using marks to express ideas, are very numerous. The manuscript of this book is very different from the printed copy; and even with regard to type, I may print the word 'book' in many different methods: thus, in Italic type, *book*; in ordinary type, book; in capitals, BOOK; in old English, **book**; in Greek, *βοοκ*; in Hebrew, בֻּךְ; in Arabic, بُق; in Bengalese, বুক. The Egyptians used to employ pictures of objects to represent letters, syllables, or ideas;—thus, an arm represents the letter A; a chisel represents the syllable *ab*; the branch of a tree represents victory. The Exchequer, till within modern times, used to employ tallies in keeping accounts. A piece of stick was taken, and notches, representing the amount, were made upon it. The stick was then divided into two parts, and one party held the first, another the second, portion. The division did not extend throughout, but only up to a notch, so that the two parts might be compared at any future time. I have one, as late as 1824, of money paid for the sake of conscience* (*Plate* 10, *fig.* 20). I have others, of moneys paid for

* This continually happens from persons having cheated the Government of revenues which were due to it, and afterwards repented of their action.

duties on exportation of coals, &c. The Houses of Parliament were said to have taken fire from burning these tallies, which are now no longer employed.

376. The use of words to represent sounds or things, for the purpose of communicating knowledge, is, in some degree, allied to the use of pictorial representations, though the latter has the superiority of communicating the real appearance, as the observer himself would have witnessed it. In this work I have taken advantage of this power, as, by the aid of the talents of Mr. Wing, I have been enabled to give to my readers an exact representation of many interesting objects, which is far better than any description I could possibly employ. This mode of communicating knowledge is not possessed by any other member of the animal creation, as there is no example of any painting or drawing having at any time been produced by any other living creature but man.

377. Knowledge may be communicated by signals, of which the old semaphore is a good example. The policemen, who patrole the streets, convey various signals during the day-time by placing the arms in particular positions, or, by night, by using their lanterns, by which a second policeman can be telegraphed. In this case one position signifies a whole sentence. I need hardly call attention to the extreme value of these signals on railroads, —as a wooden arm, when placed in one position, signifies to the driver that he may go ahead; in a second, that he must slacken his pace; and, in a third, that he must stop immediately: and disobedience or misunderstanding in the use of these signals has jeopardized, in some cases, hundreds of lives. Even by the electric telegraph the words are not all spelt, but only certain actions of the telegraph are made to represent words, or even whole sentences. Flags are much used for signals on board ship.



W. Wing del et lith.

Reeve Benham & Reeve, imp.

378. Signals expressing ideas may be also given by sentinels. I remember that, on the night of the fire of the Royal Exchange, the authorities at the Bank considered it advisable to have an additional guard of soldiers. A gentleman was sent to the Tower for that purpose, and he gave on his return a sufficiently romantic account of his proceedings. He represented that he went with all possible despatch to his destination; that he communicated his business to the sentinel outside, for the gates were closed, and there was neither ingress nor egress. The soldier outside fired his musket, the soldier inside returned the salute by firing his. This was repeated from sentinel to sentinel to the barrack-house. The drummer beat to arms, the gates were opened to receive the letter, and in a very few minutes the guard were on a double quick march to the Bank of England. Guns are frequently used for signals on the coast or by vessels to indicate distress.

379. A story comes to my mind which I have read, which well demonstrates another mode of communicating ideas by sounds. Two prisoners were shut up in two cells, and any communication between each other was always punished. In this difficulty they invented a language by which they expressed their ideas by whistling; and, though they found great difficulties at first, yet, by practice, they were enabled to converse freely, and thus they circumvented their barbarous captors.

380. At a former part of this work I have called attention to the mode by which the blind are enabled to read embossed letters with their fingers. I need hardly remind my readers of the mode by which the deaf and dumb converse with their fingers; but far greater difficulties are presented to the attempt to convey knowledge to those both deaf and blind. In the well-known case of James Mitchell, who could neither see nor hear, his sister, who

particularly attended to him, used to convey extensive information by tapping him gently on the hand, back, and neck. There is no doubt but these cases in future, as in the case of Laura Bridgman, will be taught by raised letters to read and write with comparative ease. It is curious to notice to what extent the faculty of feeling can be improved when a person is deprived of the senses of sight, hearing, and smelling, which was actually the fact with this poor creature.

381. In some degree akin to the use of words and sounds to represent things and actions, is that curious faculty which children so frequently indulge in, namely, that of substituting one thing for another. In these times children almost invariably delight in the personification of railway carriages and engines, and cough and scream like a locomotive. To such an extent is this carried, that in some families laws are obliged to be enforced to prevent the starting of these trains at undue times. Children not only personify railway trains, they personify horses, dogs, and other animals. They make chairs into trains and steam-boats, and perform many other pranks of a similar character. I know a little girl who always expresses her good humour by saying that she is a frog, and the reverse by saying that she is not a frog.

382. When manhood succeeds to the period of childhood, we do not indeed personify steam-boats, steam-engines, or the lower animals, although we still carry on a substitution similar in principle. What the child does to the simple impressions on the mind, the man does to the higher ideas, and he personifies the more hidden thoughts. Painters curiously personify life and death, good and evil, and I regret to say that there have not been found wanting masters in the pictorial art who have thought fit to represent God himself. Some time since I was applied to

by Mr. Cook to write a sheet of directions, to be used by the poor for accidents and emergencies; and his idea was, that it should be made somewhat ornamental, that they should hang it up in their cottages. I selected for the title an engraving after a painting by Sir Joshua Reynolds in the Dulwich Gallery: in this painting, we find the ideas of life represented by an angel, of death by a second figure, whilst the figure of the child most painfully indicates disease. As some thousands of these sheets have been sold amongst the poor, I am glad to have the opportunity of stating that to Mr. Cook is due the merit of that circulation, as I but simply carried out his idea.

Fig. 40.

383. Perhaps, however, the use of maps is a remarkable instance of a similar character. When we come to think what a map really is, we find that every part of the paper represents a different spot upon the earth's surface, so that the surface of the

entire world is represented by a few square inches of paper. Similar, again, to maps is the employment of plans for buildings, docks, railways, roads, and, by the use of them, one man is enabled to design, and a second is enabled to execute various operations.

384. Man not only represents visible things by marks, but he also uses certain devices to indicate sounds and the direction of sounds. The manner in which music is written is a familiar example of this kind, for, by representing the pitch and duration of each note, the most complicated compositions can be accurately produced in any country.

385. We thus find that man has the faculty of using sounds, marks, or other objects to represent various objects, or actions; and, upon the whole, he differs from every animal in this respect. It may be true that some animals do, to a certain extent, appear to understand conversation, yet we alone can write a book, draw a plan, make a map, or perform any other analogous operation.

386. Man, however, has a power of still further using signs in algebraic formulæ, by which he is enabled to make otherwise most tedious calculations with comparative ease. By the use of these algebraic signs man is enabled to grasp those calculations necessary to predict the place in the heavens where any particular star will be at any moment; and, notwithstanding the rapid motion of the earth and planets, he is enabled to predict, to within a few seconds, eclipses which will occur for thousands of years to come, and also to ascertain the period at which all others have occurred since the commencement of the world.

387. Thus we perceive the extraordinary results which man can obtain by this power to use signs and sounds. At the breakfast table the newspaper is placed, containing every news of interest in the metropolis up to two or three o'clock in the morning, together

with the latest intelligence which wealth and influence can procure from every quarter of the globe. Every week we are supplied with accurate pictorial representations of all the most remarkable occurrences on the globe. By the use of language and writing each man is enabled to follow some pursuit, and to convey the result of his experience and his investigation to the rest of his fellow-creatures. By this result a man can act, not alone upon his own experience, but upon the combined experience of all mankind.

388. In this country, at the present time, we have three distinct classes of written knowledge. The first is that which appertains to law-making and the government of mankind, and which really can hardly be said to be written. We hence see how badly a man, untrained to govern, rules his fellows. The principles on which it is conducted are, in great part, handed down from father to son, and, though the historian may give fanciful interpretations, yet the real motives which actuate the rulers generally remain in their own breast, or are only imparted to their own family circle. I would not confine this class of literature to subjects which relate to lawgivers and the government of mankind, for the more important knowledge of the management of banking, or other monetary undertakings, can hardly be said to be written. So, with respect to the knowledge which is required to manage manufactories, or, in truth, which appertains to any actual government, it is so scantily described that it can hardly be called written literature.

389. The second great class of literature is that which is destined for the middle classes. In it is comprised almost all that which appertains to passing events, or which gives us an insight into the laws of nature, and it is a class of knowledge which is fully written. There is not a vast deal known in these depart-

ments which is not contained in written works. This literature, especially in all political relations, only circulates to a certain level, and is not at all perused by persons below that level in society. This is so well known to writers of Sunday papers, that the editors know exactly by what classes their respective periodicals are likely to be read, and the articles are shaped accordingly. This antagonism of literature is daily becoming more distinct, for the two classes contain diametrically opposite principles, both moral and political. I cannot say that I am altogether without fear as to the result which this distinction ultimately may produce; for the two sets of principles are daily obtaining a stronger root in the two classes, and, as both are ignorant of the other's feelings, it does appear that, at some future time, serious results might arise therefrom.

390. Upon the whole, however, the free communication of knowledge which we now enjoy under a liberal government through the medium of printing and pictorial representation, does much to humanize society, and there is no reason to doubt but that as knowledge extends so will the happiness and welfare of man be increased, and his condition be improved.

CHAPTER X.

ON THE WORKS OF MAN, AS COMPARED WITH THE WORKS OF NATURE.

Limitation of the Works of Man, 391.—Works of Man and of Nature conducted upon Physical Laws, 392.—Examples, 393.—Imperfection of the Work of Man, 394.—The Eye, 395.—The Heart, 396.—The Generation of Force, 397; Theory of, 398.—Artificial Muscle, 399.—The Action of Muscle Obedient to General Laws, 400.—The Colours of Birds compared with De la Rue's Discovery, 401.—Principles of Human Action and of Nature Identical, 402.—Special Providences, 403.—The Case of the Mannings, 404.—The Case of Rush, 405.—Skill required for Universal Laws, 406.—Effects of Belief in Special Providence, 407; in Eastern Countries, 408.—Life Assurance, 409.—Estimate of Laws, 410.—Nature of a Law, 411.—Simplification of Natural Laws, 412.—Conclusion, 413.

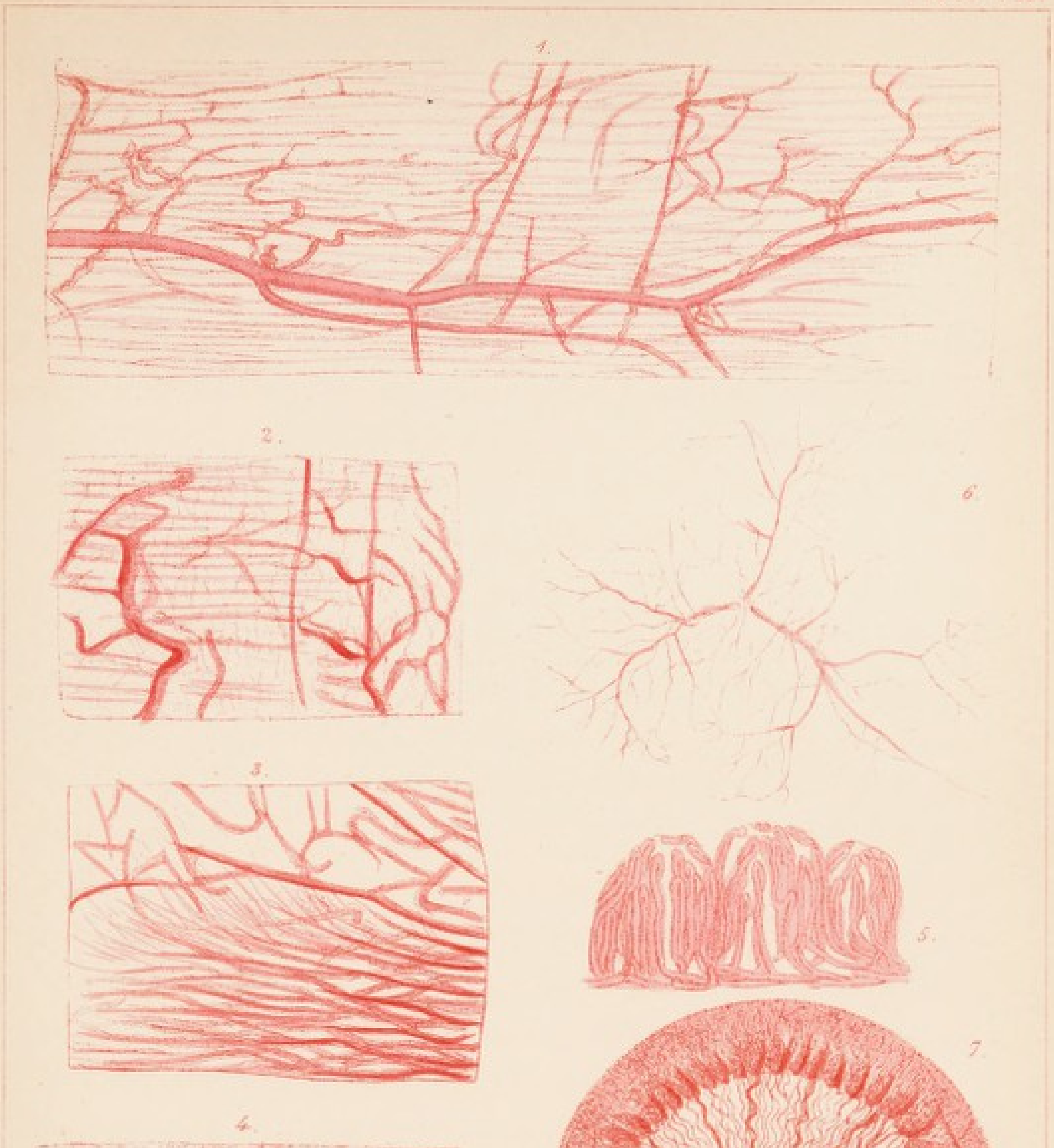
391. We have now to compare the works of man with those of nature, that we may ascertain whether they are conducted upon the same plan, or whether they are conducted upon any other system. Now, we have already found that man can perform any act in conformity with the laws of nature, and he is but limited by his organs, either of sensation to appreciate, or of motion to carry out. He cannot make anything which is too minute to be visible, nor can he construct anything too small for him to feel. Yet, by the construction of the microscope, he to a certain extent gets over the difficulty, and I have actually seen glass ruled with lines so close together that it requires the highest powers of the microscope to examine them.

392. If we regard the operations of nature, we find that they are conducted also in conformity with certain laws, and that in every operation of nature the fixed laws of the universe are as implicitly obeyed as though the operations had been conducted by the human hand; and if, in the necessary construction of our bodies, a difficulty arises, it is overcome by some arrangement in obedience to general laws : there is no single contrivance to be found in the whole range of animal bodies which is effected contrary to physical laws.

393. If I pause to consider a few examples of this character, I shall be compelled to quote illustrations which almost seem too trifling in themselves to demand notice. For instance, our limbs require to be rendered stiff, and this stiffness is given by a bone, the particles of which are in cohesion, and especially adapted for that purpose. At intervals where nature has determined that we shall have joints, there an interruption in the coherent matter exists, and the two pieces are joined together in a far more wonderful and perfect manner than the hinge of any door. Take, for example, the shoulder-joint, with its capsular ligament and numerous small muscles, which retain the head of the bone in its superficial socket, whilst the arm performs its numerous and extensive movements; take also, for example, the construction of the knee or ankle-joint, where we have a perfect hinge-joint, with little or no lateral movement; or take that of the joint of the lower jaw, which can act as a pure hinge-joint in the badger, where no lateral movement is allowed; or the same joint in the cow, where considerable lateral movement is necessary to enable the creature to masticate the food.

394. In all these cases we find that the structures are formed in a manner calculated to perform their desired end in a far more

Plate VII.



W. Wing, del et lith.

Reeve Benham & Reeve imp.

perfect manner than man can execute any work; and we observe that although man would act upon a similar principle, yet he would carry out that principle in an incomparably less perfect manner.

395. I have already called attention to the structure of the eye, and shown that it is truly an optical instrument, formed upon optical laws. It would have been here a great benefit if the eye had not required a mechanism for adjustment; but yet, in obedience to physical laws, the eye is made in such a manner that it can adapt itself to different distances. In our instruments similar to the eye, we require stops to regulate the admission of light, and nature is compelled to obtain the same result by an analogous contrivance. But when we compare our artificial stops with that natural contrivance, the iris, or curtain, what a striking difference is presented in the perfection of the construction of a part designed for a similar object! In the work of nature, the iris contracts and dilates, to adapt itself to the most minute variations of the amount of light; whilst I may say that man never has attained, and probably never will attain, a similar perfection. Again: we find that the structure of the eye is specially adapted, upon purely physical principles, to suit the various conditions of different creatures; for in the fish the lens is made nearly globular, and of far higher refracting power, to adapt it to the circumstance of the creature living in water instead of air.

396. If we regard the construction of the blood-vessels and other parts of the circulating system, we find that they are constructed entirely on physical laws. The heart is the mover which propels the blood, and, after having given the stroke, its fibres become relaxed, to receive a fresh supply. In this case it is

important that the fluid should not again regurgitate into its cavities; and to prevent that, a system of valves, not thicker than paper, have been contrived, to effect that object. Here we see a design identical with that pursued by man in the construction of his pump, or even, in some cases, of his flood-gates. The only difference between the work of man and the work of nature is, that the latter is executed in a manner so superior, that man feels that he sinks into insignificance beside the Creator.

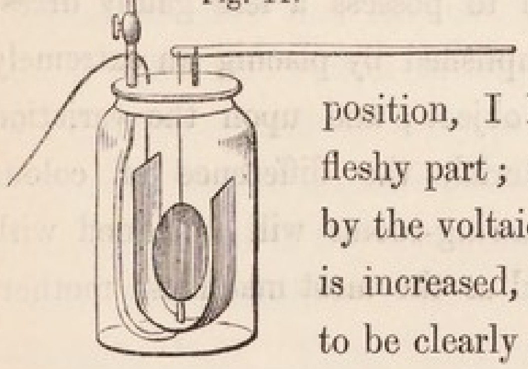
397. It really appears to me hardly necessary to pursue this interesting subject further, for I might be tempted to quote every fact in anatomy, physiology, or in other sciences, to prove my case. There is yet, however, another fact to which I must draw particular attention, and that is, the source of motion in animal bodies. I have called attention to the fact that no physical force is exerted without some corresponding change of matter:—to obtain light we must cause our tallow or oil to combine with oxygen; to obtain heat we must cause our coals to combine with the oxygen of the air; and so, if we produce these forces by electricity or any other operation, still some equivalent change of matter is always required. In animal bodies the production of either heat, light, or electricity produces an exhaustion which requires the individual to take food to make up the deficiency. If a man walks for a long distance, he feels exhausted; if the electric eel gives many shocks, it is also exhausted. I once saw a man drop down from the exhaustion of a long journey; and the eel is captured by stimulating it to exhaust itself, by giving a series of shocks. The necessity for food to be changed follows the same physical principle in the bodies of organic beings as in the machines of man. I remember once to have dined with a distinguished party of engineers. One was

greatly celebrated for the construction of docks, and to my query he replied that it was impossible, *for his work*, to obtain men to effect the labour, without feeding them well. The same answer was given, in nearly as many words, by the *railway engineer*. The builder also declared the same thing; but the point which amused me was, that each man stated that, for his own particular kind of labour, ample food was required.

398. The exact mechanism by which man obtains the power of motion is not understood, though we know that this result is accomplished by the muscles: and we find that, according to the power of motion required, so must be the bulk of the muscle. In my 'Elements of Electro-biology' I have ventured a theory of the action of muscle, deduced from its ultimate structure. It is known that muscular fibre is ultimately resolvable into tubes, containing in the interior a peculiar substance, which is the real flesh. My experiments have also clearly proved that the exercise of volition is really manifested by a voltaic current passing through the muscles. Now, the theory which I have propounded is, that action is produced by the swelling of the material of the ultimate fibre, in consequence of its combination with some new substance, probably potash.

399. Upon this fact, I have constructed an artificial muscle, which acts by a tube being distended. To illustrate my position, I have substituted water for the fleshy part; and, by decomposing the water by the voltaic force, the bulk of the material is increased, and contraction ensues. I wish to be clearly understood that I only show my artificial muscle as an example of the means by which an increase

Fig. 41.



of bulk in a membranous tube may produce contraction and give rise to motion.

400. From what I have already said, it is apparent that, even with regard to muscular action, as far as we can trace the phenomena, general physical laws are implicitly obeyed. Here again we observe that the operations of man and of nature are conducted upon the same plan, though we find that, so far as concerns the immediate mechanism, the work of the latter is so inimitably perfect that we feel the expression of the poet when he exclaims,

> "Muscle and nerve, miraculously spun,
> His mighty work who speaks and it is done."

401. When we view the glorious colours in the humming-bird, the insect, or the shell, we might suppose that general physical principles had yielded to the will of an Infinite Power. Not so, however; for man has discovered that these colours are produced by thin plates and lines; and only lately a patent has been taken out by Mr. De la Rue, for producing similar exquisite colours. I am now writing, with a piece of paper before me stamped into the form of a shell, which is as brilliant in colour as any natural object; and this gentleman has puzzled the entomologist by placing these brilliant colours on insects only designed by nature to possess a less gaudy dress. This result is beautifully accomplished by placing an extremely thin film of varnish over the object; and upon the variation in the thickness of the material, the difference of colour depends. Before long, our drawing-rooms will be lined with paper as iridescent and beautiful as the most matchless mother-of-pearl.

402. We thus find that man conducts his operations in a man-

ner precisely similar to that in which the Creator has thought fit to conduct the operations of the universe. Now, I apprehend that we are in a condition to understand how the Almighty can, in one sense, be said to have created man after his own image; for the Creator has endowed matter with certain properties, and constructed the universe in obedience to them, and he has alone permitted man, one of his created beings, to understand these properties, and to act upon them in a similar manner.

403. Although there can be no question but that the entire operations of nature are performed upon purely physical laws, yet mankind are not universally agreed as to whether the special interference of Providence does or does not in certain cases occur. The question before us is not whether Providence can interfere in any special case, for He who created can also vary or alter, or, by one word, can realize our poet's thought,—

> "The cloud-capped towers, the gorgeous palaces,
> The solemn temples, the great globe itself,
> Yea, all which it inherit, shall dissolve."

Cases are frequently brought forward in which pious individuals have thought that the divine power was exercised in a special manner; yet, upon a careful investigation, these very instances appear to show how exquisitely the laws of the universe, and those which rule human action, have been framed, so that they are enabled to embrace every particular case. In this matter we may refer to two instances which have lately occurred—the one, the punishment of the Mannings, the murderers of O'Connor; the other, the detection of Rush, the perpetrator of the tragedy of Stanfield Hall. These instances have both been brought forward as special providences, although, to my mind, they exhibit results which depended upon laws formed coeval with the creation of man.

404. With respect to the Mannings, who murdered O'Connor, the man was missed, he was traced to the house of the murderers, the house was examined, but he was not found. His relations went to my father, in his official capacity of chief accountant of the Bank of England, to inquire as to the money which O'Connor held in the funds. On the narration of the circumstances my father gave it to be his opinion that the man was murdered and secreted in Miniver-place; and, moreover, he said that, if O'Connor were his friend, he would not rest till every nook and every inch of those premises were minutely examined. Upon this recommendation, the friends applied to the police to make another examination; the body was found, and the evidence clearly showed that these parties must have been privy to the horrid deed. In this case there are no signs of special Providence, but the horrible nature of the crime caused such a minute investigation as to lead to the detection and execution of the perpetrators, under circumstances which would have prevented the discovery of their guilt had they committed but a trifling offence.

405. Again, in Rush's case, so intense was the desire to make an example of the delinquent, that every human means was employed for the discovery of the murderer. In illustration of the trouble which was taken, I may mention, that even all the inks in Rush's house were sent to me,* together with the paper thrown into Stanfield Hall, to examine them. Moreover, I ex-

* At various times I have been required to make almost innumerable examinations of different inks; and, a few years ago, I had the delight of showing, by chemical means, beyond all reasonable doubt, that a gentleman who was suspected of carelessness had been the victim of fraud, and thereby I had the pleasure of saving him from the payment of £1,000, besides the far higher gratification of sustaining his reputation.

amined inks from a large portion of the county of Norfolk, to compare with that with which the document was written. I bestowed great labour upon the examination, and the evidence which I deduced was to the effect that the ink on the document was similar to that found in his inkstand. The character of the ink—which, by the way, was villanously bad—was similar to that of the inks which were in common use all over that district, and, therefore, I recommended the authorities not to place the evidence before the jury. Had Rush used a queer compound which was in one of his inkstands but for the writing of a single word, his guilt would have been unquestionably established. In this case, as in the preceding, the magnitude of the crime caused so thorough an investigation, that his detection and conviction were ensured.

406. If we for one moment compare the Creator with the mechanic, we should say that the latter would evince the greatest skill if he constructed a machine which should act correctly under all possible circumstances; and so experience teaches us that the Creator has evidenced his infinite power by the formation of laws at the beginning of the world, which are competent to influence every human circumstance, be it ever so remarkable or unusual.

407. Medical men frequently witness very painful scenes, arising from the belief that the world is not governed by fixed laws, but by special providences or fatalism. A short time since, I had under my care a child apparently in the last stage of illness, and, when I arrived at the house, I looked to see if the windows were closed before I entered. The child was still alive, but I was shocked to find her abandoned by both the mother and the nurse, who stated that it was useless to attend to it, for, if it were God's will that it should die, it would die. The case was urgent, the time was past for compliments, and, therefore, instead of attempting to

confute this delusion, I put certain views of coroners' inquests and Newgate before their understandings. The nurse was inexorable, but the mother still preserved her natural affection for her offspring, and, after a short parleying, she burst into a flood of tears, and promised to do everything for her relief. I immediately gave the poor child some milk and water to drink. From that moment the child rallied, and now lives to bless her mother's care. After severe accidents it occasionally demands the utmost determination of the medical man to ensure proper attention.

408. The followers of Mahomet and the inhabitants of eastern countries are said to believe in the special interference of Providence in each particular case; hence they value but little human life. If a man is in peril, they do not exert themselves to extricate him, but they argue that, if God wishes it, the man will surely die. No reasonable man can doubt the truth of the proposition in this form, but in their neglect they assume the whole case; and the question we have to consider is, whether the Creator does, by a special act, will the death of a man, or any other event which takes place on the globe, or has the world been constructed in obedience to laws? Natural science, deduced from the observation of facts, appears to indicate that everything in this great globe is governed by fixed and immutable laws, and that nothing happens either by chance, or by the special interposition of Providence, apart from these general laws.

409. Perhaps one of the most remarkable examples of the value of general laws is to be found in life assurances; for what apparently can be more precarious and uncertain than the duration of human life in any individual? and yet, in the aggregate, mortality is so regular that it has been said, by an eminent mathematician, that there is no investment so certain as that of a prudently conducted

Assurance Society. If we take 5,000 persons in the prime of life, 600 die in the first ten years, 700 in the second ten years, 850 in the third. The experience under different circumstances varies but little, as Jenkin Jones, Neison, and Farrance have shown; and it is a curious fact that, as far as my experience is concerned, lives which might be called first-class lives are as prone to disease as those which appear to belong to hardly so high a class. There is an opinion existing amongst some people, that the declined lives of assurance offices are as good as ordinary average risks; but I have no hesitation in stating, from actual knowledge, that, amongst those which are declined, there is a vast mass who are afflicted with fatal disease, and that any office which ventured to accept them without due precaution would infallibly suffer. Nevertheless, each variety of cases has its law, and at the Gresham Life Assurance Society the directors obtain as far as possible the results of the experience of every class of cases, so that they may accept the risk equitably as between the company and the parties seeking the blessings of life assurance. The very able manner in which the registration is now carried on in England will, doubtless, eventually make us as thoroughly acquainted with the laws of mortality as we are with the laws of mechanics. One curious fact has lately been observed. During last summer England was visited with the terrible epidemic of the cholera, and, on one occasion, I myself saw four carried from one family to their last resting-place. Fourteen thousand five hundred and seventy-four perished in London alone; but, immediately after the visitation, the mortality from other causes fell below the average, so that it is presumed that this excessive mortality will be absorbed in the subsequent deficiency.*

* The mortality from cholera alone in Great Britain amounted to 46,285 during the years 1848 and 1849.

410. From the instances which I have already quoted, we find that we have but to interrogate nature, and we can discover principles which we may safely employ; and we find that no restraints have been imposed upon actions, beyond those which are afforded by the capacity of our organs. We must now inquire how man can learn the properties of matter and deduce the laws of nature; and we find that, by the mechanism of the eye, ear, and other organs of sensation, he derives impressions from the external world. By the mechanism of the nerves this impression is carried to the brain, where there is a mechanism by which he registers the action of the senses and remembers it; but, up to this point, he differs not from brutes. He possesses, however, a further power, by which he is enabled to deduce laws.

411. A law, however, is but the expression of universal experience; it is but the idea which man obtains from the experience of accumulated facts, expressed in a few words. In a former part of this work I have called attention to the mode of registration of the printing of each bank-note at each press, and I have mentioned that, when each press acts, a number changes. Now all these facts may be expressed by one idea,—namely, the printing of a bank-note causes a change of the numbers in the registering room. This single idea may be shown by appending a contrivance to the mechanism itself; for, if all the register-plates were arranged to one plate, which changed whenever each individual press changed, the clerk could tell at one moment whether the presses were at work, and, if at work, he would only have to descend to the examination of the register of each particular press to learn the one which was actually at work, and to ascertain the exact amount of work performed.

412. As man further advances, the laws which he deduces

from nature are continually being simplified, and, at the present time, there is an almost universal belief amongst philosophers that all the forces of matter are but modifications of each other. In my 'Sources of Physics' I have put forward an opinion that all forces of matter are the result of attraction, which, acting on attracted matter, at various times gives rise to the phenomena of heat, light, electricity; and, according to circumstances, we know as a fact, that, having a certain amount of force, we can produce therefrom a corresponding amount of any other force.

413. All that which gives to man a superiority over animals, in his capacity to deduce the laws of nature, may be derived from physical structure; and we find that, if the structure of the brain is injured or congenitally defective, this power cannot be exercised. From these facts we infer that man exceeds the brutes in this respect entirely from the Creator having bestowed on him a higher organization. Moreover, we find that, when we compare the works of man with the works of nature, man acts apparently upon the same laws as those by which the Creator has constructed the universe. Nevertheless, although man is apparently equal to the Creator in this respect, yet we are compelled to admit that God made the laws, made man and all other created beings obedient to these laws, and formed the brain of the human being in such a manner that he could understand and act upon the laws.

CHAPTER XI.

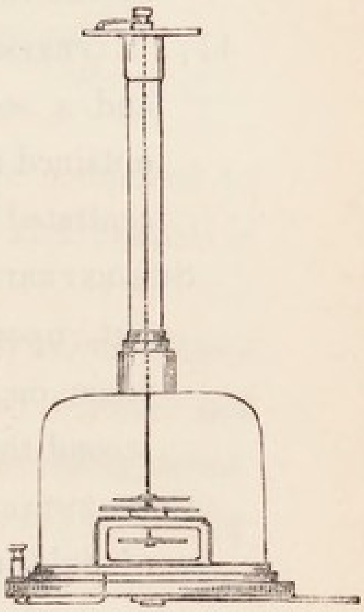
THEORY OF INSTINCT AND REASON.

414. Up to this point, the facts which have come under our notice have not presented any very considerable difficulty; but I must now beg my reader to give his undivided attention to the facts which I am about to adduce, inasmuch as from them my theory of Electro-Biology has been derived. I have full

confidence that when this theory, from the accumulated wisdom of other philosophers, shall be amended, enlarged, and perfected, it will be of great importance to mankind, by tending to reduce mind and mental operations to the certainty of mathematical demonstration.

415. Experiment 1.—I introduced two steel needles into a rabbit;—the first into the masseter, or muscle which enables the creature to masticate; the other into the subcutaneous cellular tissue. After two or three minutes, the creature, which was very tame, attempted to bite my finger: the power of volition acted on the muscle. This influenced the two steel needles, and produced deflection of the galvanometer (*fig.* 42), to which they were attached.

Fig. 42.



Sub-experiment.—I have repeated this experiment on rabbits, cats, eels, and various other animals, with the same results.

Commentary.—This experiment clearly showed that the current was produced between the terminations of the sensor nerves, distributed to the skin, and the motor nerves, distributed to the muscles. Hence it is inferred, that the current forms a circle through the sensor and motor nerves to the brain. It also shows that this current was produced by what is termed volition.

416. Experiment 2.—I introduced two needles under the skin of a rabbit, and afterwards gently irritated the skin,

when the galvanometer was deflected, as in the last experiment.

SUB-EXPERIMENT.—The results of this experiment are also very clearly shown in the eel and some other creatures.

COMMENTARY.—From these facts we learn that the action of the skin which gives rise to sensation is accompanied by the voltaic force.

417. EXPERIMENT 3.—I introduced one needle into the eye, and a second into the muscles of the eyeball, when I obtained a very slight deflection, on throwing a very concentrated light into that organ.

SUB-EXPERIMENT.—I varied the position of the needle, but, upon the whole, I obtained the greatest deflection when one needle was thrust through the choroid, the second through the muscle of the eyeball.

COMMENTARY.—This experiment indicates that the action of light upon the eye determines a voltaic current between the muscle and the choroid.

418. EXPERIMENT 4.—I introduced a needle into a rabbit's nose, and another into the subcutaneous tissues. On stimulating the nose with a strong odour, deflection occurred.

SUB-EXPERIMENT.—I have repeated these experiments in cats and rabbits, but the animals have a great repugnance to it.

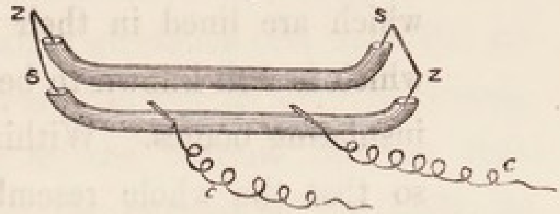
COMMENTARY.—This experiment shows that the mechanism of smelling is voltaic.

419. OBSERVATION 1.—The mechanism of the bodies of men and animals is so arranged that the motor nerves are distributed to the muscles, the sensor nerves to the skin and other organs of sensation, both of which are abundantly vascular (*Plate* 5). The two sets of nerves are continued

up to the brain (*Plate* 9, *fig.* 1), where they terminate in vesicles (*Plate* 9, *fig.* 2), in contact with the highly vascular tissue (*Plate* 6), which my artist has delineated.

Commentary.—According to voltaic laws, it follows, from these observations, that a second battery must there exist, opposed to the one in the body, as in the accompanying illustration (*fig.* 43). Hence we are compelled to admit that the general structure of man and animals is that of a double series of voltaic batteries.

Fig. 43.



420. Experiment 5.—If all the sensor and motor nerves, in their course to the brain, be divided, the power of sensation and motion is instantly annihilated, and life is extinguished. This result occurs when an animal is beheaded, or the top of the spinal chord is divided, as by the process of pithing.

Commentary.—This result is dependent upon the body, which consists of one series of voltaic batteries, being separated from the brain, which is made up of the second series opposed to them.

421. Experiment 6.—If a frog's foot be arranged under the microscope, and an intense electrical current passed through it, the circulation instantly stops, and the lymph corpuscule, which comes, as it were, slowly along the sides of the vessel, is also, in the same manner, stopped in its career.

Sub-experiment.—The same result happens, not only with frogs, but with fish of various kinds, when subjected to the action of the magneto-electric machine, or powerful voltaic batteries.

COMMENTARY.—By these experiments we learn the influence of the voltaic force upon blood corpuscules; and the phenomenon of blushing, or other increased vascularity from nervous excitement, is explained.

422. OBSERVATION 2.—The nervous fibres consist of tubes, which are lined in their interior with fat, a substance which is well known to be one of the most perfect of all insulating bodies. Within the fat is contained a fluid; so that the whole resembles a gutta-percha tube filled with fluid. (*Plate* 9, *fig*. 3.)

423. From the above experiments and observations, we learn that the entire nervous system, to which the whole of the rest of the organization is but an appendage, consists of a series of nerves, or tubes, which are prolonged, in one direction, into the brain; in the other, into the body, where one portion is distributed to the organs of sensation, the second to the muscular substance.

424. OBSERVATION 3.—As we find no provision in the body for insulating the termination of a motor or sensor nerve, it is manifest that every motor nerve is opposed to every sensor nerve, and every sensor nerve is opposed to every motor nerve.

COMMENTARY.—In consequence of this arrangement, when any sensor nerve is stimulated, any motor nerve in the body may be excited to action.

425.—EXPERIMENT 7.—If a voltaic current of a single pair be completed, though two solutions—one containing sulphate of copper, the other sulphate of zinc—and copper electrodes are used, in both instances the current will pass exclusively through the sulphate of copper.

Sub-experiment.—This experiment may be infinitely varied, but the current will always be found to pass by the readiest course, to the exclusion of all other roads.

426. Experiment 8.—When the needles are placed respectively in the muscle and cutaneous textures, the needle thrust through the muscular substance acts upon the galvanometer as though it were the zinc of a voltaic circuit.

Commentary.—Inasmuch as the current through these needles is the reverse of the current of the body, according to the well-known laws of electro-voltaic currents, it follows that the muscle is negative, the skin positive.

427. As far as the organ of thought, or brain, is concerned, we can only deduce the structure according to physical laws; but I have noticed an explanation in which volition or will is but the resultant of an immediate impression, and all other impressions existing in the body.*

428. In the first place, we may assume that nerve for nerve is simply repeated in the brain; but, although this assumption tends to elucidate the structure, on which account I have adopted it in my 'Electro-biology,' yet a careful study of the properties of this repetition, taken in conjunction with the whole theoretical structure, rather seems to indicate that it might possibly be dispensed with. (*Plate* 8, *fig*. 7, 1; *fig*. 6, 1.)

429. It is, in the next place, absolutely necessary to assume that these primitive nervous fibres enter into certain combinations. (*Plate* 8, *fig*. 6, 2; *fig*. 7, 2.)

* In submitting animals to experiment, I have on several occasions noticed deflection of the needle, when thrust into the base of the brain. The animal, however, is instantly killed, and I have therefore not that absolute certainty in the experiment which would allow me to introduce it into the text, though I must say that I have no doubt in the fact.

Observation 4.—In every animal which has a brain a multitude of fibres is found, and, according to the number of ideas which an animal can receive, so is the intricacy of this fibrous arrangement.

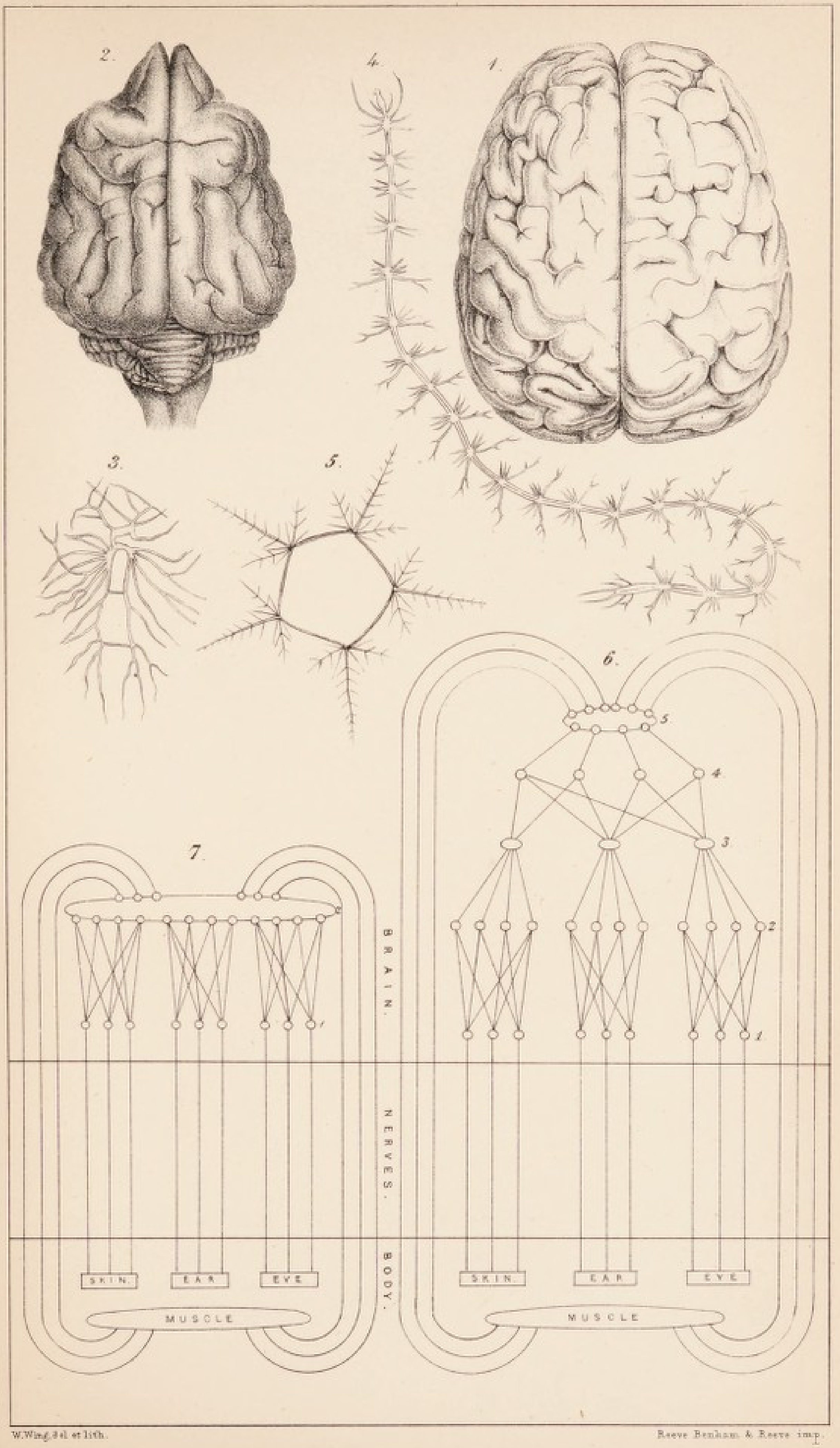
In a former part of this work I have shown that the number of all the possible combinations which could be found of all the nervous fibres is so great that the skull could not possibly contain them all. Hence we may assume that these combinations only take place to a certain extent, which is also proved by facts which I cannot now consider.

430. This battery I call the Combination* Battery, and it is in the highest degree important. In animals there appears to me to be no evidence of a higher structure, and their nervous system may thus be represented by letters.

SENSATION.	BRAIN.				MUSCLE.
a b c	*a b c*	*a b c*	*a b* *a c* *b c* *a b c*	1 2 3	1 2 3

The above mechanism, even without the repetition of the simple nerves in the brain, would be amply sufficient to account for all phenomena exhibited by animals. These creatures, we have found, only receive simple ideas, and, according to whether those simple ideas be painful or pleasurable, so is the cause of the action determined. For instance, volition, or action through the nerves marked 1 2 3, would depend upon the character of the impression implanted in the respective parts of the combination battery *a b*, *a c*, *b c*, *a b c*. (*Plate* 8, *fig*. 7, 2.)

* Syndramic.



W. Wing, del et lith.

Reeve Benham & Reeve imp.

431. For the instinctive operations which animals manifest, we have only further to assume that action is determined in *a b*, *a c*, &c., or *Plate* 8, *fig.* 7, 2, by an influence produced in the process of growth, and in that case it is certain that the idea of a nest may be implanted in the bird, of a comb in the wasp or bee, of a web in the spider, and upon this supposition we have a complete explanation of instinctive operations.

432. With respect, however, to man, we observe that he must have a structure by which he expresses a variety of ideas by one idea, or, in other words, deduces a general law. The simplest mechanism by which this can be effected is, first, by combining all the combinations of each sense into one (*Plate* 8, *fig.* 6, 3), and thus one idea would appear for any action on that sense; secondly, I again assume that these enter into combination like simple impressions (*Plate* 8, *fig.* 6, 4); and, finally, that these are again connected together, from which battery the motor nerves spring. (See *Plate* 8, *fig.* 6, 5.)

433. From these views, man is made up of a great number of voltaic elements, so arranged as to form one whole. Hence, as the whole modifies the action of every single part, it follows that every idea existing in his brain modifies his action in any particular case.

434. From the diagrams which I have given (*Plate* 8, *fig.* 6 *and* 7), it will be seen how an impression is supposed to be received from the external world, carried to the brain, and there registered. It will also be seen how it is supposed that we deduce the properties of matter, and refer its creation to an Infinite Cause. In fact, according to my theory, we can never look at any object, feel any object, or be otherwise affected, without the Infinite Cause which gave rise to it occurring to our mind. In this sense God is always more or less before us.

435. According to the electro-biological doctrine, we deduce certain principles of the human mind, aud they appear to me, at any rate, to have the merit of avoiding many difficulties which occur under other systems, more especially under those which infer an immaterial, undefinable something, which, by some persons, is supposed to join our material frames at some unknown spot, and move the body through them as a child would pull the strings of a puppet. I will not descant upon this view, which is now not held by any natural philosopher of note. In fact, its existence would only show that Providence had formed man to act by a clumsy method; for it is apparent, that if an immaterial something caused the motion of the arm to raise a weight, then it would have been a far simpler contrivance for that immaterial to have acted upon the weight without the intervention of the arm.

436. Principles of the human mind.

I. Our ideas of the external world arise, primarily, from an action upon the ultimate nervous fibres of the organs of sensation, by the specific stimulus competent to excite each organ of sensation respectively.

II. Each primitive nervous fibril is called a unit; the repetition of units, *number*.

III. That which is competent to act upon these nervous fibrils is called *matter*.

IV. Whenever matter undergoes any change which renders it appreciable to our senses, it is said to evince *force*.

V. The definite combination of nervous fibres excited to action, determines the *character of the idea* presented to the mind, such as form, position, magnitude.

VI. Each combination may be expressed by a word or cypher, and forms a definite image.

VII. The sum total of all the possible combinations of the ultimate nervous fibrils, excited to action, comprises all the possible images which can be represented to the mind.

VIII. Inasmuch as the possible combination of all the nervous fibrils is immensely numerous, so are the images which may be reflected in the mind immensely numerous.

IX. An idea is represented to the mind, when any one or more of the filaments of either specific organ of sensation is excited without reference to the definite image thereby produced.

X. This solitary idea, derived from the filaments of the eye, is termed, *vision*; of the ear, *hearing*; of the nose, *smelling*; of the palate, *tasting*; of the skin, *feeling*; and, probably, from the nerves communicating the changes occurring in our own body, *personality*.

XI. The perfect knowledge of any object is obtained by impressions received by the sum of the organs of sensation.

XII. But as matter may exist without exciting all the organs of sensation at one time, we determine the combination of senses which has concurred to give us the knowledge of any external object.

XIII. An idea is represented from the excitement of one or all the nervous fibrils of any organ of sensation indiscriminately. This idea is infinite, inasmuch as it is indivisible, incapable of addition, and represents totality.*

XIV. Our knowledge of the external world at any given period, is the sum total of the images from all our senses.

XV. These images represented to the mind are perpetually changing.

XVI. When images change, one remains; the other changes,

* Infinity is sometimes confounded with its hyperbolical use in the sense of endless number.

perhaps, several times before the first changes. The relation of these changes to each other is termed *the time of their occurrence;* that which changes the least frequently is said to be of *the longest duration.*

XVII. In the change of images, when one specific image never appears without a similar antecedent, and the matter in the external world which gave rise to the first image set in motion the the second, the antecedent image is said *to cause* the second image.

XVIII. The mind finds great difficulty in distinguishing between concomitance and cause, because the matter which produces an antecedent image may not set in motion the matter which produced the second image.

XIX. When images of the external world are produced with a certain intensity, the idea of *pleasure* is excited,—when with a greater intensity, the idea of *pain.**

XX. The transition from pleasure to pain being sudden, not gradual, it follows, that the nature of the action on the brain and, consequently, of the ideas, is different.

XXI. An image once formed in the brain produces an indelible impression, and may at any future time recur. This property is called *memory.*

XXII. When an image is produced by an action upon the external senses, the actions on the organs of sense concur with the actions in the brain; and the image is then a *reality.*

XXIII. When an image occurs to the mind without a corresponding simultaneous action of the body, it is called a *thought.*

XXIV. The power to distinguish between a thought and a reality, is called *consciousness.*

* Every action of our lives is either pleasurable or painful; and thus we perceive how vastly the former state preponderates over the latter.

Plate IX.

W. Wing, del et lith.

Reeve, Benham & Reeve, imp.

XXV. Several ideas must necessarily co-exist, giving rise to compound ideas always existing in the brain: thus, personality and infinity give us the idea of the soul; pleasure and infinity, of good; pain and infinity, of evil; cause and infinity, of God; time and infinity, of eternity; infinity, pleasure, and time, of heaven; infinity, pain, and time, of hell.*

XXVI. These intuitive ideas are not produced by the immediate action of external influences, but have their origin in the construction of the brain, or organ of thought. These intuitive ideas belong to the higher class of mental images; and there is no reason to suppose that more simple ideas are implanted in the human species.

XXVII. In the lower animals, however, it is apparent that either other images exist, which guide the creatures to perform their operations—as the bird to build the nest—the bee, the honey-comb;—or, that the nervous system is so constructed that the creature is led to perform specific acts under some definite excitement.

XXVIII. When images already implanted in the brain, which possess many points in common, continually reappear, the party is said to be reflecting.

XXIX. During reflection, the influences of the external world to produce new images are entirely, or to a great part, neglected.

XXX. By reflection, ideas may be combined so as to form general laws.

XXXI. By reflection, general laws may be applied to specific

* As these instinctive ideas are simply thoughts, and cannot be proved by our external senses, the mind may be led at times to deny the reality of their existence. Revelation, however, declares their truth, and thus compensates for the natural weakness of man.

instances, or images may be analyzed into their component parts.

XXXII. When an idea is represented to the mind, it either accords or discords with other ideas previously received, or with general laws resulting therefrom, or with the moral law. The determination between this concordance or discordance is called *judgment*.

XXXIII. Man has the power of uniting two or more antecedent images, or the parts of two or more antecedent images. By this power a totally new image is formed, and hence it is called *imagination*.

XXXIV. Observation is the basis of fancy; and the novelist is fruitful only in proportion as he stores his mind with natural images.

XXXV. Man acts by electricity, which is set in motion through the muscular structures, whereby contraction ensues, and parts of the body are moved.

XXXVI. Action may be produced by the immediate influence of the external agents upon the body, which give rise to a new image in the brain; and action may also be produced by the recurrence of a former image.

XXXVII. The mind is one and indivisible; and thus the particular muscular movement which the electrical force determines is not only regulated by an immediate image, but by every other image which has at any former time been implanted in the brain.

XXXVIII. Pleasure and pain regulate all actions; hence the particular movement which is determined arises from the pleasurable or painful character of all former images; as animals, as well as human beings, seek those actions which are likely to be pleasurable, and eschew those which are likely to be painful.

XXXIX. But the action determined in any particular instance may be painful, for the sake of obtaining greater pleasure at future periods; and the idea of obtaining infinite pleasure may allow of the most intense immediate pain.

XL. The idea of future pleasure is called hope; of future pain, fear. The government of mankind is conducted by exciting hope and fear.

XLI. When a tendency to act exists, it is called *desire*; and always exists, more or less, when a being is in good health, and in a state free from fatigue.

XLII. All actions in the higher generalizations would give the the idea either of infinite pleasure or of infinite pain. Actions which concur with those which lead to infinite pleasure are called virtuous, and those which lead to infinite pain are called vicious.

XLIII. The moral law, being infinite, is competent to control all actions. It is therefore important that it should be frequently and strongly impressed upon the human mind.

XLIV. The resultant of the force of an immediate stimulus, and of all former ideas implanted in the brain, is termed *volition*.

XLV. A man is born a free agent; but after images are once implanted, he is compelled to act from the ideas existing in his brain. Hence, could we but tell the exact ideas which any human being possessed, it would be practicable to foretell his line of action under any defined circumstance.

XLVI. The term *life* is assigned to the idea which the mind forms of the capacity of an organized being to perform its functions.

XLVII. The term *death* is assigned to the idea which the mind receives of an organized being incompetent to perform the vital actions.

XLVIII. The term *mind* is assigned to the general idea of any action of the brain, which is a part of the organization of man. An idea is the term assigned to any specific action in the brain.

XLIX. Organization is the term assigned to the construction of a being to adapt it to perform certain functions.

L. The mind has constantly represented to it the idea of a personality which will exist infinitely.

LI. Whilst, however, the idea exists, we have no power to learn the properties of infinity; and hence we cannot define the nature of the state in which we shall live hereafter.

LII. Whenever an idea appears in the brain, which is neither intuitive, nor is due to external causes, nor is deduced by the ordinary operation of the brain, it is said to be an *insane idea.*

LIII. When this idea is continuously the same, the party is said to have a *monomania.*

LIV. When various images appear and vanish indiscriminately, the state is called *incoherence;* and when this state is combined with more or less unconsciousness, it is termed *delirium.*

LV. The danger of insane ideas depends upon the *distinctness* with which these ideas are impressed upon the brain; for they will determine the party to act in proportion to the power with which it is impressed.

LVI. To the violent actions arising from strongly implanted diseased ideas, the term MANIA is given; and the violence of the mania is proportionate to the power of the delusion. To the individual it is an exaltation of pleasure.

LVII. When, from the delusion, the patient is in continual fear, he is said to be *melancholy*; and it is probably, to the individual, an exaltation of pain.

LVIII. When a fixed insane idea exists in the mind, the party cannot be said to be partially deluded; for, inasmuch as the mind is one and indivisible, it will control all actions.*

LIX. A strong moral impression may counteract an insane image, as a party may be kept from doing wrong, by feeling assured that it will lead to present or future inconvenience to himself.

LX. When the structure of the brain is congenitally defective, so that it cannot perform all its normal actions, the party is said to be an idiot.

LXI. Sometimes the power of memory is intermittent, or is totally lost, as after the frequent recurrence of epileptic fits.

LXII. Any interval of unconsciousness, except sleep, is called a fit.

LXIII. When, from loss of memory, or want of power in the brain, the functions of reflection or judgment are not perfectly performed, the individual is said to be *fatuous*.

LXIV. Sometimes the power of receiving impressions from the external world is diminished or lost, as in blindness, deafness, &c.

LXV. When parts of the body do not move by volition, they are said to be paralyzed.

LXVI. In old age, the brain loses its power to receive new images, to restore by-gone impressions, to connect different images, or to apply general laws to specific instances. That

* As a matter of jurisprudence, it has been held by the Lord Chancellors, in the House of Lords, that the mind cannot be said to be partially deluded, inasmuch as it is one and indivisible.

which ennobles the man has passed away: the outward form remains, but the inward structure has lost its power to act. Childhood again ensues—not to acquire new ideas, but to forget those before implanted. All that is beautiful or desirable in this world has passed away;—the brain has lost its power—the mind ceases—the very existence of the man is unknown to himself, till death gives rise to a new life, and discloses that new and glorious state in which our organization teaches us that man will be immaterial and immortal.

LXVII. As individuals differ in their organization, it follows that they differ in their capacity to perform various acts; and we may presume that the mind, being one of the functions of the body, is of varying power in different individuals.

LXVIII. The observations which apply to different individuals, apply with greater force to different races.

437. Such is a brief outline of the theory of instinct and reason which I developed in my treatise on 'Electro-biology.' Upon this theory, man only differs from the dog inasmuch as he has a higher organization—a more elaborate structure; but, whilst man lives on this earth, there is no reason to suppose that any other faculty than this elaborate structure comes into operation. I have already called attention to the fact of the daisy, in common with the rest of the vegetable kingdom, being totally devoid of all nervous mechanism; and, further, the stone does not manifest the vital actions. Upon this view, there is nothing to prevent man from forming an elaborate engine, which should work by change of matter, and the operations of which should be regulated by external circumstances. But, although there is nothing to prevent man from making such a machine, yet its difficulty and its delicacy of operation would be so great, that

he at once perceives that it is too much for his head accurately to design, or his body effectually to carry out. He must remain satisfied to glory in the observation of these structures, formed by the Creator of the universe, and he must, with the Psalmist, exclaim, " Such knowledge is too wonderful and excellent for me; I cannot attain unto it."

CHAPTER XI.

ON REASON AND FAITH.

438. MAN recognizes two distinct roads or paths of knowledge: one by which he obtains knowledge from his organs of sense, the other by which he obtains knowledge from religion. The first we have already fully considered under the term *reason,* and the relation which exists between reason and faith must now occupy our attention. These two roads to knowledge affect the mind in a totally opposite manner, as religion enforces general laws to be applied to each specific instance, and reason makes us acquainted with specific instances from which we deduce general laws. These two courses, although opposite, cannot be contradictory, and, in the progress of human knowledge, though, like two roads to the same spot, they may appear for a time to lead to a different end;

yet, the believer in true religion need never fear that reason can shake his faith, nor need the disciple of true science ever fear that religion can interfere with the exercise of the faculties of the mind which it has pleased Providence to afford to man.

439. We have found that man has continually before him the idea of an Infinite Cause, by whom everything in the universe has been made, and by whom the laws of their succession have been determined. Now, religion teaches that, above all doctrines, it is necessary to hold the existence of a Deity, and thus we find that reason and faith, in this instance, perfectly accord, and, from the one supporting the other, the action upon the mind is redoubled.

440. In considering intuitive ideas, we have found that man invariably holds right and wrong, and that the performance of what is right will lead to infinite eternal pleasure, and that the performance of what is wrong will subject man to infinite eternal pain. These things also are prominently taught by religion; thus, again, we find a thorough accordance between reason and faith.

441. But, although the mind is cognizant of right and wrong, it has no means to distinguish by itself those actions which are right from those which are wrong, and, therefore, we at once recognize the blessing to mankind of any infallible guide to regulate each specific act. Such an infallible guide religion supplies, and, therefore, whilst reason declares the want, faith indicates that a corrective for this want has been supplied to man.

442. For religion to be thoroughly operative, however, it should have the stamp of the Divine power; and hence it is invariably assumed that religion has been given to man by inspiration, or that it consists of the laws willed by the Almighty.

443. We find, however, that religion is not single, it is manifold; and that, amongst different religions, an act which is meri-

torious under one system is in the highest degree culpable under another. Under Paganism, man worshipped many gods; under Judaism, one God. The Christian holds that a man may have but one wife; the Mahometan teaches not only that he may have many, but, that, in a future state, he will also be furnished with a similar or still further supply.

444. As each individual man has not been directly inspired with a knowledge of that which is the true religion, it follows that, by his reason, he must decide whether any one of them be entitled to his confidence, and he must also thereby select that form of religion to which he feels compelled to yield his faith.

445. In this selection reason teaches that man must discard any religion which considers the Deity to have any material property; and thus he must at once renounce all those spurious inventions and impositions by which it is assumed that gods can be made or depicted by human hands, or by which any portion of the creation is substituted for the Creator himself.

446. Upon this principle we isolate all forms of pagan worship, and all other religions where the sun, moon, or any other material form has been made to take the place of the true God, as totally unworthy of our consideration and respect.

447. Reason further teaches us that we must, in all respects, give to matter material properties, and give to spirit spiritual qualities.

448. This principle isolates at once Mahometanism, which, amongst other things, assigns to heaven the most carnal and material qualities.

449. We have now but two religions left which can command our attention, namely, Judaism and Christianity, and our choice between the two must still be determined by reason.

450. In this case a selection is more difficult, because both religions hold the same true God, the Creator of all things. There is, however, a most remarkable addition in Christianity, namely, to "love thy neighbour as thyself," and "bless those which persecute you:" these doctrines alone, as a matter of reason, must at once determine our selection.

451. It is true that amongst those professing to be Christians there is to be found almost every shade of religious opinion, from the Pope, with his bigotry, idolatry, and intolerance, to those Christians who, with equal bigotry and intolerance, denounce the Pope in Exeter Hall, and want but the power to act like him against all those who hold not their own dogmas; and further on, to that depraved sect in the west of England, who pretend to hold that a life of continual debauchery, immorality, and vice, is in accordance with the principles of the Christian dispensation.

452. Having, therefore, from reason, consented to pledge our faith to Christianity, it behoves us now to compare how far the deductions of electro-biology comport with the Gospel, and thus ascertain whether reason and faith, at the present time, accord or discord.

453. Concerning the Deity, we read that God is a Spirit, and that those who worship him must worship him in spirit and in truth. How beautifully do reason and faith here accord; for this sentiment, so vitally inherent in the teaching of our Lord, is in perfect accordance with the deductions of electro-biology.*

454. Electro-biology clearly indicates that we must not, in any degree, confound our earthly natural body with that heavenly

* For the attributes of the Deity deduced from science, see 'Sources of Physics,' p. 273, in which I show the important results which follow from totally withdrawing all material qualities from God.

body which we shall hereafter assume; in fact, that we must consider the body which lives upon earth apart from the spirit which will dwell in heaven. Upon this point we read that "there is a natural body and there is a spiritual body," and that "flesh and blood cannot inherit the kingdom of God." "We shall not all sleep, but we shall all be changed, in a moment, in the twinkling of an eye, and the dead shall be raised incorruptible, and we shall be changed."

455. Reason teaches us that every idea impressed upon the brain controls future actions. Here, again, faith enforces upon us that "the thoughts of the righteous are right." Reason teaches us that every idea connected with the Deity controls, according to the force of its impression, every act of our lives; and faith declares the extreme value of prayer. We are told that we must pray fervently, sincerely, constantly, and believing.

456. According to reason, every time a man prays in sincerity and truth, the idea is fixed in his mind; consequently, he does all in his power to carry out the object of his prayer; and, if his prayer has been conformable with the laws of God, he generally obtains the result of his petition. Here faith and reason again accord, as both show the power of prayer over the actions of man.

457. A remarkable practical influence of prayer was observed last summer, during the prevalence of cholera in the infected districts, as neither writing, nor talking, nor preaching could cause the inhabitants to rouse themselves and prepare to endeavour to ward off death from their habitations. At length, however, when death had extensively accomplished his work, men were afraid, and in some parishes they even sacrificed a week-day's profit to pray that the malady might be stayed. With their prayers

and supplications they added all their endeavours to stop the pestilence; they subscribed for the poor; they provided attendance, remedies, and visitations; and immediately the effect was felt, and the disease was lessened. The people saw the necessity of acting vigorously and decidedly according to the laws of the attack of the malady, which were, in fact, the laws of God; thus their prayers were instantaneously followed by more or less beneficial results.

458. I have much cause to rejoice that the system of electro-biology, which I have developed, after many tedious hours of investigation with the midnight oil, and after many years of anxious thought, should now be found to be a system deduced by reason and in perfect accordance with that religion which I hold by faith. I have, indeed, even more cause to rejoice that reason and faith mutually re-act, each supporting the other, and causing it to be more firmly fixed in the mind. I have, however, most cause to rejoice, because this union of faith and reason cannot fail, when universally known, to have the best influence in supporting pure religion, in suppressing infidelity, bigotry, and irreligion, and in extending the inestimable blessings of true Christianity throughout the different countries of the globe.

CHAPTER XII.

PERVERTED REASON.

459. When we observe the elaborate mechanism of our organs of sensation, from which we derive a knowledge of events occurring

in the external world,—when we further observe the elaboráte mechanism by which these results are registered and principles deduced therefrom, we might almost suppose that so perfect a machine would always act correctly, and never exhibit any error or delusion. Upon examination, however, we find that, from various causes, man continually shows his fallibility, which strongly contrasts with the infallibility of the Deity.

460. It is useful and instructive to consider the chief sources from which errors and delusions arise, that we may know ourselves; I therefore propose to describe a few of the more important causes from which errors and delusions spring.

461. In the first place, man is continually liable to be deceived with regard to the impressions which he receives from his organs of sensation. Thus, he might look at a glass of water, and say that the water was pure, yet it might contain innumerable animalcules or living beings. In this case the error would arise directly from the organs of vision being solely competent to view bodies which exceed a certain size.

462. Again, he might view objects under particular lights, and thus obtain a wrong notion of their colour. It is a truly amusing experiment to light up a lecture-room with the pure yellow flame obtained by mixing salt with spirits of wine. All the reds and blues are rendered totally invisible, and thus the audience, when they view the lecturer's face, and witness his ghastly appearance, are prone to be much amused, and laugh heartily. I remember, on one occasion, that, when showing the experiment, I suddenly exclaimed, "Do not look at me, look at yourselves;" and, when the audience turned round and saw the rosy tint of youth to be superseded by a ghastly yellow, they roared with laughter at the strange spectacle. Under peculiar lights, therefore, an

erroneous conclusion as to the ordinary colour of any body would be arrived at.

463. To those of my readers who desire to inspect objects under coloured lights, I have great pleasure in giving some receipts. The red fire may be made by mixing forty parts of nitrate of strontia, thirteen of sulphur, five of chlorate of potash, three of charcoal: these, on burning, will produce a beautiful red flame. For the green flame, seventy parts of nitrate of baryta, thirteen of sulphur, five of chlorate of potash, three of charcoal. For the orange flame, five parts of nitrate of soda, one of charcoal, one of sulphur. White India fire, twenty-four of nitre, seven of sulphur, two of realgar. The purple, two parts of chlorate of potash, one of black oxide of copper, one of sulphur. Advantage is taken of the properties of coloured lights to make goods, the value of which depends upon their whiteness, appear whiter than they really are. Hence, lace is always wrapped up with blue paper, and wound round a blue card; and, if I mistake not, I have seen even the windows tinted in some warehouses to take in the unfortunate customer, and make him believe that he is buying a better article than is really offered to him.

464. Perhaps we should consider cases of inability to distinguish colour as a disease rather than an error. We find continually those who mistake scarlet for green, and persons have been known to paint a green tree with scarlet paint, and even to mend a green coat with scarlet cloth. In my little treatise on vision I have recorded the more remarkable case of a person who saw all colours as different shades of black; in fact, a painting appeared to him like an engraving.

465. In the fogs of London the apparent distance of bodies is surprisingly increased, so much so that the space occupied by two

or three lamps appears of immense length, and, conversely, in the clear air of Switzerland, an interval which appears but a few stone's-throws is in reality a gap of several miles.

466. Even with regard to the motion of bodies, how constantly may we be mistaken! It is almost impossible to tell whether a ship is sailing from you or towards you when it is performing either of these motions at a considerable distance. But, with regard to the sun, how easily may we be deceived! We see it rise majestically from the sea, and descend as it were again into the ocean's bed; yet the sun moves not at all, it only apparently moves, from the motion of the earth. It was only last summer I heard a number of persons debating the point, and I was much amused by hearing a countryman declare that they were not going to persuade him indeed of any such nonsense. In this case our senses easily deceive us, and it is only by a process of reason that we come to a different conclusion. A liability to error as to whether a body is at rest or in motion, or whether it is going backward or forward, may frequently be noticed on the river, when three or four steamers are parallel to each other, or on the railroad, when three or four trains are in the same relative position. When a person is in the centre, and other objects on each side of him are moving, it is in some cases absolutely impossible to tell whether the train or steam-vessel moves, or a second is in motion, and in what direction the motion is. A savage, the first time he rode in a carriage, thought that the houses flew past him.

467. As a certain time is occupied by the action of the light on the eye, which has been ascertained to be one-seventh of a second, it follows that, if any visible body is represented more frequently than that, it appears as one whole. In this way a man may be readily deceived. If we take a piece of string in a state of incan-

descence at one extremity, and then whirl it round with rapidity, it appears to be, and is, to all intents and purposes, as far as our vision is concerned, a perfect circle of flame, whereas, in reality, it is nothing but a piece of string in circular motion. As an illustration of this, a very pretty contrivance has been designed, in which, when we place a variety of drawings on a piece of circular card, and then revolve them, they will appear to have a certain motion. Hence boys are represented apparently jumping over each other's backs in such a manner that it is impossible to divest the mind of the idea that such is really the fact, whereas in reality we are only looking at a series of drawings which are represented to the eye successively one after the other.

468. There are many curious optical effects which are liable to great error. At times, ships at sea are apparently raised, so that they become visible when the rotundity of the earth would otherwise render it impossible for them to be seen. At times, ships are seen inverted in the sky, from reflection; and I once saw a daguerreotype of a house, which, from some peculiar cause, was not only represented in the normal manner, but was also represented in an inverted position.

469. A simple looking-glass might lead to erroneous notions in persons unacquainted with the property of reflection; but I have been astonished to observe how soon dogs and other animals become acquainted with the deception. By colouring the glass, it might be made to give to the countenance of the observer either a ghastly or a rosy tint; and thus different looking-glasses show the countenance in a more or less flattering manner.

470. But if we substitute for a plane looking-glass a glass with a curved surface, then, in one position, the face will appear to be changed to an almost incredible length, or extended to an almost

incredible breadth. By other curves, distortions of various other kinds may be produced; and thus, if any person relies upon such observations, he will be led into considerable error.

471. In viewing objects through the microscope, a variety of delusions may arise; and hence it is usual to test microscopes with certain objects, to ascertain whether they define correctly. Perhaps one of the most curious errors may arise from the appearance which a globule of air or any other body presents. Last summer, those unacquainted with microscopical investigation frequently mistook globules of fat for cholera corpuscules. By mere accident, I used last autumn to ride backwards and forwards in a railway carriage, which had a globule in one of the windows, and frequently amused my professional brethren by showing them a veritable cholera corpuscule in a pane of glass. I need hardly remind my readers of the philosopher who observed everything in nature to consist of fibres crossing each other; but the appearance was afterward discovered to arise from his habit of wiping his glasses with a material which scratched the glass.

472. I need, perhaps, hardly allude to the conjuring tricks which depend upon the deception of vision. For instance, the conjuror frequently pretends to semi-amputate his arm, whereas, in reality, he uses but a knife having a gap in the centre, which fits to the arm. It is very desirable that these conjuring tricks should be shown to children, that they may know that their very senses may be deceived; and thus we cannot applaud those excessively self-righteous individuals, who, to use their own cant phrase, see enough of deception in the world, without going purposely to see more.

473. The very beautiful scenic effects which are produced at the theatre are cases of illusion to the senses; and the

cloister scene in 'Roberto il Diavolo' is a noble specimen of theatrical representation. I had a great desire to see the machinery by which all these pictorial effects were produced; and, accordingly, I found an opportunity of gaining admission, to witness the proceedings behind the curtain. At first I thought that it was hardly consistent with dignity to visit such a spot; but I reconciled myself by the thought that I should be sure to see nobody whom I knew. However, to my astonishment and amusement, I found several persons, who, at one time or another, had come before me in my official capacities, and who were engaged in various departments of the opera. I was mightily delighted to observe the difference between the actors preparing for their parts, and the same individuals when actually performing; and so, afterwards, to observe Grisi, Tamburini, and others, after acting in the most impassioned scenes, walk quietly away, arm in arm. So with the ballet: the glorious disorder of some elaborate scene, previous to the time of raising the curtain, stands out in amusing contrast with the studied attitudes which the dancers exhibit to the public. To produce the wondrous effects, scenes are arranged, in the most elaborate manner, one before the other, and illuminated by contrivances so varied and complicated, and yet withal so continually changed, that it is really marvellous that accidents by fire do not more frequently occur.* The floor of the whole stage is literally riddled with holes, so that persons can be raised or depressed, whereby various curious spectacles are produced. Aloft, is contained a complexity of machinery, for similar purposes; so that, when we pay to hear the glorious music of Mozart, rendered in all its efficiency by the

* I observed this evening that the dress of one of the spirits in 'Der Freischütz' actually did take fire.

opera band, we have, at the same time, the eye gratified by scenic representations, so faithfully pourtrayed that we might almost forget that all is but a passing evanescent shadow, which lasts but an hour and fades away. The bard of bards has, in one of those stupendous bursts of genius which seem too great for humanity, compared the life of man to such a scene:—

> "All the world's a stage,
> And all the men and women merely players.
> They have their exits and their entrances,
> And one man, in his time, plays many parts,
> His acts being seven ages."

I have already shown that we should be careful how far we trust our sight; and therefore, when the bullying counsel calls out, with stentorian voice, to the discursive witness, "Confine yourself to what you have seen," he might add, "not only to what you have seen, but to what, from judgment and reflection, you have good reason to believe that you have accurately seen."

474. Not only with regard to vision, but also with regard to hearing, man may be deceived. There may be the greatest noise audible to one person, which is quite inaudible to another, from not being within the range of his hearing; for if the pitch be either too high or too low, it will not be distinguishable at all to him.

475. Of all the phenomena connected with hearing, doubtless that of ventriloquism is the most remarkable. This faculty consists of making noises, as they appear to the ear when they emanate from certain spots. It requires a most correct ear, and the nicest adaptation of the voice, to carry out successfully; but when the art is attained, the deceptions which may be produced are very remarkable.

I know a gentleman in the Church, who has considerable talent in this matter. He will catch the notes of the different lambs, and throw a flock of sheep into the utmost commotion. Before he entered upon his duties as a clergyman, he used to dress himself up, and call at his friends' houses, and, by personating different characters, used much to perplex them. He can imitate, to the greatest nicety, the exact tone of voice of all his friends; and, by the exercise of this art, has caused much astonishment and amusement among his acquaintances.

These amateur attempts are, from want of practice, not so extensive as those of persons who make the art a study, for the purpose of amusing the public, and gaining thereby a livelihood for themselves. Whilst upon this subject I thought that I could not do better than to pay a visit to Mr. Love, the ventriloquist, or polyphonist, as he terms himself; and I must say that I was mightily pleased with the entertainment which he provided for our amusement.

476. The whole secret of ventriloquism appears to me nothing more than an exact imitation of sounds, as they are heard when issuing from various situations. For its successful practice it requires not only the nicest perception of the peculiarity of the sound, but the most extensive power over the organs of voice, to produce the exact sound which is represented to our ear under different circumstances. This evening Mr. Love personated various characters, and kept up, for some considerable time, conversation in various voices. His personification of a mischief-making old maid was particularly happy. He further imitated the voice, as if it issued from a box, with wondrous effect. At a later part of the evening he produced exactly the sounds of the dog, the noises of the pig under various circum-

stances, and, to the very life, the peculiar sounds of poultry, when cooped up together, and then disturbed; and, finally, he held a conversation with six or seven imaginary persons, giving to each a peculiar voice, and sustaining that peculiarity for a considerable time. Perhaps his exact imitation of a person in bed on a floor above was the most astounding feat of the kind. I had almost forgotten to mention the hum of a bee, which he pretended to chase from place to place, imitating the various sounds which this insect produces under similar circumstances, till he pretended to put it into a bottle, when the triumph of his art was shown by causing the hum to emanate therefrom.

477. These imitations are of such surpassing excellence, that any person might be readily deceived. It is stated that Mr. Love has repeatedly stationed himself at the door of an inn, before the coach was expected, and, by imitating a blast of the guard's horn, caused a rush of the landlady, waiters, and chambermaids, from all parts of the house, to receive their expected guests; but before they arrived, he scampered away as fast as his legs could carry him. Another time, when on a stage-coach, a voice from the inside apparently exclaimed, "Stop the coach! stop the coach! I am taken very unwell." When the coach stopped, the astonished passenger declared the coachman was quite stupid. Presently, however, when the coach had moved again, the voice cried out, "Coachman, stop! I am dying." When he got down, he found his passenger sound asleep; and thinking that the man was making a fool of him, the coachman gave him a violent slap on the shoulder, when the old gentleman declared that all outside the coach were drunk: but they were fully impressed that he was *non compos*.

478. At the present time, ventriloquism is but employed for

innocent mirth and harmless recreation, even such as the most proud and imperious quaker need not object to. But at former periods of the world, there is a strong opinion prevalent, that it was employed to delude mankind. We read of divination by a familiar spirit as being well known to nations of antiquity; and if we realize to our minds the many ways in which serious deceptions might be practised through its agency, we ought to acknowledge that the amusement provided by ventriloquists, when divested of all mystery or falsehood, has a far higher effect than the merriment which their stories cause amongst their audience, as they prevent us, in these days, from being made the victims of deception by ventriloquism in the more serious affairs of life, as there is too much reason to suppose our forefathers were.

479. Man does not pay much attention to his nose, as an organ by which he derives knowledge, and therefore he does not know so much about deceptions arising therefrom. A man, however, with a cold cannot smell at all; and we can hardly doubt but that the olfactory nerves of a certain learned sanitary professor were much deceived when he swore, in a court of law, that he could detect no odour in a scavenger's dust-heap, and that, as far as that went, he would have no objection to have it under his windows in a fashionable West-end square.

480. Even with regard to taste, erroneous notions may be formed. It would be very difficult, if not almost impossible, to discover which were two identical samples of the same wine, if they were mixed amongst a great many others.

481. Upon the whole, perhaps, man does not fall into many errors with respect to ideas which he derives from his sense of touch. Nevertheless, even here he may be deceived. If he touches two bodies of different conducting power, of the same

temperature, such as iron and flannel, one will appear cold, the other warm. In this case, the cold arises from the good conductor having the power of abstracting the heat from the body more quickly than the bad conductor. But this error can only arise when the bodies are of a temperature below that of the body. If the bodies touched were of a higher temperature than that of the body, an error of an opposite character might arise, as the iron would then feel hotter than the flannel. It is upon a similar principle to that which deceives the sense, that we are in the habit of wrapping round boilers a woolly material, to keep in the heat. By the same treatment, I have carried ice with impunity in the hottest day of August.

482. An error may arise from the supposition that two objects are felt, when one alone touches the body; more especially if the foreign body touches the backs of two fingers; it is then impossible, in some cases, to tell whether the hand be touched by one or two objects.

483. We thus find that man may derive erroneous ideas from all his organs of sensation; and hence, in making any assertion based upon immediate observation, he should only make it with deference, and not then, till he has carefully considered whether, by any possibility, he may have made an erroneous observation.

484. In a former part of this work I have shown that, to a definite image of the brain we assign a particular mark, symbol, or sound, which we call a letter, or word. Now, a frequent source of error arises from the misapprehension of the use of words, or from words being used in a non-natural sense.

485. One of the more extraordinary instances of this character is to be found in the peculiar interpretation put by those in authority on a certain clause of the Wills Act. It is there

declared that the signature of the party shall be "at the foot or end thereof;" which any reasonable person would suppose to mean literally at the end, as opposed to the beginning, the middle, or any other part of the document, which was, previous to that act, fully legal.

486. Now, wills are documents to act after the testator's death, and therefore he naturally does not wish the result to be known before; and, as a matter of precaution, numbers of persons have made wills upon three sides of a sheet of paper, and signed on the fourth, so that those who attested the document could not possibly know its contents.

487. I happen to be acquainted with the facts of the will of Miss Bateman, of Newington, which has now become a legal precedent. This lady made a will, filled up three sides of the paper, and signed on the fourth, dividing her property amongst her relatives and friends. When the executor applied for the probate, he was told that the will was not good, for the signature was not at the end. He appealed to the Court, and from the Court to the Privy Council; but still, by some reasoning only clear to a legal cranium, they declared it was not at the foot or end, though, of course, they did not venture to state that it was in any other position.

488. I have often heard the old lady, with great glee, tell to children the story of the spectacles, and the legal discussion as to whether they were made for the eyes or the nose; but little did she think that her own will would be the subject of a more ludicrous quibble, and be the great will case, from the precedent of which even the will of the Vice-Chancellor's son has since been refused a probate.

489. Now, if we regard the effect of this special interpretation of the words "foot or end," we shall realize to our minds the

importance of the errors which may arise from the misapprehension or misinterpretation of the exact idea to be assigned to a word. A blind lady, who had been assisted by Miss Bateman's family, who had virtually adopted her, lost thereby £1,000, which would have secured to her a maintenance for life. An orphan lost his mite, which might have set him up in business. The very servants, who had had legacies left to them, have been deprived of their justly merited reward. The distant relatives lost their portion, which they were reasonably entitled to expect; a former companion did not obtain her promised bequest; the friends have been deprived of the legacies assigned to them; the acquaintances, of the memento of little articles of jewellery, which were actually sealed up and addressed to each respectively. Everything went to the next of kin, who, under the will, had a handsome portion left to him.

490. The overthrow of a will, as a general rule, is not thought to be of much importance, as there are few who would not consider it to be a sacred duty to carry out the wishes of a testator; yet occasionally it gives rise to very serious consequences. By this peculiar interpretation of words, it is impossible to tell how many wills are now made which will be useless. The whole case is a severe satire on the human understanding, and inculcates the important doctrine of the inadvisability of law-makers being law-administrators; as it would not be difficult for a designing person to obtain a clause in an Act of Parliament with certain words unobjectionable in their natural sense, but which, nevertheless, would be very improper in some non-natural sense, which he might subsequently impose upon them.

491. Errors may arise in the faculty of memory in many ways. In the first place, part of an event is constantly repre-

sented to the mind, whilst other portions are lost, or do not appear at the same time. It is true that everything which we have seen or heard, or in any other way apprehended, has produced an effect upon the brain, and might therefore be recollected; yet we constantly observe that affairs of but slight importance are totally forgotten, or, in other words, do not reappear. This partial memory is a constant source of error.

492. At times, objects appear very vividly to the mind, under some circumstances, when they are known to have no real existence; but yet they appear almost to possess material qualities. In this way we can account for apparitions, and for the seemingly visible return of dead persons. I know an elderly gentleman, nearly eighty years of age, of great vigour of mind, who states that, up to the present time, his father, of whom he was very fond, seems to appear to him. Poets are evidently well acquainted with this phenomenon, for how admirable is the appearance of the mother and the bride in the opera of 'Der Freischütz,' as Giulio crosses the bridge in the Wolf's Glen! At various times I have met many persons, of strong mind and vigorous intellect, who have spoken of the apparent communion with the dead, and have occasionally discoursed with persons who actually believed in its occurrence.

493. These events are but thoughts, and not realities. To the latest day of our lives, our parents, and those who are dear to us, will appear before us, and, if they have taught us right, will seem almost to direct our course. The blessings which we have derived from our parents we should transmit to our children, that, when we are removed from this transitory sphere, our image may live in their minds, and our good precepts may act as guardians throughout their lives.

494. In our sleep, indeed, these thoughts appear, without the full activity of the mind to give to each its proper weight. Until we wake, the dream appears so real, that, if unpleasant, it stands in all its naked horror; and if it be pleasant, we have a paradise, unalloyed with any unfavourable circumstance attending on humanity,—in fact, a sort of prescience of that state in which we shall exist, unfettered by a material body.

495. When we remember objects or events, two or more objects or events are represented to the mind at the same time, and the faculty of imagination arises. By constantly dwelling upon our thoughts, great errors may be the consequence, as sometimes a person really fancies that which he imagines he sees. We read that during the dancing mania which extended throughout the whole of Germany in 1374, the sufferers "neither saw nor heard, being insensible to external impressions through the senses, but were haunted by visions, their fancies conjuring up spirits, whose names they shrieked out; and some of them afterwards asserted that they felt as if they had been immersed in a stream of blood, which obliged them to leap so high; others, during the paroxysm, saw the heavens open and the Saviour enthroned with the Virgin Mary, according as the religious notions of the age were strangely and variously reflected in their imaginations."

496. In the middle ages abundant examples of a similar character are to be found, such as we read of as occurring to those who imagined themselves to be metamorphosed into wolves —an extraordinary species of insanity, which, having existed in Greece before our era, spread, in process of time, over Europe. Again, we read of the singular effects which imagination led persons to exhibit, when they supposed that they had been

bitten by the tarantula. "Those who were bitten generally fell into a state of melancholy, and appeared to be stupified, and scarcely in possession of their senses. This condition was in many cases united with so great a sensibility to music, that at the very first tones of their favourite melodies, they sprang up, shouting for joy, and danced on without intermission until they sank to the ground, exhausted and almost lifeless."

497. Great enthusiasm will stimulate imagination; and thus, at a Methodist chapel at Redruth, a man cried out, with a loud voice, "What shall I do to be saved?" This enthusiasm spread, and the clergy were weak enough to stimulate this excessive excitement by declaring that if death should surprise them in the midst of their sins, the eternal torments of hell would be their portion. This so acted upon the over-excited congregation, that they repeated these words; after which, the preacher represented to them the joys of heaven, the power of the Saviour, as well as the grace of God: whereupon the audience triumphantly shouted out that their bonds were loosed, their sins were forgiven, and that they were translated to the wonderful freedom of the children of God. They were so abstracted from every earthly thought, that they stayed two and sometimes three days and nights together in the chapels, taking neither repose nor nourishment; and it is said that at least 4,000 persons were afflicted with this malady.

498. A clergyman of Shetland managed his congregation in a far more sensible manner, when he found that some of them had a trick, nearly every Sunday, of uttering the most dismal cries. He, however, assured his audience that the physician was better than the divine for such cases, and that, on the recurrence of the malady, he had provided attendants immediately to immerse

the patient in a lake hard by; but it is recorded that he never had occasion to make a single Naiad.

499. Hecker, from whose valuable book these instances have been quoted, has very properly observed, that an overstrained bigotry is, in itself, and considered in a medical point of view, a destructive irritation of the senses, which draws men away from the efficiency of mental freedom, and peculiarly favours the most injurious emotions. We must assume, either that the Papists have been the victims of these mental stimulants, or that they have told deliberate falsehoods, when they narrate the marvellous story of the holy coat of Trèves, or other improbable occurrences. Like the Papists, the Methodists have distinguished themselves for fanatical writings; though we must do them the justice of stating that sects of this description have occasionally exhibited the phenomenon amongst all nations, and under all forms of religion.

500. The Jumpers, by the use of certain unmeaning words, work themselves into a state of religious frenzy, in which they seem to have hardly any control over their senses; and in America, at the camp-meetings, this lamentable disorder of their minds and nerves attains a still greater height.

501. A great stimulus always acts upon some persons more or less as a charm, but under its excitement the faculty of judgment is much interfered with. We find that under such circumstances large communities, or even whole nations, have their cool, unbiassed judgment deranged. I need hardly remind my readers of the Puseyite epidemic, under which so many gave up their faith and all their property to the insatiable jaws of the Roman Catholic church. I need hardly remind my readers of the revolutionary epidemic of 1847, which spread from country to country, so that

even the sober-minded English, on the memorable 10th of April, were so affected, that London was placed under military defence, and the public buildings were converted into fortifications, armed and provisioned to stand a siege. It was a strange sight to see a building like the Bank, dedicated to the peaceful occupations of trade and commerce, with its roof lined with sand-bags and otherwise fortified; and it was a still stranger sight to find soldiers substituted for clerks, sappers and miners for the peaceful artizan, and the inmates, instead of being occupied in receiving and giving gold and silver, employed in the more warlike occupation of handling gunpowder and fire-arms, and preparing for the most active defence of the establishment.

502. I will give one solitary instance of the state of the minds of the lower classes at that period. An old blind patient came to see me in more than ordinary spirits, and I said, "Well, Pat, how merry you are to-day." "Faith," says he, "these are times to make poor men merry, as they will soon have their rights." "Well, what do you mean?" I said. "The tenth of April is coming," he rejoined; "have you not heard of that day, Sir? They tell me it will all be right then." About three weeks afterwards he came again, extremely sorrowful. "Well, Pat," I said, "how sad you seem." "Yes," he replied; "enough to make any man sad. I have got no money, and my landlord says he will not wait any longer. What a cruel thing it is to disappoint poor men like me!" Upon conversation, I found that the sly old rascal thought that he should have no more rent to pay after the glorious 10th, and, Irish-like, had made excuses to his landlord, two or three weeks before, to see if he could not cheat him out of the rent which was due before the day of emancipation.

During the celebrated reform epidemic, I am credibly informed that a washerwoman gave notice to all her customers that next month they must provide themselves with the services of some other person, as she would have no more occasion for their custom. Such was the perversion of reason, occasioned by the excessive stimulus applied by the mob-orators of the day.

503. I am almost afraid that my reader will think me too tedious in recounting so many instances of perverted judgment arising from too great a mental stimulus; but it is a subject of great import. By this violent excitement, the mob-orator deludes his hearers; and, in fact, an undue stimulus is the source of half the great errors of mankind. To ensure the proper action of the faculty of judgment, it should only be exercised apart from any undue excitement; and a plan which most persons pursue, who have to decide upon weighty matters, is to take the evidence bearing upon the subject to their private homes, and in their private study, apart from the excitation of the world, there to form their opinion, which then depends upon all the particular ideas and general laws implanted in the brain.

504. In these cases of immediate excitation, the man partakes more of the maniac than of the rational being, and should be treated upon almost the same principles. It is of no use to oppose him, as opposition increases the malady; those around should, as much as possible, try to divert his attention to other thoughts, that judgment may take the place of special excitations. One of the Princeites, a sect which give themselves up to debauchery and immorality, was actually placed in a lunatic asylum; but though we cannot doubt that those who give themselves up to such mental excitation degrade the human character below that of the brute beast, still they are subjects to be reclaimed by rational means, without placing them amongst those who suffer from insanity.

It is almost incredible that, at the present time, in our own hallowed church, a bishop of the religion of love and charity on the one hand, and a would-be martyr on the other, should have their two parties upon a polemical doctrine appertaining rather to the scholastic theologian than to the practical Christian. Is it to be believed that the Exeterites and the Gorhamites should so pervert their reasoning powers as to sacrifice the inestimable blessings of the doctrines of Christ, for their own peculiar fancies and religious feuds? Even if these facts should come within our belief, what could be said to those disciples of such excitable ecclesiastics who threaten to eschew the church if their particular view is not enforced? But to crown this very antithesis of Christianity, it is rumoured that one of these unruly spirits, who is now receiving enormous revenues to teach the people obedience to the laws of his church, to his country, and to his God, is said actually to threaten not only to disobey the law, but, moreover, to carry out the dictates of his own excited and perverted reason. For the sake of the age we live in, for the sake of Christianity, I hope that such may not be the case; yet the perversion of reason, from mental stimuli, in Gorham and Exeter, must now be recorded as an historical event.*

505. There is no doubt but that these mental stimuli are very enticing. Those who have once tasted will taste again. It is a debauchery which bears the same relation to the mind that drun-

* A most lamentable specimen of perverted reason from excitement is narrated in the 'Times' of this day; the aid of Lord Campbell having been refused to a work of charity, because he was one of the Privy Council who decided the Gorham question. The writer styles herself an unworthy member of the church,—a title, the propriety of which, after this manifestation, few would be inclined to doubt, though, in charity, we must believe that she acted under the frenzy of religious impulse, whilst suffering from the Gorham epidemic, and, in the words of Macbeth, exclaimed,

"No boasting like a fool,
This deed I'll do before the purpose cool."

kenness does to the body; and, perhaps, of the two, it is by far the more hurtful and incurable. It is difficult enough to reclaim the drunkard;—he may take the pledge, but experience too frequently shows that the sow returns to her wallowing in the mire. It is, however, ten times more difficult to reclaim the mental debauchee who resigns his judgment to religious frenzy or political strife.

506. Errors frequently arise from confounding matter with spirit,—that which is heavenly with that which is earthly. Hence the worship of idols, of men, of animals. In my 'Sources of Physics' I have particularly called attention to the necessity of isolating all material qualities from those of immaterial beings. We find that we cannot determine the absolute attributes of the Deity from physical science, but only infer certain attributes by non-attributing to His Divinity the properties of matter, which solely derives its properties through the exertion of His power.

507. Man frequently falls into sad mistakes with regard to pleasure or pain, hope or fear. This, probably, in some cases depends upon the qualities of the blood, as a little indigestion or derangement of the functions of the alimentary canal will produce this result. Cowper, the immortal poet, was perpetually desponding; and drunkenness, or mental excitation, will afterwards leave the same desponding feelings. In different individuals special errors on certain points exist. I know several persons who can never go through a railway tunnel, or into a dark room, without fear, whilst, in reality, those places are as safe as any other situation. No reasoning will alter their determination. They acknowledge its foolishness, but say that they cannot help themselves; and in all probability the fear depends upon some violent impression received in early childhood.

508. A gentleman, who has much to do with various persons as an agent, assured me that the weather much influenced the actions of people; and to such an extent was he practically acquainted with it, that he never went out to canvass on a dark and gloomy day, but, when the sun shines, and the sky is bright, people feel happy within themselves, and then he can do business with them.

509. We are social animals, and our proceedings are not regulated by the experience which one individual obtains, but by the combined experience of our fellow-creatures. A want of proper appreciation of the labours of others is apt to lead to serious mistakes. For instance, an undue belief in the statements of others subjects us to be deceived, as ladies continually are by the shopmen, who persuade them that they are selling everything below cost price, and yet they make a profit by the quantity they sell.

510. Conversely, an undue disbelief of the assertions of others leads to error. When the cholera was here, there were many, even amongst those holding situations in deliberative assemblies, who denied its existence, asserting that it was only a cry of the doctors, nor would they believe the returns of the registrar-general till, in their immediate districts, they saw frequent examples of mortality. It is very curious that, in one of the frightful epidemics of the middle ages, the same circumstance occurred, and the people posted over the walls that they would kill the doctors if the disease did not instantly cease. This disbelief of the assertions of others led to much injury, as no care was taken to avert mortality when such a course would have been attended with the happiest results.

511. I have already directed attention to the difficulties which

may arise in the use of words; but, when we look into the whole question of language, we find that misunderstanding arises perpetually in the construction of sentences. This subject rather belongs to grammar and logic than to the immediate object of my present treatise, and, therefore, I shall not consider it further.

512. Having collected a number of facts, it is the peculiar province of man to induce from them general laws; but the induction is frequently incomplete or erroneous. In the first place, we are never sure that we have all the facts of the case, and a wrong or an imperfect deduction may be formed therefrom. For this reason the inductions of science are assuming a higher or more complete form.

513. The manner in which water is raised in a common pump was formerly explained by the assumption that nature abhorred a vacuum; and this general expression was applicable to every pump within a certain range. After a time, however, scientific men found that water would only rise a certain height in pumps, and therefore arrived by induction at the laws of atmospheric pressure. At the Royal Society we have a barometer made upon this principle, which shows how high water could be raised by a common pump, under varying pressures of the atmosphere.

In this case the first induction expressed all the known facts; but subsequently fresh facts were discovered, which totally subverted the first induction, and rendered it nugatory. In even the commonest events of life, a man can only act upon all the facts he knows; he cannot act upon those with which he is not acquainted. I was present once when a gentleman holding a high official position was investigating a series of frauds, and he was talking to his confidential clerk upon the subject, and telling him how to pursue the investigation. At the conclusion he said, "Do everything in your power to discover the party who has given the information which has enabled the frauds to be perpetrated; for I would give anything to get rid of such a miscreant." Little did he think at that time that his own confidential clerk, to whom he was talking, had been guilty of the error of supplying the information, perhaps rather as an effect of weakness than as a *particeps criminis*. When the astounding fact was detected, the conversation, at which I was present, came to my mind, and made a deep impression, as showing how differently we should act did we but know all the facts relating to any matter; and many times have I called the conversation to the remembrance of the official individual, as one of the most remarkable circumstances which we shall probably either of us meet with.

514. Conversely, when man is made acquainted with general laws, he may erroneously deduce an application to a particular instance. We have but to read the Gospel to find how far this, the most Christian country of the globe, varies from the practice of pure Christianity. If we look to those who especially set themselves up as being righteous above their neighbours, we find how much their pride and abuse of all about them differs from the pure spirit of the Bible. When we look around, we find that even the Pope, with his inquisition and tortures—with his idolatry and other peculiarities—still pretends to be a Christian. Akin to the Pope, in style and character, we find the Methodist parson, with exclusiveness, self-righteousness, and bigotry, still pretending that his acts are the acts of a Christian. Tracing the same subject, we constantly find persons even in our Church going with frequency to hear the Gospel preached, and yet the very smart clothes with which they show themselves off have been made by poor helpless females at a scale of pay-

ment hardly sufficient to keep body and soul together. There can be no doubt but that we are all far, very far removed from the true practice of Christianity. We have the laws, but we sadly misapply them, at the present time, to each particular instance; and how many thousand horrors have been perpetrated under pretence of their being in accordance with the Gospel of peace!

515. We are apt to fall into error with respect to time and the sequence of events, as we find constantly that two events, occurring at totally different times, may occur to the mind together, or the latter before the former. There is a song which the inimitable Parry sings with wondrous effect, where the subversion of events is well caricatured, as persons are brought into conjunction who lived many years apart. In the 'Life of Theodore Hook' is narrated an anecdote of that humourist, who persuaded a lady, who was one of the crowd to witness a procession, that some dignified personage whom she saw in one of the carriages was Cardinal Wolsey.

516. Perhaps one of the most difficult of all these operations of the mind is the accurate determination of the cause of any event. I found that of all the definitions which I have given in the chapter on the 'Theory of Instinct and Reason,' that which I have given of *cause* was the most obscure, and required the longest time to unravel. As an illustration of the difficulty in practice, I cannot do better than select the potato disease, for which so many causes have been assigned.

517. A disease suddenly appeared in Europe, to a great extent amongst potato plants, which caused the tubers to rot and decay; and thus one of the most terrible of modern famines was produced. It was considered at first a totally new malady; but on searching old books I found that it was abundantly described by

other authors. In Germany, Martius wrote an elaborate treatise on the subject, attributing its effect to a fungus (*fig.* 44, 45).

Fig. 44.

Fig. 45.

Berkeley, at a subsequent period, considered the *Botrytys* to be the cause, which is another species of fungus. On investigating this matter, however, I found that some injury to the plant always preceded these fungi; and though I beg distinctly to give the most unqualified praise to the talented authors, yet I was compelled to look for something antecedent to the fungus which affected the plant. In prosecuting my researches, I found that numerous fungi appear, which eat up, as it were, the soft decaying parts as fast as they rot (*fig.* 46, 47, 48).

Fig. 46.

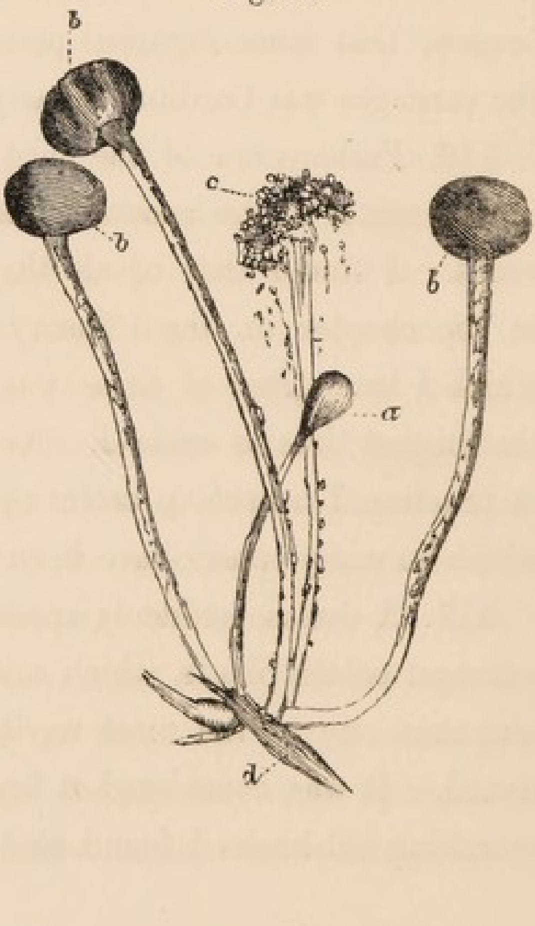


Fig. 47.

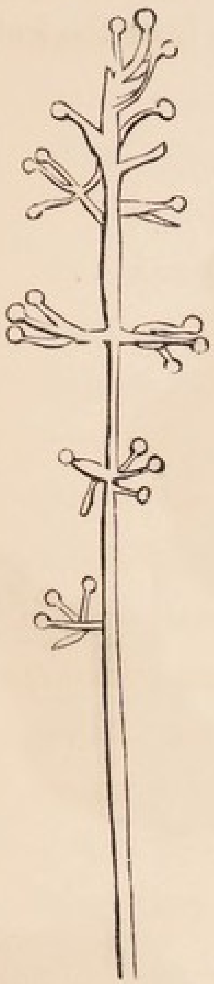


Fig. 48.

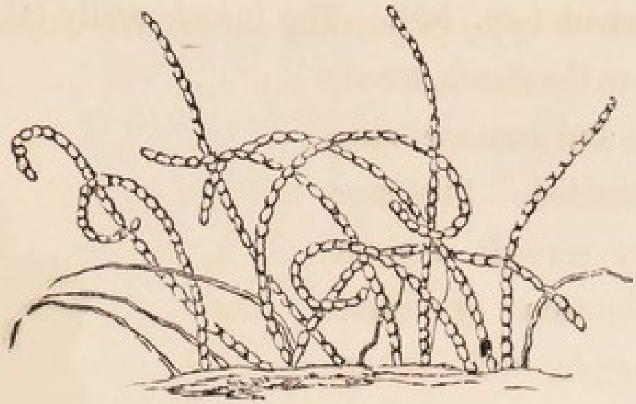
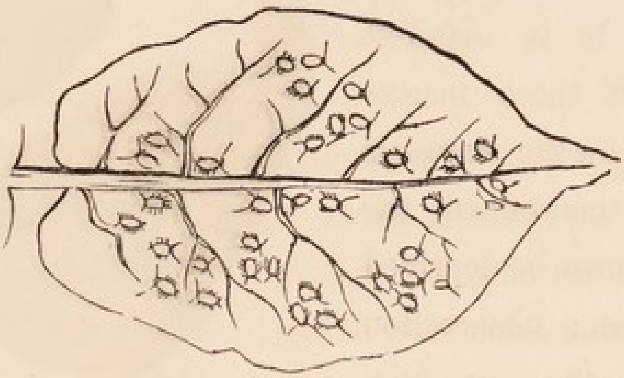


Fig. 49.

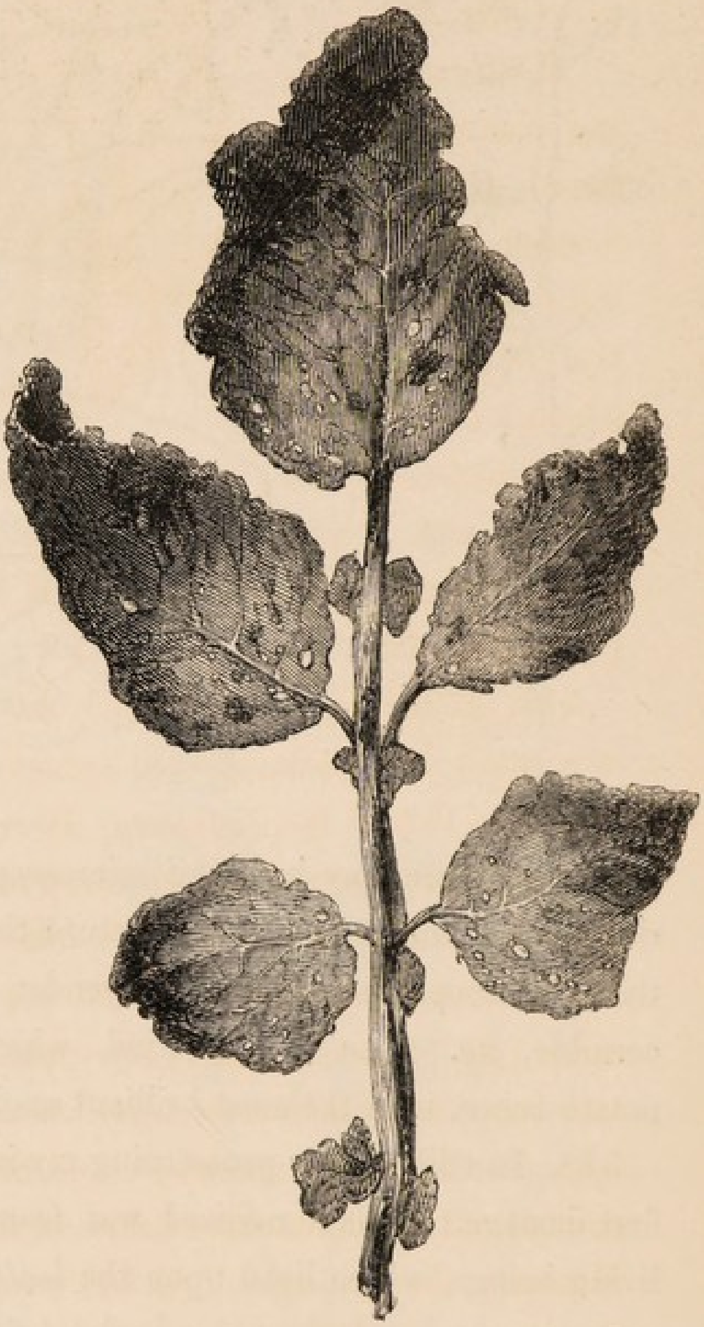


These fungi are very beautiful microscopic objects, and some of them are so minute in their structure that the highest powers of the microscope are required to render their ultimate cells discernible, &c. One of this kind, which lines the cells of the potato tuber, is of the most brilliant scarlet colour.

518. In still further prosecuting my investigations, I found the first damage the plant received was from the attack of numerous living beings, which lived upon the leaf; and sometimes I found as many as a hundred upon a leaflet (*fig.* 49). The insects first commenced at the lower leaves, and leaf after leaf perished, till the whole plant was destroyed. After the leaf was destroyed, the tuber rotted, the quantity of starch was less than was necessary for

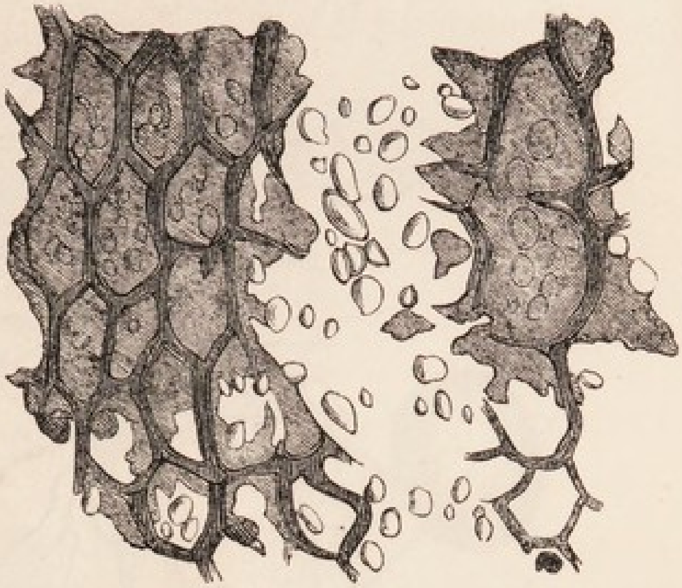
the growth of the plant, and the fibre, or skeleton, was sadly deficient (*fig.* 50). The insects really take the sap from the leaf, where the starch, woody fibre and gum are being eliminated. Professor Solly records a great diminution of these principles in the tuber, and my own analysis agrees remarkably with his. It is manifest that if these insects live upon the materials above mentioned, the plant must be deprived of them: observation proves the one fact, and chemical analysis the second. These insects always live upon the under side of the leaf, so that thousands may exist without being observed; and they are not only thus protected from view, but the leaf covers them from the rain, which might wash them off. Not only the tuber, but the stalk, becomes dark in patches, both

Fig. 50.



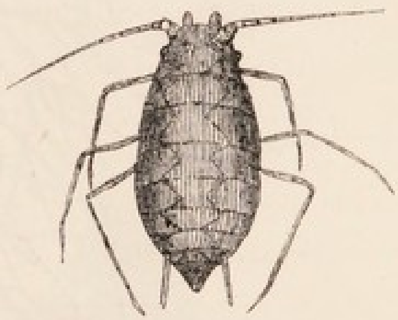
both below and above the ground, as shown in the subjoined diagram (*fig.* 53).

Fig. 51.



Upon extending my observations, I found that a vast number of plants were destroyed by the same creature, which I hence called the *Vastator*, or destroyer; and I have found it feeding upon at least a hundred plants, many of which it destroyed as effectually as it did the potato (*fig.* 39).

Fig. 52.

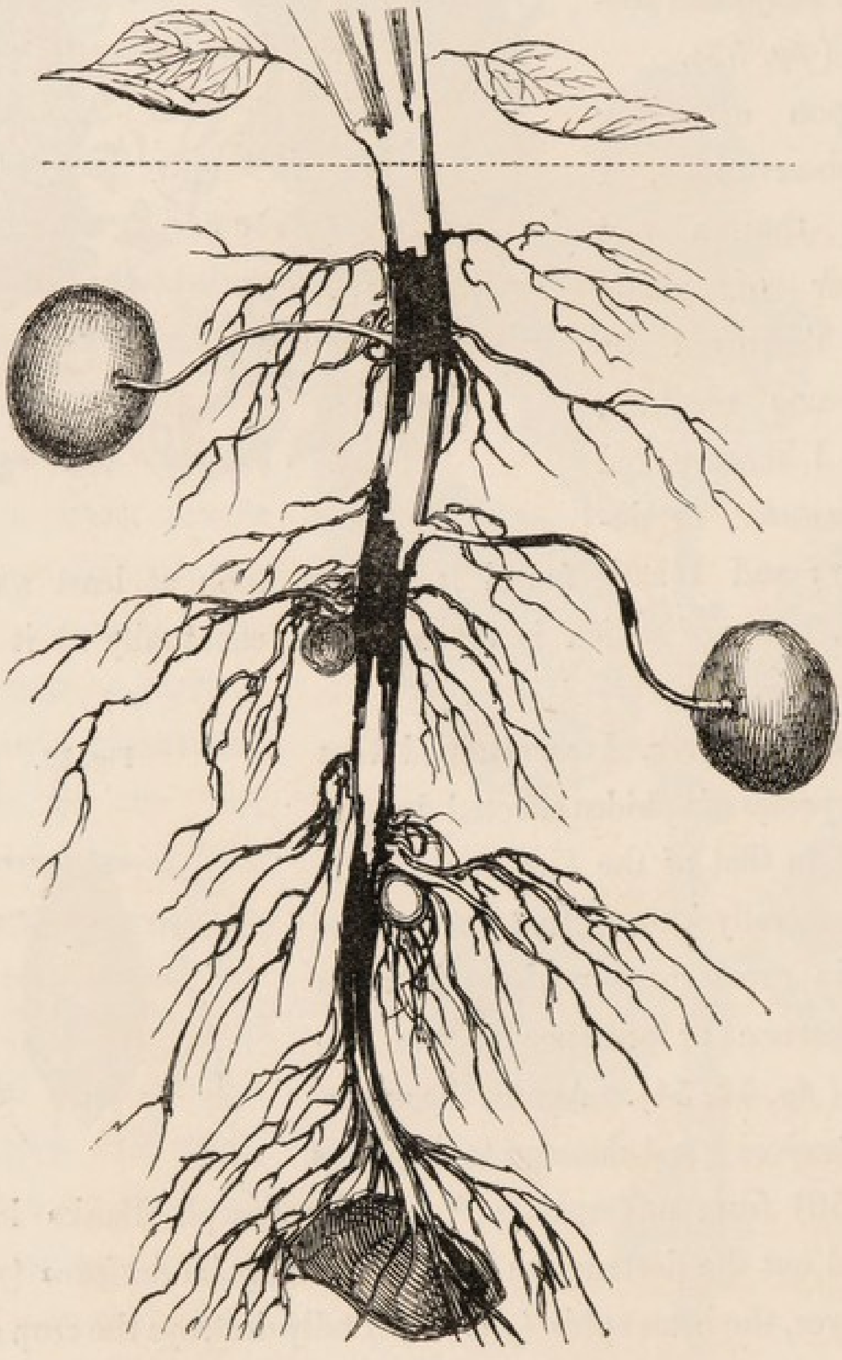


519. Moreover, I ascertained that other species of aphides effected damage similar to that of the *Vastator*. It is very generally known that the crop of hops in great measure depends upon the absence or presence of the hop aphis (*fig.* 52, 54). Again, the apple-tree receives great damage to its leaves (*fig.* 56) from one species;* and Sir Joseph Banks long ago pointed out the destructive habits of the *Aphis lanigera* (*fig.* 62). Moreover, the bean aphis (*fig.* 57) totally destroys the crop of beans in some years; and another aphis, the pea aphis, as frequently de-

* This leaf does not represent the mischief so well as it might; fortunately, however, I have the original specimens which I procured from Enfield, so that I can at any time show them to any of my readers who may desire to see them.

stroys the pea crop. Cabbage-plants are also much damaged by the

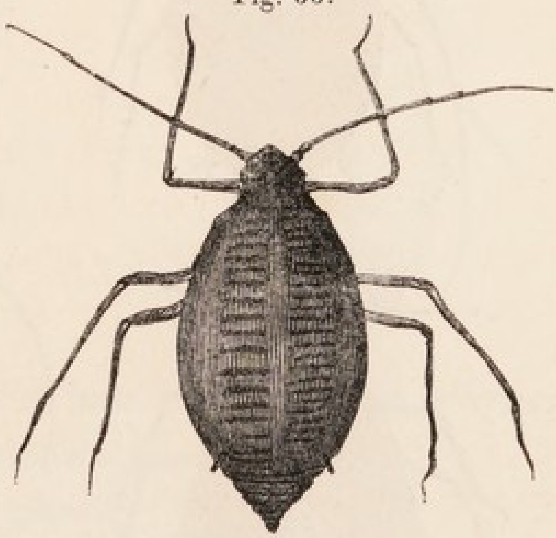
Fig. 53.



cabbage aphis (*fig.* 55); the rose-tree by the rose aphis (*fig.* 61). At times the oat is damaged by the oat aphis (*fig.* 60). I have known even the couch-grass to be killed by the grass aphis

Fig. 54.

Fig. 55.



(*fig.* 63); and the melon and cucumber are frequently destroyed by another species of aphis (*fig.* 58). The cherry-tree is wonderfully damaged in its shoots by the cherry aphis (*fig.* 64). Thus, wherever I traced the operations of these creatures, there I observed the destruction of the plant. Some aphides, indeed, live under ground, as the artichoke aphis (*fig.* 65); and others live upon young shoots, as some of the aphides which infest the oak (*fig.* 59).

Fig. 56.

Fig. 57.

Fig. 58.

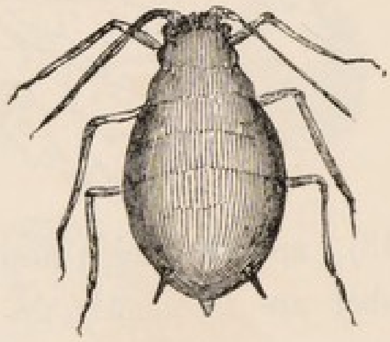


Fig. 60.

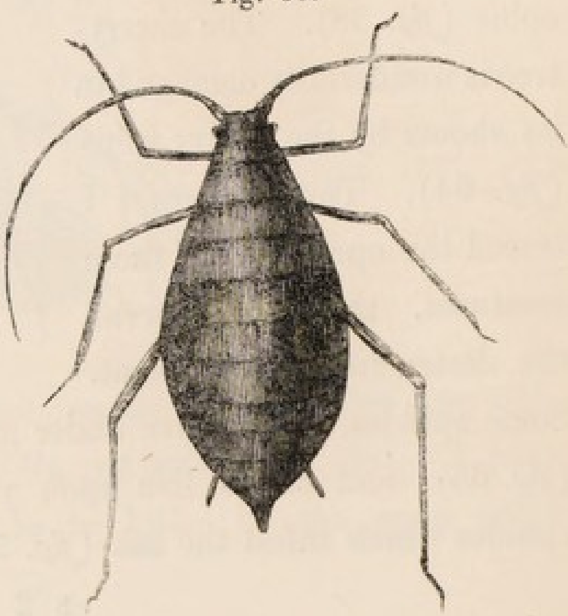


Fig. 59.

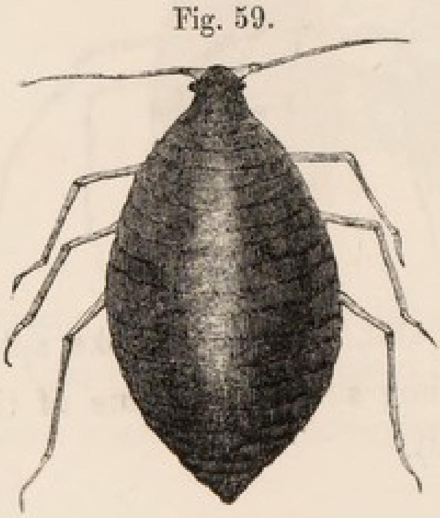


Fig. 61.

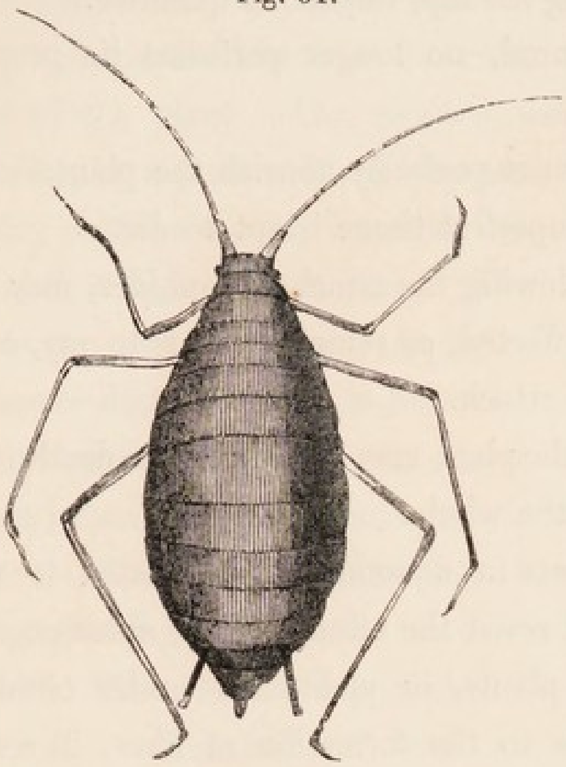


Fig. 62.

Fig. 63.

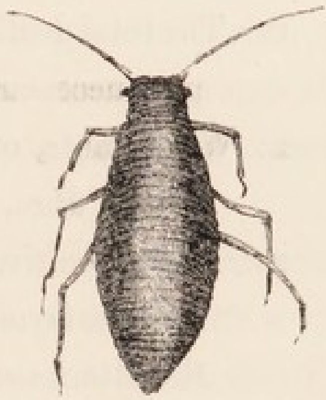


Fig. 64.

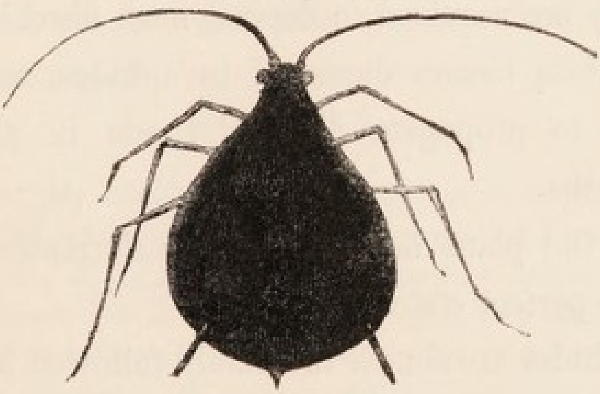
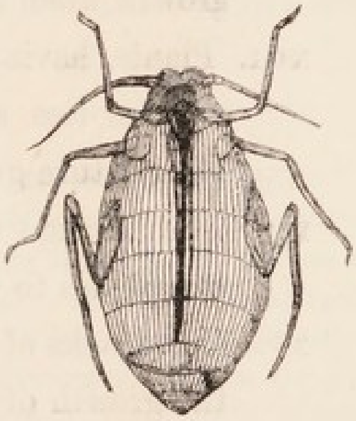


Fig. 65.



520. From all these and other facts I developed the following laws of the ravages of these creatures :—

I. Aphides feed on living plants.

II. Aphides come first upon healthy plants.

III. Aphides suck the juices of plants after having pierced the cuticle.

IV. Aphides, by sucking the sap, impair its qualities.

V. The sap, being injured, no longer performs its proper functions.

VI. The injured sap cannot perfectly nourish the plant.

VII. Unnourished or imperfect tissue is apt to die.

VIII. Partial death, following the attacks of aphides, may be local at the part affected, or remote, that is to say, at a distance from the attack.

IX. The total death of the plant may arise from the death of a part necessary to the whole.

X. Wild plants, or plants in a condition calculated to develope fibre, well resist the attacks of the aphides.

XI. Highly cultivated plants, or plants not under circumstances favourable to the formation of fibre, ill resist the attacks of aphides.

XII. Plants are most injured by aphides at that period of their growth when they are required to deposit most fibre.

XIII. Plants, having their tissues damaged by aphides, are more or less apt to propagate diseased tissue in all their future growths.

XIV. The damage to the plant hastens the transformation of aphides to the perfect state.

XV. The attacks of aphides are almost invariably followed by the growth of fungi.

521. In obedience to these laws, I have found that the aphis lives upon the potato-plant, comes first upon healthy plants, sucks the juices after having pierced the cuticle, impairs the qualities of the sap, which then cannot perform its proper functions, and thus retards the formation of fibre and starch. The imperfect tissue is apt to die, either locally at the part attacked, or

remotely at the tuber, underground stems, or root. This death may separate the leaf from the root, and thus destroy the greater part of the plant. The reputed wild potato-plant, and plants growing in a poor soil and dry atmosphere, resist more than the highly cultivated varieties, and those growing in a rich soil and a moist, cold, and dark place. The injury takes place principally when the starch is being deposited in the tubers. A set from a former diseased plant is liable to manifest the disease in all its future growths. When the potato-plant begins to perish, the larvæ become perfect insects, and fly away to commit ravages elsewhere. The injured potato-plant has a vast number of parasitic fungi growing upon it.

522. The moment I published my 'Rationale' of the potato disease, it was assailed in the most extraordinary way. The writers did not attempt to attack my facts or my reasoning, but they misrepresented my words, made me to say the very reverse of what I did say, and then wrote against their own fabulous versions of my writings.*

* My friend, Mr. Terry, jun., has lately shown me the 'Annual Register' for 1805, which, curiously enough, proves that I have only re-discovered the destructive power of the aphis over the potato-plant, and that, fifty years ago, the fact was well known. In an article upon the aphis, it is stated that "in some years the aphides are so numerous as to cause almost a total failure of the hop and *potato* plantations; in other years the peas are equally injured, while exotics, raised in stoves and green-houses, are frequently destroyed by their depredations." The late Mr. W. Curtis states, in the 'Linnean Transactions,' "To *potatoes*, and even to corn, we have known the aphides prove highly detrimental, and no less so to melons." He says that "the aphis is the grand cause of blights in plants, and that erroneous notions are entertained, not only by the vulgar and illiterate, but even by persons of education, that aphides attack none but sickly plants," with other notions as altogether false in fact as unphilosophical in principle.

"Out of old bookes, in good faithe,
Cometh all this new science that men lere."

523. The distinguished entomologist, Mr. Curtis, wrote an article in the 'Gardeners' Chronicle,' blaming me for having violated the established custom, in not having used the prior name of the aphis; but it appears that Mr. Curtis named this selfsame creature *Rapæ*, when it had the former name *Dianthi* assigned to it, as Mr. Walker has informed me.

524. An entomologist held the extraordinary opinion that the potatoes were suffering from a disease analogous to the cholera. This theory is objectionable, as the human organization differs from that of the potato; and I confess that I do not readily realize the idea of a potato being convulsed, or purged, or suffering from stomach-ache or syncope. Amongst other curious theories, the comet and volcanic theories are most remarkable.

525. The theory of Mr. Thompson, of the Horticultural Society, demands much consideration. If I mistake not his views, this eminently practical man considers that the quality of the rays of the sun has an influence upon the plant. I object to the theory on account of its not being adequately proved, and from its not being supported by injurious influence upon other plants.

526. Dr. Lindley has originated a general atmospheric hypothesis of the cause of the disease. I fully admit, with this distinguished botanist, that the term is convenient, inasmuch as it embraces so many different external conditions; but still I apprehend that it is dangerous to take so wide a range. Upon this account I should call upon any person embracing such a theory to state particularly what he meant by an atmospheric cause,—whether he meant the composition of the atmosphere, the quantity of moisture in the air, its temperature, electricity, &c.

527. In all these, and in other theories, the difficulty which the mind has to solve is, whether the fungus, the insect, the air,

or the sun really was the cause which acted upon the plant in such a manner as to produce the disease. To ascertain this fact, I have placed insects upon healthy plants, and thereby caused their destruction (*fig.* 39); upon the whole, therefore, we have good reason to believe that the insect, and the insect alone, gives rise to the disease. Also, as the insect decreased, the disease lessened. The extraordinary flight of ladybirds, when the disease began to diminish, was a singular corroboration of my conclusions. As the aphides increased, so these creatures, which fed upon them, increased, both in the larva and winged state. At last, getting ahead of them, the ladybirds flew from district to district and from county to county in vast clouds, and the newspapers recorded that, at Brighton and other places, the cliffs were literally covered with them.

528. During the great potato controversy, the violence of the various parties was truly a reproach to science. At last, foolish people used to amuse me by sending threatening letters by nearly every post, cautioning me that I should be amply punished if I dared to continue to write upon the subject. Notwithstanding all this, it was very curious to notice how kindly the public used to supply me with facts for my guidance; and I received valuable communications, some of them of great length, though, when the controversy was at its height, they were sent anonymously. By the middle of summer nearly every agriculturist was made acquainted with my investigations, despite this rancorous animosity.

529. The time at last arrived to apply practical remedies for the destruction of these insects. I tried the hydrocarbons, turpentine, naphtha, &c., and the vapour of sulphur; but these agents immediately killed the leaves. I tried lime, but without any effect; and fumigation seemed the only resource left. A

wealthy farmer determined to kill the aphides by fire, if that were possible; but one morning, just as I thought that I should be enabled to announce the cure to the world, I received the bad news that the fire sooner killed the plant than the aphis. I could think of no other remedy; and thus the severe labour to which I had subjected myself, the great expense which I had incurred, were all futile for the prevention of the disease, and I had only left the melancholy satisfaction of having traced the mischief to its origin, of having made the people acquainted with the fact, ready to receive the remedy which I felt confident science would have provided, but in which I was so sadly disappointed. Upon the whole, however, I have good cause to rejoice in the effect which my labours have had upon this subject. They have increased our knowledge very materially of these creatures, and, above all, have pointed out how very little we still know about them. I have kept millions for observation, and have never yet seen either a male or an egg of the *Vastator*, all having been viviparous females. The distinguished entomologist, Mr. Walker, who has particularly attended to the classification of these creatures, is in a similar predicament. There is evidently some mystery still hanging over them; and, from my electrical experiments and other observations, I suspect that many species, which we think perfectly distinct, are but varieties. The aphis tribe are now much more studied, and, sooner or later, many important facts connected with these creatures will doubtless be cleared up.

530. The history of the potato disease shows the extreme difficulty which the mind finds in estimating the cause of any event; and in all other instances of causality, more or less uncertainty almost invariably exists.

531. I have now briefly to allude to a series of instances of

perverted reason which degrade man, and make us feel, with sorrow, the extent to which the human race may be debased. We may take as exemplifications common country superstitions which have been handed down from father to son before the light of Christianity was diffused through this land. Mr. White records, that "In a farm-yard, near the middle of Selbourne, stands, at this day, a row of pollard-ashes, which, by the seams and long cicatrices down their sides, manifestly show that, in former times, they have been cleft asunder. These trees, when young and flexible, were severed and held open by wedges, while ruptured children, stripped naked, were pushed through the apertures, under a persuasion that, by such a process, the poor babes would be cured of their infirmity. As soon as the operation was over, the tree, in the suffering part, was plastered with loam, and carefully swathed up. If the parts coalesced and soldered together, as usually fell out where the feat was performed with any adroitness at all, the party was cured; but where the cleft continued to gape, the operation, it was supposed, would prove ineffectual. Having occasion to enlarge my garden, not long since, I cut down two or three such trees, one of which did not grow together.

"We have several persons now living in the village, who, in their childhood, were supposed to be healed by this superstitious ceremony, derived down, perhaps, from our Saxon ancestors, who practised it before their conversion to Christianity.

"At the south corner of the Plestor, or area, near the church, there stood, about twenty years ago, a very old, grotesque, hollow pollard-ash, which for ages had been looked on with no small veneration as a shrew-ash. Now, a shrew-ash is an ash whose twigs or branches, when gently applied to the limbs of cattle, will immediately relieve the pains which a beast suffers from the running of a shrew-mouse over the part affected: for it is supposed that a shrew-mouse is of so baneful and deleterious a nature, that whenever it creeps over a beast, be it horse, cow, or sheep, the suffering animal is afflicted with cruel anguish, and threatened with the loss of the use of the limb. Against this accident, to which they were continually liable, our provident forefathers always kept a shrew-ash at hand, which, when once medicated, would maintain its virtue for ever. A shrew-ash was made thus:—Into the body of the tree a deep hole was bored with an auger, and a poor devoted shrew-mouse was thrust in alive, and plugged in, no doubt, with several quaint incantations, long since forgotten. As the ceremonies necessary for such a consecration are no longer understood, all succession is at an end, and no such tree is known to subsist in the manor or hundred.

"As to that on the Plestor, 'the late vicar stubb'd and burnt it' when he was way-warden, regardless of the remonstrances of the bystanders, who interceded in vain for its preservation, urging its power and efficacy, and alleging that it had been

'Religione patrum multos servata per annos.'"

532. The berries of the mountain ash, tied round with red thread, are supposed to be a perfect preservation against witchcraft, if accompanied with the following couplet:—

"Rowan tree and red thread
Drive the witches at their sped;"

but, as I hope that belief in witchcraft has nearly disappeared, so has the use of unmeaning charms disappeared also. Amulets have also been used for a similar purpose. I have a cast of an Abraxus, a power which presides over three hundred and sixty-five others, and has therefore been thought to have wonderful efficacy.

533. At a late period we find that the use of certain coins was in common vogue, which, being touched by the king, were supposed to have the power of warding off scrofula. These coins are called royal touch-pieces, and I have casts from all those which exist in the British Museum. The distinguished London antiquary, Mr. Charles Roach Smith, has one which has been so extensively used, that the impression is quite abraded. I have also a cast of a touch-piece of the Pretender, who thought that he had a right to the English crown, and therefore had the power to confer the royal cure.

534. I need hardly call attention to the practice of fortune-telling, which is still carried on by gypsies and other rogues. Nearly allied to this, we have, at the present time, the pretended prophetic revelations of *clairvoyants*, which are attempted to be palmed off upon the credulity of mankind; and, oddly enough, many of the clergy are so weak as to attribute these fabulous results to the operations of the devil, whom they consider to be gaining more power upon earth.

535. The miracles which are declared to be wrought at certain shrines are an astounding example of human credulity. On the Continent, cartloads of votive offerings may be seen at some of the churches, as they are tried to be passed off as specimens of wonderful cures. I lately heard, from a minister, of a case where a similar attempt at a miracle was performed by a Dissenting clergyman. A young lady was confined to the sofa, and, as the saying goes, "the doctors gave her up." The minister, however, took her case in hand, and, after much preparatory prayer, suddenly told her, "In the name of the Lord Jesus, arise!" and

from that moment she got up and became quite well. My informant was much surprised when I told him that such cases were common, and that I considered all the religious formality about it was little better than blasphemy. In hysterical cases strange states are frequently taken on by the sufferer, and require a powerful mental emotion to cure them. In their treatment the *rationale* should be clearly explained, that no false impression may be left to injure the mind of those who witness the cure.

536. Some years back I remember to have had a case of a similar character. A young man had been confined to bed for a long period, and fancied that he could move neither hand nor foot. His knees were half bent, and if they were touched he screamed violently; but yet it was manifest that he had no disease whatever. I occupied his attention, and suddenly, whilst unawares, I sat upon his knees, and called out to him to draw himself up; when, before he could observe what I was about, his knees were straightened. I threw off the clothes, pointed to his straightened limbs, and told him he must get out of bed and walk. His look of astonishment was remarkable; but, with my assistance and that of his nurse, he took two or three steps that day, and in less than a week was quite well,—not by any miracle, but by acting according to the ordinary properties of living beings.*

537. There are some persons who think that man has now become so enlightened, from a liberal education, that he cannot at the present day be the victim of pseudo-miracles, charms, or other abominations of a similar character. These individuals look with contempt at the follies of our forefathers, but regard not the same deceptions which are going on around them.

* A case is recorded of a cure having been effected by the doctor whispering to the nurse that, if needful, she was to apply a red-hot poker to the back.

538. At the present moment there is a class of men who are deluding the people with a sort of spell, equal, in point of superstition and fraud, to any system which has been recorded in the annals of the world; and what will future ages say, when they read that even people holding good positions in society are occasionally entrapped by these wizards of the present time, and made to believe that the billionth of a grain of some trifling drug will so affect their vital actions as to cure the most violent maladies? These charmers by globules are, in the majority of instances, men who have been educated for the medical profession; but finding themselves unequal to practise with advantage to themselves, like the poor apothecary in 'Romeo and Juliet,' exclaim, "My poverty, but not my will, consents," and straightway give themselves up to the practice of sorcery, under the title of homœopaths.

539. These unfortunate individuals are, nevertheless, in some degree to be pitied. They are sufficiently educated to know that they live but by fraud, and by acting on the credulity of their fellow-creatures; and as they bolster up one falsehood by another, in the record of their wonderful cures, it is impossible but to suppose that, if by chance they shall obtain a party's confidence to such an extent as to be trusted with a dangerous case, in the event of death they must be troubled with the direst remorse. The public, as a mass, must always have some delusion. At one time they have homœopathy; another, a dryopathy; again, a wetopathy; then, a Raspailopathy; then, St.-John-Longopathy; then, the use of spells, charms, touch-pieces, galvanic rings, abraxes, witchcraft, and papal miracles. The same persons who employ one would also use the others, if the first were absent; therefore, in my opinion, the wish expressed by many persons, that some act

should be passed to punish the delinquents, would be of no effect, for some new deception would arise the very next day. In fact, the public who go to them go more from curiosity than from anything else, and are principally nervous individuals, and others, who have been forbidden by their medical attendants to take medicines, and who are better without drugs. Those who are seriously ill rarely, if ever, entrust their lives to any of these charlatans. Laws, however, should be made, to protect persons in an insensible state, or children, from these sorcerers.

540. These deceivers, whether medical or otherwise, from the beginning of the world, have always endeavoured to carry on their deception by appealing to the senses,—like conjurors, who always apparently give their observers ample means of ascertaining the truth for themselves, whilst they but show them the deception. In the choice of terms, a selection is made of words well calculated to mislead. The globule-vendor insists upon his right to be called a doctor, although he has resigned medicine for sorcery and witchcraft.*

541. When we regard the comical remedies of this wonderful craft, the mixture of the poet comes forcibly to our minds :—

> "Scale of dragon, tooth of wolf ;
> Witches' mummy ; maw, and gulf,
> Of the ravin'd salt-sea shark ;
> Root of hemlock, digg'd i' the dark ;
> Liver of blaspheming Jew ;
> Gall of goat, and slips of yew,

* I have lately received a newspaper from Guernsey, containing a highly amusing account of a trial, where a homœopathist brought an action for damages on account of his feelings having been wounded in not being considered a doctor. When homœopathists are upbraided by the relatives of those whom they have allowed to die, they blasphemously liken themselves to our Saviour, who was reviled and ill-treated of men.

> Sliver'd in the moon's eclipse;
> Nose of Turk, and Tartar's lips;
> Finger of birth-strangled babe,
> Ditch-deliver'd by a drab,
> Make the gruel thick and slab;
> Add thereto a tiger's chaudron,
> For the ingredients of our caldron."

A little of such a mixture, with incantation in place of the trituration, would doubtless be quite as efficacious as the homœopathic globule.

542. Perhaps nothing is more remarkable than the nature of these globules. Each weighs about the $\frac{1}{25}$ of a grain, and they are sold in little bottles, labelled, 'arsenic,' 'camphor,' 'musk,' &c. Now, it has been stated that a grain of musk will scent a room for twenty years, yet some, labelled 'musk,' which I examined, had no odour. With regard to arsenic and copper, the refinements of modern chemistry can detect extremely minute quantities, yet the most eminent chemists have failed to obtain indications of the slightest trace of these materials; and be it remembered, that the globules which have been examined have been taken from chests which, according to the statements of their owners, produced wonderful cures. It is the common belief that all the globules are made alike, but it cannot be denied that occasionally those who practise homœopathy contrive to substitute active doses of the more deadly poisons when they are persuading their followers that they are but giving them harmless globules.

As the epidemic of globules has now reached its height, and may soon be expected to abate, it would be instructive to collect the names and standing in society of those who have yielded to this superstition, that, when some new delusion shall arise, future generations may be warned by previous experience. Under the present aspect of political events, we must deeply regret that noblemen should show to the community any mental incompetency, by subscribing to such palpable absurdities, as such a course can only tend to bring the nobility into ridicule, and thus to injure our social system, devised by the wisdom of our forefathers.

543. The contents of this chapter show painfully the weak side of human nature, for its illustration has caused me to narrate many instances of mental degradation. It is not within the province of this chapter to consider insanity and diseases of the mind, and therefore I have confined my attention to those cases of perverted reason which a proper education might have avoided. If we observe the dog or other animal, we cannot say that its instincts are ever so perverted, nor can its ordinary reasoning faculties be said to exhibit such extensive aberrations. Thus we find that man, endowed with the most complex structure, and, consequently, with the highest faculties, is liable, nevertheless, to exhibit the most extensive perversions of the reasoning power under improper management, and the neglect of the laws of nature, which are, in truth, the laws of God.

543. In all the cases of perverted reason, there appears to be an irregular action of the brain, analogous to the irregular action of machinery. If a steam-engine be subjected to the undue stimulus of heat, it will, like the overstimulated man, exhibit increased action; and if too much power were applied to the striking part of a clock, it might continue its stroke, independently of a corresponding action in the other parts of the machinery. So with contrivances for ascertaining force; as a mere spider's cord might materially interfere with the correct action of the vertical force magnetic needle, which is said, by Pro-

fessor Airy, to appreciate the one-ten-millionth part of a grain. With all pieces of human mechanism we thus find that proper care must be taken that they act correctly. The elaborate mechanism of the brain, formed by nature, requires that its action should be conducted upon the laws of the Creator. Whoever ventures to set at nought these laws will surely fall into the errors and delusions of perverted reason.

CHAPTER XIV.

VARIOUS FAMILIES OF MAN.

Peculiarities of Man, 544.—Family Likeness, 545.—Anecdote, 546.—Mental Capacity, 547.—Divisions of Man, 548.—Supposed diversity of Species, 549.—Blumenbach's Division, 550.—Caucasians, 551.—Anglo-Saxon Race, 552; their Religion, 553; their consideration for Females, 554.—The French, 555.—Caucasians protect the weak, 556.—Their Intuitions, 557.—The Jews, 558.—Ninevites, 559.—Mongolians, 560.—Ethiopians, 561.—Americans, 562.—A roving Life, 563.—Influence on a Poacher, 564; on Indians, 565.—Malays, 566.—General Arrangement, 567.—General Remarks, 568.

544. We have, up to this time, traced the peculiarities of man which distinguish him from the dog, plant, or other parts of creation. But we have now to study whether those powers which are assigned to man are possessed by the various tribes scattered over the world; that we may accurately know whether man, under all circumstances, exhibits the same powers of mind,—whether he has the faculty of deducing laws, suffers the misfortune of being liable to errors, and is the subject of the same intuitions which I have already described him to possess.

545. In investigating this subject, we find that certain peculiarities appertain to the same family, both in mind and body; and hence we have a family likeness. This likeness is extended to a considerable extent over whole counties. In a more modified extent, a certain similarity may be traced through kingdoms,

even to extensive regions of the globe; and, tracing the subject to its utmost extent, we have certain peculiarities which appertain to the entire human race.

546. I may detail, as a singular illustration of family resemblance, an event which happened to my brother upon the top of a stage coach. After he had been riding a short time, a gentleman addressed him by saying, he thought that, considering the friendship which existed between them whilst they were students at King's College, my brother should not have cut him in that manner. To which assertion my brother replied, that he really had not the honour of his acquaintance, and, to the best of his belief, had never seen him before. To this the stranger replied, "You are surely Mr. Alfred Smee, of King's College?" but he rejoined, "I am not Mr. Alfred Smee, and never was at King's College." The conversation continued until both parties became very warm over the argument, to the no small amusement of all who heard it. My brother narrated the circumstance at dinner; and the event was almost forgotten till a few days since, when I accidentally had business with a perfect stranger, who told me the circumstance again exactly as my brother had detailed it, and said, that all the passengers were much amused, and wondered whether he was really Mr. Alfred Smee; but now he had seen the veritable person, he was quite convinced that the gentleman on the coach was not myself. I do not know the name of the surgeon who fell into this error; but if he should chance to read this story, he would greatly allay my curiosity by informing me upon this point.

547. The resemblance which we find in the likeness of various persons, we may trace, also, in their mental capacity, although here the similarity exists to a less degree; and as we prosecute our inquiries in a direction more remote, we observe that this pecu-

liarity vanishes, till it is ultimately lost in the general qualities of mankind.

548. The illustrious Blumenbach was the first who particularly occupied himself in the study of mankind; and his writings upon all points bear so highly the stamp of genius, that no physiologist can read them without the highest gratification. In this country my distinguished teacher, Mr. Lawrence, has obtained for himself imperishable fame by his lectures upon this subject; and though, when first published, they were made the subject of misrepresentation and party persecution, by contemporaries who feared his talents, and therefore distorted his views, yet his writings remain as a monument to his abilities; and the effect of them may be observed amongst the educated of all classes of the community at this time, and doubtless will produce results for years to come. We have not only the work of Mr. Lawrence on this subject, but we have also the elaborate treatise of Dr. Prichard, which may help us to elucidate the matter.

549. Now, physiologists are not agreed as to whether the extreme varieties, which we find amongst men, are not owing to a difference, not merely of family but of species. Rudolphi, Virey, Desmoulins, St. Vincent, Cuvier, and others, have adopted the latter view. In this country, Mr. Lawrence, after a most valuable and critical examination of the subject, adopted the former view; and Dr. Prichard, upon this point, coincides with Mr. Lawrence. From the facts which these gentlemen have collected we find that each individual presents certain peculiarities; that each family presents certain peculiarities; and that, moreover, each nation has certain characteristics: and all these ultimately merge into varieties of the one great family of man.

550. The division of Blumenbach, into five primary varieties,

is manifestly far from sufficient to identify the principal great families which cover the globe. He divides them into the Caucasian, Mongolian, Ethiopian, American, and Malay varieties; and I here draw up a table, in a great measure from Lawrence, to show the grand distribution.

CAUCASIANS.

Assyrians.	Philistines.	Circassians.	Afghauns.
Medes.	Phœnicians.	Mingrelians.	Some Hindoos.
Chaldeans.	Jews.	Armenians.	North Africans.
Samaritans.	Syrians.	Turks.	Egyptians.
Scythians.	Tartars.	Persians.	Abyssinians.
Parthians.	Georgians.	Arabians.	Guanches.

MONGOLIANS.

Mongols.	Samoiedes.	Japanese.	Pegu.
Calmucks.	Yukagires.	Thibetans.	Cambodians.
Burats.	Coriacks.	Bootan.	Laos.
Mantchoos.	Tschutski.	Tungquin.	Siamese.
Daourians.	Kamtschadales.	Cochin Chinese.	Laplanders.
Tungooses.	Chinese.	Ava.	Esquimaux.
Coreans.			

ETHIOPIANS.

Negroes.	Mandingoes.	Hottentots.	Eboes.
Foulahs.	Kaffres.	Bosjesmans.	Koromantyns.
Jaloffs.			

AMERICANS.

Chippeways.	Onondagos.	Choctaws.	Blackfoot In-
Menomonees.	Tuscaroras.	Chichaws.	dians.
Winnebagos.	Cherokees.	Piccanees.	Blood Indians.
Hashashias.	Creeks.	Sioux.	Shoshokees.
Kichapoos.	Seminoles.	Camanchees.	Chilts.
Senecas.	Euchees.	Pawnees.	Flatheads.
Wyandots.	Natches.	Crows.	Other Indians.

MALAYS.

Malacca.	Celebes and	Marian Islands.	Van Diemen's
Java.	neighbouring	Caroline Islands.	Land.
Sumatra.	Islands.	New Guinea.	South Sea Is-
Borneo.	Ladrone Islands.	New Holland.	lands.
Molucca Islands.	Philippine Islds.	New Zealand.	

551. Caucasian Family.—We have the good fortune to be members of this family, which is greatly distinguished for excellence above every other on the globe. It occupies the foremost position, as various members of this family have given to man nearly every scientific invention and nearly every principle in policy which especially raises man in dignity above other animated beings. To this family must be given the merit of the invention of printing, of excellence in sculpture and in painting, of superiority in literature and in poetry, in law-making and in government. It is this family which has given to man the steam-engine, the electric telegraph, and the railway; and in every respect it stands prominently above others as the type of excellence amongst mankind.

552. This great family has many branches; and even in this country alone we observe differences between the English, Scotch, Irish, and Welsh. If we compare the inhabitants of Great Britain with those of other countries, still more remarkable differences present themselves. We esteem, perhaps from the love of our own country, the Anglo-Saxon race above others; and Englishmen are prone to look with pride upon their colonies, where their race is being implanted, to overrun the world, and give to the less gifted inhabitants the advantages of our superior excellence. Doubtless, much of our nationality is due to the inestimable blessing of perfect liberty, which we enjoy under a form of government which protects the good, punishes the evil with justice and mercy, and gives to every individual his certain and inalienable rights. Our liberty contrasts strongly with the absolutism of the Austrians and Russians, as well as with the mob despotism of the American republicans; and the pretended freedom of his French neighbours an Englishman can only regard with pity,

as he sensibly feels the difference between English and French liberty the instant he alights on Gallic shores.

553. Doubtless, however, a further cause for the superiority of the Anglo-Saxon race, upon the whole, is to be found in that glorious form of religion which is held by our established church, whose ministers, from the pulpit, call upon their hearers to conjoin reason with faith; whilst on the other hand, our less fortunate neighbours are under the dominion of a more bigoted and designing priesthood, who, while they rule the weaker sex, cause those endowed with higher faculties not only to eschew their teaching, but too frequently to cast aside, as an imposture, all religion whatsoever; and, thus deprived of the benefit of any religion, they are held together by no common bond of unity, the source of power and beneficial action.

554. The Anglo-Saxon race are also peculiar for their kindness and consideration for females. The Turks will not allow their females to read or write, and even hold that they have not souls; in France, also, the Englishman, if he only touches upon the coast, is astonished at the menial and laborious occupations to which the women are subjected, whilst the men, too frequently, are lounging about doing nothing at all.

555. Although the Anglo-Saxon race may exceed their Gallic or continental neighbours in fixity of principle, yet in lesser things these latter far outstrip us. In matters of fashion, of taste, of art, they excel us to such an extent, that these matters we all but entirely borrow from the French metropolis.

556. Many persons consider that the Caucasian family are distinguished for their protection to the weak, and kindness to the vanquished. Yet I apprehend that these results are obtained from religion, and a strict discipline under good laws, rather than from

any peculiarity inherent in their organization. The horrors of the French revolution, in 1790, the barbarities practised on the Hungarian captives by the Austrians last year, the massacre of the Arabs in Algeria, and some of the terrible enormities of the white men on the poor Indians, show, fearfully, that we are no more proof against cruelty, than the less gifted members of the great family of man.

557. As I have already stated, the Caucasian family is ennobled by ranking amongst its members the originators of almost all inventions in science, I need not further consider these qualities. With respect to their intuitions, they universally, as a class, hold the immortality of the soul and the existence of the Deity ; and although in that time of mental disease in France, when the instrument of death was sanctified by the name of the 'Holy Guillotine,' there was inscribed upon the cemeteries "Death is an eternal sleep," and God was publicly denied, and impiously called upon to vindicate his injured name; yet such instances are rather to be classed amongst cases of perverted reason, and placed in the category of other mental epidemics; or, as Lord Byron powerfully expresses it,

"France got drunk with blood, to vomit crime."

558. I have heard it stated that the Jews do not hold the belief of a future state; but, as far as I can learn, those who hold such opinions are not considered by their fellows as orthodox Jews.

559. From the earliest period of history, we find the Caucasian family have possessed similar powers of mind. In the Nineveh sculptures, there are figures of men in the act of crossing rivers upon bags distended with air. They have also depicted boats and implements of war, evidently exhibiting an ample knowledge of

the properties of matter; and a capacity to employ that knowledge for their various purposes (*Plate* 10, *fig.* 20).

Major Rawlinson read an interesting paper to the Society of Antiquaries, in which he gave the following inscription, placed by Darius on a public building at Hamadam, the capital of Media, which well shows their belief in God:—"The great God, (he it is) who erected this earth, who created that heaven, who created mankind, who gave life to mankind, who made Darius king, as well the king of the people, as the lawgiver of the people. I am Darius, the king; the great king, the king of kings, the king of the many-peopled countries, the supporter also of this great world; the son of Hystaspes, the Achæmenian."

560. Mongolian Family.—This extensive family comprises a vast number of the inhabitants of eastern countries; but the members possess the common characteristics of man in every instance. The Chinese are remarkable for their various arts and manufactures; their junks are very wonderful performances; and other cases wherein they show a knowledge of the properties of matter are very numerous. This race of men are acquainted with the property of the compass, and I myself possess one made by these remarkable people, carved with Chinese characters. Under Blumenbach's division, certain tribes in the north are arranged under this family; and I have seen a very remarkable instance of the manufacture of a harpoon made by tying a piece of shell to a bone, which was shown to me by Mr. Gray of the British Museum. I need hardly call attention to the canoes of this tribe, which are ingeniously formed. A patient, who incidentally consulted me last week, told me of a very curious mode which these people adopt to catch salmon. They use a piece of bone, sharpened at one end, which they fix to a long

line, in a manner similar to that used by the English fisherman for his sniggles. A long line, with many of these fine needles, baited in this manner, with a heavy stone at one end and a buoy at the other, is placed in situations where these fish abound, and, in the course of the night, they catch cart-loads of the fish. The Chinese have clearly intuitions, and notwithstanding their artificial gods, they still hold a great Deity, right and wrong, and a future state of rewards and punishments.

561. Ethiopian Family.—The Negroes and Africans form a sufficiently marked group, and present considerable differences when compared with the inhabitants of Europe. The inhabitants of Africa are not distinguished by any high amount of mental power. They show their knowledge, however, of the properties of matter, by making cloth, musical instruments, and by various other manufactures. I have figured a very curious musical instrument from Ashantee (*Plate* 10, *fig*. 6), which shows their capacity to use these matters. We thus find that the difference between the mental power of this and the former family is rather a difference in degree than in kind, as, though they use the properties of matter to effect their object, yet they do not possess the skill of a Brunel, a Stephenson, or a Newton. The Ethiopians, like the Caucasians, still hold the same intuitions—they believe in the Deity, in a future state, in heaven and hell; and thus, in all respects, they exemplify, although in a lesser degree, the general peculiarities of man which separate him from the lower forms of creation.

562. American Family.—Over the whole continent of America are scattered wild men, who live in small communities, and exist by hunting and fishing; of these Catlin has figured a great many chiefs and other individuals. Some races have been entirely

destroyed by small-pox and battle, since he made his sketches. Extraordinary accounts have been given of these wild tribes, and I am myself acquainted with an aged lady who, in her youth, was taken care of and preserved by one of these races, and who, even now, records warmly their kindness and attention. These men have not distinguished themselves for arts or literature, or any knowledge beyond that which would maintain their existence. Some of these tribes use poisoned arrows, others blow arrows through a blowpipe (*Plate* 10, *fig.* 15). The Flatheads and other tribes have the remarkable peculiarity of subjecting the heads of their children to pressure, by a contrivance which thus gives a remarkable conformation to the skull.

563. There are, doubtless, great temptations to follow a roving, wandering life; and we even find some Anglo-Saxons leave the blessings of civilization to enjoy nature in all her grandeur and majestic wildness. By continually following this course for many ages, the higher faculties of the mind in the various descendants, from being never used, may, to a certain extent, be lost throughout the entire community. Living in an overpopulated country, where it is almost impossible to peep at nature untouched by the hands of man, we are almost tempted to envy these people; yet, the blessings of a cultivated mind, of good laws, and a wise government, more than compensate for this loss. I can never myself observe the few wild spots round this modern Babylon to be curtailed, without feelings of the deepest sorrow. Penge Common, over which I used to wander when a schoolboy, is now no more; the beautiful hanging wood of Forest Hill is now cut down; and even in Epping Forest, places where I have formerly disturbed the wild deer in their dense hiding-places, I see with regret to be converted into cultivated fields. I would yet appeal earnestly

to the legislature still to preserve some wild spots for our children and our children's children to visit, that they may read the proofs of their God in the glorious works of nature, where art has not impertinently meddled and disturbed. In this country, where beauties still exist, the lords of the soil occasionally, though rarely, forbid them to be seen. The Duke of Athol has earned for himself an unenviable notoriety in hiding from his fellow-creatures the noble pass of Glen Tilt; and, doubtless, if such a man could control the sun, or moon, or stars, he would, in the plenitude of his selfishness, allow them to shine only upon his own ducal person and possessions.

564. The influence of the wild life of the hunter must have much effect upon the habits and customs of individuals. The men who live on the mighty waters of the Mississippi possess peculiar characteristics. They think nothing of firing at a cap placed upon a man's head, as they will perform the feat for a cup-full of spirits. These men who navigate the Father of Waters are said to be the authors of those curious wild melodies which go by the name of the 'Nigger melodies.' Now, these melodies, although they may appear coarse to the ear accustomed to the more refined and scientific compositions which may be heard at Exeter Hall, the Operas, or Hanover-square Rooms, nevertheless are by no means devoid of merit. They have been extensively employed at our lesser theatres, and there is scarce an errand-boy in London who does not relieve the monotony of his occupation by whistling them. The Mississippi men, however, have tasted the benefits of civilization, and whilst they feel the influence of the wildness of nature, yet do not forget trade and commerce. I was once stopping at a farm which was much visited by deer-poachers. As soon as evening came, the gamekeepers, saying that they did not

wish to be murdered, used to retire, and left these men to follow their unlawful calling. At night I used frequently to sally forth to see what these men were about, and many a time I have been much amused at frightening away large parties who were going "strong after the deer;" though I must confess, that they have had the laugh against me, by equally terrifying myself on other occasions. When they found that there was "not a bit of harm in me," as far as their practices were concerned, I was enabled to come in contact with them, and I found the men were quick, active, lawless, and greatly preferred to poach at the risk of transportation, than to work at a more moral occupation. I should think that these deer-poachers would be the very people to encounter the hardships of a new settlement.

565. We must attribute many of the peculiarities of the American Indians to their mode of life, which has so many charms, that they are not likely to abandon it willingly so long as hunting-grounds exist over which they may roam. We can easily fancy with what feelings of supreme contempt the Indians, accustomed to all the beauties of nature, would view those unhappy creatures of civilization, who, day after day, seek amusement and pleasure in being driven round Hyde Park in a luxurious carriage. With respect to the intuitions of the Indians, they hold, like the rest of mankind, good and evil, a great Spirit, heaven and hell; and thus we find that they very widely differ from any of the lower members of the animal creation.

566. Malay Family.—Some portions of this family hold but a low position in the scale of civilization. However, notwithstanding this, there is not one tribe which does not possess a knowledge, more or less, of the properties of matter. We find that even the lowest of this family, the Australian natives, have

constructed a very curious instrument, the "Boomerang," which, when thrown into the air in a peculiar manner, if it does not hit its object, returns to the feet of the thrower. Now in this single instrument, we have an invention which is not equalled, in its kind, by that of any other nation (*Plate* 10, *fig*. 2). The other islanders in the Pacific may also be noticed as the discoverers of other contrivances, and I have figured many instruments made by these people. They curiously attach sharks' teeth to a handle, and use it as a warlike weapon, of which, as of the boomerang, I possess a specimen (*Plate* 10, *fig*. 3). Their mode of hoeing, by a stone bound by a coarse string to a piece of wood, is a very remarkable performance (*Plate* 10, *fig*. 1); but perhaps the artificial fish-hooks and baits are a still more wonderful contrivance. I have the good fortune to have a few fish-hooks made by the Otaheitans, which were brought over by one of the officers in Captain Cook's expedition. They are made of mother-of-pearl, with a barb formed of bone, and so ingeniously contrived, as to combine great strength with efficiency. I call particular attention to these things, because I question whether, if we were deprived of fish-hooks, there are many amongst us who could devise a similar instrument of equal utility. The fish-hooks which I possess were obtained at a time when the natives were first visited by Europeans, and, as purely savage life is fast wearing away, they are peculiarly valuable (*Plate* 10, *fig*. 12). I would earnestly beg the trustees of the British Museum to purchase the works of savages whenever they are offered for sale, as it is manifest that, a few years hence, accredited specimens of the industry of wild men will not be procurable at any price. These natives also make artificial baits by shells of cowries, to catch cuttle-fish (*Plate* 10, *fig*. 13). They also contrive chisels in a very curious manner, by affixing pieces of flint

W. Wing, del et lith.

Reeve Benham & Reeve, imp.

(*Plate* 10, *fig*. 4); hammers, by attaching a large stone to a piece of wood (*Plate* 10, *fig*. 18); hatchets, by attaching stones to long pieces of wood (*Plate* 10, *fig*. 7, 17). They also ingeniously construct files, by attaching the skin of a fish to a piece of wood (*Plate* 10, *fig*. 9); and the New Zealanders are even able to make saws, by attaching sharks' teeth to pieces of wood (*Plate* 10, *fig*. 14). These contrivances are as perfect as the members of more civilized nations could accomplish with similar means at their disposal; and I have figured a Celtic arrow-head, of flint, to show how our ancestors used to make their arrows (*Plate* 10, *fig*. 10). I have also figured a reticule, belonging to the natives of the interior of Australia, which is curious, as being made by one of the lowest tribes (*Plate* 10, *fig*. 5).

As far as we can ascertain, even in the lower species of the family, they all hold, more or less clearly, the notions of a Deity, right and wrong, and a future state in bliss or misery.

567. Really, if we desire to have a perfect history of man, we should begin with the biography of each individual person; we should then extend our information to the various other members of his family, and we should then further group these relatives together, till we comprise the description of entire mankind. In this way I can but regard these five great divisions as five great departments, wherein the members are grouped together as far as may be according to their family resemblances.

568. I have thus given a short epitome of the five great families into which Blumenbach has divided mankind; and although we find that *we* very generally surpass the rest in physical conformation and mental faculties, yet I can, with confidence, appeal to any of my professional brethren, who come in contact with all classes of society, to prove, that in this country, or even in this

metropolis, we have every shade of intellectual excellence, such as we meet in the whole range of men distributed over the globe. In nearly every workhouse, and in every other station of society, may be seen a few individuals who, in physical conformation of their brains, in knowledge or mental capacity, are but little raised above the higher order of animals. This is by no means owing to poverty or to the want of education, as we frequently meet, in the humblest paths of life, those whom circumstances have placed in this unfavourable position, but who, nevertheless, are amply endowed with a noble physical structure, ample mental faculties, and who in every respect would have done honour to a higher station of life, or a more dignified position amongst their fellows. Such persons as our poet Gray would seem to have had in his eye, when he wrote his imperishable 'Elegy in a Country Churchyard:'—

> " Some village Hampden, that with dauntless breast
> The little tyrant of his fields withstood;
> Some mute inglorious Milton here may rest,
> Some Cromwell, guiltless of his country's blood."

CHAPTER XV.

NATURAL CLASSIFICATION OF MANKIND.

Families of Men, 569.—Individuals differ, 570.—Knowledge of Individuals influenced by others, 571.—Anecdote, 572; of Stephenson, 573; of the Corporation, 574.—Philosophers regard future Reward, 575.—Mediocrity, 576.—Sydney Smith, 577.—Division into Five Classes, 578; their Enumeration, 579.—Aisthenic Variety, 580.—Subvarieties, 581.—Attention, 582.—Observing Man, 583.—Syndramic Variety, 584.—Subvarieties, 585, 586.—Noemic Variety, 587.—Pneuma-noemic Variety, 588.—Dynamic Variety, 589.—Subvariety, 590.—Pleasure and Pain, 591.—Exemplification, 592.—Examples of these Classes, 593.—Inventor, 594.—Judge, 595.—Irish, 596.—Lawgiver, 597.—Various Professions, 598.—Education, 599.—Individual Responsibility, 600.—Classification at Different Ages, 601.—Relation of Faculties to Organization, 602, 603.—Conclusion, 604.

569. In my last chapter I have called attention to the five races of men which inhabit this globe, and have shown that they may be regarded as five large sections of one family, each possessing its own peculiarity.

570. To my mind, this division is not altogether one which is convenient, either in a physical or moral point of view, because, although undoubtedly a family resemblance may be detected over a whole race, yet in each family no two individuals thoroughly accord either in body or mind. It would be great injustice to stigmatize a whole family because several members were idiots, or possessed any striking peculiarity; and thus, in a physical and religious point of view, every individual should stand upon his

own merits, apart from the peculiarities inherent in the rest of his family.

For a proper division of mankind, according to mental powers, we must have recourse to electro-biology, and, doubtless, by that we shall be able to place every individual in his proper department. An artificial arrangement of this character is, however, extremely difficult to form, because there are so many various circumstances to be taken into account. I cannot altogether say that I am satisfied with the whole matter in its various details, though, in the absence of a better system, I feel no hesitation in submitting it to my readers, trusting, that if they detect errors or imperfections, they will not hesitate to endeavour to place this important subject on its proper footing.

571. In estimating the abilities of any individual, we must bear in mind the state of knowledge in those who surround him; for if any person either knows much more, or possesses far more abilities, than his fellows, he is sure to be not appreciated, but is even liable to hatred and persecution. A short time since, a friend of mine was asked to attend a chapel where a lecture on astronomy was about to be given to the working men, in order that his presence might give a certain amount of *éclat* to the proceedings. After the commencement, he left the platform and went amongst the working men; and, as the discourse proceeded, he observed his neighbour to grow very uneasy. He told him to sit still, for what the lecturer said was quite true; but his neighbour kept muttering to himself, "I can't stand this." After a time, the lecturer spoke of the motion of the earth, and the number of miles travelled per hour, when instantly he jumped up and said, "I cannot stand this a moment longer," and he took up his hat and walked out.

572. Some years ago, being in the country, I was discussing some question with a rough, practical, farm bailiff; and I told him, as a matter of information, that water was made of two gases, oxygen and hydrogen, when he indignantly replied, "Now, young man, you must not tell that 'ere to I; you must go and tell that to some of your cockneys, who don't know no better. You must not tell that 'ere to I, no, that you mustn't. That won't do here;" and, as he uttered the words, he gave his head the significant shake of thorough self-esteem.

I remember to have read a story of a traveller in Spain, who described various things, which entitled him to great respect, till, unfortunately, he described the Thames Tunnel. This was too much for their minds to bear; and, from that moment, all his words were disbelieved, and he fell into great disgrace.

573. Nor must we look only to ignorant people for results of this character: we find similar effects in a class above them. It is curious to observe, at all the boards of parishes or corporations, or of scientific and literary institutions, how careful the members are to select a person of their own calibre of mind, who shall not, by his observations, interfere with their ignorance and demonstrate their foolishness. In public establishments, also, it is constantly noticed, that if any man of superior talent arises, the other individuals combine to misinterpret his actions, misrepresent his words, magnify his imperfections and frailties, and thus seek to turn his abilities into ridicule. If we trace the subject to our very lawgivers, here again they exhibit this foible of humanity; and it is currently stated, that the immortal Stephenson dared not tell the House of Commons that locomotives could run at more than ten miles an hour on railroads; and ultimately, the first bill was thrown out because the conveyance was not considered to be

quick enough. Nor are those scientific lights, who give knowledge to the world, protected from such weakness. Ambrose Paré, who gave to man the ligature as a substitute for the hot iron, was opposed by the entire medical profession of Paris; and only obtained leave to publish his work by making private interest with the king. Jenner and Harvey were, in a similar manner, vituperated; and probably even Paré, Jenner, and Harvey themselves, if they had met with men greatly their superiors, would have shown their humanity by a similar weakness.*

574. It is curious to observe how men cling to their own class. When the City desired to promote the exhibition of manufactures, the mayors of all the towns of England were invited to the Mansion House, as well as the masters of all the companies, and the scene, I am told, was truly entertaining. One mayor was speedily more than half seas over. The more knowing ones persuaded some of the worthies of small towns that various individuals were distinguished personages. I need hardly mention that the brilliant speeches of His Royal Highness and the other visitors were, in a great measure, lost upon those who had no interest in the exhibition. I have been much grieved to find that those who give the science, supply the money, and have the power to supply the goods, are, in some degree, estranged from the object, though I hope that no mischief will arise therefrom.

575. Those who originate new sciences, and bring forward new

* The words of the immortal Harvey, at the commencement of one of his chapters on the circulation of the blood, are significant enough:—" Nunc verò de copiâ et proventu istius pertranseuntis sanguinis quæ restant (licet valde digna considerata) cùm dixero; adeo nova sunt et inaudita, ut non solùm ex invidiâ quorumdam metuam malum mihi, sed verear ne habeam inimicos omnes homines: tantum consuetudo aut semel imbibita doctrina altisque defixa radicibus quasi altera natura apud omnes valet, et antiquitatis veneranda suspicio cogit."

views, know well that they will have the opposition of men of their own time. They look, however, to the future, as they feel sure that those who are acquiring knowledge will compare all the views, and hold that which their judgment determines to be right. We can easily imagine the pity and contempt which the true philosopher must feel for his opponents, when he sees that which he knows to be true to be vituperated, misrepresented, and misquoted by those who are jealous of his abilities, and are only fearful that his important discoveries will attract such attention as to place him, in public estimation, above his neighbours. Nearly every great man recorded in history has been persecuted in his time, and has only been appreciated when death has removed him from the scene of the envy of his contemporaries, when they instantly discover his talents and proclaim his worth.

576. We thus find that there is a strong tendency to preserve an average, or, in other words, to produce a mediocrity; hence, in any electro-biological division of mankind, the average ability or knowledge of those around them should be carefully considered; for a clever man, amongst ordinary corporate functionaries, would be sure to propound such truths as would so much startle them that he would be run down by all around him.

577. The distinguished talents of the late Sydney Smith made him thoroughly acquainted with this tendency to preserve a mediocrity. He used to say that it was useful to know what ninety-nine average men out of a hundred would say upon any definite point; and he selected persons for that purpose which he called his Foolometers. There can be little doubt but that foolometers might be brought within the range of scientific investigation, as much as thermometers, hydrometers, optometers, or any other measures used by man. The existence of foolometers in every

department of science, literature, and art, must have been noticed by all; and I need not here especially indicate the man who is, to the public, the measurer of received knowledge in each respective walk of life.

When the foolometer, or mediocrity meter, shows signs of praise, the idea or work which he praises is frequently vapid, and devoid of merit and originality; when the foolometer indicates blame, then the subject requires consideration; but when the foolometer shows great excitation, and deals out hard names, personalities, and vulgar abuse, then, indeed, the matter requires grave study; for this result indicates that the entire brain of the individual is put into commotion by the discordance between the matter treated of, and his former ideas.

578. By arranging men according to their individual mental powers, we obtain a system more in compliance with justice to the party, and more consistent with religion. Although it cannot be denied that mental power follows whole families and races, yet also is it equally certain that a man of intellect occasionally arises in a family whose various members exhibit great inferiority. To deny to such a man his proper place, on account of his family history, would be an act of great injustice to him, and calculated to act injuriously politically.

579. When I commenced this work, I made up my mind especially to avoid hard words; but I think that in this chapter, to prevent confusion and error, I shall be compelled to use a few difficult terms, for which I must beg the pardon of my readers. In the first place, according to electro-biology, we should divide mankind primarily into five great classes, according as they exhibit more or less of each particular quality of mental power. These great classes I shall subsequently subdivide into lesser divisions;

and lastly, I shall consider cases of combinations of these four classes.

The first class comprises those cases which exhibit special power in the use of organs of sensation; and hence may be termed *Aisthenic*, from αἴσθησις, *sensation*. There is no word in the English language of precisely similar signification; but the word *sensual*, which ought to be applied to this class, has been employed in a sense of degradation not necessarily applicable. The second class I have termed the *Syndramic*, from συνδραμέω, *to combine*. It means the possession of ideas, inasmuch as I have shown that we derive ideas from combinations of nervous impressions. The third class comprises those cases where the appreciation of laws is prominently seen; and, as it evinces the higher power of the mind, I have termed it the *Noemic* class, from νόος, *mind*. The fourth class I have called the *Pneuma-noemic*, from πνεῦμα, *spirit*, as it appertains to the appreciation of spiritual qualities. Lastly, I have named the fifth class *Dynamic*, from δύναμις, *force*, as it comprises the varieties which are derived according to the activity of man. These classes may be afterwards subdivided and combined; so that, ultimately, we shall be enabled to put every man in his proper place.

580. Class 1. *Aisthenic Variety*.—We find that men present great differences in their various capacity to use their organs of sensation. Some possess this faculty to a great extent, and in others it is much depressed. Not only with regard to all the organs of sensation taken together, but even with regard to each considered separately, we find a considerable variety in different individuals.* Some are quick-sighted, others are very acute in their hearing; some feel acutely, others have a keen sense of

* It might be convenient to carry out the Greek nomenclature here, as in my

odours or of savours. By this subdivision we obtain six sub-varieties, which are so very distinguishable, that I need hardly give special illustrations of them.

581. But we may even go further in this subdivision. We may distinguish, minutely, in what respect the faculty of any sense is exalted or depressed. Thus, with the eye, we may point out whether the adaptation to distance is extensive, or whether the party is remarkable in observing small objects. So with the ear, we may determine the pitch of the note or the direction of the sound; and in a very refined criticism we may even descend to further particulars.

582. In this first class, when any man exhibits any perfection, it necessarily follows that he is attentive to that which is going on around him. Perhaps we might refine our divisions to too great an extent; otherwise, this attention does not necessarily follow a capacity to use any organ of sensation. From this view, we should have cases of attention and inattention in each of these subdivisions, which would again double our heads under the class of sensations alone. I am inclined to think, however, that the former subdivision may be considered sufficient, especially if it is understood that each comprises attention.

583. The aisthenic man, as deduced from electro-biology, corresponds more nearly to the observing man, than to any other; however, I should advise the first term to be used, to the exclu-

'Elements of Electro-biology;' and upon this plan we should have the following arrangement for the Aisthenic class:—

1. Opsaisthenic: Ὦψ, an eye, *αἴσθησις*, sensation—Endowed with acute sight.
2. Ousaisthenic: Οὖς, an ear, *αἴσθησις*, sensation—Acute-hearing.
3. Gumaisthenic: Γεῦμα, taste, *αἴσθησις*, sensation—Acute-tasting.
4. Rhinaisthenic: Ῥὶν, nose, *αἴσθησις*, sensation—Acute-smelling.
5. Cœnaisthenic: Κοινὸς, common, *αἴσθησις*, sensation—Acute-feeling.
6. Somaisthenic: Σῶμα, body, *αἴσθησις*, sensation—Acute bodily feeling.

sion of the second, as the observant man, in the sense in which we use that word, often infers the possession of the higher faculties; whereas this class solely comprises those whose organs of sensation are readily and extensively capable of being excited to action.

584. Class 2. *Syndramic Variety.*—The faculty for the appreciation of simple ideas derived from the external world is of great importance; and those who specially possess this property come under this variety. But all men do not equally exhibit a knowledge of ideas obtained by the various senses. Thus, some men have a vast accumulation of ideas which they have derived from their eye, others from the ear; some, again, are remarkable for their knowledge of that which they have felt. By subdividing this variety, we have thus, as in the former case, six separate compartments, which may be named in a manner similar to the first variety.*

585. Persons comprised within this second class may exhibit recollection of these ideas; that is to say, they may be called into action under any particular stimulus which may force them upon their remembrance. Persons may, moreover, evince an active memory of these ideas, which thus occur to the mind spontaneously, constituting a man who, in ordinary language, is called a plain matter-of-fact man. Lastly, this activity in the memory of these ideas may so evince itself, that two or more events may appear together, when we have an imaginative man. But, as we

* The nomenclature would, in Anglicized Greek, run as follows:—

1. Opsyndramic, remarkable for ideas derived from the eye.
2. Ousasyndramic, ,, ,, ,, ear.
3. Rhinsyndramic, ,, ,, ,, smell.
4. Gumasyndramic, ,, ,, ,, taste.
5. Cœnosyndramic, ,, ,, ,, feeling.
6. Somasyndramic, ,, ,, ,, bodily feeling.

may have these three qualities in each subdivision of this variety, it follows that we shall note eighteen divisions of this class.

586. Moreover, all these cases may be attended with a pleasurable or a painful character. Thus, the remembrance of events is, to some persons, continually unpleasant; to others, delightful. This variety of individuals does not exhibit peculiarities which dignify mankind; as animals, to a greater or less extent, evince a similar power. In this class we continually observe certain individuals who get an idea firmly impressed in their minds, which neither will other ideas counteract, nor is it of any use to demonstrate to them that it does not accord with general laws; such a man is called, in common language, an obstinate man.

587. Class 3. *Noemic Variety.*—We find some individuals who are remarkable for the power of inducing laws from the simple ideas which they receive. This faculty of inducing laws is the faculty which constitutes a man of principles. Where the property is so active that the law is produced by a very slight effort, the person exhibiting the action is termed a theoretical man. The active memory of laws is very important, as, by obtaining ideas deduced from general laws, we obtain an individual of a high order of mind. There is a very rare quality of mind which man occasionally evinces, in the faculty to combine laws and ascertain their relations to each other. Perhaps there would be no impropriety in quoting Faraday as a remarkable exemplification of an individual possessing this power; and probably, in the records of history, we can hardly find another individual who has done so much for the extension of the knowledge of the relation of physical forces to each other. Where a man has laws so fully impressed that he is not led away by deceitful or plausible tales, but maintains inviolate the law under all circumstances,

he is termed a firm man; and, contrariwise, if the law is not firmly impressed, he is called a vacillating man. No man living can tell what such an individual will do; for he will listen to the last tale which is told him, and have no settled principles to guide his operations. Such individuals are terribly troublesome to have business with, as we cannot depend for a single instant upon their proceedings; and the more active they are, the more dangerous are they to those around them.

588. Class 4. *Pneuma-noemic Variety.*—We sometimes meet with individuals who are always dwelling upon that which is infinite—such as the Deity, the soul, eternity, heaven, hell—who may be classed under this variety. In cases where these faculties bear a proper relation to other faculties comprised within the former classes, the man is greatly dignified, and raised above his fellows. In cases where these properties of the mind are shown, to the exclusion of the other faculties, the man degenerates to the degraded position of the wild fanatic and devotee. We must not mistake cases of perverted reason for instances where these faculties are fully developed. For instance, the Hindoo priests induce the widow to sacrifice herself on the funeral pile only by an intense excitement of her nervous system; so also the Popish priests ensnare their victims for nunneries and convents in a similar manner. In like manner the fanatical enthusiasts of America are so overstimulated, that it is recorded that they not only injure their bodily frame, but occasionally damage permanently their mental powers. All these cases do not come under this class; but the sufferers exhibit the natural degradation of perverted reason under the false guidance of a heartless priesthood.

589. Class 5. *Dynamic Variety.*—Individuals who evince great activity, either from an external stimulus upon their organs of

sensation, or from the internal stimulus of their own thoughts, may be classed under this variety, which thus comprises all the active men. Activity may have its origin at various parts of the nervous system.

590. Some persons evince an activity only when acted upon immediately by external objects. Others, again, evince a tendency to act from former ideas previously implanted; hence, their activity may depend upon simple ideas, imagination, or previous laws. Various men differ much in these matters; but, perhaps, the most universally active man of the present day is Lord Brougham, whose talents are directed to a great variety of subjects, without being in any way compelled to engage in either. When any man carries out, with great vigour and determination of purpose, any definite idea, he is said to be a man of great energy; and surprising it is to observe in what manner this power acts to overcome difficulties.

591. Having thus considered the five principal classes of individuals separately, we may now direct our attention to the study of persons who possess two or three of these classes of faculties conjoined, and take a glance at some prominent characteristics which some individuals present.

592. The sensation of pleasure and pain should be equally distributed throughout the nervous system. Unless we felt pleasure from action on our senses, this beautiful world could afford to us no enjoyment; for neither the pleasures of the landscape, of music, of society, of the table, of odours, or of other sensations, would contribute their feelings of delight. Unless we felt pleasure in recalling to mind former scenes, the past would not dwell in us with satisfaction. Unless we felt pleasure from developing principles, the mental labour of habitual studies would be a bur-

den. Unless we felt pleasure from every act which we perform, the delight which we experience from obtaining our bread by the sweat of the brow would be exchanged for a feeling of anxiousness and weariness at our position. And lastly, unless we felt pleasure in contemplating our immortality and the Great Author of the universe, we should not esteem the inestimable privilege which we possess of perceiving the stamp of the Deity impressed upon every stone, on every plant, on every object which is presented for our investigation. Happy is the man who derives equal pleasure from all these events, as every moment of his life must be accompanied with joyous feelings.

593. In a former part of this work I have shown that every action on the nervous system is attended with the sensation of either pleasure or pain. Where there is an apprehension of pain, the party exhibiting it is called a nervous man, though nervousness may be frequently overcome by a mental effort. The Rev. E. Sydney, the biographer of the celebrated Lord Hill, told me that his lordship used formerly to faint at the slightest sight of blood, yet, in the field of battle, when duty compelled him to fight, he was the bravest of the brave, and neither showed fear nor exhibited nervousness. In cases where man seeks, principally, pleasure by the immediate action on his nervous system, and he gratifies his feelings, he is said to be a sensual man. Where the sensation of pleasure is easily excited, and man shows an activity from it, he partakes of the character of cheerfulness, a property which much conduces to the welfare and longevity of the individual. Lastly, cases where either the stimulus of the senses, or the memory of antecedent impressions, is continually producing pleasurable sensations, the man is called a happy man. Happiness is to be found in the middle course; for neither a vegetable

life on the one hand, nor an excited state on the other, can be accompanied by continual happiness to the individual. The mental and bodily stimuli, which I have before denounced in my chapter on perverted reason, doubtless, during the excitement, are attended with intense pleasure ; but there comes afterwards a fearful reaction, which is attended with corresponding depression or unpleasant sensation.

594. An inventor belongs to a class of men who require peculiar powers of mind. He must possess considerable knowledge of the laws of matter, so that when any difficulty arises he turns these laws at once to account, and applies them to particular events. Such a man must combine the properties of the second and third class, and, if he deduces the laws himself, must have the faculties enjoyed by the first class also.

595. The judge also requires certain powers. He must have the properties of the first class, and have an aptitude to receive all the facts. These new facts must take their proper position, with all the other ideas which he has received, both as concerns the simple event, general laws, and the moral law ; so that, in fact, the judge should have all the faculties of the mind perfect. We occasionally find men of great judgment without the slightest powers of origination. When the facts are brought before them, they take their proper position, with respect to all other facts or laws which they have before received, and the party comes to a right decision.

596. The very reverse state to that of judgment is observed very extensively throughout the vast family of the Irish. When an idea is received, instead of their assigning to it its proper position, an undue importance is given to it ; and hence the Irish are always taking up some new wild scheme without

proper thought or judgment. The only mode to control this irregular action of the brain is to exercise well-devised laws with invariable impartiality and with the most determined strictness. By good management, over a series of years, there is reason to hope that this pernicious habit may be controlled, if not ultimately broken.

597. The judge, or man possessing judgment, differs from the lawgiver either in politics or in science, from his not evincing an activity or spontaneity in arriving at his decision, although all parts of the brain must be as entire, and act as equally in both instances. The originator of discoveries of laws, whether in science, politics, or morals, is a man who confers great benefit on his fellow-creatures. In every case he must have been endowed with superior faculties by Providence, and must have equally cultivated his talents by education. Yet, notwithstanding all this, how ill we reward these distinguished individuals! They are not only exposed, too frequently, to every kind of attack from those who, to use their own cant phrase, desire no change; but even in this country their very bodily maintenance is very ill provided for, or even totally neglected.

598. If we look to six professions—the musician, the artist, the lawyer, the doctor, the engineer, the clergyman—we shall find that each requires a combination of these classes of faculties to arrive at any definite excellence. The musician requires a keen perception of sound, of the various ideas arising from combination of sounds, and of the laws of these combinations, before he can successfully be a composer and musician of the first class. When the ideas and laws have been once received, the faculty to be impressed with new sounds may be totally lost; and in this way great composers have produced wonderful compositions when

perfectly deaf; and Beethoven has been known to lead a band when he could not hear a single note. The artist must have an accurate perception of the colours and forms of bodies, as well as of the various ideas which he derives from combination of these forms. Moreover, if he wishes to excel, he must also be acquainted with general ideas, and laws of these ideas, otherwise his pictures or sculptures will exhibit no originality of design. I happen to know that our distinguished artists have to study, with great minuteness, the designs upon which they form their pictures. The lawyer has certain facts given to him, which he arranges under general laws, and determines their accordance or discordance with the laws of the realm. He, therefore, requires the second and third class of faculties more especially to be brought into play. The doctor, however, requires a more extensive range of faculties. He must have a quick perception by all his organs of sensation. At one time he gets knowledge by the touch, then he derives knowledge by the sight; again he applies his ear to the chest, to hear the action of the heart and lungs; by the eye he determines the appearance of the disease; and even sometimes his nose assists him in the discrimination of maladies. From all these facts he induces the real state of the patient; and having learnt this, from the laws of life and of the effect of agents on living bodies, he deduces the line of treatment to be followed for his patient's cure. The doctor thus requires the first three classes of faculties to be fully developed. The engineer requires faculties in almost all respects similar to those which the doctor must possess for the successful exercise of his profession. He must be quick to observe, and have the power of inducing a general principle from his observations. He must have his mind well stored with the properties of matter, to apply at once those aids which a knowledge of those laws must suggest. Sir I. Brunel, when he successfully combated the various difficulties encountered in the construction of the Thames Tunnel, and Stephenson, when he overcame the almost impossible conditions imposed by the Government, to the construction of a bridge over the Menai Straits, showed well the faculties required for the engineer. Lastly, we have to consider the clergyman: he gives the laws of morals, and shows their application to each particular case. He requires, then, a full development of the faculties of the fourth, third, and second class. Perhaps, of all clergymen whom I have ever heard, the late Sydney Smith exhibited most powerfully the faculties required for inculcating moral laws and showing their bearings on each particular point. To effect this, his sermons were so highly wrought that they must have occupied much time and attention; but then he used to deliver them over and over again: I have myself heard one sermon at St. Paul's Cathedral five times, and others two or three times. His discourses commanded the attention of the most distinguished philosophers, who listened with interest to his exposition of moral laws, whilst the meanest understanding was delighted by his exhibition of the particular instances to which the laws apply. I have heard him deliver sermons on the fifth commandment, and on the terrors of war, with wondrous effect. We thus find that, in the six professions which I have quoted, considerable difference in the mental faculties is required; and, as a result of the mind being particularly exercised in this definite manner, each profession exhibits marked peculiarities. Differences of a corresponding kind to those which we note in these professions may also be detected in every other occupation of life.

599. Doubtless, exercise and education, upon a brain properly

constructed, has great effect in improving the faculties, in the same manner as the muscles of the blacksmith's arm or postman's leg become developed from their increased employment. Where, however, there is great congenital deficiency, as in idiotcy, of a more or less complete character, very little can be done to improve the individual; although, even here, up to the extent of the natural faculties, education can be applied with the very best success.

600. We thus find that, by this biological division of men, the great and important doctrine of individual responsibility is enforced; and that from him to whom much is given much should be expected, and from him who is endowed with lesser talents we should not require so much. In our social division, it is manifest that no one class of labourers should be raised or extolled above another, but to each individual, according to his capacity, should be assigned his respective labour. It is by no means clear that talent, which is the immediate gift of God, should receive temporal reward, but, contrariwise, it is certainly wrong that those to whom superior talent is given, and higher duties assigned, should receive vituperation instead of praise, and heartless degradation instead of reward, as has too often been the case with the really great. The more we study man under the natural system of classification, the more convinced must we be that every human proceeding should tend to the benefit of every individual of our fellow-creatures.

601. In any perfect system of arrangement we have not only to consider the division of mankind into classes, according to their mental peculiarities, but we have also to consider the variation in mental faculties which is exemplified by each individual man at different periods of life. From birth to old age, every day makes

some difference in the physical organization and in the mental peculiarities, which difference has been so graphically pourtrayed by the immortal Shakespeare.—

> "At first, the infant,
> Mewling and puking in the nurse's arms:
> And then, the whining schoolboy, with his satchel
> And shining morning face, creeping like snail
> Unwillingly to school: and then, the lover;
> Sighing like furnace, with a woeful ballad
> Made to his mistress' eyebrow: Then, a soldier;
> Full of strange oaths, and bearded like the pard,
> Jealous in honour, sudden and quick in quarrel,
> Seeking the bubble reputation
> Even in the cannon's mouth: and then, the justice;
> In fair round belly, with good capon lin'd,
> With eyes severe, and beard of formal cut,
> Full of wise saws and modern instances,
> And so he plays his part: The sixth age shifts
> Into the lean and slipper'd pantaloon;
> With spectacles on nose, and pouch on side;
> His youthful hose well sav'd, a world too wide
> For his shrunk shank; and his big manly voice,
> Turning again toward childish treble, pipes
> And whistles in his sound: Last scene of all,
> That ends this strange eventful history,
> Is second childishness, and mere oblivion;
> Sans teeth, sans eyes, sans taste, sans everything."

602. It would be an interesting matter of science, to be enabled to refer each variety to some peculiar form or conformation of head; but in this matter we have not, at the present time, sufficient facts accurately noticed to assist us materially; moreover, a man may have, by conformation, structures adapted for particular purposes, which he may never have had an opportunity of exercising. On this account, the mere examination of the conformation can never altogether show us the real faculties which a

man possesses; although it is equally true, that without structure or conformation, a man cannot possibly exercise these faculties. If we turn to *Plate* 8, in which the four great divisions of the nervous system are figured, we find that the brain of man has a far higher structure, a greater size, and a greater amount of convolutions, than that of the dog; the dog has also certain parts of the brain far less intricate than that of man; and with this inferior organization he possesses inferior mental faculties. When, however, we look to the lower classes of the animal kingdom, we find that the nervous system is far less developed, and, with this slight development, we find a very faint exhibition of the qualities of the mind.

603. It appears that, with respect to man, it is very necessary that the cerebral lobes (*Plate* 8, *fig*. 1, *Plate* 9, *c c c*) should be fully developed; and great men, as Cuvier, have also frequently a great weight of brain.

Facts are still wanting upon this subject; and, although phrenologists have attempted the investigation, yet their fundamental propositions are not in accordance with received results, and, perhaps, but little dependence can be placed upon opinions which are so mixed up with a system of mental philosophy not in accordance with nature, but based upon purely empirical considerations. If, however, we discard the principles of phrenologists, yet we must not omit to award to Gall and Spurzheim their due praise for having made us acquainted with the true mode of dissecting the brain. To this class of philosophers belongs the merit of having shown the fibrous structure of the organ of thought, and the general course of these fibres to their termination in the grey matter. We must hence regard the labours of these pains-taking philosophers as works which have served their objects, contributed their benefit to man, and are only superseded by the development of that more perfect system which modern science is now deducing from more extended facts. Their writings, perhaps, have even produced a more important influence in all matters which relate to mental philosophy, as, over a series of years, they have emphatically taught that the faculties of the mind have a clear relation to the structure of the brain. It may be true that, as a science, phrenology has entailed upon its followers some amount of ridicule, from its votaries having pretended to assign to each part of the head faculties which give to the possessor a tendency to act in a particular manner. We may fairly, however, pass over these errors, and simply remember the benefits of the knowledge which they have actually enforced. In these inquiries we must remember that not only is structure necessary for a proper exercise of the mental faculties, but that aproper supply of blood must be sent to the brain (*Plate* 6), and that supply must be of a normal quality.

CONCLUSION.

604. I have now conducted my reader over the various matters with which I proposed to engage his attention at the commencement of the work; as I have now considered in what respect man differs from the dog, the daisy, a piece of mechanism like a steam-engine, or a lump of inert matter like a common stone.

From this investigation we have found that the mental faculties arise from the organization of the nervous system, and that by this mechanism we derive ideas from the external world, induce from these ideas general laws, or deduce from general laws their application to each particular instance. The exercise of the mental faculties is called Reason, which exists more or less throughout the entire animal creation. By virtue of possessing the faculties of reason, the actions of animated beings are regulated by all the former ideas which they have at any time received. But, superadded to reason, we have found ideas existing which have not been derived by the ordinary process of reasoning, but which have been implanted in the animal, and which are hence called Instinctive. In consequence of the possession of instinctive ideas, animated beings, without experience and without having been taught, are enabled to perform works as perfect as those of nature. We have found both reason and instinct to be manifested in various degrees by every animal, including man himself, although man stands prominently forward as the masterpiece of creation. To preserve this position, our continual attention should be concentrated; for when man yields to mere sensual gratification, he is lowered to the grade of the brute beast. When he yields his judgment to mental stimuli, he partakes rather of the lunatic than of the intellectual being; but when, by proper exercise, man brings each faculty of the brain into operation, and preserves a due balance of the whole, then, indeed, he is entitled to the appellation of the "Lord and Master of Creation."

INDEX.

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