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ON THE ARGUMENT FROM DESIGN IN NATURE, WITH SOME ILLUSTRATIONS FROM PLANTS.

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Part I.

THE argument from "Design" or from "Final Causes" has been used with such latitude, that I shall begin with stating the strict limitations under which I propose to consider it. In the first place I am concerned only with its application to the Natural World as presented to our senses, and I wish to exclude the more difficult questions which arise upon its extension into the moral and spiritual sphere. And, secondly, I may as well lay down at the outset the following proposition as expressing the doctrine in the form in which I am prepared to defend it. In the external world there are marks of Intelligence as shown by Order and Purpose, and from these marks we may infer with great probability the existence of an Intelligent Person, outside of and above Nature, who is the Source of this Order and Purpose. Even when thus limited the subject is so vast, that any attempt on the part of one man to pursue it into all its branches can only end in vague generalities and rhetorical declamation. For this reason I shall draw my illustrations almost exclusively from the Vegetable Kingdom.

2. Before, however, adducing those arrangements in Plant-life which I venture to consider as indicating Design, a few words may be devoted to some common misconceptions of the doctrine. Simple as the kernel of the argument is, both advocates and opponents have mixed it up with wider questions. Especially has it been identified with two theories about the world, with which it has no necessary connexion. I allude (1) to the old notion that all things were made for man; and (2) to the biological assumption that all species of animals and plants have been created separately and independently. Let us take these two subjects in their turn in their relation to Final Causes.

3. The assertion that all things exist for man may be considered as an exaggeration of the true doctrine of Design, which, like most exaggerations, has thrown discredit on the whole line of argument. Cicero, in the Second Book of the *De Naturâ Deorum*, expounds this view in its extreme form. Man was made the centre of the universe. Every phenomenon

was estimated with reference to his needs and convenience. Even the motions of the sun, moon, and stars were partly intended to afford him a pleasing spectacle. The sheep's wool was designed to clothe him, the dog to watch his flocks, the ox to plough his fields, the swine to feed him, wild animals to give him hunting exercise. Janet, in his masterly work on Final Causes, to which I acknowledge once for all my great obligations, has given some delicious instances of similar reasoning from Bernardin de St. Pierre (quoted by Biot, *Mélanges*, tom. i.): "Dogs are usually of two opposite colours, the one light and the other dark, in order that wherever they may be in the house they may be distinguished from the furniture, with the colour of which they may be confounded. Wherever fleas are, they jump on white colours. This instinct has been given them that we may the more easily catch them." It was very easy to ridicule this high-handed assumption; the following passage of Montaigne (*Essays*, ii. 12) will serve as a specimen of such criticism: "Why should not a gosling say thus: All the parts of the universe regard me; the earth serves me for walking, the sun to give me light, the stars to inspire me with their influences. I have this use of the winds, that of the waters; there is nothing which this vault so favourably regards as me, I am the darling of nature. Does not man look after, lodge, and serve me? It is for me he sows and grinds: if he eat me, so does he his fellow-men as well; and so do I the worms that kill and eat him." Now, this "exquisite fooling" of the great sceptic only assaults the exaggerated theory which sets man in the centre of the universe. It is no answer at all to the assertion that in the goose its eyes were made to see with, its lungs to breathe with, and its wings to fly with. Even now the primitive tendency to exalt man lingers in cultivated minds. People still confuse Design with our appreciation of it. Is it not possible for an animal or plant to have been planned solely with a view to its own well-being and without the slightest reference to man, as in the case of the deep-sea Fauna and Flora? The marks of Intelligence are not the least affected by not being recognised. A book is not less a book for not being read. After these deductions, we may freely admit that there is an appreciable element of truth in the human point of view when limited by good sense. To say that the sun was made to give light to the world and man is an imperfect but not a false representation of solar activities. I am now confining myself to the platform of facts and inferences, and ignoring theological speculation. From a scientific point of view it is true that

each animal and plant is best regarded as existing primarily for its own benefit. This isolation, however, is a mere act of the intellect and has no place in nature. Nature knows nothing of self-contained organisms; what she has to do with is a vast network of living things bound more or less to each other and to the inorganic world by an intricate web of mutual relations. Man has a pre-eminent place in this network. If it is false to say, "All things were made for man," it is equally false to say, "Nothing was made for man." From a purely biological point of view the advent of Man was the greatest event in the natural history of the globe. What species except man has domesticated a long list of other animals, and changed the face of the dry land by cultivation of useful plants? Any geologist would admit that the facts of his science are in accordance with the theory that preparation was made for man. So that, in a higher and general sense, the planet may reasonably be said to have been adapted for Man before Man appeared. But I hardly consider this so much the Argument from Design as a far-reaching corollary from it which requires caution in its application.

4. Let us now proceed to the other theory which is supposed to be indissolubly bound up with Design; I mean the scientific dogma, sometimes called that of special creation, but which would be better named that of the separate or independent creation of distinct species. Many opponents of Design seem to think that they are arguing against it when they are really arguing against the separate creation of species. This is a strange misconception arising from a narrow notion of Purpose in Nature. To begin with, such a line of objection does not touch the inorganic world where there are no species in the proper biological sense of the word, and where marks of Design are very evident. Again, supposing, for argument's sake, that species have originated by variation through unknown causes from pre-existent species, such variations can be conceived to have taken place according to a strictly pre-ordained scheme. In other words, there is nothing in the nature of things to prevent a Theist from combining a form of Evolution with Purpose or Ends. One thing, however, is certain, that he cannot look upon Natural Selection, acting upon the superfluous fecundity of Nature, as a key to the riddle, for, if Natural Selection can modify organs, it cannot create them. If some form of Evolution be the true account of Creation, it is not that form of it which derives its sole motive power from Natural Selection. The mode of Creation must always remain an inference, as it is removed from the sphere of observation and experiment. On

this difficult question I would only throw out as mere suggestions the following remarks :—

(I.) In the Scriptural account only one species is described as independently created; the others are brought on the stage of life in masses.

(II.) The somewhat scanty evidence in Nature seems to point to the conclusion that species have been developed from pre-existent species by means as yet undiscovered. Consider, for instance, the enormous number of allied species in the *Compositæ*. What are we to say to the Genus *Senecio*, with 900 species? It is very hard to think that such a vast series of forms insensibly passing into each other have been the objects each of a separate creative act. An Entomologist could probably give equally striking instances from his department; as, for instance, the *Noctuæ* among moths, and the countless beetles estimated at 100,000 species.

Here too comes in the development of the Parasites, both animal and vegetable. It seems impossible to believe that they were originally created as they now are, dependent for their existence on their present hosts or nurses. The parasitic habit is almost universally looked upon as an acquired one, wonderful as are the changes it has brought about. Another series of facts pointing in the same direction is found in the numerous cases of rudimentary or disused organs. To confine myself to plants, Cacti and many similar succulent plants certainly suggest to a Botanist the idea that they have lost their leaves, Broomrapes that they have lost their stems as well. Supposing, however, such a view to be established, I am at a loss to conceive how the argument for Design is thereby weakened; I should have thought, on the contrary, that the disuse of unnecessary organs, and the substitution of new adaptations in their place was a striking proof of Divine Wisdom.

But an advocate of Design may reasonably refuse to entertain the subject of creation at all. He may say, Species actually exist, or, if you prefer not to use that word, individual animals and individual plants exist. Supposing we disregard for the present any theory of their origination, and examine their present structure. If the eye, the heart, the wing of animals, the flower and leaf of plants offer evidences of contrivance, those evidences are not affected by the manner in which the species became what they are. The creation of an atom is as inconceivable as of a planet; inconceivable, but not impossible or incredible. For the laws of real existence by no means coincide with those of human thought. Many things

exist which are to us inconceivable; many processes take place which our intellects cannot grasp.

5. One other objection to Design deserves a few words, that which condemns it at the very outset as an anthropomorphic conception. It is true, the supporters of this view say, that if we come across a boat on the sea-shore we are justified in inferring that it was made for a purpose; and we know by experience that man is the only creature on this globe capable of thus making it. But it is not so with a natural object, as, for instance, a crab or a sea-weed. They were not made, but grew. They are descended from a long line of ancestors. In the course of time they have acquired their present adaptations which have only the appearance of design. In ascribing their production to a Maker acting with a definite purpose before Him, we are projecting our own personality outside of ourselves, ascribing human faculties and human aims to a Being who is not human.

To this it may be replied, that if this is justly called anthropomorphism then anthropomorphism may be claimed as being at the same time inevitable and true. But is it not an abuse of language to employ the word in this sense? There are two genuine kinds of anthropomorphic representations: (1) the frankly material conceptions of the old mythologies, as in Homer; and (2) the vivid language of poetry, as in the Psalms. Neither of these need detain us. But, when the bare ascription of Personality to God is described as anthropomorphic, it is simply an unfair way of stating a metaphysical difficulty, for it assumes it as proved that God is not a Person. All our conceptions of the Divine Being are inadequate, but they are not for that reason false. How can we transcend the limitations of our consciousness? How can we think of any thing except according to the laws of thought? But it does not thence follow that our knowledge is not knowledge because it is conditioned. So with reference to our representation of God as a Person. Personality is our highest attribute, that which makes an impassable gulf between ourselves and the rest of the animal series. The Agnostic may say you make God a Person because you are a person. May we not reply, the converse is also possible, *God has made us persons because He is a Person.* Our will, intellect, and affections are faint adumbrations of the divine attributes. The human soul, dimly conscious of its affinity to the Divine Nature, instinctively believes in a Being who possesses, in perfection, the Power, Wisdom, and Goodness which we possess in the imperfect manner of finite natures. To put it on the

lowest ground, the latter alternative is quite as probable as the former.

6. A few words more on the limits under which alone the argument from Design is tenable. Many of its opponents imagine that it ought to assign a purpose for every thing under the sun. This is a most unreasonable demand. It totally ignores the imperfection of our knowledge, the finite range of our faculties. We must be content to remain ignorant of much, especially of the higher Final Causes. What is the Purpose of Comets? We admit our ignorance. What is the Final Cause of Saturn's rings, of double stars, of the varying inclination of planetary axes to the plane of the ecliptic, of a thousand other phenomena in the visible world? A sober thinker admits at once that these question are beyond our ken: it was such final causes as these that Bacon ought to have condemned as *misleading*. In the same way I do not know that any judicious advocate of Design asserts that an "organism is launched directly at a purpose," as Professor Huxley curiously puts it; what we assert is, that *organs* aim at a distinct end, not *organisms*,—an important distinction. Many Final Causes are thus totally beyond our range; but that is no reason why we should shut our eyes to those which lie obviously in our path. Yet Materialists argue in this way: If you can show no purpose in the desolate planets and their superfluous moons, you must not talk to me about the eye.

7. From the nature of the case the argument from Design must be denied by certain schools of thought as it is fatal to their fundamental theories. The Agnostics cannot be expected to admit it, or they would, by doing so, cease to be Agnostics. I have not myself read Herbert Spencer, so I will quote the estimate of his ultimate tendency from a critic whose impartiality and ability are universally recognised, Paul Janet:* "All Mr. H. Spencer's scientific apparatus, the whole mass of these examples accumulated to satiety, all that mechanical and dynamical terminology, can neither mask nor relieve this low and common result, the only one that can be disentangled from these diffuse amplifications; namely, that organic forms are the product of fortuitous combinations of matter. And no other hypothesis is possible: hence any internal or external directive principle is rejected. The fortuitous is the veritable artist, the seminal agent of nature." Materialists again of Haeckel's school are *ex hypothesi* incapable of fairly con-

* *Final Causes* (Eng. trans., p. 313).

sidering the argument from Design. For, simple as it sounds, if once admitted, it shatters to fragments the ever-shiftiug systems of the universe which recognise only Matter and Force. Great then is the bitterness with which the Materialists assail teleology. We may fairly ask why are they so envenomed on this subject, so incapable of judicial calmness? Is it because of the lurking suspicion that, do what they will, the argument is indestructible? A man reads volume after volume of wordy and hazy disputation, in which the meaning is usually in inverse proportion to the length of the words in which it is disguised; he then goes out into the fields, he picks up a butterfly, a beetle, or a flower, and all the arguments against Design seem to melt away like the mist before the sun. He thinks of Tennyson's lines about a sea-shell:—

> "Frail, but a work divine,
> Made so fairily well
> With delicate spire and whorl,
> How exquisitely minute
> A miracle of design!"

In concluding these introductory remarks, I do not claim for a moment that the argument from Design amounts to demonstration. It is logically a high probability; it is an instinctive, deep-seated conviction, produced by the observation of countless particular instances, and it is, moreover, a reasonable conviction which admits of defence. But as an argument its value is that of a high degree of probability, an approach to demonstration which certainly cannot be predicated of any material explanation of the universe.

Part II.

8. Let us now advance to some of the arrangements which appear to indicate Design in the Vegetable Kingdom. First and foremost comes the great office of plants, that of supplying food to the animal world. On this planet we know by observation that animals are so constituted that they cannot feed exclusively upon inorganic materials,—upon air, water, and minerals. No instance has yet been known of an animal, an undoubted animal, which exists upon such food. Here comes in the function of the Vegetable Kingdom. Standing between the mineral and animal world, it manufactures food out of the former in order to supply the wants of the latter. As this generalisation is the most important point in my paper, I shall cite three eminent scientific men to show that there is no tendency whatever at the present day to call it

into question. Asa Gray, in his *Structural Botany*, p. 1 (6th ed., 1882), says: "We cannot distinguish the vegetable from the animal kingdom by any complete and precise definition. Although ordinary observation of their usual representatives may discern little that is common to the two, yet there are many simple forms of life which hardly rise high enough in the scale of being to rank distinctively either as plant or animal; there are undoubted plants possessing faculties which are generally deemed characteristic of animals; and some plants of the highest grade share in these endowments. But in general there is a marked contrast between animal and vegetable life, and in the part which animals and plants respectively play in nature. Plants only are nourished upon mineral matter, and upon earth and air. It is their peculiar office to appropriate mineral materials, and to organise them into a structure in which life is manifested—into a structure which is therefore called organic. So the material fitted for such structure, and of which the bodies of plants and animals are composed, is called organic matter. Animals appropriate and live upon this, but have not the power of producing it."

I will give another extract from Julius Sachs, *Text-book of Botany*, p. 120, 1st ed. (translated by Bennett and Dyer). After observing that it is an unquestionable fact that most plants which contain chlorophyll obtain the entire quantity of their carbon by decomposition of atmospheric carbon dioxide, and require for their nutrition no other compound of carbon from without, he goes on to say:—"Even the food of Fungi, which are parasitic in and on animals and plants, is derived from the products of assimilation of plants containing chlorophyll, inasmuch as the whole animal kingdom is dependent on them for its nutrition. The compound of carbon originally present on the earth is the dioxide, and the only abundantly active cause of its decomposition and of the combination of carbon with the elements of water is the cell containing chlorophyll. Hence all compounds of carbon of this kind, whether found in animals, or in plants, or in the products of their decomposition, are derived indirectly from the organs of plants which contain chlorophyll."

Let us now hear Dr. Carpenter, *The Microscope* (2nd ed., p. 433): "A more positive and easily-defined distinction (*i.e.* between Animals and Plants) lies in the *nature of the aliment* of the Protophyta and Protozoa respectively, and in the method of its introduction. For, whilst the Protophyte obtains the materials of its nutrition from the air and moisture that surround it, and possesses the power of detaching oxygen, hydrogen, carbon, and nitrogen from their previous binary com-

binations, and of uniting them into ternary and quaternary organic compounds (chlorophyll, starch, albumen, &c.) the simplest Protozoon, in common with the highest member of the animal kingdom, seems utterly destitute of any such power, and is dependent for its support upon organic substances previously elaborated by other beings. But, further, the Protophyte obtains its nutriment by mere absorption of liquid and gaseous molecules, which penetrate by simple imbibition; whilst the Protozoon, though destitute of any proper stomach, makes (so to speak) a stomach for itself in the substance of its body, into which it ingests the solid particles that constitute its food, and within which it subjects them to a regular process of digestion. Hence these simplest members of the two kingdoms, which can scarcely be distinguished from each other by any *structural* character, seem to be *physiologically* separable by the mode in which they perform those actions wherein their life most essentially consists."

Again, in his Animal Physiology (ed. 1859), p. 144, he observes:—"The nature of the food of animals is as various as the conformation of their different tribes. It always consists, however, of substances that have previously undergone organisation. . . . . There are many instances in which, no obvious supplies of food being afforded, the mode of sustenance is obscure; and it has been frequently supposed that, in such cases, the animals are sustained by air and water alone. But it will always be found that, where food is taken in no other way, a supply of the microscopic forms of animal or vegetable life is introduced by ciliary action; and it is on these, indeed, that a large proportion of the lower forms of aquatic animals depend entirely for their support."

These testimonies will suffice for the fact; let us now try to set before our minds its significance. Let us try and get rid of the deadening effect of our familiarity with it. In making war one main point is admitted to be the feeding of the army. In nature the main point is obviously the same. When you have peopled a planet with varied forms of life, the most pressing question is, how are they to be fed? And this is answered not by an aggregation of dead nutritive matter, which must be exhausted sooner or later, but by the constant processes of growth, by a living laboratory incessantly engaged in manufacturing food. There is something grand and overpowering in this unceasing universal toil, carried on, if we regard the planet as a whole, without a moment's intermission, from year to year, from century to century. Not only does this activity go on in favourable places, on plains and hill-sides; but in the sea, in lakes and rivers, on the verge of eternal

snow, on the thin soil that covers ice-cliffs, on the burning sands of Africa, on the parched and rough lava-rocks, in the boiling water of mineral springs. On this function of plants the life of the whole animal world ultimately depends, and, if we rest on the uniformity of nature, has depended through all past geological ages. Do we often give its full weight to this fact as evidence of a great plan in nature? Here are the two series of animals and plants, standing, on the whole, on different planes of existence. For, however much a few microscopic animals and plants seem to approach each other, any candid reasoner will allow that the vast majority of animals,—all the vertebrates, for instance, all the insects, all the crustaceans,—occupy an altogether different sphere of being from trees, shrubs, and grasses. I repeat, then, here are the two series of organisms bound together by one general bond, which on further examination resolves itself again into myriads of particular bonds between particular plants and particular animals. And we are asked to believe that there is no prescience, no pre-established harmony, no benevolent care in all this! Supposing the world were developed according to blind unconscious forces from a fiery haze, what were the chances that plants and animals would have been developed *pari passu* with an accommodating reference to each other's welfare? The materialist assumes as a matter of course, not only that life originated accidentally on this globe, but that plants were kind enough to originate themselves, just as they were required by animals! I do not believe any materialistic thinker can have realised the monstrous, the incredible hap-hazard to which he intrusts the creation of the world. As matters actually are, what a spectacle of harmonious adjustment nature presents between the vegetable and animal kingdoms! Man, of course, interferes with it in civilised countries. But who ever landed on an uninhabited island without finding a perfect balance between the producing and consuming agencies of nature?

As yet I have stated the law of the manipulation of the inorganic world by plants only generally. Let us go a little more into details. If we wish to stand face to face with this every-day mystery, we can do so by observing *Algæ*. Many of them float freely in the water, and it is obvious that they must construct their cell-walls and cell-contents from the surrounding element and the gaseous and mineral elements which it contains in solution. Carbon dioxide is dissolved in all surface water, and so supplies the indispensable carbon, and the nitrogen they get from the products of decaying organic matter or the nitrates washed from the land. But

the seaweeds that are rooted to rock or timber present the phenomenon in almost the same simplicity, as their roots are little more than holdfasts, and assimilation takes place by the whole plant-body, so long as its cellular tissue is alive. How often at the seashore may we see a mass of Bladder-weed (*Fucus vesiculosus* or *serratus*) floating in the tideway; on its outer divisions will be found bunches of soft brown wool (sp. of *Ectocarpi*), or the pretty red tassels of *Ceramium rubrum;* on these latter again will be found under the microscope colonies of the commoner Diatoms, *Synedra, Cocconeis,* or *Achnanthes!* Yet all these associated plants build up their diverse forms from the same sea water. They all agree in possessing chlorophyll, though its presence is disguised more or less by other colouring matters: by means of their chlorophyll they all agree in decomposing the carbon dioxide present in the water, and in setting free oxygen. But, in addition to this common function, the *Fuci* will select atoms of Iodine and Bromine, the Diatoms atoms of Silicon, while the *Corallina officinalis,* growing on the same rock, will accumulate atoms of Calcium. Thus is carried on in its simplest form the transmutation of lifeless matter into nutritious living substance.

It is unnecessary, and would be tedious, to follow out the process in its increasing complexity through the vegetable kingdom. Suffice it to say, that in a tree the appropriation of carbon is, in the present state of knowledge, supposed to be confined to the green chlorophyll-bearing cells of the leaves and similar parts, whilst water, with the other elements of plant-food dissolved in it, is sucked up by the roots. The higher the plant stands in the scale, the greater is the division of labour.

A few words on the actual adjustment of the animal world to its food. The plan that we see to have been in fact adopted is this; a large number of vegetable-feeders is kept in check by less numerous carnivorous creatures. So it is in the case of mammals and birds, in the enormous class of insects, in molluscs. In the class *Reptilia,* one order, that of serpents, is purely carnivorous; another, that of turtles, purely herbivorous. Other animals, again, subsist on a mixed diet. We have some difficulty in observing Fish, but there are many reasons for believing that even in their case plants are the food of some genera. Although marine *Algæ* are usually thought to extend only a mile or so from shore, Diatoms exist almost everywhere in the upper strata of the deep sea. Darwin and Sir J. D. Hooker observed them in mile-long patches on their voyages. More recently, Sir C. Wyville Thomson says that Diatoms are found abundantly on the surface, especially when

the specific gravity of the water is comparatively low. Again (*Voyage of the Challenger*, vol. ii., p. 339), "*the frustules of Diatoms occur in all the deep-sea deposits in greater or less number;* and in some places, as at a few of the stations in the Indian Ocean, they form the bulk of the sample brought up by the sounding machine."

The stomach of *Holothuridea* taken over this area was found to be "distended with the 'diatom-ooze' so completely that the animal looked like a thin transparent bag filled with it."

Again, it is well known that diatoms are found in the stomach of fish and crustaceans, and, moreover, of purely pelagic forms, as of *Salpœ*. Much still remains to be done in the study of marine life, but we may confidently expect that it will exhibit subordination to the same great laws of nutrition as those exemplified in terrestrial life.

Since writing the above, I have read in a daily paper a remarkable confirmation of the assertion made of the importance of Diatoms. The contributor was describing the cod-fishery. The existence of the Newfoundland shoals, he says, depends upon a great Polar current which flows that way from the Arctic regions. This current gives the fish the cold water they like, and also brings them the food they require. From the way in which he describes the food as colouring the sea green or brown, it is pretty clear that he is speaking of minute *Algœ*, probably Diatoms.

We can scarcely allude to carnivorous animals without being reminded of the sensational descriptions of the so-called cruelty of nature given under this head by Pessimists and Sceptics. May we ask, in reply, what other arrangement they can propose? If all animals fed on vegetables, they would sooner or later exhaust the supply and perish by famine. The Utilitarians set up the principle of the Happiness of the Greater Number as their guide. Is not this precisely what now results from the system of checks and counter-checks which keeps up the due balance of Animated Nature?

Closely connected with the primary function of the Vegetable Kingdom are subsidiary purposes fulfilled by it. In the first place, it purifies air and water. The gas carbon dioxide is produced in large quantities by the respiration of animals, on land and in the sea, and also by artificial combustion. This noxious compound, if not got rid of, would accumulate through its weight in the lower strata of the atmosphere, so as to be fatal to all life on the globe. But plants consume it, as I have

stated above, with perhaps wearisome reiteration. If this is not a designed result, it is a very lucky accident for Theists and Sceptics alike. In the next place, the formation of soil is obviously due to vegetables. Strip the world, in imagination, of its plant-life, and see what a waste it would become. Its present fertility is the result of the life and death of countless generations of plants which have gradually enriched the *débris* of rocks with organic materials. Another secondary end to be noticed in plants is their adaptation to be the dwelling-places as well as to supply the food of many animals. Whole genera are known which are exclusively arboreal. Even among mammals we have monkeys, sloths, fruit-bats, opossums. Vast multitudes of birds are solely at home on trees, as parrots and lories. Above all, the insect world affords the most astounding attachment to plants. Insects are so localised, as it were, that in a great tree the bark, the wood, the leaves, the flowers give food and shelter to distinct tribes. Out of this unbounded field I will only give one fact. The Butterfly, when seeking to deposit her eggs, always chooses the plant on which the caterpillars are to feed when they emerge. Perhaps many of my hearers could not point out in a hedge the two Buckthorns, or *Rhamni;* but the Brimstone Butterfly (*Gonepteryx Rhamni*), we are told, selects them, and them alone, with unerring accuracy as the guardians of her eggs.

9. I shall now pass on to another great purpose which can be traced throughout the Vegetable Kingdom—that of Reproduction. The proofs of pre-ordained contrivances, of processes brought to bear upon one end, are here very striking. According to Hartmann, a final cause involves four stages—(1) conception of the end; (2) conception of the means; (3) realisation of the means; (4) realisation of the end. The final effect must be regarded as imaged in some way beforehand. This analysis applies admirably to reproduction in the vegetable kingdom. First, a distinct end is clearly visible,—that of continuing the species. Means are adopted for securing that end; speaking broadly, the conjugation of sperm-cells and germ-cells. In the next place, this effect is brought about in the most varied ways, and so, after much toil, the seed is finally produced, or the original end is realised. Is it possible to think otherwise than that this purpose is foreseen, predetermined, and that "this predetermination conditions and dominates the series of phenomena of which it is in appearance the result? . . . . We maintain that what occurs as an *effect* becomes an *end* by reason of the number and

complexity of the combinations which have rendered it possible." (Janet, *Final Causes.*)

Let us now look upon a flower from this point of view. I need not describe it any further than is necessary for my argument. It will be enough to remind my hearers that it is the reproductive apparatus of the plant, and that it is made up of leaves variously modified. The two most important series of transformed leaves are the stamens, which produce the sperm-cells in the form of the pollen-grains, and the carpels which develope the ovules, within which the germ-cells are stowed away. Around these are grouped the generally showy corolla and calyx, which serve partly as protective envelopes to the internal organs, and partly as sources of attraction to insects. The fundamental mark of design in a flower is the distinction between the internal organs. In these we have two series of cells,—the sperm-cells or pollen-grains and the germ-cells, which are part of the ovules, both of which advance to a certain stage independently of each other, and then perish if they are not brought into contact. The whole purpose of the flower is to secure their being brought into contact. In the vast majority of flowers, moreover, the pollen does not fall directly upon the ovules; it is arrested at a halfway-house, the stigmatic surface of the style. It then begins to grow and to emit the long slender tubes which push their way down the style and reach the micropyle of the ovules. Only microscopic observers know of the difficulty of following out any further the process of fertilisation from the excessive minuteness of the objects in question. Any good text-book will supply technical details which I can hardly give here.

In many flowers further and more complex devices are introduced to secure cross-fertilisation by insects. Whole orders are more or less adapted to insect visits. If a flower is what is called zygomorphic, *i.e.*, symmetrical only in one plane passing (to speak popularly) down through its middle, such a flower has been altered to attract insects. Such are orchids, pea-blossoms and their kin, Pelargonium, Tropæolum, and balsams. So much attention has been paid to this subject lately that I may be excused going into particulars. But for the purposes of my argument, consider the significance of all these phenomena co-existing, and co-operating for one ultimate purpose, the production of seed. We have,—

(1.) The development of pollen and of ovules in distinct organs.

(2.) The secretion of honey.

(3.) The modification of a petal or sepal to hold this honey.

(4.) The indication by bright colour and by special *streaks* where this honey lies.

(5.) The fondness of bees, butterflies, and moths for this honey.

(6.) The arrangement of stamens and stigma, so as to profit most by the visits of the insects thus occasioned.

How all these co-ordinate arrangements were brought about I am not bound to say; *why* they exist is obvious, namely, to secure the continuance of the species: in other words, no candid observer can deny the force of the argument for design. Even Sachs confesses (*Text-Book of Botany*, 1st ed. Eng. trans., p. 843) that the reproductive processes "have the appearance of being the result of the most careful and far-sighted calculation and deliberation." I may add that in the second edition of this valuable work, which has appeared since I wrote this paper, either the venerable author or the translator repudiates purpose in plant-life as an antiquated superstition. Such is the narrowing effect of over-specialisation; one of the crying evils to which the science of the present day is subject. The students of natural history write too often, as if there were no such branches of knowledge as metaphysics, history, or theology.

But I wish, in the next place, to call your attention to some of the complicated reproductive arrangements in Cryptogams. Speaking broadly, yet still with strict accuracy, Phanerogams are distinguished from Cryptogams by this mark: in the case of the former the sperm-cells, *i.e.* pollen-grains, are adapted to the air; in the latter the sperm-cells, *i.e.* the antherozoids, are adapted to water. The simplest Cryptogams (*Schizophytes*) are apparently reproduced only by self-division, but wherever a higher form of reproduction is found, the antherozoids invariably require water, in which they swim about until they reach the *anchegonium*. What is so amazing, however, is the variety of details, the diversity of contrivances, which are far greater than in flowering plants. I will trespass upon your patience with a description of the reproductive organs in *Chara*. Species of *Chara* are common in ponds and ditches, and are easily distinguished by their whorled branches, their gritty feel from their being encrusted with calcareous matter, and the brick-red colour of the mature *antheridia*. These last look like little pills, and are bounded by eight cortical cells, which separate at maturity. "Of these eight cortical cells,"

to quote Dr. A. W. Bennett,* "sometimes called shields, the four nearer the base are four-sided, the four nearer the apex three-sided. From the middle of the inner face of each shield, a cylindrical cell, termed a *manubrium* or handle, projects inwards, nearly to the centre of the hollow globule; and at the extremity of each *manubrium* is a roundish hyaline cell, the head or *capitulum*. The shields, *manubria* and *capitula*, form, therefore, twenty-four cells, which, together with the pedicel-cell of the globule (the older name of the *antheridium*), constitute its framework. Each *capitulum* bears six smaller cells, secondary heads or *capitula*, and from each of these grow four long whip-shaped filaments, the number of which, therefore, is about 200 ($8 \times 6 \times 4 = 192$). Each of these 200 filaments divides transversely into from 100 to 200 cells, and in each of these cells an antherozoid is produced by a peculiar transformation of its protoplasmic contents, and is provided with two cilia, by means of which it moves rapidly about when it escapes by the separation of the shields and rupture of the parent-cell. The number of antherozoids produced by a single *antheridium* may therefore be from 20,000 to 40,000. The organ known as the nucule consists of an axial row of cells, which form a kind of crown at the summit. At a certain period this crown separates and leaves open a canal leading down to the central cell, through which the antherozoids enter and effect the fertilisation." Familiar as the motion of antherozoids has become to microscopical observers, it can never cease to be one of the standing marvels of plant life. But as an argument for design, what better contrivance could be adopted for dispersing the spores in water than this ciliary motion? If we could explain the physical causes which produce it, it would still be equally wonderful. For *efficient causes do not exclude final*; and the fundamental fallacy, the πρῶτον ψεῦδος (Janet) of Materialism lies in the assumption that they do.

We may next take up the urn of the Urn-mosses (*Bryaceæ*) as an elegant instance of the adaptation of means to ends. In mosses there is what is called an alternation of generations; *i.e.* one stage of the plant which produces *antheridia* and *oogonia*, the organs which contain the sperm-cells and germ-cells respectively, and another which produces vegetative spores which germinate without any act of fertilisation. The very existence of this double provision for the multiplication of

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* Translation of Thomé's *Botany*, p. 295. The exact words of Dr. Bennett are not given, but the substance.

plants found in all the *Muscineæ* * and *Pteridophytes* * is a wonderful contrivance. Now the familiar fruit of the moss is, scientifically speaking, the second generation resulting from the fertilisation of the *oogonium* by the antherozoids of the *antheridium*. Its function is to produce spores, to guard them till mature, and then to disperse them. All of us know the pretty little urn elevated on the top of a long stalk. Within it the spores are developed by free-cell formation. To protect them the following devices occur: (1) a little thatch or pent-house more or less hairy, which is the remains of the original wall of the *oogonium* carried up by the growth of the stalk. Then comes a lid which in time opens. Then comes a single or double fringe of teeth, called the peristome, which are always in number a multiple of 4, either 4, 8, 16, 32, or 64. These peristomes are well known as furnishing objects of great beauty for the low powers of the microscope. In some cases the inner fringe is not separated into teeth, but forms a beautiful lattice-work. Now, what is the object of this fringe? I will give it in the language of one of the most recent writers on the *Muscineæ*, Dr. Goebel (Schenk's *Handbuch der Botanik*, vol. ii., p. 399).

"The teeth of the peristome are very hygroscopic, their function is principally that of closing the opening of the capsule-urn in moist and wet weather, and so preventing the egress of the spores. In this way, on the one hand, moisture is not allowed to penetrate into the capsule, and so produce premature germination of the spores; and, on the other hand, the latter cannot escape from the capsule under circumstances that would be unfavourable for their wide dispersion. In dry weather, on the contrary, the teeth of the peristome bend back, and so allow the fine powdery spores to escape." The word "function" is here used, as you observe, but it is a mere *façon de parler*, an evasive equivalent for "purpose." Indeed, the learned Doctor just after uses the word "purpose" bluntly ("Der Zweck, die Sporen in der geöffneten Kapsel vor dem Zutritt von Feuchtigkeit zu schützen, wird . . . . erreicht." "The purpose of protecting the spores in the opened capsule from the access of moisture . . . . is reached"). But he apologises in a note for the indiscretion. ("Man gestatte der Kürze halber diese Bezeichnung!" "This designation may be excused for brevity's sake!") Science, it seems, has its

* The group of *Muscineæ*, as a sub-kingdom, includes *Hepaticæ* and *Musci*. Pteridophytes include the Vascular Cryptogams, Ferns, Horsetails, Club-mosses, &c.

pedantic fashions as well as philology. Whatever may be their own convictions, men are afraid or ashamed to admit the notion of purpose in Nature. There must be a reaction against this tyranny of authority, and I should be glad to think that it is already beginning. I will conclude with the reproduction of the *Algæ*. Low as they stand in the scale of vegetation, they in common with the fungi possess a bewildering multiplicity of reproductive processes. It is impossible to do more than select one or two cases. The common *Fuci* present us with one distinct type. In them the *antheridia* and *oogonia* are both produced in spherical cavities imbedded in the substance of the frond. These cavities communicate by a pore with the surrounding water, and through this pore the mature reproductive cells escape before fertilisation. The germ-cell, when compared with the minute antherozoids, is of enormous size, and, as it floats passively about, the latter swarm around it like bees, communicate to it a rotating motion by their ciliary action, and so fertilise it.

The beautiful *Florideæ*, or red seaweeds, deviate from this plan. Their sperm-cells have no cilia; they do not move about by lashing the water, but drift to and fro. They thus come into contact with the *trichogyne*, an organ which reminds us in function of the stigma of Phanerogams. This is the topmost of two or three cells forming a short branch, which grows into a long transparent mucilaginous hair. The floating sperm-cells adhere to this hair, and appear to form an intimate union with it by the absorption of the intervening cell-walls. As a result of this act, a kind of fruit is produced, the part generally observed by collectors, who are well aware of the elegant forms it often assumes, as in the urns of the *Polysiphoniæ*.

In addition, however, to this mode of increase, the *Florideæ* possess vegetative gemmæ, called *tetraspores*, which germinate without any act of fertilisation. They are often found in fruit-like receptacles, like little pods, or occur on transformed branchlets, or all over the frond. Hence in red seaweeds a man may pick up four different forms of the same species:—(1) a totally barren frond; (2) a frond with *antheridia*; (3) a frond with *oogonia*; (4) a frond with *tetraspores*. In some rare cases, however, both the reproductive elements occur on the same plant. Now all this is very surprising. I am at a loss to conceive how Natural Selection can account for this lavish exuberance of reproductive agencies. We seem to have variety for the sake of variety, and beauty for the sake of beauty.

10. In dealing with my subject I have entered into

abundant detail, as nothing is more unsatisfactory than the usual vague generalities employed in discussing this argument. Consequently, I have not shrunk from bringing forward actual facts which I am prepared to submit to the test of purpose. One result, however, of this method is that I can only very briefly indicate the immense field that still remains untrodden. I will only point out, then, as it is impossible for me at present to dwell upon them more fully, abundant marks of design which are found—

(1.) in the devices for the preservation of seeds till maturity, and their dispersion after maturity;

(2.) in the adaptations of the Stem, Leaf, and Root, as, for instance, in the *stomata* of the *Epidermis;*

(3.) in forms of plants fitted for special purposes, such as parasites and insect-traps;

(4.) in the production of useful plants contemporaneously with the late appearance of Man;

(5.) in the order and harmony seen in the finely-graduated adaptation of plants to every degree in the thermal scale from the Pole to the Equator;

(6.) in the Unity of plan involved in the fact that every vegetable structure can be referred to the cell as its ultimate element;

(7). in the Unity of plan to be discovered also in the past geological history of the Vegetable Kingdom.

11. Out of this embarrassing wealth of materials I will select for my concluding illustration of Design the Pitcher-Plant. A more wonderful, complicated, and effective Insect-trap could hardly be imagined. In the first place, it attracts its victims from afar by its conspicuous colour, red, or blue, or purple, which makes it stand out boldly from the inconspicuous shrub with dicœcious flowers which produces it. In the next place its jug-like shape is as good a device as can be employed for a trap in which the captured flies are to be drowned: it has a close-fitting lid which is not opened until the arrangements are complete, and when once opened never shuts again. When all is ready within, the lid opens, and we see a bait, a danger and a pool of destiny; the bait is a honeyed secretion produced by glands situated just in the neck of the pitcher; below this zone are glaucous walls of glassy smoothness, and below these again is the water poured forth by thousands of glands. The insects eat their fill of the honey, then slip helplessly down the precipitous sides, and are drowned at the bottom. In addition to these striking features, some of the pitchers have external fringes calculated to lead insects the right way to their destruction. I need hardly point out the

important anatomical differences between the two series of glands in this case, those that secrete honey and those that secrete water. Here we see remarkable and unusual arrangements all co-operating to one result. Can any reasonable man deny that the purpose, the design, of the Pitcher is to kill flies? Nay, more, is he not irresistibly led on to a further question, namely, what is the object of this singular immolation? The solution now in vogue to this latter question is that the plant requires more nitrogenous food than it can get from the swampy soil in which it lives. In pursuing researches such as these Science is really seeking for Final Causes however disguised under the latest fashionable name of function, adaptation, correlation, &c., and yet we are told that the reign of Final Causes is over! Perhaps the one-sided cultivators of Natural Science will one day awake to the great truth that Efficient Causes do not exclude Final Causes, and that Purpose and Design exist unchanged and unchangeable however much they may be ignored by Materialists.

NOTE.

The following extracts from Professor H. N. Moseley's address on Pelagic Life, delivered at the Southampton meeting of the British Association on 28th August, 1882, are interesting.

After defining *pelagic* life as those animals and plants which inhabit the surface waters of seas and oceans, the lecturer proceeds: "The existence of pelagic animals at all is directly dependent on that of pelagic plants. No animal life can exist without vegetable food as a basis, and the first living substance which came into existence must have been capable of constructing protein for itself from inorganic sources, and been physiologically a plant. Now in many regions the sea-surface teems with vegetable life. In the Polar waters diatoms swarm, sometimes occurring so abundantly that they render the water thick like soup" . . .

In temperate and warmer seas, the Professor declares, diatoms are scarcer, though present, and their place is taken by other simple minute *Algæ*, namely *Oscillatoriaceæ*. In the Arafura Sea the Challenger expedition passed for days through discoloured water which smelt like a weedy pond. In the Atlantic also they had for days found the sea filled with *Trichodesmium*. Small marine animals, on which the larger exist, feed on these minute *Algæ*, and also on organic *débris* from the shore, and on floating sea-weeds (in the more ordinary sense of the word). Prof. Moseley pronounces strongly for the vegetable nature of the disputed cells in Radiolarians, and even hints that Coccospheres and Rhabdospheres may turn out to be vegetables.

The Chairman (Rev. R. THORNTON, D.D.).—I am sure I may tender to Mr. James the thanks of the meeting for his very interesting paper,

Rev. Prebendary Row, M.A.—I feel some difficulty in offering any remarks upon Mr. James's paper, because it is one with which I very cordially agree. Generally speaking, one can make more effective remarks upon points with which one does not agree, than with regard to those with which one does agree. The attempts which are being made at the present time to ignore the arguments from *design*—perhaps it had better be termed adaptation, because when we speak of design we are charged with assuming the existence of a designer—are very extraordinary. I find that this charge, of assuming the existence of a designer is one which is constantly being made against us; but I do not doubt that those who make the charge understand what we mean when we use the term I have just employed. Not only is this argument of ours largely ignored by scientific men, but I am sorry to say that several persons whom I very highly esteem have to a great extent given up the argument from design,—a circumstance which always excites in my own mind unspeakable astonishment. What we want is to have the whole force of this argument stated in exceedingly simple language: and although I regard Janet's as a most valuable work, I think, at the same time, that it is one of those books which we find appealing solely to what I may term the aristocracy of intellect. What we want is a work addressed to the democracy of intellect. As it is, people generally are not able to appreciate the arguments we employ, and this is what has caused a large amount of unbelief. Therefore, the remedy we require is to have our arguments stated in plain English, so that they may be on a level with the ordinary intelligence of the million, instead of being confined to the understanding of what I call the intellectual aristocracy. It is very difficult to commend such works as we have upon this subject to an ordinary man who is busied with the affairs of life, because, the great mass of the existing books treat the question from an elevated point of view and not from such a standpoint as is comprehensible to the masses. There is in this paper one expression, and although I quite agree with it, yet I should like to see it somewhat qualified; it is the statement in which the author asserts that the argument from design amounts only to probability. I quite admit that it is an argument founded on probability; but I think that by adopting these words we may be greatly misleading the ordinary class of readers. Of course, as a matter of fact, there are only two things which are capable of strict demonstration, namely, the truths which relate to space and number. The term "demonstration" is also extensively used in modern scientific works to denote a truth capable of distinct and positive verification. Now, let us observe the real position of the question in relation to the argument from adaptation. I do not think it at all yields in force to the strongest demonstration in Euclid. I will not take the argument derived from the human eye, strong as it is, but will refer to the faculty of hearing. Let us see what are the correlations therein involved. First of all we have a wondrous musical instrument—the human mouth, the palate, and the whole of the interior structure, constituting a musical instrument of surpassing completeness and complexity,

inasmuch as it is capable of producing every variety of sound in the most perfect harmony. This is very wonderful in itself, but it is, after all, only a small portion of the wonder; for, unless every portion of that marvellously delicate sound-producing instrument was correlated to the atmospheric air, which is entirely independent of it, this organ would exist for no purpose at all, and, if the atmospheric air were largely different from what it is, it would produce a widely different result. The two, then, being perfectly correlated to each other, I would draw attention to one correlation more, and that is the auric nerve. But for this third factor the wonderful correlations which exist between the organ of speech and the atmospheric air would exist in vain. Therefore, we have here three singularly complicated correlations, each absolutely independent of the other, and yet producing a common result, viz., articulate speech and harmonious sound, which could not exist, if one factor in these correlations failed. Now, to exhibit the force of the evidence it will be necessary to multiply the chances against each individual factor coming together at the right time and place so as to perfect the combination, and the result would have to be expressed by a fraction, of which the numerator is unity and the denominator a number so large that it is impossible for our limited understandings to form a definite conception of it. But when we consider the number of complicated correlations in the universe, and estimate the chances against their concurrence at the right time and place, the denominator of the fraction representing the improbability of their concurrence cannot be distinguished by a finite understanding from infinity itself. A common fallacy of the day denies that these correlations prove intelligence, but I think that if this argument in proof of design was stated in a popular manner, the objections to it would fail to convince any unprejudiced person. It is objected that many of these adaptations and correlations seem to exist for the purpose of inflicting pain and death, Still there remains the fact that they exist, and whatever may be the results which they produce, they prove the presence of intelligence. One word on a subject which is referred to in this paper, and that is the manner in which we are charged with using an anthropomorphic idea in transferring an idea which belongs as far as direct observation goes only to man, to the being of God. This charge has been urged again and again, especially by Herbert Spencer and other unbelievers, who say that it overthrows at once the whole of our reasoning from design. I wish to ask any scientific man upon this point whether it is possible that we cannot get beyond ourselves? The fact is, because we are men, every one of our conceptions must be in terms of human thought, and so far, anthropomorphic. Even when a scientist is dealing with the objects of nature he is obliged to use anthropomorphic thoughts and conceptions, because we have no other; therefore, the objection falls to the ground. The lower and baser attributes of human nature have in pagan and uncivilised ages been applied to God. This is objectionable anthropomorphism; but when we come to ascribe to Him the higher

qualities of man, as the author has well observed, we may justly do this because we are made in the image of God, and not because we make a God in the image of man. I press this point, inasmuch as I regard all that is said by our opponents upon the subject as simply absurd; for, if we cease to think in anthropomorphic conceptions, we must cease to think at all, inasmuch as we can have nothing but anthropomorphic conceptions wherewith to think.

Mr. D. HOWARD, V.P.I.C.—I regard this as a most interesting paper upon a most interesting subject. Prebendary Row has very ably put forward an immensely important argument in favour of *design*, by combating the idea that, if you can quarrel with Paley's mode of dealing with evidence, you have done away with evidence altogether,—that if you quarrel with the enunciation of Butler's *Analogy*, you have got rid of the *Analogy* itself. The truth is, that the argument lies before our eyes, and we cannot get over it except by shutting our eyes to it. This paper, which deals only with one little corner of the subject, but which deals most distinctly and ably with what it does grasp, not only gives instances of design against which it is impossible to close our eyes, but points to a sphere in which there are countless others. With regard to any fact on which it is possible to get cumulative evidence, it is undoubtedly easy to arrive at absolute certainty. I remember soon after the siege of Strasburg, standing on the cathedral-tower with the old custodian of the edifice, and I necessarily noticed that a few bombshells had burst on the building. The custodian told me that the German artillery fired at the cathedral night and day. Just below, however, was the citadel, which they had really fired at night and day, and they could hardly help a chance shot or two falling on the old ecclesiastical structure; but the citadel, which is not nearly so conspicuous a building as the cathedral, was utterly annihilated. Of course, one could not have supposed that chance had guided the great mass of the bombs into the citadel, and that the same chance had preserved the cathedral. In the same way, we may regard the manifold evidences we see converging to a given point as evident proofs of design. When one looks at the materialistic fallacies of the present day, one finds that design, although rejected in specious language, comes back again; that after all, what are termed the blind forces of nature have design attributed to them; and that you are speaking in the most anthropomorphic form when you refuse to give the honour to God, and give it to the forces of nature. In point of fact the forces of nature become those of a personal God by the very language applied to them. If people find that the arguments of our opponents against design satisfy their intellect, they must be wonderfully constituted. Reasoning from analogy, we must say from the evidence of something in nature which we cannot speak of without attributing intelligent personality to the Author of it, is so strong, that it is absolutely certain that in denying an intelligent Being to govern it, they are making a blunder. It is truly said, by this paper, that the precise way of creation is not to the point. That is a question upon which there may be wide diversities of opinion; but, as I have just said, that is not the real point at issue. If we

admit, for the sake of argument, evolution as a mode of formation, we only put off the difficulty one stage, because we are bound to ask whence come the forces of nature which display the evolving power? How is the balance preserved? Chance cannot effect this—the idea is absurd. We must attribute to nature powers of discrimination which are utterly alien to anything we know of the forces of nature. Take the balance between the animal and vegetable kingdoms, and you will see that it is very easy to interfere with it. What is it that makes the streams, in any over-populated part of England, abominable? Simply that the balance is lost. If any of that noxious fluid which now is a black stagnant abomination, be sufficiently diluted to give the forces of nature play, the vegetable kingdom will set it all right again. Instead of a horrible black mass, you would have almost a pure fluid. I might follow the same illustration through all nature, and show how impossible it is that mere chance can do what is everywhere seen, and that we are bound to conclude that the forces of nature are Divinely guided. We may boldly say this; for, after all, what does the phrase, "forces of nature," mean but the expression of God's will? The second part of the paper touches on the infinite richness of the reproductive arrangement of the lower plants, and also of those of some of the lower animals, which are equally wonderful, and equally worthy of study. Why is it that, when it is perfectly possible for a single cell to sprout up and divide itself off, there should be combined with so simple a process so inconceivably complex a system of reproduction? Surely, if this were due to chance alone, the chance would be immensely in favour of the simplest method. If you throw dice, the chances are that exceedingly simple combinations will turn up, and not that you will produce thousands of double sixes running. And this brings me to one point I wish to allude to before sitting down. I cannot but think that Lord Bacon is rather hardly dealt with for calling final causes a barren study. What he meant was this: that if we begin by assuming that we know how a thing was reproduced, we shall be very far from knowing how it was reproduced. The truth is that the wisdom shown in the final causes is beyond our wisdom. There is a wondrous wisdom in these final causes, which we do not understand. Why should there be a double form of reproduction, apparently for no reason? Why, for instance, when a branch, by touching the ground, can reproduce a tree, should there be a seed-vessel to accomplish that object? I would merely say to our opponents, if you admit that there are forces in nature with intelligent foresight, that is all I ask you to grant, because, if you grant that, you have granted Theism without knowing it.

Mr. J. Hassell.—I agree with the suggestion that we want a popular exposition of "The Argument from Design," and also that we ought not to be backward in teaching that doctrine whenever we can. It is the custom nowadays, with many scientific teachers, to take it for granted that there is no ground upon which to take our stand in teaching the great truth that God is the Creator of the Universe; would it not be well in these days of scientific dogmatism to show plainly and clearly the absurdity of the

arguments used against design? If I may be allowed to speak of myself personally, I might mention that I was able to do something in this way the other day, while conversing with two working men. I had in my hand a skeleton head of one of the parrot tribe, and the workmen, who had not made a study of such things, could hardly believe that the structure possessed so little weight. They asked me how it was that it was so light and yet so strong; and in order to satisfy them I took the skull to pieces. They then saw that the outer and the inner walls of the mandibles, which are very thin, are separated from each other, but that the two are united by an infinite number of cross-bars, each of which is wonderfully thin, thus securing great strength and durability combined with the lightest possible construction. I then said to them: "You must understand that once upon a time there was a very clever parrot who happened to have a weak bill which used to get injured when he tried to get at certain fruits. Well, this parrot said to itself: 'I will have a stronger bill in future,' and thereupon laid for itself the germs of a stronger one in the next generation." The men told me I must be joking, and one of them said: "Oh! that can't be; surely it must have been constructed for the bird?" "Precisely so," I replied; "there is no doubt but that this wonderful piece of adaptation of means to ends was planned"; and then, wishing to apply the advantage thus gained, I asked the man how he, as a carpenter, would proceed under such circumstances. The man replied that if he wanted to strengthen two outer walls which were rather thin, he would unite them by cross-bars, and if he wished to prevent its being very heavy he should make the bars numerous but very thin. "Well," I answered, "that is just how God has done it, and by so doing He has brought about the two great requisites, extreme lightness and great stability." The man saw this at once. I say, then, that teachers should not be backward in showing the working man the absurdity of any other mode of bringing about the wonderful results which God has produced by such extraordinary means. We ought to endeavour to prove that the marvellous structures found in God's works could only have been planned by a great and wise Architect, who, seeing the end from the beginning, planned all these things as being best adapted for the purposes they were to serve.

The CHAIRMAN.—Before Mr. James replies, I should like to offer a few observations, although I do not intend them as criticisms upon his admirable paper, in which there is really nothing that I can disagree with, as the paper is one that commends itself most entirely to my own views. I shall only express my confidence that the argument from *design*, for which Mr. Row and myself concocted the phrase "teleological adaptation," is, for practical use, the most important we can employ. I do not mean to say I look upon it as *the* most important, because the argument of my own consciousness is a stronger one; but for all practical purposes it is decidedly the most important; and I think, also, that the illustration given by Mr. Hassell is one of much value, as tending to show that if you put such a thing as the skull of a parrot before a working man and ask how it has been formed, he at once says it is the

product of intelligence, and that chance or the blind force of nature could never have brought about the result exhibited. I think the paper read to us by Mr. James an extremely able and important one, and we are greatly indebted to him for it. I can only express my regret that our first meeting this year has fallen on New Year's Day, as the usual family gatherings on that day may have prevented some being present.

Mr. JAMES.—It has been very gratifying to me to find that almost all the speakers have been in entire agreement with the views I have expressed. I am sorry Prebendary Row has left the room, and that consequently I cannot have the pleasure of thanking him personally for the cordial way in which he has spoken of my paper. I quite agree with him that a popular statement of the arguments I have urged would be very valuable ; but I must point out that my paper has been written throughout with obvious reference to the views put forward by our opponents, and, as I have had to meet them somewhat on their own ground, my exposition has necessarily been rather dry. It is the doctrines of the materialists that I have been combating. I have been extremely pleased to be able to read the protest, contained in my paper, against the materialistic tone which has become so common in works of natural science of the present day. I do not mean to say that a work on botany ought or need contain any allusion to theology, but it certainly need not go out of its way to deny purpose and assault design. This is a fault which we can most certainly charge against Sachs's great work, which has now reached its second edition, and which is officially published by the University of Oxford. I do not think the University ought to give its sanction to a one-sided statement of this question, whereas Dr. Sachs, or his translator, goes out of his way to cast a slur on design, although he does not bring anything like arguments against it. If the idea of design is not scientific, if it be contrary to the impartiality of science to say anything in favour of Theism, why say anything contrary to Theism ? It is as a protest against this course that I have been most pleased to deliver this paper, in spite of the fact, referred to by our Chairman, that this is New Year's Day. (Applause.) On any day I am glad to offer my paper as a protest against scientific prejudice. To a certain extent, perhaps, this tone in works on botany and kindred subjects is a matter of fashion ; many people who, doubtless, do not hold materialistic views are, nevertheless, apt to fall into what has become the *mode*, and are led to do so possibly from want of courage. As to what Mr. Row has said about probability, I have used that word in its strict logical, and not its popular sense. The logical value of the Argument from Design is, of course, only that of high probability. Mr. Howard has been kind enough to do nothing but praise the paper. With regard to what has been said about Lord Bacon, I still think he went too far in condemnation of final causes. But Darwin, although he formally denied them, nevertheless practically used them when he started a most fertile subject in introducing the notion of the benefit to be derived from cross-fertilisation. The question which he asked was, what was the advantage to be derived by different plants from cross-fertilisation,

—that is to say, from the fact that the pollen of one individual generally fertilised the stigma of another? The following out of this principle led to so fertile a field of observation that it absolutely metamorphosed that particular branch of botany. All at once it was seen to afford an explanation of hundreds of forms of flowers which used to be called irregular, but which were really insect-adapted. If this paper had been read in the summer-time I could have brought you a garden Nasturtium (*Tropœolum majus*) in which I could have shown you a beautiful instance of the adaptation of flowers to insect visits. When you look at that flower you cannot fail to see that its whole object is to make the most of the spur which contains the nectar sought for by the insects. Everything groups itself around that spur. First of all there are the five petals, of which the two upper and more prominent ones are the more richly coloured, their darker streaks pointing the way the butterfly has to go. The three lower petals have fringes so placed as to prevent the ants going past them to steal the nectar. Being so brilliantly coloured the flower is not adapted to moths, because they only fly by night and generally make for the white flowers; and whatever butterfly comes, the proboscis must be long enough to get to the bottom of the tube. The insect alights on the three lower petals or on the central part of the flower and inserts its proboscis, and in doing so rubs against some of the stamens, of which there are eight, which are arranged in a beautiful manner with reference to the tube. They are placed in pairs, there being one pair close to the opening of the spur, another a little further down, and then another, and another, all of them at first, declining or stooping down. Moreover, they do not all reach maturity at the same time, but rise up in turns one by one, those nearer to the mouth of the tube coming sooner, and then the rest in rotation. Whilst this pollen is being shed the device adopted to prevent its dusting the stigma of the flowers is that the stigma of the individual flower is not yet receptive. The three styles are closely applied to each other, and they do not open until all the stamens have shed their pollen. These anthers are attached to their filaments by a very small pedestal, and then when they have all been emptied, the three styles open and are capable of receiving the pollen of another plant. The same process takes place in many other flowers, and all I have to say here is that we owe all this knowledge to Darwin, who first began to observe what was going on in the orchids. Darwin was more familiar with cultivated plants than with the wild ones, and his examples were taken mainly from what he observed in hot-houses. Had he taken the wild flowers he would have found that the cross-fertilisation in their case was quite as wonderful as he found it to be among the orchids. I would only mention one—the Iris, as to which any one here will be able to make observations for himself. I have only now to thank the other speakers for their agreement with me, and also this Institute for having given me the opportunity of reading a paper which expresses my own opinions, whether they be right or wrong.

The meeting was then adjourned.