LECTURES.

ON SPECIES AND RACES, AND THEIR ORIGIN.

Delivered at the Royal Institution of Great Britain,
By Professor T. H. HUXLEY, F.R.S.

The speaker opened his discourse by stating that its object was to place the fundamental propositions of Mr Darwin's work 'On the Origin of Species by Natural Selection' in a clear light, and to consider whether, as the question at present stands, the evidence adduced in their favour is, or is not, conclusive.

After some preliminary remarks, in the course of which the speaker expressed his obligations for the liberality with which Mr Darwin had allowed him to have access to a large portion of the MSS. of his forthcoming work, the phenomena of species in general were considered—the Horse being taken as a familiar example. The distinctions between this and other closely-allied species, such as the Asses and Zebras, were considered, and they were shown to be of two kinds, structural or morphological, and functional or physiological. Under the former head were ranged the callosities on the inner side of the fore and hind limbs of the Horse—its bushy tail, its peculiar larynx, its short ears and broad hoofs: under the latter head, the fact, that the offspring of the Horse with any of the allied species is a hybrid, incapable of propagation with another mule, was particularly mentioned.

Leaving open the question whether the physiological distinction just mentioned is, or is not, a universal character of species, it is indubitable that it obtains between many species, and therefore has to be accounted for by any theory of their origin.

The species Equus caballus, thus separated from all others, is the centre round which a number of other remarkable phenomena are grouped. It is intimately allied in structure with three other members of the existing creation, the Hyrax, the Tapir, and Rhinoceros; and less strait, though still definite bonds of union, connect it with every living thing. Going back in time, the Horse can be traced into the Pliocene formation, and perhaps it existed earlier still; but in the newer Miocene of Germany it is replaced by the Hippotherium, an animal very like a true Equus, but having the two rudimental toes in each foot devoloped, though small. Further back in time, in the Eocene rocks, neither Equus nor Hippotherium have been met with, nor Rhinoceros, Tapirus, or Hyrax; but instead of them, a singular animal, the Palæotherium, which exhibits certain points of resemblance with each of the four existing genera, is found. The speaker pointed out that these resemblances did not justify us in considering the Palæotherium as a more generalized type, any more than the resemblance of a father to his four sons justifies us in considering him as of a more generalized type than theirs.

The geographical distribution of the Equidæ was next considered; and the anomalies and difficulties it offers were pointed out; and lastly, the variations which horses offer in their domesticated condition were discussed.

The questions thus shown to be connected with the species Horse, are offered by all species whatever; and the next point of the discourse was the consideration of the general character of the problem of the origin of species of which they form a part, and the necessary conditions of its solution.

So far as the logic of the matter goes, it was proved that this problem is of exactly the same character as multitudes of other physical problems, such as the origin of glaciers, or the origin of strata of marble, and a complete solution of it involves—1. The experimental determination of the conditions under which bodies having the characters of species are producible; 2. The proof that such conditions are actually operative in nature.

Any doctrine of the origin of species which satisfies these requirements must be regarded as a true threory of species; while any which does not, is, so far, defective, and must be regarded only as a hypothesis whose value is greater or less according to its approximation to this standard.

It is Mr Darwin's peculiar merit to have apprehended these logical necessities, and to have endeavoured to comply with them. The Pigeons called Pouters, Tumblers, Fantails, &c., which the audience had an opportunity of examining, are, in his view, the result of so many long-continued experiments on the manufacture of species; and he considers that causes essentially similar to those which have given rise to these birds are operative in nature now, and have in past times been the agents in producing all the species we know. If neither of these positions can be upset, Mr Darwin's must be regarded as a true theory of species, as well based as any other physical theory: they require, therefore, the most careful and searching criticism.

After pointing out the remarkable differences in structure and habits between the Carrier, Pouter, Fantail, Tumbler, and the wild Columba livia, the speaker expressed his entire agreement with Mr Darwin's conclusion, that all the former domesticated breeds had arisen from the last-named wild stock; and on the following grounds: —1. That all interbreed freely with one another. 2. That none of the domesticated breeds presents the slightest approximation to any wild species but C. livia, whose characteristic markings are at times exhibited by all. 3. That the known habits of the Indian variety of the Rock Pigeon (C. intermedia) render its domestication easily intelligible. 4. That existing varieties connect the extremest modifications of the domestic breeds by insensible links with C. livia. 5. That there is historical evidence of the divergence of existing breeds, *e.g.* the Tumbler, from forms less unlike C. livia.

The speaker then analysed the process of selection by which the domesticated breeds had been produced from the Wild Rock Pigeon; and he showed its possibility to depend upon two laws which hold good for all species, viz.: 1. That every species tends to vary. 2. That variations are capable of hereditary transmission. The second law is well understood; but the speaker adverted to the miscomprehension which appears to prevail regarding the first, and showed that the variation of a species is by no means an adaptation to conditions in the sense in which that phrase is commonly used. Pigeon-fanciers, in fact, subject their pigeons to a complete uniformity of conditions: but while the similarly-used feet, legs, skull, sacral vertebræ, tail-feathers, oil-gland, and crop undergo the most extraordinary modifications; on the other hand, the wings, whose use is hardly ever permitted to the choice breeds, have hitherto shown no sign of diminution. Man has not as yet been able to determine a variation; he only favours those which arise spontaneously, *i.e.* are determined by unknown conditions.

It must be admitted that, by selection, a species may be made give rise experimentally to excessively different modifications; and the next question is, do causes adequate to exert selection exist in nature? On this point, the speaker referred his audience to Mr Darwin's chapter on the struggle for existence, as affording ample satisfactory proof that such adequate natural causes do exist.

There can be no question that just as man cherishes the varieties he wishes to preserve, and destroys those he does not care about; so nature (even if we consider the physical world as a mere mechanism) must tend to cherish those varieties which are better fitted to work harmoniously with the conditions she offers, and to destroy the rest.

There seems to be no doubt, then, that modifications equivalent in extent to the four breeds of pigeons might be developed from a species by natural causes; and therefore, if it can be shown that these breeds have all the characters which are ever found in species, Mr Darwin's case would be complete. However, there is as yet no *proof* that, by selection, modifications having the physiological character of species (*i.e.* whose offspring are incapable of propagation, *inter se*) have ever been produced from a common stock.

No doubt the numerous indirect arguments brought forward by Mr Darwin to weaken the force of this objection are of great weight; no doubt it cannot be proved that all species give rise to hybrids infertile, *inter se*; no doubt (so far as the speaker's private conviction went), a well-conducted series of experiments very probably would yield us derivatives from a common stock, whose offspring should be infertile, *inter se*; but we must deal with facts as they stand, and at present it must be admitted that Mr Darwin's theory does not account for all the phenomena exhibited by species; and so far, falls short of being a satisfactory theory.

Nevertheless the speaker expressed his sense of the extremely high value to be attached to Mr Darwin's hypothesis; and, avowing his own conviction that the following it out must ultimately lead us to the detection of the laws which have governed the origin of species, he concluded his discourse in the following words, which he wishes to be added in full to the very brief preceding account of his view of Mr Darwin's argument:—

"I have endeavoured to lay before you what, as I fancy, are the turning points of a great controversy; to render obvious the mode in which the vast problem of the origin of species must be dealt with; and so far as purely scientific considerations go, I have nothing more to say. But let me beg you still to listen to a last word respecting the unscientific objections which I constantly hear brought forward, on the part of the general public, against such doctrines as those we have been discussing. For this is a matter upon which it is of the utmost importance that men of science and the public should come to an understanding. I have heard it said, that it is presumptuous for us to atttempt to inquire into such matters as these; that they are problems beyond the reach of the human understanding. Do you remember what was the reply of the old philosopher to those who demonstrated to him so clearly the impossibility of motion? 'Solvitur ambulando,' said he, and got up and walked. And so I doubt not that one of these days either Mr Darwin's hypothesis, or some other, will get up and walk, and that vigorously; and so save us the trouble of any further discussion of this objection.

"Another and unfortunately a large class of persons take fright at the logical consequences of such a doctrine as that put forth by Mr Darwin. If all species have arisen in this way, say they—Man himself must have done so; and he and all the animated world must have had a common origin. Most assuredly. No question of it.

"But I would ask, does this logical necessity add one single difficulty of importance to those which already confront us on all sides whenever we contemplate our relations to the surrounding universe? I think not. Let man's mistaken vanity, his foolish contempt for the material world, impel him to struggle as he will, he strives in vain to break through the ties which hold him to matter and the lower forms of life.

"In the face of the demonstrable facts, that the anatomical difference between man and the highest of the Quadrumana is less than the difference between the extreme types of the Quadrumanous order; that, in the course of his development, man passes through stages which correspond to, though they are not identical with, those of all the lower animals; that each of us was once a minute and unintelligent particle of yolk-like substance; that our highest faculties are dependent for their exercise upon the presence of a few cubic inches more or less of a certain gas in one's blood; in the face of these tremendous and mysterious facts, I say, what matters it whether a new link is or is not added to the mighty chain which indissolubly binds us to the rest of the universe? Of what part of the glorious fabric of the world has man a right to be ashamed—that he is so desirous to disconnect himself from it? But I would rather reply to this strange objection by suggesting another line of thought. I would rather point out that perhaps the very noblest use of science as a discipline is, that now and then she brings us face to face with difficulties like these. Laden with our idols, we follow her blithely—till a parting in the roads appears, and she turns, and with a stern face asks us whether we are men enough to cast them aside, and follow her up the steep? Men of science are such by virtue of having answered her with a hearty and unreserved Yea; by virtue of having made their election to follow science whithersoever she leads, and whatsoever lions be in the path. Their duty is clear enough.

"And, in my apprehension, that of the public is not doubtful. I have said that the man of science is the sworn interpreter of nature in the high court of reason. But of what avail is his honest speech, if Ignorance is the assessor of the judge, and Prejudice foreman of the jury? I hardly know of a great physical truth, whose universal reception has not been preceded by an epoch in which most estimable persons have maintained that the phenomena investigated were directly dependent on the Divine Will, and that the attempt to investigate them was not only futile, but blasphemous. And there is a wonderful tenacity of life about this sort of opposition to physical science. Crushed and maimed in every battle, it yet seems never to be slain; and after a hundred defeats it is at this day as rampant, though happily not so mischievous, as in the time of Galileo.

"But to those whose life is spent, to use Newton's noble words, in picking up here a pebble and there a pebble on the shores of the great ocean of truth—who watch, day by day, the slow but sure advance of that mighty tide, bearing on its bosom the thousand treasures wherewith man ennobles and beautifies his life—it would be laughable, if it were not so sad, to see the little Canutes of the hour enthroned in solemn state, bidding that great wave to stay, and threatening to check its beneficent progress. The wave rises and they fly; but, unlike the brave old Dane, they learn no lesson of humility: the throne is pitched at what seems a safe distance, and the folly is repeated.

"Surely, it is the duty of the public to discourage everything of this kind, to discredit these foolish meddlers who think they do the Almighty a service by preventing a thorough study of his works.

"The Origin of Species is not the first, and it will not be the last, of the great questions born of science, which will demand settlement from this generation. The general mind is seething strangely, and to those who watch the signs of the times, it seems plain that this nineteenth century will see revolutions of thought and practice as great as those which the sixteenth witnessed. Through what trials and sore contests the civilised world will have to pass in the course of this new reformation, who can tell?

"But I verily believe that, come what will, the part which England may play in the battle is a grand and a noble one. She may prove to the world, that for one people, at any rate, despotism and demagoguy are not the necessary alternatives of government; that freedom and order are not incompatible; that reverence is the handmaid of knowledge; that free discussion is the life of truth, and of true unity in a nation.

"Will England play this part? That depends upon how you, the public, deal with science. Cherish her, venerate her, follow her methods faithfully and implicitly in their application to all branches of human thought; and the future of this people will be greater than the past.

"Listen to those who would silence and crush her, and I fear our children will see the glory of England vanishing like Arthur in the mist; they will cry too late the woful cry of Guinever:

'It was my duty to have loved the highest;
It surely was my profit, had I known;
It would have been my pleasure, had I seen.'"

HIPPOCRATES.—We learn that a new and splendid edition of the father of medicine is in course of publication at Utrecht, under the auspices of the Royal Academy of Sciences of the Netherlands. The editor is Dr Frans Zacharias Ermerins, who for many years has devoted himself to the criticism and interpretation of Hippocrates. The first volume has just made its appearance, under the following title: "Ἱπποκρατους και αλλων Ἰατρων παλαιων λειψανα. Hippocratis et aliorum Medicorum veterum reliquiæ. Mandatu Academiæ Regiæ Disciplinarum quæ Amstelodami est edidit F. Z. Ermerins. Vol. I. Trajecti ad Rhenum." The text of this addition is in Greek and Latin, and the work is printed in quarto form, with bold, handsome types, the Greek especially being remarkably clear and beautiful. Prefixed to the first volume are a preface and copious prolegomena, in the former of which the writer explains the necessity for a new edition of the Physician of Cos, notwithstanding the labours of M. Littré, whose edition of Hippocrates, although begun in 1839, is not yet completed.

PHYSIOLOGY OF THE SYMPATHETIC SYSTEM OF NERVES.

By JAMES RORIE, M.D., &c.

(Continued from page 82.)

II. *Does the Sympathetic System possess Sensory Properties?*—This question, whether or not the sympathetic system possesses sensory properties, can evidently be solved only by experimental research—*i.e.*, by irritating the nerves and watching the movements produced in the different organs. Now, it is evident at the very outset that this plan is beset with many difficulties; for the motions of the animal may be misinterpreted, and, again, on the application of an irritant we cannot be certain whether it acts on the sympathetic or on the cerebro-spinal fibres. It is, therefore, not at all to be wondered at that we have the following contradictory statements:

"Bichat, Magendie, Dupuy, and others, observed that section of the branches of the sympathetic was attended with few or no signs of pain." Dupuy states that he has removed the superior cervical ganglion from the horse without the operation appearing to call forth any marked expression of pain. Haller found, on the other hand, that irritation of the hepatic plexus in the dog gave rise to distinct signs of pain. The same results were also obtained by Meyer from irritation of the solar plexus. When he made incisions into the superior cervical ganglion, he found, contrary to what had been observed by Dupuy, that clear indications of pain were elicited. From ligatures applied to the renal nerves, as well as from the application of chemical or mechanical stimuli to the semilunar ganglia, animals suffered great pain. So also Flourens found that, on irritating the semilunar ganglia in dogs, the animals exhibited distinct signs of pain; and the same results were obtained by Brachet from irritation of the thoracic ganglia. A host of other authorities might be here mentioned, some of whom obtained pain, while others failed in doing so. How are these statements to be reconciled? As follows:—The sympathetic system in all probability possesses no sensory properties; and that, when pain was elicited in the foregoing experiments, it was in all probability due to irritation of the cerebro-spinal fibres. This also explains why intestinal diseases are accompanied by pain.

It may, however, here be asked that since cerebro-spinal fibres are distributed to the intestines, why are the movements of the latter not always perceptible? This I believe to be due simply to the paucity of the nerve fibres. Some parts, even of the external surface of the body, are so scantily supplied by nerves as to possess little sensibility. No body, for instance, while sitting quiet, can tell whether or not he has anything on his back until he sets his clothes in motion by muscular effort. And again, how often do we see a person going about in search of his hat, until, from memory or accident, he discovers it on his head! Indeed, we have here a law which, although not noticed by any one so far as I am aware, must be patent to everybody; namely, to feel an object, *i. e.*, to become conscious of the existence of an object by the sense of touch, motion on the part of the sentient body is absolutely necessary. The bland contents of the intestines thus produce so little irritation that no perception of their presence is obtained; but no sooner does a hard, indigestible mass irritate the intestines, than pain is elicited.

The correctness of the above explanation also received support from the experiments of Valentine as to the sensibility of different parts of the sympathetic nerves. Thus he found, 1st. That the very grey branches which have passed through several ganglia, as the mesenteric nerves, do not, when the stimulus applied to them is slight, give rise to any signs which would indicate that pain was produced. Still these on firm pressure do give evidence of pain, because, although not numerous, cerebro-spinal fibres *are* present. 2ndly. "That irritation of the ganglia themselves gives indications of pain, because cerebro-spinal fibres pass through these structures." 3rdly. "That the connecting cord of the sympathetic is similarly circumstanced with regard to sensibility, for a like reason." And, 4thly. "That the rami communicantes are as highly endowed with sensibility as the posterior roots of the neighbouring spinal nerves, in consequence of the large number of white fibres existing in these cords."

III.—*The Motor Function of the Sympathetic.*—That the sympathetic system possesses motor properties, there can be little doubt, as shown by the experiment already referred to, namely, that the heart continues to beat after the brain and spinal cord have been destroyed; and, as shown by Professor Simpson, that expulsion of the fœtus takes place after destruction of the spinal cord. Again, irritation of the sympathetic nerves has, by different experimenters, been found to be followed by contraction of organs, as the intestines, supplied by these nerves.

The organs supplied by motor power from the sympathetic, are all those in which involuntary muscular fibres have been found—the vascular, the digestive, including the accompanying glands, spleen, &c., and the genito-urinary systems. Before, however, proceeding to consider at length the different motion of these systems, we may refer for a little to some very curious analogies in these movements.

1. *The Continuance of the Motion.*—When muscles supplied by cerebro-spinal nerves perform their functions, their contraction is followed by relaxation or cessation of motion, lasting until the next act of volition re-excites the contraction. There is thus no regularity as regards the period of their contractions. They may remain hours at rest, or they may for hours continue in a state of almost constant contraction. It is very different with organs supplied by the sympathetic system. Here the movements are of a very precise character, consisting of an alternate contraction and relaxation, continuing so long as the body remains in health. This is seen in the action of the heart, and in the vermicular movement of the intestines.

2. *The Character of the Motion.*—The movements of the organs now under consideration are of a peculiar character. When a voluntary muscle contracts, it does so equally throughout all its extent; but when the involuntary muscular systems contract, the case is different. Thus the beat of the heart commences in the auricles, passes to the ventricles, and thence along all the arterial branches. The movements of the intestines, again, commence at the stomach and continue slowly onwards to the rectum; the contraction of the uterus begins at what is in reality its commencement, the Fallopian tubes, and terminates at the cervix; and finally, in the case of the vesiculæ seminales contraction commences at their distal extremities, and terminates in the urethra. These peculiar movements of these organs have received the name of the undulatory or vermicular action.

3. *The Cause of these Movements.*—This is a point which has caused much discussion. Some ascribe it to the presence of their special excitants, blood, food, the fœtus, and liquor seminis. This theory, however, is shown to be erroneous, by the experiment, in the case of the vascular system, of removing the heart (which is equivalent to removing the special stimulus, blood); when it will be found to continue to beat for a length of time, varying according as the animal experimented on is warm or cold-blooded.

This experiment also shows that the contraction cannot be due to the cerebro-spinal system. We are, therefore, driven to the conclusion that the motor power resides in the sympathetic alone, probably arising in the ganglia situated in the heart's substance, and already described.

4. *Periodicity of Motion.*—However much the vascular, digestive, and genito-urinary systems resemble one another in the character, continuance, and cause of their movements, an anomaly appears to exist in the periodicity of their action. Thus, contraction of the heart and vessels occurs, on an average, 70 times a minute; while, in the intestines, only 20 (?) times an hour; and again, in the uterus and vesiculæ seminales, only at certain times—but when it does take place, the movements characteristic of organs supplied by the sympathetic then occur. On a more careful examination, however, although differing in the period of duration of each contraction, a remarkable similarity will