CHAPTER III.

THE COEXISTENCE OF CLOSELY-SIMILAR STRUCTURES OF DIVERSE ORIGIN.

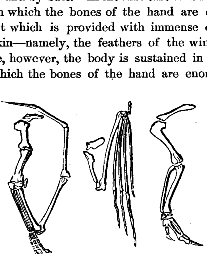
Chances against Concordant Variations.—Examples of Discordant Ones.—Concordant Variations not unlikely on a non-Darwinian Evolutionary Hypothesis.—Placental and Implacental Mammals.—Birds and Reptiles.—Independent Origins of Similar Sense Organs.—The Ear.—The Eye.—Other Coincidences.—Causes besides Natural Selection produce Concordant Variations in Certain Geographical Regions.—Causes besides Natural Selection produce Concordant Variations in Certain Zoological and Botanical Groups.—There are Homologous Parts not genetically related.—Harmony in respect of the Organic and Inorganic Worlds.—Summary and Conclusion.

THE theory of "Natural Selection" supposes that the varied forms and structure of animals and plants have been built up merely by indefinite, fortuitous,[1] minute variations in every part and in all directions—those variations only being preserved which are directly or indirectly useful to the individual possessing them, or necessarily correlated with such useful variations.

On this theory the chances are almost infinitely great against the independent, accidental occurrence and preservation of two similar series of minute variations resulting in the independent development of two closely-similar forms. In all cases, no doubt (on this same theory), *some* adaptation to habit or need would gradually be evolved, but that adaptation would surely be arrived at by different roads. The organic world supplies us with multitudes of

[1] By accidental variations Mr. Darwin does not, of course, mean to imply variations really due to "chance," but to utterly indeterminate antecedents.

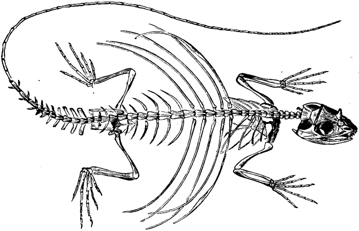
examples of similar functional results being attained by the most diverse means. Thus the body is sustained in the air by birds and by bats. In the first case it is so sustained by a limb in which the bones of the hand are excessively reduced, but which is provided with immense outgrowths from the skin—namely, the feathers of the wing. In the second case, however, the body is sustained in the air by a limb in which the bones of the hand are enormously in-



WING-BONES OF PTERODACTYL, BAT, AND BIRD.

(Copied, by permission, from Mr. Andrew Murray's "Geographical Distribution of Mammals.")

creased in length, and so sustain a great expanse of naked skin, which is the flying membrane of the bat's wing. Certain fishes and certain reptiles can also flit and take very prolonged jumps in the air. The flying-fish, however, takes these by means of a great elongation of the rays of the pectoral fins—parts which cannot be said to be of the same nature as the constituents of the wing of either the bat or the bird. The little lizard, which enjoys the formidable name of "flying-dragon," flits by means of a structure altogether peculiar—namely, by the liberation and great elongation of some of the ribs which support a fold of skin. In the extinct pterodactyls—which were *truly* flying reptiles—we meet with an approximation to the structure of the bat, but in the pterodactyl we have only one finger elongated in each hand: a striking example of how the very same function may be provided for by a modification similar in principle, yet surely manifesting the independence of its origin. When we go to lower animals, we find flight produced by organs, as the wings of insects, which are not even modified limbs at all; or we find even the



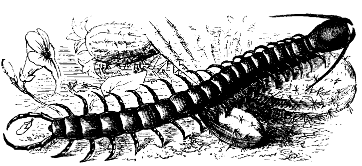
SKELETON OF THE FLYING-DRAGON.
(Showing the elongated ribs which support the flitting organ.)

function sometimes subserved by quite artificial means, as in the aërial spiders, which use their own threads to float with in the air. In the vegetable kingdom the atmosphere is often made use of for the scattering of seeds, by their being furnished with special structures of very different kinds. The diverse modes by which such seeds are dispersed are well expressed by Mr. Darwin. He says:[2]

[2] "Origin of Species," 5th edit., p. 235.

"Seeds are disseminated by their minuteness—by their capsule being converted into a light balloon-like envelope—by being embedded in pulp or flesh, formed of the most diverse parts, and rendered nutritious, as well as conspicuously colored, so as to attract and be devoured by birds—by having hooks and grapnels of many kinds and serrated awns, so as to adhere to the fur of quadrupeds—and by being furnished with wings and plumes, as different in shape as elegant in structure, so as to be wafted by every breeze."

Again, if we consider the poisoning apparatus possessed by different animals, we find in serpents a perforated—or, rather, very deeply-channelled—tooth. In wasps and bees the sting is formed of modified parts, accessory in reproduction. In the scorpion, we have the median terminal process of the body specially organized. In the spider, we have a specially-constructed antenna; and finally in the centipede a pair of modified thoracic limbs.



A CENTIPEDE.

It would be easy to produce a multitude of such instances of similar ends being attained by dissimilar means, and it is here contended that by "the action of Natural

Selection" *only* it is so improbable as to be practically impossible for two exactly-similar structures to have ever been independently developed. It is so because the number of possible variations is indefinitely great, and it is therefore an indefinitely great number to one against a similar series of variations occurring and being similarly preserved in any two independent instances.

The difficulty here asserted applies, however, only to pure Darwinism, which makes use *only* of indirect modifications through the survival of the fittest.

Other theories (for example, that of Mr. Herbert Spencer) admit the *direct* action of conditions upon animals and plants—in ways not yet fully understood—there being conceived to be at the same time a certain peculiar but limited power of response and adaptation in each animal and plant so acted on. Such theories have not to contend against the difficulty proposed, and it is here urged that even very complex extremely similar structures have again and again been developed quite independently one of the other, and this because the process has taken place not by merely haphazard, indefinite variations in all directions, but by the concurrence of some other and internal natural law or laws coöperating with external influences and with "Natural Selection" in the evolution of organic forms.

It must never be forgotten that to admit any such constant operation of any such unknown natural cause is to deny the purely Darwinian theory, which relies upon the survival of the fittest by means of minute fortuitous indefinite variations.

Among many other obligations which the author has to acknowledge to Prof. Huxley are, the pointing out of this very difficulty, and the calling his attention to the striking resemblançe between certain teeth of the dog and of the thylacine as one instance, and certain ornithic peculiarities of pterodactyls as another.

Mammals[3] are divisible into one great group, which comprises the immense majority of kinds termed, from their mode of reproduction, *placental Mammals*, and into another very much smaller group comprising the pouched-beasts or marsupials (which are the kangaroos, bandicoots, phalangers, etc., of Australia), and the true opossums of America, called *implacental Mammals.* Now, the placental mammals are subdivided into various orders, among which are the flesh-eaters (Carnivora, i. e., cats, dogs, otters, weasels, etc.), and the insect-eaters (Insectivora, i. e., moles, hedgehogs, shrew-mice, etc.). The marsupial mammals also present a variety of forms (some of which are carnivorous beasts, while others are insectivorous), so marked that it has been even proposed to divide them into orders parallel to the orders of placental beasts.

The resemblance, indeed, is so striking as, on Darwinian principles, to suggest the probability of genetic affinity; and it even led Prof. Huxley, in his Hunterian Lectures, in 1866, to promulgate the notion that a vast and widely-diffused marsupial fauna may have existed anteriorly to the

TEETH OF UROTRICHUS AND PERAMELES

development of the ordinary placental, non-pouched beasts, and that the carnivorous, insectivorous, and herbivorous

[3] I. e., warm-blooded animals which suckle their young, such as apes, bats, hoofed beasts, lions, dogs, bears, weasels, rats, squirrels, armadillos, sloths, whales, porpoises, kangaroos, opossums, etc.

placentals may have respectively descended from the carnivorous, insectivorous, and herbivorous marsupials.

Among other points Prof. Huxley called attention to the resemblance between the anterior molars of the placental dog with those of the marsupial thylacine. These, indeed, are strikingly similar, but there are better examples still of this sort of coincidence. Thus it has often been remarked that the insectivorous marsupials, e. g., *Perameles*, wonderfully correspond, as to the form of certain of the grinding teeth, with certain insectivorous placentals, e. g., *Urotrichus*.

Again, the saltatory insectivores of Africa (*Macroscelides*) not only resemble the kangaroo family (*Macropodidæ*) in their jumping habits and long hind-legs, but also in the structure of their molar teeth, and even further, as I have elsewhere[4] pointed out, in a certain similarity of the upper cutting teeth, or incisors.

Now, these correspondences are the more striking when we bear in mind that a similar dentition is often put to very different uses. The food of different kinds of apes is very different, yet how uniform is their dental structure! Again, who, looking at the teeth of different kinds of bears, would ever suspect that one kind was frugivorous, and another a devourer exclusively of animal food?

The suggestion made by Prof. Huxley was therefore one which had much to recommend it to Darwinians, though it has not met with any notable acceptance, and though he seems himself to have returned to the older notion, namely, that the pouched-beasts, or marsupials, are a special ancient offshoot from the great mammalian class.

But, whichever view may be the correct one, we have in either case a number of forms similarly modified in harmony with surrounding conditions, and eloquently proclaiming some natural plastic power, other than mere fortuitous

[4] "Journal of Anatomy and Physiology" (1868), vol. ii., p. 139.

variation with survival of the fittest. If, however, the reader thinks that teeth are parts peculiarly qualified for rapid variation (in which view the author cannot concur), he is requested to suspend his judgment till he has considered the question of the independent evolution of the *highest organs of sense.* If this seems to establish the existence of some other law than that of "Natural Selection," then the operation of that other law may surely be also traced in the harmonious coördinations of dental form.

The other difficulty, kindly suggested to me by the learned professor, refers to the structure of birds, and of extinct reptiles more or less related to them.

The class of birds is one which is remarkably uniform in its organization. So much is this the case, that the best mode of subdividing the class is a problem of the greatest difficulty. Existing birds, however, present forms which, though closely resembling in the greater part of their structure, yet differ importantly the one from the other. One form is exemplified by the ostrich, rhea, emeu, cassowary, apteryx, dinornis, etc. These are the *struthious* birds. All other existing birds belong to the second division, and are called (from the keel on the breast-bone) *carinate* birds.

Now, birds and reptiles have such and so many points in common that Darwinians must regard the former as modified descendants of ancient reptilian forms. But on Darwinian principles it is impossible that the class of birds so uniform and homogeneous should have had a double reptilian origin. If one set of birds sprang from one set of reptiles, and another set of birds from another set of reptiles, the two sets could never, by "Natural Selection" only, have grown into such a perfect similarity. To admit such a phenomenon would be equivalent to abandoning the theory of "Natural Selection" as the sole origin of species.

Now, until recently it has generally been supposed by evolutionists that those ancient flying reptiles, the pterodactyls, or forms allied to them, were the progenitors of the class of birds; and certain parts of their structure especially support this view. Allusion is here made to the blade-bone (scapula) and the bone which passes down from the shoulder-joint to the breast-bone (viz., the coracoid). These bones are such remarkable anticipations of the same parts in ordinary (i. e., carinate) birds that it is hardly possible for a Darwinian not to regard the resemblance as due to community of origin. This resemblance was carefully pointed out by Prof. Huxley in his "Hunterian Course" for 1867, when attention was called to the existence in *Dimorphodon macronyx* of even that small process which in birds gives attachment to the upper end of the merry-thought. Also Mr. Seeley[5] has shown that in pterodactyls, as in birds, the optic lobes of the brain were placed low down on each side—"lateral and depressed." Nevertheless, the view has been put forward and ably maintained by the same professor,[6] as also by Prof. Cope in the United States, that the line of descent from reptiles to birds has not been from ordinary reptiles, through pterodactyl-like forms, to ordinary birds, but to the struthious ones from certain extinct reptiles termed Dinosauria; one of the most familiarly known of which is the Iguanodon of the Wealden formation. In these Dinosauria we find skeletal characters unlike those of ordinary (i. e., carinate) birds, but closely resembling in certain points the osseous structure of the struthious birds. Thus a difficulty presents itself as to the explanation of the three following relationships: (1) That of the Pterodactyls with carinate birds; (2) that

[5] See "Ann. and Mag. of Nat. Hist." for August, 1870, p. 140.

[6] See "Proceedings of the Royal Institution," vol. v., part iv., p. 278: Report of a Lecture delivered February 7, 1868. Also "Quarterly Journal of the Geological Society," February, 1870. "Contributions to the Anatomy and Taxonomy of the Dinosauria."

of the Dinosauria with struthious birds; (3) that of the carinate and struthious birds with each other.

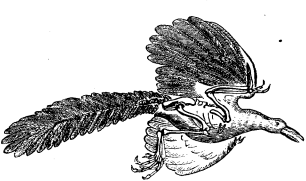
Either birds must have had two distinct origins whence they grew to their present conformity, or the very same skeletal, and probably cerebral characters, must have spontaneously and independently arisen. Here is a dilemma, either horn of which bears a threatening aspect to the exclusive supporter of "Natural Selection," and between which it seems somewhat difficult to choose.

It has been suggested to me that this difficulty may be evaded by considering pterodactyls and carinate birds as independent branches from one side of an ancient common trunk, while similarly the Dinosauria and struthious birds are taken to be independent branches from the other side of the same common trunk; the two kinds of birds resembling each other so much on account of their later development from that trunk as compared with the development of the reptilian forms. But to this it may be replied that the ancient common stock could not have had at one and the same time a shoulder structure of *both kinds*. It must have been that of the struthious birds or that of the carinate birds, or something different from both. If it was that of the struthious birds, how did the pterodactyls and carinate birds independently arrive at the very same divergent structure? If it was that of the carinate birds, how did the struthious birds and Dinosauria independently agree to differ? Finally, if it was something different from either, how did the carinate birds and pterodactyls take on independently one special common structure when disagreeing in so many; while the struthious birds, agreeing in many points with the Dinosauria, agree yet more with the carinate birds? Indeed, by no arrangement of branches from a stem can the difficulty be evaded.

Prof. Huxley seems inclined[7] to cut the Gordian knot

[7] "Proceedings of Geological Society," November, 1869, p. 38.

by considering the shoulder structure of the pterodactyl as independently educed, and having relation to physiology only. This conception is one which harmonizes completely with the views here advocated, and with those of Mr. Herbert Spencer, who also calls in direct modification to the aid of "Natural Selection." That merely minute, indefinite variations in all directions should unaided have independently built up the shoulder structure of the pterodactyls and carinate birds, and have laterally depressed their optic lobes, at a time so far back as the deposition of the Oolite



THE ARCHEOPTERYX (of the Oolite strata).

strata,[8] is a coincidence of the highest improbability; but that an innate power and evolutionary law, aided by the corrective action of "Natural Selection," should have furnished like needs with like aids, is not at all improbable. The difficulty does not tell against the theory of evolution, but only against the specially Darwinian form of it. Now, this form has never been expressly adopted by Prof. Huxley;

[8] The archeopteryx of the oolite has the true carinate shoulder structure.

so far from it, in his lecture on this subject at the Royal Institution before referred to, he observes:[9] "I can testify, from personal experience, it is possible to have a complete faith in the general doctrine of evolution, and yet to hesitate in accepting the Nebular, or the Uniformitarian, or the Darwinian hypotheses in all their integrity and fulness."

It is quite consistent, then, in the professor to explain the difficulty as he does; but it would not be similarly so with an absolute and pure Darwinian.

Yet stronger arguments of an analogous kind are, however, to be derived from the highest organs of sense. In the most perfectly-organized animals—those, namely, which, like ourselves, possess a spinal column—the internal organs of hearing consist of two more or less complex membranous sacs (containing calcareous particles—otoliths), which are primitively or permanently lodged in two chambers, one on each side of the cartilaginous skull. The primitive cartilaginous cranium supports and protects the base of the brain, and the auditory nerves pass from the brain into the cartilaginous chambers to reach the auditory sacs. These complex arrangements of parts could not have been evolved by "Natural Selection," i. e., by minute accidental variations, except by the action of such through a vast period of time; nevertheless, it was fully evolved at the time of the deposition of the upper Silurian rocks.

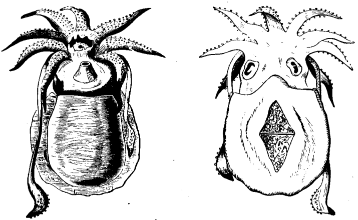
Cuttle-fishes (*Cephalopoda*) are animals belonging to the molluscous primary division of the animal kingdom, which division contains animals formed upon a type of structure utterly remote from that on which the animals of the higher division provided with a spinal column are constructed. And indeed no transitional form (tending even to bridge over the chasm between these two groups) has ever

[9] "Proceedings of the Royal Institution," vol. v., p. 279.

yet been discovered, either living or in a fossilized condition.[10]

Nevertheless, in the two-gilled Cephalopods (*Dibranchiata*) we find the brain supported and protected by a cartilaginous cranium. In the base of this cranium are two cartilaginous chambers. In each chamber is a membranous sac containing an otolith, and the auditory nerves pass from

A B



CUTTLE-FISH.

A. Ventral aspect. B. Dorsal aspect.

the cerebral ganglia into the cartilaginous chambers to reach the auditory sacs. Moreover, it has been suggested by Prof. Owen that sinuosities between processes projecting from the inner wall of each chamber "seem to be the first rudiments of those which, in the higher classes (i. e., in animals with a spinal column), are extended in the form of

[10] This remark is made without prejudice to possible affinities in the direction of the Ascidians—an affinity which, if real, would be irrelevant to the question here discussed.

canals and spiral chambers, within the substance of the dense nidus of the labyrinth." [11]

Here, then, we have a wonderful coincidence indeed; two highly-complex auditory organs, marvellously similar in structure, but which must nevertheless have been developed in entire and complete independence one of the other! It would be difficult to calculate the odds against the independent occurrence and conservation of two such complex series of merely accidental and minute haphazard variations. And it can never be maintained that the sense of hearing could not be efficiently subserved otherwise than by such sacs, in cranial cartilaginous capsules so situated in relation to the brain, etc.

Our wonder, moreover, may be increased when we recollect that the two-gilled cephalopods have not yet been found below the lias, where they at once abound; whereas the four-gilled cephalopods are Silurian forms. Moreover, the absence is in this case significant in spite of the imperfection of the geological record, because when we consider how many individuals of various kinds of four-gilled cephalopods have been found, it is fair to infer that at the least a certain small percentage of dibranchs would also have left traces of their presence had they existed. Thus it is probable that some four-gilled form was the progenitor of the dibranch cephalopods. Now, the four-gilled kinds (judging from the only existing form, the nautilus) had the auditory organ in a very inferior condition of development to what we find in the dibranch; thus we have not only evidence of the independent high development of the organ in the former, but also evidence pointing toward a certain degree of comparative rapidity in its development.

Such being the case with regard to the organ of hearing, we have another yet stronger argument with regard to

11 "Lectures on the Comp. Anat. of the Invertebrate Animals," 2d edit., 1855, p. 619; and Todd's "Cyclopædia of Anatomy," vol. i., p. 554.

the organ of sight, as has been well pointed out by Mr. J. J. Murphy.[12] He calls attention to the fact that the eye must have been perfected in at least "three distinct lines of descent," alluding not only to the molluscous division of the animal kingdom, and the division provided with a spinal column, but also to a third primary division, namely, that which includes all insects, spiders, crabs, etc., which are spoken of as Annulosa, and the type of whose structure is as distinct from that of the molluscous type on the one hand, as it is from that of the type with a spinal column (i. e., the vertebrate type) on the other.

In the cuttle-fishes we find an eye even more completely constructed on the vertebrate type than is the ear. Sclerotic, retina, choroid, vitreous humor, lens, aqueous humor, all are present. The correspondence is wonderfully complete, and there can hardly be any hesitation in saying that for such an exact, prolonged, and correlated series of similar structures to have been brought about in two independent instances by merely indefinite and minute accidental variations, is an improbability which amounts practically to impossibility. Moreover, we have here again the same imperfection of the four-gilled cephalopod, as compared with the two-gilled, and therefore (if the latter proceeded from the former) a similar indication of a certain comparative rapidity of development. Finally, and this is perhaps one of the most curious circumstances, the process of formation appears to have been, at least in some respects, the same in the eyes of these molluscous animals as in the eyes of vertebrates. For in these latter the cornea is at first perforated, while different degrees of perforation of the same part are presented by different adult cuttle-fishes—large in the calamaries, smaller in the octopods, and reduced to a minute foramen in the true cuttle-fish sepia.

[12] See "Habit and Intelligence," vol. i., p. 321.

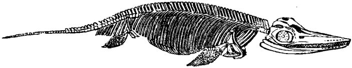
Some may be disposed to object that the conditions requisite for effecting vision are so rigid that similar results in all cases must be independently arrived at. But to this objection it may well be replied that Nature herself has demonstrated that there is no such necessity as to the details of the process. For in the higher Annulosa, such as the dragon-fly, we meet with an eye of an unquestionably very high degree of efficiency, but formed on a type of structure only remotely comparable with that of the fish or the cephalopod. The last-named animal might have had an eye as efficient as that of a vertebrate, but formed on a distinct type, instead of being another edition, as it were, of the very same structure.

In the beginning of this chapter examples have been given of the very diverse mode in which similar results have in many instances been arrived at; on the other hand, we have in the fish and the cephalopod not only the eye, but at one and the same time the ear also similarly evolved, yet with complete independence.

Thus it is here contended that the similar and complex structures of both the highest organs of sense, as developed in the vertebrates on the one hand, and in the mollusks on the other, present us with residuary phenomena for which "Natural Selection" alone is quite incompetent to account; and that these same phenomena must therefore be considered as conclusive evidence for the action of some other natural law or laws conditioning the simultaneous and independent evolution of these harmonious and concordant adaptations.

Provided with this evidence, it may be now profitable to enumerate other correspondences, which are not perhaps in themselves inexplicable by Natural Selection, but which are more readily to be explained by the action of the unknown law or laws referred to—which action, as its necessity has been demonstrated in one case, becomes *a priori* probable in the others.

Thus the great oceanic Mammalia—the whales—show striking resemblances to those prodigious, extinct, marine



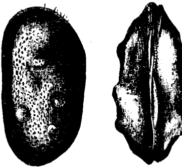
SKELETON OF AN ICHTHYOSAURUS.

reptiles, the Ichthyosauria, and this not only in structures readily referable to similarity of habit, but in such matters as greatly elongated premaxillary bones, together with the concealment of certain bones of the skull by other cranial bones.

Again, the aërial mammals, the bats, resemble those flying reptiles of the secondary epoch, the pterodactyls; not only to a certain extent in the breast-bone and mode of supporting the flying membrane, but also in the proportions of different parts of the spinal column and the hinder (pelvic) limbs

Also bivalve shell-fish (i. e., creatures of the muscle, cockle, and oyster class, which receive their name from the body being protected by a double shell, one valve of which is placed on each side) have their two shells united by one or two powerful muscles, which pass directly across from one shell to the other, and which are termed "adductor muscles" because by their contraction they bring together the valves and so close the shell.

Now there are certain animals which belong to the crab and lobster class (Crustacea)—a class constructed on an utterly different type from that on which the bivalve shell-fish are constructed—which present a very curious approximation to both the form and, in a certain respect, the structure of true bivalves. Allusion is here made to certain small Crustacea—certain phyllopods and ostracods—which have the hard outer coat of their thorax so modified as to look wonderfully like a bivalve shell, although its nature and composition are quite different. But this is by no means all—not only is there this external resemblance



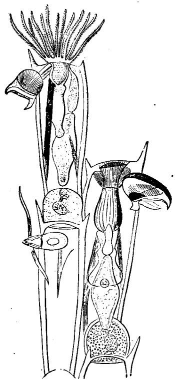
CYTHERIDEA TOROSA.

[An ostracod (Crustacean), externally like a bivalve shell-fish (Lamellibranch).]

between the thoracic armor of the crustacean and the bivalve shell, but the two sides of the ostracod and phyllopod thorax are connected together also by an adductor muscle!

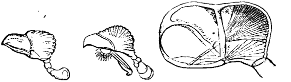
The pedicellariæ of the echinus have been already spoken of, and the difficulty as to their origin from minute, fortuitous, indefinite variations has been stated. But structures essentially similar (called avicularia, or "bird's-head processes") are developed from the surface of the compound masses of certain of the highest of the polyp-like animals (viz., the Polyzoa or, as they are sometimes called, the Bryozoa).

These compound animals have scattered over the surface of their bodies minute processes, each of which is like the head of a bird, with an upper and lower beak, the whole supported on a slender neck. The beak opens and shuts at intervals, like the jaws of the pedicellariæ of the echinus, and there is altogether, in general principle, a remarkable similarity between the structures. Yet the echinus can have, at the best, none but the most distant genetic relationship with the Polyzoa. We have here again,



A POLYZOON WITH BIRD'S-HEAD PROCESSES.

therefore, complex and similar organs of diverse and independent origin.



BIRD'S-HEAD PROCESSES VERY GREATLY ENLARGED.

In the highest class of animals (the Mammalia) we have almost always a placental mode of reproduction, i. e., the blood of the fœtus is placed in nutritive relation with the blood of the mother by means of vascular prominences. No trace of such a structure exists in any bird or in any reptile, and yet it crops out again in certain sharks. There indeed it might well be supposed to end, but, marvellous as it seems, it reappears in very lowly creatures; namely, in certain of the ascidians, sometimes called tunicaries or sea-squirts.

Now, if we were to concede that the ascidians were the common ancestors [13] of both these sharks and of the higher mammals, we should be little, if any, nearer to an explanation of the phenomenon by means of "Natural Selection," for in the sharks in question the vascular prominences are developed from one fœtal structure (the umbilical vesicle), while in the the higher mammals they are developed from quite another part, viz., the allantois.

So great, however, is the number of similar, but apparently independent structures, that we suffer from a perfect *embarras de richesses.* Thus, for example, we have the convoluted windpipe of the sloth, reminding us of the condition of the windpipe in birds; and in another mammal,

[13] A view recently propounded by Kowalewsky.

allied to the sloth, namely, the great ant-eater (Myrmecophaga), we have again an ornithic character in its horny gizzard-like stomach. In man and the highest apes the cæcum has a vermiform appendix, as it has also in the wombat!

Upper Figure—ANTECHINUS MINUTISSIMUS (*implacental*).
Lower Figure—MUS DELICATULUS (*placental*).

Also the similar forms presented by the crowns of the teeth in some seals, in certain sharks, and in some extinct Cetacea, may be referred to; as also the similarity of the beak in birds, some reptiles, in the tadpole, and cuttle-fishes. As to entire external form, may be adduced the wonderful similarity between a true mouse (*Mus delicatulus*) and a small marsupial, pointed out by Mr. Andrew

Murray in his work on the "Geographical Distributions of Mammals," p. 53, and represented in the frontispiece by figures copied from Gould's "Mammals of Australia;" but instances enough for the present purpose have been already quoted.

Additional reasons for believing that similarity of structure is produced by other causes than merely by "Natural Selection" are furnished by certain facts of zoological geography, and by a similarity in the mode of variation being sometimes extended to several species of a genus, or even to widely-different groups; while the restriction and the limitation of such similarity are often not less remarkable. Thus Mr. Wallace says,[14] as to local influence: "Larger or smaller districts, or even single islands, give a special character to the majority of their Papilionidæ. For instance: 1. The species of the Indian region (Sumatra, Java, and Borneo) are almost invariably smaller than the allied species inhabiting Celebes and the Moluccas. 2. The species of New Guinea and Australia are also, though in a less degree, smaller than the nearest species or varieties of the Moluccas. 3. In the Moluccas themselves the species of Amboyna are the largest. 4. The species of Celebes equal or even surpass in size those of Amboyna. 5. The species and varieties of Celebes possess a striking character in the form of the anterior wings, different from that of the allied species and varieties of all the surrounding islands. 6. Tailed species in India or the Indian region become tailless as they spread eastward through the Archipelago. 7. In Amboyna and Ceram the females of several species are dull-colored, while in the adjacent islands they are more brilliant." Again:[15] "In Amboyna and Ceram the female of the large and handsome *Ornithoptera Helena* has a large patch on the hind-wings constantly of a pale dull ochre or buff color; while in the scarcely distinguish-

[14] "Natural Selection," p. 167. [15] Ibid., p. 173.

able varieties from the adjacent islands, of Bouru and New Guinea, it is of a golden yellow, hardly inferior in brilliancy to its color in the male sex. The female of *Ornithoptera Priamus* (inhabiting Amboyna and Ceram exclusively) is of a pale dusky-brown tint, while in all the allied species the same sex is nearly black, with contracted white markings. As a third example, the female of *Papilio Ulysses* has the blue color obscured by dull and dusky tints, while in the closely-allied species from the surrounding islands, the faemles are of almost as brilliant an azure blue as the males. A parallel case to this is the occurrence, in the small islands of Goram, Matabello, Ké, and Aru, of several distinct species of Euplœa and Diadema, having broad bands or patches of white, which do not exist in any of the allied species from the larger islands. These facts seem to indicate some local influence in modifying color, as unintelligible and almost as remarkable as that which has resulted in the modifications of form previously described."

After endeavoring to explain some of the facts in a way to be noticed directly, Mr. Wallace adds:[16] "But even the conjectural explanation now given fails us in the other cases of local modification. Why the species of the Western Islands should be smaller than those farther east; why those of Amboyna should exceed in size those of Gilolo and New Guinea; why the tailed species of India should begin to lose that appendage in the islands, and retain no trace of it on the borders of the Pacific; and why, in three separate cases, the females of Amboyna species should be less gayly attired than the corresponding females of the surrounding islands, are questions which we cannot at present attempt to answer. That they depend, however, on some general principle is certain, because analogous facts have been observed in other parts of the world. Mr. Bates in-

[16] "Natural Selection," p. 177.

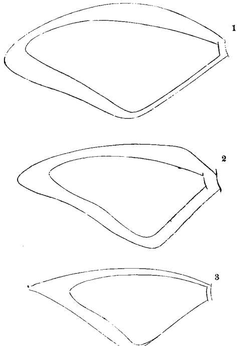
forms me that, in three distinct groups, Papilios, which, on the Upper Amazon, and in most other parts of South America, have spotless upper wings, obtain pale or white spots at Pará and on the Lower Amazon, and also that the Æneas group of Papilios never have tails in the equatorial regions and the Amazon valley, but gradually acquire tails in many cases as they range toward the northern or southern tropic. Even in Europe we have somewhat similar facts, for the species and varieties of butterflies peculiar to the Island of Sardinia are generally smaller and more deeply colored than those of the main-land, and the same has been recently shown to be the case with the common tortoise-shell butterfly in the Isle of Man; while *Papilio Hospiton*, peculiar to the former island, has lost the tail, which is a prominent feature of the closely-allied *P. Machaon*.

"Facts of a similar nature to those now brought forward would no doubt be found to occur in other groups of insects, were local faunas carefully studied in relation to those of the surrounding countries; and they seem to indicate that climate and other physical causes have, in some cases, a very powerful effect in modifying specific form and color, and thus directly aid in producing the endless variety of nature."

With regard to butterflies of Celebes belonging to different families, they present "a peculiarity of outline which distinguishes them at a glance from those of any other part of the world:" [17] it is that the upper wings are generally more elongated and the anterior margin more curved. Moreover, there is, in most instances, near the base, an abrupt bend or elbow, which in some species is very conspicuous. Mr. Wallace endeavors to explain this phenomenon by the supposed presence at some time of special persecutors of the modified forms, supporting the opinion by the remark that small, obscure, very rapidly flying and mim-

[17] "Malay Archipelago," vol. i., p. 439.

icked kinds have not had the wing modified. Such an enemy occasioning increased powers of flight, or rapidity in



OUTLINES OF WINGS OF BUTTERFLIES OF CELEBES COMPARED WITH THOSE OF ALLIED SPECIES ELSEWHERE.

Outer outline, *Papilio gigon*, of Celebes. Inner outline, *P. demolion*, of Singapore and Java.—2. Outer outline, *P. miletus*, of Celebes. Inner outline, *P. sarpedon* India.—3. Outer outline, *Tachyris zarinda*, Celebes. Inner outline, *T. nero*.

turning, he adds, "one would naturally suppose to be an insectivorous bird; but it is a remarkable fact that most of the genera of fly-catchers of Borneo and Java on the one side, and of the Moluccas on the other, are almost entirely absent from Celebes. Their place seems to be supplied by the caterpillar-catchers, of which six or seven species are known from Celebes, and are very numerous in individuals. We have no positive evidence that these birds pursue butterflies on the wing, but it is highly probable that they do so when other food is scarce. Mr. Bates suggested to me that the larger dragon-flies prey upon butterflies, but I did not notice that they were more abundant in Celebes than elsewhere." [18]

Now, every opinion or conjecture of Mr. Wallace is worthy of respectful and attentive consideration, but the explanation suggested and before referred to hardly seems a satisfactory one. What the past fauna of Celebes may have been is as yet conjectural. Mr. Wallace tells us that now there is a remarkable *scarcity* of fly-catchers, and that their place is supplied by birds of which it can only be said that it is "highly probable" that they chase butterflies "when other food is scarce." The quick eye of Mr. Wallace failed to detect them in the act, as also to note any unusual abundance of other insectivorous forms, which therefore, considering Mr. Wallace's zeal and powers of observation, we may conclude do not exist. Moreover, even if there ever has been an abundance of such, it is by no means certain that they would have succeeded in producing the conformation in question, for the effect of this peculiar curvature on flight is by no means clear. We have here, then, a structure hypothetically explained by an uncertain property induced by a cause the presence of which is only conjectural.

Surely it is not unreasonable to class this instance with the others before given, in which a common modification of form or color coexists with a certain geographical distribution quite independently of the destructive agencies of ani-

[18] "Natural Selection," p. 177.

mals. If physical causes connected with locality can abbreviate or annihilate the tails of certain butterflies, why may not similar causes produce an elbow-like prominence on the wings of other butterflies? There are many such instances of simultaneous modification. Mr. Darwin himself[19] quotes Mr. Gould as believing that birds of the same species are more brightly colored under a clear atmosphere, than when living on islands or near the coast. Mr. Darwin also informs us that Wollaston is convinced that residence near the sea affects the color of insects; and finally, that Moquin-Tandon gives a list of plants which, when growing near the sea-shore, have their leaves in some degree fleshy, though not so elsewhere. In his work on "Animals and Plants under Domestication,"[20] Mr. Darwin refers to M. Costa as having (in *Bull. de la Soc. Imp. d'Acclimat.*, tome viii., p. 351) stated that "young shells taken from the shores of England and placed in the Mediterranean at once altered their manner of growth, and formed prominent diverging rays *like those on the shells of the proper Mediterranean oyster;*" also to Mr. Meehan, as stating (*Proc. Acad. Nat. Sc. of Philadelphia*, Jan. 28, 1862) that "twenty-nine kinds of American trees all differ from their nearest European allies in *a similar manner*, leaves less toothed, buds and seeds smaller, fewer branchlets," etc. These are striking examples indeed!

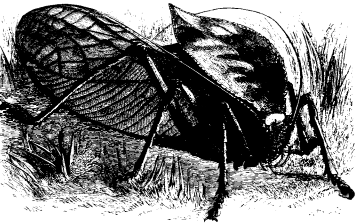
But cases of simultaneous and similar modifications abound on all sides. Even as regards our own species there is a very generally admitted opinion that a new type has been developed in the United States, and this in about a couple of centuries only, and in a vast multitude of individuals of diverse ancestry. The instances here given, however, must suffice, though more could easily be added.

It may be well now to turn to groups presenting similar variations, not through, but independently of, geographical

19 "Origin of Species," 5th edit., p. 166.

20 Vol. ii., p. 280.

distribution, and, as far as we know, independently of conditions other than some peculiar nature and tendency (as yet unexplained) common to members of such groups, which nature and tendency seem to induce them to vary in certain definite lines or directions which are different in



THE GREAT SHIELDED GRASSHOPPER.

different groups. Thus with regard to the group of insects, of which the walking leaf is a member, Mr. Wallace observes:[21] "The *whole family*[22] of the Phasmidæ, or spectres, to which this insect belongs, is more or less imitative, and a great number of the species are called 'walking-stick insects,' from their singular resemblance to twigs and branches."

Again, Mr. Wallace[23] tells us of no less than four kinds

[21] See "Natural Selection," p. 64.

[22] The Italics are not Mr. Wallace's.

[23] "Malay Archipelago," vol. ii., p. 150; and "Natural Selection," p. 104.

of orioles, which birds mimic, more or less, four species of a genus of honey-suckers, the weak orioles finding their profit in being mistaken by certain birds of prey for the strong, active, and gregarious honey-suckers. Now, many other birds would be benefited by similar mimicry, which is none the less confined, in this part of the world, to the oriole genus. It is true that the absence of mimicry in other forms may be explained by their possessing some other (as

THE SIX-SHAFTED BIRD OF PARADISE.

yet unobserved) means of preservation. But it is nevertheless remarkable, not so much that one species should mimic, as that no less than four should do so in different ways and degrees, all these four belonging to *one and the same genus*.

In other cases, however, there is not even the help of protective action to account for the phenomenon. Thus we have the wonderful birds of Paradise,[24] which agree in de-

[24] See "Malay Archipelago," vol. ii., chap. xxxviii.

veloping plumage unequalled in beauty, but a beauty which, as to details, is of different kinds, and produced in different ways in different species. To develop "beauty and singularity of plumage" is a character of the group, but not of any one definite kind, to be explained merely by inheritance.

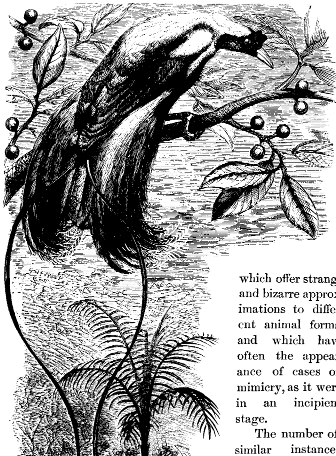
Again, we have the very curious horned flies,[25] which

THE LONG-TAILED BIRD OF PARADISE.

agree indeed in a common peculiarity, but in one singularly different in detail, in different species, and not known to have any protecting effect.

Among plants, also, we meet with the same peculiarity. The great group of Orchids presents a number of species

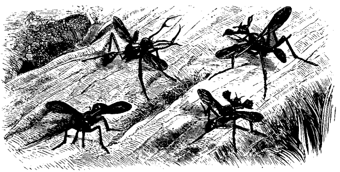
[25] Loc. cit., p. 314.



THE RED BIRD OF PARADISE.

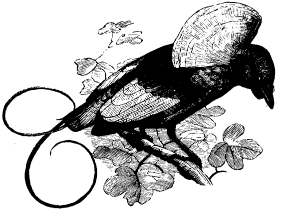
which offer strange and bizarre approximations to different animal forms, and which have often the appearance of cases of mimicry, as it were in an incipient stage.

The number of similar instances which could be brought forward from among animals and plants is very great but the examples given are, it is hoped, amply sufficient to point toward the conclusion which other facts will, it is thought, establish, viz., that



HORNED FLIES.

there are causes operating (in the evocation of these harmonious diverging resemblances) other than "Natural Se-



THE MAGNIFICENT BIRD OF PARADISE.

lection," or heredity, and other even than merely geographical, climatal, or any simply external conditions.

Many cases have been adduced of striking likenesses between different animals, not due to inheritance; but this should be the less surprising, in that the very same individual presents us with likenesses between different parts of its body (e. g., between the several joints of the backbone), which are certainly not so explicable. This, however, leads to a rather large subject, which will be spoken of in the eighth chapter of the present work. Here it will be enough to affirm (leaving the proof of the assertion till later) that parts are often homologous which have no direct genetic relationship—a fact which harmonizes well with the other facts here given, but which "Natural Selection," pure and simple, seems unable to explain.

But surely the independent appearance of similar organic forms is what we might expect, *a priori*, from the independent appearance of similar inorganic ones. As Mr. G. H. Lewes well observes:[26] "We do not suppose the carbonates and phosphates found in various parts of the globe —we do not suppose that the families of alkaloids and salts have any nearer kinship than that which consists in the similarity of their elements, and the conditions of their combination. Hence, in organisms, as in salts, morphological identity may be due to a community of casual connection, rather than community of descent.

"Mr. Darwin justly holds it to be incredible that individuals identically the same should have been produced through Natural Selection from parents *specifically distinct*, but he will not deny that identical forms may issue from parents *genetically distinct*, when these parent forms and the conditions of production are identical. To deny this would be to deny the law of causation."

Prof. Huxley has, however, suggested[27] that such mineral identity may be explained by applying also to minerals

[26] *Fortnightly Review*, New Series, vol. iii. (April, 1868), p. 372.

[27] "Lay Sermons," p. 339.

a law of descent; that is, by considering such similar forms as the descendants of atoms which inhabited one special part of the primitive nebular cosmos, each considerable space of which may be supposed to have been under the influence of somewhat different conditions.

Surely, however, there can be no real parity between the relationship of existing minerals to nebular atoms, and the relationship of existing animals and plants to the earliest organisms. In the first place, the latter have produced others by generative multiplication, which mineral atoms never did. In the second, existing animals and plants spring from the living tissues of preceding animals and plants, while existing minerals spring from the chemical affinity of separate elements. Carbonate of soda is not formed, by a process of reproduction, from other carbonate of soda, but directly by the suitable juxtaposition of carbon, oxygen, and sodium.

Instead of approximating animals and minerals in the mode suggested, it may be that they are to be approximated in quite a contrary fashion; namely, by attributing to mineral species an internal innate power. For, as we must attribute to each elementary atom an innate power and tendency to form (under the requisite external conditions) certain unions with other atoms, so we may attribute to certain mineral species—as crystals—an innate power and tendency to exhibit (the proper conditions being supplied) a definite and symmetrical external form. The distinction between animals and vegetables on the one hand, and minerals on the other, is that, while in the organic world close similarity is the result sometimes of inheritance, sometimes of direct production independently of parental action, in the inorganic world the latter is the constant and only mode in which such similarity is produced.

When we come to consider the relations of species to space—in other words, the geographical distribution of organisms—it will be necessary to return somewhat to the subject of the independent origin of closely-similar forms, in regard to which some additional remarks will be found toward the end of the seventh chapter.

In this third chapter an effort has been made to show that while on the Darwinian theory concordant variations are extremely improbable, yet Nature presents us with abundant examples of such; the most striking of which are, perhaps, the higher organs of sense. Also that an important influence is exercised by conditions connected with geographical distribution, but that a deeper-seated influence is at work, which is hinted at by those special tendencies in definite directions, which are the properties of certain groups. Finally, that these facts, when taken together, afford strong evidence that "Natural Selection" has not been the exclusive or predominant cause of the various organic structural peculiarities. This conclusion has also been reënforced by the consideration of phenomena presented to us by the inorganic world.