THE GENESIS OF SPECIES

CHAPTER II.

THE INCOMPETENCY OF "NATURAL SELECTION" TO ACCOUNT FOR THE INCIPIENT STAGES OF USEFUL STRUCTURES.

Mr. Darwin supposes that Natural Selection acts by Slight Variations. -These must be useful at once. -Difficulties as to the Giraffe; as to Mimicry; as to the Heads of Flat-fishes; as to the Origin and Constancy of the Vertebrate Limbs; as to Whalebone; as to the Young Kangaroo; as to Sea-urchins; as to certain Processes of Metamorphosis; as to the Mammary-gland; as to certain Ape Characters; as to the Rattlesnake and Cobra; as to the Process of Formation of the Eye and Ear, as to the Fully-developed Condition of the Eye and Ear; as to the Voice; as to Shellfish; as to Orchids; as to Ants. -the Necessity for the Simultaneous Modification of Many Individuals. -Summary and Conclusion.

"NATURAL Selection," simply and by itself, is potent to explain the maintenance or the further extension and development of favorable variations, which are at once sufficiently considerable to be useful from the first to the individual possessing them. But Natural Selection utterly fails to account for the conservation and development of the minute and rudimentary beginnings, the slight and infinitesimal commencements of structures, however useful those structures may afterward become.

Now, it is distinctly enunciated by Mr. Darwin, that the spontaneous variations upon which his theory depends are individually slight, minute, and insensible. He says, [1] "Slight individual differences, however, suffice for the work, and are probably the sole differences which are effective in the production of new species." And again, after

[1] "Animals and Plants under Domestication," vol. ii., p. 192

mentioning the frequent sudden appearances of domestic varieties, he speaks of "the false belief as to the similarity of natural species in this respect." [2] In his work on the "Origin of Species," he also observes, "Natural Selection acts only by the preservation and accumulation of small inherited modifications." [3] And "Natural Selection, if it be a true principle, will banish the belief . . . of any great and sudden modification in their structure." [4] Finally, he adds, "If it could be demonstrated that any complex organ existed, which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down." [5]

Now the conservation of minute variations in many instances is, of course, plain and intelligible enough; such e. g., as those which tend to promote the destructive faculties of beasts of prey on the one hand, or to facilitate the flight or concealment of the animals pursued on the other; provided always that these minute beginnings are of such a kind as really to have a certain efficiency, however small, in favor of the conservation of the individual possessing them; and also provided that no unfavorable peculiarity in any other direction accompanies and neutralizes, in the struggle for life, the minute favorable variation.

But some of the cases which have been brought forward, and which have met with very general acceptance, seem less satisfactory when carefully analyzed than they at first appear to be. Among these we may mention "the neck of the giraffe."

At first sight it would seem as though a better example in support of "Natural Selection" could hardly have been chosen. Let the fact of the occurrence of occasional severe droughts in the country which that animal has inhabited

[2] "Animals and Plants under Domestication," vol. ii., p. 414.

[3] "Origin of Species," 5th edit., 1869, p. 110.

[4] Ibid., p. 111.

[5] Ibid., p. 227.

be granted. In that case, when the ground vegetation has been consumed, and the trees alone remain, it is plain that at such times only those individuals (of what we assume to be the nascent giraffe species) which were able to reach high up would be preserved, and would become the parents of the following generation, some individuals of which would, of course, inherit that high-reaching power which alone preserved their parents. Only the high-reaching issue of these high-reaching individuals would again, *cæteris paribus*, be preserved at the next drought, and would again transmit to their offspring their still loftier stature; and so on, from period to period, through æons of time, all the individuals tending to revert to the ancient shorter type of body, being ruthlessly destroyed at the occurrence of each drought.

(1.) But against this it may be said, in the first place, that the argument proves too much; for, on this supposition, many species must have tended to undergo a similar modification, and we ought to have at least several forms, similar to the giraffe, developed from different Ungulata. [6] A careful observer of animal life, who has long resided in South Africa, explored the interior, and lived in the giraffe country, has assured the author that the giraffe has powers of locomotion and endurance fully equal to those possessed by any of the other Ungulata of that continent. It would seem, therefore, that some of these other Ungulates ought to have developed in a similar manner as to the neck, under pain of being starved, when the long neck of the giraffe was in its incipient stage.

To this criticism it has been objected that different kinds of animals are preserved, in the struggle for life, in very different ways, and even that "high reaching" may be attained

[6] The order Ungulate contains the hoofed beasts; that is, all oxen, deer, antelopes, sheep, goats, camels, hogs, the hippopotamus, the different kinds of rhinoceros, the tapirs, horses, asses, zebras, quaggas, etc.

in more modes than one - as, for example, by the trunk of the elephant. This is, indeed, true, but then none of the African Ungulata [7] have, nor do they appear ever to have had, any proboscis whatsoever; nor have they acquired such a development as to allow them to rise on their hind-limbs and graze on trees in a kangaroo attitude, nor a power of climbing, nor, as far as known, any other modification tending to compensate for the comparative shortness of the neck. Again, it may perhaps be said that leaf-eating forms are exceptional, and that therefore the struggle to attain high branches would not affect many Ungulates. But surely, when these severe droughts necessary for the theory occur, the ground vegetation is supposed to be exhausted; and, indeed, the giraffe is quite capable of feeding from off the ground. So that, in these cases, the other Ungulata *must* have taken to leaf-eating or have starved, and thus must have had any accidental long-necked varieties favored and preserved exactly as the long-necked varieties of the giraffe are supposed to have been favored and preserved.

The argument as to the different modes of preservation has been very well put by Mr. Wallace, [8] in reply to the objection that “color, being dangerous, should not exist in Nature.” This objection appears similar to mine; as I say that a giraffe neck, being needful, there should be many animals with it, while the objector noticed by Mr. Wallace says, “A dull color being needful, all animals should be so colored.” And Mr. Wallace shows in reply how porcupines, tortoises, and mussels, very hard-coated bombadier beetles, stinging insects, and nauseous-tasted caterpillars, can afford to be brilliant by the various means of active defence or passive protection they possess, other than obscure coloration.

[7] The elephants of Africa and India, with their extinct allies, constitute the order *Proboscidea*, and do not belong to the Ungulata.

[8] See “Natural Selection,” pp. 60-75.

He says: "The attitudes of some insects may also protect them, as the habit of turning up the tail by the harmless rove-beetles (Staphylinidæ), no doubt leads other animals, besides children, to the belief that they can sting. The curious attitude assumed by sphinx caterpillars is probably a safeguard, as well as the blood-red tentacles which can suddenly be thrown out from the neck by the caterpillars of all the true swallow-tailed butterflies."

But, because many different kinds of animals can elude the observation or defy the attack of enemies in a great variety of ways, it by no means follows that there are any similar number and variety of ways for attaining vegetable food in a country where all such food, other than the lofty branches of trees, has been for a time destroyed. In such a country we have a number of vegetable-feeding Ungulates, all of which present minute variations as to the length of the neck. If, as Mr. Darwin contends, the natural selection of these favorable variations has alone lengthened the neck of the giraffe by preserving it during droughts; similar variations, in similarly feeding forms, at the same times, ought similarly to have been preserved and so lengthened the neck of some other Ungulates by similarly preserving them during the same droughts.

(2.) It may be also objected, that the power of reaching upward, acquired by the lengthening of the neck and legs, must have necessitated a considerable increase in the entire size and mass of the body (larger bones requiring stronger and more voluminous muscles and tendons, and these again necessitating larger nerves, more capacious bloodvessels, etc.), and it is very problematical whether the disadvantages thence arising would not, in times of scarcity, more than counterbalance the advantages.

For a considerable increase in the supply of food would be requisite on account of this increase in size and mass, while at the same time there would be a certain decrease in strength; for, as Mr. Herbert Spencer says, [9] "It is demonstrable that the excess of absorbed over expended nutriment must, other things equal, become less as the size of an animal becomes greater. In similarly-shaped bodies, the masses vary as the cubes of the dimensions; whereas the strengths vary as the squares of the dimensions." . . . "Supposing a creature which a year ago was one foot high, has now become two feet high, while it is unchanged in proportions and structure - what are the necessary concomitant changes that have taken place in it? It is eight times as heavy; that is to say, it has to resist eight times the strain which gravitation puts on its structure; and in producing, as well as in arresting, every one of its movements, it has to overcome eight times the inertia. Meanwhile, the muscles and bones have severally increased their contractile and resisting powers, in proportion to the areas of their transverse sections; and hence are severally but four times as strong as they were. Thus, while the creature has doubled in height, and while its ability to overcome forces has quadrupled, the forces it has to overcome have grown eight times as great. Hence, to raise its body through a given space, its muscles have to be contracted with twice the intensity, at a double cost of matter expended." Again, as to the cost at which nutriment is distributed through the body, and effete matters removed from it, "Each increment of growth being added at the periphery of an organism, the force expended in the transfer of matter must increase in a rapid progression - a progression more rapid than that of the mass."

There is yet another point. Vast as may have been the time during which the process of evolution has continued, it is, nevertheless, not infinite, Yet, as every kind, on the Darwinian hypothesis, varies slightly but indefinitely in every organ and every part of every organ, how very generally

[9] "Principles of Biology," vol. i., p. 122.

must favorable variations as to the length of the neck have been accompanied by some unfavorable variation in some other part, neutralizing the action of the favorable one, the latter, moreover, only taking effect during these periods of drought! How often must not individuals, favored by a slightly-increased length of neck, have failed to enjoy the elevated foliage which they had not strength or endurance to attain; while other individuals, exceptionally robust, could struggle on yet further till they arrived at vegetation within their reach!

However, allowing this example to pass, many other instances will be found to present great difficulties.

Let us take the cases of mimicry among lepidoptera and other insects. Of this subject Mr. Wallace has given a most interesting and complete account,” showing in how many and strange instances this superficial resemblance by one creature to some other quite distinct creature acts as a safeguard to the first. One or two instances must here suffice. In South America there is a family of butterflies, termed *Heliconidæ*, which are very conspicuously colored and slow in flight, and yet the individuals abound in prodigious numbers, and take no precautions to conceal themselves, even when at rest, during the night. Mr. Bates (the author of the very interesting work “The Naturalist on the River Amazons,” and the discoverer of “Mimicry”) found that these conspicuous butterflies had a very strong and disagreeable odor; so much so that any one handling them and squeezing them, as a collector must do, has his fingers stained and so infected by the smell, as to require time and much trouble to remove it.

It is suggested that this unpleasant quality is the cause of the abundance of the Heliconidæ; Mr. Bates and other observers reporting that they have never seen them attacked

[10] See “Natural Selection,” chap. iii., p. 45.

by the birds, reptiles, or insects, which prey upon other lepidoptera.

Now it is a curious fact that very different South American butterflies put on, as it were, the exact dress of these offensive beauties and mimic them even in their mode of flight.

In explaining the mode of action of this protecting resemblance Mr. Wallace observes: [11] "Tropical insectivorous birds very frequently sit on dead branches of a lofty tree, or on those which overhang forest-paths, gazing intently around, and darting off at intervals to seize an insect at a considerable distance, with which they generally return to their station to devour. If a bird began by capturing the slow-flying conspicuous Heliconidæ, and found them always so disagreeable that it could not eat them, it would after a very few trials leave off catching them at all; and their whole appearance, form, coloring, and mode of flight, is so peculiar, that there can be little doubt birds would soon learn to distinguish them at a long distance, and never waste any time in pursuit of them. Under these circumstances, it is evident that any other butterfly of a group which birds were accustomed to devour, would be almost equally well protected by closely resembling a Heliconia externally, as if it acquired also the disagreeable odor; always supposing that there were only a few of them among a great number of Heliconias."

"The approach in color and form to the Heliconidæ, however, would be at the first a positive, though perhaps a slight, advantage; for although at short distances this variety would be easily distinguished and devoured, yet at a longer distance it might be mistaken for one of the uneatable group, and so be passed by and gain another day's life, which might in many cases be sufficient for it to lay a quantity of eggs and leave a numerous progeny, many of

[11] Loc. cit., p. 80.

which would inherit the peculiarity which had been the safeguard of their parent."

LEAF BUTTERFLY IN FLIGHT AND REPOSE.
(*From Mr. Wallace's "Malay Archipelago."*)

As a complete example of mimicry Mr. Wallace refers to a common Indian butterfly. He says: [12] But the most wonderful and undoubted case of protective resemblance in a butterfly, which I have ever seen, is that of the common Indian *Kallima inachis*, and its Malayan ally, *Kallima paralekta*. The upper surface of these is very striking and showy, as they are of a large size, and are adorned with a broad band of rich orange on a deep-bluish ground. The under side is very variable in color, so that out of fifty specimens no two can be found exactly alike, but every one of them will be of some shade of ash, or brown, or ochre, such as are found among dead, dry, or decaying leaves. The apex of the upper wings is produced into an acute point, a very common form in the leaves of tropical shrubs and trees, and the lower wings are also produced into a short, narrow tail. Between these two points runs a dark curved line exactly representing the midrib of a leaf, and from this radiate on each side a few oblique lines, which serve to indicate the lateral veins of a leaf. These marks are more clearly seen on the outer portion of the base of the wings, and on the inner side toward the middle and apex, and it is very curious to observe how the usual marginal and transverse striæ of the group are here modified and strengthened so as to become adapted for an imitation of the venation of a leaf." . . . "But this resemblance, close as it is, would be of little use if the habits of the insect did not accord with it. If the butterfly sat upon leaves or upon flowers, or opened its wings so as to expose the upper surface, or exposed and moved its head and antennæ as many other butterflies do, its disguise would be of little avail We might be sure, however, from the analogy of many other cases, that the habits of the insect are such as still further to aid its deceptive garb; but we are not obliged to make any such supposition, since I myself had the good fortune to observe scores of *Kallima paralekta*,

[12] Loc. cit., p. 59.

in Sumatra, and to capture many of them, and can vouch for the accuracy of the following details. These butterflies frequent dry forests, and fly very swiftly. They were seen to settle on a flower or a green leaf, but were many times lost sight of in a bush or tree of dead leaves. On such occasions they were generally searched for in vain, for while gazing intently at the very spot where one had disappeared, it would often suddenly dart out, and again vanish twenty or fifty yards farther on. On one or two occasions the insect was detected reposing, and it could then be seen how completely it assimilates itself to the surrounding leaves. It sits on a nearly upright twig, the wings fitting closely back to back, concealing the antennæ and head, which are drawn up between their bases. The little tails of the hindwing touch the branch, and form a perfect stalk to the leaf, which is supported in its place by the claws of the middle pair of feet, which are slender and inconspicuous. The irregular outline of the wings gives exactly the perspective effect of a shrivelled leaf. We thus have size, color, form, markings, and habits, all combining together to produce a disguise which may be said to be absolutely perfect; and the protection which it affords is sufficiently indicated by the abundance of the individuals that possess it."

Beetles also imitate bees and wasps, as do some Lepidoptera; and objects the most bizarre and unexpected are simulated, such as dung and drops of dew. Some insects, called bamboo and walking-stick insects, have a most remarkable resemblance to pieces of bamboo, to twigs and branches. Of these latter insects Mr. Wallace says: [13] "Some of these are a foot long and as thick as one's finger, and their whole coloring, form, rugosity, and the arrangement of the head, legs, and antennæ, are such as to render them absolutely identical in appearance with dry sticks. They hang loosely about shrubs in the forest, and have the

[13] Loc. cit., p, 64.

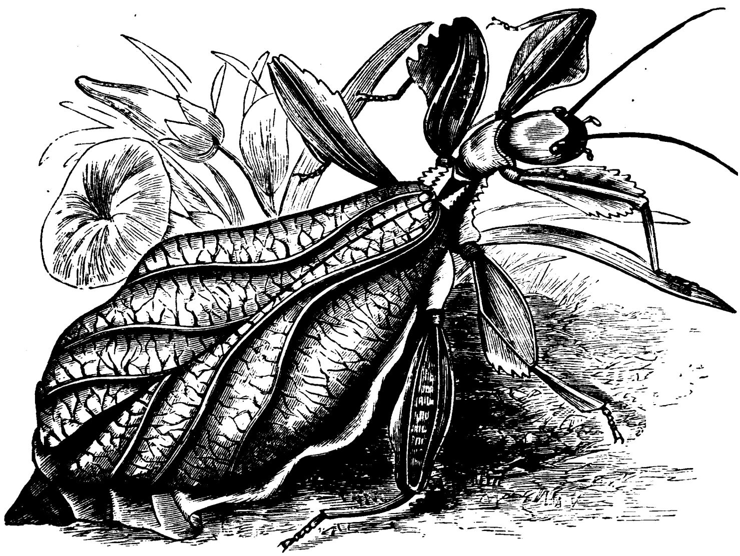
extraordinary habit of stretching out their legs unsymmetrically, so as to render the deception more complete." Now let us suppose that the ancestors of these various animals were all destitute of the very special protections they at present possess, as on the Darwinian hypothesis we must do. Let it also be conceded that small deviations from the antecedent coloring or form would tend to make some of their ancestors escape destruction by causing them more or less frequently to be passed over, or mistaken by their persecutors. Yet the deviation must, as the event has shown, in each case be in some definite direction, whether it be toward some other animal or plant, or toward some dead or inorganic matter. But as, according to Mr. Darwin's theory, there is a constant tendency to indefinite variation, and as the minute incipient variations will be in *all directions*, they must tend to neutralize each other, and at first to form such unstable modifications that it is difficult, if not impossible, to see how such indefinite oscillations of infinitesimal beginnings can ever build up a sufficiently appreciable resemblance to a leaf, bamboo, or other object, for "Natural Selection" to seize upon and perpetuate. This difficulty is augmented when we consider - a point to be dwelt upon hereafter - how necessary it is that many individuals should be similarly modified simultaneously. This has been insisted on in an able article in the *North British Review* for June, 1867, p. 286, and the consideration of the article has occasioned Mr. Darwin to make an important modification in his views. [14]

In these cases of mimicry it seems difficult indeed to imagine a reason why variations tending in an *infinitesimal degree* in any special direction should be preserved. All variations would be preserved which tended to obscure the perception of an animal by its enemies, whatever direction those variations might take, and the common preservation

[14] "Origin of Species." 5th edit., p. 104.

of conflicting tendencies would greatly favor their mutual neutralization and obliteration if we may rely on the many cases recently brought forward by Mr. Darwin with regard to domestic animals.

Mr. Darwin explains the imitation of some species by others more or less nearly allied to it, by the common origin of both the mimic and the mimicked species, and the consequent



THE WALKING-LEAF INSECT

possession by both (according to the theory of "Pangenesis") of gemmules tending to reproduce ancestral characters, which characters the mimic must be assumed first to have lost and then to have recovered. Mr. Darwin says, [15] "Varieties of one species frequently mimic distinct species, a fact in perfect harmony with the foregoing cases,

[15] "Animals and Plants under Domestication," vol. ii., p. 851.

and explicable *only on the theory of descent*." But this at the best is but a partial and very incomplete explanation. It is one, moreover, which Mr. Wallace does not accept. [16] It is very incomplete, because it has no bearing on some of the most striking cases, and of course Mr. Darwin does not pretend that it has. We should have to go back far indeed to reach the common ancestor of the mimicking walkingleaf insect and the real leaf it mimics, or the original progenitor of both the bamboo insect and the bamboo itself. As these last most remarkable cases have certainly nothing to do with heredity, [17] it is unwarrantable to make use of that explanation for other protective resemblances, seeing that its inapplicability, in certain instances, is so manifest.

Again, at the other end of the process it is as difficult to account for the last touches of perfection in the mimicry. Some insects which imitate leaves extend the imitation even to the very injuries on those leaves made by the attacks of insects or of fungi. Thus, speaking of one of the walking-stick insects, Mr. Wallace, says: [18] "One of these creatures obtained by myself in Borneo (*Ceroxylus laceratus*) was covered over with foliaceous excrescences of a clear olive-green color, so as exactly to resemble a stick grown over by a creeping moss or jungermannia. The Dyak who brought it me assured me it was grown over with moss, although alive, and it was only after a most minute examination that I could convince myself it was not so." Again, as to the leaf-butterfly, he says: [19] We come to a still more extraordinary part of the imitation, for we find representations of leaves in every stage of decay, variously blotched, and mildewed, and pierced with holes, and in many cases irregularly covered with powdery black dots,

[16] Loc. cit., pp. 109, 110.

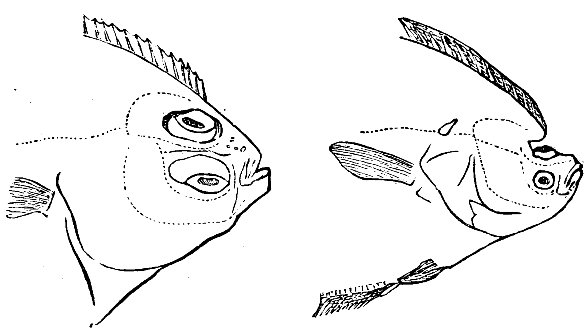
[17] Heredity is the term used to denote the tendency which there is in offspring to reproduce parental features.

[18] Loc. cit., p. 64. [19] Loc. cit., p. 60.

gathered into patches and spots, so closely resembling the various kinds of minute fungi that grow on dead leaves, that it is impossible to avoid thinking at first sight that the butterflies themselves have been attacked by real fungi."

Here imitation has attained a development which seems utterly beyond the power of the mere "survival of the fittest" to produce. How this double mimicry can importantly aid in the struggle for life seems puzzling indeed, but much more so how the first faint beginnings of the imitation of such injuries in the leaf can be developed in the animal into such a complete representation of them - *a fortiori* how simultaneous and similar first beginnings of imitations of such injuries could ever have been developed in several individuals, out of utterly indifferent and indeterminate infinitesimal variations in all conceivable directions.

Another instance which may be cited is the asymmetrical condition of the heads of the fiat-fishes (P1euronectidæ), such as the sole, the flounder, the brill, the turbot, etc. In



PLEURONECTIDÆ, WITH THE PECULIARLY-PLACED EYE IN DIFFERENT POSITIONS.
(*From Dr. Traquair's paper in the Transactions of the Linnean Society*, 1865.")

all these fishes the two eyes, which in the young are situated as usual one on each side, come to be placed, in the adult, both on the same side of the head. If this condition had appeared at once, if in the hypothetically fortunate common ancestor of these fishes an eye had suddenly become thus transferred, then the perpetuation of such a transformation by the action of "Natural Selection" is conceivable enough. Such sudden changes, however, are not those favored by the Darwinian theory, and indeed the accidental occurrence of such a spontaneous transformation is hardly conceivable. But if this is not so, if the transit was gradual, then how such transit of one eye a minute fraction of the journey toward the other side of the head could benefit the individual is indeed far from clear. It seems, even, that such an incipient transformation must rather have been injurious. Another point with regard to these flat-fishes is that they appear to be in all probability of recent origin i. e., geologically speaking. There is, of course, no great stress to be laid on the mere absence of their remains from the secondary strata, nevertheless that absence is noteworthy, seeing that existing fish families, e. g., sharks (Squalidæ), have been found abundantly, even down so far as the carboniferous rocks, and traces of them in the Upper Silurian.

Another difficulty seems to be the first formation of the limbs of the higher animals. The lowest Vertebrata [20] are perfectly limbless, and if, as most Darwinians would probably assume, the primeval vertebrate creature was also apodal, how are the preservation and development of the first rudiments of limbs to be accounted for - such rudiments being, on the hypothesis in question, infinitesimal and functionless?

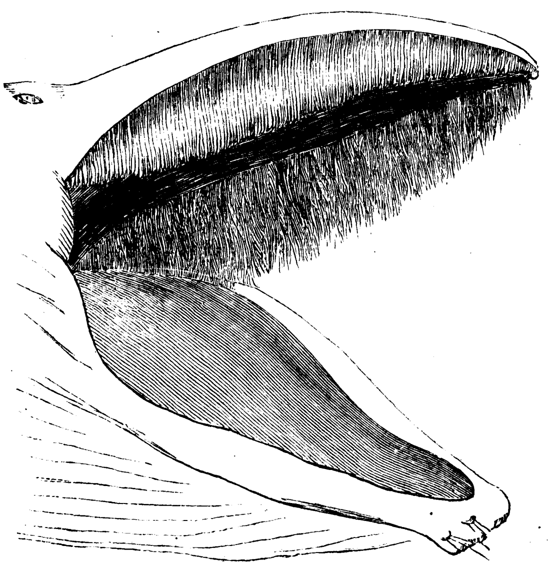
In reply to this, it has been suggested that a mere flattening of the end of the body has been useful, such, e. g., as

[20] The term "Vertebrata" denotes that large group of animals which are characterized by the possession of a spinal column, commonly known as the "backbone." Such animals are ourselves, together with all beasts, birds, reptiles, frogs, toads, and efts, and also fishes.

we see in sea-snakes, [21] which may be the rudiment of a tail formed strictly to aid in swimming. Also that a mere *roughness* of the skin might be useful to a swimming animal by holding the water better, that thus minute processes might be selected and preserved, and that, in the same way, these might be gradually increased into limbs. But it is, to say the least, very questionable whether a roughness of the skin, or minute processes, would be useful to a swimming animal; the motion of which they would as much impede as aid, unless they were at once capable of a suitable and appropriate action, which is against the hypothesis. Again, the change from mere indefinite and accidental processes to two regular pairs of symmetrical limbs, as the result of merely fortuitous, favoring variations, is a step the feasibility of which hardly commends itself to the reason, seeing the very different positions assumed by the ventral fins in different fishes. If the above suggestion made in opposition to the views here asserted be true, then the general constancy of position of the limbs of vertebrata may be considered as due to the position assumed by the primitive rugosities from which those limbs were generated. Clearly only two pairs of rugosities were so preserved and developed, and all limbs (on this view) are descendants of the same two pairs, as all have so similar a fundamental structure. Yet we find in many fishes the pair of fins, which correspond to the hinder limbs of other animals, placed so far forward as to be either on the same level with, or actually in front of, the normally anterior pair of limbs; and such fishes are from this circumstance called "thoracic," or "jugular" fishes respectively, as the weaver-fishes and the cod. This is a wonderful contrast to the fixity of position of vertebrate limbs generally. If, then, such a change can

[21] It is hardly necessary to observe that these "sea-snakes" have no relation to the often-talked-of "sea-serpent." They are small, venomous reptiles, which abound. in the Indian seas.

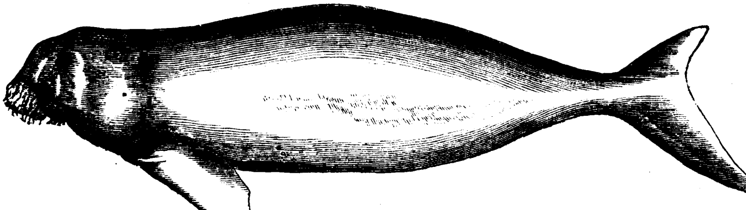
have taken place in the comparatively short time occupied by the evolution of these special fish forms, we might certainly expect other and far more bizarre structures would (did not some law forbid) have been developed from other rugosities, in the manifold exigencies of the multitudinous organisms which must (on the Darwinian hypothesis) have been gradually evolved during the enormous period intervening between the first appearance of vertebrate life and the present day. Yet with these exceptions, the position of the limbs is constant from the lower fishes up to man, there being always an anterior pectoral pair placed in front of a posterior or pelvic pair when both are present, and in no single instance are there more than these two pairs.



MOUTH OF A WHALE.

The development of whalebone (baleen) in this mouth of the whale is another difficulty. A whale's mouth is furnished with very numerous horny plates, which hang down from the palate along each side of the mouth. They thus form two longitudinal series, each plate of which is placed transversely to the long axis of the body, and all are very close together. On depressing the lower lip the free outer edges of these plates come into view. Their inner edges are furnished with numerous coarse hair-like processes, consisting of some of the constituent fibres of the horny plates - which, as it were, fray out - and the mouth is thus lined, except below, by a net-work of countless fibres formed by the inner edges of the two series of plates. This net-work acts as a sort of sieve. When the whale feeds it takes into its mouth a great gulp of water, which it drives out again through the intervals of the horny plates of baleen, the fluid thus traversing the sieve of horny fibres, which retains the minute creatures on which these marine monsters subsist. Now it is obvious, that if this baleen had once attained such a size and development as to be at all useful, then its preservation and augmentation within serviceable limits would be promoted by "Natural Selection" alone. But how to obtain the

FOUR PLATES OF BALEEN SEEN OBLIQUELY FROM WITHIN.



DUGONG

beginning of such useful development? There are indeed certain animals of exclusively aquatic habits (the dugong and manatee) which also possess more or less horn on the palate, and at first sight this might be taken as a mitigation of the difficulty; but it is not so, and the fact does not help us one step further along the road: for, in the first place, these latter animals differ so importantly in structure from whales and porpoises that they form an altogether distinct order, and cannot be thought to approximate to the whale's progenitors. They are vegetarians, the whales feed on animals; the former never have the ribs articulated in the mode in which they are in some of the latter; the former have pectoral mammæ, and the latter are provided with two inguinal mammary glands, and have the nostrils enlarged into blowers, which the former have not. The former thus constitute the order Sirenia, while the latter belong to the Cetacea. In the second place, the horny matter on the palates of the dugong and manatee has not, even initially, that "strainer" action which is the characteristic function of the Cetacean "baleen."

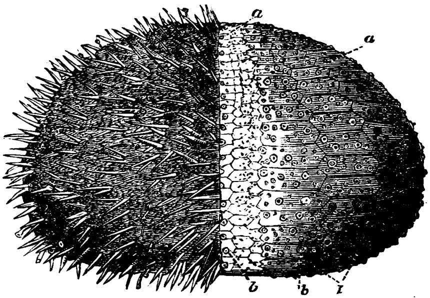
There is another very curious structure, the origin or the disappearance of which it seems impossible to account for on the hypothesis of minute indefinite variations. It is that of the mouth of the young kangaroo. In all mammals, as in ourselves, the air-passage from the lungs opens in the floor of the mouth behind the tongue, and in front of the opening of the gullet, so that each particle of food as it is swallowed passes over the opening, but is prevented from falling into it (and thus causing death from choking) by the action of a small cartilaginous shield (the epiglottis), which at the right moment bends back and protects the orifice. Now the kangaroo is born in such an exceedingly imperfect and undeveloped condition, that it is quite unable to suck. The mother, therefore, places the minute blind and naked young upon the nipple, and then injects milk into it by means of a special muscular envelope of the mammary gland. Did no special provision exist, the young one must infallibly be choked by the intrusion of the milk into the windpipe. But there *is* a special provision. The larynx is so elongated that it rises up into the posterior end of the nasal passage, and is thus enabled to give free entrance to the air for the lungs, while the milk passes harmlessly on each side of this elongated larynx, and so safely attains the gullet behind it.

Now, on the Darwinian hypothesis, either all mammals descended from marsupial progenitors, or else the marsupials sprung from animals having in most respects the ordinary mammalian structure.

On the first alternative, how did “Natural Selection” remove this (at least perfectly innocent and harmless) structure in almost all other mammals, and, having done so, again reproduce it in precisely those forms which alone require it, namely, the Cetacea? That such a harmless structure *need not* be removed, any Darwinian must confess, since a structure exists in both the crocodiles and gavials, which enables the former to breathe themselves while drowning the prey which they hold in their mouths. On Mr. Darwin's hypothesis it could only have been developed where useful, therefore not in the gavials (!) which feed on fish, but which yet retain, as we might expect, this, in them, superfluous but harmless formation.

On the second alternative, how did the elongated larynx itself arise, seeing that if its development lagged behind that of the maternal structure, the young primeval kangaroo must be choked; while, without the injecting power in the mother, it must be starved? The struggle by the solo action of which such a form was developed must indeed have been severe!

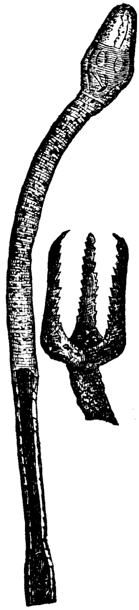
The sea-urchins (Echinus) present us also with structures the origin of which it seems impossible to explain by the action of "Natural Selection" only. These lowly animals belong to that group of the star-fish class (Echinodermata), the species of which possess generally spheroidal bodies, built up of multitudinous calcareous plates, and constitute



AN ECHINUS OR SEA-URCHIN.
(The spines removed from one-half.)

the order Echinoidea. They are also popularly known as sea-eggs. Utterly devoid of limbs, the locomotion of these creatures is effected by means of rows of small tubular suckers (which protrude through pores in the calcareous plates), and by movable spines scattered over the body.

Besides these spines and suckers there are certain very peculiar structures, termed "Pedicellariæ." Each of these consists of a long slender stalk, ending in three short limbs - or rather jaws - the whole supported by a delicate internal skeleton. The three limbs (or jaws), which start from a common point at the end of the stalk, are in the constant habit of opening and closing together again with a snapping action, while the stalk itself sways about. The utility of these appendages is, even now, problematical. It may be that they remove from the surface of the animal's body foreign substances which would be prejudicial to it, and which it cannot otherwise get rid of. But granting this, what would be the utility of the *first rudimentary beginnings* of such structures, and how could such incipient buddings have ever preserved the life of a single Echinus? It is true that on Darwinian principles the ancestral form from which the sea-urchin developed was different, and must not be conceived merely as an Echinus devoid of pedicellariæ; but this makes the difficulty none the less. It is equally hard to imagine that the first rudiments of such structures could have been useful to *any* animal from which the Echinus might have been derived. Moreover, not even the *sudden* development of the snapping action could have been beneficial without the freely movable stalk, nor could the latter have been efficient without the snapping jaws, yet no minute merely indefinite variations could simultaneously evolve these complex coördinations of structure; to deny this seems to do no less than to affirm a startling paradox. Mr. Darwin explains the appearance of some structures, the utility of which is not apparent, by the existence of certain "laws of correlation." By these he means that certain parts or organs of the body are so related to other organs or parts, that when the first are modified by the action of "Natural Selection," or what not, the second are simultaneously affected, and increase proportionally or possibly so decrease. Examples of such are the hair and teeth in the naked Turkish dog, the general deafness of white cats with blue eyes, the relation between the presence of more or less down on young birds when first hatched, and



PEDICELLARIÆ. (Immensely enlarged.)

the future color of their plumage, [22] with many others. But the idea that the modification of any internal or external part of the body of an Echinus carries with it the effect of producing elongated, flexible, triradiate, snapping processes, is, to say the very least, fully as obscure and mysterious as what is here contended for, viz., the efficient presence of an unknown internal natural law or laws conditioning the evolution of new specific forms from preceding ones, modified by the action of surrounding conditions, by "Natural Selection," and by other controlling influences.

The same difficulty seems to present itself in other examples of exceptional structure and action. In the same Echinus, as in many allied forms, and also in some more or less remote ones, a very peculiar mode of development exists. The adult is not formed from the egg directly, but the egg gives rise to a creature which swims freely about, feeds, and is even somewhat complexly organized. Soon a small lump appears on one side of its stomach; this enlarges, and, having established a communication with the exterior, envelops and appropriates the creature's stomach, with which it swims away and develops into the complete adult form, while the dispossessed individual perishes.

Again, certain flies present a mode of development equally bizarre, though quite different. In these flies, the grub is, as usual, produced from the ovum, but this grub, instead of growing up into the adult in the ordinary way, undergoes a sort of liquefaction of a great part of its body, while certain patches of formative tissue, which are attached to the ramifying air-tubes, or tracheæ (and which patches bear the name of "imaginal disks"), give rise to the legs, wings, eyes, etc., respectively; and these severally-formed parts grow together, and build up the head and body by their mutual approximation. Such a process is unknown outside the class of insects, and inside that class it is only

22 "Origin of Species," 5th edit., 1869, p. 179.

known in a few of the two-winged flies. Now, how "Natural Selection," or any "laws of correlation," can account for the gradual development of such an exceptional process of development - so extremely divergent from that of other insects - seems nothing less than inconceivable. Mr. Darwin himself [23] gives an account of a very peculiar and abnormal mode of development of a certain beetle, the sitaris, as described by M. Fabre. This insect, instead of at first appearing in its grub stage, and then, after a time, putting on the adult form, is at first active and furnished with six legs, two long antennæ, and four eyes. Hatched in the nests of bees, it at first attaches itself to one of the males, and then crawls, when the opportunity offers, upon a female bee. When the female bee lays her eggs, the young sitaris springs upon them and devours them. Then, losing its eyes, legs, and antennæ, and becoming rudimentary, it sinks into an ordinary grub-like form, and feeds on honey, ultimately undergoing another transformation, reacquiring its legs, etc., and emerging a perfect beetle! That such a process should have arisen by the accumulation of minute accidental variations in structure and habit, appears to many minds, quite competent to form an opinion on the subject, absolutely incredible.

It may be objected, perhaps, that these difficulties are *difficulties of ignorance* - that we cannot explain them because we do not know *enough* of the animals. But it is here contended that this is not the case; it is not that we merely fail to see how "Natural Selection" acted, but that there is a positive incompatibility between the cause assigned and the results. It will be stated shortly what wonderful instances of coördination and of unexpected utility Mr. Darwin has discovered in orchids. The discoveries are not disputed or undervalued, but the explanation of their *origin* is deemed thoroughly unsatisfactory - utterly insufficient

23 "Origin of Species," 5th edit., p. 532.

to explain the incipient, infinitesimal beginnings of structures which are of utility only when they are considerably developed.

Let us consider the mammary gland, or breast. Is it conceivable that the young of any animal was ever saved from destruction by accidentally sucking a drop of scarcely nutritious fluid from an accidentally hypertrophied cutaneous gland of its mother? And, even if one was so, what chance was there of the perpetuation of such a variation? On the hypothesis of "Natural Selection" itself, we must assume that up to that time the race had been well adapted to the surrounding conditions; the temporary and accidental trial and change of conditions, which caused the so-sucking young one to be the "fittest to survive" under the supposed circumstances, would soon cease to act, and then the progeny of the mother, with the accidentally hypertrophied, sebaceous glands, would have no tendency to survive the far outnumbering descendants of the normal ancestral form. If, on the other hand, we assume the change of conditions not to have been temporary but permanent, and also assume that this permanent change of conditions was accidentally synchronous with the change of structure, we have a coincidence of very remote probability indeed. But if, again, we accept the presence of some harmonizing law simultaneously determining the two changes, or connecting the second with the first by causation, then, of course, we remove the accidental character of the coincidence.

Again, how explain the external position of the male sexual glands in certain mammals? The utility of the modification, when accomplished, is problematical enough, and no less so the incipient stages of the descent.

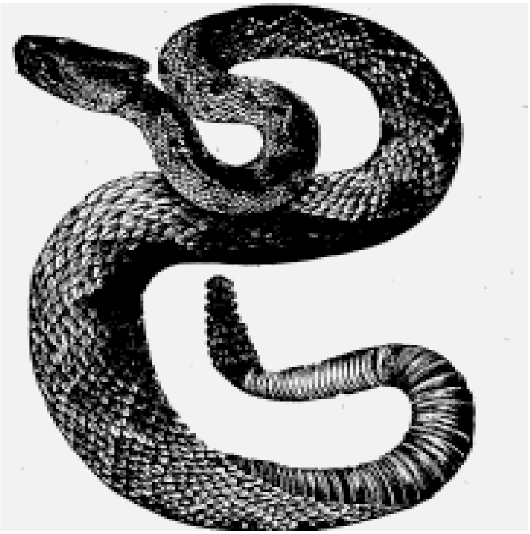
As was said in the first chapter, Mr. Darwin explains the brilliant plumage of the peacock or the humming-bird by the action of sexual selection: the more and more brilliant males being selected by the females (which are thus attracted) to become the fathers of the next generation, to which generation they tend to communicate their own bright nuptial vesture. But there are peculiarities of color and of form which it is exceedingly difficult to account for by any such action. 'Thus, among apes, the female is notoriously weaker, and is armed with much less powerful canine tusks than the male. When we consider what is known of the emotional nature of these animals, and the periodicity of its intensification, it is hardly credible that a female would often risk life or limb through her admiration of a trifling shade of color, or an infinitesimally greater though irresistibly fascinating degree of wartiness.[24]

Yet the males of some kinds of ape are adorned with quite exceptionally brilliant local decoration, and the male orang is provided with remarkable, projecting, warty lumps of skin upon the cheeks. As we have said, the weaker female can hardly be supposed to have developed these by persevering and long-continued selection, nor can they be thought to tend to the preservation of the individual. On the contrary, the presence of this enlarged appendage must occasion a slight increase in the need of nutriment, and in so far must be a detriment, although its detrimental effect would not be worth speaking of except in relation to "Darwinism," according to which, "selection" has acted through unimaginable ages, and has ever, tended to suppress any useless development by the struggle for life. [25]

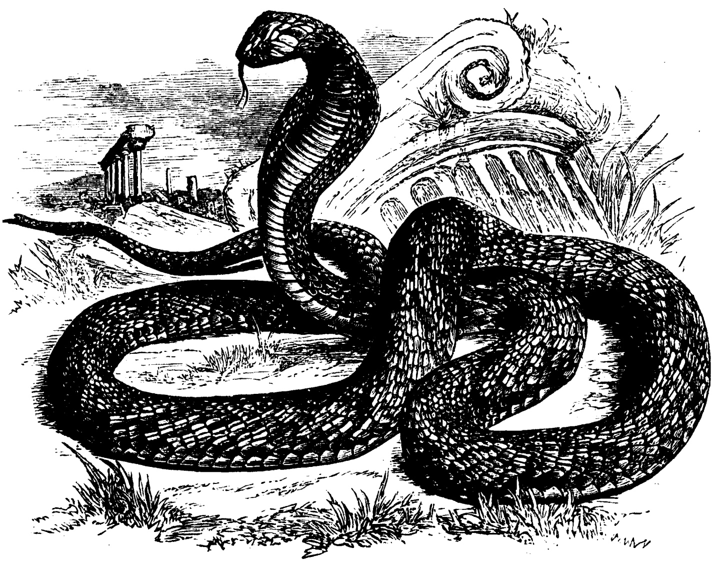
[24] Mr. A. D. Bartlett, of the Zoological Society, informs me that at these periods female apes admit with perfect readiness the access of any males of different species. To be sure this is in confinement; but the fact is, I think, quite conclusive against any such sexual selection in a state of nature as would account for the local coloration referred to.

[25] Mr. Darwin, in the last (fifth) edition of "Natural Selection," 1869, p. 102, admits that all sexual differences are not to be attributed to the agency of sexual selection, mentioning the wattle of carrier-pigeons, tuft of turkey-cock, etc. These characters, however, seem less inexplicable by sexual selection than those given in the text.

In poisonous serpents, also, we have structures which, at all events, at first sight, seem positively hurtful to those reptiles. Such are the rattle of the rattlesnake, and the expanding neck of the cobra, the former seeming to warn the ear of the intended victim, as the latter warns the eye. It is true we cannot perhaps demonstrate that the victims


RATTLESNAKE.

are alarmed and warned, but, on Darwinian principles, they certainly ought to be so. For the rashest and most incautious of the animals preyed on would always tend to fall victims, and the existing individuals being the long-descended progeny of the timid and cautious, ought to have an inherited tendency to distrust, among other things, both "rattling" and "expanding" snakes. As to any power of fascination exercised by means of these actions, the most distinguished naturalists, certainly the most distinguished erpetologists, entirely deny it, and it is opposed to the careful observations of those known to us. [26]



COBRA.
(Copied, by permission, from Sir Andrew Smith's "Reptiles of South Africa.")

The mode of formation of both the eye and the ear of the highest animals is such that, if it is (as most Darwinians assert processes of development to be) a record of the actual steps by which such structures were first evolved in antecedent forms, it almost amounts to a demonstration

[26] I am again indebted to the kindness of Mr. A. fl. Bartlett, among others. That gentleman informs me that, so far from any mental emotion being produced in rabbits by the presence and movements of snakes, he has actually seen a male and female rabbit satisfy the sexual instinct in that presence, a rabbit being seized by a snake when *in coitu*.

that those steps were never produced by "Natural Selection."

The eye is formed by a simultaneous and corresponding ingrowth of one part and outgrowth of another. The skin in front of the future eye becomes depressed, the depression increases and assumes the form of a sac, which changes into the aqueous humor and lens. An outgrowth of brain-substance, on the other hand, forms the retina, while a third process is a lateral ingrowth of connective tissue, which afterward changes into the vitreous humor of the eye.

The internal ear is formed by an involution of the integument, and not by an outgrowth of the brain. But tissue, in connection with it, becomes in part changed, thus forming the auditory nerve, which places the tegumentary sac in direct communication with the brain itself.

Now, these complex and simultaneous coördinations could never have been produced by infinitesimal beginnings, since, until so far developed as to effect the requisite junctions, they are useless. But the eye and ear when fully developed present conditions which are hopelessly difficult to reconcile with the mere action of "Natural Selection." The difficulties with regard to the eye had been well put by Mr. Murphy, especially that of the concordant result of visual development springing from different starting-points and continued on by independent roads.

He says, [27] speaking of the beautiful structure of the perfect eye, "The higher the organization, whether of an entire organism or of a single organ, the greater is the number of the parts that coöperate, and the more perfect is their coöperation; and consequently, the more necessity there is for corresponding variations to take place in all the cooperating parts at once, and the more useless will be any variation whatever unless it is accompanied by corresponding

[27] "Habit and Intelligence," vol. i., p. 319.

variations in the coöperating parts; while it is obvious that the greater the number of variations which are needed in order to effect an improvement, the less will be the probability of their all occurring at once. It is no reply to this to say, what is no doubt abstractedly true, that whatever is possible becomes probable, if only time enough be allowed. There are improbabilities so great that the common-sense of mankind treats them as impossibilities. It is not, for instance, in the strictest sense of the word, impossible that a poem and a mathematical proposition should be obtained by the process of shaking letters out of a box; but it is improbable to a degree that cannot be distinguished from impossibility; and the improbability of obtaining an improvement in an organ by means of several spontaneous variations, all occurring together, is an improbability of the same kind. If we suppose that any single variation occurs on the average once in *m* times, the probability of that variation occurring in any individual will be -

$$1/m;$$

and suppose that *x* variations must concur in order to make an improvement, then the probability of the necessary variations all occurring together will be

$$1/m^x.$$

Now suppose, what I think a moderate proposition, that the value of *m* is 1,000, and the value of *x* is 10, then -

$$1/m^x = 1/1000^{10} = 1/10^{30}.$$

A number about ten thousand times as great as the number of waves of light that have fallen on the earth since historical time began. And it is to be further observed, that no improvement will give its possessor a *certainty* of surviving and leaving offspring, but only an *extra chance*, the value of which it is quite impossible to estimate." This difficulty is, as Mr. Murphy points out, greatly intensified by the undoubted fact that the wonderfully complex structure has been arrived at quite independently in beasts on the one hand and in cuttle-fishes on the other; while creatures of the insect and crab division present us with a third and quite separately developed complexity.

As to the ear, it would take up too much space to describe its internal structure; [28] it must suffice to say that in its interior there is an immense series of minute rod-like bodies, termed *fibres of Corti*, having the appearance of a key-board, and each fibre being connected with a filament of the auditory nerve, these nerves being like strings to be struck by the keys, i. e., by the fibres of Corti. Moreover, this apparatus is supposed to be a key-board in function as well as in appearance, the vibration of each one fibre giving rise, it is believed, to the sensation of one particular tone, and combinations of such vibrations producing chords. It is by the action of this complex organ, then, that all the wonderful intricacy and beauty of Beethoven and Mozart come, most probably, to be perceived and appreciated.

Now, it can hardly be contended that the preservation of any race of men in the struggle for life ever depended on such an extreme delicacy and refinement of the internal ear - a perfection only exercised in the enjoyment and appreciation of the most perfect musical performances. How, then, could either the minute incipient stages, or the final perfecting touches of this admirable structure, have been brought about by vague, aimless, and indefinite variations in all conceivable directions of an organ, suitable to enable the rudest savage to minister to his necessities, but no more?

[28] The reader may consult Huxley's "Lessons in Elementary Physiology," p. 204.

Mr. Wallace [29] makes an analogous remark with regard to the organ of voice in man - the human larynx. He says of singing: "The habits of savages give no indication of how this faculty could have been developed by Natural Selection, because it is never required or used by them. The singing of savages is a more or less monotonous howling, and the females seldom sing at all. Savages certainly never choose their wives for fine voices, but for rude health, and strength, and physical beauty. Sexual selection could not therefore have developed this wonderful power, which only comes into play among civilized people."

Reverting once more to beauty of form and color, there is one manifestation of it for which no one can pretend that sexual selection can possibly account. The instance referred to is that presented by bivalve shell-fish. [30] Here we meet with charming tints and elegant forms and markings of no direct use to their possessors [31] in the struggle for life, and of no indirect utility as regards sexual selection, for fertilization takes place by the mere action of currents of water, and the least beautiful individual has fully as good a chance of becoming a parent as has the one which is the most favored in beauty of form and color.

Again, the peculiar outline and coloration of certain orchids - notably of our own bee, fly, and spider orchids - seem hardly explicable by any action of "Natural Selection." Mr. Darwin says very little on this singular resemblance of flowers to insects, and what he does say seems hardly to be what an advocate of "Natural Selection"

[29] "Natural Selection," p. 350.

[30] Bivalve shell-fish are creatures belonging to the oyster, scallop, and cockle group, i. e., to the class Lamellibranchiata.

[31] The attempt has been made to explain these facts as owing to "manner and symmetry of growth, and to color being incidental on the chemical nature of the constituents of the shell." But surely beauty depends on some such matters in *all* cases!

would require. Surely, for minute accidental indefinite variations to have built up such a striking resemblance to insects, we ought to find that the preservation of the plant, or the perpetuation of its race, depends almost constantly on relations between bees, spiders, and flies respectively and the bee, spider, and fly orchids. [32] This process must have continued for ages constantly and perseveringly, and yet what is the fact? Mr. Darwin tells us, in his work on the "Fertilization of Orchids," that neither the spider nor the fly orchids are much visited by insects, while, with regard to the bee orchid, he says, "I have never seen an insect visit these flowers." And he shows how this species is even wonderfully and specially modified to effect self-fertilization.

In the work just referred to Mr. Darwin gives a series of the most wonderful and minute contrivances by which the visits of insects are utilized for the fertilization of orchids - structures so wonderful that nothing could well be more so, except the attribution of their origin to minute, fortuitous, and indefinite variation.

The instances are too numerous and too long to quote, but in his "Origin of Species" [33] he describes two which must not be passed over. In one (*Coryanthes*) the orchid has its lower lip enlarged into a bucket, above which stand two water-secreting horns. These latter replenish the bucket from which, when half-filled, the water overflows by a spout on one side. Bees visiting the flower fall into the bucket and crawl out at the spout. By the peculiar arrangement of the parts of the flower, the first bee which does so carries

[32] It has been suggested in opposition to what is here said, that there is no real resemblance, but that the likeness is "*fanciful*!" The denial, however, of the fact of a resemblance which has struck so many observers, reminds one of the French philosopher's estimate of facts hostile to his theory - "Tant pis pour les faits!"

[33] Fifth edition, p. 236.

away the pollen-mass glued to his back, and then when he has his next involuntary bath in another flower, as he crawls out the pollen-mass attached to him comes in contact with the stigma of that second flower and fertilizes it. In the other example (*Catasetum*), when a bee gnaws a certain part of the flower, he inevitably touches a long delicate projection, which Mr. Darwin calls the antenna. "This antenna transmits a vibration to a certain membrane, which is instantly ruptured; this sets free a spring by which the pollen-mass is shot forth like an arrow in the right direction, and adheres by its viscid extremity to the back of the bee!"

Another difficulty, and one of some importance, is presented by those communities of ants which have not only a population of sterile females, or workers, but two distinct and very different castes of such. Mr. Darwin believes that he has got over this difficulty by having found individuals intermediate in form and structure [34] between the two working castes; others may think that we have in this belief of Mr. Darwin, an example of the unconscious action of volition upon credence. A vast number of difficulties similar to those which have been mentioned might easily be cited - those given, however, may suffice.

There remains, however, to be noticed a very important consideration, which was brought forward in the *North British Review* for June, 1867, p. 286, namely, the necessity for the simultaneous modification of *many individuals*. This consideration seems to have escaped Mr. Darwin, for at p. 104 of his last (fifth) edition of "Natural Selection," he admits, with great candor, that until reading this article

[34] Mr. Smith, of the Entomological department of the British Museum, has kindly informed me that the individuals intermediate in structure are very few in number - not more than five per cent. - compared with the number of distinctly differentiated individuals. Besides, in the Brazilian kinds these intermediate forms are wanting.

he did not "appreciate how rarely single variations, whether slight or strongly marked, could be perpetuated."

The *North British Review* (speaking of the supposition that a species is changed by the survival of a few individuals in a century through a similar and favorable variation) says: "It is very difficult to see how this can be accomplished, even when the variation is eminently favorable indeed; and still more difficult when the advantage gained is very slight, as must generally be the case. The advantage, whatever it may be, is utterly out-balanced by numerical inferiority. A million creatures are born; ten thousand survive to produce offspring. One of the million has twice as good a chance as any other of surviving; but the chances are fifty to one against the gifted individuals being one of the hundred survivors. No doubt the chances are twice as great against any one other individual, but this does not prevent their being enormously in favor of *some* average individual. However slight the advantage may be, if it is shared by half the individuals produced, it will probably be present in at least fifty-one of the survivors, and in a larger proportion of their offspring; but the chances are against the preservation of any one 'sport' (i. e., sudden, marked variation) in a numerous tribe. The vague use of an imperfectly-understood doctrine of chance has led Darwinian supporters, first, to confuse the two cases above distinguished; and, secondly, to imagine that a very slight balance in favor of some individual sport must lead to its perpetuation. All that can be said is that in the above example the favored sport would be preserved once in fifty times. Let us consider what will be its influence on the main stock when preserved. It will breed and have a progeny of say 100; now this progeny will, on the whole, be intermediate between the average individual and the sport. The odds in favor of one of this generation of the new breed will be, say one and a half to one, as compared with the average individual; the odds in their favor will, therefore, be less than that of their parents; but owing to their greater number, the chances are that about one and a half of them would survive. Unless these breed together, a most improbable event, their progeny would again approach the average individual; there would be 150 of them, and their superiority would be, say in the ratio of one in a quarter to one; the probability would now be that nearly two of them would survive, and have 200 children, with an eighth superiority. Rather more than two of these would survive; but the superiority would again dwindle, until after a few generations it would no longer be observed, and would count for no more in the struggle for life than any of the hundred trifling advantages which occur in the ordinary organs. An illustration will bring this conception home. Suppose a white man to have been wrecked on an island inhabited by negroes, and to have established himself in friendly relations with a powerful tribe, whose customs he has learned. Suppose him to possess the physical strength, energy, and ability of a dominant white race, and let the food and climate of the island suit his constitution; grant him every advantage which we can conceive a white to possess over the native; concede that in the struggle for existence his chance of a long life will be much superior to that of the native chiefs; yet from all these admissions, there does not follow the conclusion that, after a limited or unlimited number of generations, the inhabitants of the island will be white. Our shipwrecked hero would probably become king; he would kill a great many blacks in the struggle for existence; he would have a great many wives and children." . . . "In the first generation there will be some dozens of intelligent young mulattoes, much superior in average intelligence to the negroes. We might expect the throne for some generations to be occupied by a more or less yellow king; but can any one believe that the whole island will gradually acquire a white, or even a yellow, population?"

"Darwin says that in the struggle for life a grain may turn the balance in favor of a given structure, which will then be preserved. But one of the weights in the scale of Nature is due to the number of a given tribe. Let there be 7,000 A's and 7,000 B's, representing two varieties of a given animal, and let all the B's, in virtue of a slight difference of structure, have the better chance of life by 1/7000 part. We must allow that there is a slight probability that the descendants of B will supplant the descendants of A; but let there be only 7,001 A's against 7,000 B's at first, and the chances are once more equal, while if there be 7,002 A's to start, the odds would be laid on the A's. True, they stand a greater chance of being killed; but then they can better afford to be killed. The grain will only turn the scales when these are very nicely balanced, and an advantage in numbers counts for weight, even as an advantage in structure. As the numbers of the favored variety diminish, so must its relative advantages increase, if the chance of its existence is to surpass the chance of its extinction, until hardly any conceivable advantage would enable the descendants of a single pair to exterminate the descendants of many thousands if they and their descendants are supposed to breed freely with the inferior variety, and so gradually lose their ascendency."

Mr. Darwin himself says of the article quoted: "The justice of these remarks cannot, I think, be disputed. If, for instance, a bird of some kind could procure its food more easily by having its beak curved, and if one were born with its beak strongly curved, and which consequently flourished, nevertheless there would be a very poor chance of this one individual perpetuating its kind to the exclusion of the common form." This admission seems almost to amount to a change of front in the face of the enemy!

These remarks have been quoted at length because they so greatly intensify the difficulties brought forward in this chapter. If the most favorable variations have to contend with such difficulties, what must be thought as to the chance of preservation of the slightly-displaced eye in a sole or of the incipient development of baleen in a whale?

SUMMARY AND CONCLUSION.

It has been here contended that a certain few facts, out of many, which might have been brought forward, are inconsistent with the origination of species by "Natural Selection" only or mainly.

Mr. Darwin's theory requires minute, indefinite, fortuitous variations of all parts in all directions, and he insists that the sole operation of "Natural Selection" upon such is sufficient to account for the great majority of organic forms, with their most complicated structures, intricate mutual adaptations, and delicate adjustments.

To this conception has been opposed the difficulties presented by such a structure as the form of the giraffe, which ought not to have been the solitary structure it is; also the minute beginnings and the last refinements of protective mimicry equally, difficult or rather impossible to account for by "Natural Selection." Again, the difficulty as to the heads of flatfishes has been insisted on, as also the origin, and at the same time the constancy, of the limbs of the highest animals. Reference has also been made to the whalebone of whales, and to the impossibility of understanding its origin through "Natural Selection" only; the same as regards the infant kangaroo, with its singular deficiency of power compensated for by maternal structures on the one hand, to which its own breathing-organs bear direct relation on the other. Again, the delicate and complex pedicellarliæ of Echinoderms, with a certain process of development (through a secondary larva) found in that class, together with certain other exceptional modes of development, have been brought forward. The development of color in certain apes, the hood of the cobra, and the rattle of the rattlesnake, have also been cited. Again, difficulties as to the process of formation of the eye and ear, and as to the fully-developed condition of those complex organs, as well as of the voice, have been considered. The beauty of certain shell-fish; the wonderful adaptations of structure, and variety of form and resemblance, found in orchids; together with the complex habits and social conditions of certain ants, have been hastily passed in review. When all these complications are duly weighed and considered, and when it is borne in mind how necessary it is for the permanence of a new variety that many individuals in each case should be simultaneously modified, the cumulative argument seems irresistible.

The author of this book can say that, though by no means disposed originally to dissent from the theory of "Natural Selection," if only its difficulties could be solved, he has found each successive year that deeper consideration and more careful examination have more and more brought home to him the inadequacy of Mr. Darwin's theory to account for the preservation and intensification of incipient, specific, and generic characters. That minute, fortuitous, and indefinite variations could have brought about such special forms and modifications as have been enumerated in this chapter, seems to contradict not imagination, but reason.

That either many individuals among a species of butterfly should be simultaneously preserved through a similar accidental and minute variation in one definite direction, when variations in many other directions would also preserve; or that one or two so varying should succeed in supplanting the progeny of thousands of other individuals, and that this should by no other cause be carried so far as to produce the appearance (as we have before stated) of spots of fungi, etc. - are alternatives of an improbability so extreme as to be practically equal to impossibility.

In spite of all the resources of a fertile imagination, the Darwinian, pure and simple, is reduced to the assertion of a paradox as great as any he opposes. In the place of a mere assertion of our ignorance as to the way these phenomena have been produced, he brings forward, as their explanation, a cause which it is contended in this work is demonstrably insufficient.

Of course in this matter, as elsewhere throughout Nature, we have to do with the operation of fixed and constant natural laws, and the knowledge of these may before long be obtained by human patience or human genius; but there is, it is believed, already enough evidence to show that these as yet unknown natural laws or law will never be resolved into the action of "Natural Selection," but will constitute or exemplify a mode and condition of organic action of which the Darwinian theory takes no account whatsoever.