

## HUMMING-BIRDS.

THERE are now about ten thousand different kinds of birds known to naturalists, and these are classed in one hundred and thirty families which vary greatly in extent, some containing a single species only, while others comprise many hundreds. The two largest families are those of the warblers, with more than six hundred, and the finches, with more than five hundred species spread over the whole globe; the hawks and the pigeons, also spread over the whole globe, number about three hundred and thirty and three hundred and sixty species respectively; while the diminutive humming-birds, confined to one hemisphere, consist of about four hundred different species. They are thus, as regards the number of distinct kinds collected in a limited area, the most remarkable of all the families of birds. It may, however, very reasonably be asked, whether the four hundred species of humming-birds above alluded to are really all distinct—as distinct on the average as the ten thousand species of birds are from each other. We reply that they certainly are perfectly distinct species which never intermingle; and their differences do not consist in colour only, but in peculiarities of form, of structure, and of habits, so that they have to be classed in more than a hundred distinct genera or systematic groups of species, these genera being really as unlike each other as stonechats and nightingales, or as partridges and blackcocks. The figures we have quoted, as showing the proportion of birds in general to humming-birds, thus represent real facts; and they teach us that these small and in some respects insignificant birds constitute an important item in the animal life of the globe.

Humming-birds are, in many respects, unusually interesting and instructive. They are highly peculiar in form, in structure, and in habits, and are quite unrivalled as regards variety and beauty. Though the name is familiar to every one, few but naturalists are acquainted with the many curious facts in their history, or know how much material they afford for admiration and study. I propose, therefore, to give a brief and popular account of the form, structure, habits, distribution, and affinities of this remarkable family of birds.

The humming-birds form one compact family, named Trochilidæ. They are all small birds, the largest known being about the size of a swallow, while the smallest are minute creatures whose bodies are hardly larger than a humble-bee. Their distinguishing features are, excessively short legs and feet, very long and pointed wings, a long

and slender bill, and a long extensible tubular tongue; and these characters are found combined in no other birds. The feet are exceedingly small and delicate, often beautifully tufted with down, and so short as to be hardly visible beyond the plumage. The toes are placed as in most birds, three in front and one behind, and have very strong and sharply curved claws; and the feet serve probably to cling to their perch rather than to support the weight of the body. The wings are long and narrow, but strongly formed, and the first quill is the longest, a peculiarity found in hardly any other birds but a few of the swifts. The bill varies greatly in length, but is always long, slender, and pointed, the upper mandible being the widest and lapping over the lower at each side, thus affording complete protection to the delicate tongue, the perfect action of which is essential to the bird's existence. The humming-bird's tongue is very long, and is capable of being greatly extended beyond the beak and rapidly drawn back, by means of muscles which are attached to the hyoid or tongue-bones and bend round over the back and top of the head to the very forehead, just as in the woodpeckers. The two blades or laminæ, of which the tongues of birds usually seem to be formed, are here greatly lengthened, broadened out, and each rolled up; so as to form a complete double tube connected down the middle, and with the outer edges in contact but not united. The extremities of the tubes are, however, flat and fibrous. This tubular and retractile tongue enables the bird to suck up honey from the nectaries of flowers and also to capture small insects, but whether the latter pass down the tubes or are entangled in the fibrous tips and thus drawn back into the gullet is not known. The only other birds with a similar tubular tongue are the sun-birds of the East, which, however, as we shall presently explain, have no affinity whatever with the humming-birds.

The colours of these small birds are exceedingly varied and exquisitely beautiful. The basis of the colouring may be said to be green, as in parrots; but, whereas in the latter it is a silky green, in humming-birds it is always metallic. The majority of the species have some green about them, especially on the back; but in a considerable number rich blues, purples, and various shades of red are the prevailing tints. The greater part of the plumage has more or less of a metallic gloss, but there is almost always some part which has an intense lustre as if actually formed of scales of burnished metal. A gorget covering the greater part of the neck and breast most commonly displays this vivid colour, but it also frequently occurs on the head, on the back, on the tail-coverts above or below, on the upper surface of the tail, on the shoulders or even the quills. The hue of every precious stone and the lustre of every metal is here represented; and such terms as topaz, amethyst, beryl, emerald,

garnet, ruby, sapphire, golden, golden-green, coppery, fiery, glowing, iridescent, refulgent, celestial, glittering, shining, are constantly used to name or describe the different species. No less remarkable than the colours are the varied developments of plumage with which these birds are adorned. The head is often crested in a variety of ways ; either a simple flat crest, or with radiating feathers, or diverging into two horns, or spreading laterally like wings, or erect and bushy, or recurved and pointed like that of a plover. The throat and breast are usually adorned with broad scale-like feathers, or these diverge into a tippet, or send out pointed collars, or elegant frills of long and narrow plumes tipped with metallic spots of various colours. But the tail is even a more varied and beautiful ornament, either short and rounded, but pure white or some other strongly contrasted tint, or with short pointed feathers forming a star, or with the three outer feathers on each side long and tapering to a point ; or larger, and either square, or round, or deeply forked, or acutely pointed ; or with the two middle feathers excessively long and narrow ; or with the tail very long and deeply forked, with broad and richly-coloured feathers ; or with the two outer feathers wire-like and having broad spoon-shaped tips. All these ornaments, whether of the head, neck, breast, or tail, are invariably coloured in some effective or brilliant manner, and often contrast strikingly with the rest of the plumage. Again, these colours often vary in tint according to the direction in which they are seen. In some species they must be looked at from above, in others from below, in some from the front, in others from behind, in order to catch the full glow of the metallic lustre. Hence when the birds are seen in their native haunts, the colours come and go and change with their motions, so as to produce a startling and beautiful effect.

It is a well-known fact that, when male birds possess any unusual ornaments, they take such positions or perform such evolutions as to exhibit them to the best advantage while endeavouring to attract or charm the females or in rivalry with other males. It is therefore probable that the wonderfully varied decorations of humming-birds, whether burnished breast-shields, resplendent tail, crested head, or glittering back, are thus exhibited ; but almost the only actual observation of this kind is that of Mr. Belt, who describes how two males of the *Florisuga mellivora* displayed their ornaments before a female bird. One would shoot up like a rocket, then suddenly expanding the snow-white tail like an inverted parachute, slowly descend in front of her, turning round gradually to show off both back and front. The expanded white tail covered more space than all the rest of the bird, and was evidently the grand feature of the performance. Whilst one was descending, the other would shoot up and come slowly down expanded.<sup>1</sup>

(1) *The Naturalist in Nicaragua*, p. 112.

The bill differs greatly in length and shape, being either straight or gently curved, in some species bent like a sickle, in others turned up like the bill of the avoset. It is usually long and slender, but in one group is so enormously developed that it is nearly the same length as the rest of the bird. The legs, usually little seen, are in some groups adorned with globular tufts of white, brown, or black down, a peculiarity possessed by no other birds. The reader will now be in a position to understand how the four hundred species of humming-birds may be easily distinguished, by the varied combinations of the characters here briefly enumerated, together with many others of less importance. One group of birds will have a short round tail, with crest and long neck-frill; another group a deeply-forked broad tail, combined with glowing crown and gorget; one is both bearded and crested; others have a luminous back and pendent neck-plumes; and in each of these groups the species will vary in combinations of colour, in size, and in the proportions of the ornamental plumes, so as to produce an unmistakable distinctness; while, without any new developments of form or structure, there is room for the discovery of hundreds more of distinct kinds of humming-birds.

The name we usually give to the birds of this family is derived from the sound of their rapidly-moving wings, a sound which is produced by the largest as well as by the smallest member of the family. The Creoles of Guiana similarly call them Bourdons or hummers. The French term, Oiseau-mouche, refers to their small size; while Colibri is a native name which has come down from the Carib inhabitants of the West Indies. The Spaniards and Portuguese call them by more poetical names, such as Flower-peckers, Flower-kissers, Myrtle-suckers,—while the Mexican and Peruvian names showed a still higher appreciation of their beauties, their meaning being rays of the sun, tresses of the day-star, and other such appellations. Even our modern naturalists, while studying the structure and noting the peculiarities of these living gems, have been so struck by their inimitable beauties that they have endeavoured to invent appropriate English names for the more beautiful and remarkable genera. Hence we find in common use such terms as Sun-gems, Sun-stars, Hill-stars, Wood-stars, Sun-angels, Star-throats, Comets, Coquettes, Flame-bearers, Sylphs, and Fairies; together with many others derived from the character of the tail or the crests.

*The Motions and Habits of Humming-birds.*—Let us now consider briefly, the peculiarities of flight, the motions, the food, the nests, and general habits of the humming-birds, quoting the descriptions of those modern naturalists who have personally observed them. Their appearance, remarks Professor Alfred Newton, is entirely

unlike that of any other bird. "One is admiring some brilliant and beautiful flower, when between the blossom and one's eye suddenly appears a small dark object, suspended as it were between four short black threads meeting each other in a cross. For an instant it shows in front of the flower; again another instant, and emitting a momentary flash of emerald and sapphire light, it is vanishing, lessening in the distance, as it shoots away, to a speck that the eye cannot take note of." Audubon observes that the Ruby humming-birds pass through the air in long undulations, but the smallness of their size precludes the possibility of following them with the eye farther than fifty or sixty yards, without great difficulty. A person standing in a garden by the side of a common althæa in bloom, will hear the humming of their wings and see the little birds themselves within a few feet of him one moment, while the next they will be out of sight and hearing. Mr. Gould, who visited North America in order to see living humming-birds while preparing his great work on the family, remarks that the action of the wings reminded him of a piece of machinery acted upon by a powerful spring. When poised before a flower, the motion is so rapid that a hazy semicircle of indistinctness on each side of the bird is all that is perceptible. Although many short intermissions of rest are taken, the bird may be said to live in the air—an element in which it performs every kind of evolution with the utmost ease, frequently rising perpendicularly, flying backward, pirouetting or dancing off, as it were, from place to place, or from one part of a tree to another, sometimes descending, at others ascending. It often mounts up above the towering trees, and then shoots off like a little meteor at a right angle. At other times it gently buzzes away among the little flowers near the ground; at one moment it is poised over a diminutive weed, at the next it is seen at a distance of forty yards, whither it has vanished with the quickness of thought.

The Rufous Flame-bearer, an exquisite species found on the west coast of North America, is thus described by Mr. Nuttall:—"When engaged in collecting its accustomed sweets, in all the energy of life, it seemed like a breathing gem, a magic carbuncle of flaming fire, stretching out its glorious ruff as if to emulate the sun itself in splendour." The Sappho Comet, whose long forked tail barred with crimson and black renders it one of the most imposing of humming-birds, is abundant in many parts of the Andes; and Mr. Bonelli tells us that the difficulty of shooting them is very great, from the extraordinary turns and evolutions they make when on the wing; at one instant darting headlong into a flower, at the next describing a circle in the air with such rapidity that the eye, unable to follow the movement, loses sight of the bird until it again returns to the flower which at first attracted its attention. Of the little Vervain hum-

ming-bird of Jamaica, Mr. Gosse writes: "I have sometimes watched with much delight the evolutions of this little species at the Moringa tree.<sup>1</sup> When only one is present, he pursues the round of the blossoms soberly enough. But if two are at the tree, one will fly off, and suspend himself in the air a few yards distant; the other presently starts off to him, and then, without touching each other, they mount upwards with strong rushing wings, perhaps for five hundred feet. They then separate, and each starts diagonally towards the ground like a ball from a rifle, and wheeling round comes up to the blossoms again as if it had not moved away at all. The figure of the smaller humming-birds on the wing, their rapidity, their wavering course, and their whole manner of flight are entirely those of an insect." Mr. Bates remarks that on the Amazons during the cooler hours of the morning and from four to six in the afternoon humming-birds are to be seen whirring about the trees by scores; their motions being unlike those of any other birds. They dart to and fro so swiftly that the eye can scarcely follow them, and when they stop before a flower it is only for a few moments. They poise themselves in an unsteady manner, their wings moving with inconceivable rapidity, probe the flower, and then shoot off to another part of the tree. They do not proceed in that methodical manner which bees follow, taking the flowers seriatim, but skip about from one part of the tree to another in the most capricious way. Mr. Belt remarks on the excessive rapidity of the flight of the humming-bird giving it a sense of security from danger, so that it will approach a person nearer than any other bird, often hovering within two or three yards (or even one or two feet) of one's face. He watched them bathing in a small pool in the forest, hovering over the water, turning from side to side by quick jerks of the tail, now showing a throat of gleaming emerald, now shoulders of glistening amethyst, then darting beneath the water, and rising instantly, throw off a shower of spray from its quivering wings, and again fly up to an overhanging bough and commence to preen its feathers. All humming-birds bathe on the wing, and generally take three or four dips, hovering between times about three or four inches above the surface. Mr. Belt also remarks on the immense numbers of humming-birds in the forests, and the great difficulty of seeing them; and his conclusion is, that in the part of Nicaragua where he was living they equalled in number all the rest of the birds together, if they did not greatly exceed them.

The extreme pugnacity of humming-birds has been noticed by all observers. Mr. Gosse describes two meeting and chasing each other through the labyrinths of twigs and flowers till, an opportunity

(1) Sometimes called the horse-radish tree. It is the *Moringa pterygosperma*, a native of the East Indies, but commonly cultivated in Jamaica. It has yellow flowers.

occurring, the one would dart with seeming fury upon the other, and then, with a loud rustling of their wings, they would twirl together, round and round, till they nearly came to the earth. Then they parted, and after a time another tussle took place. Two of the same species can hardly meet without an encounter, while in many cases distinct species attack each other with equal fury. Mr. Salvin describes the splendid *Eugenes fulgens* attacking two other species with as much ferocity as its own fellows. One will knock another off its perch, and the two will go fighting and screaming away at a pace hardly to be followed by the eye. Audubon says they attack any other birds that approach them, and think nothing of assaulting tyrant-shrikes and even birds-of-prey that come too near to their home.

The food of humming-birds has been a matter of much controversy. All the early writers down to Buffon believed that they lived solely on the nectar of flowers; but since that time every close observer of their habits maintains that they feed largely, and in some cases wholly, on insects. Azara observed them on the La Plata in winter, taking insects out of the webs of spiders at a time and place where there were no flowers. Bullock, in Mexico, declares that he saw them catch small butterflies, and that he found many kinds of insects in their stomachs. Waterton made a similar statement. Hundreds and perhaps thousands of specimens have since been dissected by collecting naturalists, and in almost every instance their stomachs have been found full of insects, sometimes, but not generally, mixed with a proportion of honey. Many of them in fact may be seen catching gnats and other small insects just like fly-catchers, sitting on a dead twig over water, darting off for a time in the air, and then returning to the twig. Others come out just at dusk, and remain on the wing, now stationary, now darting about with the greatest rapidity, imitating in a limited space the evolutions of the goatsuckers, and evidently for the same end and purpose. Mr. Gosse also remarks: "All the humming-birds have more or less the habit, when in flight, of pausing in the air and throwing the body and tail into rapid and odd contortions. This is most observable in the *Polytmus*, from the effect that such motions have on the long feathers of the tail. That the object of these quick turns is the capture of insects, I am sure, having watched one thus engaged pretty close to me. I observed it carefully, and distinctly saw the minute flies in the air which it pursued and caught, and heard repeatedly the snapping of the beak. My presence scarcely disturbed it, if at all."

There is also an extensive group of small brown humming-birds, forming the sub-family *Phaethornithinae*, which rarely or never visit flowers, but frequent the shady recesses of the forest, where they hunt for minute insects. They dart about among the foliage, and

visit in rapid succession every leaf upon a branch, balancing themselves vertically in the air, passing their beaks closely over the under surface of each leaf, and thus capturing, no doubt, any small insects that may lurk there. While doing this, the two long feathers of the tail have a vibrating motion, serving apparently as a rudder to assist them in performing the delicate operation. Others search up and down stems and dead sticks in the same manner, every now and then picking off something, exactly as a bush-shrike or a tree-creeper does, with the difference that the humming-bird is constantly on the wing; while the remarkable Sickle-bill is said to probe the scale-covered stems of palms and tree-ferns to obtain its insect food. It has also been often stated that, although humming-birds are very bold and easily tamed, they cannot be preserved long in captivity, even in their own country, when fed only on syrup. Audubon states that when thus fed they only live a month or two and die apparently starved; while if kept in a room whose open windows are covered with a fine net, so as to allow small insects to enter, they have been kept for a whole year without any ill-effects. Another writer, Mr. Webber, captured and tamed a number of the Ruby-throat in the United States. He found that when fed for three weeks on syrup they drooped, but after being let free for a day or two they would return to the open cage for more of the syrup. Some which had been thus tamed and set free, returned the following year, and at once flew straight to the remembered little cup of sweets. Mr. Gosse in Jamaica also kept some in captivity, and found the necessity of giving them insect food; and he remarks that they were very fond of a small ant that swarmed on the syrup with which they were fed. It is strange that, with all this previous experience and information, those who have attempted to bring live humming-birds to this country have fed them exclusively on syrup; and the weakness produced by this insufficient food has no doubt been the chief cause of their death on, or very soon after, arrival. A box of ants would not be difficult to bring as food for them, but even finely-chopped meat or yolk of egg would probably serve, in the absence of insects, to supply the necessary proportion of animal food.

The nests of the humming-birds are, as might be expected, beautiful objects, some being no larger inside than the half of a walnut-shell. These small cup-shaped nests are often placed in the fork of a branch, and the outside is sometimes beautifully decorated with pieces of lichen, the body of the nest being formed of cottony substances and the inside lined with the finest and most silky fibres. Others suspend their nests to creepers hanging over water, or even over the sea; and the Pichincha humming-bird once attached its nest to a straw rope hanging from the roof of a shed. Others again build nests of a hammock-form attached to the face of rocks by spider's



web; while the little forest-haunting species fasten their nests to the points or to the under sides of palm-leaves or other suitable foliage. They lay only one or two white eggs.

*Geographical Distribution and Variation.*—Most persons know that humming-birds are found only in America; but it is not so generally known that they are almost exclusively tropical birds, and that the few species that are found in the temperate (northern and southern) parts of the continent are migrants, which retire in the winter to the warmer lands near or within the tropics. In the extreme north of America two species are regular summer visitants, one on the east and the other on the west of the Rocky Mountains. On the east the common N. American or Ruby-throated humming-bird extends through the United States and Canada, and as far as  $57^{\circ}$  north latitude, or considerably north of Lake Winnipeg; while the milder climate of the west coast allows the Rufous Flame-bearer to extend its range to beyond Sitka to the parallel of  $61^{\circ}$ . Here they spend the whole summer, and breed, being found on the Columbia River in the latter end of April, but retire to Mexico in the winter. Supposing that those which go furthest north do not return further south than the borders of the tropics, these little birds must make a journey of full three thousand miles each spring and autumn. The antarctic humming-bird visits the inhospitable shores of Tierra del Fuego, where it has been seen visiting the flowers of fuchsias in a snow-storm, while it spends the winter in the warmer parts of Chili and Bolivia. In the southern parts of California and the Central United States three or four other species are found in summer; but it is only when we enter the tropics that the number of different kinds becomes considerable. In Mexico there are more than thirty species, while in the southern parts of Central America there are more than double that number. As we go on towards the equator they become still more numerous, till they reach their maximum in the equatorial Andes. They especially abound in the mountainous regions; while the luxuriant forest plains of the Amazons, in which so many other forms of life reach their maximum, are very poor in humming-birds. Brazil, being more hilly and with more variety of vegetation, is richer, but does not equal the Andean valleys, plateaux, and volcanic peaks. Each separate district of the Andes has its peculiar species and often its peculiar genera, and many of the great volcanic mountains possess kinds which are confined to them. Thus, on the great mountain of Pichincha there is a peculiar species found at an elevation of about fourteen thousand feet only; while an allied species on Chimborazo ranges from fourteen thousand feet to the limits of perpetual snow at sixteen thousand feet elevation. It frequents a beautiful yellow-flowered alpine shrub belonging to the Asteraceae. On the extinct volcano of Chiriqui in Veragua a minute humming-

bird, called the little Flame-bearer, has been only found inside the crater. Its scaled gorget is of such a flaming crimson that, as Mr. Gould remarks, it seems to have caught the last spark from the volcano before it was extinguished.

Not only are humming-birds found over the whole extent of America, from Sitka to Tierra del Fuego, and from the level of the sea to the snow-line on the Andes, but they inhabit many of the islands at a great distance from the main land. The West Indian islands possess fifteen distinct species belonging to eight different genera, and these are so unlike any found on the continent that five of these genera are peculiar to the Antilles. Even the Bahamas, so close to Florida, possess two peculiar species. The small group of islands called Tres Marias, about sixty miles from the west coast of Mexico, has a peculiar species. More remarkable are the two humming-birds of Juan Fernandez, situated in the Pacific Ocean four hundred miles west of Valparaiso in Chili, one of these being peculiar; while another species inhabits the little island Mas-afuera, ninety miles further west. The Galapagos, though very little further from the mainland and much more extensive, have no humming-birds, neither have the Falkland Islands; and the reason seems to be that both these groups are deficient in forest, and in fact have hardly any trees or large shrubs, while there is a great paucity of flowers and of insect life.

The three species which inhabit Juan Fernandez and Mas-afuera present certain peculiarities of great interest. They form a distinct genus, *Eustephanus*, one species of which inhabits Chili as well as the island of Juan Fernandez. This, which may be termed the Chilian species, is greenish in both sexes, whereas in the two species peculiar to the islands the males are red or reddish-brown, and the females green. The two red males differ very slightly from each other, but the three green females differ considerably; and the curious point is, that the female in the smaller and more distant island somewhat resembles the same sex in Chili, while the female of the Juan Fernandez species is very distinct, although the males of the two islands are so much alike. As this forms a comparatively simple case of the action of the laws of variation and natural selection, it will be instructive to see if we can picture to ourselves the process by which the changes have been brought about. We must first go back to an unknown but rather remote period, just before any humming-birds had reached these islands. At that time a species of this peculiar genus, *Eustephanus*, must have inhabited Chili; but we must not be sure that it was identically the same as that which is now found there, because we know that species are always undergoing change to a greater or less degree. After perhaps many failures, one or more pairs of the Chilian bird got blown across to Juan Fernandez, and

finding the country favourable, with plenty of forests and a fair abundance of flowers and insects, they rapidly increased and permanently established themselves on the island. They soon began to change colour, however, the male getting a tinge of reddish-brown, which gradually deepened into the fine colour now exhibited by the two insular species, while the female, more slowly, changed to white on the under surface and on the tail, while the breast-spots became more brilliant. When the change of colour was completed in the male, but only partially so in the female, a further emigration westward took place to the small island Mas-afuera, where they also established themselves. Here, however, the change begun in the larger island appears to have been checked, for the female remains to this day intermediate between the Juan Fernandez and the Chilian forms. More recently, the parent form has again migrated from Chili to Juan Fernandez, where it still lives side by side with its greatly changed descendant.<sup>1</sup> Let us now see how far these facts are in accordance with the general laws of variation, and with those other laws which I have endeavoured to show regulate the development of colour.<sup>2</sup> The amount of variation which is likely to occur in a species will be greatly influenced by two factors—the occurrence of a change in the physical conditions, and the average abundance or scarcity of the individuals composing the species. When from these or other causes variation occurs, it may become fixed as a variety or a race, or may go on increasing to a certain extent, either from a tendency to vary along certain special lines induced by local or physiological causes, or by the continued survival and propagation of all such varieties as are beneficial to the race. After a certain time a balance will be arrived at, either by the limits of useful variation in this one direction having been reached, or by the species becoming harmoniously adapted to all the surrounding conditions; and without some change in these conditions the specific form may then remain unaltered for a very long time, whence arises the common impression of the fixity of species. Now in a country like Chili, forming part of a great continent very well stocked with all forms of organic life, the majority of the species would be in a state of stable equilibrium, the most favourable variations would have been long ago selected, and the numbers of individuals in each species would be tolerably constant, being limited by the numerous other forms whose food and habits were similar, or which in any way impinged upon its sphere of existence. We may, therefore, assume that the Chilian humming-

(1) In the preceding account of the probable course of events in peopling these islands with humming-birds, I follow Mr. Selater's paper on the Land-Birds of Juan Fernandez, —Ibis, 1871, p. 183. In what follows, I give my own explanation of the probable causes of the change.

(2) See Macmillan's Magazine, Sept., 1877, On the Colours of Animals and Plants.

bird which migrated to Juan Fernandez was a stable form, hardly if at all different from the existing species which is termed *Eustephanus galeritus*. On the island it met with very changed but highly favourable conditions. An abundant shrubby vegetation and a tolerably rich flora; less extremes of climate than on the mainland; and, most important of all, absolute freedom from the competition of rival species. The flowers and their insect inhabitants were all its own; there were no snakes or mammalia to plunder its nests; nothing to prevent the full enjoyment of existence. The consequence would be, rapid increase and a large permanent population, which still maintains itself; for Mr. Moseley, of the *Challenger* expedition, has informed the writer that humming-birds are extraordinarily abundant in Juan Fernandez, every bush or tree having one or two darting about it. Here, then, we have one of the special conditions which have always been held to favour variation—a great increase in the number of individuals; but, as there was no struggle with allied creatures, there was no need for any modification in form or structure, and we accordingly find that the only important variations which have become permanent are those of size and of colour. The increased size would naturally arise from greater abundance of food with a more equable climate throughout the year, the healthier, stronger, and larger individuals being preserved. The change of colour would depend on molecular changes in the plumage accompanying the increase of size; and the superior energy and vitality in the male, aided by the favourable change in conditions and rapid increase of population, would lead to an increased intensity of colour, the special tint being determined either by local conditions or by inherited tendencies in the race. It is to be noted that the change from green to red is in the direction of the less refrangible rays of the spectrum, and is in accordance with the law of change which has been shown to accompany expansion in inorganic, and growth and development in organic, forms.<sup>1</sup> The change of colour in the female, not being urged on by such intense vital activity as in the case of the male, would be much slower, and, owing probably to inherited tendencies, in a different direction. The under surface of the Chilean bird is ashy with bronzy-green spots on the breast, while the tail is entirely bronze-green. In the Juan Fernandez species the under surface has become pure white, the breast-spots larger and of a purer golden-green, while the whole inner web of the tail-feathers has become pure white, producing a most elegant effect when the tail is expanded.

We may now follow the two sexes to the remoter island, at a period when the male had acquired his permanent style of colouring, but was not quite so large as he subsequently became; while the

(1) See *Colours of Animals*; Macmillan's Magazine, Sept., 1877, pp. 394—398.

change of the female bird had not been half completed. In this small and comparatively barren island (a mere rock, as it is described by some authors) there would be no such constant abundance of food, and therefore no possibility of a large permanent population; while the climate would not differ materially from that of the larger island; variation would therefore be checked, or might be stopped altogether; and we find the facts exactly correspond to this view. The male, which had already acquired his colour, remains almost undistinguishable; but he is a little smaller than his immediate ancestral form, indicating either that the full size of that form had not been acquired at the period of migration, or that a slight diminution of size has since occurred owing to a deficiency of food. The female shows also a slight diminution of size, but in other respects is almost exactly intermediate between the Chilian and Juan Fernandez females. The colour beneath is light ashy, the breast-spots are intermediate in size and colour, and the tail-feathers have a large ill-defined white spot on the end of the inner web, which has only to be extended along the whole web to produce the exact character which has been acquired in Juan Fernandez. It has probably remained since its migration nearly or quite stationary, while its Juan Fernandez relative has gone on steadily changing in the direction already begun; and the more distant species geographically thus appears to be more nearly related to its Chilian ancestor.

Coming down to a more recent period, we find that the comparatively small and dull-coloured Chilian bird has again migrated to Juan Fernandez, but it at once came into competition with its red descendant, which had firm possession of the soil and had probably undergone slight constitutional changes exactly fitting it to its insular abode. The new comer, accordingly, only just manages to maintain its footing; for we are told by Mr. Reed, of Santiago, that it is by no means common; whereas, as we have seen, the red species is excessively abundant. We may further suspect that the Chilian birds now pass over pretty frequently to Juan Fernandez, and thus keep up the stock; for it must be remembered that whereas, at a first migration, both a male and a female are necessary for colonization, yet, after a colony is formed, any stray bird which may come over adds to the numbers, and checks permanent variation by cross-breeding.

We find, then, that all the chief peculiarities of the three allied species of humming-birds which inhabit the Juan Fernandez group of islands, may be fairly traced to the action of those general laws which Mr. Darwin and others have shown to determine the variations of animals and the perpetuation of those variations. It is also instructive to note that the greater variations of colour and size have been accompanied by several lesser variations in other characters. In the Juan Fernandez bird the bill has become a little shorter,

the tail-feathers somewhat broader, and the fiery cap on the head somewhat smaller; all these peculiarities being less developed or absent in the birds inhabiting Mas-a-fuera. These may be due, either to what Mr. Darwin has termed correlation of growth, or to the partial reappearance of ancestral characters under more favourable conditions, or to the direct action of changes of climate and of food; but they show us how varied and unaccountable are the changes in specific forms that may be effected in a comparatively short time, and through very slight changes of locality.

If now we consider the enormously varied conditions presented by the whole continent of America—the hot, moist, and uniform forest-plains of the Amazon; the open llanos of the Orinoco; the dry uplands of Brazil; the sheltered valleys and forest slopes of the Eastern Andes; the verdant plateaus, the barren paramos, the countless volcanic cones with their peculiar Alpine vegetation; the contrasts of the East and West coasts; the isolation of the West Indian islands, and to a less extent of Central America and Mexico, which we know have been several times separated from South America; and when we further consider that all these characteristically distinct areas have been subject to cosmical and local changes, to elevations and depressions, to diminution and increase of size, to greater extremes and greater uniformity of temperature, to increase or decrease of rainfall, and that with these changes there have been coincident changes of vegetation and of animal life, all affecting in countless ways the growth and development, the forms and colours, of these wonderful little birds—if we consider all these varied and complex influences, we shall be less surprised at their strange forms, their infinite variety, their wondrous beauty. For how many ages the causes above enumerated may have acted upon them we cannot say; but their extreme isolation from all other birds, no less than the abundance and variety of their generic and specific forms, clearly point to a very high antiquity.

*The Relations and Affinities of Humming-birds.*—The subject of the position of this family in the class of birds and its affinities or resemblances to other groups, is so interesting, and affords such good opportunities for explaining some of the best-established principles of classification in natural history in a popular way, that we propose to discuss it at some length, but without entering into technical details.

There is in the Eastern hemisphere, especially in tropical Africa and Asia, a family of small birds called Sun-birds, which are adorned with brilliant metallic colours, and which, in shape and general appearance, much resemble humming-birds. They frequent flowers in the same way, feeding on honey and insects; and all the older naturalists placed the two families side by side as undoubtedly allied. In the

year 1850, in a general catalogue of birds, Prince Lucien Bonaparte, a learned ornithologist, placed the humming-birds next to the swifts, and far removed from the Nectarinidæ or sun-birds; and this view of their position has gained ground with increasing knowledge, till now all the more advanced ornithologists have adopted it. Before proceeding to point out the reasons for this change of view, it will be well to discuss a few of the general principles which guide naturalists in the solution of such problems.

It is now generally admitted that, for the purpose of determining obscure and doubtful affinities, we must examine by preference those parts of an animal which have little or no direct influence on its habits and general economy. The value of an organ, or of any detail of structure, for purposes of classification, is generally in inverse proportion to its adaptability to special uses. And the reason of this is apparent when we consider that similarities of food and habits are often accompanied by similarities of external form or of special organs, in totally distinct animals. Porpoises, for example, are modified externally so as to resemble fishes, yet they are really mammalia. Some marsupials are carnivorous, and are so like true carnivora that it is only by minute peculiarities of structure that the skeleton of the one can be distinguished from that of the other. Many of the hornbills and toucans have the same general form, and resemble each other in habits, in food, and in their enormous bills; yet peculiarities in the structure of the feet, in the form of the breast-bone, in the cranium, and in the texture and arrangement of the plumage, show that they have no real affinity, the former approaching the king-fishers, the latter the cuckoos. These last-mentioned peculiarities have no direct relation to habits, and they are therefore little liable to change, when from any cause a portion of the group may have been driven to adopt a new mode of life. Thus all the Old World apes, however much they may differ in size or habits, and whether we class them as baboons, monkeys, or gorillas, have the same number of teeth; while the American monkeys all have an additional premolar tooth. This difference can have no relation to the habits of the two groups, because each group exhibits differences of habits greater than often occur between American and Asiatic species; and it thus becomes a valuable character, indicating the radical distinctness of the two groups, a distinctness confirmed by other anatomical peculiarities.

On the other hand, details of organization which seem specially adapted to certain modes of life, are often diminished or altogether lost in a few species of the group, showing their essential unimportance to the type as well as their small value for classification. Thus, the woodpeckers are most strikingly characterized by a very long and highly extensible tongue, with the muscles attached to the

tongue-bone prolonged backward over the head so as to enable the tongue to be suddenly darted out, and also by the rigid and pointed tail, which is a great help in climbing up the vertical trunks of trees. But in one group (the Picumni), the tail becomes quite soft, while the tongue remains fully developed; and in another (*Meiglyptes*) the characteristic tail remains, while the prolonged hyoid muscles have almost entirely disappeared, and the tongue has consequently lost its peculiar extensile power. Yet in both these cases the form of the breast-bone and the character of the feet, the skeleton, and the plumage, show that the birds are really woodpeckers, while even the habits and the food are very little altered. In like manner the bill may undergo great changes, as from the short crow-like bill of the true birds-of-paradise to the long slender bills of the *Epimachinae*, which latter were on that account long classed apart in the tribe of *Tenuirostres*, or slender-billed birds, but whose entire structure shows them to be closely allied to the paradise-birds. So, the long feathery tongue of the toucans differs from that of every other bird, yet it is not held to overbalance the weight of anatomical peculiarities which show that these birds are allied to the barbets and the cuckoos.

The skeleton, therefore, and especially the sternum or breast-bone, affords us an almost infallible guide in doubtful cases, because it appears to change its form with extreme slowness, and thus indicates deeper-seated affinities than those shown by organs which are in direct connection with the outside world, and are readily modified in accordance with varying conditions of existence. Another, though less valuable guide, is afforded, in the case of birds, by the eggs. These often have a characteristic form and colour, and a peculiar texture of surface, running unchanged through whole genera and families which are nearly related to each other, however much they may differ in outward form and habits. Another detail of structure which has no direct connection with habits and economy is the manner in which the plumage is arranged on the body. The feathers of birds are by no means set uniformly over their skin, but grow in certain definite lines and patches, which vary considerably in shape and size in the more important orders and tribes, while the mode of arrangement agrees in all which are known to be closely related to each other; and thus the form of the feather-tracts, or the "pterylography" as it is termed, of a bird is a valuable aid in doubtful cases of affinity.

Now, if we apply these three tests to the humming-birds, we find them all pointing in the same direction. The sternum or breast-bone is not notched behind; and this agrees with the swifts, and not with the sun-birds, whose sternum has two deep notches behind, as in all the families of the vast order of *Passeres*, to which the latter belong. The eggs of both swifts and humming-birds are white, only two in



number, and resembling each other in texture. And in the arrangement of the feather-tracts the humming-birds approach more nearly to the swifts than they do to any other birds; and altogether differ from the sun-birds, which, in this respect as in so many others, resemble the honey-suckers of Australia and other true passerine birds.

Having this clue to their affinities, we shall find other peculiarities common to these two groups, the swifts and the humming-birds. They have both ten tail-feathers, while the sun-birds have twelve. They have both only sixteen true quill-feathers, and they are the only birds which have so small a number. The humming-birds are remarkable for having, in almost all the species, the first quill the longest of all, the only other birds resembling them in this respect being a few species of swifts; and, lastly, in both groups the plumage is remarkably compact and closely pressed to the body. Yet, with all these points of agreement, we find an extreme diversity in the bills and tongues of the two groups. The swifts have a short, broad, flat bill, with a flat horny-tipped tongue of the usual character; while the humming-birds have a very long, narrow, almost cylindrical bill, containing a tubular and highly extensible tongue. The essential point however is, that whereas hardly any of the other characters we have adduced are adaptive, or strictly correlated with habits and economy, this character is pre-eminently so; for the swifts are pure aerial insect-hunters, and their short, broad bills, and wide gape, are essential to their mode of life. The humming-birds, on the other hand, are floral insect-hunters, and for this purpose their peculiarly long bills and extensile tongues are especially adapted; while they are at the same time honey-suckers, and for this purpose have acquired the tubular tongue. The formation of such a tubular tongue out of one of the ordinary kind is easily conceivable, as it only requires to be lengthened, and the two laminæ of which it is composed curled in at the sides; and these changes it probably goes through in the young birds. When on the Amazon I once had a nest brought me containing two little unfledged humming-birds, apparently not long hatched. Their beaks were not at all like those of their parents, but short, triangular, and broad at the base, just the form of the beak of a swallow or swift slightly lengthened. Thinking (erroneously) that the young birds were fed by their parents on honey, I tried to feed them with a syrup made of honey and water, but though they kept their mouths constantly open as if ravenously hungry, they would not swallow the liquid, but threw it out again and sometimes nearly choked themselves in the effort. At length I caught some minute flies, and on dropping one of these into the open mouth it instantly closed, the fly was gulped down, and the mouth opened again for more; and each took in this way fifteen

or twenty little flies in succession before it was satisfied. They lived thus three or four days, but required more constant care than I could give them. These little birds were in the "swift" stage; they were pure insect-eaters, with a bill and mouth adapted for insect-eating only. At that time I was not aware of the importance of the observation of the tongue, but as the bill was so short and the tubular tongue not required, there can be little doubt that the organ was, at that early stage of growth, short and flat, as it is in the birds most nearly allied to them.

In respect of all the essential and deep-seated points of structure, which have been shown to offer such remarkable similarities between the swifts and the humming-birds, the sun-birds of the Eastern hemisphere differ totally from the latter, while they agree with the passerine birds generally, or more particularly with the creepers and honey-suckers. They have a deeply-notched sternum; they have twelve tail-feathers in place of ten; they have nineteen quills in place of sixteen; and the first quill, instead of being the longest, is the very shortest of all; while the wings are short and round, instead of being excessively long and pointed. Their plumage is arranged differently; and their feet are long and strong, instead of being excessively short and weak. There remain only the superficial characters of small size and brilliant metallic colours to assimilate them with the humming-birds, and one structural feature—a tubular and somewhat extensile tongue. This however is a strictly adaptive character, the sun-birds feeding on small insects and the nectar of flowers, just as do the humming-birds; and it is a remarkable instance of a highly peculiar modification of an organ occurring independently in two widely-separated groups. In the sun-birds the hyoid or tongue-muscles do not extend so completely over the head as they do in the humming-birds, so that the tongue is less extensible; but it is constructed in exactly the same way by the inrolling of the two laminae of which it is composed. The tubular tongue of the sun-birds is a special adaptive modification acquired within the family itself, and not inherited from a remote ancestral form. This is shown by the amount of variation this organ exhibits in different members of what is undoubtedly one family. It is most highly developed in the *Arachnotheræ*, or spider-hunters, of Asia, which are sun-birds without any metallic or other brilliant colouring. These have the longest bills and tongues, and the most developed hyoid muscles; they hunt much about the blossoms of palm-trees, and may frequently be seen probing the flowers while fluttering clumsily in the air, just as if they had seen and attempted to imitate the aerial gambols of the American humming-birds. The true metallic sun-birds generally cling about the flowers with their strong feet; and they feed chiefly on minute hard insects, as do many humming-birds.

There is, however, one species (*Chalcoparia phœnicotis*) always classed as a sun-bird, which differs entirely from the rest of the species in having the tongue flat, horny, and forked at the tip; and its food seems to differ correspondingly, for small caterpillars were found in its stomach. More remotely allied, but yet belonging to the same family, are the little flower-peckers of the genus *Diceum*, which have a short bill and a tongue twice split at the end; and these feed on small fruits, and perhaps on buds and on the pollen of flowers. The little white-eyes (*Zosterops*), which are probably allied to the last, eat soft fruits and minute insects. We have here a whole group of birds, considerably varied in external form, yet undoubtedly closely allied to each other, one division of which is specially adapted to feed on the juices secreted by flowers and the minute insects that harbour in them; and these alone have a lengthened bill and double tubular tongue, just as in the humming-birds. We can hardly have a more striking example of the necessity of discriminating between adaptive and purely structural characters. The same adaptive character may coexist in two groups which have a similar mode of life, without indicating any affinity between them, because it may have been acquired by each independently to enable it to fill a similar place in nature. In such cases it is found to be an almost isolated character, connecting apparently two groups which otherwise differ radically. Non-adaptive, or purely structural characters, on the other hand, are such as have, probably, been transmitted from a remote ancestor, and thus indicate fundamental peculiarities of growth and development. The changes of structure rendered necessary by modifications of the habits or instincts of the different species have been made, to a great extent, independently of such characters, and as several of these may always be found in the same animal, their value becomes cumulative. We thus arrive at the seeming paradox, that the *less* of direct use is apparent in any peculiarity of structure, the *greater* is its value in indicating true, though perhaps remote, affinities; while any peculiarity of an organ which seems essential to its possessor's well-being is often of very little value in indicating affinity for other creatures.

This somewhat technical discussion will, it is hoped, enable the general reader to understand some of the more important principles of the modern or natural classification of animals, as distinguished from the artificial system which long prevailed. It will also afford him an easily remembered example of those principles, in the radical distinctness of two families of birds often confounded together,—the sun-birds of the Eastern Hemisphere and the humming-birds of America; and in the interesting fact that the latter are essentially swifts—profoundly modified, it is true, for an aërial and flower-haunting existence, but still bearing in many important peculiarities of structure the unmistakable evidences of a common origin.

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