both of Malacca and of Borneo, but it seems to have much less peculiarity than the latter's.

We then have Java, the best-explored, the most thickly-peopled, and, proportionately to its fauna, the most peculiar, perhaps, of the Indo-Malay Islands. Here we find about 270 species of Land-birds, of which about 45 are peculiar—most of them being from the mountains in the western part of the island. The reappearance in Java of several Burmese species, as *Crypsirhina varians*, *Picus analis*, *Pavo muticus*, and others, which do not occur in the Malay Peninsula south of Penang, is very remarkable.

Of Bali, so interesting as the southern outpost of the Region, we only know from Mr Wallace that he saw there several Birds highly characteristic of Javan ornithology, and whether the island has any peculiar species nowhere appears. We are then brought to the brink of that remarkable strait through which runs "Wallace's Line," and crossing it find ourselves at once in the Australian Region, with which we began this protracted dissertation.

It is, of course, much to be regretted that at present our information does not allow of our treating all the Six Zoological Regions of the globe on a uniform plan, or of dealing equally with their several component portions. That this will be possible in a few years, as materials are accumulated, none can doubt; but as yet we are far from the attainment of so desirable an end, and must be content to make the most of what we have. Want of space, also, has hindered the proper consideration here of many points that fully deserve notice, and especially the negative characteristics of the different Regions—often quite as important as those which are positive. Of the imperfections of the preceding sketch no one can be more painfully aware than its author, but its very imperfections may serve a useful purpose in drawing attention to the districts about which least is known. Yet it would be affectation for him not to believe that it has some actual merit, but that merit is greatly if not chiefly due to the kindness of Mr Wallace, who, in the manner already stated, has allowed his forthcoming work to be laid under contribution, though in several respects its conclusions are not here adopted. That work, when published, will unquestionably form a foundation on which a noble superstructure will ultimately be erected, but it were vain to anticipate the ends which such a building will one day serve, and it would be beyond our scope to enter into any theoretical disquisition on the deductions which follow from the facts here advanced.

MIGRATION.

Most strangely and unaccountably confounded by many writers with the subject of Distribution is that of Migration. True it is that owing to the vast powers of locomotion possessed by nearly all Birds, we have individuals belonging in the main to certain groups, but by no means always confined to them, straying from their proper quarters and occurring in places far removed, not only from the land of their birth, but from the country whither they are ordinarily bound in their journeys, to reach which is the object wherefore such journeys are undertaken. It may be that in some measure this erraticism is governed by fixed laws, and indeed indication is not wanting that such laws exist, though as yet we know much too little to lay them down with any approach to confidence. But it is obvious on reflection that granting the existence of most rigorous laws of this kind—determining the flight of every winged vagabond—they must be very different from those which are obeyed by Birds commonly called "Migratory," and migrating year after year according to a more or less fixed rule from one locality to another with the seasons as they roll. The former laws would seem to be created or controlled by purely external circumstances, which if they possess any periodicity at all possess a periodicity of cycles, and are most likely dependent in the main on cycles of the weather, but on this point observation has not yet supplied us with the means of avoiding speculation. We may indeed say almost without much risk of error that so many individuals of a foreign species—whether North-American or Asiatic—will occur in Great Britain so many times in the course of a term of years; but, though we may safely predict that if they appear at all they will do so at a certain season, it is impossible to make a forecast as to the year in which an example will turn up, or whether in one year some half-dozen may or may not occur. The matter thus becomes a matter of averages, and like all such is open to the influence of many perturbants, not that such may not well be subject to some law of which we are ignorant. Besides this, the average is hard to strike, depending as it must on the existence of favourably-placed and watchful observers. Moreover if we consider that the number of competent observers, though possibly greater in England than anywhere else in the world, has been at all times small, it is not surprising that little has been effected towards the compassing of any definite notion on this head. At present we can but attribute the appearance of foreign stragglers on our shores, and no doubt the same may be said of other countries, to the influence of storms which have driven the wanderers from their course, and though other more remote causes may possibly be assigned, there seems to be none but this on which we can safely rely. Consequently until the periodicity of storms is brought within our knowledge we must be content to abide in our ignorance of the laws which govern the appearance of the strangers. Still confining our remarks to the British Islands, the effect of these laws is in some degree constant. Singular as it may appear, the greatest number of North-American Birds—and especially of the *Limicolæ*, or Shore-birds, which are recorded as having occurred in this country have been met with in the eastern part of England or Scotland. There are two ways of accounting for this fact, the first of which is the unfortunate scarcity of observing naturalists in Ireland and on its western coast especially, and this is by no means to be overlooked; but it may be remarked that in no part of the United Kingdom is the profession of the gunner more enthusiastically followed than in the sister island, and the men who pursue that vocation are all alive to the mercantile value of any strange bird which may fall in their way. Of course they have no means of knowing what it is, yet as their spoils are sent for sale to the nearest market, it cannot but happen that if many examples of North-American species were procured by them, some proportion of these would find their way to the notice of the amateur naturalist and by him be recorded in the public prints.[1] Now, as compared with Great Britain, this so rarely occurs in Ireland that it is by no means unfair to draw the inference that Transatlantic Birds are there far less frequently met with. The second mode of accounting for the fact above stated is that the majority of North-American Birds which occasionally visit Europe are of species which breed in somewhat high northern latitudes. On their way thence to their winter-quarters, some are driven out to sea by violent westerly gales—the strongest winds, be it remembered, that prevail

Appearances of American Birds in Britain.

[1] It seems also not unlikely that the very scarcity of rare birds in Ireland is one reason why there are so few ornithologists in that country, for here it is not uncommon for a man to have his attention first called to zoology by meeting with some strange animal—be it beast, bird, beetle, or butterfly, and for such a man afterwards to become no mean field-naturalist.

in the North Atlantic, and thus strike the coast of Norway.[1] In that country observers may be said to be practically absent, and fowlers as a rule unknown. Such storm-beaten wanderers there consort with the allied species to be found at that season in abundance on its shores and in their company pursue the same southerly course. With them they cross to the east of Great Britain, and once arrived here are speedily picked out and secured by the practised gunner. But should they even escape his notice, they with their comrades follow the shore-line, where they obtain the best supply of food, until passing round the south coast they find themselves at the western extremity of England—the district of the Land's End, in which, next to Norfolk and Suffolk, the greatest number of these Transatlantic stragglers have been obtained. This suggestion may serve to shew what most likely goes on in other parts of the world, though the materials for establishing its general truth are not forthcoming.

But returning to the subject of Migration proper, distinguished as it ought to be from that of the more or less accidental occurrence of stray visitors from afar, we have here more than enough to excite our wonder, and indeed are brought face to face with perhaps the greatest mystery which the whole animal kingdom presents—a mystery which attracted the attention of the earliest writers, and can in its chief point be no more explained by the modern man of science than by the simple-minded savage or the poet or prophet of antiquity. Some facts are almost universally known and have been the theme of comment in all ages and in all lands. The Hawk that stretches her wings toward the south is as familiar to the latest Nile-boat traveller or dweller on the Bosphorus as of old to the author of the book of Job. The autumnal thronging of myriads of Waterfowl by the rivers of Asia is witnessed by the modern sportsman as it was of old by Homer. Anacreon welcomed the returning Swallow, in numbers which his imitators of the colder north, to whom the associations connected with it are doubly strong, have tried in vain to excel. The Indian of the Fur-Countries in forming his rude calendar names the recurring moons after the Birds-of-passage whose arrival is coincident with their changes. But there is no need to multiply instances. The flow and ebb of the mighty feathered wave has been sung by poets and reasoned of by philosophers, has given rise to proverbs and entered into popular superstitions, and yet we must say of it still that our "ignorance is immense."

On one point and one only in connection with this subject can we boast ourselves to be clearly wiser than our ancestors. Some of them fully believed that the seasonal disappearance of the Swallow, the Nightingale, the Cuckow, and the Corncrake was due to hibernation, while others indeed doubted whether or not this was the true explanation of the fact. It is not so long since this belief and these doubts were in vogue, but now assuredly they have no hold upon the mind of any one capable of appreciating evidence, and this absurd fancy being exploded need not again trouble us.

In considering the phænomena of Migration it will be best first to take the facts, and then try to account for their cause or causes. That a very large number of Birds all over the world change their abode according to the season is well known, and we find that in almost all countries there are some species which arrive in spring, remain to breed, and depart in autumn; others which arrive in autumn, stop for the winter, and depart in spring; and others again—and these are strictly speaking the "Birds of Passage"—which shew themselves but twice a year, passing through the country without staying long in it, and their transient visits take place about spring and autumn. People who have given but little thought to the subject are apt to suppose that these migrants, which may thus easily be classed in three categories, are acted upon by influences of different kinds, whereas very little reflection will show that all are really affected by the same impulse, whatever that may be, and that the at first sight dissimilar nature of their movements is in truth almost uniform. The species which resort to this and to other temperate countries in winter are simply those which have their breeding-quarters much nearer the poles, and in returning to them on the approach of spring are but doing exactly as do those species which, having their winter-abode nearer the equator, come to us with the spring. The Birds-of-passage proper, like our winter-visitants have their breeding-quarters nearer the poles, but, like our summer-visitants, they seek their winter-abode nearer the equator, and thus perform a somewhat longer migration. So far there is no difficulty and no hypothesis—the bringing together of these three apparently different categories is the result of simple observation.

Partial migrants.

This however is not the only fact which is evident on the most cursory examination. To take the birds of the British Islands as an example (though exactly similar cases are presented in other countries) we find that while there are some species, such as the Swallow or the Fieldfare, of which every individual disappears at one period of the year or another, there are other species, such as the Pied Wagtail or the Woodcock, of which only the majority of individuals vanish—a few being always present[2]—and these species form the so-called "Partial Migrants." If we extend our view and look to birds on the continent of Europe, we find that many species are there notoriously migrant which are not generally suspected to be so in this country—such as the Song-Thrush and the Redbreast, both of which species closer observation has proved to be with us subject to the migratory impulse. In respect of the former it is known that towards the end of summer or in autumn our native Song-Thrushes receive a considerable accession in numbers from the birds which arrive from the north, though the immigration is by no means so well marked as it is in Belgium, France, or Germany, where the arrival of the strangers sets all the fowlers to work, and the beginning of the *Chasse aux Grives* or *Drosselzug* is regarded in many places nearly as the Twelfth of August or the First of September is with us. In most localities in Britain the new comers depart after a short sojourn, and are accompanied by so many of the home-bred birds that in some parts of the island it may be safely declared that not a single Song-Thrush can be found from the end of November to the end of January, while in others examples can always be seen. Much the same may be said of the Redbreast. Undeniably resident as a species, attentive scrutiny will reveal the fact that its numbers are subject to very considerable variation according to the season of the year. At no time do our Redbreasts collect in bands, but towards the end of summer they may be seen in the south of England successively passing onward, the travellers being mostly if not wholly young birds of the year; and so the great majority disappear, departing it may be safely presumed for more southern countries, since a few weeks later the markets of most towns first in France and then in Italy are well supplied with this species. But the migratory influence affects, though in a less degree, many if not most of the Redbreasts that remain with us. Content during the autumn to occupy their usual haunts,

Song-Thrush.

Redbreast.

[1] Prof. Baird's remarks on this subject are much to the point (*Am. Journ. Sc.*, ser. 2, xli. pp. 344, 345).

[2] Whether these few be not migrants from another district is a point that would require further consideration.

the first sharp frost has a decided effect upon their distribution, and a heavy fall of snow drives them towards the homesteads for the larger supply of food they find there, while should severe and long-continued hard weather follow even these birds vanish, leaving only the few which have become almost domesticated.

These two species have been here chosen as illustrative cases because they are at once plentiful and familiar, and want of space only forbids us from citing others, but we shall find on inquiry that there is scarcely a Bird of either the Palæarctic or Nearctic Region, whose habits are at all well known, of which much the same may not be said, and hence we are led to the conclusion that every Bird of the northern hemisphere is to a greater or less degree migratory in some part or other of its range. Such a conclusion brings us to a still more general inference—namely that Migration, instead of being the exceptional characteristic it used formerly to be thought, may really be almost universal, and though the lack of observations in other, and especially tropical, countries does not allow us to declare that such is the case, it seems very probable to be so. Before proceeding however to any further conclusions it is necessary to examine another class of facts which may possibly throw some light on the matter.

Affection for old breeding-places.

It must be within the experience of every one who has ever been a birds'-nesting boy that the most sedentary of Birds year after year occupy the same quarters in the breeding season.[1] In some instances this may be ascribed, it is true, to the old haunt affording the sole or the most convenient site for the nest in the neighbourhood, but in so many instances such is not the case that we are led to believe in the existence of a real partiality, while there are quite enough exceptions to show that a choice is frequently exercised. The same may equally be said of the most migrant of Birds, and perhaps the strongest instance that has ever come to the knowledge of the writer refers to one of the latter. A pair of Stone-Curlews (*Œdicnemus crepitans*)—a very migratory species, affecting almost exclusively the most open country—were in the habit of breeding for many years on the same spot though its character had undergone a complete change. It had been part of an extensive and barren rabbit-warren, and was become the centre of a large and flourishing plantation.

Want of food the most obvious cause of migration.

With these two sets of facts before us we may begin to try and account for the cause or causes of Migration. In some cases want of food would seem to be enough, as it is undoubtedly the most obvious cause that presents itself to our mind.[2] The need which all animals have of finding for themselves proper and sufficient sustenance is all-powerful, and the difficulties they have to encounter in obtaining it are so great that none can wonder that those which possess the power of removing themselves from a place of scarcity should avail themselves of it, while it is unquestionable that no Class of animals has this facility in a greater degree than Birds.[3] Even among many of those species which we commonly speak of as sedentary, it is only the adults which maintain their ground throughout the year. It has long been known that Birds-of-prey customarily drive away their offspring from their own haunts so soon as the young are able to shift for themselves. The reason generally, and no doubt truly, given for this behaviour, which at first sight appears so unnatural, is the impossibility of both parents and progeny getting a livelihood in the same vicinity. The practice, however, is not limited to the Birds-of-prey alone, but is much more universal. We find it to obtain with the Redbreast, and if we watch our feathered neighbours closely we shall perceive that most of them indulge in it. The period of expulsion, it is true, is in some Birds deferred from the end of summer or the autumn, in which it is usually performed, until the following spring, when indeed from the maturity of the young it must be regarded as much in the light of a voluntary secession on their part as in that of an act of parental compulsion, but the effect is ultimately the same. These cases, however, which make certainly the exception rather than the rule, we can account for in another manner. It is to be observed that they are confined to species having a peculiar mode of life, the individuals associating in family-parties to form small bands. The members of the Titmouse-family (*Paridæ*) offer a good instance of this peculiarity, but it requires no very abstruse reflection to perceive that the adoption of this habit is one eminently conducive to the easy attainment of their food, which is collected, as it were, into particular spots often far apart, but where it does occur occurring plentifully. Thus a single Titmouse searching alone might hunt for a whole day without meeting with a sufficiency, while if a dozen are united by the same motive it is hardly possible for the place in which the food is lodged to escape their detection, and when discovered a few call-notes from the lucky finder are enough to assemble the whole company to share the feast. It is impossible to watch a band of any species of Titmouse, even for a few minutes, without arriving at this conclusion. One tree after another is visited by the active little rovers, and its branches examined: if nothing be forthcoming away goes the explorer to the next that presents itself, merely giving utterance to the usual twitter that serves to keep the body together. But if the object of search be found, another kind of chirp is emitted, and the next moment the several members of the band are flitting in succession to the tree and eagerly engaged with the spoil.[4]

Exceptional cases.

The mode in which the want of sustenance produces Migration may best be illustrated by confining ourselves to the unquestionably migrant Birds of our own northern hemisphere. As food grows scarce towards the end of summer in the most northern limits of the range of a species, the individuals affected thereby seek it elsewhere. Thus doing, they press upon the haunt of other individuals: these in like manner upon that of yet others, and so on,

Outward migration caused by scarcity of food.

[1] Two remarkable instances of this persistency may be noticed. The nest of a Falcon (*Falco peregrinus*) on Avasaxa—a hill in Finland somewhat celebrated as one of the most southern points whence the midnight sun may be seen—is mentioned by the French astronomer Maupertuis as having been observed by him in the year 1736. In 1799 it was rediscovered by Skjöldebrand and Acerbi. In 1853 Wolley found it tenanted, and from enquiries he made of the neighbours it was evident that such had yearly been the case so far as any one could remember, and so it was in 1855 as the writer can testify. In 1779 according to one account, in 1785 according to another, a pair of the Blue Titmouse (*Parus cæruleus*) built their nest in a large earthenware bottle placed in the branches of a tree in a garden at Oxbridge near Stockton-on-Tees. With two exceptions only, this bottle, or a second which has lately been placed close to it, has been tenanted by a pair of birds of this species from the year in which it was first occupied until 1873, when the writer saw it.—See Yarrell's *British Birds*, 4th ed. i. pp. 58, 486.

[2] Far more so than variation of the temperature, though in popular belief that probably holds the first place. But Birds generally, as compared with other Vertebrates, are but slightly affected by extremes of heat or cold, and indeed (so far as we can judge) by most climatic influences, provided only their supply of food is not affected thereby. —*Cf.* Max Schmidt, *Zoolog. Garten*, 1865. pp. 330–340.)

[3] The only animals which approach Birds in the extent and character of their migrations are Fishes, of which there is no need here to say anything.

[4] The case is altogether different with those species which in winter form themselves into large flocks, as most of the Finches (*Fringillidæ*) and Buntings (*Emberizidæ*). The discoverer of a favourite morsel perhaps by his actions betrays what he has obtained, and accordingly his fellows may repair to the place, but it is without invitation on his part, and the only particular bond of union not entirely selfish which keeps them together is the cry of alarm with which a stranger is greeted.

until the movement which began in the far north is communicated to the individuals occupying the extreme southern range of the species at that season; though, but for such an intrusion, these last might be content to stay some time longer in the enjoyment of their existing quarters.

This seems satisfactorily to explain the southward movement of all migrating Birds in the northern hemisphere; but when we consider the return movement which takes place some six months later, doubt may be entertained whether scarcity of food can be assigned as its sole or sufficient cause, and perhaps it would be safest not to come to any decision on this point. On one side it may be urged that the more equatorial regions which in winter are crowded with emigrants from the north, though well fitted for the resort of so great a population at that season are deficient in certain necessaries for the nursery. Nor does it seem too violent an assumption to suppose that even if such necessaries are not absolutely wanting, yet that the regions in question would not supply sufficient food for both parents and offspring—the latter being at the lowest computation, twice as numerous as the former—unless the numbers of both were diminished by the casualties of travel.[1] But on the other hand we must remember what has above been advanced in regard to the pertinacity with which Birds return to their accustomed breeding-places, and the force of this passionate fondness for the old home cannot but be taken into account, even if we do not allow that in it lies the whole stimulus to undertake the perilous voyage.

Mr Wallace on origin of migratory habits.

Mr Wallace in some remarks on the subject (*Nature*, x. p. 459) ingeniously suggests the manner in which the habit of Migration has come to be adopted:[2]—

"It appears to me probable that here, as in so many other cases, 'survival of the fittest' will be found to have had a powerful influence. Let us suppose that in any species of migratory bird, breeding can as a rule be only safely accomplished in a given area; and further, that during a great part of the rest of the year sufficient food cannot be obtained in that area. It will follow that those birds which do not leave the breeding area at the proper season will suffer, and ultimately become extinct; which will also be the fate of those which do not leave the feeding area at the proper time. Now, if we suppose that the two areas were (for some remote ancestor of the existing species) coincident, but by geological and climatic changes gradually diverged from each other, we can easily understand how the habit of incipient and partial migration at the proper seasons would at last become hereditary, and so fixed as to be what we term an instinct. It will probably be found, that every gradation still exists in various parts of the world, from a complete coincidence to a complete separation of the breeding and the subsistence areas; and when the natural history of a sufficient number of species is thoroughly worked out, we may find every link between species which never leave a restricted area in which they breed and live the whole year round, to those other cases in which the two areas are absolutely separated."

Earlier return of male migrants.

A few more particulars respecting Migration are all that can here be given, and it is doubtful whether much can be built upon them. It has now been ascertained by repeated observation that in the spring movement of most species of the northern hemisphere the cock-birds are always in the van of the advancing army, and that they appear some days, or perhaps weeks, before the hens. It is not difficult to imagine that, in the course of a journey prolonged throughout some 30° or 60° of latitude, the stronger individuals should outstrip the weaker by a very perceptible distance, and it can hardly be doubted that in most species the males are stouter, as they are bigger than the females. Some observers assert that the same thing takes place in the return-journey in autumn, but on this point others are not so sure, which is not surprising when we consider that the majority of observations have been made towards what is the northern limit of the range of the *Passeres*, to which the remark is especially applicable—in the British Islands, France, North Germany, and the Russian Empire—for it is plain that at the beginning of the journey any inequality in the speed of travelling will not have become so very manifest. There is also another matter to be noticed. It has been suspected that where there is any difference in the size of birds of the same species, particularly in the dimensions of their wings, the individuals that perform the most extensive journeys are naturally those with the longest and broadest *remiges*, and in support of this view it certainly appears that in some of the smaller migrants—such as the Wheatear (*Saxicola œnanthe*) and Willow-Wren (*Phylloscopus trochilus*)—the examples which reach the extreme north of Europe and there pass the summer possess greater mechanical powers of flight than those of the same species which stop short on the shores of the Mediterranean. It may perhaps be also inferred, though precise evidence is wanting, that these same individuals push further to the southward in winter than do those which are less favoured in this respect. It is pretty nearly certain that such is the case with some species, and it may well be so with individuals. Canon Tristram has remarked (*Ibis*, 1865, p. 77) that, in many genera of Birds, "those species which have the most extended northerly have also the most extended southerly range; and that those which resort to the highest latitudes for nidification also pass further than others to the southward in winter," fortifying his opinion by examples adduced from the genera *Turdus*, *Fringilla*, *Cypselus*, and *Turtur*. But supposing this to be true for many Birds, it may fairly be doubted whether it is so for all, and whether in some species certain individuals do not always occupy the most northern portion of the range and others always keep to the most southern, no matter what the season of the year may be, or over what countries the range may extend. On this point therefore it will be advisable to await further investigation.

Presumed effects of weather on migration.

For many years past a large number of persons in different countries have occupied and amused themselves by carefully registering the dates on which various migratory Birds first make their appearance, and certain publications abound with the records so compiled.[3] Some of the observers have been men of high scientific repute, others of less note but of not inferior capabilities for this especial object. Still it does not seem that they have been able to determine what connection, if any, exists between the arrival of birds and the state of the weather. This is not very wonderful, for the movements of the migrants, if governed at all by meteorological forces, must be influenced by their action in the places whence the travellers have come, and therefore to establish any direct relation of cause and effect corresponding observations ought equally to be made in such places, which has seldom been done.[4]

[1] If the relative proportion of land to water in the Southern Hemisphere were at all such as it is in the Northern, we should no doubt find the birds of southern continents beginning to press upon the tropical and equatorial regions of the globe at the season when they were thronged with the emigrants from the north, and in such a case it would be only reasonable that the latter should be acted upon by the force of the former, according to the explanation given of the southward movement of northern migrants. But, though we know almost nothing of the migration of birds of the other hemisphere, yet, when we regard the comparative deficiency of land in southern latitudes all round the world, it is obvious that the feathered population of such as now-adays exists can exert but little influence, and its effects may be practically disregarded.

[2] In principle Captain Hutton had already foreshadowed the same theory.—(*Trans. New Zeal. Inst.* 1872, p. 235.)

[3] These are far too numerous to mention here. Perhaps the most remarkable series of them is that carried on from 1736 to 1810 and again from 1836 to 1874 by four generations of the Marsham family at Stratton-Strawless and Rippon near Norwich, of which an account is given by Mr Southwell (*Trans. Norf. and Norw. Nat. Soc.* ii. p. 31).

[4] To a limited extent it must be admitted that the popular belief as to certain Birds being the harbingers of severe weather is justifiable. Cold comes from the north, and when it is accompanied, as is most gene-

As a rule it would seem as though Birds were not dependent on the weather to any great degree. Occasionally the return of the Swallow or the Nightingale may be somewhat delayed, but most Sea-fowls may be trusted, it is said, as the almanack itself. Were they satellites revolving around this earth, their arrival could hardly be more surely calculated by an astronomer. Foul weather or fair, heat or cold, the Puffins (*Fratercula arctica*) repair to some of their stations punctually on a given day as if their movements were regulated by clock-work. Whether they have come from far or from near we know not, but other Birds certainly come from a great distance, and yet make their appearance with scarcely less exactness. Nor is the regularity with which certain species disappear much inferior; every observer knows how abundant the Swift (*Cypselus apus*) is up to the time of its leaving its summer-home—in most parts of England, the first days of August—and how rarely it is seen after that time is past.

Statistics of migration.

It must be allowed, however, that, with few exceptions, the mass of statistics above spoken of has never been worked up and digested so as to allow proper inferences to be made from them, and therefore it would be premature to say that little would come of it, but the result of those few exceptions is not very encouraging. Some twenty years ago Dr von Middendorff carefully collated the records of the arrival of migratory Birds throughout the Russian Empire, but the insight into the question afforded by his published labours[1] is not very great. His chief object has been to trace what he has termed the *isepipteses* (ἴσος = *æqualis*, ἐπίπτησις = *advolatus*) or the lines of simultaneous arrival, and in the case of 7 species[2] these are laid down on the maps which accompany his treatise. The lines are found by taking the average date of arrival of each species at each place in the Russian dominions where observations have been regularly made, and connecting those places where the dates are the same for each species by lines on the map. The curves thus drawn indicate the inequality of progress made by the species in different longitudes, and assuming that the advance is directly across the isepiptesial lines, or rather the belts defined by each pair of them, the whole course of the migration is thus most accurately made known. In the case of his seven sample species the maps show their progressive advance at intervals of a few days, and the issue of the whole investigation, according to him (*op. cit.* p. 8) proves that in the middle of Siberia the general direction of the usual migrants is almost due north, in the east of Siberia from south-east to north-west, and in European Russia from south-west to north-east. Thus nearly all the migrants of the Russian Empire tend to converge upon the most northern part of the continent, the Taimyr Peninsula, but it is almost needless to say that few of them reach anything like so far, since the country in those high latitudes is utterly unfit to support the majority. With the exception of some details, which, though possessing a certain special interest, need not here be mentioned, this treatise fails to shew more; for the fact that there are places that notwithstanding their higher latitude are reached by Birds on their spring-migrations sooner than others in a lower latitude was already known.

The routes followed by migratory Birds, so far as our information at present extends, has been the subject of a very exhaustive memoir by Herr Palmén,[3] but it would be impossible within the limits of the present article to do more than mention his results concisely. He enters very fully into this part of the enquiry and lays down with much apparent probability the chief roads taken by the most migratory Birds of the Palæarctic Region in their return autumnal journey, further asserting that in the spaces between these lines of flight such birds do not usually occur. These main routes are, he states, *nine* in number. The first (A—to use his notation), leaving the Siberian shores of the Polar Sea, Nova Zembla, and the North of Russia, passes down the west coast of Norway to the North Sea and the British Islands. The second (B), proceeding from Spitsbergen and the adjoining islands, follows much the same course, but is prolonged past France, Spain, and Portugal to the west coast of Africa. The third (C) starts from Northern Russia, and, threading the White Sea, and the great Lakes of Onega and Ladoga, skirts the Gulf of Finland and the southern part of the Baltic to Holstein and so to Holland, where it divides—one branch uniting with the second main route (B), while the other, running up the valley of the Rhine and crossing to that of the Rhone, splits up on reaching the Mediterranean, where one path passes down the western coast of Italy and Sicily, a second takes the line by Corsica and Sardinia, and a third follows the south coast of France and eastern coast of Spain—all three paths ending in North Africa. The fourth (D), fifth (E), and sixth (F) main routes depart from the extreme north of Siberia. The fourth (D) ascending the river Ob, branches out near Tobolsk—one track, diverging to the Volga, descends that river and so passes to the Sea of Azov, the Black Sea, and thence, by the Bosphorus and Ægean, to Egypt; another track makes for the Caspian by way of the Ural River and so leads to the Persian Gulf, while two more are lost sight of on the steppes. The fifth (E) mounts the Jennesei to Lake Baikal and so passes into Mongolia. The sixth (F) ascends the Lena and striking the Upper Amoor reaches the Sea of Japan, where it coalesces with the seventh (G) and eighth (O) which run from the eastern portion of Siberia and Kamchatka. Besides these the ninth (X) starting from Greenland and Iceland passes by the Færoes to the British Islands and so joining the second (B) and third (C) runs down the French coast. These being the main routes it must be added that, in Herr Palmén's opinion and that of many others, nearly all river-courses form minor routes.[4]

The return of birds to their former haunts seemingly inexplicable.

But lay down the paths of migratory Birds, observe their comings and goings, or strive to account for the impulse which urges them forward as we will, there still remains for consideration the most marvellous thing of all—How do the birds find their way so unerringly from such immense distances? This seems to be by far the most inexplicable part of the matter. Year after year the migratory Wagtail will build her nest in the accustomed spot, and year after year the migratory Cuckow will deposit her eggs in that nest, and yet in each interval of time the former may have passed some months on the shores of the Mediterranean, and the latter, absent for a still longer period, may have wandered into the heart of Africa.[1] The writer cannot offer an approach to the solution of this mystery. There was a time when he had hopes that what is called the "homing" faculty in Pigeons might furnish a clue, but Mr Tegetmeier and all the best authorities on that subject declare that a knowledge of landmarks obtained by sight, and sight only, is the sense which directs these Birds, while sight alone can hardly be regarded as affording much aid to Birds—and there is reason to think that there are several such—which at one stretch transport themselves across the breadth of Europe, or even traverse more than a thousand miles of open ocean, to say nothing of those—and of them there are certainly many—which perform their migrations by night. That particular form of Bluethroat which yearly repairs to breed upon the mosses of the Subalpine and Northern parts of Scandinavia (*Cyanecula suecica*) is hardly ever seen in Europe south of the Baltic.[2] Throughout Germany it may be said to be quite unknown, being replaced by a conspicuously different form (*C. leucocyana*), and as it is a Bird in which the collectors of that country, a numerous and well-instructed body, have long taken great interest, we are in a position to declare that it is not known to stop in its transit from its winter haunts, which we know to be Egypt and the valley of the Upper Nile, to its breeding-quarters. Other instances, though none so crucial as this, could be cited from among European Birds were there room here for them. In New Zealand there are two Cuckows which are annual visitors: one, a species of *Chrysococcyx*, is supposed to come from Australia, the other, *Eudynamis taitensis* is widely spread throughout Polynesia, yet both these birds yearly make two voyages over the enormous waste of waters that surrounds the country to which they resort to breed. But space would utterly fail us were we to attempt to recount all the examples of these wonderful flights. Yet it seems impossible that the sense of sight should be the faculty whereby they are so guided to their destination, any more than in the case of those which travel in the dark.

Explanations offered:—Magnetism.

Dr von Middendorff (*op. cit.* p. 9), from the conclusions he has drawn, as before mentioned, as to the spring-movement of all birds in the Russian Empire being towards the Taimyr Peninsula, the seat of one of the magnetic poles, has suggested that the migrating Bird is always aware (he does not sufficiently explain by what means) of the situation of this point, and thus knows how to steer its course. Not only is this hypothesis unsupported by any considerations known to the writer, but it is not at all borne out by the observed facts of Migration in North America, where Birds as has been shewn by Professor Baird (*op. cit.* p. 347) do not migrate in the direction of the magnetic pole.

Instinct.

Other authors there are who rely on what they call "instinct" as an explanation of this wonderful faculty. This with them is simply a way of evading the difficulty before us, if it does not indeed remove the question altogether from the domain of scientific inquiry. Rejecting such a mode of treatment, Herr Palmén meets it in a much fairer spirit. He asserts (*op. cit.* p. 195) that migrants are led by the older and stronger individuals among them, and, observing that most of those which stray from their right course are yearlings that have never before taken the journey, he ascribes the due performance of the flight to "experience." But, granting the undisputed truth of his observation, his assertion seems to be only partially proved. That the birds which lead the flock are the strongest is on all accounts most likely, but what is there to show that these are also the oldest of the concourse? Besides this, there are many Birds which cannot be said to migrate in flocks. While Swallows, to take a sufficiently evident example, conspicuously congregate in vast flocks and so leave our shores in large companies, the majority of our summer-visitors slip away almost unobserved, each apparently without concert with others. It is also pretty nearly certain that the same species of Bird does not migrate in the same manner at all times. When Skylarks arrive on our north-eastern coast in autumn they come flitting over in a constant, straggling stream, not in compact flocks; yet a little later these same birds collect in enormous assemblages which prosecute their voyage in company. It is indeed possible that each bird of the stream intentionally follows that which goes before it, though in a long sea-passage it must be hard to keep the precursor in sight, and it may perhaps be granted that the leader of the whole is a bird of experience. But then we must consider not these cases only, but also those of Birds which do not migrate in company, and we must also have regard to what is implied in the word "experience." Here it can only signify the result of knowledge acquired on former occasions, and obtained by sight. Now it was stated by Temminck[3] many years ago, and so far as would appear the statement has not been invalidated, that among migrants the young and the old always journey apart and most generally by different routes. The former can have no "experience," and yet the greater number of them safely arrive at the haven where they would be. The sense of sight, essential to a knowledge of landmarks, as we have above attempted to demonstrate, is utterly insufficient to account for the success that attends Birds which travel by night, or in a single flight span oceans or continents. Yet without it the idea of "experience" cannot be substantiated. We may admit that inherited but unconscious experience, which is really all that can be meant by instinct, is a factor in the whole matter—certainly, as Mr Wallace seems to have proved, in originating the migratory impulse, but yet every aspect of the question is fraught with difficulty, and we must leave to time the discovery of this mystery of mysteries.

Exceptional migration.

There yet remain a few words to be said on what may be termed Exceptional Migration, that is when from some cause or other the ordinary practice is broken through. This differs from the chance occurrence of the waifs and strays with which this section of the article began in that the Birds subject to it keep in a great measure their customary habit of migrating, and yet are compelled to indulge it in an irregular, or perhaps an altogether novel, manner, though they are not entirely the sport of circumstances. The erratic movements of the various species of Crossbill (*Loxia*) and some allied forms afford perhaps the best-known examples. In England no one can say in what part of the country or at what season of the year he may not fall in with a company of the Common Crossbill (*L. curvirostra*), and the like may be said of many other lands. The food of these Birds consists mainly of the seeds of conifers, and as its supply in any one locality is intermittent or precarious, we may not unreasonably guess that

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rally the case, by heavy falls of snow, such Birds are of course driven southward to seek their living. But as often as not the Birds arrive with the kind of weather they are commonly held to prognosticate, while sometimes this does not follow their appearance.

[1] *Die Isepiptesen Russlands. Grundlagen zur Erforschung der Zugzeiten und Zugrichtungen der Vögel Russlands.* St Petersburg: 1855.

[2] *Hirundo rustica, Motacilla alba, Alauda arvensis, Oriolus galbula, Cuculus canorus, Ciconia alba,* and *Grus communis.*

[3] *Om Foglarnes flyttningsvägar* (Helsingfors: 1874). In this and the work of Dr von Middendorff, already cited, reference is made to almost every important publication on the subject of Migration, which renders a notice of its very extensive literature needless here, and a pretty full bibliographical list is given in Prof. Giebel's *Thesaurus Ornithologiæ* (i. pp. 146–155). Yet mention may be made of Prof. Schlegel's *Over het trekken des Vogel's* (Harlem: 1828), Mr Hodgson's "On the Migration of the *Natatores* and *Grallatores* as observed at Kathmandu" in *Asiatic Researches* (xviii. pp. 122–128), and M. Marcel de Serres's *Des causes des Migrations des Animaux et particulièrement des Oiseaux et des Poissons* (Harlem: 1842). This last though one of the largest publications on the subject is one of the least satisfactory. Prof. Baird's excellent treatise *On the Distribution and Migrations of North American Birds* has been before adverted to.

[4] In giving this abstract the present writer wishes to state that he does not thereby express his agreement with all that it contains. Herr Palmén's views deserve the fullest attention from the truly scientific spirit in which they are put forward, but some of the details on which they are founded seem to require correction.

[1] Absolute proof of the identity of the particular birds is of course wanting, but if that objection be raised the circumstance becomes still more puzzling, for then we have to account for some mode of communicating precise information by one bird to another.

[2] It has occurred indeed as a straggler in about a dozen instances in England, and it arrives twice a year in greater or less numbers in Heligoland as reported by the ever-watchful observer on that island, Mr Gätke, to whom ornithologists are so deeply indebted for his long-continued and intelligent scrutiny of the extraordinary number of wandering birds which alight there.

[3] *Manual d'Ornithologie,* iii. Introd. p. xliii. note.