THIS BONDAGE

A STUDY OF THE 'MIGRATION' OF BIRDS, INSECTS AND AIRCRAFT, WITH SOME REFLECTIONS ON 'EVOLUTION' AND RELATIVITY

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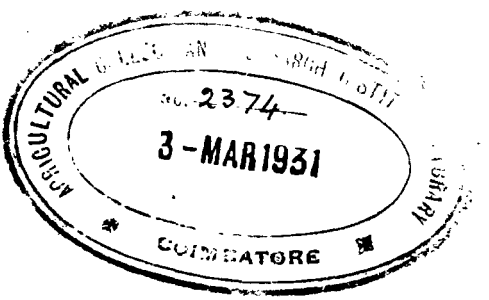

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THIS BONDAGE

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TO

PHYLLIS

"Blind unbelief is sure to err
And scan His work in vain"

PREFACE

WHILE on a fishing holiday at Lochboisdale, in the Outer Hebrides, in the summer of 1926, the conversation at dinner turned upon birds. The company at dinner consisted of anglers who, as is most usual, were also ardent naturalists. During the meal the author remarked that he supposed everybody realised that of all creatures, birds in free flight are the only living things that have never felt a breath of the wind that is blowing, no matter how fierce or tempestuous the wind may be. Strangely enough, the statement of this simple truth occasioned much surprise, interest and incredulity. On the following day, while fishing on Loch Kildonan, the author explained the matter to his gillie, Donald, a shrewd old seaman, and inquired if the fact was new to him. His reply, after a long pause, was striking. "Sur, its wunnerful, a' doot there's a mon in Scotland kens it." When asked if he understood the significance of the fact in its relation to mechanical flight, he showed at once that he did, which was only to be expected of an old merchant seaman.

Subsequent conversations in London and elsewhere, among all sorts and conditions of men and women, including scientists of distinction, have

made it abundantly plain that the misapprehension of Lochboisdale is, generally speaking, the misapprehension of the world at large. The simple fact of absence of wind-pressure on air-borne bodies, whether birds, insects, or machines, and the very general, but quite natural, misunderstanding of the lay public on this important matter, gave rise in the author's mind to a long series of reflections of which this modest volume is the embodiment.

Considerable portions of this book have previously appeared, in a somewhat different form, in the *Spectator*, *National Review*, and *Discovery*, to the Editors of which reviews the author would like to express his thanks for their permission to reprint certain portions.

In *The Times* of April 23rd, 1928, the Scientific Correspondent in his weekly article 'The Progress of Science' very kindly paid me the compliment of reviewing these articles at considerable length. While mildly rebuking my 'enthusiasm,' he admitted the accuracy of the premises upon which this book is based. He admits that "Prevailing winds must help or hinder to an extent not yet fully appreciated by the ornithologist, and may play a large part in determining certain routes and making others impossible." Again, in referring to the connection between air-streams and migration, he says: "This is a matter which should be worked out in detail." It is hoped that the author's

treatment of this question may to some small extent fulfil his wishes.

After referring at some length to certain laws of physics and dynamics which the author had emphasised, and with the accuracy of which the scientific correspondent of *The Times* agrees, he concludes his article in the following words:

"Without doubt a due consideration of such physical factors may explain some, or many, of the phenomena of migration, leaving a smaller burden to instinct, inherited habit, intelligence, and so forth. But there remain many features for which biological explanations would seem to be necessary, and even Commander Acworth posits a mysterious power of orientation or sense of direction."

The author hopes it may be his good fortune to convince this distinguished writer that 'biological' explanations of bird phenomena are in reality incorrect and therefore worse than unnecessary, and that a steady and unswerving application of the physical laws of flight will throw new light on matters of debate among ornithologists and of interest to laymen concerned with natural history and natural philosophy.

B. A.

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THIS BONDAGE

INTRODUCTION

THE flight of birds has been regarded from time immemorial as a symbol and a sign of that bodily and spiritual freedom for which earth-bound mortals yearn. "Oh that I had the wings of a dove, so that I might flee away and be at rest." All men, in all eras, have associated flight with freedom, and the present world-wide fever for flying reveals the widespread belief that at long last Science, like a God, has presented to mankind the powers and the freedom for which man has ever striven. Airmen are exhorted by sober and reverent monitors to emulate the powers and the 'minds' of birds, and it is doubtful if any greater compliment can now be paid to man than to liken him to a human bird as Colonel Lindbergh and Captain Hinkler have recently been likened.

To birds are now attributed the most wonderful powers, not only of locomotion, but of 'mind.' So mysterious and wonderful do the habits of birds appear that the feathered world is said by biologists to supply one of the most conclusive proofs of the truth of the theory of evolution. So

interwoven with evolution has flight become that the evolutionary jargon and the evolutionary cast of mind have permeated mechanical flight. Thus no protest arises when we read of "the natural evolution of the airship and aeroplane." Indeed, evolution is now assumed to be a proven fact and is regarded, and treated, as a perfectly natural process in the industrial, political, military, naval, surgical, and religious worlds. This absurdly vulnerable theory has not only been accepted by our modern Pantheists as a mechanical self-acting process of nature, but the original passive meaning of the verb 'to evolve' has undergone a subtle but startling change by taking on the contradictory application of an active verb, a statement which is borne out not only by reflection and observation, but by the categorical assertion of Sir Arthur Keith in his Presidential Address to the British Association in 1927. On the principle of judging a tree by its fruits it might well be thought that the growing chaos of man's affairs, based as the majority of human action now is upon relative as opposed to absolute standards, would have led the world to question the validity of the evolutionary, that is to say the relative philosophy upon which such actions are based. But such is not the case.

In this book the author has undertaken to prove that the 'Freedom of the Air' is in reality a terrible and iron bondage. He hopes to convince his readers, once and for all, that wings do not confer

freedom on birds, but on the contrary, a slavery shared by few, if any, earth-bound creatures. It will be shown that birds are of necessity devoid of any reflecting capacity whatever, and that their aerial environment is of such a nature as to preclude the exercise of calculation, memory, or objective thought, this absence of 'mind' being, in truth, a condition precedent to their survival in the world, and thus a blow to modern evolutionary doctrine.

It will be shown that human beings, by leaving the fixed earth and entering the moving air, have deserted a medium in which, alone, reason can steadily and continuously operate. The author has essayed to render 'Relativity' an easily understood phenomenon, and while questioning the validity of Professor Einstein's theory of Cosmic Relativity, it will be shown that flight has introduced to man, for the first time in his earthly history, that Terrestrial Relativity which is a terrible fact, not an amiable and academic abstraction, being indeed an environment which has brought death, ruin, and misery into thousands of English and foreign homes.

In the closing chapters the obstacle that must for ever intervene between man and his ambitious Empire-linking air projects is carefully examined.

The simple laws upon which this book is founded will help us to solve many of those bird-mysteries which have perplexed and fascinated the world since man first existed upon it. It is hoped that the chapters on the 'migration' of birds and other curious

phenomena of the bird world will prove of interest to those who, mercifully for themselves, are unconcerned with the philosophical aspect of these phenomena.

In attacking the theory of evolution, wherever this theory draws sustenance from the *scientific* treatment of the flight of birds, the author is well aware that he is attacking the temple of 'Modern Science,' a contradiction in terms which would surely have raised a smile in a perhaps more humorous because less materialistic age. Is not the time ripe, however, for taking stock of a theory which is the avowed parent of recent enterprises in all fields of human activity, and of those activities desired and foreshadowed by eugenists, including the very Christian Dean of St. Paul's? In the mechanical world, railway-engines, motor-cars, men-of-war, guns, torpedoes, aircraft, and so forth are being objectively 'evolved' from already perfect machines—as perfect, that is to say, as human *art* within known physical laws and limitations can make them—into uneconomic monstrosities and white elephants. Is not evolution, now admittedly the warp and woof of modern surgery, deserving of proof before thousands of human beings are deprived of organs which have been pronounced by Darwin to be useless "in our evolved state"? That very distinguished surgeon, the late Sir James Hodsdon, admitted to the author that but for the Darwinian hypothesis many ultra-fashionable operations would not have been instituted, the

surgical trade being reduced, in consequence, to a state of profound depression.

The Right Reverend Bishop of Birmingham and the merry Dean of St. Paul's, those learned shepherds of a confused flock, have been at pains to state, with more perspicacity and logic than the kindly Bishop of London can compass, that the Creative Doctrine of the Bible is incompatible with the glorious truths revealed by "competent biologists," as indeed it is. The competence of the Bishop's and the Dean's biological bed-fellows is examined in this book, and the tremendous pronouncements of anatomists on the evolution of bird-structure, to cope with an environment which they erroneously believe to exist in the air, are also exposed to the judgment of physicists and laymen.

With few exceptions every member of that vast and growing army of state-paid scientific research workers, in what may be called the life-sciences, has imbibed from intellectual childhood the mother's-milk of evolution. Indeed, research has little meaning divorced from evolution as the major premise. Upon the theory now depends for its very livelihood a great concourse of professors, research workers, and school-teachers. Children throughout this country and America are being taught to regard the Biblical revelation of the Creator as a foolish, if not a dangerous, myth.

Is there a shred of proven truth in this mainspring of very modern action, conduct, and belief?

A study of *Evolution Criticised* by T. B. Bishop will most assuredly fill anyone who has read it, or may read it, with very grave apprehension, this devastating criticism drawing its strength from the fact that the disproof of the validity of the theory is entrusted to scientists themselves, who riddle one another's theories and so-called 'facts' with a completeness that could not be bettered by an evolutionary sceptic of surpassing brilliance. The method employed of setting a 'thief' to catch a 'thief' was employed with conspicuous success by 'Neon' in the *Great Delusion*, where, on aerial questions, the same chaos of incompatible and therefore mutually destructive ideas is tragically exposed.

We live in an age which claims its extreme toleration as perhaps its greatest virtue: an age in which nothing is absolute, all is relative; nothing black or white, everything grey; nothing correct or accurate but everything a mere matter of opinion, as, for example, the value of a giant airship. Trial and error alone, we are told, can settle this question and others: reason—deduction from accurate premises—having seemingly abdicated in favour of methods more suited to Central Africa than to England in 1929.

Those who still belong, as does the author, to the diminishing band of those who believe in the absolute and unchanging nature of truth, even though we cannot always apprehend it with our finite minds, must expect some rough treatment

from evolutionists when we take arms against one another. The gulf that separates these creeds is unbridgable: compromise is impossible, the Bishop of London notwithstanding. Though in the absence of quantitative proof little headway can be made between the two embattled philosophies, there comes a time when philosophy takes the ponderable form of action based on a definite philosophy so that action in the physical sphere, such as mechanical flight, becomes liable to quantitative analysis and exposure of its narrow limitations.

The author is second to no one in his reverence for true science—physical truth—and for that small band of great discoverers of truths as old as eternity itself though new to man's understanding and knowledge. In this country to-day there are a few, though from the nature of things very few, who have in very deed discovered something capable of proof and demonstration, but, as these distinguished few will readily admit, there are to be seen peeping out from under the skirts of the Giant's Robe of Science a great army of *speculators* entitled to no nobler garment than small-clothes.

To the honoured scientific few, to physicists and ornithologists in particular, and to laymen at large, this book is very respectfully offered.

AUTHOR'S NOTE.—Where italics are used in quotations, such italics are the author's and are not to be found in the original text.

PART I

THE LAWS OF FLIGHT

CHAPTER I

THE REIGN OF LAW

THOUGH interest and wonderment have from the earliest times surrounded the flight of birds, interest has been quickened in recent times by the development of mechanical flight. Books dealing with the flight, the habits, and the 'mind' of birds are constantly appearing before the public, and articles on the natural flight, the migration, and the habits of birds have become regular features of newspapers, magazines, and scientific journals. Public interest seems, therefore, to be thoroughly aroused on all matters connected with birds and flight, and the supply of self-constituted teachers keeps pace with the growing demand for information. The author, not as a scientist or a theologian, but as a sailor, has himself been a close student of flight for many years, and in pursuit of this study considerable attention has been devoted quite naturally to ornithological books, articles, and scientific treatises on the flight factor in birds, particularly as this affects the phenomenon of migration and the so-called mind of birds.

It must, however, be acknowledged at the outset that the author's knowledge of the curiosities of

bird life have been in great measure derived from the patient and brilliant observations of famous ornithologists rather than from observations of his own, and it is therefore upon the evidence collected by others, acknowledged authorities, that the author largely relies to demonstrate the laws upon which leans the argument of this book. This grateful acknowledgment to devoted ornithologists is made at the outset because it has an intimate bearing upon the qualifications of a layman to discuss with his ornithological and scientific betters such questions as flight and migration.

In that very remarkable book *The Reign of Law*, the late Duke of Argyll discusses the unchanging nature of law in the physical universe, and in referring to 'the First Law of Motion' in particular, he writes on page 111 as follows:

"Like many other laws of the same class, it was discovered not by looking outwards, but by looking inwards; not by observing, but by thinking. The human mind, . . . by careful reasoning, . . . is able, from time to time, to reach now one, now another, of those purely Intellectual Conceptions which are the basis of all that is intelligible to us in the Order of the Material World."

Here, then, is some warrant for a seaman to pit his thinking against the observation of scientific specialists and to contrast the conclusions reached by the two totally dissimilar processes.

Before passing to a consideration of the laws

which govern equally the flight of birds, insects, and machines, the author would like to pay his insignificant tribute to the philosophical aspect of the late Duke of Argyll's famous book. It seems to have all the essential elements of a classic, combining as it does extreme simplicity of diction, brilliant analysis and deduction, with a nobility, a humility, and an awe which contrast strangely and refreshingly with the unintelligible jargon, mumbo-jumbo, bald assertion, and fantastic speculation which all too often masquerade to-day as 'science.' With extraordinary clearness the Duke of Argyll analyses the nature of Law, showing that all physical laws, and indeed spiritual laws, are the bricks and mortar, so to speak, of Design and Purpose, and as little capable of utilising themselves, or of arranging themselves towards one another in such a manner as to produce the infinite number of natural phenomena that we see around us, or the infinite variety of character to be found in human beings, as are the letters of the alphabet capable of arranging themselves into a great epic poem. Natural laws that are indeed laws, and not mere fancies or theories, must be utterly unchangeable: before any other conception of law, other than imperfect man-made law, reason staggers and recoils.

If, then, laws are the invisible bricks of which nature is the physical and visible manifestation, it seems to follow that a failure to detect or to inter-

pret a law which is unceasingly and overwhelmingly operative in a particular natural phenomenon must lead to a complete misapprehension of the whole subject to which this law, in its various aspects, is applicable.

If the law is a basic and all-pervading matter upon an understanding of which sound conclusion must rest, a mis-statement of this law, or the overlooking of it, becomes a major false premise. This being so, it is not necessary to emphasise to his readers the deadly nature of a false premise upon which a vast edifice of philosophy and conjecture is raised. This point is well brought out by the Duke of Argyll on page 55:

"We must cast a sharp eye indeed on every form of words which professes to represent a scientific truth. If it be really true in one department of thought, the chances are that it will have its bearing on every other. And if it be not true, but erroneous, its effect will be of a corresponding character; for there is a brotherhood of Error as close as the brotherhood of Truth. Therefore, to accept as a truth that which is not a truth, or to fail in distinguishing the sense in which a proposition may be true from other senses in which it is not true, is an evil having consequences which are indeed incalculable. *There are subjects on which one mistake of this kind will poison all the wells of truth, and affect with fatal error the whole circle of our thoughts.*"

Here we must leave his Grace as a just, and therefore wise, philosopher and pass to his reliability as a

'scientist' and a specialised 'observer,' and in doing so it is of interest to recall his belief that it is by thinking, not by observing (the method almost exclusively employed by professional scientists and research workers), that truth is usually perceived. It is no discredit to the Duke of Argyll, as a thinker, that in his own person as a 'scientist' and an 'observer' he throws a startling light on the truth of his wise philosophical dictum. In Chapter III of *The Reign of Law* he passes from the nature of laws to their application in practice, and he proceeds by inductive reasoning from observation to use his specialised study of birds and his 'observation' of flight to enunciate certain laws and to show these alleged laws in operation for the benefit of his readers.

One of his laws, however, he has determined by hearsay or by that 'observation' against which he shrewdly warns us. In discussing the various forces which a bird employs and with which it has to contend, he states again and again that the force of the wind on the outspread wings of the flying bird is one of the governing factors in the dynamics of flight, and a few quotations will suffice to exemplify this vital point.

Speaking of the soaring of birds when a wind is blowing, he states on page 149:

"Gravity is ceaselessly acting on the bird to pull it downwards; and downwards it must go

unless there is a countervailing force to keep it up This force is the force of the breeze striking agains the vanes of the wing."

In case it might be argued that the 'breeze' ma refer to the draught set up by the bird's wings an not to the bodily movement of the air—the wind— it may be well to quote again from page 161, when in discussing flight generally, he says:

"*When a strong current of air strikes against th wings of a bird, the same sustaining effect is produce as when the wing strikes against the air.* Conse quently birds with very long wings have this grea advantage, that with pre-acquired momentun they can often for a long time fly without flapping their wings at all. Under these circumstances, bird is sustained very much as a boy's kite is sus tained in the air. The string which the boy holds and by which he pulls the kite downwards with certain force, performs for the kite the same office which its own weight and balance and momentun perform for the bird. The great long-winge oceanic birds often appear to float rather than t fly. The stronger is the gale, their flight, thoug less rapid, is all the more easy—so easy indeed as t appear buoyant; *because the blasts which strik against their wings are enough to sustain the bird wit comparatively little exertion of its own, except tha of holding the wing-vanes stretched and exposed a proper angles to the wind.*"

Here, then, is a categorical statement which pre cludes any doubt about the Duke of Argyll's view

of the relation of wind to a bird flying in it. Further examples could, if necessary, be given from this chapter on the flight of birds, which would exemplify his belief, a belief he raises to the dignity of a law, that a bird experiences pressure from the winds in which it is flying. The belief is erroneous; but before passing to an examination of this vitally important matter it should be said at once that the misapprehension of the Duke of Argyll in 1867 seems to have been shared by the world of 'Science' of his day. In view of the searching criticism to which *The Reign of Law* subjects the theories of Darwin, it seems incredible that this chance of retaliating on his critic, and of exposing his fallacy, would have escaped Darwin had he been aware of his opportunity. At the same time it must be said at once, as it will later be shown, that had the fallacy of the Duke been known to the great naturalist and his enthusiastic disciples, those evolutionary theories which rest upon birds would have appeared, even to themselves, shaky if not altogether untenable.

Lest it may be thought that the belief of the Duke of Argyll is scientifically antiquated, it may be well to quote, out of the large supply available, some statements of prominent scientists and ornithologists, written within the last few months, which are not only similar in import to paragraphs in the book under discussion, but which, in some cases, reproduce the Duke of Argyll's explanations almost

verbatim, showing that *The Reign of Law* is a book well known and still regarded, with respect to flight, as authoritative by scientists to-day.

That the theory of Evolution is intimately linked up with the air is emphasised by Professor Patten, M.A., M.D., D.Sc., Professor of Anatomy in Sheffield University, when he writes in the September 1927 number of *Discovery*:

"In no department of biological study is the evolutionary factor brought out more strongly than in bird-movement."

Professor C. J. Patten, writing in *Discovery* of September 1927,[1] commences an article entitled 'Researches on the Flight Factor in Birds' in the following words:

"Watch a herring-gull, on outspread motionless wings, *sail into the teeth of the tempest* and then float onward in calm but progressive flight."

Farther on we read:

"Without proportionate weight the necessary momentum gathered as the bird proceeds under way would not be sustained. An aerial creature lighter than air would pass into space uncontrolled like a helpless, hapless balloon."

This statement exemplifies the belief that the pressure of wind on airships is greater than its pressure

[1] British Association Number.

on aeroplanes and birds, a fallacy of far-reaching importance, as subsequent chapters will make clear.

Again, Professor Patten quotes Headley as the author of the statement:

"If by any means a bird attained the lightness of a balloon, he could not fly";

and to Headley is again attributed the assertion:

"Flapping flight is rendered all the more efficient by induced currents, which are to the wings what a stiff breeze is to a boy's kite."

Though this statement is so characteristically obscure as to be well-nigh incomprehensible, it contains the kite simile—and fallacy—employed by the Duke of Argyll in 1868. For a complete and exhaustive exposition of mistaken ideas about the mechanics of flight, the author would refer ornithologists at large, and physicists in particular, to Professor Patten's recently published work *The Story of the Birds*, a book which embodies his series of wireless talks to a listening world.

Writing in *The Times* of March 27th, 1927, an anonymous but presumably authoritative writer, under the title 'Birds in Rough Weather—Discomfort and Danger,' makes the following extraordinary and uncontradicted statement:

"Though birds have the mastery of the air, they dislike strong winds; and this is comprehensible

from the structure of their plumage. Their feathers slope backwards, so that they must face the wind to escape not merely the discomfort of rumpled plumage, but a positive danger. Birds' flight-feathers are elaborately hooked together, so as to allow them to strike the air as one flexible vane. A violent gust from behind must sometimes be strong enough to tear web from web, and make the bird an almost flightless cripple. Add to this, the sharp wrench at the root of the quill which such a buffet would give, and we need not wonder why we see most birds shirking conflict with a gale, or at their skill in hiding in rough weather."

Here speaks the anatomical specialist, and here is revealed the ever-present danger of extremely specialised observation and reflection, no matter how accurate or 'scientific.' From mere anatomical structure, a wing-structure which we are told has been 'evolved' to grapple with physical conditions in the air which in fact do not exist, the author of this article makes broad and sweeping deductions about the habits of birds, which, to put it very soberly, are misleading. This ornithologist repeats a constant error of Professor Patten when he says in another place in the same article: "They are careful to face the wind *either on the wing* or at rest."

It cannot be too strongly emphasised that the few statements quoted are not isolated statements.

The idea which they contain, the idea that birds in flight feel the wind, is implied if not explicitly stated in all 'scientific' books, articles, and letters on flight and migration, *with the exception of those from the pens of Mr. Stubbs and Mr. Coward*, and the author has nowhere seen, with these notable exceptions, any contradiction of the beliefs which they embody or of the deductions and conclusions to which they inevitably give rise.

'The Brotherhood of Error' in fact persists.

CHAPTER II

THE FIRST LAW OF CURRENTS

In the preceding chapter emphasis was laid on the all-pervading nature of law in the physical universe, and it was affirmed that ignorance of a law, or the disregard of it, must lead to a vast superstructure of false doctrine on matters with which such a law is inextricably interwoven. No further time must therefore be lost in enunciating and explaining those laws which now, and for all time, must govern and continue to govern the flight of birds and machines.

No bird or machine can experience any pressure from the movement of the medium in which it is supported and operating This simple fact, which may well be called 'the First Law of Currents,' may be amplified and expressed thus:

"A bird or any other air-borne body in flight feels only a dead calm so far as wind-pressure is concerned. It feels neither the force nor the direction of the wind except possibly a momentary sensation due to change of inertia if, in the immediate region of the relatively minute area it occupies, a sharp variation in speed or direction of the wind occurs. In the open and unobstructed spaces of the atmosphere it is doubtful if such variations obtain."

It may appear to be a hard saying, but it is not on that account any less true, that a bird in flight is the only creature (with the exception of a submerged fish) which has never *felt* a breath of wind.

This simple but fundamental fact can perhaps be simply conceived by thinking of a fly flying in the enclosed calm of the saloon of an ocean-liner, travelling over the sea at a speed of 20 knots, the air enclosed in the liner's saloon being to the fly what the wind is to birds and aircraft. The fly experiences a draught from right ahead equal to its flight-speed through the saloon, regardless of the fly's direction of flight and of the speed and course of the liner itself. Again, though the fly rises and falls with the roll or pitch of the ship it feels no pressure from the bodily movement of the enclosed air in which it is flying. As with the fly, so with ourselves in a vehicle which is itself moving and enclosed. In short, the dynamics of movement in a single, all-embracing medium, are totally unaffected, whether the medium is stationary or in motion. This analogy of the ocean-liner's saloon, which is referred to again in subsequent chapters, is introduced at this stage because the author has been assured by his friends that it is a real help at the outset in grasping the essential reason why birds and machines do not feel any pressure from the winds in which they fly.

Now this simple little fact of absence of wind-pressure has a bearing upon bird life in general,

and upon bird 'mind' and migration in particular, out of all apparent proportion to the simplicity of the fact, and some explanation of the matter and of its significance may not be out of place. A bird flying in a strong adverse wind, even a wind of gale force, feels nothing of the pressure of this wind, neither does it feel the pressure of a gale blowing in the same direction as the bird's direction of flight, nor yet of a wind at an angle to its direction of progression. To a bird in flight there is no such thing as 'wind,' the bird being, in fact, in a dead calm so far as pressure is concerned, even in a gale of hurricane force. Air-borne bodies, whether giant airships, aeroplanes, albatrosses, tiny birds, insects, or a puff of smoke, become an integral part of the medium in which they are supported and operating, in precisely the same way as a submarine in a current, a fish in a river, or an insect flying in an ocean-liner is at one with the movement of the water in which it is submersed, or with the enclosed air of the steamship in which the insect flies. This being so, the idea that the wind has a relation to the outspread wings of a bird in any way analogous to the action of wind on the sails of a ship or a kite, or of steam on a turbine, is entirely false.[1] The wings of birds are *oars*, not sails, with all the vital effects that the distinction involves. The expressions 'a following wind,' 'a head wind,' or 'a

[1] This matter has been shortly discussed in *The Great Delusion* by 'Neon.'

side wind,' so often used in the newspapers and elsewhere in connection with birds and machines, have no true meaning though they convey a false one. These so-called winds are in reality *currents*, and their movements *relative to all air-borne bodies* are always non-existent. A bird (like all air-borne bodies of whatever size or weight) feels only a draught exactly equal to its own speed of flight *through* this moving medium, a draught always, and for all time, from right ahead, between its eyes and on its beak.

Though the bird *feels* no pressure of wind, the effect of these rapid currents is overwhelming, as a simple example will amply demonstrate. Bearing in mind that air-borne bodies assume the full speed and direction of the air in which they are borne, let us consider a swallow with a flight capacity through the air of 50 miles per hour, and let us assume three conditions of the atmosphere in which it is flying:

(*a*) A calm, that is to say, still air.

(*b*) A favourable current of 40 m.p.h.

(*c*) An adverse current of 40 m.p.h.

For the sake of simplicity assume the bird to fly for 24 hours on a course which renders the current, if flowing, to be directly favourable or adverse. With these simple assumptions, assumptions which can be varied infinitely to meet all cases of flight or migration, we arrive at some remarkable discrepancies as to the ground covered in each case, *though*

the distance through the moving air and the energy expended by a bird, or fuel by a machine, is exactly the same in all cases.

In case (*a*), the bird covers 50 × 24 miles = 1,200 miles over land or sea.

In case (*b*), the bird covers (50 + 40) × 24 miles = 2,160 miles over land or sea.

In case (*c*), the bird covers (50 — 40) × 24 miles = 240 miles over land or sea.

Thus in one day the direction of what we on land or sea *call* the wind, but what to air-borne bodies is in truth a pressureless current—*a moving calm*—affects the bird's horizontal translation by no less than 1,920 miles.

In face of such figures it is strange to find such a notable modern scientist as Professor Patten stating and teaching that birds *elect* to fly head to wind. Writing in *Discovery* in the article previously quoted, Professor Patten states:

"During migration birds always *elect* to fly as close as possible, *ceteris paribus*, head to wind, at a moderate velocity and altitude."

The author ventures to suggest that the Professor, in this short paragraph, is mistaken in three particulars. Firstly, birds can only reach their destination if the wind is favourable, or at least not sufficiently unfavourable to counterbalance the difference between the bird's maximum flight-capacity through

the air and the terrestrial distance of the voyage to be accomplished. Secondly, birds cannot *elect* to fly head to wind for the very simple reason that they do not feel it, and cannot—except after alighting on water or a tree or standing on firm ground—feel from what direction it is blowing. Thirdly, the paragraph as a whole, and especially that *ceteris paribus*, presupposes that birds plan and calculate their movements on passage, and are therefore in the full sense of the word reasonable beings. In truth, though wind is the governing and overruling factor in bird-migration, 'election' does not enter into the question, for reasons that will subsequently, it is hoped, be clear.

For the present the author will content himself with asking any readers who may be interested in the matter to vary the three assumptions made in this specific case of the swallow in any way they like. He believes that they will find the results of their chosen examples, examples selected to fit the flying powers and habits of any particular species of migratory or non-migratory bird, surprising and illuminating, especially when they bear in mind that the bird is always flying in what feels to the bird a dead calm. When we consider that anatomists deduce from mere anatomical structure, as exemplified in the last chapter, that birds risk damage to their wings if they fly with the wind favourable, it is perfectly natural that such scientific observers should attribute to birds a *preference* for

facing the wind on the wing, though it must be clear to laymen that *election* will constantly be at war with *preference*, and indeed must triumph over it, if birds are to reach a particular spot. Under such circumstances birds on the wing must be anxious creatures indeed, being 'landed,' if the solecism can be permitted, between the devil of discomfort and danger and the deep sea of necessity.

Mercifully for the birds, owing to natural laws intimately known to their Creator though not seemingly to leading biologists, birds do not feel wind-pressure from any direction and cannot therefore feel from what direction it is blowing. They can thus have no preference or election in the matter, and in reality they seldom do face the wind on the wing *except when arriving at their destination*, which leads me naturally and simply to the Second Law of Currents which may well form the subject-matter of the next chapter.

CHAPTER III

THE SECOND LAW OF CURRENTS

BEFORE enunciating and explaining the Second Law of Currents it may be well, for the sake of clearness, though at the risk of being tiresome, to restate the substance of the First Law of Currents in a slightly different manner and in the following words:

Air-borne bodies experience no pressure from the air-currents—the wind—in which they are flying because they assume the full speed and direction of the wind, upon the movements of which their own flying speed and course are merely superimposed. Any change in the speed or direction of the current cannot therefore be detected if landmarks are not visible.

If the foregoing fact is perfectly clear, it facilitates the understanding of the Second Law of Currents, which may be stated thus:

Air-borne bodies heading continuously for a *fixed* spot on the sea or earth, nearby or distant, and flying through an air-current, *must proceed on a curve*, and can arrive at their destination in one way and in one way only, that way being exactly and unconsciously head to wind.

Leaving out of account the supposed preferences of birds for flying head to wind, preferences which anatomists have deduced from the anatomical structure of the bird, it seems likely that the supposed preference of birds for facing the wind on the wing has been deduced by others from the fact that when birds are approaching their journey's end, the time when they are most subject to observation, they always are, in fact, approaching from leeward.

A simple analogy of a bird, or any other air-borne body, heading steadily and continuously for a fixed spot through an air-current is furnished by an ignorant or inexperienced person in a boat crossing a river.

Experienced boatmen in the case of a river, or seamen in the case of the sea, bound for a fixed destination through a current or a tide, steer a course which, though not apparently the direct course, becomes the direct course when the course and speed of the boat or ship are superimposed upon the direction and speed of the tide or current. Careful judgment, considerable knowledge, and close reasoning are needed in both cases. When the destination, as in the river, is visible, the practical method employed is so to adjust the direction of progression of the boat through the moving water that the bearing of the destination, the equivalent of the direct course over the ground to the destination, remains steady and constant. When the

destination is not visible, and the eye cannot therefore be used for keeping the bearing constant, the seaman lays off the course he is going to steer by mathematics, this course being, as in the case of the boat, not the direct course for his destination, though it will produce the direct course when superimposed upon the direction and speed of the known tide or current in which the indirect course is steered.

On the other hand, *an inexperienced and therefore ignorant person* will head continuously and steadily for the spot he wishes to reach, if the spot is visible, with a result that he will row an unnecessarily long distance, and if he can reach the desired point at all before he is exhausted, he will reach it *exactly* bows on to the current. The possibility of reaching the desired point depends upon the endurance of the rower and is, of course, strictly governed by the relative speeds and direction of the current and the rowing speed and course steered by the rower. If this ignorant person was in a ship, however, and his destination was not visible, he would not arrive at all and would be lost, if he did not meet with physical disaster on an unknown shore.

These simple matters, well known to all seamen, can very easily be demonstrated by two simple diagrams.

In Fig. 1 suppose a boatman wishes to row from A. to B, between which points a current CD is flowing at right angles to the line joining A and B.

Assume again that EF represents a speed of 4 m.p.h. at which the boatman can propel his boat through the water. Assume the speed of the current CD to be 2 m.p.h., then GH is half of EF. The

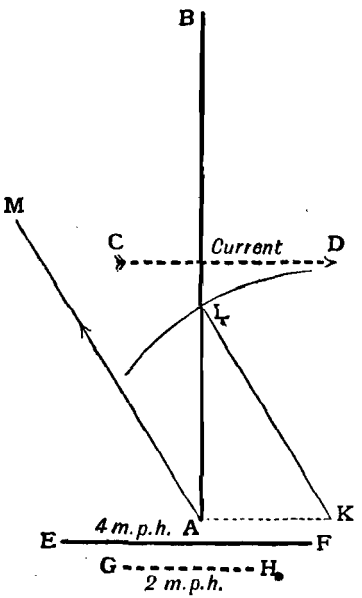

FIG. 1.

course an experienced seaman would steer through the current is quite simply arrived at thus:

He lays off a distance GH from A parallel to the direction of the stream, shown as AK in the diagram. With K as a centre and EF (the speed of the boat) as a radius, he describes a circle cutting the line AB at L and he joins KL. From A he draws a

straight line AM parallel to KL. If the boatman now steers a course parallel to AM at his steady speed of 4 m.p.h., he will actually travel along the shortest route AB, reaching the point B, not bows on to the current, but at an angle exactly equal to the angle between the direction of the current and the steady course he has steered through the current. It makes no difference whether A and B are in sight of one another, or whether, as in the case of a ship at sea, B is not visible from A. The correct course to steer is the same. In the case of the boat this course can be arrived at by sight, that is to say by keeping the bearing of the destination steady, whereas in the ship at sea the bearing is kept steady by steering by compass the course AM mathematically calculated. Though the problem is simple, it will be seen that it requires the closest reasoning faculties and knowledge to arrive at the correct procedure for making voyages safely, with the maximum expedition, with the lowest possible exertion to the rower, or the least expenditure of fuel to the ship.

Let us now assume that the boatman is an ignorant and inexperienced person, and keeps the bow of his boat heading continually for B. Since the boat is unceasingly headed for B, the exact course over the ground which the boat makes good requires very intricate mathematical calculations, but for practical purposes the course can be very accurately demonstrated by Fig. 2. In this

figure, while the boat is heading for B along AN, KP, LQ, MR, NS, OB, it is carried by the current to positions K, L, M, N, O, at which last position, O, the boatman is rowing at 4 m.p.h. nearly bows on to an adverse current of 2 m.p.h. and making

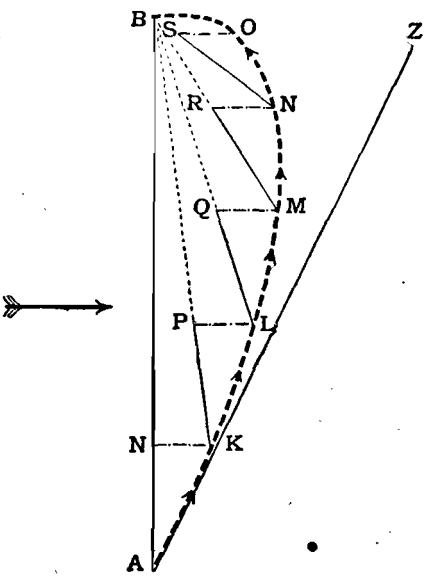

FIG. 2.

good, therefore, 2 m.p.h. and a fraction only. On arrival at B, but not before, he will be heading *exactly* bows on to the current at 2 m.p.h. It will be noticed that the farther he gets from his point of departure A the less becomes the distance over the earth he makes good in a given time. This figure also demonstrates the fact that a boat heading

continually for a given spot through a current proceeds to its destination *on a curve*, and that it must arrive at B in one way only, if it can arrive at all, *and that way is exactly and unfailingly head on to the current.*

An admirable example in nature of the curve assumed by an unreasoning creature steering for a fixed spot through a current is provided by the water-rat. Here the speeds are reduced to speeds which the eye can follow, and an observer, himself unobserved by the water-rat, can watch the ever-varying angle which the course of the rat through the water makes with the direction of the stream itself. Furthermore, the current of water, unfelt and unperceived by the water-rat, can be seen by the observer. Those who, perhaps while fishing, have seen these little creatures cross the stream will immediately recall the curve, and recollect how the rat, as it nears the other side, is heading progressively more upstream, and how it eventually reaches the other side, if there is no impediment, exactly head on to the current. It may well happen that a little spit of sand, a tree-root, or other obstruction may jut out into the stream, so that the rat's *homing curve* is interrupted. In this case it lands, and then proceeds overland to its destination, this last piece of the journey being *straight* because the ground is stationary. But who has ever seen the water-rat *allow* for the current as a seaman allows for the current through which he is

navigating his vessel? If it is true that the animal world learns wisdom by experience and transmits this accumulated wisdom as instinct to succeeding generations, it is curious that, as the ages roll by, no water-rat has yet perceived the saving of exertion that is possible if it made *allowance* for the current which separates it from its objective across the stream. Such a seemingly trifling, though in reality of course infinite, step forward in the mental 'evolution' of rat 'mind' continues to be conspicuous by its absence.

Turning again to the prosaic diagram under discussion, if B is not in sight from A and between A and B no fixed marks are visible, the navigator of a ship leaving A and steering steadily on a compass course AB would be carried with his ship on a course AZ and would be lost. Now a bird flying for a fixed spot through an air-current is in exactly the same case, physically, as a boat or a ship making for a fixed spot through a water-current, or a rat steering for a destination across a stream. The fact that air-currents are mill-races compared to water-currents is a difference of degree, not of kind. Furthermore, we must remember that air-borne bodies, like water-borne bodies, can feel or see nothing of the current with which they are moving, and if fixed marks are not visible they cannot tell the speed of the current, the direction of the current, or any changes in the speed or direction of the current. Mercifully the sea,

unlike the atmosphere, is almost stationary, and where currents or tides prevail they are relatively slight, they are known and charted, and can therefore, as demonstrated, be exactly allowed for.

It has been shown that there are two ways of reaching a given spot through a current if the spot is visible. One method requires reason and calculation, resulting therefore in a minimum of effort. The only alternative method entails no reason whatever, requiring only an eye kept steadily on the destination. This unreasoning method will ensure a safe arrival, with the appropriate increase of effort, if the current is within certain definite and calculable limits both in speed and incidence. If the destination is not visible, reason can still, by calculation and thought, assure arrival if the speed and direction of the current are known and constant and are not unduly adverse. If, however, the speed and direction of the current are not known, and no fixed marks are visible, reason ceases to be operative, air-borne or water-borne bodies, if they are to arrive at their journey's end, requiring under these circumstances a substitute for vision—*an unfailing sense of direction.*

Have birds, unlike airmen, this unerring 'sense of direction,' a sense of orientation which is the equivalent of sight?

CHAPTER IV

AN ASSUMPTION

In the preceding chapters the author has enunciated and explained to the best of his ability what he has termed the First and Second Laws of Currents, and he has endeavoured to show the effects of these laws on bodies operating in single moving media. It has also been shown that there are two ways in which an air-borne or water-borne body can reach a fixed spot when the air or water within which the body is borne is itself on the move. There is the way of calculation, which is the way of reason; applicable not only when the destination is visible, but equally so when the destination is not visible and no intermediate fixed marks are in sight, *provided the speed and direction of the current are known.* There is also the way of unreasoning mechanism, a method employed with success, if the current is not too strong, by a thoughtless person in a boat who closely resembles the water-rat, *provided the destination is visible.* If the destination is not visible, however, a man without the data for reasoning cannot reach his destination except by luck, for outside the realm of abstract reasoning he has no sense by which he can keep his

vessel heading continually for the spot he wishes to reach. Have birds a 'sense of direction' which continually orientates them to their destination, wherever it may be?

If we can answer this question affirmatively and without hesitation, the mysteries and phenomena of bird-movement in space, mysteries which have fascinated the world from the earliest times, seem to be capable of being brought measurably nearer to simple and final solution. Up to the present no assumptions have been made. Laws only have been stated. The one and only assumption that this book will contain is this:

Birds, like fish and flying insects (single-medium creatures), have the inherent power to *sense* a given spot in space, this sense of exact direction being the sole and automatic, but at the same time amply sufficient guide in their navigation.

This one assumption may appear at first sight to be unwarrantable. That it never has been, and never can be, definitely proved by anatomical, physiological, or other physical researches is true. All the evidence of experiment and observation, however, reinforces common sense in asserting it to be a fact, the assumption having had hitherto, it should be added, the full weight of scientific and ornithological opinion to buttress it. In the July 1927 number of the *Quarterly Review* Professor J. A. Thomson states:

"The experiments made with brooding terns

removed in closed baskets from the Tortugas and taken on board steamer for hundreds of miles into unknown waters, whence a variable percentage returned in safety,[1] seem to prove conclusively that there is a 'sense of direction' whose nature and location are quite unknown."

Again, on the authority of Professor J. A. Thomson, a pigeon returning to its nest will fail to retrieve its eggs which have been removed from the nest to a distance of *two inches*, a fact which well illustrates the exactness of the mechanical sense of direction, but which reflects gravely on the 'mind.' A. G. Butler, in vol. ii, page 110, of *British Birds*, records:

"I once removed a nest with three eggs from a hedge, and passing a few days later saw the bird sitting on a little platform of ivy twigs upon which the nest had been partly supported; as I approached she flew away, disclosing her fourth egg."

If it be argued in these latter cases that the birds used leading marks, implying recognition and reflection, in finding the exact spot on which they laid their eggs, the question inevitably arises as to why they should exercise a reasoning and therefore fallible faculty when a purely mechanical sense is amply sufficient in an infinity of cases where leading marks are quite clearly non-existent?

[1] That some birds did not reach home was owing to the mean speed of the intervening air-current and the consequent failure in endurance of the bird: it was not attributable to a variable accuracy in the sense of direction.

Chickens turned out into a field from a hen-house on wheels will return, if the hen-house is moved in their absence, to the exact spot where the hen-house previously stood.

If a bee-hive is moved a short distance, the bees are nonplussed. Bees released from a match-box will return to, and orientate themselves upon, the exact spot from which the match-box has been removed. Swallows, martins, and other long-distance migrants return over great tracts of land, sea, and desert to the same nest: fish, through a waste of waters, to the same pool or loch. The authenticated evidences of this 'sense of direction,' most perfect in the lowest forms of life but fading gradually to extinction in the highest where reason is enthroned, are legion,[1] and this evidence of a sense, unaffected by distance and lack of marks for recognition, is immeasurably reinforced by the knowledge that birds, like the unreasoning person in the boat, or the water-rat, head straight for a given point when physical sight comes into play. "To make a bee-line" for a spot and the expression "As the crow flies" are terms which disclose a vast consensus of opinion on this question. A curiosity about these two expressions will be examined later, but for the purposes of the writer's

[1] In the *Nineteenth Century* of October 1928, Mr. T. A. Coward gives an interesting account of the amazing, indeed infinite, accuracy of this imponderable sense of orientation in the lower forms of life.

argument he will now treat his one assumption as a fact as sure and true as are 'the Laws of Currents' or 'the First Law of Motion,' and as immutable; for the test of the absolute truth of a physical law is its universal application and its admittance of no exception. Physical law is thus a legitimate spring-board for generalisation.

Note

At this stage it is necessary to treat the endowment of birds with an exact 'sense of direction' as an assumption warranted by common sense, experiment, and observation by experts. In succeeding chapters what is at present treated as an assumption will be *proved*, beyond a possibility of doubt, to be a fact, the proof being independent of, though supported by, observation and experiment. It will be shown that flight by recognition, the only conceivable alternative to flight controlled by the imponderable 'sense of direction,' is physically impossible.

CHAPTER V

CURVES OF FLIGHT

In previous chapters the laws governing the operation of air-borne or water bodies in air- or water-currents have been carefully examined. One assumption only has been made. If these laws are not indeed laws, and if the assumption is unwarrantable, the argument of this book is mere foolishness, and the author's thesis as a whole is an impertinence. The truth of the laws the author is content to leave to the verdict of mathematicians and his only assumption to the judgment of ornithologists. On the validity of the assumption hangs the whole concept of this book. If the assumption is well founded, it enables us, in conjunction with the changeless laws of physics and dynamics, to bring a simple and intelligible order out of a seeming chaos. If, however, the assumption is false, while the laws of currents remain true, the author will have expended great labour in making confusion worse confounded, for he will have revealed birds as aerial parasites utterly rudderless, without that controlling influence which can instantly, yet alone, convert a parasitical chaos into a perfectly ordered and exquisitely harmonious com-

munity of natural machines. It must be emphasised, however, that the author's one assumption has no bearing on the eternal disability of ambitious aerial navigation, *for airmen unquestionably have not 'a sense of direction.'*

It is now proposed to illustrate graphically the 'curves of flight' which birds assume when heading continuously for a particular fixed spot, visible or invisible, through intervening air-currents.

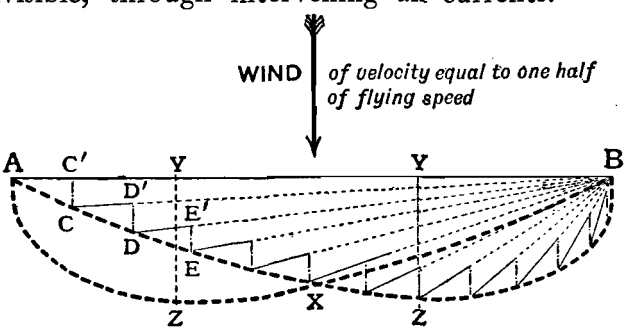

FIG. 1.—Distance flown 135% of direct distance AB.

Fig. 1 shows the curve of flight AZB from A to B through a wind at right angles to the direct line AB, the velocity of which is equal to one-half of the flight-speed of the bird. The line BZA shows the return curve of flight from B to A through a wind which has remained constant. The lines CD^1B, DE^1B etc. show the bird heading for its destination B. C^1C, D^1D etc. show wind drift.

The following points merit attention:

In both cases the bird reaches its destination

exactly head to wind without any volition on the part of the bird. Thus the alighting speed of the bird is always the difference between its flight-speed and the speed of the wind.

At only three points, A, B, and X, does the bird revisit the same spot on the outward and return journey, though on approaching or leaving these spots it progressively or retrogressively passes near to spots over which it previously flew.

Since the curves are similar in structure whether AB is 1,000 yards or 1,000 miles, it will be seen that the maximum divergence, YZ, from the direct line AB, as the crow is *reputed* to fly, is, in this relatively moderate wind, 200 yards or 200 miles.

These simple curves provide not only a somewhat startling commentary on the recognition theory of flight, but enable an approximate calculation to be made of the effect of a specific wind on a bird of specific flight capacity in the following manner. If we add together AC^1, CD^1, DE^1, etc., and compare the total with AB, we arrive at a comparison between flight in this particular wind with flight in a dead calm, which may be stated in terms of time or exertion.

In this particular instance the wind increases these factors of time and exertion by approximately 35 per cent. over calm-air conditions.

Fig. 2 shows the wind slightly heading a bird flying from A to B, though still of the very moderate velocity of one-half the flight-speed of the bird.

No detailed explanation of this curve is necessary. As before, the bird reaches B head to wind, but in this case the aspects of time and exertion are affected to the extent of 80 per cent. over these aspects in calm-air conditions. If AB is 100 miles the bird flies 180 miles.

Fig. 3 represents the same physical conditions as in Fig. 2, but in this case the bird is returning from B to A in the same wind, which is now, however, slightly favourable. It is instructive to compare

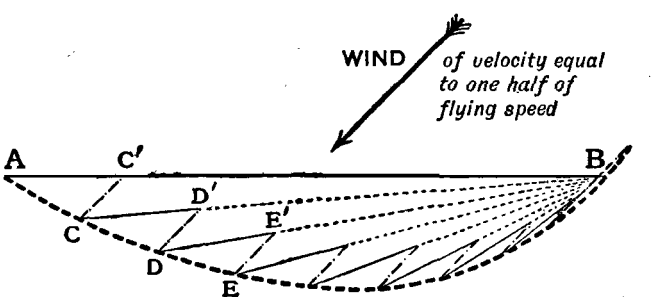

FIG. 2.—Distance flown 180% of direct distance AB.

this curve with Fig. 2, and to note not only the complete dissimilarity of the curve, but in addition the comparatively slight *relief* which this particular wind affords to the bird. In this case the time required for the journey and the exertion expended are affected to the extent of approximately 7½ per cent. only over calm-air conditions, whereas when the same wind was slightly heading the bird

the effect on these two factors was no less than 80 per cent. Here if AB is 100 miles the bird flies 93 miles.

Comparing these two curves (Figs. 2 and 3), we see at once how totally different is the territory over which the bird flies on the outward and return journey to and from a particular spot—perhaps a feeding-ground—and they afford a clue to the apparent aimlessness of birds in their movement

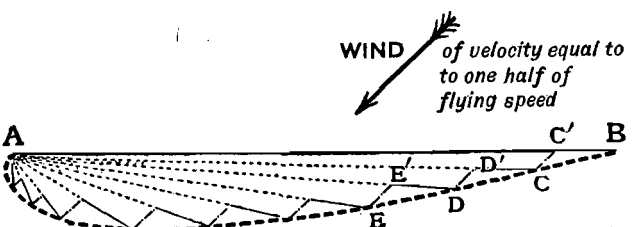

FIG. 3.—Distance flown 90% of direct distance AB.

about their 'territory' to and from the fixed 'home' within that territory.

It will again be noticed that the bird reaches its destination, A, head to wind, *after having slightly passed it.*

Fig. 4 shows the construction of the flight-curve from B to A when a wind, three-quarters the speed of the bird's flight-speed, is blowing at an angle of 20° from the direct line between the bird's destination and point of departure. In this case the two factors of time and exertion are affected to the extent of 300 per cent. over calm-air conditions.

The effort, or time, required in this wind is four times as great as would be required on a calm day. The bird must fly 400 miles to accomplish 100 miles.

In Fig. 5 the curve in Fig. 4 with the wind largely adverse is superimposed upon the curve from A to B with the same wind blowing, but largely favourable to the bird.

In this figure the divergence of the two curves, though striking, is as nothing compared with the

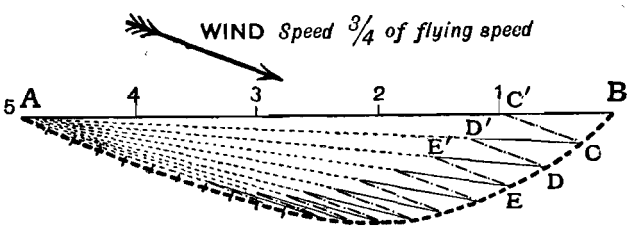

FIG. 4.—Wind 20° from right ahead. Distance flown from B to A approximately 400% of direct distance AB.

enormous discrepancy between the respective factors of time and exertion. While these factors are affected disadvantageously to the extent of 300 per cent. over calm-air conditions in the case of the flight with the wind adverse, the advantage to the bird with the wind favourable is only 35 per cent. The extraordinary discrepancy is, of course, introduced by the great difference in time during which the bird is subject to the air-current. Once again we see that the bird reaches its destination exactly head to wind, and that in the case of

the flight with the wind favourable the bird passes its destination and reaches it eventually from a direction almost opposite to the direction on which it set out. The bird flies 75 miles to accomplish 100 miles.

Fig. 6 represents the curve described by a bird trying to fly from A to B through a wind at right angles to the direct route and equal in velocity to the flying speed of the bird. When the bird reaches

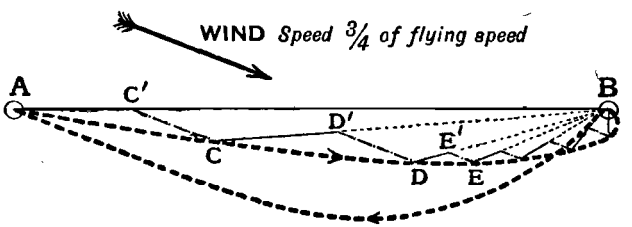

FIG. 5.—Wind 20° from right astern. Distance flown 65% of distance AB. Course of return from B to A shown on dotted line. Distance flown nearly exactly 400% of straight line BA.

C it is head on to the wind and to the spot B for which it was flying, and it has thus made the nearest approach to B that it can make because the wind and its flight-speed are equal. At C, therefore, the bird is stationary relative to its destination, though flying quite normally in what feels to the bird a normal calm. Under these specific conditions the nearest approach that can be made to B is half the original distance AB. Suppose now the bird attempts to return to the spot A—perhaps

its nest—it will then follow the curve CD, and on reaching the point D will again be head to wind and stationary, the distance DA from its 'home,' A, being four-fifths the original distance AB.

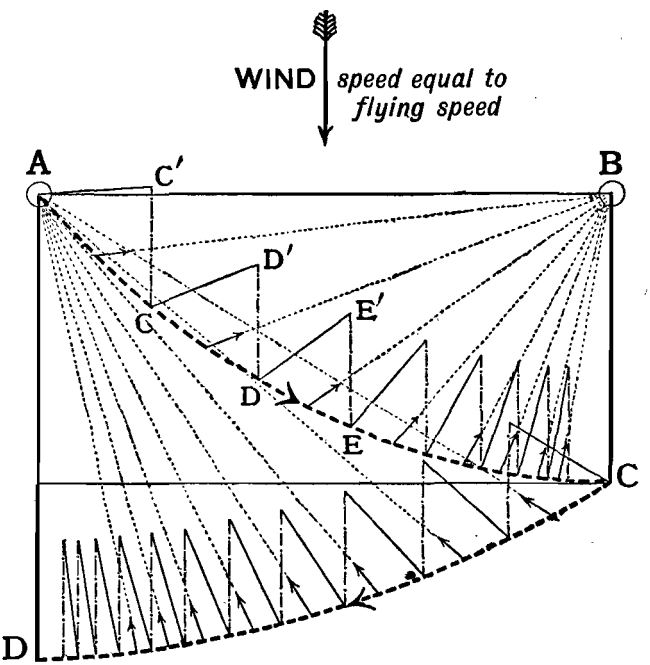

FIG. 6.—Wind-speed at right angles to AB is equal to the bird's flying speed. Bird trying to fly from A to B reaches C. BC = $\frac{1}{2}$ AB. Bird then tries to go back to A and reaches D. AD = $\frac{4}{5}$ AB.

This figure reveals some curious facts, and sheds some rather startling light on a variety of bird phenomena. It shows us, for example, that quite

a moderate breeze is sufficient to compel weak-flying birds to desert their nests in the nesting-season if their nests are exposed to the wind, and even strong fliers in a strong wind in exposed positions are helpless in so far as returning 'home' is concerned.

We also see that in a wind of a velocity equal to any bird's flight-speed that particular bird cannot return to its nest, perch, or indeed any spot at all, if once it leaves it for food or other purposes. Assuming that its object in life is a return to its home at A, it will be seen that the whole trend of the bird will be away from A along the line AD. In other words, the bird will drift away dead to leeward of the spot A.

If the wind is only a trifle more rapid than the flight-speed of the bird, it will also be seen that the bird will not only be unable to maintain itself at A, but will be unable to alight on *any* spot fully exposed to the wind, for on nearing such a spot it will be travelling backwards away from the spot, and even birds cannot alight backwards. Thus without shelter from trees or projections the bird will eventually fall to the ground or into the sea from exhaustion.

Here we seem to have a clue to local 'migrations,' wholesale desertion of nests, cock-nests of wrens, exhausted birds on the ground, and many other curiosities of bird life, matters which will be examined in more detail in subsequent chapters.

For the present it is the author's intention to confine himself to the laws which govern flight, and it may here be of interest to revert for a moment to the two graphic expressions "To make a bee-line" for a spot and "As the crow flies." Expressions enshrined in a graphic language, such as English, show perhaps more clearly than anything a great consensus of opinion. These two phrases, especially the latter, are universally used to express the exact distance, measured by a straight line, between two places, and the conclusion must be drawn that the view has prevailed hitherto that birds and insects *pierce the wind.* The curves show the nature of the course made good between given spots by flying creatures under specific conditions, and they reveal the singularly inapt nature of the conception conjured up by these two expressions, hallowed by usage, especially when we consider that these curves of flight are as variable as the winds of heaven and as the flight-powers of the various species of the feathered world.

In studying these curves it is essential to remind ourselves continually that the bird executes each one of them under physical conditions which, so far as sensation is concerned, are identical. The bird feels itself to be steering perfectly straight for its destination. It feels all the time nothing but a calm so far as wind-pressure is concerned, and always experiences a draught between its eyes and on its beak exactly equal to

the speed of its own flight through still air. This absence of sensation in a medium of infinitely varying flux leads us quite naturally to a consideration of Relativity, for in flight we have the most perfect demonstration of 'Relativity in Action,' a subject which it is hoped may be made both interesting and clear in the next chapter.

Note

The representative curves in this chapter can be interpreted in terms of space or energy. The factor of *time* is ever present. They may indeed be called in current language 'Space-Time Curves.' These 'space-time curves' should be carefully borne in mind by any readers who care to accompany the author, in the next chapter, on a voyage in an Aerial Dome of Relativity. The movements of the birds in this Aerial Dome are on curves of the nature here exemplified, and they are executed in a perfect calm, the paths of the birds to their landing-grounds being, to the birds, seemingly *straight*.

CHAPTER VI

TERRESTRIAL RELATIVITY AS AN ENVIRONMENT

'Cosmic relativity' is one of the more reputable of evolution's many concubines, accompanying it as naturally as darkness accompanies the setting of the sun. Newton's laws, which enable perfect astronomical predictions to be made for millenniums to come, are furthermore the basis of all sound engineering practice, being of such a nature as to set predictable limitations to the useful and economic development of any one particular type of machine or appliance. These laws can be said, therefore, to be also the basis of all sound economy in the industrial world of machines. Whereas Newton's laws are fixed and changeless, evolution stands for flux, and strictly considered is the negation of law, and therefore of finality, in principles, species, or machines. It is curious to observe how disastrously we fare when we begin deliberately to 'evolve' any machine, be it a super-airship, super-locomotive, super-ship, or super-anything. Indeed the prefix 'super,' so beloved by the extreme Modern, almost invariably indicates the transition—the evolution—of a particular and perhaps perfected instrument, machine, or material

from the realm of sound economic engineering practice into the uneconomic realm of 'scientific marvels' and white elephants, with a consequent decline in prosperity in such old-established industries as shipping, railways, and steel.

In approaching the subject of relativity it may be thought that the author is about to involve his readers in a vague mist of unreality and academic conjecture. It is true that relativity *as an environment* involves us all in a form of nightmare in which reason loses her bearings, in which reality and appearance are not in harmony, where things seen are not the shadow of things unseen, where in truth, nothing is what it seems, nothing is measurable, all is relative, nothing absolute. This is, in very deed, the nature and effect of relativity, the environment to which the flight of birds and machines is nevertheless exposed in all but calm weather. The paradoxical thing about relativity, however, is this. Though it precludes, under certain circumstances, the exercise of thought and reason to men and creatures in its clutches, its nature and effects can be perceived and foreseen by men and women who are outside its sphere of influence. Thus a judicious layman on the ground, if the speed and direction of the intervening wind are known to him, can foretell exactly the fate of a trans-Atlantic or trans-Pacific flight (disregarding mechanical breakdowns), though the airman on his way cannot do so, as will be shown. The founda-

tion of reason is the existence of known, fixed, and therefore absolute standards upon which calculation, comparison, action, and moral conduct can be based. In aerial navigation (single-medium operation) we are dealing with relativity in action, not with relativity as an amiable abstraction. In navigation on land or sea (two-medium operation) we are dealing with fixed standards, the Absolute—the realm of reason and of mind.

It is not easy to compress the explanation of these matters into a short space in such a manner as to make them readily understood by readers who, perhaps, have not closely analysed flight for themselves, and the writer can only hope that he is going to make himself clear without being unduly prolix and therefore tedious. Before transporting his readers into a vast, shadowy, transparent aerial vessel with which he hopes to make the subject of relativity plain, he would ask them to bear the following facts steadily in mind in order that they may understand what a bird is experiencing in the air, to what forces it is exposed, to what forces it is *not* exposed, and, equally important, what we observers on the relatively fixed earth actually witness.

In the first place, as previously emphasised, a bird on the wing is in a dead calm so far as wind-pressure is concerned, no matter how fiercely the 'wind' is 'blowing,' or how loudly, to our ears, it roars. An analogy has already been drawn between the flight of birds and machines in 'wind' and

the flight of a fly in the saloon of a liner under way. For a more perfect analogy of a bird flying through, but immersed and supported in, a moving medium, we must go to the earth itself as it glides silently in its atmospheric shroud through space with our own movements superimposed upon the earth's unperceived movement, unperceived, that is, so far as *sensation* is concerned. Relative to the sun and planets motion can of course be *observed* and *measured*. The motion of the solar system itself, however, cannot even be observed, and hence the simple truism that absolute movement can have no observable effect upon physical phenomena, which is not to postulate, however, as does Professor Einstein, that absolute motion does not exist. Motion, like truth itself in all its infinite aspects, is manifestly Absolute. To our finite minds, however, it can only become apparent when it is relative. Thus speed can be measured only when it can be contrasted with some fixed standard, just as truth and goodness, for their accurate apprehension, require that perfect and absolute standard for which the divine philosopher Plato so passionately yearned and which, a few centuries later, Christ revealed to the world. But this is a digression. Reference to the observable motion of the earth relative to the sun and planets, and of the unobservable motion of our solar system relative to infinite space, may seem to be far-fetched as an analogy of the flight of aeroplanes and

birds, and yet, curiously enough, it is in many respects exact. The motion of airmen or birds relative to terrestrial landmarks *in sight* is the counterpart in kind, though not of course in degree, of the movement of terrestrial vehicles relative to our sun and our fellow-planets, while the movement of airmen or birds over the oceans, deserts, in mist, rainstorms, clouds, or at night, that is to say when terrestrial landmarks are not in sight, is the counterpart of that transmigration, undiscoverable on this side of the grave, of ourselves and the solar system through space.

In the second place, though birds and airmen feel nothing of the pressure of the 'wind' in which they are flying, they are subject to the full speed and direction of the 'wind' upon which their own speed and direction are merely superimposed, just as our movements in a railway-carriage are superimposed upon the movement of the train. Furthermore, if a 50-mile-an-hour 'wind' is blowing and the bird's own speed of flight is 50 m.p.h., by an observer on the earth the bird will be seen to be stationary if the direction of the wind is directly opposite to the direction of the bird's flight, but travelling at 100 m.p.h. past the observer if the direction of the wind and the direction of flight are identical. To the bird, however, the conditions in both cases are identical in so far as *sensation* is concerned, the bird feeling nothing but the draught caused by its own speed of 50 m.p.h.,

always from right ahead. If the bird alters its direction across the wind it still feels the same 50-m.p.h. draught between its eyes and on its beak, because 50 m.p.h. is its flying speed through the moving air in which it is immersed, the air being the 'liner' or 'railway-train' which is carrying it along. To the observer on the ground, however, it assumes a speed and course (a curve of some such nature as shown in the last chapter) which is governed by combining the speed and course of the bird *through* the air with the speed and course of the air itself, the 'railway-carriage' in which it is progressing.

In the face of this simple fact it is astonishing to find a distinguished school of ornithologists, of whom Gätke is a notable example, asserting that birds elect to fly beam on to the wind and that they are guided by the pressure which such a wind exerts. The absurdity of such a view, and the ignorance of physical laws which it reveals, is referred to by Mr. T. A. Coward in *The Migration of Birds*. Not less remarkable is the view of many modern scientists, though understandable perhaps in mere anatomists, that birds elect to fly head to wind to avoid rumpled plumage. As repeatedly emphasised, wind can cause no strain or pressure to a bird on the wing.

In the third place, if the bird flies upward at an angle to the horizontal movement of the medium in which it is progressing, it will rise into the air at an angle which is governed by the velocity of its

own speed of flight, the speed of the moving medium on which its own speed is superimposed, and the angle of its flight relative to the horizontal. Thus a bird with acquired momentum can rise vertically with its wings stationary, as we so often see, though on its outspread wings, inclined at an angle to the ' wind,' no breath of the rushing ' wind ' in reality impinges. As in all cases of air-borne bodies in free flight, whether bird or machine, the only *pressure* experienced is the draught caused by the bird's own speed through the moving air, the major portion of which pressure, of course, provides the lift against gravity. Perhaps in no case is the onlooker more apt to regard the wings of a bird as *sails* than in the case of soaring, and the writer has found it difficult on many occasions, so perfect is the illusion, to persuade his friends that the wings are *oars* and not *sails*, with all that this implies.

In the fourth place, it is essential continually to remind ourselves that we are observing motion in an invisible medium which is itself in motion from a platform (the earth) which is relatively *fixed*. Conversely the bird is flying in a medium which, relative to its own flight movement, is as fixed to birds and aircraft as is the earth fixed to mammals or vehicles, or the moving water to a ship. A careful consideration of these four axioms affecting flight will reveal at once how extraordinarily deceptive appearances must be to a terrestrial observer unconscious of the physical laws operating before

his eyes, a deception made immeasurably more treacherous owing to the complete invisibility of the overruling component, the air—the 'moving platform,' 'ocean-liner,' 'railway-carriage,' or moving medium upon or in which all these flying movements take place.

In case any of the foregoing analogies may seem unconvincing, the author will endeavour to bring into focus all that has been said on the laws of flight, curves of flight, and kindred questions, by inviting his readers to accompany him on a short excursion into the realm of fancy. Let us cease to think of 'wind' as we are in the habit of thinking of it, and instead let us think of this natural phenomenon as a great body of still air imprisoned in a vast, dome-shaped vessel, suspended from the skies by a wire held in the hand of a giant—Eolus. Let us imagine that the bottom of this vessel, unlike the sides and roof, is unenclosed. Let us now suppose that this fabulous dome is 1,000 miles in diameter and is suspended with its centre over England as a large dish-cover might be placed over a solitary chop, the circumference of its base touching the sea at all points. Everything above sea-level will thus project up into the great hanging dome.

It will be seen that such a vessel, if we can conceive it, could be moved about over England, the base being at sea-level and the sides of the vessel over the surrounding sea, just as a large dish-cover could be moved about on a table without disturbing

projections in the middle of it. This fabulous dome, we will imagine, is at the moment held stationary and steady by the giant at the end of the suspension-wire, and while in this static state let us let loose in the great enclosed dome all species of birds, butterflies, and insects. Let us also fly giant airships and aeroplanes of all types inside its depths, and let us release a balloon with no motive power whatever.

It will be seen at once that the conditions inside this mighty dome are still and quiet, corresponding to unconfined conditions of the atmosphere on a dead-calm day. The birds, insects, and machines flying inside the dome will feel a draught exactly equal to their flight-speed, and the draught will be from right ahead, whatever course they steer. The balloon will of course remain stationary overhead. Furthermore, the trees, shrubs, hills, anything in fact that projects from the earth into the dome, will be stationary in relation to the enclosed air. If birds alight on the projecting trees, or aircraft on a landing-ground, their course to a particular tree or landing-ground will be *straight*, in fact as the crow is reputed to fly, and further, the distance to a given spot will be *the absolute geographical distance*. If any reader will imagine himself sitting on the ground beneath this mighty dome, with the suspended dome stationary, he will see at once that this is so. Finally, let another reader imagine himself to climb up into a seat

suspended from the roof of our imaginary dome, immediately above the person on the ground. The observer on the ground and the observer in the seat attached to the suspended dome are both in dead-still air, and the birds and machines flying in the dome above them both make an identical picture to both observers. Conditions are, in fact, absolute, both in the enclosed air and on the ground, and reason, calculation, and measurement can thus be employed while these conditions hold.

Now let us touch a magic button. The mighty dome-shaped vessel becomes transparent, the suspension-wire of the dome invisible. The birds, insects, machines, and the two observers, remain visible, as do also the trees, shrubs, and hills which project into the now invisible dome. All is as it was before the button was pressed, the reality of the dome being preserved without the material cloak of visibility.

But now let us suppose that Eolus, dome in hand, commences without warning or consultation to stalk silently away with a leisurely stride of 30 m.p.h. in obedience to an irresistible call made to him by his master, the sun, who causes a rise in temperature in another district. What is now the effect on the birds, insects, and aircraft inside the great invisible dome, and upon the observer in his seat suspended from the roof of the dome? So far as sensation is concerned there is no effect whatever, neither is there any change in the appearance

of the flight of the birds and machines to the observer in the dome, the balloon remaining stationary overhead. To the observer on the ground which projects into the moving dome the sensation, on the other hand, is the rising of a 30-m.p.h. wind, and the imposition of 30 m.p.h. on the speed of the flying birds and machines. The balloon passes away from the observer on the ground at 30 m.p.h., while remaining motionless as before over the head of the observer suspended from the dome.

Now suppose Eolus, still dome in hand as we might carry a bird-cage, changes his leisurely stroll of 30 m.p.h. to a run of 50, changing his direction and varying his speed from time to time. The movements of Eolus with his dome will be exactly observable by the observer on the ground in the form of wind corresponding exactly in speed and direction to the movements of the air-filled dome. The sensation of the birds and aircraft flying in the imprisoned air of the moving dome will, however, undergo no change, for they will still feel the draught of their own speed from right ahead, and nothing else. If, however, a bird now steers for a tree, building, or any other fixed spot on the earth over which the great dome is being carried, the bird, without any sensation, and steering seemingly straight for the fixed spot, will in reality execute a curve similar to one of the curves illustrated in the preceding chapter. It will arrive head to the 'wind' that the observer on the

ground *feels*, but which the bird does not feel, the alighting speed being the difference between the bird's flight-speed and the speed of the air-filled dome in which the bird is flying. The distance to a fixed spot on the earth from a bird or machine flying in the still air in the moving dome is now immeasurable, depending upon the speed at which Eolus is carrying his dome, a speed which no creature in the dome can possibly know by sensation, since no sensation would be entailed if the dome was moving at 1,000 miles an hour.

As with distance and speed over the fixed earth, so with time. Without a clock, where distance, speed, and other fixed aids to time-measurement are lacking, time itself has no meaning. Up to now it has been assumed that it is daylight, and clear, and that the objects on the fixed earth beneath the moving dome are visible. Though the movements of the dome are utterly beyond the control of the creatures and airmen flying in its space, or of meteorologists upon the ground, it is still possible for both airmen and birds to reach a particular spot on earth provided the difference between the flight-speed of the bird or machine within the dome and the speed of the dome itself is not beyond the compass of the reserve power of flight of a bird, or the reserve fuel-supply of a machine, and provided also, in the case of an airman, that particular features of the landscape beneath are known and, therefore recognisable, or a coast-line available to hug and

follow. In such cases the arrival or non-arrival of a bird or machine in a long non-stop flight is entirely conditioned by the movement of the dome—the wind. If a machine is flying at 100 m.p.h. in the dome, and the dome is moving at 40 m.p.h., when the two movements are in harmony the speed over the earth beneath will be 140 m.p.h., but if opposed it will be 60 m.p.h. The difference in these two speeds may be expressed indifferently in distance, time, exertion, or fuel expenditure, and it will be seen at once that these factors are increased nearly two-and-a half times if the movements are opposed, a relative movement over which no scientist, certainly not any ordinary man, has any shadow of control.

So much for the ideal conditions of daylight and recognisable landmarks beneath the travelling dome. Now let darkness settle down, or, what is almost equally effective, let us move our dome over wastes of desert, ocean, arctic wastes of ice, or even unrecognisable and deserted landscape, where no such features as charted coast-lines, great rivers, railway lines, telegraph wires, or Mesopotamian sand-furrows can act, while they remain, as a simple guide to airmen. Without the inherent 'sense of direction'—the 'homing sense' of birds—the conditions now become as fantastic as a nightmare. Let the observer *on the ground* imagine that he feels the direction of the wind changing and its force increasing. This observer can thereby tell the

exact motions of the dome, and knowing as he does the speed, course, and maximum endurance of the machines flying within the dome, what must be his agony of apprehension on their account, nay more, of certainty, when by a short effort of mental arithmetic he realises that his flying friends are certainly doomed unless the heartless and soulless Eolus eases his stride and amends his direction. Inside the dome a deceptive but deadly calm prevails, a calm broken only by the steady roar of the engines with the steady draught appropriate to the engine-speed. The compass may be perfect, and the airmen may steer a steady compass course, but this course has no connection whatever with the fixed terrestrial spot for which it was originally laid, Captain Wilkins of Arctic fame notwithstanding. The birds alone, with their beaks ever pointing to their destination, are making steadily on mathematical curves for their 'homes,' at which they will eventually arrive if the movement of the dome is not unduly adverse. Birds, without understanding, are without apprehension or anxiety. Without the mechanical 'sense of direction' of birds, but possessed of reason and understanding, what must have been the feelings of the Atlantic and Pacific victims in an environment in which reason, under the prevailing circumstances, was inoperative?

Let us now bring this aerial juggernaut of relativity to rest over a suitable landing ground to enable the observer suspended from the dome, and

therefore utterly ignorant of the Odyssey upon which he has been conducted, to alight. Let us leave the embrace of this monster, relativity, and conclude our examination of it from the ground as rational two-medium beings, to whom wind *is* wind and not a deadly moving and all-embracing calm. Before dismissing our dome of relativity, however, it is necessary to add this reflection. For the sake of simplicity it has been assumed that the air within the dome is one homogeneous whole. In reality the velocity of the moving air increases with height, up to a certain altitude, through infinitely graduated steps, much as black shades off through grey to white. Thus we have relativity piled upon relativity in the air, like Pelion piled upon Ossa. It should also be added that upon the horizontal slidings of the structureless atmosphere are superimposed vertical air-currents set in motion by terrestrial obstructions, temperature, and electrical disturbances. These aerial 'waves,' though they set up strains, exert, like horizontal wind, no *pressure* on air-borne bodies, being indeed to the atmosphere and aircraft what waves are to the sea and ships, though they may be proportionally as large or larger than are the speeds of air-currents to the speeds of sea-currents. It is these aerial waves which cause the buffetings and bumps of which we read so much in the newspapers, and though an added source of danger to aircraft, and of acute danger to airships, they are not a result of high

wind-speed, nor do they affect the lateral drift of the moving air in which the aircraft are borne, because they are merely vertical disturbances of the moving air itself.

Dismissing our legendary 'dome,' let us imagine ourselves again on Mother Earth, looking up at the gulls in a gale of wind. Suppose a large sea-bird to be flying at a speed of 50 m.p.h. in a directly adverse gale of 50 m.p.h. Suppose an observer, facing the wind, to be watching a bird flying exactly 'stern on' to him at an altitude of 45° from him. This bird is stationary relative to himself, though the bird is flying and experiencing a 50-m.p.h. progression in the gale. Now, this bird has a *potential* speed relative to the observer of 100 m.p.h., for if it turned right about it would add its own rate to the rate of the wind and thus seem to be flying at 100 m.p.h.: indeed by a twitch of its tail it can present to the observer an infinite variety of speeds and courses within the limits of 0 and 100 m.p.h. in speed and 0° and 360° in direction. Out of the almost infinite view of itself which the bird can thus present to an observer in the twinkling of an eye let us take two examples.

Suppose, first, the bird changes its direction 180°, which it can do in a fraction of a second. In this fraction of a second from seeing a certain perspective of a large stationary bird the observer will see the perspective changing at the rate of 100 m.p.h. as the bird flashes over his head, thus

giving the bird, perhaps, the appearance of soaring. Suppose again the bird changes its direction 135°. The resolved speeds and directions instantaneously introduced to the observer's eye will now give the appearance of curves, banks, soarings, and side-slips, so rapid is the change in the perspective of the bird. Add to these rapid changes of mere perspective the *real* sky-rocketing or plunging effect of an alteration by the bird of a few degrees in the angle of its progression above or below the horizontal moving air (due to the resolution of speeds, *not* pressures) and it is not difficult to see what acrobatics the bird appears to perform. So much for the observer, but what of the bird? The bird has done nothing but fly perfectly normally in air perfectly still relative to itself, for it is always carried along with the air, and it has assumed merely the natural bank in turning suitable for a bird of its particular build and weight at a speed of 50 m.p.h. In fact the bird has turned and moved in a 50-m.p.h. 'dome.' The bird's 'dome' is, however, a vast invisible one, and hence the extraordinary discrepancy between appearance and fact.

If we now turn from particular cases to the general aspect of flight, there are two cases that deserve attention. Firstly, on a dead-calm day. In this case the bird's movements overhead and the picture they present to our eyes are one and the same. Furthermore, if we take a certain area, and a certain period of time, and draw a diagram through every

point in space through which the bird flies, and if further we project this diagram on to the surface of the earth, since the air and the earth have been stationary in relation to each other, the two diagrams will clearly be identical, assuming for the sake of simplicity that the bird flies in one horizontal plane. (If we introduce a third dimension we largely increase the discrepancy between reality and appearance when a wind is blowing.)

Secondly, on a windy day. Assume a 30-m.p.h. wind and a bird speed of flight of 40 m.p.h. Now, if we assume the bird to fly on the same courses as on the calm day and if, as before, we draw a diagram through each point in the air through which the bird passes in a given time, the diagram *relative to the* '*wind*'—the vast transparent 'dome' in which the bird is flying—will be identical with the diagram on the dead-calm day. If, however, we project this diagram on to the earth we shall get a terrestrial diagram which is fantastically different from the diagram on a calm day. The first diagram represents the bird's experiences, effort, and reality of motion in its 'dome,' while the second diagram projected on to the surface of the earth represents the reality of the bird's motion relative to the earth and the observer, the resultant of its own efforts and the motion of its medium—its dome. If landmarks are visible, birds or airmen can see vaguely or clearly according to circumstances this projected terrestrial diagram, though they only

feel the sensation of the aerial diagram, which is the same in calm or windy weather. If, on the other hand, landmarks are not in sight, the bird or airman must be utterly ignorant of the projected terrestrial diagram, in other words of locality, direction of flight made good, speed over the earth.

In concluding this examination of the relativity of bird-movement on the wing, or of aircraft in flight, we may legitimately reverse the conditions of moving air and fixed land and sea. Let us *fix* the atmosphere in which all flight takes place, and let us imagine the land and sea to be moving at any place throughout the world at speeds, and in directions, exactly *opposite* to what had previously been the speed and direction of the wind at that particular locality of the earth's surface. It is clear that at all these places, now moving through a stationary atmosphere, a sensation of 'wind' will be created which is identical with the sensation caused by actual wind passing over these same places on the surface of the earth.

Let us expand the capacity of physical sight to such an extent that an airman can see his destination across the oceans and continents. The airman on his way through the now stationary atmosphere, though feeling just the same sensation as he would feel if a gale were blowing, will, if he steers a steady compass course, see his destination sliding away from him to left or right, or receding from him, or rushing to meet him. Indeed, very literally *the*

world will be swimming before his eyes. This is exactly the state of affairs with which birds and airmen are eternally faced, with the unfortunate exception that airmen have not this miraculous sight any more than birds, which latter, however, do not require it because their perfect sense of orientation is an equivalent of sight.

It is feared that these explanations may strike readers as clumsy and confusing. The truth is, of course, that Relativity involves a certain complexity. Here in the flight of birds or machines we have, perhaps, the most perfect demonstration of Professor Einstein's theory, but with this distinction. Professor Einstein deals with infinity and in certain vital respects he makes unwarranted assumptions about the speed of light, its nature and its behaviour in absolute space, as opposed to its behaviour in the earth's atmosphere, *in which alone it can be observed*, which do not appear to be definitely proved. In this case of finite, that is to say terrestrial, Relativity we are dealing with tangible facts, measurable speeds, and ponderable dynamic laws. The flight of birds introduces to our finite conceptions relatively high speeds, fixed and rapidly moving media, and *invisibility* in the overruling component —the air. It is this invisibility of one of the media—the air—which to the writer's mind renders light such a wonderful terrestrial exposition of Professor Einstein's theory. Had Professor Einstein closely studied and utilised for exposition the

phenomenon of flight, he could at once have expounded Relativity as an easily understood law, and furthermore he could have rendered his *theory* of infinite Relativity easily understandable, though by no means acceptable, in view of the unproven nature of his major premise with regard to the nature of light and its behaviour in absolute space as opposed to its behaviour in the earth's atmosphere.

The truth or falsity of the Einstein theory stands or falls upon the truth or falsity of his second postulate, which is this:

"The speed of light is the same in all directions at a given place, and its value at one place is the same as at any other place in the universe."

This postulate is based on the results of what is known as the Michelson-Morley experiment, conducted with an instrument known as "the Michelson's inferometer." In this experiment, however, *the source of light was a terrestrial one.* Now if light in fact travels in waves in absolute space, and if it has a speed that corresponds to the speed of wireless waves in the earth's atmosphere (186,000 miles per second, so it is said), we should expect to find short wireless waves in an upward direction passing away without interruption into infinity at a uniform velocity. If on the other hand light, like the force we call gravity, is instantaneous in its manifestation in an absolute void, as gravity is instantaneous in its action; and if, further, an

infinitely perfect vacuum is an insulator of electro-magnetic waves, we should expect to find wireless waves deflected on reaching the extreme limit of the earth's atmospheric shroud if such a perfect vacuum in fact exists.

Now the new scientific theory of 'the Heaviside layer,' so called after Professor Heaviside, is upon us. 'The Heaviside layer' does in fact, so physicists assure us, deflect, or in other words repel, short wireless waves, a fact which seems to deal a very shrewd blow at the wave theory of light in absolute space, at light years, and thus at Einstein's theory, a theory which demands 'ether' in which light waves can travel. With its proverbial love for convenient hypotheses—a love now extended to two mutually destructive theories of light—'Modern Science' invented the 'ether' as calmly and characteristically as the myth was invented that 'scientists' discovered the properties of short wireless waves, which were in fact, as is perfectly well known in wireless circles, discovered by amateurs and laymen, to whom, on account of its supposed uselessness, this band of short wireless waves (the Beam System) was flung by professional scientists as a bone might be flung to dogs.

In conclusion, the author would like to say that this book was projected and largely completed before he had read any book, pamphlet, or article on Professor Einstein's theory. Within the last few months, however, he has carefully studied Professor

Einstein's address to the University of Leyden (*Ether and the Theory of Relativity*), and he has had the good fortune further to read a brilliant little book entitled *Relativity—an Exposition without Mathematics*, by Professor James Rice, M.A., Associate Professor of Mathematics in the University of Liverpool. Professor Rice's short and lucid explanation of Professor Einstein's theory will doubtless be very widely read and it is only intended, therefore, to quote one short passage from its pages.

In summing up on page 76 Professor Rice writes as follows:

"And what has all this—'Relativity'—got to do with me and my affairs? What change is it going to make?

"None at all in the sense in which certain other famous discoveries have made immediate and obvious changes."

Is Professor Rice correct? Undoubtedly he is correct in so far as Professor Einstein's theory of the universe is concerned, even supposing it for one moment to be true. The writer ventures to think, however, that Professor Rice is mistaken with regard to the terrestrial *Law* of Relativity as demonstrated in the flight of birds and machines, for this simple law rules out of practical politics for ever *long-distance* aerial transport, whether by airship or aeroplane, as a practicable commercial proposi-

tion. Long-distance aerial transport has already proved in a terrible manner the danger of applying man's absolute standards (speed, time, distance, place) to operations which are governed in the case of air-borne bodies by *Relativity in Action*. Even assuming that our engineers could in the future build airships or aeroplanes of perfect stability, strength, comfort, mechanical safety, of fabulous speed and lifting power—assumptions rendered fantastic by other immutable and well-known Newtonian laws of dynamics—this law of aerial relativity would still interpose between man and his cherished dream of Empire-linking by mechanically perfect airships, aeroplanes, or flying boats.

Relativity is the province of conjecture, and under many conditions, and in many aspects, it precludes the operation of thought and reason, for the exercise of which a relatively fixed platform (the earth) and absolute standards of measurement are essential. The aerial *distance* from London to Karachi, London to New York, or California to Honolulu may vary by thousands of miles according to the wind. The distances by land or sea remain absolute and immovable, thus enabling time-tables to be made out in advance and adhered to, and, most important of all, fuel supplies to be gauged and carried. Mechanical flight has introduced to man's experience for the first time in his history that 'Relativity' which Professor Rice has told us can have nothing to do with our affairs, but in playing

with Relativity on an ambitious scale we are playing, like children, with fire. The sooner its devastating nature is understood and accepted by Authority, the sooner will unnecessary death and financial ruin be avoided. Though aerial enthusiasts and their scientific advisers have overlooked this fatal flaw in their unceasing aerial advocacy, they still have to face it, and acknowledge their impotence in the presence of Law. Will not those great English physicists who are detached from aerial policy confirm the truth of what is here set forth or expose the author's error?

PART II

THE 'MIGRATION' OF BIRDS AND OTHER PHENOMENA

CHAPTER VII

THE 'MIGRATION' OF SWALLOWS

'MIGRATION' is a word that is used with extraordinary looseness in ornithological books, as a study of *Problems of Bird Migration* by such an authority as Dr. Landsborough Thomson makes abundantly plain. In the author's view the term 'migration,' if used at all, should be confined to the well-known *non-hardy* species, of which the swallow tribe is the most famous because the most conspicuous and therefore best known. For the ceaseless ebb and flow of birds over great areas of the northern and southern hemispheres and for the slight movement of tropical birds about the tropics, 'drift' seems a more suitable term. This unceasing ebb and flow of birds in the northern hemisphere will be examined later, and for the present the question of the 'migrations' of swallows will alone be considered.

Not only is the term 'migration' used indiscriminately of all bird movement, but the theories surrounding the phenomenon are to-day as numerous, conflicting, and mutually destructive as have become in these latter days the theories of man's descent from the brute creation. It is interesting

to study the methods of observation so largely employed for arriving at the laws governing the movement of birds, and to compare these methods with those employed for proving evolution by biologists, anatomists, geologists, zoologists, anthropologists, palæontologists, physiologists, microbologists, psychologists, embryologists, pestologists, and so forth, *ad absurdum* and *ad infinitum*. Each group of these narrow specialists, narrow by their own admission and choice, pursue their investigations with their attention riveted to some minute material detail or some narrow aspect of a vast problem, and though they not unnaturally arrive at laughably conflicting conclusions, all these 'researches' have this in common. They one and all employ as a working hypothesis a theory which these researches are mainly devoted to proving as law. Outside biological circles the employment, as the major premise, of the thing it is desired so passionately to prove is not unnaturally regarded as a mere ecstasy of obsession, and in lay circles it seems likely that diametrically conflicting conclusions based upon a common premise would discredit the hypothesis which led to such antagonisms. But the ways of 'modern research' are past finding out. This question will not be pursued here, and indeed is only mentioned because these methods of research are very similar to those employed by biologists in their endeavour to solve the mysteries of bird movement in space.

By what methods does this particular school of ornithologists (the biological school) attempt to solve the age-long wonders of bird life? Briefly stated, on inductive lines in the approved Baconian fashion. The laws of what we *call* gravity and motion were not so discovered. Newton made his great discovery as a young man and as a classical scholar. In the bosom of the Royal Society (a bosom to which all discoverers are welcomed *after* the discovery) and with the term 'scientist' thereafter branded on his brow, he became, as is not universally known, something very near a 'charlatan,' being engaged subsequently, as professors are engaged to-day and have been from time immemorial, on the transmutation of matter—the conversion of dross into gold. It is not surprising to find Newton, in his later years, a zealous supporter of, and shareholder in, that South Sea Bubble which Swift so brilliantly derided. From thousands of inevitably differing observations an attempt is made to induce, so to speak, certain principles which will account adequately for the infinite variety of bird phenomena which daily intrigue and confound us. The great majority of this school of observers, however, have this in common. They assume as a working hypothesis the evolutionary conception of bird 'mind,' which implies objectivity and calculation in birds. Is it not possible that we may see light on these vexed questions by looking inward, not outward, not by observing but by

thinking, as the Duke of Argyll urged in *The Reign of Law*?

The author is not so foolish, or indeed impertinent, as to under-estimate the immense value and interest of the observations of our most distinguished ornithologists. On the contrary, if the deductive and inductive schools can together find a solution of the questions which perplex and fascinate us all, it will only have been made possible, at least in the more detailed aspects, by the devoted labours of brilliant observers of bird life, upon whose observations the author leans to point his argument. In the first part of this book the laws which govern the flight of all air-borne bodies have been carefully examined. It has been shown that these laws govern equally the flight of the most powerful machines, birds, or the tiniest insects, and that the effect of wind on a giant aeroplane is no more and no less than its effect on a thread of gossamer spun by a spider, floating freely and detached in air.

Now these laws of flight are either true or false. If false, the conclusions based upon them are as fantastic as must be all conclusions based on mere observation, which take no note of these laws if true. It will be remembered that the first part of this book contains one assumption only, an assumption which readers will, it is believed, consider reliable when they reflect that the first authorities in the world are agreed, and indeed emphasise, that birds have an inherent sense of direction which

enables them to steer for an exact terrestrial spot no matter how distant, and regardless of any landmark. Not only have they the necessary sense of direction, but, re-enforcing this sense, all birds, hardy or otherwise, have what Sir H. Maxwell describes as an invincible habit of returning to their birth-places to nest.

With these laws and our one assumption then as premises, the problem of the movement of swallows, for example, in its broader aspects appears capable of accurate analysis. Wonders cease to be wonderful if we know the laws which make them not only possible but inevitable. The Cornish Riviera express would have amazed us all 100 years ago had it suddenly appeared one morning travelling at 60 m.p.h., the laws of dynamics and heat being known only to its creator! Should we not, one and all of us, have exclaimed "A miracle!"?

Now what are the outstanding features of swallows? In the first place, though temperate, they are non-hardy, requiring warmth for the maintenance of life. The fact that they always are to be found in warm, as opposed to tropical, climates should be sufficient answer to any who may be disposed to say, "How do you know?" This being so, it seems to follow that there is a critical degree of temperature which will make a swallow restless, and a degree which would prove fatal if endured for an undue length of time. This critical temperature may be one of heat or cold, since the

birds are temperate birds. Again, swallows live during daylight on the wing, and feed upon the wing. They feed upon flies and tiny insects which, in their turn, are subject to the laws of currents and whose life again is governed by temperature. Thus a fall in temperature affects adversely the birds' food-supply at the same time as it affects physically the bird. From this dying down, and passing away, of the food-supply many scientists have deduced that the lack of food provides a *motive* for the bird to depart south, where a genial climate will naturally re-stock the bird's larder. It will be seen at once, however, that to attribute lack of food as a motive for migration is to attribute knowledge to a bird, and not only knowledge but powers of decision and calculation, which demand abstract reasoning based upon a knowledge which first-year birds most certainly and demonstrably could not have.

There is another assertion about swallows which is repeatedly made by many, but by no means all, authoritative ornithologists. The regular non-hardy migrants are said to have two 'homes,' one in temperate northern lands and another in the south, these 'homes' being fixed spots for which the swallow heads when its odyssey in either direction is undertaken. So much for the bird, but what of the physical environment in which the bird flies?

The movement of the air, the wind, is governed by barometric pressure, but this pressure is again regulated by temperature, as a study of the wind-

charts of the world, re-enforced by a rudimentary knowledge of physics, makes abundantly plain. Thus at the autumnal change of the seasons the cold which depresses the swallow's vitality, and kills off and carries away its food-supply, sets the great 'dome' in which the birds fly in motion towards the south and east. So well known is it that birds retreat from a high barometric pressure to a lower one, that it is perhaps not surprising that another school of scientists has reasoned inductively that birds are affected physiologically and adversely by the height of the barometer. Thus we have the food-supply motive school and the barometrical motive school. Both these schools have a half-truth in their theories, the mistake being to read into either of these physical conditions a cause or motive for migration. Both are *effects* of the over-ruling *cause*, temperature, which gives rise simultaneously, so exquisite is the harmony of natural law, to the necessity, the means, and the final reward in the form of food and a genial climate to creatures obedient to the laws of their Maker—His bricks and mortar.

It has been hazarded by some lay ornithologists, upon whom scientists are apt to frown, that swallows pursue the sun. This group are in a sense correct, though nowhere has the author seen the influence of the sun on the swallows explained. The departing sun summons the first of the cold northerly winds upon the motion of which the birds' flight and speed will be superimposed. It

kills or carries south the flies upon which the swallows feed, and physically agitates the birds in their northern 'home.' High winds will re-enforce the effect of the falling temperature, for, as has already been shown, the effort of a bird in maintaining itself is greatly increased when its medium is on the move, the exertion passing the bounds of possibility when the speed of the wind is equal to the flight-speed of the bird.

Herein seems to lie a contributory explanation of the first passage south of a first-year bird which has yet to establish a second 'home' in the south, thus providing the two spots between which the bird is said to oscillate for the remainder of its life. The young birds are weaker fliers than their parents, possibly a shade less robust in withstanding cold, though this is mere hazard. After the equinox these young birds, the weaker fliers, will very soon encounter conditions the whole trend of which is in the direction in which their parents and forbears have passed south, and in which their descendants will continue to do so, as long as temperature continues to rule, as it does rule, all physical phenomena. Such a first-year bird, unlike the older birds, has still to establish a southern home on reaching a suitable climate, which it will do if other birds do. The general drift south may well be re-enforced by flight in a southerly direction with a herd of other birds. This first flight, however, will always be 'blind,' as the bird can know nothing

of its new southern home. The return 'home' to the north will always, for individuals, be to a *definite* home, temperature again providing the necessity at the same time as it supplies the means by setting the 'dome' in motion to the north. The necessity may be a temperature above or below what is essential to the bird, but the means remain the same.

Thus it will be seen that both in the north and in the south the three considerations of necessity, means, and reward are all met by the mechanics of temperature. Though every natural phenomenon is simple when the laws which govern it are known, such a simple solution will doubtless be distasteful to those who dislike and mistrust simplicity, as does seemingly the profession of Science, but it will particularly offend those physiologists and biologists who trace most things in the animate world to sex and passion and who teach us that the urge of reproduction is the *motive* of the northward flight, as they teach it is the motive of most human actions. Here again seems to be a confounding of cause and effect. It will be shown in a subsequent chapter how exquisitely the laws of flight harmonise with the mating and monogamy of birds, and indeed ensure it. It is only intended to draw attention here to the fact that such a brilliant ornithologist as Mr. Coward has exploded this 'reproductive-urge' motive of migration by pointing out that hosts of immature birds return north each season,

and that countless mature birds never mate or reproduce their species at all for reasons that can be shown.

It is not intended to examine in this chapter the evolutionary law (so-called) of dispersal, extension of range, and so forth. This must be reserved for a later chapter. It is proposed now to pass on to the nature of the migration passage when once it has been set in motion by the universal arbiter of nature, temperature, in other words by the sun, which it is not surprising to find as an object of worship in heathen lands. Here we are dealing with those laws of flight which have been carefully examined in preceding chapters, and which are as changeless and as simple as the laws of physics and dynamics.

Let us now suppose a swallow at its northern 'home' in Kent to have been rendered uncomfortable by a fall in temperature, accompanied as this will be after the equinox by a northerly wind and the loss of its food-supply. It leaves perforce its northern 'home' and heads straight for its southern 'home,' if it indeed has one, with the same unerring accuracy as is displayed by the terns, which, over a waste of unknown and unknowable waters return to their nests, as do the swallows themselves in the spring. Though they head straight for this alleged southern home, indeed because they do so, they will proceed on great curves, the proportions of which will vary directly as the speed and direction of the wind. The number of rests on the

voyage will again be conditioned by the wind, the endurance of the bird on the wing, and the locality in which the bird is found when darkness is approaching. Circumstances of wind and locality on the approach of darkness may render the voyage a very speedy affair or a protracted one with numerous stops on passage. Furthermore, a great percentage of casualties must inevitably occur, for the bird may be over the sea as its powers of endurance lapse, or over land in darkness when it can fly no longer, in which case it will almost certainly be killed, because birds cannot alight if they cannot see a point to head for, thus bringing them automatically head to the wind which they do not feel.

Ornithologists of standing have emphasised again and again that portions of these long migration passages often, though not always, take place at great altitudes, and this being so the passage between resting-places on the way to the 'southern home' may well be accomplished at great speeds, which may at times reach a speed over the ground of 150 m.p.h., for, as is well known, the velocity of the wind increases greatly with increased altitude above the earth. The utilisation of these high altitudes with the corresponding speed of the wind at these altitudes has been quoted by many ornithologists as a proof of 'mind' in birds, for, it is argued, the birds 'know' that at these great heights the favourable wind will increase in speed. This matter is of importance, because the first Law of Currents

proves quantitatively that this argument for attributing 'mind' to birds is without foundation. The birds feel a calm throughout their flight, no matter at what height they fly, or what the speed of the wind—their dome—may be. This is well shown by the fact that birds are often seen flying high against the wind when descent from such altitudes would be advantageous to progression. It is doubtful if Professor Patten himself would attribute to the birds the power of abstract reasoning on the nature of wind (which they do not feel). He cannot suppose that birds have reasoned out that the friction of the earth slows up the wind at the surface while the higher strata pass on progressively (up to a certain height) at ever-increasing speeds. Man himself has had to discover these phenomena by experiment with balloons and sextants.

Why then, it may be asked, do birds travel at these great heights and thereby gain, as a general rule, just the advantage which they require, though occasionally it turns, unknown to themselves, to their disadvantage and premature exhaustion? Here again the answer seems perfectly simple if we look to natural causes and clear our minds of the belief, so sedulously fostered by evolutionists in recent years, that the mind of birds is of the same nature as our own. When we observe swallows, or indeed any birds, flying over our heads on land, we are apt to forget the vast distinction that exists between sea-level and land-level. Every

large obstacle on land that a bird encounters causes the bird to rise. These obstacles vary in different parts of the country, and in different countries. They may vary from trees and hillocks in low-lying country to high table-lands and great mountain ranges. But the normal flight of birds, due to gravity, anatomy, and other causes, is horizontal. Thus birds launched on a long continuous passage will pass, during the passage, over great land elevations. Having cleared these, they will proceed on their normal horizontal flight which will carry them over sea, desert, and average land-levels at a considerable elevation, at which elevation the speed of the wind will obtain a great acceleration due to height above the *average* land-level or sea-level.

There is yet another school of scientists who assert that birds *elect* to fly at these great heights (much as they assert that birds elect to fly against the wind to avoid rumpled plumage) in order to sight prominent and remembered landmarks by which to lay off their courses to their 'home.' Here again we see a very natural reason for attributing to birds a 'mind' which does not differ in kind, only in degree, from our own. It may be said that if birds indeed steered by recognition, their minds would not only be the same in kind as an airman's mind, but in many respects they would be superior in degree. It will be seen, however, that since birds always fly in curves, the recognition theory of

flight vanishes like smoke, since the curves of flight are as variable as the winds of heaven.

There is one case and one case only in which an aeroplane could, theoretically, exactly reproduce the homing of a swallow to a definite fixed point. Let us imagine the northern home of an aeroplane to be the exact magnetic north pole, and the aeroplane to be bound for it from any place on earth. To make the analogy realistic we will assume that the aeroplane can always obtain fuel, that is to say food, at any spot on its long journey to the magnetic pole. In this one and only case that exists the airman has merely to keep his machine headed on a magnetic compass course due north whenever he is on the wing and he must eventually arrive, excluding accidents, at the magnetic north pole for which he has unceasingly headed. On his voyage to the north magnetic pole he will execute great and varying curves, the curves varying according to the winds which he experiences, and though he will, therefore, never pass over the same country a second time, sometimes not over the same continent, recognition is as unnecessary as it is impossible, for he must eventually reach his northern home, the magnetic north pole, by merely persisting to fly on an accurate compass course north. It must be emphasised, however, that no suggestion is made that birds have a magnetic sense. Indeed a magnetic sense is out of the question for birds for the simple reason that the employ-

ment of magnetism, as in a compass, necessitates careful calculation of a course from an inanimate magnetic pointer. The sense of direction which birds do possess is imponderable to human beings, but its effect is the same as in the one and only case that is conceivable for men and machines. To us the terrestrial magnetic poles are the only two spots in the world for which airmen can head where the compass will do for man what a bird's 'sense of direction' will do for birds between *any* two spots. For this very enlightening analogy the author is indebted to Mr. A. H. Pollen.

Though the prevailing winds at the respective seasons of the year favour the passage of the swallows and other non-hardy migrants, thereby, of course, rendering the general trend of the route constant, a most casual acquaintance with the winds teaches us that within certain limits, that is to say within the general passage route, winds will vary very considerably both in speed and direction. This being so, we need not be surprised "that fly-lines vary in a most striking manner," as Professor Patten emphasises in his previously quoted article in *Discovery*. This striking variation of fly-lines, it may be said in passing, seems a curious point for a scientist to stress so vigorously when he is engaged in demonstrating that birds fly by recognition, such recognition being very properly advanced as a proof of 'mind' and the capacity for reflection.

In a long flight in a wind of considerable velocity

a variation of a few degrees in the incidence of the wind, or of a few knots in its velocity, will be ample to ensure a variation of fly-lines sufficient to make recognition of any landmark impossible. Furthermore, birds cross stretches of sea and desert, and fly at night, when marks for recognition are evidently unavailable. It is true that in *Discovery* Professor Patten pooh-poohs the author's assertion that birds cover great stretches of sea in migration flights, but in doing so he lays his own *detailed* knowledge of the movements of birds open to the gravest question, for, as Mr. Coward points out in his engrossing little book *The Migration of Birds*, several species of American shore birds, notably the American golden plover, make an annual voyage of 2,500 miles over the sea from Nova Scotia to South America, the return route being overland and far to the westward. These two authenticated routes provide, perhaps, as clear an example of an uninterrupted curve of flight pursued by birds on passage through an air-current as any to be found, providing at the same time a striking commentary on the power of, or need for, recognition by birds.

Mention has been made of *variations* of wind within the prevailing limits, but before leaving the subject it is necessary to point out that it not infrequently happens that the wind assumes a totally different direction from the normal, a westerly wind in southern Europe changing,

perhaps, for a day or two while the birds are on the wing, to a strong easterly wind if not a gale. If this change of wind is sufficiently strong and protracted and from a disadvantageous quarter, the curve of flight may swerve out into the Atlantic and merge into the north-east trade-wind, in which case hosts of birds will perish in the sea because their distance over the earth made good will approximate to the difference instead of the sum of the wind and flying speed. That such wholesale disasters do occur is evidenced by the fact that the bird population, including the swallows, remains, comparatively speaking, constant, in spite of the vast additions to the population during the spring.

In concluding this necessarily abbreviated examination of a great and varied subject it is necessary to draw attention to the scope within the laws of flight for almost infinite variation in the observed facts of the great 'migrations.' The dates on which the necessity and the means of 'migration' coincide are variable within certain limits. The direction from or in which the birds arrive or depart will also vary within limits, since birds always arrive at their journey's end exactly head to the wind, which is itself variable. The localities in which the birds are first sighted will vary with the curves of flight. The plentifulness or otherwise of the birds in a particular year will be governed by the direction and force of the winds in which the birds have spent the intervening winter months. The revisiting

or desertion of a last year's nest will give a clue to the winds to which that particular nest-full of swallows, old and young, were subjected in their absence. Unlike some species of birds, the dangers to which fledged swallows are exposed are almost exclusively the dangers of the element in which they live and have their being—the air.

Before leaving the subject of the regular vernal and autumnal passage of the swallows and passing on to other aspects of bird life, it may be well to refer to the fact that the swallows not infrequently arrive in this country during cold and inclement weather, during weather, in fact, which is seemingly chillier than is the weather in which they leave our shores. Whether the lowest temperature reached at night after the arrival is in reality lower than the lowest night temperature reached in the autumn before they leave, the author cannot say, as he has been unable to find these particular statistics in any book on migration.[1] However this may be, it may safely be said that the day of arrival, if cold and inclement, as it is likely to be, is a day of discomfort and restlessness for the birds, and furthermore, should a strong wind arise after their arrival they will leave their 'homes' temporarily when the speed of the wind reaches

[1] In 1928 in Norfolk a few very sharp night-frosts occurred within a day or two of the disappearance of the swallows with a north-west wind. The days, however, were beautifully warm and roses in full bloom.

proportions which introduce an exceptional strain on the flying powers of the birds, for swallows live almost entirely, by daylight, on the wing. Such a sudden cold wind will carry off temporarily to more suitable surroundings the first birds to arrive, and delay the arrival of the remainder. Thus truly one swallow, or a few swallows, do not make a summer.

But if their sorrows and discomforts endure for a night, joy comes unfailingly in the morning, for swallows are, in very deed, the *harbingers* of summer, not because they know that summer is near and therefore come to enjoy it, but because they have been borne to us in the very bosom of summer itself—the south wind. Though they have been coming with the summer, it will not be overlooked that they have been flying at a considerable speed *through* this summer—the south wind, and thus it is not only possible, but probable, that they will outstrip the summer by a few hours, at most a very few days, and reach us before we experience those summer surroundings in which, through which, and out of which they have flown. Thus are they harbingers in the strictest sense, and their promise, even if a little delayed, must be fulfilled, for otherwise they could not have reached our shores at all, as a glance at the distances covered by swallows in a wind, referred to in the second chapter, amply demonstrates.[1]

[1] See page 26.

It will be noticed that the author has spoken of a 'southern home' for non-hardy birds, but he has been careful not to commit himself to such a view. He has done so out of deference only to that great body of ornithologists and bird-lovers to whom this southern home is almost sacred. Mr. T. A. Coward, however, does not share the general belief. On page 26 of *The Migration of Birds* he makes it clear that swallows in southern lands are *travellers* and *vagrants* without any fixed home. It was gratifying to find this authoritative confirmation of a conviction, amounting to certainty, to which the author had already been driven by deductive methods. Swallows live upon the wing and feed upon the wing, their food being air-borne. It will thus be seen that when conditions become permanently unstable the birds and their food become equally subject to drift to an extreme degree. Because any wind to a bird in flight is a moving calm they will pursue their food, as often as not, in the direction in which the air is moving, thus rapidly losing ground which they cannot recover, though the home of their birth is still, as for all birds, an object for which they strive when not satisfying their voracious appetites. This seems to account for the flocks of tired birds in the autumn, birds which have no *intention* of 'migrating' but which are compelled to do so, fortunately for themselves, by the hard necessity of remaining on the wing in ceaseless pursuit of food which is passing away with the moving air.

Thus they will drift away to southern and eastern lands, returning to their homes, like other birds, when conditions permit. Hence, as frequently happens, swallows will unexpectedly return in a warm November, disappearing again when conditions are adverse. So will they often vanish for a few days after their first advent in spring. Young fledged birds will drift away before the parent birds, and they will drift farther afield and thus return home later. There is no *motive* or *intention* in 'migration,' on the part of the bird: only stark and compelling physical necessity because the bird is parasitical to a moving medium. Swallows, like all other birds, are subject to the ceaseless ebb and flow of the wind, and 'Migration' as an objective and purposeful movement is non-existent. We shall all, however, continue to speak of Migration, just as from habit and happy association we continue to speak of the rising and setting of the sun.

CHAPTER VIII

THE EBB AND FLOW OF WIND AND BIRDS

In the last chapter an examination of the passage of the swallow species was undertaken. Though this examination was of necessity abbreviated and incomplete, the subject requiring a book to itself for its adequate treatment, it is hoped that it may throw some new light upon a subject that has always been as contentious as it will always remain fascinating. It is proposed now to pass on to that great 'drift' of the hardy birds which is only a little less pronounced phenomenon than is the departure of the swallows. It will be found that this ceaseless mechanical ebb and flow of bird life will provide us with quite simple explanations of a large variety of avian curiosities, some examples of which will be dealt with in detail in subsequent chapters. It is intended for the present to confine the attention of readers to the general question of bird movement in space, and to offer an explanation of the problems of local and variable migration.

Since the laws of flight laid down in the first part of this book are true, many readers will already have seen for themselves the inevitable deductions to which they give rise, and to such readers the

continuance of the discussion will seem to be an act of supererogation if not a definite source of tedium. In case, however, the author may be privileged to have readers to whom the unrefutable consequences of the laws of flight are not altogether clear, he will continue his self-appointed task of exposition in the hope that he will be able to retain their interest and curiosity without sacrificing their sympathy.

It is a matter of general knowledge that in Europe and England there are a great number of species of birds which are hardy in the strictest sense of the word, living throughout their lives in northern lands, and capable of enduring great temperate heat as they can endure great cold. We all know many such birds. There are others which may be called half-hardy birds and others which it would be difficult to place definitely in either of these two categories. Trees, shrubs and flowers present, in this respect, a very close analogy to birds. Now the flying powers of birds are as variable as species, the speeds of flight of the innumerable species shading imperceptibly down from perhaps 60 m.p.h. to 10 m.p.h. Furthermore, some birds have seemingly a fixed speed, or, at most, a variation between their maximum and minimum speed that is exceedingly small. Others, the large-winged sea-birds for example, have a great range of speed between their maximum speed and the minimum necessary to avoid 'stalling,' that is to

say, falling like a stone to earth under the influence of gravity.

The point to be clearly visualised is this. All birds have a maximum flight-speed which they cannot under any circumstances exceed, and these maxima are as variable as are the species. Furthermore, in any single particular species these maximum speeds will vary with the sex and age of the bird. Thus in a male bird, which is slightly heavier than the female, the minimum speed of flight will be a shade faster than the minimum flight-speed of the female and *vice versâ*. Similarly a young newly fledged bird will be slower on the wing than its parents.

It will be seen, therefore, that the flying powers of the bird world are more variable even than species, a single family of wrens or robins in their first year as parents and young being divisible into three speeds.

Before leaving the question of the speed of flight, it is essential to consider the maximum continuous *endurance* on the wing of the various species. The maximum power of endurance on the wing is clearly as variable as are the flight-speeds, and, as before, this endurance is variable not only between the species but between individuals of a particular species. Thus the male and female robin will become exhausted under similar conditions at different times, as also will newly fledged or young birds.

Turning now from the speed and endurance of birds on the wing to the speed of the medium in which these powers of flight are exercised, we are at once presented with an even more marked variation. Not only do winds vary almost infinitely in speed in the course of the seasons, but a particular wind varies with altitude. Not only is the speed infinitely variable, but the directions also vary, though at particular seasons and in particular localities a certain definite trend of the wind prevails. Over western Europe, however, in the heart of great land-masses, the winds are at certain periods of the year very variable even in general trend.

But there is yet another aspect of the speed and direction of the wind to be considered. A particular wind is variable in different, but closely adjacent, localities. Thus a wind at the surface of the earth may have a maximum speed of 30 m.p.h., but its speed will be varied according to the nature of the country over which it is passing. It may attain its maximum of 30 m.p.h. on a flat and open moor, shading away to a dead calm in the heart of a wood, or perhaps to gentle eddies such as are to be found in a rapid stream of water. Not only will the speed vary, but its direction will be varied by geographical features, so that while the general trend is perhaps north-easterly, eddies will occur among buildings, around trees, and on the outskirts of woods.

If now upon such an infinitely varying medium, varying though general in trend, we superimpose the variable flight-powers of birds exercised within this moving medium, we get variation piled upon variation, and a continual drift, but with a perfectly orderly and intelligible general trend within the limits of law. The extent of this unceasing drift will be regulated according to the species, and therefore habits, of the bird. In the case of the very weak fliers, living for the most part in sheltered surroundings, the effect of the wind will be slight so long as circumstances do not draw them out into full exposure to the passing current. Moreover, within a few inches of open ground, especially if such ground is uneven or dotted with shrubs or stones, there is a great reduction of wind-speed which will enable small birds, by that combination of flying and hopping which we so often see, to progress to windward, though with great effort, for a certain period of time. Birds living in exposed localities will be exposed to stronger currents, the effect of which on stronger fliers will render their drift proportionate. Thus there will be an unceasing tendency for the entire bird world to drift to leeward with the prevailing winds at a speed which corresponds in some degree to the average difference between the speed of the prevailing wind and the bird's maximum flight-speed and powers of endurance on the wing. Drift, it will readily be understood, can be expressed not

only in distance and speed, but also in *time*, if a bird sets about recovering the distance it has drifted to leeward, a point which leads me back to the one assumption which this book contains. It has been assumed that birds have the inherent power to 'sense' a given spot in space which is their 'home,' this sense of exact direction being the sole and automatic (but at the same time amply sufficient) guide in their navigation.

This homing 'urge'—a continual striving for their 'home' or 'territory'—is a phenomenon universally insisted upon by expert ornithologists, and provides us with the master-key with which we may unlock a small door into the chamber of knowledge, revealing a perfect harmony and ordered sequence in a world of seeming chaos of irresponsibility and variation.

It may make the understanding of the whole matter simpler if we go on another short excursion into the realm of imagination. Let us convert the invisible wind into a visible fluid, eliminate the third dimension, and change the birds into boats with their wings as *oars*. Let us also reduce proportionally the great speeds of flight and wind to speeds which more nearly correspond to the condition of rowing-boats in a great tideway.

Let us picture such a scene to ourselves. We see buildings, hills, trees, and woods projecting out of the surface of the water, whereas moors and all

open and flat spaces are submerged. On the surface of this calm sheet of water, in the open and uninterrupted spaces, in the water-logged woods, attached to trees, bushes, rocks, buildings, and all projections, let us imagine myriads of tiny oar-propelled boats capable of speeds varying infinitely from 6 to 1 m.p.h. Let us imagine that the whole body of this water is capable of movement at speeds varying from 8 miles per hour to zero, just as a great spring-tide varies. Let us imagine also that each of these tiny cockle-shells of boats has to launch out on the bosom of this watery environment scores of times a day for the obtaining of fuel in the form of food, and that on each occasion the little boat returns to the same moorings. We shall expect to see the larger and stronger rowing-boats in the more exposed districts, and the tiniest cockle-shells of all in amongst the reeds, branches, and tangled growth of the woods, and in the shelter of the rocks.

Let us suppose that we first sight this picture at dead-slack water, the boats casting off and making fast with ceaseless bustle and activity. Now let the slack water of spring and early summer pass and the water commence flowing strongly in obedience to the sun as do the tides in the sea in obedience, mainly, to the moon, increasing with variable velocities to 8 miles per hour and decreasing again to zero. All, from time to time, will be rowing for their moorings, some unable to return

and forced to moor up to the nearest object they can cling to, others returning to their own moorings but with increasing difficulty and exertion, and with failing powers. All the little cockle-shells are executing the strangest of curves because all or each is endeavouring at varying speeds and from different points of departure to reach a variety of fixed points through varying currents. The curves may be strange or imperceptible to us, the spectators, because we do not know for what particular fixed spot a particular little cockle-shell is heading. Though all seems chaos to us, all is in reality ordered and regular. Let this great tide hold for a few days, reaching very occasionally 8 m.p.h., and every cockle-shell will gradually vanish far over the horizon, except perhaps a few which have paddled tenaciously in the eddies and slower streams of the woods and gardens, and which have not been sucked into the main tidal stream while rowing out of shelter for food.

Let this great tidal stream now ease down and very gradually turn. Over the horizon the stronger rowers will eventually appear, the weaker rowers following days, perhaps weeks, behind the stronger, until at last, in a long calm spell, all classes of the little boats will be back at their moorings, though many old moorings will never again accommodate a particular boat of its class, and many new moorings will be claimed and occupied. As each little boat reaches its moorings it will of course be seen that

each one reaches that spot exactly bows on to the current prevailing at that particular spot.

Here we will leave fancy, reconverting our two-dimensional tide into an aerial environment, the little oar-propelled cockle-shells into birds, and return to a general consideration of the drift of birds as we witness it unconsciously year in and year out, except during the usually quiescent months of late spring and early summer. What must be the effect of superimposing upon the variable winds the variable speeds and powers of endurance of the many species of birds, all of which are diligently engaged in a ceaseless effort to maintain themselves in their 'territories' and at their 'homes' within these territories, or in an effort to return to their territories and homes, subject to the search for food, when the winds have carried them far away?

We shall find, in the first place, a vast ebb and flow of bird life over definite regions of the world, this ebb and flow synchronising with the prevailing winds of those great half-yearly tides upon which the birds are supported and in which they are borne. The extent of the ebb and flow of the birds, as opposed to the wind, will be governed by the powers of the various species to stem this tide, these powers being, in their turn, regulated by the flight-capacity and endurance of the birds, which in their turn again are governed by the habits of each species and the localities—woods, gardens, open spaces—which natural habit leads them to occupy. We find

that the tendency of northern birds is to drift south with the northerly winds that bring cold and inhospitable conditions, with a prevailing tendency to the eastward in more southerly parts away from that death-trap to air-borne bodies—*the Atlantic*. The *range* of the various species, the average dates of their return to their 'homes'—their nesting-places and birth-places—will vary between the species in accordance with their flight-powers and habits. Within these general phenomena we should expect to find, as indeed we do, exceptional appearances of rare birds, and the disappearance from this country, perhaps for years, of certain species. Red-legged cuckoos and other American and Canadian birds are periodically found in this country, a matter for no surprise when we comprehend the tremendous velocities of westerly winds in the North Atlantic.

In a recent ornithological article in *The Times* the arrival of rare Arctic birds in Scotland during an exceptionally hard winter was discussed. The explanation advanced was again a *conscious* quest for food on the part of snowy owls and other birds, the idea being that the Arctic regions were so exceptionally inhospitable that birds deliberately forsook these bitter regions for the comparative friendliness of the Scottish climate, of the existence of which they are supposed to know and about the nature and properties of which they are presumed to speculate. But what causes an exceptionally

hard winter in Scotland? The steady and continual drift of the Arctic atmosphere to Scotland (the north wind), a drift which may become slow and almost imperceptible in Scotland, but which is rapid and continuous in Arctic regions and of such a nature as to cause comparatively weak-flying birds to pass away in their drifting medium when the exertion of maintaining themselves becomes over-great or *over-protracted*. This ornithologist presumed exceptionally inhospitable conditions in the Arctic, an assumption in no way legitimate. In any case a few extra degrees of frost, where cold is reckoned in tens of degrees below zero, is hardly likely to be noticeable or unduly troublesome to Arctic birds.

Reference is frequently made in ornithological books, and notably in *British Birds*, by A. C. Butler, to the fact that birds, otherwise 'migratory,' are found to be indigenous in the Cape Verde Islands. This matter is also referred to by Darwin and Dixon in discussing the evolutionary 'Law of Dispersal.' Lay readers, who are not for ever seeking props with which to shore up the jerry-built edifice of evolution, will see at once that the north-east trade-wind must render these drifted European and North African birds indigenous,[1] just as it would

[1] It is open to question whether these European birds are in reality indigenous in the Cape Verde Islands for any length of time. It seems more likely that in these wind-swept islands birds are carried away off the island to the south-west by the north-east

have rendered Señor Franco and other famous airmen 'indigenous,' had they not *elected* to pass on south-west to Fernando Nerhona and South America in this mighty south-western stream, though some airmen, alas! by ceasing to be indigenous, met their death, while others avoided 'indigenousness' by departure to the north in ships.

Leaving exceptional phenomena introduced by a combination of exceptional circumstances and returning, for a short time, to the general ebb and flow of birds, we can contemplate a harmony in a seeming chaos that may, without exaggeration, be described as beautiful and awe-inspiring. This ebb and flow of birds upon the bosom of the great winter ebb and summer flow of the sun-controlled aerial tides ensures to each species conditions essential to the survival of the species, without a glimmer of understanding or conscious effort on the part of Nature's beneficiaries. It provides food and *rest* in a restless environment. It gives to man an ever-changing and ever-recurring joy. It may leave the thrush and robin in our sheltered gardens where food and shelter will be available in the bleakest weather, while others of the same

trade-current, and that their places are constantly filled by other birds of the same species which have been drifted, like their predecessors, from Europe and North Africa. Since birds of the same species are indistinguishable one from another, such a process of continual replacement would have all the appearance of 'indigenousness.'

species, in bleak and exposed localities, will automatically pass to more favoured regions. Some may be drifted out of the country to southern lands, others from the north of England to the south.

The dispersal of the birds will be exactly harmonised with their essential requirements, and will provide the necessary environment at all seasons. Not only will the bird world as a whole be suitably dispersed and finally reunited, but the mated birds and young of one nest will themselves be inevitably separated for the greater part of the year, since their flight-powers are not identical. The young will drift farther than their parents and their return to their home will tend to be delayed. This vast ebb and flow will tend, furthermore, to distribute the flora of the northern hemisphere and to cause variation in plants and trees, as birds, being seed carriers, are one of the great sources of distribution and interchange of vegetable life.

These conclusions may seem fantastic and far-fetched, but since winds are air-currents and the laws of currents are indisputable, these effects are mathematically inevitable and therefore obtain.

It is not proposed to pursue very much further the general consideration of the ebb and flow of bird life and its general effects. Particular aspects of the phenomenon will be examined in some detail in following chapters, but before leaving the general question it may be well to draw the attention of readers to the exact similarity of one bird to another

of the same sex and species. With the rarest of exceptions, as in the case of a marked bird, one robin of the same sub-species is the same as another, one white-throat is as indistinguishable from another as is a buttercup from its neighbour. We thus see that this great ebb and flow can take place before our very eyes and under our noses, before the last warbler or swallow has drifted past us, without the movement being apparent.

One vitally important fact deserves emphasis, even at the cost of reiteration. The birds' movements in these mighty streams of air are always on curves of infinite variety, variable between the species, as they are variable for birds of the same species. A particular bird will never return in the spring to its 'home' by the route on which it left, nor will the sexes arrive simultaneously. Even from day to day, within a particular territory, the bird is going to and returning from its feeding-ground on variable curves over new ground, which definitely precludes the employment of or need for recognition in its drifting passage through life. This matter can scarcely be over-emphasised, going as it does to the very root of natural history, and philosophy based upon natural history.

If we look at the apparent chaos of a great crawling city, we know that each unit of that seething crowd is pursuing its *elected* path on a fixed platform—the earth—with reason as its guide; recognition, connoting memory, being reason's vehicle. Substi-

tuting in the myriad bird world for a *fixed* platform an *ever-moving* platform, and for reason, natural dynamic laws and the 'homing sense,' we see at once a great and ordered community with physical law as its inexorable tyrant—a mechanical policeman on point duty.

CHAPTER IX

THE DESERTION OF NESTS AND OTHER PHENOMENA

HAVING examined in some detail, though by no means exhaustively, the spectacular seasonal drift of a non-hardy bird such as the swallow, and having discussed the general question of the unceasing drift—the ebb and flow—of the bird world in general, it may be of interest to apply the unchanging physical laws of flight in a moving medium to a few particular and noteworthy aspects of bird life.

The desertion of nests during the mating-season is a subject of perennial discussion, this constantly recurring event being very widely attributed to distress on the part of the mother-bird brought about by the removal of some of the eggs, or by fear of human beings who have discovered her nest. The sentimental school, the term being used in no derogatory sense, has contracted the habit of attributing to birds the feelings and thoughts which actuate ourselves, and the influence of this school is so powerful that we are in danger of being saddled with fussy and finicky legislation directed against that multitude of boys and grown-ups to whom ornithology is a hobby and an innocent delight,

and bird-nesting a healthy and harmless excitement.[1]

The evidence of the total lack of affection in birds for their mates or their young is conclusive. Anyone who doubts this seemingly brutal assertion would do well to study Lord Grey's recent book, *The Charm of Birds.* Robins never sing more blithely than after the violent death of their brood. Dunnocks are eager in rearing a cuckoo which has expelled their natural children which lie mangled and dead beneath their nest. Birds are as happy sitting on a few stones as on their eggs. Their 'minds' seem as completely conspicuous by their absence as do their affections. A bird has not sufficient sense to draw an egg underneath her if it has been displaced an inch. Move a nest of a ground-bird but a few feet and it will fail even to locate it.

The total lack of sense in birds is well illustrated by A. G. Butler in *British Birds*, where, in writing of tits, he recounts the following significant story:

"The nest, when I discovered it, contained four eggs only. Each day I took one egg, but sub-

[1] Unsentimental but highly competent ornithologists have emphasised again and again that the depredations of human beings on the wild-bird world are negligible when compared to the losses imposed upon the generality of birds by natural causes, of which flight failure is outstandingly the greatest contributory factor.

stituted a marble for the last one on which the tit was contented to sit. After three or four days I removed the marbles, and a day or two later the nest: what then was my astonishment, about two days afterwards, to find the stupid bird squatting in the hole in the wall. She had the sitting fever on her and meant to sit it out."

A similar story is told of the tree-pipit.

If, then, we rule out of consideration both affection and mind, can we account by other means for the ever-recurring desertion, sometimes wholesale desertion, of nests? Most certainly we can, and for purely mechanical reasons. The nesting-season takes place, in the main, during the quiescent period which succeeds the change of the seasons at the end of March. Thus, as a general rule, the birds can maintain themselves at a fixed spot for building, laying, sitting, and, most important of all, feeding, throughout the whole cycle of reproduction. Should, however, a strong wind arise during this season, a wind of velocity exceeding the bird's flight-speed, the bird must of necessity immediately desert, for it cannot return to the nest. On the other hand a very moderate wind, if protracted in duration, will force weak fliers *eventually* to desert because the unceasing effort of providing food will be increased. It is not generally realised that wind of any strength, and from any direction, adds to the time required for a journey by air—by a bird or an aeroplane, an airship

or an insect—if return has to be made to a fixed spot.

This point, so far as aeroplanes are concerned, was stressed by Air Vice-Marshal Brooke-Popham in a lecture at the Royal United Service Institute. In the course of his lecture he said :

"I might mention that wind is always a disadvantage to an aeroplane if one wants to get to a place and come back again."

The extraordinary extent of this disadvantage is well illustrated by figs. 5 and 6, Chapter V. The increased time occupied on each journey in pursuit of food is of course reflected in increased exertion to an animate creature, and in fuel expenditure in an inanimate machine such as an aeroplane.

In cases where the male bird feeds the female on the nest, or *vice versâ* in species where the male sits, the exhaustion of one will spell the exhaustion of the other, with enforced desertion by both. It is interesting to note that those birds which are most prone to desertion are also distinguished for multiple nest-building and for their prolific egg-laying.

An interesting example of wholesale desertion of some thirty nests in a small area is given us by Miss Frances Pitt in an article in the *National Review* of December 1927. Here she relates how in early June in Norway, in a small wood of birch

trees, a colony of fieldfares, bramblings, and other birds deserted their nests and their eggs. Having graphically described the building of the nests and the laying of full clutches of eggs in warm, calm weather, she tells us of the oncoming of cold and snow, to which cold she attributes the wholesale desertion. Here, again, we see an incidental *effect* attributed as a *cause*. It was the north wind that brought the snow and the cold, and it was the wind, not the cold, that caused the desertion, a fact borne out at the close of the article by Miss Pitt's quite casual reference to the *searching wind* which she experienced at this time. As the fieldfares deserted, their place was taken by Arctic birds such as Lapland buntings and temmincks, a fact which accurately demonstrates the ebb and flow of the birds in the great wind-currents. She relates how that after some days the wind shifted to the south, with the natural result that the birds were enabled to return to those nesting-spots for which they are ever striving.

Miss Pitt expresses her astonishment that 'the most unexpected birds' carried on nesting when the others deserted, these birds being the house-martins. The non-desertion of the house-martins, so far from being inexplicable, demonstrates conclusively the accuracy of the author's thesis, and at the same time explodes the popular idea that *cold*, as such, upsets the birds. Martins are powerful fliers, their speed on the wing being perhaps

twice that of the birds that deserted their nests. On the other hand, house-martins are non-hardy birds, and if the cold in itself was sufficient to upset physiologically the hardy birds which deserted, its effect on these regular southern non-hardy birds of passage would have been disastrous.

It may seem, at first sight, fantastic to attribute to mere physical laws of flight such a wonderful phenomenon as the monogamy of birds, separation of mated birds for most of the year, and their reunion in the nesting-season. To many it will seem not merely fantastic but a positive offence against that pretty romance which we so industriously weave round the phenomenon. The reunion of mated pairs, if achieved by any means other than physical compulsion, implies memory, recognition, choice, selection, and deliberate faithfulness, all of which imply mind and affections which are the counterpart of our own.

Some reference was made to this question of reunion and monogamy of birds when discussing the general question of the drift of birds, but the matter is of sufficient interest to receive a little more detailed treatment than was there bestowed upon it. When the mating-season is over, the male, female, and young may perhaps maintain themselves in the same territory for some little time, but as the season grows less calm and stable the inevitable drift of the birds will set in. Once the bird begins to lose ground, so to speak, it will

be lost in varying degrees by species, sexes, and ages, since the flight-capacity of all varies. Not only so, but the male and female of a particular pair will drift apart in direction as well as in distance, for their curves of flight vary with their speeds. Not only will the mated pair be separated, but the young will be dispersed from the parents. Thus a pair and their young, which nested in Cheshire, might drift in the course of the autumn and winter to Suffolk and France, the weaker fliers tending to get farther afield. All, however, by completely different routes from the routes by which they dispersed will press home to the spot at which they reproduced their species, or at which they were born, and survivors will eventually arrive exactly, infinitely exactly, at the same spot, so that reproduction and re-mating will be a matter of mathematical exactness if both parent birds, or any former tenants of the same nest, survive the winter. In the mating-season a nest, prepared in advance by the stronger flier—generally the male—will afford a common shelter for their mutual satisfaction. Not infrequently more than one female, one of the young, will lay in the same nest, and hence phenomenal clutches.

If, however, owing to circumstances of wind, the female—or young—returns to the territory of her mate before or after the mating-season, and thus from time to time to that exact spot in the territory which is the mutual 'home,' there is certain to be

trouble between the birds, all of which blindly seek the same spot. If we think of two human beings without reason, and therefore without memory, in fact mentally blind, whose one object in life is to reach and to hold a particular bedroom, there is likely to be the same vindictiveness when they both arrive in the same bedroom, a vindictiveness that would vanish if a bed was placed in the centre of the bedroom at the 'mating-season.' Such a concurrence of two animate but unreasoning creatures at a spot which is a lodestone only to a formerly paired male and female and last year's young would explain the apparent dislike of the male for his paramour and species which, on any other ground, must be a puzzle indeed to those who regard birds as a pattern of faithful and loving chivalry which human beings might well emulate.

Those who resent the assertion that birds are mere machines, and who like to impute to them the noble qualities that we frail and erring human beings so often singularly lack, may be comforted by reflecting that the perfection of their behaviour, their faithfulness, their beauty, the beauty of their homes, their rigid obedience to physical law, and the symbol they thus afford of the beauty of moral law, are a manifestation of the perfect nature and goodness, forethought and care, of the Divine Mind that conceived, designed, and created these living machines to fit those physical laws outside the

bounds of which Omnipotence and Omniscience Themselves never trespass, even in so-called miracles, and with so few of which laws we human beings are acquainted.

Turning again to the death-roll among birds, we can find a very simple explanation of the holocaust that annually attends this aspect of animal life. Leaving out of account the terrestrial enemies to which bird life is subject, let us consider the birds in our corner of the world which pass backwards and forwards across the North Sea and Channel. Let us assume a bird to have a non-stop flying power, that is to say a natural fuel-supply, for a voyage of 180 miles. Suppose this bird to be bound for a voyage across the sea of 100 miles. Suppose, again, the speed of the wind—the air-current—to be 20 miles per hour. Assume the bird's own speed of flight through the air to be 30 air-miles per hour. Finally, assume that the bird is bound for a particular spot at the end of its 100-mile voyage—an old nest or bush.

With these assumptions as premises—and the assumptions and conditions can be infinitely varied to provide for the actual circumstances that birds of all species encounter—we arrive at certain mathematically correct results with regard to bird and aeroplane voyages.

In one case let us imagine the wind—the current—to be from right ahead of the bird. The speed per hour of the bird due to its own power

of flight through the moving air is 30 miles per hour, but the speed of the air-current in which it is borne and with the movement of which it is in harmony is 20 miles per hour in a directly adverse direction. Under these conditions the bird progresses 10 miles per hour towards its destination, though flying at its normal speed of 30 miles per hour through the oppositely moving air. Since the bird can only fly a distance of 180 miles, it can keep in the air for six hours, by which time it will have accomplished 60 miles only over the sea, after having flown 180 through the moving air. As its nest was 100 miles away at the start it will fall into the sea 40 miles from its destination, after having accomplished its utmost distance of 180 air-miles in what, to the bird, appears a normal calm.

Now reverse the current. The bird, still so far as it is aware flying at its normal speed of 30 miles per hour in still air, will cover the distance of 100 miles to its nest or bush at a speed of 50 miles per hour, and in two short hours will arrive fresh and strong, having a reserve of fuel for another 120 miles in its wings. If the 20-mile-per-hour current is *across* the direct route from the point of departure to the nest or bush, and the bird still heads for its destination, whether the bird will arrive depends upon the speed and direction of the air-current relative to the speed of flight and the course of the direct route, the resultant curve of the bird's

track being still exactly calculable, as also the distance travelled and the time of arrival—or disaster. So also with aeroplanes and racing pigeons.

It is possible to refer many other well-known curiosities of bird and insect life to the few simple and unchanging laws upon which this unpretentious book is founded. These laws will, the author believes, throw much light on such marvels as the prolific nest-making of wrens: the periodic invasion of cross-bills after a lapse of years and their gradual disappearance: the comparative fixity of the localities—dense woods—in which nightingales are found: the lasting widowhood of an eagle, without young, that has lost its mate: the apparent *polyandry* of the phalarope: the brooding of a male swan on an empty nest: the battles in rookeries for a last year's nest, or its remains, between parents and young: the arrival of young northern 'passage migrants' in winter before the mature birds make a later appearance. Many queer facts, truisms to ornithologists, seem much less queer and mysterious when approached from the standpoint of laws which birds cannot help but obey, instead of from the standpoint which projects our reasoning minds into the bodies of the birds. Language is the vehicle of reason, and of necessity it is essentially objective since it is employed for giving expression to purpose, design, and intention. The very nature of language, particularly of active verbs and

adverbs, is a snare for the unwary when such language is employed for discussing the animal kingdom.

It was surprising to receive very recently from a distinguished scholar at Oxford, the suggestion that the thesis of this book, founded on fixed laws, provides a crutch on which the materialists can lean. Surely the truth is just the reverse. All creation shows us, at every turn, the domination of mind and thought over machinery. Our forefathers knew this at least as well as our professors, and attributed it quite simply to an all-wise Personal Creator. The theory of evolution, however, has been responsible for transferring this indisputable evidence of mind from the Maker of the machine to the machine itself, and by an amazing confusion of thought, the confounding of cause and effect, with the cart careering madly downhill with the horse dragging behind, it is now seriously believed that a mind has somehow 'evolved' itself in birds which enables them to manage their own affairs. A sickly form of sentimentality is the inevitable handmaiden of 'evolution,' and it is not surprising, therefore, to find that the Dean of St. Paul's and his school of thought should be disgusted at the age-long practice of what are now called 'blood sports,' including the shooting birds with 'evolved minds,' for, as they rightly perceive, it is with the mind that fear, sorrow, and to a great extent pain, are experienced. What must be the reverend

gentleman's feelings as he passes a poulterer's shop on Christmas Eve? What are his sensations, after his morning sermon in St. Paul's, as he sits down to his Sunday joint of roast mammal in which the mind has been so powerfully 'evolved'? What, it may be wondered, do the mammals think of the Dean?

How do 'evolutionists' justify their attitude towards wholesale vivisection, a practice opposed, strangely enough, by those like the author who do not exalt the dumb animals as does the biological world?

And what of our spiritual Lord, Dr. Barnes, F.R.S., who, on September 28th, 1928, in Westminster Abbey seemed to convey to the boys of Westminster School his personal doubt as to whether there was in truth a God behind the Universe? Are Christians content that this Bishop of the Church of Christ should recommend children to biological professors if they wish to walk in the light as children of the light? Dr. Barnes stated, with a solemnity that would be amusing under other circumstances, that evil is part of God's plan and that he, Dr. Barnes, holds God ultimately responsible for the evil in the world since He obviously employs it. Thus does biology blind the eyes to the glory and awful responsibility of Free-Will, that great Divine attribute which evolution whittles down and then bids us share with the brute creation.

CHAPTER X

THE FLYING 'FEATS' OF GULLS

In a previous chapter a reference was made to the beautiful and extraordinary gymnastic feats which certain birds *appear* to perform. The expression 'appear to perform' was used advisedly, because a large part of these convolutions is undoubtedly an optical illusion, while that part which is real is due, as previously pointed out, to a resolution of *speeds* (the speed of the bird and the speed of the rapidly moving medium in which it flies) and not to a resolution of *pressures*. As misapprehension on this question is very widespread, leading, as such misapprehension must do, to a misinterpretation of the habits, powers, and so-called 'skill' of birds on the wing, it may be of interest to readers to examine with the author the true facts of the case.

Though the flight of the large-winged sea-birds in the open and unobstructed atmosphere represents the major aspect of the flight of gulls, these birds reveal to us at the same time the fascinating phenomenon of gliding, and of maintaining equilibrium and forward motion in *upward* air-currents set in motion by vertical barriers such as hillsides, artificial obstructions, waves of the sea, and so forth. This

minor aspect of flight is somewhat apart from the general problem of flight in the open, though even in the case of 'gliding' in upward or horizontal air-currents the very general idea that the wind acts on the wings of the gliding bird as it does upon the sails of a ship is incorrect. Turning, however, to the open and unobstructed atmosphere where the currents are mainly horizontal, and disregarding for the moment the phenomenon of gliding, it is proposed to study briefly those bird movements that are *apparent* to observers, and to pass from the *apparent*, the result of observation, to the *real*, the outcome of simple law. In considering the flight of a gull it may assist us if we keep in mind the transparent 'dome' with which the author endeavoured to simplify the understanding of relativity, of which the flight of gulls is a beautiful example.

Most of us have stood on the decks of ships and watched the great sea-birds apparently performing the most exquisite feats of flying, above the ship, round the ship, and in its wake. Sometimes the bird will come up from astern at an overtaking speed, and on reaching us it will cease its flapping and, with wings fixed and outspread, soar vertically upwards, swoop downwards, draw ahead of the ship and keep near it for long periods in the teeth of the wind without a visible movement of its wings. At other times it will not follow or keep station on the ship, but will fly round it with

alternating periods of flapping and 'sailing.' With a strong wind blowing we see apparently the most marvellous banks and turns, the bird sometimes appearing to fall backwards, tossing itself about and executing great curves as if from sheer joy in the whistling wind. When alighting on the water we notice that they always land exactly head to wind, with a short rise before alighting and with wings exposed at an acute angle to the wind, giving the delusive appearance of utilising 'wind-pressure' as a brake, whereas in reality there is no wind-pressure. In dead-calm weather, on the other hand, they mostly sit in the water, changing position for the most part but rarely with a very slow and leisurely movement, as though the water, under these circumstances, was the more convenient element. Many readers will recall those warm, lazy summer days at sea with the gulls chanting their monotonous chorus as they float like slightly restless statues on the shimmering water.

It is not the writer's intention to dwell on these beautiful exhibitions of flight. They have excited man's admiration and wonder from the earliest times, providing a theme for poets, and stimulating an age-long passion for human flight, a passion which, in the past quarter of a century, has been gratified, though disillusion is stalking grimly on the heels of achievement. Now these apparently extraordinary feats of flying call for no more 'skill' (which entails calculation) than do the physical

movements of mammals. Flight is not so mysterious as it seems, being indeed little if any more wonderful than all the other physical operations of natural progression. A great part of what we see, though in a sense real to ourselves, is non-existent in fact to the bird, while that part which is real and existent to the bird as well as to ourselves—progression with fixed wings in the teeth of the wind, for example—contains no element that is not capable of simple explanation.

In the light of all that has previously been said on the subject of flight in a moving medium, let us now examine, as briefly as possible, a few of the remarkable sights which gulls present to our eyes, sights which we are apt to regard as feats of airmanship or 'birdmanship,' involving some mysterious secret which 'research' and 'observation' alone can discover. Assume ourselves to be standing on the quarter-deck of a ship steaming at 10 m.p.h. into a head wind of 20 m.p.h. Assume, again, that a great gull is gaining 1 mile every 6 minutes, that is to say it is overtaking the vessel at 10 m.p.h. As the gull reaches the stern directly overhead it is moving through the moving air at an 'engine' or flying speed of 40 m.p.h. (the speed of the adverse wind, 20 m.p.h. + the speed of the vessel, 10 m.p.h. + its overtaking speed, 10 m.p.h.). The bird of course feels a draught of exactly 40 m.p.h., its flying speed through the air. Now assume that having reached the ship, it has reached its objective,

and it therefore ceases flying and spreads its wings rigidly. What picture will be presented to our eyes? Since the bird is heavy it has very considerable inertia, and so exquisitely is it formed, and so perfectly adapted to its environment, it will continue for a time to draw ahead of us—the observers on the deck—but at a gradually diminishing rate till it appears to 'float' stationary in the air above us, though in reality it is then progressing through the moving air at a speed of 30 m.p.h. (the speed of the wind, 20 m.p.h. + the speed of the ship, 10 m.p.h.).

Assume now that it continues to 'coast'—to use a bicycling expression. The speed of 30 m.p.h. will gradually diminish, giving the bird, relatively to our view, a correspondingly increasing retrograde motion, making it appear to 'float' away astern. In all probability, however, at, or before, this stage is reached the bird would increase its inertia by flapping its wings in order to remain in the immediate vicinity of the ship, though it might, as it sometimes does, continue to 'coast' until it approached its 'stalling' speed, which appears, for a large-winged gull, to be in the neighbourhood of 10 m.p.h.[1] At this critical point it must regain momentum, though it sometimes just passes it with the result which we often see, namely, that

[1] This minimum speed is probably underestimated. The exactness of that estimation has, however, no bearing on the general argument.

the bird drops vertically, though at this point it always recommences to move its wings. What are the actual conditions at the moment before this critical point is reached? To us the bird appears to be still floating on outstretched wings, but dropping astern at a considerable rate, the exact rate being, in fact, 20 m.p.h. (the speed of the wind, 20 m.p.h. + the speed of the ship, 10 m.p.h. — the bird's speed through the moving air, now reduced to 10 m.p.h.). To the bird, however, everything feels perfectly normal, the draught merely dropping from 40 to 10 m.p.h., notwithstanding that the wind has all the time been 20 m.p.h. from right ahead of the bird.

The classic exhibition of progression with fixed wings is provided by the albatross in the Southern Seas. The albatross, as we know, has an enormous wing-spread, enabling it therefore to spend the majority of its existence on the wing. The albatross of the Southern Seas provides merely an extreme demonstration of the 'sailing' and 'gliding' habits of gulls which we observe in the Northern Hemisphere, and like gulls it must move its wings periodically to provide itself with the necessary momentum to 'coast' beside the ship, except in one case where there is a possible exception. In moderate winds the periodical movements of the wings need be very slight, and may well involve only the unperceived movement of certain feathers. As the combined speeds of the ship and wind increase,

however, a critical speed will be reached at which the movements of its wings—*its oars*—will become apparent. If flying near the surface of the sea it can of course utilise the upward currents caused by waves, and perhaps by the ship herself, to gain position for gliding down again into the trough.

Under these circumstances the movements of its feathers will be reduced to very minute proportions, but even here some very slight movement will usually be required to overcome the slight friction of its body through its medium.

But there is an exception in which circumstances may combine to render it possible for an albatross, with its enormous wing-spread, to keep station on a moving ship without any movement of its wings whatever, and the circumstances seem to be these: If the wind is from ahead, and regular vertical currents are thrown up from the waves or the ship, there is a critical combination of circumstances, depending upon the speed of the wind, the speed of the ship, the stalling-speed of the albatross, and the minimum gliding-angle of the bird, in which the bird will be enabled to glide slowly down through steadily rising vertical currents at a speed of horizontal advance relative to the fixed water which corresponds to the speed of the ship through the water. This gliding progression, however, must always be in a direction opposite to that of the wind.

Close observers of sea-birds from the decks of

ships will recollect the variety of methods by which gulls retain themselves in the immediate vicinity of the vessel. In a ship of fair speed (say 12 m.p.h.) on a flat-calm day, or in a very slow ship with a very light wind blowing from ahead, the gulls keep station on the ship by steadily flapping their wings in a very leisurely manner. If the speed of the ship + the speed of the adverse wind is equal to, or very slightly greater than, the stalling-speed of the bird, the bird will slowly but continuously flap its wings. If the combined speeds of the ship and wind are considerably greater than the bird's stalling-speed, we shall periodically witness the phenomenon of 'sailing' with fixed wings. If, however, the combined speeds of the ship and wind are *less* than the stalling-speed of the bird, the bird will *circle round* the ship, flapping and 'sailing' according to the direction of the wind relative to the course of the ship, the amount of each operation being governed by the relation between the speed of the ship, the speed of the wind, and the stalling-speed of the bird.

If the wind is a *following* wind and the speed of the wind is greater than the speed of the ship, it will be noticed that the birds keep station facing the stern, the proportion of 'floating' or 'sailing' to flapping being again governed entirely by the relative speeds of the ship and wind. If the wind is at an angle to the course of the ship, the bird will keep station with its head at an angle to the course

of the ship, the exact angle between the axis of the bird and the course of the ship being obtained again by resolving the speed and course of the ship with the speed and course of the 'wind'—the moving 'dome'—in which it is progressing. The stronger the wind, up to a certain critical point, the longer will be the period of 'coasting.' When the speed of the wind equals the maximum flying speed of the bird, it will not be able to 'sail' or 'coast' for a moment without losing touch with the ship, and under these circumstances, having once lost touch, it cannot regain it. In all these cases, we must continually remind ourselves, the bird is totally unconscious of any pressure from the 'wind,' neither can it feel from what direction it is 'blowing.'

It is not necessary to enlarge upon the beautiful convolutions which the bird will appear to perform on a windy day, as this question was adequately dealt with in the chapter dealing with the Relativity of Flight. It must be clear to readers that the exquisite symmetry of the curves, banks, soarings, and side-slips that we witness is, in a sense, an optical illusion to ourselves, though in a sense it is also real. The beautiful appearance presented to our eyes, whether we like to call it real or apparent, is, however, the outcome of no acrobatic skill, 'high spirits,' or exceptional behaviour of any description on the part of the performer. The bird is all the time flying and turning in its usual manner,

experiencing in a mighty gale the same sensations as on a dead-calm day. In one case it is flying in *a moving calm*, and in the other *a stationary calm*. The beautiful symmetry and poise of flight is confined mainly to the large-winged sea-birds with a large reserve of flight-power over and above the speed required to avoid 'stalling,' though rooks, crows, pigeons, and other land-birds reveal the same powers in varying degrees. Heavy birds with small wings, heavy bodies, and therefore high flight-speed—such as ducks—have very little reserve of speed over their normal flight-speed, and in such birds, as well as in the small birds, we see few, if any, of those 'feats of airmanship' which have always fascinated us when watching the flight of birds at sea.

The hovering and soaring of hawks, larks, and other birds is merely an example of the perfect mechanical efficiency of natural flying machines. The wings are continually moving at great velocity in such a manner as to produce a helicopter effect on a calm day. If, however, there is a wind, the bird must fly forward and upward at such an angle to the horizontal that the resolved speeds of the wind and of flight through the moving air produce a *resultant* which is vertical. Though the birds feel nothing of the wind, the angle of flight required to produce this vertical rise is automatically obtained by keeping an eye steadily fixed upon a point beneath, with the result that the vertical flight is

automatically and of necessity carried out head to the wind which the bird does not feel.

In contrasting the marvellous efficiency of the natural flight of birds with the relative inefficiency of machines it is well to remember the following points. Birds, though absolutely perfect in their construction, are very poor weight-lifters, a great eagle, with its enormous wings, being incapable of supporting for any length of time a weight so slight as that of a little animal. Birds, like aeroplanes, lift weights exactly proportional to their design. They can thus carry practically no 'useful' load for any distance, and for reasons which are clear. Mammals have not to lift themselves as well as the weight which they carry or drag. Gravity, the ally of mammals and land-machines, is the unchanging and unchangeable foe of aerial creatures as weight-lifters.

While the wings of birds combine the functions of the planes, propellers, and operating gear of an aeroplane, the combined engine and fuel-supply of a bird is LIFE, that mysterious, intangible, and weightless source of energy which must remain, regardless of the Lilliputian efforts of biologists, the riddle of the Universe. It is true that food is required from time to time, and with birds almost unceasingly, to maintain life and to renew energy, but it is equally true that by the perfection of a natural process food is quickly converted into a great supply of stored and weightless energy, the

by-product of the process—excretion, which has weight—being discharged very soon after the bird has consumed its last meal. When we carefully consider these things we may begin to understand, without the intrusion of mathematics and dynamics, why a man-made flying machine, with its heavy engine and fuel-supply, is of all vehicles the most completely and ludicrously inefficient.

Though on a long flight a man must forgo reasonable food, comfort, and useful cargo for himself, he must lift not only a heavy engine but also fuel for his engine, which may amount to many tons. Indeed the engine and fuel must always remain the principal cargo in aircraft, just as it is the only cargo which natural flying machines carry, in which case it weighs nothing when digestion is complete. The safety of birds depends directly on their fuel-supply—their natural power of endurance. Aircraft, with every additional ounce of paying load embarked, are sacrificing that margin of safety to which everything in the natural bird is subordinated. In spite of the absolute perfection of natural flight, the loss of life annually owing to the exhaustion of the bird is nothing short of prodigious.

CHAPTER XI

THE FLIGHT FACTOR IN INSECTS

THOUGH the flight of insects must be treated very shortly, it cannot be entirely excluded from consideration in a book which has as its object an investigation of flight in all its aspects. Furthermore, with the intrusion of 'pestology' into the serried ranks of modern 'sciences,' the flight factor in the insect world at once becomes a matter of practical as well as academic interest.

The fact that the effect of wind on a mosquito, a bee, a butterfly, or the gossamer thread of a spider is exactly the same as its effect upon the giant airship which Commander Burney is so industriously building, or upon the aeroplane that won the Schneider Trophy Cup, may seem a hard saying, but it is none the less true. If we form a procession consisting of an aeroplane, an airship, a seagull, a wren, a mosquito, or a puff of smoke in a cross-wind of 30 m.p.h., and if we then set them all flying at their maximum speeds on the same course, at the end of an hour all will still be in a straight line 30 miles to leeward of the line they occupied an hour previously. They will all, of course, be farther apart on this line, the change in the distance

apart being proportional to the flying speed of each machine or creature.

All that has been said about the flight of birds is equally applicable to the flight of insects. No butterfly or insect of any sort feels any pressure from the wind in which it is flying. All insects must alight automatically head to wind, thus producing an alighting speed which, as in the case of birds and of aircraft if they are to avoid disaster, is the difference between the speed of the wind and their own flight-speed. As with birds, the speed of insect flight is merely superimposed upon the speed and direction of the medium in which they fly. Insects are subject to the same ebb and flow as birds, but as flying insects are a summer phenomenon, often a summer pest, their relatively weak flight-powers are seldom swamped by a very much higher speed of the single medium in which these powers are exercised. Nevertheless, if a strong wind arises in the summer when bees are absent from their hives, the hive will be deserted by the absent bees. Furthermore, if a light wind prevails for several days, the quantity of honey collected must be reduced because the exertion of each odyssey in search of honey will be heavier, the time required for each journey being increased, whatever the direction of the wind may be.

Turning to mosquitoes, it is interesting to note that 'pestologists' are disposed to deal with the breeding-grounds of these pests on a basis of the

observed distance which they can fly. Any calculation which disregards the fact that insects, like aircraft and birds, are wind-borne parasites will lead to faulty action in dealing with breeding-grounds. A mosquito, like a bird or an aeroplane, can fly for a definite length of time, and no longer. This endurance on the wing, in conjunction with speed on the wing in a dead calm, governs the absolute distance a mosquito can fly in calm air, but it has no relation whatever to the distance it can penetrate over the local countryside. Thus, if a mosquito is bred in a certain pond and can fly for half an hour without alighting at a speed of 10 miles an hour, it can cover 5 miles in any direction on a dead-calm day. If, however, there was a wind of 30 m.p.h., at the end of half an hour it would be 10 miles to leeward, assuming that it headed continually at its maximum speed of 10 m.p.h. for its breeding-ground, which it does not necessarily do. It will thus be seen that mosquitoes drift over the country perhaps hundreds of miles in the course of their life, and may never return to the spot where they were bred.

From this it seems to follow that not only is it impossible to classify mosquitoes, as is sometimes done, by the distances the various species are supposed to be able to fly, but more important still, no clearing of ground between a swamp and an inhabited place will remove the mosquito scourge from an encampment, village, or town unless such a

place is in a *regularly* prevailing windward position from the breeding-ground. In temperate countries such as England, where the winds are very variable, mosquito life will spread itself in all directions and no particular breeding-ground can be connected with any particular species of mosquito, which may quite well have arrived from the continent.

The author was recently told by an experienced big-game shooter that in Ceylon and India the butterflies migrate regularly in vast flocks. As certain flowers die off, the butterflies come south where these flowers are still in bloom, and it was said that the butterflies migrated in search of food, as is frequently asserted of birds. But here again is a confounding of cause and effect. It was on the wind that killed off the food-supply that the butterflies were carried to a locality where the flowers were still blooming.

The separation of the sexes of butterflies seems to be a phenomenon in the butterfly world as it is in the bird world, for again the author has read of encounters with great flocks of male butterflies over the seas of South America without a female in the flock. If the male butterfly differs in weight or flying power from the female this phenomenon, as with the birds, is inevitable.

Insects fly on curves in just the same way as do the birds, and 'recognition' is therefore neither possible nor necessary for insects in their short and uneasy passage through life.

It is perhaps not without interest to observe that on a windy day birds on the wing have no added difficulty in catching flies, because the bird and the fly are equally affected by the wind on which they both are borne, and to which they are both parasitical. Herein lies a secret of the passage of swallows.

It is not intended to investigate further the flight factor in the life-history of insects, but in conclusion the author would like to turn the attention of his readers very briefly to the bee, an insect which, in conjunction with the ant, is being increasingly used as an example of the 'evolved' mind of brutes. Upon ants and bees, indeed, are being reared some of the most amazing theories and doctrines that have ever disfigured the various schools of human philosophy, materialistic theories of which the Dean of St. Paul's is so ardent a preacher.

The bee has been a source of wonderment to men from the days of Virgil, and in all probability it aroused speculation before this great poet-philosopher's day. Here we have a living creature, the same now as then, apparently endowed with a brain as great, indeed far greater, than that of the greatest theoretical mathematician and with an apparent knowledge of applied mathematics which makes the architects of St. Paul's Cathedral or the Forth Bridge look clumsy by comparison. Controversy has raged round the mentality of this tiny insect for many centuries, but is there room for

controversy? Surely it is abundantly plain that the perfection of the work of bees (like ants and spiders) is proof that they are utterly without mentality of their own as engineers or navigators.

With regard to their excursions in pursuit of honey, their return to the hive is conditioned by the same laws of currents and flight as is the homing or migration of birds. Move the hive but a short distance and the bee is nonplussed. Their work inside the hive is the perfection of their own unreason, never varying in its exquisite truth. The engineering and navigation of a bee continue perfect, and therefore the same, as the centuries roll by.

How true seems the analogy between the work of a bee and the marvellous work performed by the latest creations of man in, let us say, match-making machines. Men's machines, as we often say colloquially, seem alive and sentient. Yet they are but material instruments embodying and clothing only a man's thought and repeating their identical operations and *his* purpose so long as they are supplied with artificial power through a valve, or until the machine wears out. The riddle of the universe, the origin and nature of living power, remains with us, if in truth it is a riddle to God-fearing men and women; but accepting physical life as a natural fuel-supply, we are presented with the patent fact that the lower we go in the strata of life, the more wonderful are the apparent powers of creatures and plants. *A breath of freewill and perfection*

vanishes. If the machine, like the bee, is perfect, it seems to follow that Truth is absolute, not relative; static, not evolutionary; and that unchanging law, the alphabet of Absolute Truth, is the basis of all order in the physical universe as assuredly it is in the spiritual. If this is so, it is difficult to bring the reason to conceive that what we *call* a bird or a bee can ever have been different from what we know them now to be—perfect flying musical boxes or honey-making machines, within their limitations, with life as fuel, and the directing mind external to the machine itself. To think otherwise is to regard Almighty God as a mere experimenter and 'scientist,' whatever this absurdly overworked title may mean.

It is as contrary to experience as it is to common sense to find machines 'evolving' to meet new conditions. Old laws, though new to us, are *discovered*, and by faithfully understanding and applying these laws new machines are designed and *created* by man to meet, or to give rise to, a new environment. Motor-cars were not 'evolved' to meet the new environment of tarred and concrete roads. Laymen (not scientists) discovered the laws of internal combustion as they discovered the laws of steam, and on these laws, as free men and therefore as finite gods, they designed and perfected new machines to run on a new species of road, objectively designed in its turn to carry, though very imperfectly, the new species of machine which

the unearthing of old and eternal laws had enabled men to *create*.

A motor-car engine requires much the same anatomy as a steam-engine, a hand-spinning wheel, or a wooden knife-grinder for the conversion of power and motion from one state or direction into another. Man-created machines of every species require, and exhibit, most structures in common, just as living machines—animate bodies—require most parts in common for those functions of physical life which are common to them all. Who in his senses, however, regards the engines of a motor-bicycle, the *Mauretania*, an airship, or a locomotive as the product of a natural evolutionary process from the more primitive type of the spinning-wheel? Every new *species* of machine is clearly the outcome of freewill and design within the framework of fixed laws, and freewill is obviously supernatural in the strictest sense of that very loosely used word.

The possibility of 'evolution,' that is to say of progress and cultivation within the framework of fixed and changeless laws, is patent, and always has been patent, to every sane man, woman, and child. In the realm of material things and of machines, however, perfection in a particular species of machine —a railway-engine or an aeroplane—is very rapidly achieved, especially in a mechanical age such as the present, because the laws which circumscribe perfection are simple and few. In the moral and religious sphere alone is the scope for improvement

still infinite, not because of the complexity of the moral laws revealed to us, but because of that *free-will* which we men and women stubbornly refuse to subject to those laws which should bound our freedom, leaving us nevertheless a freedom within the moral law that is infinite. In this vital and transcending aspect of life will anyone dare to claim that man progresses *automatically* from a lower to a higher state of perfection? Was Rome in her decline nobler than Rome in her more primitive state? Are we of to-day a less self-seeking and therefore more righteous society than in days gone by? Has Miss Sitwell 'evolved' a nobler poetry than that of the prehistoric, primitive, Homeric giant? Must the Venus of Milo hang her lovely head and cloak her sweet form in shame in the presence of Mr. Epstein's masterpieces?

We all believe in the *capacity* for improvement—evolution—within fixed principles, but who outside a materialistic bedlam can conceive the evolution of principles themselves? God, as the great 'I Am,' is incompatible with evolution as now taught and believed, because Truth, the very nature of God and of all His Works, is unchanging through eternity.

Guided by experience and simple good sense, it seems natural to suppose that the flora and fauna of other temperature ages perished and vanished, being replaced by new creatures and plants adapted to and designed for new physical conditions, and totally

unrelated by generation with their predecessors, though of necessity exhibiting mechanical similarities. The Purpose and the Act can never be revealed by any reasoning, certainly not by mechanical and materialistic reasoning, but we can all stand in awe when contemplating the results. Through all the changes of this cooling planet unknown physical laws, as well as the few laws we do know, must have operated, including the laws of flight, for laws, unlike things seen, are not temporal but eternal.

CHAPTER XII

THE EVOLUTIONARY 'LAW' OF DISPERSAL

'THE Law of Dispersal' is an evolutionary 'law' based, according to Charles Dixon, upon the assumption that bird life underwent wholesale extermination in pre-glacial, inter-glacial, pliocene, or pleistocene ages. Arising out of this alleged disaster, present migrations are attributed to "the constant endeavour of what we must now regard as but relics of such exiled life to regain and re-people the area that it once occupied during pre-glacial time." 'Extension of range' is treated as an indication of the gradual success of this 'constant endeavour,' while the trend of birds northwards at the breeding-season is advanced by biologists as a proof of inherited memory and love of home passed on to succeeding generations in the form of instinct, 'sexual urge'—that bee for ever buzzing in the biological bonnet—being invoked as the 'trigger' which sets this train of inherited memory in motion. The main routes of migration are linked up with, and indeed are said to provide evidence of, long-vanished land-masses over which, without a shred of evidence, hundreds of fathoms of sea are now alleged to roll. Thus do the geologists, biologists,

physiologists, and so forth shore up their particular theories with the theories of other specialised investigators, on the very rare occasions when their respective theories are agreeable to one another, instead of being, as is most usual, mutually destructive.

Those of us who have studied modern books on 'scientific' ornithology can hardly have failed to notice the calm assumption that there was 'a cradle of the bird world' in which bird life first 'evolved' out of reptilian life, from which progenitors the various species in their turn 'evolved' to meet new environments introduced, so far as an ordinary person can understand, by migration from the 'cradle' to the outlying parts of the world. These 'cradles' for the various creatures of the world seem to be almost as various as are the branches of 'Science,' and though TRUTH is solemnly inscribed over the portals of each laboratory and school, a more appropriate motto for evolution would seem to be "Quot homines, tot sententiæ," a motto, it is true, more liberal than scientific, and therefore inadmissible, for science must either, from its very nature, be quantitative—the quintessence of illiberality—or nothing more substantial than grossly materialistic speculation. Though some place the 'cradle of life' in Africa, others in Asia, and some, for all the author knows, in the fabulous Island of Atlantis, ornithological evolutionists have a taste for the Arctic regions as the theatre in which the first adventurous and far-

seeing reptile, in an ecstasy of high spirits, sprang out of the water and slush into the air, though whether the beast performed this prodigious feat as an air-borne egg or an air-borne bird is a little conundrum that science prefers to treat, in its proverbially ponderous manner, as an irrelevant and unseemly joke on the part of 'unscientific' laymen.

It is noteworthy that the 'cradle of life,' or 'specific centre theory' as it is sometimes called, is a necessity of the evolutionary creed. Remove it, and evolution vanishes, except as a somewhat vague expression for a capacity for development, cultivation, improvement, and therefore of variation within definite limits, a form of 'evolution' or refinement which is a matter of mere common sense, observation, and general acceptance to-day as it was five thousand years ago. Darwin himself admitted the enormous difficulty of reconciling the geography of the world with 'a cradle of life,' extended by migration, so far as mammals were concerned. He and his disciples, however, feel themselves on firmer ground, though in reality they are in the air, when they apply their theory of migration from a primitive cradle to the bird world, for, as they erroneously suppose, birds are *free*, and can fly away where they like and evolve and change their nature at leisure and according to taste to grapple with new environments.

The author is not so innocent as to suppose that the foregoing remarks will be regarded by scientists

as anything but an exposure of his ignorance of what the theory of evolution is. He will admit at once that he really does not know, and furthermore that he cannot find out, for many years of study have convinced him that his ignorance is shared by the world at large, and more particularly by 'science' itself. Many sensible laymen boil it all down quite simply to a self-acting mechanical process by which a piece of fabulous, and presumably omniscient and omnipotent 'protoplasm' converted itself variously into tape-worms, rhinoceroses, canaries, monkeys, scientists, Shakespeare, rattlesnakes, and, it must reverently be added, the Author of our Faith Himself. Others more charitable, and with perhaps a greater sense of humour, regard it as a former battleground and subsequent rubbish-heap of a hundred contradictory beliefs and theories, all of which theories, strange to say, are described and accepted to-day as 'scientific.' Though the author confesses willingly his abysmal ignorance of 'evolution,' he disclaims emphatically an ignorance of the laws of dynamics which control the dispersal of birds, laws which are nothing more or less than the domination of bird life by the winds of the world, in their turn governed by temperature. Not only do the winds govern the movement of birds about the world, but they demarcate for all time the regions to which certain species have access, to which some species are rigidly confined, and from which others are permanently excluded.

It is not intended to reopen in detail the examination of the ebb and flow of bird life about the world. This matter has been adequately dealt with in preceding chapters. The author wishes merely to draw the attention of his readers to the great seasonal and *permanent* winds of the world and to ask them to consider these in conjunction with the laws of flight which have been expounded with considerable care in the earlier part of the book. If we study the wind-charts of the world we shall find two great belts of permanent wind round the world, with one notable break over the Indian Ocean. These two winds are north-easterly north of the equator, and south-easterly south of the equator. The tropics are dominated by these two great permanent winds, which are in reality vast equatorial air-currents flowing inwards from the outlying world and oceans. It is abundantly plain that the great bulk of tropical birds inhabiting the regions upon which these inflowing currents converge must be mechanically prevented from leaving them so long as they prevail. Conversely, if these mighty currents for some cataclysmic reason reversed their directions, the tropical bird world would be dispersed over temperate lands, their dead bodies being recovered in myriads, for they could not, of course, sustain life below a certain mean temperature. Though it is only intended to deal in any detail with physical conditions as they now are and as they have been so

long as human records of any description exist, it is deserving of notice that these inward-blowing winds must have prevailed since the world took shape, and for the following reason.

The earth has, from the nature of things, been subject to a variation of that temperature which is derived from the sun, so that relatively to the temperate and arctic regions there must always have been a tropics. When the superficial heat of the cooling earth was greater, as it once undoubtedly and manifestly was, this added temperature was common to the world as a whole and was merely superimposed upon a permanently differentiated temperature caused by the sun. Since differences in temperature, in conjunction with great land-masses and water-masses, are the direct cause of wind, the rotation of the earth, which is constant, superimposing a trend upon these temperature-created wind-currents, it seems manifest that there always must have been winds in the furthest ages of the past which would then, as now, present impassable barriers and 'moving platforms' to creatures which moved and had their being in the moving medium of the air.

This reflection seems to throw a rather awkward obstacle in the way of 'the cradle of life' theory in so far, at least, as it concerns life in one of the elemental environments—the air. It must appear as remarkable to his readers, as it is almost incredible to the author, that the absolute nature of the

barrier presented by wind to air-borne bodies of limited flying powers has not been enlarged upon elsewhere. And yet, search as he will, he cannot find in any book, scientific or otherwise, any suggestion that birds are mere aerial parasites with their own powers of flight merely superimposed upon the full speed and direction of the wind in which they fly.[1] Darwin himself, in *The Origin of Species*, speaks of birds being 'blown' from their natural home, and in the few places in which he deals with the flight factor in birds he indicates that he shares, or perhaps originates, the delusion of Professor Patten and the evolutionary school of scientists that birds experience *pressure* from the moving air in which they are borne.

Turning from the inevitable and permanent confinement of the bulk of tropical birds to the tropics and their immediate neighbourhood, we can definitely exclude South American birds from Northern Africa and Europe because of the utterly impassable barrier of the north-east trade-wind. The impassability of such a barrier becomes apparent when we reflect that the geographical—the absolute—*distance* from Cape St. Rogue to Cape Verde of 1,800 miles becomes 7,200 miles to a bird of such a strong flight-speed as 40 m.p.h. if we assume the average speed of the north-east trade-

[1] In the pages of the *Encyclopædia Britannica* which are devoted to birds, the word 'wind' does not occur on a single occasion.

wind to be as moderate as 30 m.p.h. at average flying heights.

Leaving the neighbourhood of the tropics and passing to the northern hemisphere, we find the prevailing wind over vast areas to be westerly, and we should expect to find, as indeed we do find, similar species of temperate birds appearing in areas separated by thousands of miles. Because in the great easterly and westerly belts of temperate lands prevailing winds within prevailing winds exist, there is a tendency, though only a tendency, for particular species to inhabit particular areas, a tendency which is modified by constantly recurring incursions from far-distant lands owing to the variability of temperate winds. This exceptional drift is, of course, far more frequent from west to east, as evidenced by the not infrequent appearance in Europe of American and Canadian species. The appearance in America and Labrador of European and East Arctic birds is always a matter of special remark, as during the present year when unusual easterly wind conditions have carried English birds to Canada, an aeroplane from Tokio to Paris in 6 days, and lapwings, and the *Bremen* so we are told, to Labrador.

A careful study of the wind-charts and 'wind-roses' of Great Britain, North-western Europe, and Scandinavia will extinguish at a glance the speculation as to the reason for the coming and going of the hardy birds in our little corner of the world. When

we examine the atmospheric environment of the Cape Verde Islands we shall not fly to the evolutionary theory for explanations of the 'non-migratory instincts' of birds trapped in that island, engulfed perpetually in the north-east trade-current. Indeed, as shown by A. G. Butler, *hardy birds have no migratory instinct or 'urge,'* for, as he points out, redstarts and redwings—regular hardy migrants—show no restlessness whatever at the migration season when confined in a large sheltered aviary.

To trace the innumerable sub-species of a single species of bird that are to be found in great belts of countries and continents of approximately similar physical condition is quite beyond the scope of this small book. It need hardly be said that latitude is only the roughest of guides in marking out such belts, since temperature is governed by terrestrial considerations of elevation, equatorial and arctic sea-currents, and other features of the globe, which affect the latitudinal consequences of temperature in historical times in much the same way as the earth's surface temperature must have modified, though uniformly, the differential solar temperatures of tropical, temperate, and arctic belts in pre-historic times. Now as then, however, the trend of the winds must be of such a nature as to provide permanent barriers and permanent avenues for birds in their passage about the world, barriers and avenues which will ensure that while the various

species cannot trespass into regions in which permanently unsuitable temperature would kill them, they can travel about the world where physical conditions are agreeable to the preservation of life. Thus birds, like their prototypes in the vegetable world, will develop immense varieties due to local variety of conditions, *the varieties, however, remaining true to type* and being interchangeable and capable of thriving and of cultivation in other lands so long as the geographical transference is confined to the natural belts of life prescribed by temperature.

Before leaving this brief examination of the dispersal of birds, an examination which leaves, to the author's mind, 'the cradle of life' theory hanging rather uneasily in the air, he would like to draw attention very briefly to one aspect of *prehistoric* birds which is striking. The author has read, and been told, that the avian contemporaries of the dinosaurs and mammoth beasts have always been found near the surface of the earth, whereas the mammals have been discovered deep down in various geological strata. *The author does not say that this is true*, but if it is a fact, and not mere hearsay, it would seem to throw a flood of light on the mysterious disappearance of species of a bygone era, for it would prove almost as conclusively as sight that vast upheavals killed and buried earth-bound creatures. The prehistoric birds, however, would naturally rise at the first signs of the impending upheavals, coming to earth and dying on

the surface, beneath which lay buried at varying depths their mammalian contemporaries.

Such a sequence of events would not only be inevitable, but would reveal at once that the strata in which the prehistoric beasts lie buried provide no means whatever of estimating the lapse of time since such awful, though quite natural, cataclysms on a cooling planet occurred. Not only might such cataclysms have occurred in comparatively recent times, but it would account for the mysterious absence of any semblance of connecting-link between that gruesome buried life of a prehistoric time and the life on the world as we know it, and have known it, since the earliest dawn of history or legend.

Such distinguished geologists as Dr. G. Frederick Wright, author of *The Origin and Antiquity of Man*, and Sir J. W. Dawson, author of *The Meeting-place of Geology and History*, state categorically that gross exaggeration surrounds the antiquity of geological time in general and of post-glacial time in particular. Sir J. W. Dawson has said:

"The certainly known remains of man . . . cannot be older, according to the best geological estimates, than from seven thousand to ten thousand years."

Though very eminent men are convinced that the contour of the earth and its physical features, as we now know them, are very modern, their voices and

their evidence are drowned by the monotonous chant of evolutionary fanatics who *demand* periods varying from one hundred thousand to one thousand million years for the working out of their mutually destructive theories. The fact that 'patient research,' by some thought to be feverish rather than patient, continues to reveal no authentic connection whatever between prehistoric life and life as we know it, seems to lend powerful support to the conviction that cataclysms, caused by the cooling of the earth's crust, extinguished life which was appropriate to the fœtid conditions existing before the cataclysm. Curiously enough, a mighty flood followed by a prolonged frost of mighty proportions is precisely what might be expected to follow an eruption of proportions with which our imaginations are unable to grapple. If it is true that prehistoric birds have been found near the earth's present surface, we have in this fact, if it is a fact, strong presumptive evidence that there is no generative connection whatever between present life and that pre-cataclysmic life which, from time to time, is unearthed from the bowels of the earth. The earliest historical men, it should be noted, were perfectly well acquainted with the fact that "*there were giants in the earth in those days*" (Gen. vi. 4), just as there were minor giants in tropical regions in their own days similar to those in 1928.

The most casual observer cannot fail to see that temperature governs all manifestations of life. The

'modern' tropics still provide us with examples of the coarseness, grossness, and brutality which extreme heat breeds. It is only common sense to assume that if the earth's own surface temperature, before the last great upheavals occurred, was uniformly applied to the temperature which the earth then, as now, obtained from the sun in varying degrees according to *latitude*, we should have a variable terrestrial temperature which, however, at its lowest point might equal or exceed the temperature of the tropics to-day. If a steady thermometer of 83° can produce a giraffe, a hippopotamus, a water-buffalo, or a gigantic spider, what might not a world warmed up uniformly 100° above our present varying temperatures present to our astonished gaze? Should we not expect to find, as we do, our present tropical species in the prehistoric Arctic? That there are worlds in such a temperature and physical state among the tens of millions of planets which we are justified, by analogy, in *guessing* to exist in the universe, seems far from improbable, and if such a planet exists, in that planet it seems likely we shall still find our long-lost dinosaurs, placidly chewing the cud in the steaming and diabolical surroundings of an infernal tropics, with the pterodactyls flapping clumsily overhead.

But these reflections are purely speculative, and reasoning by analogy is notoriously dangerous. The unchanging laws of flight through a moving medium

are, on the other hand, facts, and as such they seem to compel a reconsideration of the evolutionary 'law of dispersal' based upon 'a cradle of life' theory. With 'the cradle of life' theory exploded, and with feathered life permanently confined by the mechanics of temperature to definite temperature belts, it is self-evident that there can never have been any mutation of species, though wide variations, both natural and artificial, among birds of a particular family are as natural and unsurprising features of the bird world as are the varieties of elms or apples to be found in the family of trees, or the variety of cattle and dogs in the world of mammals.

CHAPTER XIII

BIRD 'MIND'

THAT birds pilot themselves through life by the exercise of 'mind' has become in recent years a commonplace assumption and assertion on the part of 'Science,' and, in consequence, a matter of very general belief on the part of the lay public. The tendency to accept as truth the unsupported assertions of so-called Authority is becoming universal, while the fact that the dogmas of one school of science are in diametrical opposition to the dogmas of other schools, all totally unsupported by real evidence, seems to leave the prestige of that great 'school-marm' Science entirely unaffected. At a meeting of the Victoria Institute on June 21st, 1915, Lord Halsbury, the President of the Institute, made the following very striking and sensible statement:

"I wish to make a general protest against the notion that a gentleman who calls himself a 'professor,' without any sufficient qualifications, is thereby placed in a position of authority, and can make statements without a particle of evidence to prove them. I may be prejudiced in my view by my experience as a lawyer, but in court we are

expected to give full proof in support of every assertion, and if we do not, it is naturally assumed that it is because we cannot do so. A 'professor,' on the other hand, appears to consider himself relieved from any such anxiety. He seems to think that all he has to do is to say that such and such is the case, and as he is a professor he cannot be contradicted or brought to book. If anyone brings forward an argument on the other side, the 'professor' says that his opponent has made a mistake; but being a 'professor' he does not consider himself obliged to substantiate even this assertion."

The theory at the moment holding the field is that the 'mind' of birds is a combination of intelligence and instinct. Some treat their powers of navigation as falling within the 'intelligent' sphere, their mating, nesting, and reproductive activities belonging to instinct, which is spoken of as a sort of potted memory of bygone eras, 'evolved' into instinctive habits. Others reverse the two spheres of intelligence and instinct, but all combine in asserting the existence of 'mind,' and for an obvious reason. *Without it there can clearly have been no such thing as evolution of mind at all.*

In earlier chapters the author has examined the perfectly simple laws of flight. Now these laws are either known or they are not known to the professors who so industriously instruct us in articles, books, lectures, and wireless 'talks.' If they are known, how comes it that they disregard

them, and that they allow statements about the strain which wind inflicts upon birds to pass unchallenged? If they do not know the effect of currents upon bodies borne in and upon them, the professors must be, with all due respect to them, more ignorant than many A.B.s in His Majesty's ships and the Merchant Service. Why do not the Physicists *muzzle* the anatomists, the biologists, the physiologists, and the pestologists when they talk what is manifest nonsense about birds, insects, and fish?

As previously mentioned, in the British Association number of *Discovery*, September 1927, Professor Patten, Professor of Anatomy in Sheffield University, states:

"In no department of biological study is the evolutionary factor brought out more strongly than in bird movements."

Those readers who may have studied what may be termed 'scientific' books on ornithology will admit at once that this very definite statement of Professor Patten is no exaggeration of orthodox evolutionary doctrine. Modern treatises on birds are riddled and inextricably interwoven with the theory, now, strangely enough, treated and accepted as 'law' by such 'scientific experts' as Dr. Barnes, F.R.S., and the Very Reverend Dean of St. Paul's, both of which ecclesiastics are panting to re-write the Bible in the light of "competent biological thought." It

can hardly be doubted that these dignitaries of the Church share with Professor Patten and modern biologists a general acceptance of the views expounded by Sir Arthur Keith, and this being so, it must have been disconcerting to them to read the candid admission of Sir Arthur in the *Evening Standard* of October 15th, 1928, when he says:

"To confess the truth, we are a team of tipsters rather than serious students of the book of life."

There appears to be more than a substratum of truth in this somewhat overdue confession, in so far at least as it affects bird life, for Professor Patten and his fellow-anatomists, physiologists, and competent biologists have betrayed a curious ignorance of certain simple little aspects of physics and dynamics, and in a manner which prevents them from extricating themselves on any plea of misunderstanding. If space were available, it would be possible to quote innumerable passages from his writings, and from those of many other 'scientists,' which reveal instantly their startling misconceptions about the flight of birds. That the Professor knows himself to be on the horns of a dilemma is adequately revealed when, in defending himself in *Discovery*, he writes:

"Full flapping flight (not as we often see it performed in half-measure by gulls leisurely following the ship) gives birds that wonderful mastery on

the wing which enables them, on getting up sufficient speed, to pierce the air when necessity arises, and thereby removes them from the perpetual serfdom of the iron law of air-currents. No doubt aeroplanes and insects (with their rigidly stretched wings) are much more under the control of air-currents; heaven forbid, however, that the bright little, intelligent, sparkling-eyed bird, so full of life and powers of observation, should be thus enslaved."

If this strange bundle of sentimentalism, contradictions, and begged questions is illustrative of 'modern science,' the writer is not ashamed to confess himself an unscientific layman. Heaven does not forbid, on the contrary It ordains, that "the bright little, intelligent, sparkling-eyed bird, so full of life"—but alas! with *no* power of observation of any kind—*is* thus enslaved, with all the repercussions on modern biological theories that this simple little fact gives rise to.

It may be thought that too much can be made of the disregard of fixed laws with relation to bird movement, but careful study shows that ignorance of a fundamental factor of flight has given birth to the so-called 'law of dispersal,' and made it essential, and indeed natural, to endow birds with the power of recognition, in the human sense, a recognition which implies memory, calculation, and those errors of judgment which arise from freewill and the process of reasoning. So universal indeed has become the conviction among biologists

that in birds and beasts have been 'evolved' the same mental attributes as those of the human race, that it is not surprising to find Miss Frances Pitt stating in her recent book *Animal Mind:*

"I firmly believe that the mind of *Homo sapiens* differs in degree, but not in kind, from that of his fellow-inhabitants in the world"—

presumably much as the mind of Shakespeare at its prime differed from his own undeveloped and uncultivated mind at the age of one year. Professor Patten states that "the views expressed by Miss Frances Pitt in *Animal Mind* are now accepted as commonplace by modern biologists." That such views are indeed "commonplace" goes without saying, and it is perhaps not surprising therefore that Professor Patten, while speaking with real and deep feeling about the author's "degraded sublimation of bird life," should see nothing lowering in his estimate of man, the possessor of that freewill which is the hall-mark of the Divine image. In truth, if the simple laws of flight which the author has expounded are accurate—as they are—the bottom falls out of biological theory about the evolution of mind, as proved to the satisfaction of modern biologists by their assumptions of recognition, memory, calculation, and so forth in birds. Few readers who may have studied in the past, or who perhaps will study in the future, the books on the question of evolution and birds will dispute that

recognition, memory, calculation, and judgment form the sheet-anchor of the biological theory of the essential common denominator of man and beast, reinforced by the observations and absurd deductions of anatomists, an example of which was quoted in the first chapter of this book.

The very real importance of what has been said is brought out vividly by Dr. Landsborough Thomson on page 94 of his *Problems of Bird Migration*. It seems that Mr. F. J. Stubbs and Mr. T. A. Coward had come somewhat falteringly to the enunciating of 'the First Law of Currents,' though they can hardly have been sure of themselves or seen the far-reaching significance of the law. Dr. Thomson, however, seems to have been uneasily aware of the extraordinary significance of the views of Mr. Stubbs and Mr. Coward, as the following passage from page 94 reveals:

"It is *argued* [by Stubbs and others] that once a bird is launched on migration flight, its direction must be greatly affected by the movement of the whole body of air in which it moves and also by rotating cyclonic currents within this. These factors, of course, vary from day to day and from hour to hour, so that even birds departing at short intervals from the same point and in the same initial direction would necessarily be borne on different, sometimes widely different, courses. *The theory, however, seems to prove too much.* Pushed to its logical conclusion, it would negative the known constancy of the general direction of migration

movements, about which there can nowadays be no room for doubt."

To be fair, he should have added that 'the logical conclusion' makes mincemeat of the theory that birds fly by recognition, a direct outcome of memory, though it does *not* negative the *general* direction of migration, as has been shown in a previous chapter. But to continue:

"To reconcile the two sets of facts, it therefore seems necessary to assume that, except in the case of very strong winds, the migrants can adjust their flight to correct the effects of the external factors, or that if they are carried out of their course they regain it at the first opportunity."

How, it may be asked, can birds regain 'a course,' and by what means? Clearly not by recognition, for they have been carried away from landmarks which are supposed to have been the recognition marks by which they flew. But to continue again:

"This leads to the manner in which migrants are guided on their journeys, a problem reserved for further consideration at a later stage. It has, of course, to be admitted that birds flying without the aid of landmarks must, like aviators flying above a continuous stratum of clouds, be unable to gauge the effect of the changing directions and velocities of the air-currents within which they are moving."

Thus is fact dubbed theory at one moment, admitted as fact the next, and finally whittled away

as it would utterly invalidate the vast collection of theory which is the basis of the present taste for asserting that the mind of man differs in degree, not in kind, from that of the brute creation.

Let us turn again to Professor J. A. Thomson, who, upon a false premise of a somewhat different nature, but still closely allied, explains to his students the *physiological* aspect of instinctive behaviour. Writing in the *Quarterly Review* of July 1927, Professor J. A. Thomson, LL.D., states:

"If instinctive behaviour be regarded, on its physiological side, as a chain of hereditarily established reflex action, there is a gradual transition to *tropisms*, or obligatory movements, which play an important part in the life of lower animals. By a tropism is meant an inborn and automatically working adjustment of the body, so that the two sides—or it may be the two eyes, the two ears, the two nostrils, the two antennæ, and so forth—are equally stimulated. The animal does not try to adjust itself; a tropism is an automatic means of securing *physiological equilibrium.* Thus the moth, if it turns towards the light in flying past a candle, is *almost* bound to fly into the flame. *Thus the young eels or elvers must swim straight up stream, for their bodies automatically adjust themselves to have equal pressure on the two sides.*"

The assumption contained in the Professor's carefully chosen example of the eel is false, being a mere repetition of the innumerable fallacies con-

tained in 'scientific' treatises on flight, with water substituted for air. A fish in a current, like a submarine in a current or a bird in a current, can experience no pressure from the current in which it is operating, the pressure on the sides of the fish being equal, whatever the course of the fish relative to the direction of the current may be. But what of the physiological edifice that rests upon such a fallacious premise?

In publicly, and finally, disposing of the immortal soul of man, Sir Arthur Keith has very recently delivered himself of the following high-sounding, if humorous, assertion:

"The one thing the man of science insists upon above all others is that his currency be struck in the mint of truth, and that each coin must carry on its face the stamp of verifiable truth. Once let the human fancy free to wander at will, untrammelled by fact, and the markets of the scientific world will be flooded with debased coin."

The author is bold enough to think that this particular coin of 'tropisms' will require all the research of our modern transmuters of matter to enable Professor Thomson to convert this typical piece of dross into coin of gold. Indeed some explanation of his position seems to be as desirable in the case of Professor Thomson as it manifestly is essential on the part of other scientists who, as anatomists or biologists, have committed

themselves to false statements about the flight factor in birds.

Professor Thomson is not infrequently commended for his habit of simple and lucid exposition, this simplicity being favourably contrasted with the unintelligible jargon and mumbo-jumbo with which professional science conceals its thought, thereby gaining a spurious reputation for profundity. This praise of Professor Thomson's style and simplicity of diction is well deserved, but unfortunately his very lucidity lays open to immediate challenge the basis of his ingenious 'scientific' edifice.

Lest it may be thought irrelevant to refer to so extraordinary a blunder on the part of so celebrated an authority as Professor J. A. Thomson, it need only be said that the Professor's plausible doctrine of 'tropisms' permeates the recently published *Outline of Science*, of which he is the moving spirit, and finds an early echo in the bird world, for Mr. H. Magrath, writing on the migration of birds in the *Spectator* of January 21st, 1928, defines migration as "a tropism or forced movement." His simple deductions, however, are rendered obscure, if not definitely meaningless, by his introduction of the scientifically fashionable ultra-violet rays, light wave-lengths, ductless glands, gonads, endocrine system, and so forth, all of which are assumed, in varying combination, to set in motion this precious 'tropism.' The 'tropism,' as has been shown, is merely a piece of jargon employed by scientists to

describe a physiological 'reaction,' which does not, in fact, exist. We may well parody Shakespeare and exclaim, "What's in a name? A tropism by any other name would mean as little," this little being, in fact, precisely nothing. Tropisms, like our old friends the 'vitamins,' and a whole vocabulary of ugly, incomprehensible words, including the term 'biology' itself, are merely high-sounding scientific terms for nothing in the world but a cloak for muddled thinking and ignorance.

Apart from his scientific leanings, however, Mr. Magrath has quite clearly no sympathy whatever with the intellectual eminence of birds, and his closing paragraph, which bears a very striking resemblance to a passage in this book which he had certainly not seen, may well be repeated. He says:

"Migration, then, as opposed to local seasonal movements due to hunger and weather, is the ebb and flow of birds between two fixed points, the breeding-station and the winter resort, and is as mechanical as the tides."

Then follows the meaningless phrase, "It is in fact a tropism or forced movement," which represents, presumably, a hesitating act of worship in the scientific Temple of Rimmon. Thus does 'Science' obscure the clearest mind that succumbs to its deadening influence.

To conclude. In one place or another in this book all the various grounds on which biologists

attribute 'mind' to birds have been examined and, the author is bold enough to say, exploded. Birds and insects are mere machines with life as fuel—parasites of the air in the strictest sense of the word.

To those of his readers who may resent such an assertion as an insult to 'romance,' the author would very humbly offer the following reflections. Romance founded upon false premises is no true romance at all, but rather pseudo-romance. Pseudo-romance is to true romance what sentimentality is to love, necromancy to true science, superstition to true religion, what error is to truth. Is not the time ripe for a rebirth of the virile belief and faith of our forefathers, who were at least as wise and scientific as we are—a faith which set man infinitely further above the beasts than our Maker is above ourselves, for we are made in His Image, not in the image of the brute creation? Can we not trace in all the wonders of nature, in the bird world as elsewhere, the infinite knowledge and love of a Personal, Purposeful God who makes glorious provision for every physical need of the meanest creature that walks, swims, or flies—creatures which are utterly helpless to feed, warm, or protect themselves?

If, by bringing evidence to the aid of faith, the author can assist any single man, woman, or child who has any doubt on the matter to believe implicitly in the actual and active Personality of

God, and in the inherent divinity and indestructibility of man made in His Image, and His only—the body being a mere temporal instrument for the manifestation of spiritual reality—the author will not have spent his leisure in vain.

This book is founded upon simple law, and laws cannot change, being in truth the very stuff within the framework of which Omnipotence Itself builds.

"The Heavens declare the glory of God, and the firmament showeth His handiwork."

PART III

THE FLIGHT OF MACHINES

CHAPTER XIV

AIRCRAFT AND BIRDS—AN ANALOGY

In previous chapters consideration of the laws governing flight has been confined almost exclusively to its natural aspects, though allusion has been made from time to time to the allied question of the flight of machines.

It is now proposed to turn the attention of readers from natural flying machines—birds and insects—to airships and aeroplanes, and to set forth clearly those unchanging laws, unchangeable even by scientists, which impose a permanent barrier, *now and for all time*, between man and his great Empire-linking dream. Before doing so, however, it may be well to reiterate, at the risk of tediousness, that the laws which govern the flight of birds govern equally and identically the flight of machines, and it is for this reason that emphasis has constantly been laid on the fact that the translatory effect of 'wind' on a tiny bird or insect, on a giant airship, or on a Schneider Trophy winning aeroplane is the same as its effect on a giant balloon with no motive power whatever or on a toy balloon out of a Christmas cracker. In all cases *pressure* is totally absent.

In a former chapter the 'wind' was likened to an

infinitely vast transparent dome or ocean-liner, in the enclosed calm of which the flying powers of birds and machines are exercised. It is hoped that these analogies, apt if seemingly fantastic, will be borne in mind, for they contain perhaps as simple a method of grasping the phenomenon of flight in a 'wind' as any to hand. In using the illustration of the ocean-liner, however, we must remind ourselves that the speeds and courses of seagoing ships are directly under man's control, whereas at the controls of the 'Aerial Dome' of the 'wind' in which aircraft and birds are flying stands Nature, whose obstinate refusal to share this control with meteorologists or scientists remains, and will continue to remain, complete.

It should also be remembered that birds are exquisitely adapted for transferring their existence from a relative to an absolute environment, that is to say, for passing from progression in a moving medium to existence on a fixed one. The perching birds are fitted with legs and claws which grip instantly and mechanically—as with a spring—the twigs of those trees, bushes, and hedges which have caused the death of countless airmen. Add to this automatic and instantaneous grip (alluded to by expert ornithologists) the bird's automatic and inevitable arrival at its alighting destination exactly head to wind (for reasons previously explained), we can see at once the beautiful harmony of the passage of birds from a relative to an absolute

environment which the natural laws of physics make possible, a harmony which is instantly upset by the intrusion of 'calculation,' that is to say of mind and reason, qualities which airmen have to substitute for the blind obedience of birds to laws of which birds can know or understand nothing.

The sea-birds take the water with the ease comparable to the ease with which we place one foot before the other, and they ride the storms with a comfort and sureness far excelling that of the stoutest lifeboat. These perfect and automatic powers and means of alighting secure to birds the essentials of existence. When their fuel-supply inside the 'dome' is failing or their need for food is urgent, they can alight at will on a fixed platform, regardless of their locality, unless the speed of the 'dome' itself—the wind—is greater than their maximum speed of flight inside the 'wind.'[1] Under such circumstances, circumstances which sometimes arise in very exposed localities, birds will be forced to remain on the wing until they reach shelter, until the wind abates, or the bird is exhausted, for even birds cannot alight *backwards*.

[1] On a dead-calm day, that is to say a day on which there is no 'wind'-speed to deduct from the bird's flight-speed, birds of certain species must have difficulty in landing or taking off, if in some cases it is not actually impossible. This fact alone is sufficient to account for the reduced bird movement on still days, and for the fall of such a bird as a cormorant from its perch into the water, a matter referred to by Lord Grey in *The Charm of Birds*.

If perching birds—the equivalent of land machines—unfortunately find their 'dome' over water when their fuel-supply is exhausted, or conversely sea-birds—the equivalent of sea-planes—find their 'dome' over trees or obstructions, disaster will occur, as indeed it does occur to countless hosts of birds each year, a natural process by which the bird population is largely, if not mainly, kept within bounds, thus rendering birds a joy to human beings instead of a dangerous scourge.

The very great death-roll among the weak fliers is well exemplified by the multitude of eggs which such birds lay and the comparative stability of the species in spite of their yearly multiplication. The author has seen it computed, with what truth he cannot say, that approximately 70 per cent. of birds of all species are lost annually from disasters arising directly from flight. Add to this appalling and yet essentially desirable death-roll from flight dangers the terrestrial dangers to which birds are exposed, as well as casualties attributable to mere age—the wearing out of the machine—it is easy to see why birds seldom become a plague and remain one of God's happiest gifts to man.

It is curious to trace the closeness with which the long-distance flights of airmen coincide with the migration routes of birds, and how accurately the ambitious air-routes follow the general routes which weather conditions *impose* upon birds. Trace every route, and we find that aircraft drift

away like birds with the prevailing wind, and seldom return by the same route (except in a ship) on the comparatively rare occasions when they return at all. A few aircraft drift across from America to Europe with their own speed superimposed upon and added to the speed of the prevailing wind. Many, even under these chosen conditions, are lost, and few if any return. So with the Pacific flights. Aircraft drift from Western Europe to Asia, waiting very naturally for a westerly wind at the start of the 'migration,' the period being timed to harmonise with the north-east monsoon. Thus the movement of the four giant R.A.F. sea-planes to the east, a movement between England and Singapore that has taken four months instead of a few days to complete, is timed to a nicety to benefit by this monsoon, when for many months, year in and year out, the Indian Ocean is wrapped in a profound calm.

Turning again to successful flights and projected routes from North Africa to South America, we at once observe the significance of the steady and permanent north-east trade-wind. But where can we find the return voyages? In South America European aircraft will become as indigenous as are European birds reported to become indigenous in the Cape Verde Islands. Flights to and from South Africa follow the route, and to a great extent the seasons, of the swallows. There is indeed no exception to the rule that aircraft in long flights

migrate with the wind and are seldom seen again in the land of their origin if the prevailing wind is from one direction, as in the northern hemisphere it is. Thus all 'migratory' aircraft in the northern hemisphere gradually accumulate in the East until they are destroyed from one cause or another, when they are replaced from the 'breeding-grounds' in the West.

Short trips between adjacent cities will always of course be possible, though not necessarily desirable or economic, for the simple reason that the fuel that can be lifted is sufficient to enable the aircraft to cope with the average divergence between the absolute and relative distance, that is to say, the terrestrial and aerial distance between such places on all but very windy days. On such days, as we not infrequently find, aircraft run short of fuel and are forced to descend on such a trifling route as Paris to London, though seldom on the London to Paris trip, for the simple reason that the prevailing wind is westerly.

The permissible average speed of an adverse wind that will enable an airship or aeroplane to reach its destination can always, of course, be exactly calculated, and a large margin of fuel must be allowed, if it can be lifted, for even a meteorologist cannot undertake that a fair wind will not become an adverse wind or a less favourable wind after the departure of the machine.

Conversely, when we read of 'record' journeys

from Croydon to Le Bourget—or anywhere else—such a 'record' merely means that the mean speed of the favourable wind was precisely equal to the difference between the ordinary flying speed of the machine itself and the 'record' speed of the voyage. Thus if a 300-mile voyage by a 100-m.p.h. commercial aeroplane is accomplished in two hours, such a time-table implies that the mean speed of the wind in which this flight took place was 50 m.p.h. On such a day a flight in the reverse direction would require six hours. It will be noticed that though the reduction in time when the wind is favourable is one hour only over the time required for the voyage on a calm day, the increase in time over the calm-day voyage when the wind is adverse is three hours,[1] implying very possibly the exhaustion of fuel and the completion of the journey by train or motor-car if a safe landing is happily accomplished.

Turning to the destruction of aircraft and the death-roll among airmen, is there not here also a terrible similarity to the death-roll among birds? Where now are the hundreds of airships that man has built? Gone, save for a few rusty skeletons not unlike the mouldy skeletons of prehistoric beasts. Where are the tens, indeed hundreds, of thousands of aeroplanes that man has constructed at a cost of hundreds of millions in the last twelve years? Gone, vanished, as utterly as a tale that is

[1] See fig. 5, page 49.

told. What have they achieved beyond the demonstration of man's ingenuity and that indomitable bravery and perseverance which require no demonstration of this nature? What has been the toll of the youth of all nations since 1918? Slur over the facts as we will, the truth is that daily and hourly men of all races are going the way of the comparatively valueless birds. There is indeed, as we are frequently reminded, a 'freemasonry of the air,' but it is a freemasonry of death.

Let us now turn aside from these general and gloomy reflections to a brief and particular examination of the overruling disabilities of aerial transport. Critics of these ambitious and world-wide projects are looked upon and spoken of as Noahs or as "men destitute of vision," men utterly lacking the divine spark of imagination. Does reasoned criticism and insistence on the unchanging nature of natural law merit the contempt that aeronautical visionaries bestow upon their opponents? Is a reasoning and reasonable critic of necessity a person of no imagination?

CHAPTER XV

MECHANICAL FLIGHT EXAMINED

THAT imagination is the greatest gift of the mind is a truism. It is the parent of all that is great in literature and art and in the discovery and development of physical resources. The power of seeing with the mind what is physically invisible sets the seal on man's latent divinity, and enables him, by clothing his ideas with matter, with words, with paint, or with musical symbols, to create machines, poems, pictures, or music, which are great in proportion to the truth and greatness of the idea which they embody. In truth, civilisation itself is imagination clothed. There are, however, two types of imagination of a very different nature. The one is strictly and austerely disciplined to keep itself within the limits of reason and law, withholding its flight till it has mastered its premises. These are the only limits it recognises, but within this framework of natural law it rigidly confines itself, finding its infinite scope, not laterally, but longitudinally as the physical eye employs the telescope.

But there is another form of imagination, as common in the dark and middle ages as it is becoming

at the present day, an imagination which knows none of the lateral limits of law and reason and which therefore sees visions and dreams dreams in which the wish, or the fear, becomes father to the thought. The telescope which these 'imaginers' employ is more remarkable for its girth, diffusion, and consequent distortion, than for its length and concentration, and it is not therefore surprising that the schemes and visions of our present-day 'seers' bear a striking resemblance to those of the immortal projectors in the kingdom of Laputa generally and of the five hundred laboratories of Lugado in particular. Logic and pure reasoning from sound premises, combined with simple and childlike obedience to known and demonstrable law, is the secret of great discoveries and inventions, and of the proper and limited application and employment of great discoveries that have been made. This obedience to and recognition of unchanging law has always been a distinguishing feature of discoverers, who in no single instance, so far as the author is aware, have been drawn from the ranks of professional state-paid or salaried scientists. Examine any modern biographical dictionary and we find that the term 'scientist' was attached to the discoverer *after* the discovery had burst upon an astonished Royal Society.

There is a remarkable tendency to-day to assume that we can do anything we wish, or have anything we want, by instituting 'research' at public charges.

It is such an attitude of mind which causes a great body of men and women, praised for their powerful imagination, to picture, for example, airships and aeroplanes sailing safely and effectively in the moving medium of the atmosphere over continents and oceans to all quarters of the globe, carrying vast cargoes of passengers, merchandise, or armament at will. There is, however, another body of men and women—if a small one—which takes the trouble to study the facts first, and to comprehend the elementary, but none the less immutable, laws of navigation, currents, flotation of gases, dynamics, and that most unfashionable law of all, the law of economics, which is still the touchstone of the value of commercial enterprises for all purposes other than epics of adventure and daring. Let us examine shortly some of the laws, callously indifferent to research, which should bound the circumference of the mental telescope through which we gaze on the future of aerial transport. It is only by so doing that we can get the full value of effort, maintain a true, if small, image, and avoid distortion and caricature.

It is, or should be, a commonplace that all vehicles unconfined to tracks, roads, or railway-lines must contain within themselves the means of knowing their whereabouts by day or night, in good or in bad weather, not only longitudinally, but more particularly laterally, relative to the spot for which they are bound.

Navigation on the seas is an *art*, not a science, and a lifetime of study and practice cannot ensure vessels against disaster from the elements or an error of judgment on the part of a navigator. Nevertheless, the navigation of the oceans is carried on within the laws known to seamen, never in defiance of them, with the result that the oceans of the world teem with the activities of the human race. Now what are the elements of success in trade and commerce on the seas ?

In the first place, the weight of water is so great that its displacement on a large scale enables vast weights to be water-borne, weights which in one vessel may amount to many thousands of tons. For moving these vast loads at moderate speeds very moderate power only is required, 900 h.p. being sufficient to move some thousands of tons at a steady and continuous speed of 10–12 knots, or nearly 300 miles per day. After a certain speed for a given tonnage and length of vessel is attained, the added power required for each additional knot is disproportionally great, and, except in rare cases like the fast Atlantic traffic, high speed is uneconomic, and therefore, in a world where economics is a consideration, is not employed. Thus we see that huge loads can be supported on the sea, and that for the moving of these loads at moderate and economic speeds relatively trifling power is required. Since the oceans are fixed with relation to the land, the distance between ports in any part

of the world is also fixed, thus enabling time-tables to be prepared weeks or even years in advance, and, with the introduction of steam, very accurately adhered to. Furthermore, the requisite amount of fuel can be estimated and carried. These considerations are platitudes, but it will be conclusively shown in due course that these requirements, as primitive as they are essential, are absent in aerial navigation.

Having shown very briefly why vast loads can be carried at steady if not spectacular speeds on the sea, why time-tables can be published in advance and can be adhered to, and why fuel supplies can be gauged and carried, it may not be out of place to touch upon the means by which these loads are safely and surely piloted from any one port in the world to any other port with a percentage of failure that is infinitesimally small.

The sea and the land being relatively fixed, the currents of the sea negligible, or where not actually negligible known and charted, the periodic *tides* being exactly predictable, and since the speed of the ship through the water is known within a knot at most, the position of the ship can constantly be established with fair accuracy by what is known as *dead-reckoning*, the dead-reckoning position being obtained from the course steered and distance run along this course. This dead-reckoning position has, however, to be constantly checked by accurate observations of the heavenly bodies, because dead-

reckoning accumulates errors which cumulatively, after a long run, might be very considerable and a source of danger when making a landfall, or in the neighbourhood of reefs or shoals. Thus the *art* of safe navigation lies principally in the constant correction of a dead-reckoning position by accurate observation with the sextant or by bearings of recognisable landmarks if land is in sight, these landmarks, perhaps sighted for the first time, being recognisable from charts *only because the dead-reckoning position is reasonably accurate.*

In fog or thick weather in the open sea the passage can continue without anxiety since dead-reckoning is sufficiently accurate when clear of land, and the fuel-supply is ample and assured. In fog, thick weather, darkness, or when near land, if any uncertainty exists as to the *exact* position of the ship, she can stop, take soundings, or possibly anchor till the weather clears. All the infinitely varying conditions with which the seaman is faced through life constitute the 'mystery' of his profession and to some slight extent the risk, but the outstanding feature is this. In all but rare cases his difficulties are *calculable* and *manageable*, and hence the teeming life and activity upon the highway of all nations—the sea.

In concluding this brief and almost primitive survey of the art of navigation and seamanship, and of the factors which render sea-transport economic as well as practicable, it would be unwise to omit

reference to the countless harbours and anchorages with which nature, by the hand of God, has strewn the sea-boards of the world. Dry docks and jetties men have built, but one dock will satisfy innumerable ships, for docks are not harbours to ships as hangars and aerodromes are to airships and aeroplanes.

In turning from marine to aerial navigation and transport, it should be emphasised at the outset that the three-dimensional navigation of the atmosphere includes all the difficulties and necessities of the two-dimensional navigation of the seas, but with all the difficulties, and in some vital respects the insuperable difficulties, that the third dimension superimposes. A recently published book—*The Great Delusion*—has caused some slight stir, but the public interest in this work has so far mainly centred in the startling statistics and figures which it exposes. These disquieting figures, statistics, and experiences are the natural outcome of a disregard of first principles, clinching, *not forming*, the argument. Not until the central idea of that book, the navigational and operational disabilities of aircraft, has been mastered, can we look for a modification of the world-wide credulity in the future of long-distance aerial transport as a serious contribution to the transport facilities of the world.

What are the facts? Since aircraft, like birds and fishes—but unlike all other means of transport—operate in one medium only and that a movable and infinitely variable one, they fly *within* a vast,

invisible, and movable ocean of currents, and not, like a sailing- or steam-ship, on a wind-swept stationary sea. The distinction is dramatic in its finality. As repeatedly emphasised, no airship, aeroplane, flying boat, or bird feels anything of the pressure we call wind. They become an integral part of the air on and in which they are borne, as a ship conforms to the very slight movement of the water on and in which her bulk is supported. This perfectly simple and unchanging law imposes two changeless disabilities on single-medium vehicles such as aircraft. These two disabilities are introduced by the two phenomena which can be shortly stated as follows:

The distance between any two places in aerial mileage is relative, not absolute.

The drift of an air-borne body, if no fixed object is visible, is and must remain incalculable.

Since an aeroplane or an airship assumes, without feeling the pressure, the full speed and direction of the atmosphere in which it is flying, the wind experienced in either is always from right ahead and equal in force to its exact speed through still air, regardless of the direction and speed of the atmosphere in which it is flying, and with which it is moving in harmony.

Assume the engine-speed of an airship or aeroplane bound on a 3,200-mile non-stop voyage to be 80 m.p.h.

Assume again the wind, that is to say, the bodily

movement of the medium in which it is flying—the 'dome'—to have an average translatory movement for the whole distance of 40 m.p.h., a by no means unusual speed at flying heights.

Now assume, for the sake of simplicity, that the atmosphere is flowing towards the destination of the aircraft. The aeroplane or airship makes good, under these circumstances, 120 m.p.h. and, disregarding the innumerable mischances which may overtake it on the voyage, will reach its destination in 26·66 hours, having expended fuel for 2,132·8 miles only while achieving 3,200 miles over the earth. Assuming it to have filled up with fuel for forty-eight hours, its maximum carrying capacity, it will have enough fuel remaining to fly on for another 21·34 hours, in which time it can fly 1,706·2 miles with its engine, making good 2,560·8 land-miles beyond its original destination—in all 5,760·8 miles over the land and sea in forty-eight hours.

Now reverse the current—the direction of the 'dome.'

The airship or aeroplane, still flying with an engine-speed of 80 m.p.h. in what feels like calm air, is now only making good 40 m.p.h. over the land or sea towards its destination. Under these circumstances, at the end of forty-eight hours it will have exhausted its fuel, but will only have covered 1,920 miles over the land or sea and will come down in the sea or on the land 1,280 land-miles from its destination.

In one case aircraft can cover 5,760·8 land-miles and in the other case 1,920, *a difference of* 3,840·8 *land miles in forty-eight hours.* In view of these facts it is clear that the pursuit of 'records' is, to put it bluntly, childish.

Thus the geographical distance between two places by air is relative, not absolute. In the simple but by no means unusual example cited, the *distance* from west to east, assuming the air-current to be flowing from the west, is 2,128 miles, but from east to west it is 6,400 miles. The *Southern Cross* in its recent trans-Pacific flight reached Honolulu, so it was reported, with fuel for one and a half hours' farther flight. The crossing was brilliantly achieved with a steady and favouring air-current. Had this current been a trifle less favourable or strong, the gallant crew would have fallen into the Pacific short of Honolulu. Had the current been *adverse*, and only moderately rapid, the fliers would have fallen short of Honolulu by a thousand miles or more, the exact position of the disaster depending upon the relative speed of the machine and of the atmosphere in which the machine was borne. So with all the trans-oceanic flights.

Now for a moment let us consider the incalculable nature of *drift.* It has already been shown that all aircraft fly in calm air so far as horizontal currents are concerned. They always feel a head breeze, and a head breeze only, exactly equal to their engine-speed. Suppose an airship or an aeroplane

to start across the Atlantic, Pacific, or any other great expanse of trackless waste such as the Arctic, from west to east with the air-current exactly favourable. Suppose rain, mist, snow, or darkness to overtake her, and that the wind shifts eight points and blows from the north. In twelve hours the aeroplane would be drifted to the south, without any possibility of knowledge on the part of the pilot, a distance in miles equal to twelve times the speed of the wind, while the aeroplane is still being steered inside its 'dome' on the supposedly correct compass course for the destination, for airmen, unlike birds, have no *sense of direction.*

It must surely be plain to every understanding man and woman that long-distance navigation in aircraft under such circumstances, circumstances for ever arising, is a matter of blind chance, the time of arrival or disaster being a matter entirely outside the will, control, or skill of the flier. Here we have an example of 'Relativity in Action,' a subject dealt with in a former chapter. A trifling change in the direction of a favourable wind may lead to disaster, while a considerable change will ensure it. Meteorologists cannot at present foretell the weather: they are unlikely ever to control it. This being so, trans-oceanic or trans-continental flights by airships or aeroplanes can never, so long as natural law continues to rule the universe, be of any commercial or scientific significance whatever, and, except on fine days with a favourable and steady

current, the majority of flights undertaken by brave men, spurred on by the glitter of public applause, by the bribes of interested persons, and often at great public expense, will end in disaster and death and the loss of great sums of public money.

It is repeatedly argued that the increased range of aircraft is a sign of progress. This is not in reality the case. The greater the power, speed, and range of the aeroplane the greater are the fuel requirements to get the aeroplane and its pilot to their destination. If petrol is surrendered, more useful load, it is true, can be lifted, but it can only be carried a correspondingly reduced distance. Broadly speaking, air-borne transport is two thousand times less efficient than terrestrial forms of transport, and considerable 'research' will be required to alter *the already well-known laws of physics and dynamics which precisely govern the lift, speed, and power ratios of wing-surface and engine-power.*

Having discussed in some detail the simple laws of currents and drift, and having shown that *aerial* mileage between two places is a relative and not an absolute quantity, it may be of interest to examine why it is not possible to fix the position of aeroplanes in transit as the position of a ship is fixed. We may dismiss the amiable talk about the marvels of wireless telegraphy for position-finding, talk set on foot by those with strong wireless interests or a wireless bee in their bonnets, by pointing out that few

pilots, concerned for their own safety, contemplate the carrying of a wireless installation on long non-stop flights, preferring very properly the few gallons of extra fuel that the discarding of Senatore Marconi's wonderful position-finders enables the airman to carry.

It is true that a wireless transmitting set enables newspapers to satisfy the craving for sensation which is such a disquieting feature of the last few years, and that a wireless set may be of service in bringing relief to *beleaguered* airmen. While it cannot, however, give security to the fliers from their own resources, it makes easily possible to any evilly disposed person the perpetration of a cruel hoax, for any person with a transmitting set at his disposal can gossip to a listening and over-wrought world. If the aircraft is known to be fitted with wireless, who is to say whether an aerial message is true or false ?

In attacking *The Great Delusion*, some aeronautical enthusiasts unwisely prated about sextants and the fixing of position by observation. The existence of this mathematical instrument is known to these amateur navigators, but the conditions of its use clearly are not.

Apart altogether from the almost prohibitive difficulties of using a sextant in a quivering aeroplane and of working out problems derived from the data obtained by sextant angle of the heavenly bodies (height of eye can only be approximately

known and artificial horizons are useless), our aeronautical friends have overlooked a small but vital matter, in much the same way as they overlooked, in an amusing manner, the inoperativeness of Buys-Ballot's law for the avoidance of storms.

As is well known, one observation of the sun gives merely a position line. To obtain a 'fix,' it is necessary to run on for another two hours or more to allow the bearing of the sun to alter sufficiently to get a second position line which will give a cut with the first position line and therefore what is known as a 'fix.'

Now the 'run' between the two observations can only be estimated, but in a ship, because the speed of this vessel is moderate and known, and because the sea in which it is supported is stationary, the small error of this dead-reckoning is negligible and will not cause an error of more than a mile or so in the final observed position.

In aircraft, however, the 'run' between observations is a combination of engine-speed, current-speed, and lateral drift, of which total the two latter components may amount to a hundred miles or more, and which are precisely what the 'fix' is required to determine, but which it cannot determine.

The circumstances that make sea-transport and navigation a practical and economic matter have already been described as platitudinous, but it was further said that it would conclusively be shown that

the primitive yet utterly essential requirements of navigation and transport were absent in aerial navigation.

Who will deny the disabilities here laid bare?

Will anyone deny that the distance between two places in aerial mileage is relative and not absolute? That in view of this fact time-tables for long non-stop flights cannot be laid down, or if laid down, adhered to? Can the essential fuel-supplies be gauged or carried? Who will deny that the life of the pilot and any passenger is entirely at the mercy of the prevailing air-currents, since the utmost cargo of fuel that can be carried may be utterly inadequate? Can meteorologists control the winds of Heaven? Can they certainly foretell them?

Will anyone dispute that drift, in the absence of visible marks, cannot be measured or even known to exist?

Who will dispute the inability of aeroplanes in flight to fix their position by observation of the sun or stars or to keep a dead-reckoning that is of any value when out of sight of recognisable leading marks—rivers, coast-lines, railway-lines, furrows in the desert—except on a practically windless day?

How then can aircraft explore and report upon unknown and *uncharted* lands? What can be their contribution to accurate, and therefore genuine, cartography? Mr. Edward Reeves, the map curator to the Royal Geographical Society, and

possibly the greatest living authority on survey, has recently and publicly stated:

"I do not attach much importance to Polar flights for survey work. It is *impossible* for observers from an airship or an aeroplane to obtain any precise measurements of the regions over which they pass."

True as this statement is, its converse is equally true and therefore more disturbing, the exact implication of which will not, however, be examined further.

Who, in the light of recent long-distance flights, will champion the value of wireless position-finding in aircraft? Will anyone deny that any vehicle should be free to stop at any moment without risking, thereby, the life of the passengers? How comes it that such categorical questions meet with no reply but the hysterical cry of 'Progress'? Wherein lies any scope for progress within the well-known laws of dynamics?

It is not intended to dwell on other aspects of long-distance aerial travel which in themselves render such a conveyance a definite retrogression—the roar of the engines; the cramped position; the risk of fire, or death by drowning; the absence of food and sleep; the absence of the common decencies of life; the entire absence of reasonable luggage. Who would travel, except as an adventure, in a vehicle in which a small temporary defect in the

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engine, a faulty sparking-plug, might result in disaster, and over the sea in almost certain death ?

To say soberly but firmly that if the vast sums of taxpayers' money were withdrawn from these enterprises, aircraft would almost, but still not quite, vanish from the world, is to court abuse. Yet such is the case. Why in the name of all that is quietly sensible should aerial 'commercial transport' and flying clubs have millions of public funds squandered on them, when all other means of transport and pleasure, ancient and modern, have established themselves on their merits as private enterprises, often in the face of official obstruction ?

There seems to be a universal impression that this country must pursue a phantom because foreign nations are feverishly engaged in the same pursuit. Such a view is surely to prostitute reason. From a nationally selfish point of view we should welcome the awful waste of money and effort in other lands, though deploring the waste of life, since humane feeling knows no frontiers.

Aerial success is now measured by the amount of it in which any particular nation indulges. In other walks of life it is realised that to increase effort founded on false premises is merely to multiply error, but the absence of absolute standards in the air precludes the exercise of reason. This is no academic or philosophical abstraction but a perfectly simple concrete fact which this book has demonstrated. Just as aerial navigation is, per-

force, carried out in an environment of relativity, reason being thus inoperative, so all talk and chatter about the air is relative and devoid of any absolute standard. Able men, distinguished for their clear and sober judgment, inevitably leave their reasons beneath them when they leave the fixed earth, if only in thought, and soar into the clouds. Having, however, no instinctive sense of direction in this relative environment, unlike the unreasoning birds, but like aircraft over the Atlantic, they are lost. Indeed, 'air-mindedness,' by expelling reason, breeds 'air-sense' as a substitute for the saving grace of old-fashioned common sense.

We are assured day by day, by scientists and others, that flying is in its infancy. This is demonstrably untrue, for the aeroplane in the last analysis is its engine, and aircraft engines have reached, if they have not passed, the danger-point of lightness for horse-power. If the internal-combustion engine were a less perfect instrument than it is admitted to be after nearly fifty years of development, there would be some semblance of reason in the parrot-cry of 'Infancy,' and in the constantly repeated analogy of motor-cars in their early days. Surely it must be plain that it was the *imperfection* of the internal-combustion engine which provided just that scope for the future perfection of the motor-car which we now enjoy.

Can the simple necessities of navigation be dispensed with? Is the *art* of navigation in its

infancy? We hear, *ad nauseam*, of the great 'science' of aerodynamics, whereas in reality it is no 'science' at all, but our old friend dynamics, every aspect of which is, or should be, known and applied by the regular profession of genuine engineers. Mere increase in size of wings, power of engines and speed[1] is no sign of progress. This is recognised in other branches of engineering. It is perfectly possible to build a ship of 100,000 tons and to install propelling plant of 500,000 h.p. giving enormous speed, yet we simply have not done it, for Reason still rules the world outside the magic cloudland of aeronautics.

The old expression 'to make' a thing is now seldom heard. Instead we read of 'evolving' the perfect airship, the super-aeroplane, or the vast, safe flying boat. The jargon of evolution now actually pervades the manufacture of machinery, and it is seriously believed that there is no finality in any one particular mechanical means of achieving an object; that, in fact, principles and laws are themselves 'evolving.' Had our present salaried research staffs and 'chairs of research' existed in the days of the bow and arrow or of sailing ships, it seems more than likely that modern weapons and craft would still be in the limbo of the future. Instead

[1] Great speed, always attainable with the installation of excessive power, is purchased at the price of endurance and reduced useful load. *Slow* flying would indicate true progress, but this is unattainable except with the flimsy machines of twenty years ago.

of the discovery, generally by laymen,[1] of substitutes for old means, evolutionary projectors—*professional* scientists—would be busily 'evolving' the bow and arrow and the sailing ship to a condition in which teams of horses would be required to bend the bow and carry the arrow, and harbours would require remodelling to accommodate 'the triumphs of progress' in sailing ships. There must be many men and women in all countries of the world who wait with amusement if they are cynics, and with impatience if they are humane, that cataclysmic day when commercial and sporting aviation are instructed to support themselves. On that very day, within twelve hours, aviation will fade away like smoke, and the world will know it for what it was —a vast modern North Sea Bubble, protected from exposure as such by public funds forcibly wrung from threadbare taxpayers.

[1] Pneumatic tyres, a revolutionary discovery, were invented by a veterinary surgeon; automatic weapons by the son of a gunsmith; steam by an artisan; electrical induction by the son of a blacksmith; and so forth.

CHAPTER XVI

SOME QUESTIONS FOR THE AIR LEAGUE

STEMMING a stream in a pair-oared boat is a thankless labour, especially when progress towards the haven is so slow as to be hardly perceptible. There comes a time indeed when the temptation to lay aside the oars and to drift amiably with the current is almost overwhelming, a temptation only to be resisted by the man or woman who keeps steadily in mind that the haven has got to be recovered eventually, and that the greater the drift the greater must be the final effort and distress. As with a river, so with a great current of popular opinion to the obstinate few who refuse to drift with the main stream till they are carried at last over a deep and rushing cataract.

There can seldom have been a period in which catchwords were so potent or mere reiteration so apt to convince. Indeed, the ordinary man and woman, without expert knowledge, can hardly be blamed for believing in a great aerial future for the world when such a future is painted in rosy or rather *purple* colours by those in authority, in their turn imposed upon by a powerful combination of involved and interested persons whose reputations and liveli-

hoods are manifestly dependent upon the sustenance of the great delusion.

Few will deny that the taxpayers' money, poured like water in the past into aerial projects, has been unproductive of any commercial success up to the present time. Indeed, it is universally conceded that aviation as we know it, after a quarter of a century of feverish effort and prodigious outlay, is commercially useless, and would lapse altogether but for its artificial sustenance. This is no foolish or partisan over-statement but a sober fact, emphasised again and again by those in authority, who actually use the unpleasant fact as their excuse for further extortion.

As with so-called 'commercial' aviation, so in a great measure is it with military aircraft, except when used, in fair weather, as a humble auxiliary to the infantry, who still decide battles as they have done in the past, and as they undoubtedly will continue to do until the end of the chapter. The nations of the world are being feverishly educated into the belief that aircraft have upset all orthodox conceptions of strategy. The striking inability of aircraft, despite the heroism and skill of the pilots, to seriously influence events in the crises of the late war is obstinately overlooked. With tens of thousands of aircraft in the hands of a skilled and conscienceless opponent, our cities, docks, food-ships, and troopers remained, for all practical purposes, unscathed. Bombing angered

the country; it did not cow it. No gases more potent for use from aircraft have since been discovered. Gas at high pressure has still to be conveyed in heavy steel containers. The laws governing the lift of machines have not changed. Bomb-dropping has not shed its narrow limitations. Nothing in fact has changed for the better or for the worse, with the exception of speed, which characteristic, however, is no true mark of progress, for it can be purchased now as it could have been in the past, by sacrificing the essential requirements of a practical vessel—that is to say, at a price which is exactly calculable and therefore known.

Since the War France has exposed the fatal limitations of aircraft to the observation of the world both in Morocco and Syria, limitations experienced by ourselves in Irak, and of which we have by no means heard the end. Now we have a ludicrous object-lesson in Afghanistan where wild tribesmen, as in North Africa, Syria, and elsewhere, have routed a regular army trained in terms of ultra-modern strategy and armed with modern weapons and aircraft. The aerodrome is captured; the aeroplanes are scrap-iron. To put it bluntly, their sole use has been for scuttling—an admitted use in adversity, but one no longer possible now that the tribesmen are in possession, except by the tribesmen's permission, most kindly afforded. Even so, the second dethroned King had to be conveyed to Peshawar instead of Kandahar, *because the wind*

was unfavourable, a special train and a 2,000-mile railway journey being thus involved, though the distance from Kabul to Kandahar was but 300 *geographical* miles by air.

Fear is the offal on which Englishmen are now invited to feed. Pictures of red ruin and havoc for all but 'first-class Air Powers' are accepted as credible by sober-minded men and women. Fear being the natural parent of cruelty, injustice, and thus of unwise policies, it is perhaps a matter for no wonder that Englishmen should contemplate against France, and against Mohammedans regularly employ, methods of warfare hitherto universally associated with assassination, and for this reason as ineffective as they are monstrous. Blunt as this statement may appear, it is none the less true on that account. Disguise it as we will, the fact remains that bombing, from its nature indiscriminate, is rousing the indignation, hatred, and armed resistance of the Mohammedan world.

To where is this aerial fever leading? So far it has landed us in a morass of financial jobbery and military miscarriage, a morass in which two courses, and two only, are now open to us, for by common consent we cannot stand still up to our necks in a bog. Not too far behind us is the solid ground of financial purity and stability, and of sound, if unspectacular, military doctrine. Before us lies a vast horizonless quicksand with no haven in sight. Are we, as sadder and wiser men, painfully to

retrace our steps to the shore, or are we, goaded by the popular cry of 'progress,' to struggle out farther into the morass, with no guiding light of reason but a will-o'-the-wisp?

There is no doubt as to what the world's decision would be, in spite of the experts, if it was once persuaded that the vague beacon ahead was in fact a phantom light. But how is the world to be convinced when the voices of authority, self-interest, and *amour-propre* are merged into one stentorian roar? It is not surprising that the still small voice of reason can only be heard during intermittent lulls in the old Ephesian chant in which drab, and bloody, 'Air Power' has supplanted the charming, and chaste, Diana.

We may disregard those few persons, and they are few outside those financially involved, who would continue to advocate or tolerate a continuing outlay of public funds to perpetuate aviation as we know it. It is the inevitability of dramatic progress that is widely believed to lie ahead of aviation that deludes laymen into a fatalistic shouldering of their heavy aerial burdens. But wherein lies this mighty future, apart from the *wish* for it, or the *fear* of it? What is there, so to speak, in the aerial lucky-bag? Aerial experts consistently refuse to disclose by so much as a hint the source from which this progress is to spring, chattering idly instead to their critics about old gentlemen who disbelieved in trains, and old women who argued that iron would not float.

Many, led by Mr. Garvin, regard all aerial critics as first cousins of Noah and advocates of the construction of Arks. There can be no question that Noah knew his business, and few will deny that an airship would have proved a sorry vehicle for the salvage of mammals, considerably less effective indeed than the trusty old ark in fact proved itself to be.

Principles do not change with centuries, nor yet with millenniums.

The writer has himself flown so long ago as eighteen years, and since, and has commanded submarines in all parts of the world for fifteen years, and he can, therefore, hardly be accused of ignorance of modern engineering standards.

No aerial critic is so innocent as to suppose that his questions will receive an answer, though doubtless they receive notice, from aerial soothsayers. In the aerial world a straight question is no incitement, as it is elsewhere, to a straight answer; rather is it a spark to kindle a blaze of abuse: but notwithstanding the inevitable silence, it is proposed to ask certain questions to which, as sure as dawn follows night, an answer will ultimately be demanded by taxpayers when the failure of aerial enterprises, whether by airships or aeroplanes, is patent for all to see.

The questions, which are simple, are as follows:

(1) Airships and aeroplanes, unlike all other vehicles, are *parasitical to a moving medium* which

is under no man's control, and which attains velocities not infrequently bearing a high relation to the speed of the vehicle. Will the Air League deny this ?

(2) Assuming the foregoing fact to be admitted, will any expert inform the public how any sort of time-table is possible for long non-stop voyages, when we realise that the full speed and course of the aircraft is merely superimposed upon the full speed and direction of the wind ?

(3) Time-tables being clearly impossible, will the Air League inform us whether they consider a time-table to be a necessity of modern transport, and, within reason, of ancient transport ? By time-tables is not meant an accuracy of minutes or hours, but of days, not to mention those *weeks* in summer during which aircraft are delayed from leaving if the wind is adverse, and those winter *months* when ambitious flights entirely cease, giving place to prophecy about future summer flights.

(4) A 40-knot adverse wind to an 80-knot airship or aeroplane renders a voyage of 3,000 sea-miles three times as great in *distance*, time, or fuel expenditure as would be the case if the same wind was favourable. Thus, with such a wind adverse, the voyage of 3,000 miles becomes a voyage of 6,000 miles, while with the wind favourable, the voyage is reduced to 2,000 miles. Will the Air' League deny this ?

(5) Since no denial to the last question will be forthcoming, it is pertinent to ask how fuel and 'pay-load' are to be adjusted in the present absence of *control* of the wind by 'scientists.' Is it anticipated that science will be able to reverse the winds? If so, we must not overlook the unhappy aircraft voyaging at the same time in the opposite direction. But perhaps one-way traffic only is contemplated.

(6) Since in long non-stop flights aircraft carry every gallon of fuel they can lift off the ground at the start, jettisoning for the sake of fuel every ounce of anything (including the peel of the regulation orange) that is not essential to the life of the pilot and crew, and since the hours of endurance in the air are known in advance, what but disaster is in store for the aircraft if the favourable wind (in which all voyages are commenced) becomes unfavourable on passage?

(7) Passing from the overruling governance of the wind to the machine itself, it is obvious, and freely admitted, that the security of an aeroplane is as dependent upon the perfect running of its engine as is a man upon the working of his legs; indeed, far more so, for anyone but an exceptionally heavy man can at least sit down without crashing. Does the Air League consider that life should be dependent upon all absence of trifling error in a sparking-plug, a tappet, or a petrol joint?

(8) Sir Alan Cobham has stated that, from a

mechanical point of view, "the aeroplane is about as perfect as any form of transport can be." The Air Ministry, in their official memorandum "The Approach toward a System of Air Communications," has emphasised that "the commercial aeroplane has emerged from its experimental stage." What are the views of the Air League on these authoritative pronouncements? If they consider the views of the Air Ministry and Sir Alan Cobham are unwarranted, will they say so, and tell us wherein lies the scope for advance in the machine itself, disregarding trifles?

(9) If, on the other hand, the Air League agrees with Sir Alan and the Air Ministry, what are their proposals for the future? What is their justification for painting it in rosy colours?

(10) Turning from the unchanging disabilities of the moving medium in which aircraft operate, and from the machine itself, and considering the question of *operation* and *navigation*, will the Air League deny that a public vehicle must be free at any time to stop without endangering the lives of the crew and passengers, disregarding the destruction of the costly vehicle itself, which in these progressive days counts, seemingly, for nothing?

(11) Assuming that our aerial friends admit the desirability, if not the necessity, of being able to stop at any time, will they tell us how aeroplanes can stop without coming to mother-earth or sea? Since they cannot stop in mid-air, how can they

ensure a safe landing? The ghastly and growing casualty-list of the world supplies, of course, the answer.

(12) Since aeroplanes and airships cannot, from the nature of things, estimate their speed or course made good over the sea or earth in the absence of fixed landmarks, how is navigation to be carried out at night or in mist over the land, or at any time over the sea or a desert, in anything but stable weather when the wind, if existent, remains constant during the flight?

(13) Should all vessels have the means within themselves of fixing their position with reasonable accuracy in all weathers, or does the Air League regard this need as an old-fashioned and out-of-date necessity?

(14) Does the Air League regard the fixing of position by external wireless as satisfactory in view of the repeated and almost invariable failure, or absence, of directional wireless over oceans and continents?

(15) Questions of operational significance could be multiplied, but it is proposed to close this modest questionnaire with an inquiry as to whether the Air League believes in the old-fashioned law of supply and demand?

(16) As the preceding question must of necessity be answered in the negative by all aeronauts, the urgent need of subsidy being recognised and indeed insisted upon, it is of use only to ask disinterested

taxpayers why aircraft, alone among vehicles, must be forced upon a world in which the demand for such transport cannot sustain, and does not pretend to sustain, the ever-ready and increasing supply?

The foregoing questionnaire could be indefinitely prolonged by many equally pertinent questions. The lay public, as has already been said, admits the present failure of aircraft to justify their existence as a State enterprise for commercial purposes: it is the great future to which the world universally looks for the crowning of the present sacrifices and daily disasters.

The writer can hardly doubt that satisfactory replies to his sixteen questions would be a source of considerable relief to the public: does the public, however, realise that *an unsatisfactory answer to a single one of them* entails the ultimate pricking of the commercial air-bubble? Can the nature and effect of air-currents on air-borne vehicles be changed? It can be no more changed than can the law of what we *call* gravitation.

Can the machine be materially changed for the better? Experts say definitely that it cannot, the reason being, as experts know, that lift is governed by well-known laws of dynamics which limit the weight of the machine, its fuel-supply, and therefore its endurance to-day, as they did ten years ago or at the time of the Deluge.

Speed, the one and only factor that has been

materially altered in the past ten years, can always be purchased up to a limit, now nearly attained, but only at the cost of attributes absolutely essential in any commercial vehicle. Slow, not rapid, flight is the real need.

The Schneider Trophy aeroplanes are freaks, as is perfectly well known, unable to remain in the air for two consecutive hours; as useless for war as for commerce. Their horse-power for weight conveyed is abortional, so much so that these dangerous and extravagant toys, upon the performance of which great countries are now content to wager their prestige, were unable to proceed to the racecourse on their own power, requiring a vast floating aerodrome, known by courtesy as an aircraft carrier, but resembling in looks and function a Noah's Ark.

'Sporting aviation,' a source of ever-recurring annoyance and disgust to the neighbourhood in which the meetings take place, is 'safeguarded' from extinction by subsidy, without which the sporting clubs would wilt and die. On what conceivable grounds of propriety or common sense is this questionable sport sustained by compulsory levies on taxpayers among whom not more than two or three out of a million fly, or have any intention of doing so, unless, as seems not impossible in this once free land, 'flying for all' is rendered as compulsory as the support of it now is.

In conclusion, it might be well once again to

draw attention to the quarrel between the two schools of thought, calling themselves, surely humorously, the 'lighter-than-air' and 'heavier-than-air' schools. The indictment of airships in *The Great Delusion* met with the almost universal approval of all 'heavier-than-air' pundits, who were considerably disgusted, however, at the criticisms of their aeroplanes. Mr. Spanner, the author of *The Broken Trident* and other aeronautical extravaganzas, and perhaps one of our leading 'air-fans,' suddenly sprang into prominence as the saviour of his country from the airship madness, though his attitude would have been more valuable, and less subject to adverse remark, had his belated indignation burst all bounds when these airship schemes were first launched, with his full knowledge of the plans, instead of three months after 'Neon' appeared on the scene, when millions had already been squandered. However, Mr. Spanner's conversion is no matter for complaint: indeed it would be entirely satisfactory were it not for the unfortunate fact that he still seems to labour under the delusion that wind has a greater effect upon an airship in flight than upon his beloved super-aeroplanes and flying-boats. In this extraordinary misapprehension he seems to be at one with Lord Thomson of Cardington and a large portion of the lay public, in whose case, however, the misunderstanding is perfectly natural.

'Neon' presented a case against airships which

will stand valid for all time, but in spite of the demonstrable futility of these aerial monsters they are, as 'Neon' is at pains to point out, more practicable than commercial aeroplanes can ever be. Their endurance is far greater: they can make at least some pretence of navigation: they can ease down to dead-slow speed without crashing, unlike an aeroplane which must charge madly on like a wild beast if a landing-ground is unfortunately absent or, if present, invisible.

How long is the post-war air-fever to rage in the land? How long are the cemeteries to be fed with its victims, and the taxpayers and ratepayers [1] compelled to 'safeguard' its survival? Aeronauts, unlike the writer, are for the most part 'evolutionists,' believing therefore in 'survival value' and that the 'survival of the fittest' is a law of nature. Very well then. Let aircraft prove their value and thus their fitness to survive—naturally.

[1] The new subsidised company "National Flying Services, Ltd." is involving ratepayers in commitments which may well grow to the dimensions to be found in Germany.

CONCLUSION

LITTLE remains to be said on the subject of mechanical flight. 'Neon' has presented a case against a great future for the air which is as unanswerable as it remains, in every particular, unanswered. Death and ruin continue to punctuate and underline every page of her book. For every highly placed or well-known person who goes to his or her death, scores of unassuming boys pass from life to a horrid death unhonoured and unsung, sometimes unreported. The tale of disaster in England represents but a little fraction of the youth who daily are being sacrificed 'on the altar of Science' to appease the hunger of the modern Moloch of the Air. Who pauses to inquire how widows and orphans are supporting themselves? Who seriously reflects that scores of men must accept the bribes of great oil and aircraft industries to save themselves from destitution?

Who can view with equanimity the modern practice of committing to one of H.M. aeroplanes the honour of a great nation, as though England's honour hung on such a narrow thread as 5 m.p.h.? Who will maintain that 'records'[1] are a fit pursuit

[1] See pages 189 and 200.

for the governments of great nations? If aeroplane speed-races, why not an international tortoise race with tanks over the Alps, or cruiser races round the world with specially constructed, but otherwise useless, racing cruisers? Who can view without shame and dismay the new form of indiscriminate warfare by bomb, futile as it is evil, evil as it is futile? Who can contemplate coolly the employment of aircraft for police duties, which from their nature must be judicial? Certainly not the Mohammedan races whom, since the war, Christians have been subjecting repeatedly and continuously to these novel and futile means of tax-collecting and order-keeping. For what practices did we rightly brand our late enemies as Huns? Who can view without grave anxiety the position of those gallant young Air Force officers in Irak, who may yet be faced, if we do not cease these practices, with a great open-order attack on their aerodromes without a vestige of a chance of saving themselves or their machines from infuriated Arabs when the 150-m.p.h. bombing career over the desert comes to an undignified and fuelless end, as the Arabs know it must come to an end after a few hours?

Why cannot the country and its leaders realise and admit that the great commercial future of the air is a terrible mirage? Why does England fear the future destruction of her cities, shipping, and docks? Is the ludicrous failure of thousands of aircraft to drop one single bomb on the locks and

docks of Zeebrugge or on ships in the Channel and ports in the late war to count for nothing in our judgment? The inherent inaccuracy and relative futility of bombing has in no way altered. For every thirty-six aeroplanes we possessed at the close of the war we now have one, notwithstanding an outlay of over £200,000,000 in the interval. Four years of fierce aerial warfare by a brilliant and unscrupulous opponent left our cities and docks unscathed after 103 air-raids. The death by bombing inflicted on civilians in four years of war was incomparably less than the death caused in our streets in a single year by motor-vehicles.

Why all this feverish to-do? Is it not because the priesthood of Science, the false prophets of Materialism, the great vested and state-aided Interests have nailed their Jolly Roger to the tails of airships and aeroplanes? So narrow and specialised has the religion of 'Science' become that its archbishops, bishops, priests, and deacons have actually overlooked the basic principles of transport, navigation, and warlike operations, and have, by their oversight, revealed to judicious men and women that their ignorance of the inescapable disabilities of operation in a single-moving medium appears to be as profound as is their incapacity to remove these disabilities unquestionable. That great statesman and seaman, Sir Eric Geddes, has recently expressed his "firm conviction" that within

ten years[1] civil aviation will be "standing on its feet." The author shares Sir Eric's conviction, though ten years is undoubtedly an over-liberal estimate of the interval that must elapse before we witness a dignified return to rational means of locomotion, including the pedestrianism foreseen by Sir Eric.

What are we to think? Do scientists and aerial propagandists, or do they not, understand the implications of Applied Relativity, or are they entirely engrossed in speculation about that Infinite Relativity which they have so industriously reared on premises which are in immediate danger of being proved to be false? Anyone who may think that the aeroplane holds a future denied to the airship will do well to reflect that the fundamental disabilities of operation in a single-moving medium apply equally to aeroplanes and to airships, a fact which, as has been pointed out, Mr. Spanner seems to have overlooked, but which he, in common with many others, has still to face.

On the question of the future of ambitious air-schemes and 'Empire-linking' the world can be divided into three groups and three only:

[1] Four years of the original ten years of subsidy to Imperial Airways having elapsed, the period has been extended to another full ten years, this 'company' being now in receipt of a grant of £2,490,000 from the taxpayers. Sir Eric Geddes has now resigned, leaving his "firm conviction" for his successor to translate into reality.

Those, the masses of the public of all countries, who quite naturally are unaware of the laws of flight.

Those who know the laws but are unable to grasp their implications.

Those who are aware of the laws and alive to their consequences, and yet preach a vast aerial future.

Aerial experts have no alternative to placing themselves definitely in one of these three categories.

Professional scientists connected with the study of the air, as biologists or aeronautical advisers, are either ignorant of these laws or, as this seems inconceivable, they know the laws but are deceiving the world into the belief that Bondage can be converted into Freedom, and that science can alter those eternal laws, both physical and spiritual, outside the bounds of which the Great Architect of the Universe Himself has never trespassed.

" Why do the heathen so furiously rage together : and why do the people imagine a vain thing ? "

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