cause of an actual increase in the amount of protein absorbed, and has shown that some improvement in condition attends this alteration. His work promises, therefore, to be in a very real sense of economical value to the Government, indicating a better maintenance of health on wisely diminished rations. This statement also applies to his study of the salt requirements of these diets, which lead him to the conclusion that more salt is supplied than is useful, and that the excess is detrimental.

The author has carefully studied changes following an increased absorption of protein from the diet, and presents an admirable case for discussion alongside the valued contributions of Chittenden. He has enlarged his presentation of this case by reference to the habits of the different native races within his view. According to him, these races may be arranged in a series, in which virile characteristics vary directly with the protein value of the diet, and are greatest where, as amongst flesh-eaters, this value is at a maximum. Carnivorous man sets to his work with zest, and is prepared to labour strenuously, and, if need arise, fight for life. The vegetarian spends a gloomy existence, embarrassed by an internal tangle of cellulose, and is swept off by feebly resisted disease. Some of the evidence offered in support of this contention is not of the same value as that in the remainder of the report, but it is highly interesting, and has been usefully published.

Prof. McCay is to be congratulated upon a report that should be found in every library of physiological literature. The opportunities provided by such a systematic observation of human beings under very precise control are great, and have been well utilised.

J. S. MACDONALD.

RECENT PROGRESS IN AËRONAUTICS.[1]

THE sudden development of the art of flying which has come upon the world during the last few years may be classed as one of the most extraordinary events in the world's history. We have had far-reaching inventions introduced before, such as the railway, the telegraph, the telephone, the motor-car, and many others, but all these have gradually developed, have sprung from small beginnings, and often it seemed doubtful whether they would ever develop into utility of real importance. With the flying machine it is different. True it is that the advent of such an apparatus has been foreseen, not merely for some years, but for centuries. The inception is very old. Like the sailor's story to his incredulous grandmother of the flying-fish, so a hundred years ago no one would have been dumbfounded if one had prophesied that men would fly, although one would have been accused of talking nonsense had one foretold that we could talk along a wire hundreds of miles long, see bullets embedded in the lungs, or be able to reproduce a song sung by one departed. We dare not at present hazard a guess as to what the flying-machine may eventually develop into. There are still those who think it will never be much more than a curiosity, but there are others who believe it will soon become our usual mode of travel, and that railways, steamboats, and motor-cars will have to take quite a back place in comparison.

My object to-night is not to give a full history of the navigation of the air. That is getting into a big subject that would occupy a long time to properly relate. Nor is this to be a very technical lecture; I propose now merely to refer to the latest developments—to trace some lines of thought which I hope may serve as a basis on which my hearers may build more solid structures for the improvement of the navigation of the air.

Aërial machines have been classed under two headings, known as lighter-than-air and heavier-than-air. I do not purpose going very deeply into the question of the first class, because I am inclined to think it is a subject of comparatively little importance, the latter having made such very much greater progress of late, and being able to effect almost all that the dirigible is designed to do and with greater ease and efficiency, that it seems likely to entirely oust the former.

A few words, however, on gas-borne vessels may be desirable to point out how they have been evolved, and in which direction improvements may be looked for, should their development be considered advantageous.

Balloons.

First we have to consider that simple contrivance the balloon, by means of which men have, for the last century and a quarter, been able to rise in the atmosphere and drift with the wind wheresoever it listeth. It is a remarkable fact that, notwithstanding the great hopes it raised in early days, scarcely any improvement has been made in this contrivance during a hundred years of practice. This refers to the simple balloon. Almost immediately after its invention suggestions were made to form it as a long vessel and propel it with screws, and though to-day we have the practicable dirigible balloon, it is probable that no invention has been longer in developing. Step by step it has grown from the ideas of Meusnier, through the crude machines of Giffard, de Lôme, Tissandier, to the first successful vessel, that designed by Colonel Renard, nearly thirty years ago. Though much progress has been made since, it has always been slow.

Santos Dumont evoked much public interest with his little vessels; Count Zeppelin certainly made a big step forward with his large rigid-framed leviathans, while Parseval, Gross, Julliot, and others have further developed the invention. From Giffard's steam engine of 3 horse-power to the 500-horse motor of the Siemens-Schuckert, every variety of engine has been tried, continually increasing in power.

Nor does it appear that any very revolutionary advancement is likely to be effected in the future with dirigibles. We may hope to go on making each vessel a little better than the last, much in the way in which steamships have progressed.

Undoubtedly the main path along which improvement is possible and desirable is that of speed. So long as an aërial machine is only able to progress at a rate not much above that at which the wind usually blows, it is bound to be very dependent on the ever changeful weather. A dirigible can never be considered really practical (in this country at least) until it is capable of travelling at, say, 40 miles an hour. This is a speed not yet attained by any dirigible. The wind at one or two thousand feet up frequently blows at 30 miles an hour, and not only must we be able to make head against this, but we ought to be able to progress fully 10 to 20 miles in the teeth of it. Now, considering for the moment solely the lighter-than-air machine, given a certain weight of engines, since buoyancy is dependent on displacement, we cannot make the vessel any smaller if it is to lift the weight. In order to increase its speed, then, presuming the shape and the surface and fittings to be such as to offer a minimum of resistance, there seem but two possible means. One is to make engines more powerful for their weight, and progress in this line seems moving rapidly. The other is to increase the size of the gas-holder. As the volume is enlarged the lifting power (and hence ability to carry more powerful engines) is increased at a greater rate than is the cross-section and surface, and consequent resistance. So we get the tendency to construct huge machines ever growing larger. This size, however, is one of the greatest practical drawbacks to the employment of such vessels. It is true there is plenty of room in the sky, and if the machines had to remain always aloft there might be no difficulty. But to be of use they must come to earth, and the enormous bulk has to be held stationary against any wind that may happen to blow. This is exceedingly difficult, and necessitates the use of sheltered harbours and sheds to house these monstrous structures, which implies vast expense.

There is, however, yet another means by which it may be possible to increase the speed without adding to the bulk. It is one that has often been suggested, several times tried on a large scale, but does not seem to show signs of general application. I refer to the use of horizontally disposed surfaces known as aëroplanes. If we have an apparatus travelling at, say, 30 miles an hour, and we add such devices, it will be found that they give a very considerable extra lift, and this may be utilised for raising an extra weight of engines. By adding to the propulsive power we both increase the speed, and thereby

[1] Paper read before the Junior Institution of Engineers on April 11, by Major B. Baden-Powell.

the lift, which enables us to carry still further weight of engines, and so *ad infinitum*. This soon leads us on into another kind of appliance, for if we then want to increase our speed further, all we have to do is to reduce the resistance. This can now easily be done by lessening the size of the gasholder. Having thus gained more speed and got more lift out of our aëroplanes, we can still further curtail the volume, and so we go on until we find we have no gas left, and yet our machine progresses at a greater rate than ever! Therefore, why start with the troublesome gas bag at all!

Aëroplanes.

Six years ago such a thing as a real flying machine was unheard of. We had seen Maxim's great structure running along its rail. We had rumours of Ader having done something in secret in France. We had read of Langley's steam-driven model going for three-quarters of a mile. But it was in 1905 that accounts began to leak out of real flights having been accomplished by the Brothers Wright in America. In the following year Santos Dumont gave the first public demonstrations of a man being lifted off the ground by such an apparatus. In 1907 Farman made a number of short flights up to about half a mile; Blériot and Esnault-Pelterie also made some "hops." It was not until 1908, however, that anything approaching real flight was shown to the world, when Henry Farman and Delagrange accomplished what was considered extraordinary performances on a Voisin machine, and when later in that year Wilbur Wright set up his machine in France, while his brother Orville flew (with such unfortunate results) in America; the introduction of practical flight may then be said to have come about.

In order to realise the great progress in the art of flying from that period to now, some two years and a half, I may quote the "records" accomplished:—

	Duration in the air. Hrs.	Mins.	Distance travelled. Miles.	Altitude attained. Feet.	Speed Miles per hour.
1905	0	36	24	—	40
1906	—		$\frac{1}{8}$	—	25·8
1907	0	$\frac{3}{4}$	$\frac{1}{2}$	19	33·7
1908	2	20	$77\frac{1}{2}$	328	40·5
1909	4	17	145	1,560	48
1910	8	12	365	10,500	65·5

During 1909 much progress was made. In England, Cody made some creditable flights; in America, Glenn Curtis, McCurdy, and others; while in France quite a number of aviators budded forth. In 1910 all records were beaten out and out, and very much was accomplished.

It is thus evident that immense progress has been accomplished in flying. Now let us turn to the machine itself and see in what essentials it has been improved. A vast variety of machines have been built and even tried, but of those differing much from what we may call the standard types, very few have accomplished any success.

I take as the standard types the Wright (with large elevators and no tail), the Farman or Voisin (with small elevator and big tail), and the Blériot monoplane (with no elevator in front, but tail behind); most other machines are but modifications of them.

Wright Type.—The original Wright machine has undergone three important modifications, which render the latest pattern a completely distinct type from the first machine. First, wheels have been applied, so that it is now capable of rising directly off the ground after a preliminary run, and is not dependent, as it originally was, on being drawn along a rail by falling weights, so as to give it an initial impulse. Secondly, a horizontal tail has been added, which has greatly improved the inherent fore and aft stability. Finally, the front biplane elevator, which seemed so essential a feature, has been done away with. A machine of smaller area has also been produced, the span being only 22 feet, or nearly half the dimensions of the original machine. It is now reported that the Wrights are building a machine to carry eight people in a closed carriage, with a 100 horse-power motor.

The Cody biplane is very similar in general design to the original Wright, at first having no tail (though one has been added recently), the main difference being that it has only a single propeller, and has ailerons placed between the planes at the outer ends to effect the same as the warping of the Wright planes. The details of arrangement of the frame and wheels are somewhat different, and the elevator in front consists of two independent planes side by side. It is a large machine, having a span of $46\frac{1}{2}$ feet, and the upper planes being $8\frac{1}{2}$ feet above the lower.

Voisin and Farman.—To follow up the development of the Henry Farman and Voisin types, the two must be taken together, since the former was but a modification of the latter.

The first successful Voisin machine consisted of a biplane divided into "cells" by vertical walls. The span was about 34 feet. It had one biplane elevator and a very large cellular tail. The latter was soon reduced in size to a span of 8 feet.

The Henry Farman biplane, which was evolved from the Voisin type, the main difference being the omission of vertical planes and the addition of flaps for transverse control, has not altered very materially. The size of the box tail has gradually been reduced, and in the latest machines the upper plane is made wider than the lower by the addition of extensions. Both H. Farman and Grahame White have recently tried machines of much smaller area. The former has planes of 150 square feet each, and has lifted at the rate of $6\frac{1}{2}$ lb. per square foot. There are a number of other machines of similar build. The Curtiss differs in having ailerons instead of flaps, but the Maurice Farman, the Sommer, the Bristol, and the Howard Wright differ only in small details.

Blériot.—The Blériot monoplane, which underwent a great variety of modifications to start with, has now settled down into the well-known type with a span of about 30 feet, with a fixed tail behind fitted with inclinable planes on each end. The latest type of two-seater is of 36-foot span, with a trailing flap tail.

The *Antoinette* monoplane is not very different in its general characteristics. It is much larger, and the "aspect ratio" or plan of the wings shows a greater span for length. Flaps are attached to the trail of the outer ends of the planes, and a fixed horizontal tail, or "empennage," is arranged at the end of the body.

Santos Dumont's *Demoiselle* monoplane is much the same type as the Blériot, but has always been of smaller size. Other features are that the man is underneath, and the engine is placed on top of the planes, so as to raise the centre of gravity, which would otherwise be very low, and to be able to couple the $6\frac{1}{2}$-feet diameter propeller direct to the shaft.

Other Types.—Other types of successful machines include the Breguet, which, though a biplane, has all the other characteristics of a monoplane, viz. propeller in front of all, with the engine behind it, fish-shaped body, and cruciform tail behind. This has proved very satisfactory, having recently taken up as many as twelve people. A new pattern of Bristol is of similar design.

The Dunne biplane and monoplane, with redan-shaped planes and no elevator or tail, for which a large degree of automatic stability is claimed, have achieved considerable success.

The *Valkyrie* monoplane, which may be considered as a separate type, having its elevator, as well as a small fixed plane, in front, and the propeller behind the main planes, has also done well.

Taking a general view of the recent developments, we are confronted with strange anomalies. Some inventors, such as the Wrights, have discarded the front elevator, though this does not seem to prove it undesirable, for others have adopted it. While some Farmans have been improved by the addition of more surface, yet small machines of nearly half the area have proved highly satisfactory.

One of the most surprising results of a study of these changes in design is that it seems possible to alter the disposition of the surfaces of a machine in quite a marked manner, and yet there is but little difference apparent in the ability to fly. It becomes very puzzling to the mathematician and theorist who wishes to investigate the subject, and to ascertain the whys and wherefores, when he reads of areas being reduced without detriment, of eight and even twelve men being carried on a machine designed to carry only one or two, of a machine fitted with a 50 horse-power engine flying faster than one almost exactly similar having a 100 horse-power engine. It all seems to show how very little we know of the principles which underlie the matter, and how much really careful experiment and research are needed if we are to go by anything more than rule of thumb.

Now that a certain amount of experience has been gained, we can get at some idea as to which type of machine is generally pronounced the most satisfactory. It is perhaps curious that two types so different as the Farman biplane and the Blériot monoplane have performed so similarly, and there does not seem to be any decided preference among flying men between the two. The following figures of the machines on which certificates had been gained in France last year give some idea of the popularity :—

93 Blériot monoplane, 81 H. Farman biplane, 37 Antoinette monoplane, 30 Sommer biplane, 26 Voisin biplane, 16 Wright biplane, 15 Hanriot monoplane, 9 M. Farman biplane, 20 on other biplanes, 17 on other monoplanes (besides 10 others not specified), that is, 162 monoplanes and 182 biplanes.

Of British-owned machines, according to Jane's "All the World's Airships," there are (or *were* five months ago) :—

34 Blériot, 14 H. Farman, 6 Voisin, 8 Wright's, 5 Sommer, 4 Antoinette, 1 Demoiselle (besides small numbers of various English makes).

This list is, however, not very trustworthy as an indication, as many of these machines have scarcely been tried, and many others (not included) have done good service during the last four or five months.

Automatic Stability.—A great deal has been said and written on this subject. Before practical flight had been attained, it was often thought that it would be necessary to apply some controlling mechanism actuated by a pendulum or gyroscope, so that when the machine tilted over it would be automatically forced back. Practice has shown that such an arrangement is quite unnecessary. We still hear of projects of this nature, but it is evident, not only from the performances of actual machines in the hands of expert aviators, but also from uncontrolled models, that a properly designed and properly balanced machine is quite stable by itself.

Motors.—The subject of motors for aërial work is perhaps rather beyond the scope of this paper, but since so much depends upon the motive power—indeed, the advent of the successful aëroplane may be said to have been entirely due to the invention of the petrol engine—I must refer briefly to it.

The chief notable feature in this line is the very general adoption of the Gnome rotary motor. This peculiar engine, which, of course, consists of seven cylinders radiating from a central shaft, which spin round forming a fly-wheel, and very efficiently cooling themselves by their rapid motion through the air, was at first looked upon as an impracticable freak. In 1909, however, it was fitted to several machines, and at once proved itself trustworthy and superior to all other motors for the purpose. Recently quite a number of engines of somewhat similar design have been brought out, and some of them, such as the Buckman, seem likely to prove even more efficient.

Meanwhile, several British-built engines of more ordinary design have come to the fore, notably the Green, with four water-cooled vertical cylinders, the N.E.C., a two-stroke motor, and the E.N.V., and several others, but for one reason or another these do not seem to be so popular with practical aviators.

Future Developments.—It is, of course, extremely difficult to foresee in which direction aëroplanes are likely to develop. There is, however, here again one of those what I may call "reciprocal" situations such as I have referred to with regard to balloons. The tendency seems to be to make the planes smaller. By this decrease the weight is lessened as well as the resistance. By lessening the resistance the machine should travel farther, and the decrease of weight of planes should enable a heavier and more powerful engine to be carried, and thus speed again increased. By travelling faster we obtain more lift, and can therefore further cut down the size of the planes. So we go on, making the machines smaller and the speed faster; and who can say where the limit may be?

Other types of machines have often been suggested, notably those of the wing-flapping species, and those with vertically acting screws. Seeing the success which has attended the simple aëroplane, I think it is doubtful if any other form will supersede it, but I have long been of opinion that some combination may prove advantageous. For instance, it is possible to arrange for vertically thrusting screws to assist in starting the machine, and it seems quite probable that a propeller on the flapping-wing principle may prove highly efficient.

THE AUSTRALASIAN ANTARCTIC EXPEDITION.[1]

AUSTRALIA and New Zealand have always been anxious for further knowledge of the great frozen continent lying to the southward of them. Because the Ross sea area is more conveniently situated to the south geographic pole, most expeditions to the Australian quadrant have wintered there. This has led to the neglect of the great coast-line westward of Cape Adare. Our information regarding it is very fragmentary, and for the most part untrustworthy. Properly equipped, an expedition to this region should have no difficulty in achieving great geographical successes. In the words of Dr. H. R. Mill, "It is time, at any rate, that someone should revisit the lands discovered by Biscoe, Balleny, D'Urville, and Wilkes. . . ."

Lying within wireless telegraphic distance of our borders, this region has a special call upon Australians. Alive to the value of scientific data there massed waiting to be collected, I have ardently sought for an opportunity to reap the harvest. Captain Scott's programme was too full with the determined efforts in view, upon the south geographical pole and King Edward VII. Land, to accede to my request to be landed this year with a party at Cape Adare. It was then that Sir Ernest Shackleton proposed to raise the necessary funds, and, with myself in charge of the scientific work, to attack the whole coast-line between Cape Adare and Gauss Berg. The plans were published in the Press on March 19, 1910, and repeated later in the year. Eventually Sir Ernest Shackleton handed over command to me.

Until the last fifteen years, though touched upon as early as 1820, only about seven expeditions, excepting whalers in the areas south of America, have come within sight of the continent. It was not until 1898 that the first Antarctic night had been experienced; even to the present day but four expeditions have wintered on the continent, and their contributions refer only to isolated spots of the 8000 miles, more or less, of coast-line. It is gratifying to note the successes which have attended recent assaults upon the unknown, and we can confidently look forward to the complete unravelling of the broader features and secrets of Antarctica within the next three years.

The Antarctic Continent.

Conclusions of any but local value based on the data available are obviously liable to prove in error, but will always serve a useful purpose in directing the attention of explorers to possible contingencies. The inadequacy of the data available is comprehended when we find, based upon them, several entirely different views regarding the geomorphology of the South Polar region. There is, nevertheless, a general agreement regarding the seaward limits of the land and the permanently attached ice. That is to say, we can now guess approximately the limits of southward navigation—where ships must be brought up either by land or barrier ice. Assuredly considerable portions of this coast-line are no more than barrier ice—marginal shelf-ice of great thickness—which in the recent past may have been of greater seaward extent, and in the future may retreat even hundreds of miles before the rocky coast-line is revealed. These barriers originated from the land glaciers, and are partly aground, partly afloat. It appears probable that the immense thickness of nearly 2000 feet is sometimes reached. In such cases the barrier ice, though afloat,

[1] From a paper read before the Royal Geographical Society, on April 10, by Dr. Douglas Mawson.