AERIAL NAVIGATION.

BY VICTOR TATIN.

The purely mechanical solution of the problem of aerial navigation has been sought through three means—helicoptera, or large helices with vertical axes, imitation of the natural flight of birds, and aeroplanes moved by helices with horizontal axes.

Helicoptera.—The first helicopteron that was able to sustain itself in the air was that of Launoy and Bienvenu, and dates back to 1784, the epoch at which it was presented to the Academy of Sciences. The necessary motive power was furnished it by a bow of whalebone. At that time a practical solution was far from being reached, and the apparatus just mentioned awaited improvement for more than three-quarters of a century. It was then that an ingenious experimenter, Mr. A. Penaud, happily modified it by substituting a twisted rubber thread for the spring. This apparatus gave results so superior to those that had before been obtained that it might almost have passed for a new creation. But despite the efforts of Penaud and a number of other investigators, it was impossible to devise any practical result from the helicopteron, and the little machine became an interesting plaything, and that was all.

The only apparatus of the kind that has since been constructed is Mr. Forlanini's helicopteron. This experiment was made upon a little larger scale. The springs were replaced by a small and very light steam engine, whose boiler consisted of a vessel filled with water raised to a high temperature. The whole weighed 6½ pounds, and rose in the air when the engine developed a one-fourth horse power, or one horse per 26 pounds. In spite of all the interest that such an experiment presents, we cannot prevent ourselves from remarking that the disposable weight was very feeble in proportion to the considerable work demanded of the engine. Notwithstanding the contrary opinion of many persons, we shall demonstrate without trouble that we can, by means of a helix, obtain much more favorable results. The experiments which we take for a basis were, like those of Mr. G. Tissandier, performed with helices which, through their very construction, did not possess a maximum of sustaining power. They were not constructed, as in Mr. Forlanini's apparatus, in view of a recoil of about 100 per cent. Every helix, in fact, should be carefully studied from the standpoint of what we expect from it. So, in the helicopteron, as the helix is at the same time a sustaining plane, it should be likened to a surface moving horizontally, and in which, consequently, the resistance to motion will be to the lifting power as the sinus is to the cosinus of the angle formed by such plane with the horizon. Should we construct, then, a like helix of sufficiently short pitch and of wide surface, we might theoretically, and by pushing things to the extreme, lift an indefinite weight with a very slight power, and we should be limited only by passive resistances and friction. When, on the contrary, the helix, instead of being stationary, or nearly so, is destined to have a motion in the direction of its axis, it can be given a longer pitch, since it then attacks the air at an angle that is so much the smaller in proportion as the recoil is less. It is thus situated under as favorable circumstances as one with a very short pitch, whose recoil is 100 per cent. We think the detractors of the helix have not understood this condition.

However this may be, it seems to us that the helicopteron system has indeed but little future before it, because of the extreme lightness that it would be necessary to give the immense structures whose every part would be in motion. Besides, we may ask, What velocity would we obtain, since we would have here only one means to employ—that of inclining the rotary axes of the helices? To make use of secondary helices would evidently be a complication as compared with the use of the aeroplane. What also would be the relative immobility of the car suspended from the axes of two helices revolving in opposite directions? These questions are not as yet answered.

Mechanical Birds.—The imitation of nature must have always seemed to man as the most rational means of artificially solving the problems that she herself has worked out, and we find a proof of this in some old mythological fables whose origin is lost in the depths of time. Among the attempts that have been made since, none has given a real result, and we are scarcely more advanced to-day than they were in the time of Archytas of Tarentum. It is again to Mr. Penaud that we owe the first important results in this path—the most arduous that we could select in order to reach success with apparatus heavier than air, and the one in which we are most backward. When Penaud, through the use of twisted rubber, caused a small machine to fly, our emulation was excited, and no one perhaps was more enthusiastic than we in the pursuit of a definite result.

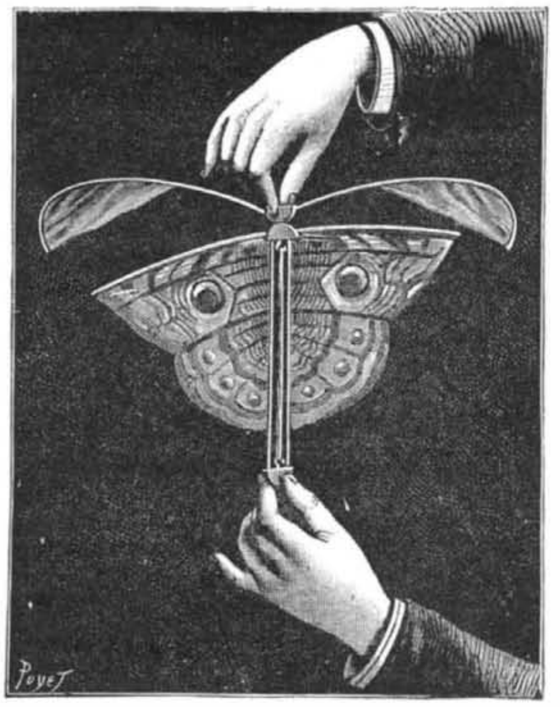

Fig. 1.—TOY HELICOPTERON.

During the course of our researches, which lasted for several months, we constructed a large number of mechanical birds of all sizes and various weights, from that of half a gramme up to that of more than a kilogramme, and reaching in the latter case a spread of wings of more than two meters. In our smallest models the rubber spring was always used, but we varied the form and relative extent of the wings *ad infinitum*, as we did the number and amplitude of their strokes. We compared the advantages and disadvantages accompanying the use of wings of birds or cheiroptera, and finally we obtained results that have never been surpassed, nor even reached, but always by exceeding a power that was out of proportion to the effect obtained. We afterward tried to find as exactly as possible the value of this excessive expenditure, by constructing compressed air machines designed to replace the rubber. These apparatus were the largest that we experimented with, and their extreme lightness permitted us to furnish a mechanical bird nearly ten times its weight in kilogrammes per second.

After modifications without number, and entire or partial reconstructions, the results were so unfortunate that we had to give up the struggle, at least in this direction. Is that to say that a mechanical bird is a machine impossible to realize? In no wise; we must not conclude from our defeat that better cannot be done, but we shall not advise any one to try it with a view to obtaining a practical result in aeronautics. The very complex motions of a bird's wing during flight are very difficult to imitate in mechanics, and, if nature has used them, it is because the organs of these animals could not adapt themselves effectively to other and simpler motions that mechanics make use of—rotary motion, for example. It will be thought, perhaps, that we have been a pretty bad mechanic. We admit this very willingly, but at present we are convinced by force of time and money that the imitation of nature has no other interest than that of making us better understand the means that she employs. It seems to us inadmissible to construct a mechanical bird in order to navigate the air. Our fathers did not try to construct the locomotive after the type of the hare or antelope in order to imitate the speed of those animals.

Aeroplanes.—By this name are designated apparatus whose invention is quite recent, since the first rational project published about them is due to Henson, and dates back to 1842 only. This, moreover, is the type that has always been reproduced since then. The principle of this apparatus consists in the maintaining in air of a vast plane, to which propelling helices communicate a rapid forward motion. No one that we know of had obtained good results by means of these apparatus before Penaud, who again employed twisted rubber for setting these small and astonishingly simple apparatus in motion. This ingenious experimenter unfortunately devised nothing but types of aeroplanes of small dimensions. The disease that was to remove him from us doubtless interfered with his researches.

A few years before his death he published, in conjunction with one of our friends, Mr. P. Gauchot, a project for an aeroplane of large dimensions, but his demise prevented its being carried out. This construction would doubtless have entailed quite a heavy expense, but we believe that it would have given a victorious proof of the superiority of the aeroplane over all the apparatus that we have described above. At the epoch at which Penaud definitely devoted himself to the use of the aeroplane as the most capable method of giving practical results, we were still engaged in constructing apparatus based upon the imitation of the flight of birds. Our eyes were finally opened to the evidence, and we entered a path which since then we have not ceased to follow. We soon congratulated ourself upon this change, for, from the very time of our first trials, the results have been satisfactory.

A small aeroplane of about 0·7 square meter surface was actuated by two helices that revolved in opposite directions. The motor was a compressed air machine analogous to a steam engine, whose boiler was replaced by a relatively large receptacle of 8 liters capacity. Despite the little weight that we could dispose of we were, nevertheless, enabled to give the receptacle sufficient strength to cause it to resist, on trial, more than 20 atmospheres (in our experiments the pressure never exceeded 7). Its weight was only 700

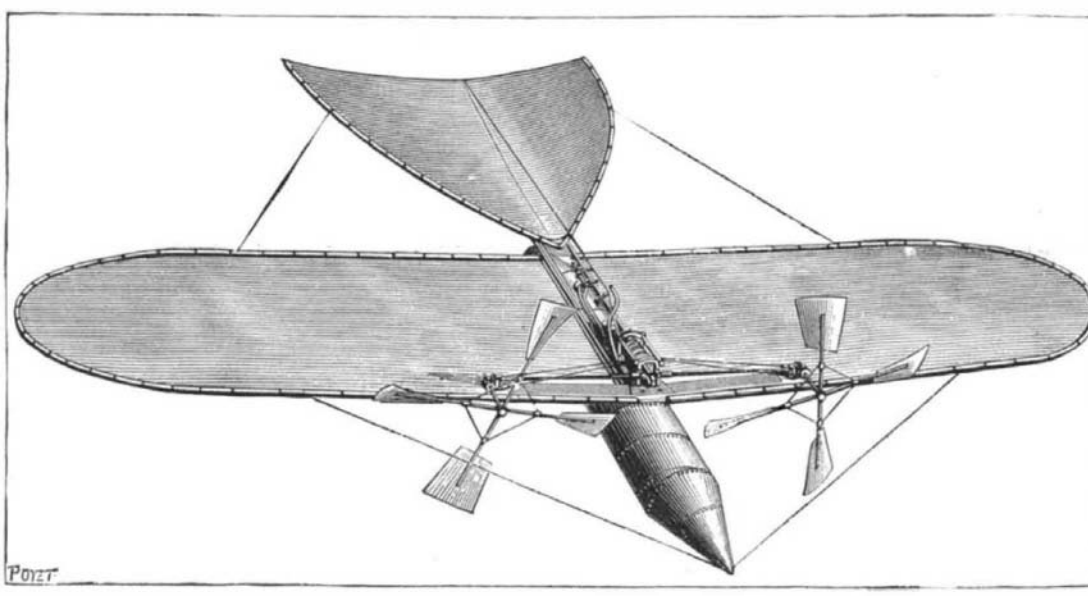

Fig. 2.—TATIN'S AEROPLANE.

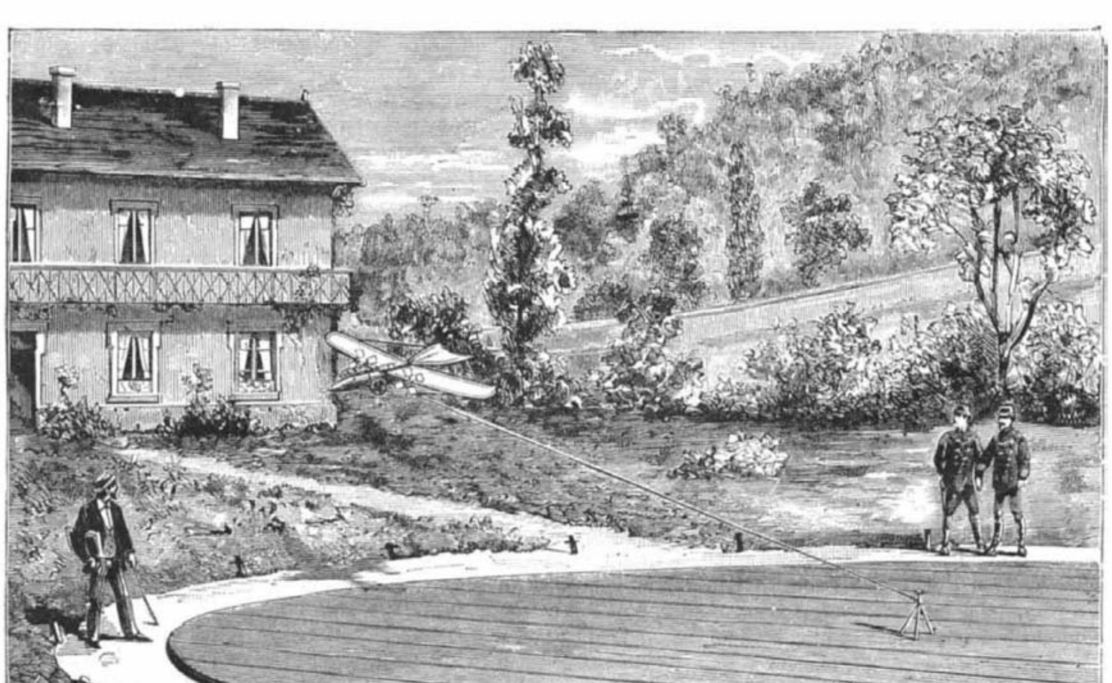

Fig. 3.—EXPERIMENT AT CHALAIS-MEUDON.

grammes. The little engine, which developed a motive power of about 2 kilogrammeters per second, weighed 300 grammes. Finally, the total weight of the apparatus, mounted upon rollers, was 1·75 kilogrammes. This entire affair (Fig. 2) left the earth at a velocity of 8 meters per second, although the resistances were almost equal to those due to the opening of the angle formed by the planes above the horizon. The experiment was performed in 1879 at the Chalais-Meudon Military Establishment. The aeroplane, which was attached by a cord to the center of a circular flooring, revolved around the track, rose from the ground, and once, even, passed over the head of a spectator (Fig. 3). We can only renew here the thanks that we have already addressed to Messrs. Renard and Krebs for their extreme obligingness and the interest which they appeared to take in our experiments.

After this result we formed a project of studying with this apparatus the advantages or disadvantages connected with the use of more or less extended planes, of more or less open angles, and of different velocities in the two cases; but our resources, which were then more than exhausted by these long and costly labors, did not permit it, and, to our great regret, we have since had to content ourself with indicating the programme of our experiment, without carrying it out ourself.

The experiment which we have just described confirmed our previsions, however, and we think that we are now able to trace the principal lines of an aeroplane without fear of committing a grave error. In an aeroplane, as in a balloon, the resistance to a forward motion increases as the square of the velocity. The motive power, then, will here also have to increase as the cube of such velocity; but since, for a given angle that is supposed invariable, the sustaining thrust and the resistance to motion will always be in the same ratio, the disposable weight will increase with the square of the velocity, so that, as regards this point, we will be more favored than by the use of balloons.

It must be remarked, per contra, that, with the aeroplane system, large constructions will merely offer the advantage of permitting us to obtain motors that are relatively lighter and more economical.

It is very evident that the first essays made with aeroplanes would be only of short duration. Let us at first have modest views. Let an aerial machine work only an hour, half an hour even, at a velocity of 15 meters per second, and the progress made will be immense; one may even say that the problem will be entirely solved. After this first step will rapidly come the improvements that experience will indicate. New motors will become an object of researches that will soon prove fecund, and humanity will finally find itself in possession of the most powerful engine that it has ever imagined.—*La Nature.*

CHOLERA has prevailed in this country in 1832, 1848–49, 1854, 1865–66, and 1873.

DINOSAURS.

The first naturalists who described reptiles as crawling animals would certainly have modified the opinion that they expressed had they known the strange creatures whose history we are about to sketch.

These animals, which are designated as ornithoscelians or dinosaurians, partake, by certain characteristics of their organization, of the nature of mammals, birds, and reptiles properly so called, while at the same time exhibiting characters that are proper to themselves. They seem to bridge over the gap which in present nature separates the most perfect of the reptiles, the crocodiles and the tortoises, from the lower mammals—the marsupials—and from such birds as the ostrich, emu, and cassowary. They are so far removed from the reptiles that we have to form a distinct subclass for them equal in value to that which is admitted for reptiles of the present time.

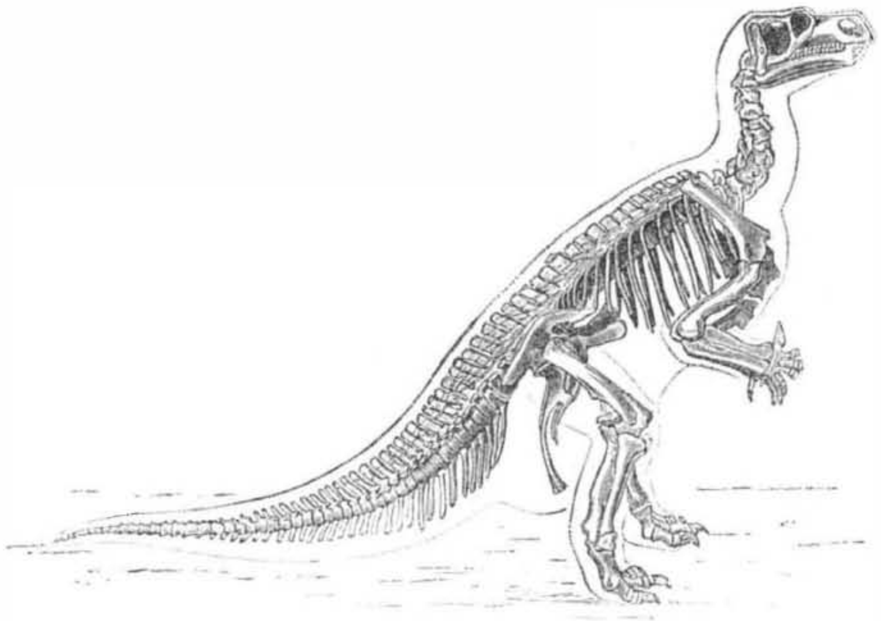
Fig. 5.—SKELETON OF IGUANODON.

The differences that they present from our reptiles are much greater than those that we find between tortoises and serpents, for example, to merely cite the two extreme terms of the series. We know nothing of the dinosaurs except their skeleton. It is probable that if it were permitted us to know what their organization was, how their circulation was effected, and what their mode of development was, we should not hesitate to put them into a class intermediate between that of the mammals and birds and that of the reptiles properly so called. It was along toward 1820 that Gideon Mantell found the first bones of dinosauriansin the midst of Tilgate forest, on the Isle of Wight, in strata which are referred to the lower portion of the Cretaceous formation, and which are terrestrial and fresh water ones that mark a transition from the Jurassic to the Cretaceous. These bones, which were very incomplete, were referred by Mantell to an animal of great size, which he called an *iguanodon*, as the teeth offered certain analogies, as regards form, with those of a lizard of the present time called the iguana. Since that epoch, and especially since a few years back, our knowledge concerning the dinosaurs has peculiarly increased, and we are beginning to get a glimpse, among these animals, of very different types, which indicate orders just as distinct as are those of the pachyderms, ruminants, and carnivora among mammals.

Upon the sides of the Rocky Mountains, in the United States, we find strata which can be followed for several hundred miles in extent, and which have yielded for the investigation of paleontologists a small marsupial, remains of fishes, remains of pterodactyls, crocodiles, and tortoises, and especially an enormous quantity of bones of gigantic dinosaurs. We have here a true bone yard in which lie buried, pellmell, the most curious and strange forms of all the animals that the ancient ages have bequeathed to us. It is to the admirable researches of Marsh and Cope that we owe our knowledge of a fauna that has entirely disappeared.

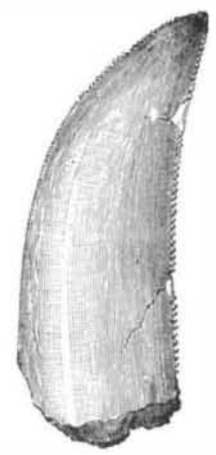
Fig. 1.—TOOTH OF MEGALOSAURUS.


Fig. 2.—TOOTH OF IGUANODON.

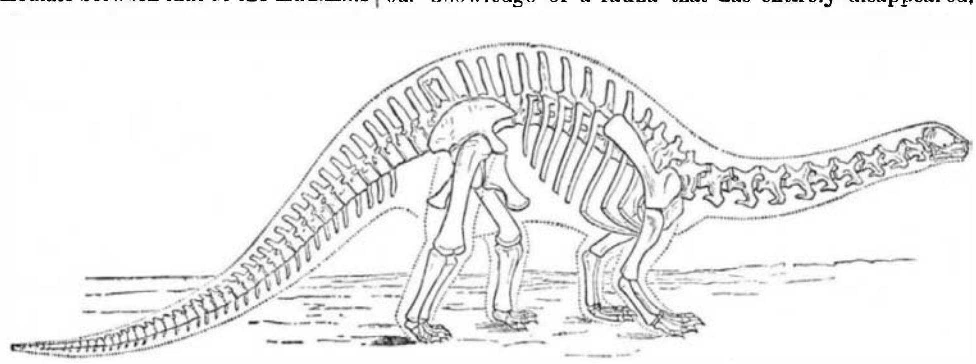
Fig. 4.—SKELETON OF BRONTOSAURUS (× 1-125).

Guided by the two great laws of correlation of forms and subordination of characters—laws which we owe to the incomparable genius of Cuvier, and which, like Ariadne's thread, permit us to find our way in the inextricable labyrinth that is presented by the forms of extinct animals—these two learned American paleontologists have evoked an entirely new world, and brought up before us the evidences of a fauna of which nothing in existing nature could have given us the least notion.

During the secondary epoch the dinosaurs lived also in Europe and in Southern Africa, where they were represented by very diverse types, as has been shown us by the learned researches of Mantell, Owen, Phillips, Huxley, Seeley, Hulke, Dollo, and Matheron.

Very recent researches have thrown an entirely new light upon the organization of these animals, and permitted of as complete a study of their skeletons as could have been made of those of animals now living. We can grasp the general features that connect them with other reptiles, and the peculiar ones that distinguish them from each other.

What essentially separates the dinosaurs from all other reptiles is that the sacrum is always composed of more than two vertebræ, which form a very solid, single bone like that of mammals. These vertebræ, which exceed the normal number of two, are caudal ones that are modified so as to serve as a support of the pel-


Fig. 3.—AMERICAN LANDSCAPE OF THE JURASSIC EPOCH WITH REPTILES AND PLANTS OF THE PERIOD.