The problem of fitting a long breeding cycle into a year divided by marked seasonal changes is faced by all large birds of high southern latitudes. The royal albatross (*Diomedea epomophera*)^{5,6}, possibly also the wandering albatross (*D. exulans*), takes a full year to complete its cycle and breeds only in alternate years. Emperor penguins breed annually but are unique in laying their eggs immediately before mid-winter; the chicks lose their down precociously and are ready for the sea when the fast ice breaks in January and February⁷. The period in which their eggs may be laid is apparently restricted to about a month in all three species. King penguins, which can lay during November–February with every chance of rearing their young successfully, achieve a compromise in being able to raise two chicks in three years. Early breeders of one season, particularly those efficient parents which dispose of their chicks rapidly in spring, may become the successful late breeders of the second season. In the third season

they fail to breed, but start again as early breeders at the beginning of the fourth.

Several lines of evidence suggest that king penguins are once again increasing in South Georgia, and are re-colonizing other breeding areas from which they were exterminated during the nineteenth century. These investigations were made on behalf of the Falkland Islands Government, and a full account will be published later in the series of Falkland Islands Dependencies Scientific Reports.

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⁶ Gillespie, T. H., "A Book of King Penguins" (H. Jenkins, London, 1932).

⁷ Stonehouse, B., *Ibis*, **98**, No. 1 (1956).

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¹⁰ Sorensen, J. H., "The Royal Albatross". Cape Expedition Scientific Results, 1941–5. Bull. No. 2 (1950).

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NIKOLA TESLA (1856–1943)

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TO-DAY, with scientific research conducted by teams rather than individual workers, the lone research worker who in flashes of genius ventured into the uncharted regions of science belongs to the past. One of the most remarkable, if not the most audacious, of these men was Nikola Tesla, many of whose ideas are now commonplace.

Tesla was born a century ago at Smitjan, Lika, in Yugoslavia. He received his earlier education there, at the neighbouring town of Gospić and at Karlovac in Croatia, and it is said of him that even at this time he displayed unusual abilities in mathematics and science. In 1875 he entered the Polytechnic at Graz, graduating in 1878 and proceeding to the University of Prague for graduate work, which he completed a year later.

At this time Tesla's attention was attracted by the invention of the telephone by Bell a few years earlier, and hearing of an exchange being built at Budapest, he proceeded to that city, and when the exchange was completed he was placed in charge of it and had soon patented a telephone repeater for use there. From Budapest, Tesla went to Paris and thence he emigrated to the United States—a step that was to lead to his greatest single achievement. For a time he worked with Thomas A. Edison in the latter's New York laboratory, designing electric machinery; but as Edison favoured direct current for all electrical applications and Tesla favoured his new theory of alternating current, the differences created forced Tesla to leave and proceed to Pittsburgh, where he received an offer from George Westinghouse, who as a rival of Edison was interested in the possibility of alternating current.

It was here that Tesla's theory of alternating current became reality. The principle of alternating current had been known for some time, but the problems of vibration and stalling of motors had baffled all. Tesla neatly solved the problem by replacing the single circuit hitherto used by several circuits carrying the same frequency but out of step with each other; in this way smooth running was

achieved as in a multi-cylinder engine. With improvements in the motor came the development of the alternating current generator and transformers.

Legal troubles over patents in this field forced Tesla to leave Pittsburgh and return to New York, where he opened a private laboratory in which he carried out research in a variety of aspects of electrical fields, including generation of high-frequency currents, transmission of energy over single wires without return, methods of conversion, oscillatory charges and mechanical vibration. He described an electronic valve, but there the matter rested; it remained for Fleming and others to bring this to fruition. At one time he publicly demonstrated the control of a ship by wireless, and visualized (more prophetically than he may have then realized) future wars being fought by robots; although he saw his ideas as a benefit to mankind rather than for its destruction. At one stage he conducted a series of experiments in Colorado to prove the Earth a conductor, and about 1901 opened a laboratory on Long Island, where he conducted experiments into such phenomena as high-frequency oscillations and radio waves and discovered what are now regarded as the fundamental laws of broadcasting, although he did not actively enter the field. The Long Island laboratory, however, closed in 1916 because of financial troubles.

The only field outside electrical research in which Tesla actively engaged was in his development of a steam turbine; but as the ideas of Curtis, de Laval and Parsons were by now firmly established, his idea never progressed beyond the prototype stage. However, like Parsons, Tesla visualized the gas turbine.

Tesla's final years were largely given up to theoretical research, much of which was never committed to paper. Financial difficulties forced him into retirement, and there can be little doubt that many secrets went with him to his grave when he died in New York, early in 1943.

In retrospect, Tesla presents an enigmatic figure, who made a sudden appearance on the scientific

scene with one outstanding contribution to electrical engineering and then to put forth many ideas which seemed to lead nowhere. Undoubtedly his greatest contribution was his development of alternating current, with all its ramifications, as witnessed by the pioneer station at Niagara Falls in 1896 (although he played no part in it), and above all the availability of electricity generated economically. It was a crowning achievement in the astonishing development of electric power from its discovery by Faraday. But it is, after all, in his research in the realms of high-frequency current that his contribution remains baffling, for while he made what were later regarded as fundamental discoveries, he seldom brought any of them to reality and in some cases published nothing on them. The failure to do this can possibly be attributed to the non-existence of the research laboratory as we know it, and to the fact that the then infant electrical industry preferred to consolidate its gains in the light of tried ideas rather than embark on anything new. Then the sensational discoveries of Röntgen and of the Curies may have turned attention away from Tesla and his work. Finally, Tesla's habit of almost always working alone may have had not a little influence on his work going unnoticed, for he was no teacher and so never was attached to a university, where he would have gathered around him a circle of brilliant young men who could have carried on his ideas and brought many of them to fruition.

International acclaim came to Tesla, particularly as a result of his work on alternating current, and he

was invited to address learned societies both in the United States and Europe, among these being the Institution of Electrical Engineers in 1892. In 1893 he received the Elliott G. Cresson Gold Medal of the Franklin Institute for original work presented before the Institute.

Although he left many of his ideas unpublished, Tesla was a prolific writer and a holder of many patents. Two of his books on high-frequency currents and on his other researches reveal his stature as a scientist, for here he describes complex phenomena that have only recently become to be understood. But if Tesla aspired higher than his era was prepared to accept, it must be stated that he aspired in the finest sense, for as he said in London at the Institution of Electrical Engineers in 1892, his aim was "to advance ideas which I am hopeful will serve as starting points for new departures". In this he was successful.

Nikola Tesla may be likened to an explorer who reaches the summit of an unconquered peak and then waits for a support party to consolidate his newly found gains. That done, he proceeds to survey the unmapped untrodden territory beyond and to report on it; but those who follow must often spend much time wandering, often aimlessly, in these realms ere they rediscover their secrets, often without recognition of the first discoverer. Perhaps these are the misfortunes of the idealist; yet the apparent idealist is he who often points the way for others, and therein is the secret of the noble aspirations and greatness of Tesla.

GENERALIZATIONS ON THE APICAL MERISTEM

By PROF. C. W. WARDLAW

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ALTHOUGH the vegetative shoot apical meristems of vascular plants show very evident differences in histological organization, they all give rise to a vascularized leafy axis. That such apices have some organogenic property in common thus presents itself as an inescapable fact¹. There is therefore a need for concepts that will have a general application to apices, irrespective of their histological patterns.

During recent years a group of French botanists, under the leadership of Plantefol² and Buvat^{3,4}, have been active in histological investigations of vegetative (and floral) meristems of vascular plants, this work having been stimulated by a new theory of phyllotaxis by Plantefol. Among their main conclusions, the following are of special interest: (1) Leaf primordia originate in a superficial ring of actively meristematic tissue, described as the *anneau initial* (initial or initiating ring), which is situated around the base of the inert, or relatively inert, distal apical zone. This *meristematic ring* is regarded as a self-perpetuating embryonic tissue. It is held to be the true vegetative meristem, which would, therefore, be sub-terminal and lateral, and not distal as has so long been thought. The most distal zone of the apex is thus considered to be unimportant in histogenesis and to have no effective part in organogenesis during the vegetative phase. (2) The inception of leaf primordia in the meristematic ring is part of the theory of phyllotaxis proposed by Plantefol². This states

that the phyllotaxis of most plants can be referred to a small number of foliar helices. At the extremity of each of these, in the meristematic ring, there is a generative centre which gives rise to all the leaf primordia on that helix. The activities of the several generative centres are harmonized by an organizer which is present in the apex. A generative centre is held to be a physiological, rather than a recognizable, morphological unit. While some investigators^{5,6} claim that the theory has been verified by experimental treatments of the apex, others⁷⁻⁹ have expressed or implied disagreement with it.

In a contemporary monograph from the French school, Camefort¹⁰ has taken up my point about the need for general concepts relating to the shoot apex¹, and has suggested that a meristematic ring (*anneau initial*) may perhaps be present in the apices of all vascular plants. He has, moreover, suggested that, within this concept, it may be possible to interpret the structural differences in the apices of Spermatophyta. He points out that the difference in activity between the allegedly inert apical zone and the meristematic ring may vary according to the species. Where this difference is profound, as in some gymnosperms, for example, in *Picea*, the distal region tends to be homogeneous and a tunica is absent; where it is less pronounced, as in the angiosperms, a tunica is present. In his view, the absence or presence of a tunica is thus associated with a more or less pro-