living animals and depart with "living" ideas. The installation of an exhibition depicting the evolution of the lizard to the bird, which has recently been installed in the birdhouse at the park, is a preliminary step in this direction and has aroused wide popular interest.

Our educational services to students have been active, as indicated by the fact that during the past year 900 school classes registered at the park gates, and fourteen high schools and junior high schools availed themselves of the special tours of the park, conducted under the direction of our curator of educational activities. The use of our educational films and lantern slides is steadily being extended, showings having been made to a total of 71,560 students during the year.

The society is determined to develop its scientific activities in every way possible. The hospital and laboratory at the park is not only a place for the technique of keeping our animal population healthy, but it is being developed constantly as a center for biological and pathological research. An important opportunity lies open to the society in this direction. Active collaboration is being carried on at the present time with the following medical and scientific institutions: Mt. Sinai Hospital, New York University, Cornell University, College of Physicians and Surgeons, International Health Division of the Rockefeller Foundation, U. S. Bureau of Fisheries and Yale University. Students from some of these institutions are working daily in our laboratories.

The tropical research department, under the leadership of Dr. William Beebe, has already completed one expedition of five months' protracted study of deep sea life at the Bermuda Oceanographic Station, and is engaged at this writing in another expedition in the Pacific, carrying on the work started during 1936 in collecting data as to marine forms found off the west coast of Southern California and Northern Mexico.

As readers of SCIENCE are undoubtedly aware, the results of the scientific and technical work of our staff are published currently in *Zoologica*.

Definite advancement in the society's activities in the field of conservation is being made. The Wild Life Protection Fund, founded and carried forward until his death by Dr. William T. Hornaday, came under the management of the society in the early part of last year. In December the International Wild Life Protection Committee proposed that its activities be taken over by the society, and this additional work is being assumed. It is apparent therefore that our opportunities in carrying forward effective work in conservation, always an integral part of our activities, are increasing as time goes on.

We mourn the death of our former president, Mr. Madison Grant, which occurred on May 30, 1937. Among all his activities throughout his lifetime, his prime interest was always the Zoological Society—from its founding in 1895 through the years of its development and growth—until the very day of his death.

We regret the retirement of Dr. Charles H. Townsend (on November 2, 1937), who for thirty-five years so successfully conducted the aquarium. However, Dr. Townsend will continue his valuable contributions to the *Bulletin* and to *Zoologica*, as well as continue his study of the distribution of whales throughout the world.

In conclusion, it is apparent that the interest of the public in the wonders of the animal world are perennial and unceasing, of which a visitors list of more than five million persons a year is sufficient evidence. In addition to the administration of the zoological park and the aquarium, and the carrying out of its marine expeditions, the officers, board of trustees and administrative staff of the society are also doing everything in their power, with the means at their disposal, towards enlarging the society's usefulness in the boundless fields of education, scientific research and the conservation of wild life.

FAIRFIELD OSBORN

SPECIAL ARTICLES

THE X PARTICLE

FROM the studies of cosmic ray data physicists had come to the conclusion that the energy in cosmic radiation was carried by an unknown particle, the X particle. In 1936 Anderson and Neddermeyer discovered from an examination of cosmic ray tracks in cloud chambers what they conceived to be this new particle; a particle with the same charge as the electron but with very great penetrating power. Street and Stevenson almost simultaneously announced the detection of the same particle. From their measurements, the latter investigators concluded that it had a mass 130 times that of the normal electron. Corson and Brode[1] estimated from the track that they observed that the mass ratio is nearer to 700 than 130.

When Dirac set forth his relativistic theory of the electron in 1927 he advanced the opinion that there should exist a corresponding particle with a positive charge. The discovery of this particle, the positron, by Anderson from cloud chamber photographs of cosmic ray tracks constituted the major achievement resulting from cosmic ray studies. Since that time

[1] D. R. Corson and R. B. Brode, *Phys. Rev.* (A), 27, Stanford meeting, December, 1937.

Dirac[2] has constructed a mathematical model of a new particle which has the same charge as an electron but a spin greater than ½. The writer has proposed[3] that this latest prediction of Dirac's represents the newly discovered X particle. This note contains a summary of the properties of this particle to be expected on the basis of this latest Dirac theory.

If we let p_t and p_x represent the energy and momentum—the x component—operators of the wave mechanics, then the equations which describe the properties of the particle moving in the x direction in free space are $(p^2{}_t - p^2{}_x)\ \psi = (m\,c)^2\ \psi$ and $(p_t - A\,p_x)\ \psi = B\ (m\,c)\ \psi$, where A and B are matrices. If the spin of the particle is k units, the Hermetian matrix A is such that $A^2 = k\ (k+1)\ /3\,k^2$. The wave function may be written in the form $\psi = \alpha \exp. \frac{2\pi i}{h}\ (Wt + p_x X)$.

The question naturally arises whether or not for sufficiently high values of the energy W the term containing the mass of the particle m can be neglected. In that case the equations reduce to $(p^2{}_t - p^2{}_x)\ \alpha = 0$ and $(p_t - A\,p_x)\ \alpha = 0$. From the first equation we get $p_t = p_x$, so that the second equation can be written as $p_t\ (1 - A)\ \alpha = 0$. By manipulating the conjugate imaginary equation in the same manner, it can be shown that these equations have a solution only if A is such that $A^2 = 1$. Thus the mass term can be neglected legitimately for that case in which $k = \frac{1}{2}$ or expressed non-mathematically for the case of the ordinary electron. On the other hand, for the new X particle, the energy can never become so great that the mass calculated from the Einstein relation $W = m\,c^2$ is large compared to the rest mass m. Some very interesting properties of this particle can be deduced from this fact. 1. The ionization of a very high energy particle must be large compared to that of an ordinary electron of the same energy because the large value for the rest mass requires that the velocity never becomes comparable with the velocity of light. 2. The radiation will always be small in comparison to that of the same standard, the ordinary electron, because of the high value for its rest mass. This calculation is made under the restriction that the change in mass in this process can be neglected. 3. The X particle through a spin transformation can change its mass into kinetic energy at a nuclear collision. In this process a number of neutrinos sufficient to take care of the change in spin must be generated. The newly formed charged particle, in the limiting case an ordinary electron, will take the residual energy from this process off in the form of kinetic energy.

Properties of this nature for the X particle are perfectly consistent with the data on the new particle accumulated up to the present time. Exact analytical formulae for these various properties must wait until a rigorous solution of the spin matrices for large values of k is found. It is probable that the theory of ideal factors[4] will contain the key to their solution.

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[2] P. A. M. Dirac, *Proc. Roy. Soc.*, 155, July, 1936.

[3] A. Bramley, *Phys. Rev.* (A), 22, Madison meeting, June, 1937.

[4] Weitzenbock, "Invarianten-theorie," Groningen.

ADMINISTRATION OF OESTRONE TO YOUNG ALLIGATORS

RELATIVELY little study has been made of the effects of female sex hormone injections into reptiles. Kehl[1] stated that the administration of folliculin to sexually immature female turtles was followed by oviduct hypertrophy. Turner[2] injected theelin into adult male skinks; the result was a decrease in testis weight, a proliferation of germinal cells and a hypertrophy of the epididymides. Dantchakoff[3] introduced folliculin into incubating lizard eggs. Examination of the lizards after hatching revealed larger oviducts in both male and female experimental animals than were found in female controls. Dantchakoff stated that the control male oviducts disappeared before hatching. The injections also inhibited the development of the penis.

In the work to be reported here, 22 immature alligators of both sexes, 15 months old when injections began, comprised the experimental group. Sex can not be distinguished externally at this age. Eighteen of the animals were injected with a total of 9,300 R.U. (46,500 I.U.) of Progynon[4] each, evenly distributed over an 80-day period, while the remaining 4 animals received lesser amounts of the hormone. A similar group of 22 alligators served as controls.

Autopsy two days after the last injection revealed that there were 9 males and 13 females in the experimental group, and 7 males and 15 females in the control group. The oviducts of the injected females were so greatly hypertrophied as to distend the abdomen. Vestigial male Müllerian duct segments, difficult to locate even microscopically in normal males of this age, had so greatly hypertrophied under experimental treatment as to be readily visible macroscopically as small nodules, one of which lay just lateral to each testis in the injected males. The cloacae and penes or clitorides of the injected animals were not visibly affected.

Histological study of the testes showed that the persistent isolated areas of germinal epithelium, equivalent to a vestigial cortex and lying external to and penetrating the tunica albuginea of the normal testis

[1] R. Kehl, *C. R. Soc. de biol.*, 105: 512–13, 1930.

[2] C. D. Turner, *Biol. Bull.*, 69: 143–58, 1935.

[3] V. Dantchakoff, *C. R. Acad. des Sci.*, 205: 424–27, 1937.

[4] Supplied through the courtesy of Dr. Erwin Schwenk, of the Schering Corporation.