If the pendulum is taken above the equator of its sphere of rotation, a further reduction in the number of possible loops in the orbit appears to occur, but this is deceptive because there is now a loop above and a loop below the equator, which correspond. Also the figuring can now be dependent on velocity, the angle of initial swing not necessarily deciding the pattern, as in small spherical angle orbits.

If the speed of projection of the pendulum is high, the orbit tends to become a great circle on its sphere, which orbit precesses in the same direction as would be the case with a gyroscope.

It follows that if the orbit is nearly in the horizontal plane, precession occurs rapidly for any given mean velocity of pendulum; and as approaching the vertical plane precession becomes relatively slow, it should, in the limit, become zero again when the pendulum rotates completely in a vertical plane.

The rate of precession for any given inclination of great circle orbit now depends on the velocity of the pendulum bob, in the same way that the rate of precession of an unbalanced gyroscope at a given slope depends on the velocity of rotation.

A sphere rolling in a hemispherical saucer can be shown to have orbits resembling those of the hemispherical pendulum, but modified by the unavoidable gyroscopic rotation of the sphere as it rolls. These orbits can be modified by giving an initial spin to the sphere, causing it to run up or down the slope and form open or closed loops accordingly.

Spinning the pendulum bob will, of course, also modify the orbits.

Probably the orbits of electrons in the structure of the atom will be found to display similar phenomena.

Mathematics of Inheritance

As an outcome of his prolonged and elaborate studies of the inheritance of racing capacity in the thoroughbred horse, Dr. Harry H. Laughlin has put forward a mathematical expression termed "The General Formula of Heredity" which he has discussed in a recent paper under the same title (*Proc. Nat. Acad. Sci.*, 19, 787; 1933). He remarks that the majority of characters in which practical men are interested are too complex genetically for their inheritance to have been analysed in terms of genes:

". . . Practically all of the structural and functional qualities of the many species with which students of evolution work belong to this same category of qualities too complex to be resolved by the theory of the gene. Also, in the same class we must list most of the inborn human qualities with which anatomy, physiology, medicine, psychology, education, the fine arts, athletics and religion are concerned. As anatomical or physiological entities, many of these qualities have been accurately measured or diagnosed, with due allowance for the effects of environment. But only an occasional one has been analyzed into its constituent genes. The fact is that a structural quality like stature in man, or a functional quality like racing capacity in the Thoroughbred horse, far from being based upon a single or a few genes, is the developmental end-product of a great many genes, possibly a score, but more likely a thousand. In the course of development these genes interact, some accelerating their fellows, others cancelling what otherwise would be plus-values in the individual. The result is that the offspring from a given antecedent type often possess the subject-quality in end-values ranging over a scale from very low to very high."

The practical procedure which Dr. Laughlin advocates is to find a formula which shall give in terms of the antecedent information available as to parents or more remote ancestry, the frequency among the offspring not of the different possible genotypes, but of the different values for the measurable character in question. He rightly stresses, and illustrates from his racing data, both the difficulty and the possibility of arriving at a satisfactory basic measure. The general formula given involves fifteen 'basic constants' which are to be fitted to the data.

Such a formula, though very laborious to construct, should on good data give a satisfactory basis for practical prediction. The difficulty which most geneticists will feel lies in deciding whether Dr. Laughlin's formula is better than others equally complicated which could be constructed, and in discussing the genetic interpretation of its ingredients. However, the first step is clearly for Dr. Laughlin to explain his actual procedure and this he has done in some detail in this condensed paper. R. A. FISHER.

Oceanographical Research in Japan

In recent numbers of "Records of Oceanographic Works in Japan" compiled by the Committee on Pacific Oceanography of the National Research Council of Japan (vol. 4, No. 2, Dec. 1932, and vol. 5, No. 1, Jan. 1933) a list of researches is given showing that a large amount of important work has been done on various subjects. A classified list of papers and reports bearing on oceanography published in Japan during 1930 and 1931 is included. These are entered under the heads "Physical and Chemical Oceanography" and "Fundamental Marine Biology".

In the December number there is a short abstract of a paper by E. Sawano read before the twenty-fifth meeting of the Committee on the Progress of Researches on the Biology of Corals carried on in the South Sea Islands, Zappu and Palau. This includes studies of growth by T. Tanura and Y. Hada, classification of corals at Palau Island by Y. Hada, respiration of corals by T. Mimura, and the digestive enzymes of corals by E. Sawano.

In the January number, besides a paper by K. Okamura on the Algæ from Alaska collected by Y. Kobyashi, there is a long report by F. Hiro on the Cirripedia collected on the continental shelf bordering Japan by the surveying ships of the Imperial Fisheries Experimental Station. This is fully illustrated and contains descriptions of twenty-five species belonging to thirteen genera, the greater part of which were obtained on the Pacific Ocean side while only a few came from the Japan Sea. They