a crow-shrike (*Barita destructor*) pecked it only once, the latter vigorously shaking his head and wiping his beak after the taste. A Cuban mocking-bird (*Mimus orpheus*) and a Brazilian hangnest (*Ostinops viridis*) attempted it, but after a few pecks gave it up. Finally, the mangled remains were eaten with much hesitation by a rufous tinamou (*Rhynchotus rufescens*). Whether the latter would have eaten it, if given the first refusal, it is, of course, impossible to say; but there is no doubt that the other birds found the butterfly highly distasteful. I was particularly impressed by its rejection by the two bustards, which on previous occasions have eaten some of the most unpalatable of British insects (see Proc. Zool. Soc., 1911, pp. 809-68).

The birds used for these experiments belong to tropical American, Asiatic, Australian, and African species, and were purposely selected from a variety of families. *Anosia plexippus* has, I understand, comparatively recently invaded the Old World from the New; and the result of the above-recorded experiments suggests that no serious barrier to its dispersal will be offered by insectivorous birds. If it succeeds in widely distributing itself it may, as a useful model, bring about marked mimetic changes in the Lepidoptera of the districts in which it settles.

The Zoological Society.

R. I. Pocock.

The Arithmetic of Hyperbolic Functions.

THROUGHOUT the books treating of hyperbolic functions, although elaborate series for their determination are given, the possibility of calculating them directly from their definitions, by means of common logarithms, is never suggested, and it would appear, therefore, that the merits of the direct method are insufficiently recognised.

If the hyperbolic functions of a quantity U are required, it is convenient, for purposes of writing and printing, to get rid of the exponential and to write $A=e^U$. Then $\log_{10} A = 0.43429448 U$, and A is thus found at once from a book of common logarithms. The functions can then be calculated by a slide-rule, or by logarithms, in the simple form

$$\cosh U = \frac{1}{2}(A + 1/A) \\ \sinh U = \frac{1}{2}(A - 1/A);$$

and similarly for $\tanh U$, $\coth U$, $\operatorname{sech} U$, $\operatorname{cosech} U$, and $\operatorname{versh} U$ —all in terms of A .

For example, calculate $\cosh 2$ and $\sinh 2$. Here

$$\log_{10} A = 0.43429448 \times 2 = 0.86858896;$$

A is therefore 7.389060, and $1/A$ is 0.135335. Hence $\cosh 2 = 3.76220$ and $\sinh 2 = 3.62686$.

In the more general case the functions of a complex quantity ($U+i\theta$) are required, and they have consequently to be expanded in terms of $\cosh U$, $\sinh U$, $\cos \theta$, and $\sin \theta$. So far as $\cosh U$ and $\sinh U$ are concerned, the direct method by common logarithms is still available, and the result is best dealt with in the form, for example,

$$\sinh(U+i\theta) = \frac{1}{2}(A - 1/A) \cos \theta + i(A + 1/A) \sin \theta.$$

The only real difficulty then left for the student is in ensuring that $\cos \theta$ and $\sin \theta$ are given their proper signs. That is to say, he must be clear regarding how many quadrants are contained in θ , how many degrees there are in θ beyond that number of quadrants, and the proper sign of $\cos \theta$ and $\sin \theta$, respectively, in each quadrant.

In general, as is well known, if the functions are not required to a greater degree of accuracy than 1 in 10,000, it is permissible for all real values of U greater than 5 to write

$$\cosh U = \sinh U = \frac{1}{2}A;$$

and the direct method has obvious advantages. For values of U less than 8, Ligowski's excellent tables give $\sinh U$ and $\cosh U$, proceeding by increments of 0.01 of U ; but for practical purposes these 0.01 steps are too great, and "difference" columns have to be used. Consequently, to find the functions for values of U less than 5, where U is given to three or more places of decimals, it will usually be as quick and as accurate to adopt the direct method as to worry through the irksome arithmetic involved in estimating "differences."

In cable problems it is, as a rule, desirable to retain at least four significant figures for U .

October 3.

ROLLO APPLEYARD.

NO. 2189, VOL. 87]

Hot Days in 1911.

By a "hot day" will here be meant one with 70° or more. There are about seventy-seven of these at Greenwich, on an average, in the year. I propose to show how a method of forecasting recently described would apply to those days in 1911.

The series of annual numbers (1841-1910) is first smoothed with sums of five; then we compare, in a dot-diagram, each sum with the difference between it and the fifth after.

The last comparison before this summer was that between 324 (for 1903) and its difference with 335 (for

Comparison of hot day numbers, Greenwich.

1908), i.e. +11. Next we come to 343 (for 1904) and the position of the new dot (for 1909, representing the sum of 1907-11).

Placing an arrow-head at 343 in the horizontal scale, we might fairly expect the new dot to be above the zero line. Suppose, however, to be on the safe side, we say not below -10. Then $343 - 10 = 333$. Now the four years 1907-10 yield 243, and $333 - 243 = 90$. So that we might say the year 1911 was likely to have at least 90 hot days.

The actual number is 101.

The method may be commended, perhaps, for application to various weather items. ALEX. B. MACDOWALL.

Frequency of Lightning Flashes.

A LETTER on rainless thunderstorms in NATURE of August 31 leads me to ask if any accurate counts have ever been taken of the frequency of lightning flashes.

Watching a severe storm from my bungalow about a year ago, I made an attempt to separate and count the flashes—to the unassisted eye the lightning was as continuous as a flickering arc-lamp.

The only thing I could find to help me was a gramophone; I took its top works off, and on the horizontal disc I put one radial white chalk line. The speed of the disc was adjusted, by trial, exactly to 100 revolutions per minute, and the instrument was placed where the storm-light fell directly on it.

The appearance of the revolving disc was as if irregularly spaced phosphorescent spokes were being shown instantaneously in sections of various sizes in continually changing positions. It was difficult to estimate the number of separate streaks in one revolution, but I finally settled on eight as a fair average during the whole storm—sufficiently exact to show the order of figures being dealt with.

This works out at 800 flashes per minute, or, say, 50,000 an hour.

H. O. WELLER.

Jamalapore (Dist. Mymensingh), E. Bengal,

September 19.