

L , suprasternal notch to upper border of pubes.

M , circumference of abdomen at level of umbilicus.

N , circumference of thorax at level of nipples in the male, and just above breasts in the female.

Thighs, $O(P + Q)$, 0.508.

O , superior border of the great trochanter to the lower border of the patella.

P , circumference of thigh just below the level of the perineum.

Q , circumference of hips and buttocks at level of trochanters.

Legs, RS , 1.40.

R , from sole of foot to lower border of patella.

S , circumference at level of lower border of patella.

Feet, $T(U + V)$, 1.04.

T , length of foot.

U , circumference of foot at base of little toe.

V , smallest circumference of ankle.

II (943)

On the law relating milk flow to age in dairy cattle.

By **RAYMOND PEARL**.

[*From the Biological Laboratory of the Maine Agricultural Experiment Station.*]¹

Before the production records of different cows may be critically compared, as in the study of the inheritance of milk flow, for example, it is necessary to make proper corrections for the differing ages of the individuals compared. It has long been a matter of common knowledge that there is a change in amount of milk produced as a cow grows older. Before any proper corrections for this factor can be applied it is essential to determine with precision, and, so far as may be, generality, the quantitative law connecting these two characters milk flow and age. By the associations and individuals who have in charge the Advanced Registry records in all of the dairy breeds of cattle it is generally, and quite erroneously, assumed that the relation between these two variables is a strictly linear one.

¹ Paper No. 74.

During the past two years I have been engaged (with the assistance of Messrs. John Rice Miner, John W. Gowen, and S. W. Patterson) upon a study of this problem, as a necessary preliminary to a genetic investigation of milk production. The essential result reached may be stated as follows: *The amount of milk produced by a cow in a given unit of time (7 days, 1 year, etc.) is a logarithmic function of the age of the cow.*

The actual curves which were found to graduate successfully the non-linear regression lines in the case of the different breeds were of the general form

$$Y = a + bX + cX^2 + d \log X,$$

where Y denotes the amount of milk produced in a given time, and X denotes the age of the cow. This form of curve is one with which we are already familiar in connection with studies of growth, the change in size of the hen's egg with age, etc.

The law may be stated verbally in the following way: Milk flow increases with increasing age but at a constantly diminishing rate (the increase in any given time being inversely proportional to the total amount of flow already attained) until a maximum flow is reached. After the age of maximum flow is passed the flow diminishes with advancing age and at an increasing rate. The rate of decrease after the maximum is, on the whole, much slower than the rate of increase preceding the maximum.

In general the law above stated applies to the absolute amount of fat produced in a unit time as well as to the milk.

Fitted curves, on which the above statements are based, have been worked out for three of the four important "dairy breeds," and data are in hand indicating that the same general law holds for all breeds of cattle. Detailed reports of these investigations will appear in another place.