

THE EFFECT OF GESTATION ON THE RATE OF
DECLINE OF MILK SECRETION WITH THE
ADVANCE OF THE PERIOD OF
LACTATION.

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In the last communication¹ it was shown that from the 2nd to the 12th month of lactation, the course of decline of milk secretion of the dairy cow with the advance of the period of lactation is very nearly exponential; that is, each month's milk production is nearly a constant percentage of the production of the preceding month. In two of the groups of animals—the Guernsey and Jersey cows consisting of a large number of animals on official test—the fit of the exponential equation to the data was quite satisfactory except for a slight deviation for the last 1 or 2 months. In the case of the Holstein and Scrub cows not on official test, and where the number of animals was limited, the observed values of the last months of lactation tended to fall considerably below the values computed from the exponential equation. It was suggested that the condition of advanced pregnancy during the last months may be the cause of this discrepancy. It is, in fact, commonly believed by experienced dairymen that gestation is an important factor in bringing about a decreased milk flow, and for this reason breeding is usually delayed in cows on official test. We have investigated gestation as a possible factor in bringing about the discrepancy between the observed and calculated values for the decline of milk secretion with the advance of the period of lactation, and it is the purpose of this communication to report the results.

1. One method of investigating this problem consisted in dividing milk records into two groups; a farrow group, in which the cows were not bred during the year under observation, and a pregnant group, in which the animals were bred during the 3rd and 4th months after calving, which brings the last month of gestation to the 12th month

¹ Brody, S., Ragsdale, A. C., and Turner, C. W., *J. Gen. Physiol.*, 1922-23, v, 441.

of lactation (the period of gestation in the cow being about $9\frac{1}{2}$ months). The averages for these two groups of cows are presented in Table I and Fig. 1.

TABLE I.
The Relative Decline of Milk Secretion with the Advance of the Period of Lactation of Farrow and Gestating Cows (Guernsey Breed).

Month of lactation.	Farrow cows.			Gestating cows.	
	No. of animals.	Yield per month.		No. of animals.	Yield per month.
		Observed.	Calculated.*		Observed.
		lbs.	lbs.		lbs.
2	920	1,052	1,049	373	1,052
3	912	998	994	374	983
4	923	938	942	373	911
5	914	879	874	372	862
6	917	833	846	372	819
7	912	792	802	374	776
8	904	752	760	371	728
9	905	715	720	369	679
10	906	676	682	369	618
11	852	650	641	358	538
12	653	617	613	283	469

* Calculated from the equation $M_t = 1167.2 e^{-0.0537t}$ where M_t is the milk production during any month of the lactation period, t .

From these data it is evident that the decline in milk secretion of the farrow group of animals follows almost exactly the course of the exponential equation²

$$M_t = M_0 e^{-kt}$$

² M_t is the milk produced during any month of the lactation period, t ; M_0 and k are constants. It may be remarked incidentally that the total amount of milk a farrow cow is capable of producing due to one pregnancy approaches $\frac{M_0}{k}$ as a limit since $\int_0^{\infty} M_0 e^{-kt} dt = \frac{M_0}{k}$. For the Guernsey cow under consideration, $\frac{M_0}{k} = \frac{1167.2}{0.0537} = 21,735$ lbs. of milk. This is only a little over twice the amount of milk secreted during the 1st year of lactation. Theoretically, the milk produced during the 1st year is 10,050 lbs.; during the 2nd, 5,276; during the 3rd, 2,770; during the 4th, 1,453; and during the 5th, 763; each year's production is 52.48 per cent of the preceding year's production, or each month's production is 94.77 per cent of the preceding month's production.

thus substantiating the suggestion of the preceding communication¹ that the decline of milk secretion with the advance of the period of lactation is limited by a chemical reaction when other factors, such as pregnancy, are eliminated.

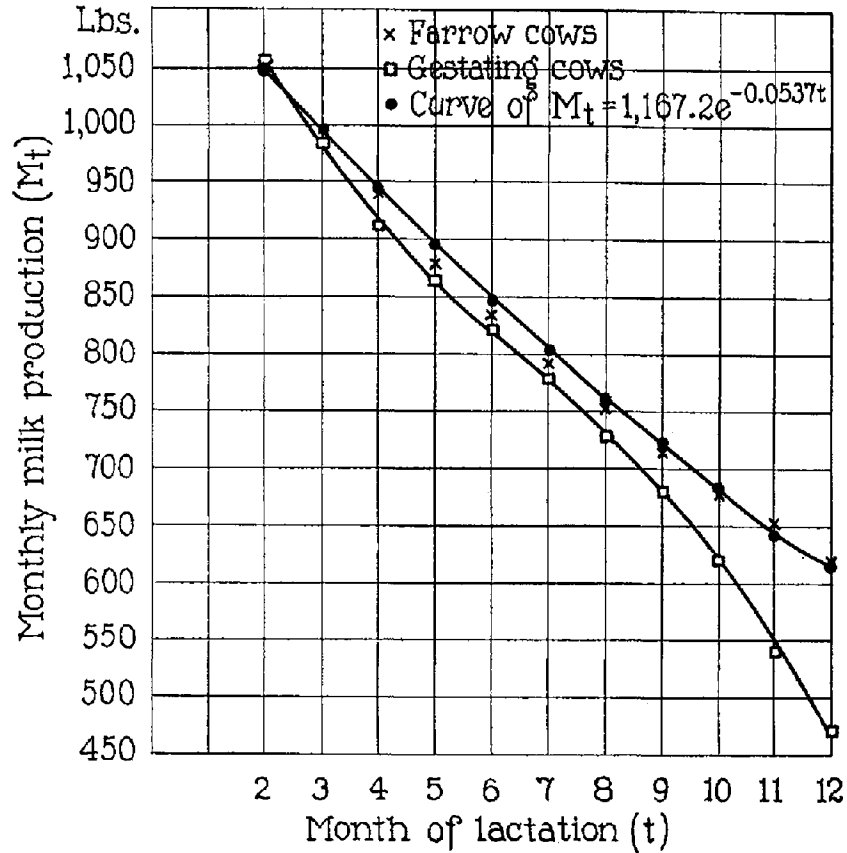


FIG. 1. The relative decline of milk secretion with the advance of the stage of lactation of farrow and gestating Advanced Registry Guernsey cows.

That pregnancy materially affects the course of decline of milk secretion with the advance of the period of lactation, especially after the 5th month of breeding, is evident enough from the decline curve of the pregnant groups of cows. Pregnancy then, no doubt, was the

chief cause of this discrepancy between the observed and calculated values for the decline of milk secretion with the advance of the period of lactation.

2. Another method of investigating this problem concerning the effect of pregnancy on milk secretion consisted in keeping the stage of lactation constant and varying the stage of gestation. This was practically accomplished by grouping cows for a given month of lactation according to the time after breeding. The averages for such variation of milk secretion with the period of gestation are pre-

TABLE II.

The Effect of the Stage of Gestation on the Milk Flow of Advanced Registry Guernsey Cows, and on the Body Weight of Gestating Jersey Cows.

Month of gestation.	10th month of lactation.		12th month of lactation.		Body weight of gestating Jersey cows.	
	No. of cows.	Milk yield per month.	No. of cows.	Milk yield per month.	No. of cows.	Body weight.
0	907	676	654	617	15	921
1	393	674	276	622	16	912
2	616	682	307	627	16	908
3	890	658	399	616	17	910
4	1,133	655	593	608	17	919
5	975	627	861	571	17	940
6	659	602	1,085	562	15	973
7	294	596	909	508	16	975
8	18	537	563	472	17	1,013
9			199	474	15	1,048
10			11	562		

sented in Table II and Fig. 2. These data show convincingly that gestation decreases the milk flow especially after the 4th month of breeding.

The most simple explanation that may be offered concerning the reduction of milk flow by pregnancy is that the demand for nutrients required for growth by the gestating cow reduces by an equivalent amount, the supply of nutrients usually at the disposal of the mammary gland. In other words the nutrients are divided between the needs of the uterus and the mammary gland. This simple explanation is substantiated, first, by the parallelism between the decline

in milk flow and increases in weight of the gestating cow as shown in Fig. 2 (special attention is called to the pause in the body weight and milk secretion curves about the 7th month after breeding); and second, by the fact that the difference in milk flow between the

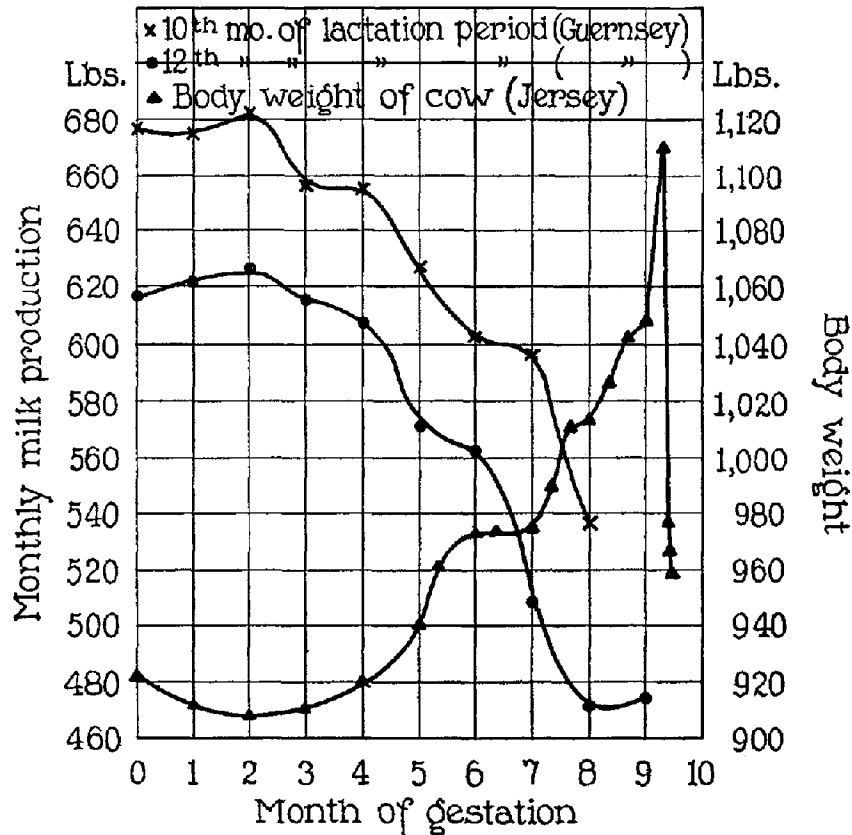


FIG. 2. The effect of the stage of gestation on the milk flow during the 10th and 12th months of the lactation period of Advanced Registry Guernsey cattle, and on the body weight of Jersey cattle. Special attention is called to the pause in the curves during the 6th and 7th months of gestation both in milk secretion and body weight.

pregnant and farrow groups (about 450 lbs. of milk) contains an amount of dry matter which one would expect might be required to produce growth of the calf and to support its life processes while *in*

utero. According to Eckles³ on the dry matter basis, a calf at birth is equivalent to from 110 to 275 lbs. of milk, depending upon the size of the calf and the composition of the milk. The difference between this estimate given by Eckles, and the difference in milk production between the farrow and pregnant groups of cows, can be accounted for easily by the relatively high metabolic rate of the embryonic and fetal tissues,⁴ and by the demand of the extra metabolism of the maternal organism due to the extra strain incident to gestation.

SUMMARY.

1. Data are presented showing that the course of decline of milk secretion with the advance of the period of lactation in farrow cows follows the course of decline of a monomolecular chemical reaction, that is each month's milk production is a constant percentage of the production of the preceding month (94.77 per cent in the case of the cow under consideration), from which it is inferred that milk secretion is limited by a chemical reaction initiated at parturition, and declining with the decrease of the concentration of the limiting substance as it is transformed into milk.

2. Data are presented showing that the decline in milk secretion due to pregnancy is related to the increase in weight of gestating animals, from which it is inferred that growth of the fetus is in part, at least, responsible for the decline in the milk flow due to the demand of the fetus for nutrients to support its life processes.

³ Eckles, C. H., *Research Bull. 26, Univ. Missouri Agric. Exp. Station, 1916.*

⁴ Cf. Bohr, C., *Skand. Arch. Physiol.*, 1900, x, 413. Murlin, J. R., *Am. J. Physiol.*, 1908-09, xxiii, p. xxxii. Carpenter, T. M., and Murlin, J. R., *Arch. Int. Med.*, 1911, vii, 184. For other references consult Lusk, G., *The elements of the science of nutrition*, Philadelphia and London, 3rd edition, 1917, 379-390. Marshall, F. H. A., *The physiology of reproduction*, London and New York, 1922, Chapter XI.