

Prolongation of Lactation in the Rat by Litter Replacement.* (24839)

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In animals such as cow or goat, in which daily milk production has been measured quantitatively, milk yields reach a peak soon after parturition and then gradually decline. Lactation can be extended beyond the usual milking or weaning period, but level of milk production continues to decline. This is apparently due to decrease in secretion of hormones which stimulate lactation, as demonstrated for prolactin in the rabbit(1), and to progressive involution of mammary secretory tissue(2). Selye and McKeown(3) demonstrated that lactation could be prolonged in 8 postpartum mice by providing them with fresh litters at frequent intervals, but noted involutionary changes in mammary glands after about 30 days and inability to nourish the young after 2 months. The rat normally lactates about 3 weeks after parturition since the young are weaned at this time. It was of interest to determine whether lactation could be prolonged in this species by providing them with fresh litters every 10 days, and to observe effects on mammary involution and milk yields as judged by litter weight gain.

Methods. Eight mature female albino Carworth rats and 8 mature female Long-Evans rats were used. Since no significant differences in lactation were observed in these 2 strains, as judged by litter weight gains, they may be considered as a single population in this experiment. Rats were bred, placed in individual cages, and on day of parturition their litters were standardized to 6 pups/dam. The litters were weighed daily and the dams weighed every 10th day. Every 10 days litters were replaced with equal number of 4-day-old foster pups. In a few cases after 50th day of lactation, it was necessary to replace litters between 9th-14th day, instead of 10th day after previous litter exchange, since some of the 6 young died or new litters were

not immediately available. Daily weight gains of litters were averaged for each 10-day interval of lactation. Three rats were killed every 10 days starting on 30th day after parturition, to remove mammary glands for gross and histological examination. The 4 remaining rats were killed on 70th day. Litters were withdrawn from each rat 4 hours prior to autopsy to standardize secretory activity in the alveoli, and right inguinal mammary glands were removed.

Results. By 3rd 10-day interval after parturition the average daily milk yield, as judged by litter weight gains, declined to approximately two-thirds of that observed during 1st 10-day period. Average daily weight gain/litter was 9.6 ± 1.3 g during 1st 10 days and declined to 6.3 ± 1.3 g by 3rd 10-day interval. Thereafter no further decline was observed throughout remaining 40-day interval (Fig. 1). The dams gained in body weight during 70 days of experiment, averaging 262 ± 4 g on day of parturition and 311 ± 4.6 g on 70th day of lactation. This suggests that continued milking did not adversely affect the rats and may have stimulated body growth.

Degree of mammary involution observed was relatively slight in most animals during the 70-day period of lactation. Glands of one of the rats killed at end of 30 days lactation, showed severe alveolar degeneration while glands of 4 rats which had lactated for 70

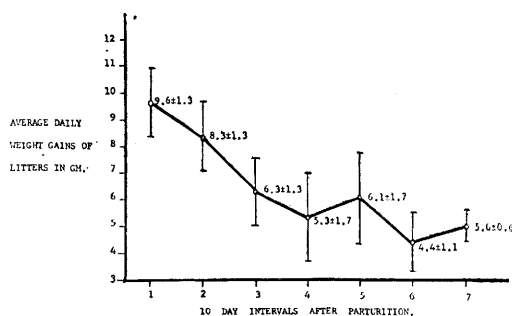


FIG. 1. Avg daily wt gains of litters during successive 10-day intervals. Range represents stand. error.

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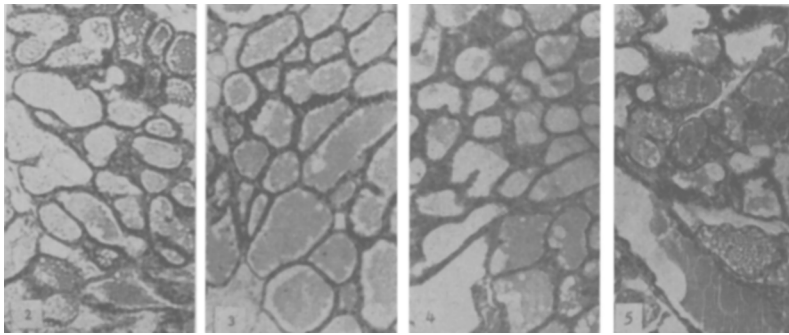


FIG. 2-5. Mammary sections from lactating rats at (2) 4 days, (3) 30 days, (4) 50 days, (5) 70 days. $\times 63$. (Photographs by C. R. Replogle.)

days, showed only slight regressive changes. A few extruded epithelial cells were present in the alveolar lumina of all glands examined. Since most rats showed good preservation of the lobule-alveolar system, mammary involution was probably not the primary factor responsible for decline in milk yield. Figs. 2-5 show histological sections of the mammary glands of rats on days 30, 50, and 70 after parturition, as compared with section taken from rat on 4th day after parturition.

Discussion. Milk secretion was successfully maintained in these rats for 70 days after parturition by regular replacement with fresh litters. Decrease in milk production in these rats may be due to diminished secretion of galactopoietic hormones or a decline in secretory capacity of alveolar cells or both. However, total secretory tissue present during each 10-day period could not be measured and may have been reduced in amount.

Recent investigations by Meites and Nicoll (unpublished)[†] have shown that secretion can be maintained for as long as 75 days after litter removal in postpartum rats, by injecting a combination of prolactin, oxytocin and cortisol. Secretory activity progressively declined, however, and mammary tissue exhibited gradual involution during the 75-day period. Mammary glands of suckled rats in this experiment were much better preserved than in non-suckled, hormone treated rats, probably due mainly to removal of milk, reducing pressure in glands, and possibly also to release of hormones other than prolactin, oxytocin and cortisol by the milking stimulus.

[†] *Fed. Proc.*, 1959, v18, 103.

Bruce(4) recently reported that lactation was prolonged in 3 rats for 9-12 months by frequent litter replacement, and that the litters continued to gain at about the same rate throughout experiment. The latter finding is not in accord with our results, nor with those of Selye and McKeown(3) in mice. It and the present study show, however, that providing rats with fresh litters can greatly extend lactation after parturition. It is believed that litter replacement technic will prove useful for investigations concerned with long term maintenance of lactation and mammary integrity in the rat.

Summary. Lactation was prolonged in 16 rats up to 70 days after parturition by providing them with fresh litters every 10 days. Milk production, as judged by litter weight gains, declined about $\frac{1}{3}$ after first 20 days and continued at this level for the remainder of 70-day period. The lobule-alveolar system of most rats showed little or no evidence of involution during entire period. This suggests that the decline in milk yield was due either to decrease in secretion of galactopoietic hormones or to reduction in secretory capacity of alveolar cells, or both.

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