LXXX. A NOTE ON THE WEIGHT OF THE RAT DURING GESTATION.

By GLADYS ANNIE HARTWELL.

*From the Physiological Laboratory, Household and Social Science Department,
King's College for Women, Kensington, London, W. 8.*

(Received April 28th, 1927.)

MANY observers have demonstrated the now well-established fact that a nursing mother can sacrifice her own tissues for the benefit of her suckling young, and it has been shown that a rat can lose as much as one-third of her weight during the lactation period [Hartwell, 1922]. The loss in weight of the mother is correlated with a poorness in *quality* of her diet, and a problem which at once presents itself is: does a similar sacrifice of the maternal organism occur during gestation?

The earlier research work on pregnancy was mainly along metabolic lines and was based on an analysis of excreta, the N balance being the primary consideration, while the weight of the animal was rarely recorded. A summary of this earlier work is given by Marshall [1922] who points out that the majority of the experiments were made before the vitamins were known and therefore are of little value now. According to the same writer, Cramer finds that rats fed on a diet of bread, rice and maize maintained their weight at the end of pregnancy, but when the diet was supplemented by yeast preparations, the mother always showed a considerable gain in weight during this period.

Feldman [1920], summing up the chief points of Bar's researches, regards pregnancy as a "state of symbiosis" and considers that there should be no loss to the maternal organism, provided the diet is satisfactory, but if it is not, then the results are disastrous, both for the mother and her foetus. In some earlier experiments [Hartwell, 1924, 2] when the rats were receiving a notably poor diet, it was found that there was little or no loss in the mother's weight at the end of gestation, so it was thought advisable to work out any available data in this respect.

EXPERIMENTAL.

(a) Methods.

The rats from which the data given in this paper have been collected are piebald animals bred in the laboratory. In most of the experiments 6 ♀ and 6 ♂ were used and were kept in a cage together; the method of weighing, feeding, etc., has been fully described in previous papers [Hartwell, 1926 and earlier]. The number of young in each litter was reduced to six, and the doe was returned to the bucks at the end of the suckling period (21 days); she

was not allowed a "rest" as given by other workers [Smith and Chick, 1926]. According to Donaldson [1924] and Greenman and Duhring [1923] the gestation period is 22 days, but 23 days was taken in these experiments, because it has been found that litters are never born before 23 days after mating. The difference in weight at the beginning and end of gestation given in the table was obtained as follows: the mother rat was weighed the day after the litter was born and the beginning of pregnancy was taken as approximately 23 days before the birth of the young.

(b) *Diets.*

The proportions used in the different foods were:

- I a. 30 g. white bread, 3 g. butter, 0.7 g. salt mixture, water [Hartwell, 1924, 1 and 2].
- I b. 30 g. brown bread, 3 g. butter, 0.7 g. salt mixture, water [Hartwell, 1924, 2].
- II. 30 g. white bread, 12 g. food casein, 3 g. butter, 0.7 g. salt mixture, water [Hartwell, 1924, 3].
- III a. 30 g. white bread, 3 g. food casein, 3 g. butter, 0.7 g. salt mixture, water [Hartwell, 1924, 3].
- III b. 30 g. white bread, 3 g. ash-free casein, 3 g. butter, 0.7 g. salt mixture, water.
- IV. 30 g. white bread, 3 g. gluten, 3 g. butter, 0.7 g. salt mixture, water [Hartwell, 1924, 3].
- V. 100 g. oatmeal, 2.88 g. salt mixture, 14 g. butter, 500 cc. water [Hartwell, 1926].
- VI. 100 g. boiled potato, 5 g. butter, 1 g. salt mixture, 25 cc. water [Hartwell, 1927].
- VII. 15 g. white bread, 4.3 g. dried milk, 36 cc. water [Hartwell, 1925, 2].
- VIII. 15 g. white bread, 36 cc. cow's milk [Hartwell, 1925, 2].
- IX. 15 g. white bread, 36 cc. diluted evaporated milk [Hartwell, 1925, 2].
- X a. Synthetic diet [Hartwell, 1925, 1].
- X b. The same as X a, but containing more marmite.
- XI. Controls fed on kitchen scraps supplemented by bread and milk.

RESULTS AND COMMENTS.

A striking feature is the almost constant gain in weight of the mother during gestation. The actual differences in weight are summed up in the following table.

Diet	Number of rats	Number of litters born	Weight of does at begin- ning and end of gestation			Average		Gain		Loss	
			Number of times weight gained	Number of times no loss or gain	Number of times weight lost	gain g.	loss g.	max. g.	min. g.	max. g.	min. g.
I a (Exp. 1)	3	9	9	0	0	18	0	37	9	0	0
(Exp. 2)	6	11	11	0	0	20	0	35	5	0	0
(Exp. 3)	6	12	12	0	0	23	0	37	14	0	0
I b	5	13	13	0	0	25	0	42	7	0	0
II	6	17	14	1	2	19	8.5	36	1	17	10
III a (Exp. 1)	6	35	30	1	4	21	20	58	1	39	10
(Exp. 2)	6	34	31	1	2	20	6	47	1	7	5
III b	6	12	12	0	0	26	0	47	13	0	0
IV	6	17	11	0	6	19	8	38	1	15	3
V	5	14	12	2	0	20	0	55	5	0	0
VI	3	7	4	0	3	11	10	22	3	20	5
VII	6	15	12	0	3	20	10	48	1	14	4
VIII	6	15	14	0	1	24	20	43	4	20	20
IX	6	20	20	0	0	22	0	44	1	0	0
X a (Exp. 1)	6	34	29	0	5	18	7	45	2	18	1
(Exp. 2)	4	21	17	1	3	18	10	40	5	14	7
X b (Exp. 1)	6	35	35	0	0	27	0	57	4	0	0
(Exp. 2)	9	28	27	1	0	26	0	58	2	0	0
(Exp. 3)	7	14	14	0	0	30	0	66	14	0	0
XI	6	40	37	0	3	26	5	68	3	10	1
Totals	114	403	364	7	32						

The diets used were very varied, and one or two were extremely poor. In order to make some sort of comparison the following table was drawn up to show the approximate amounts of fat, protein, carbohydrate and mineral salts in each diet. The figures are based on analyses given by Plimmer [1921].

Diet	Protein	Fat	Carbohydrate	Mineral salts
I <i>a</i>	11	12	71	6
II	39	8	46.5	6.5
III <i>a</i>	20	11	63	6
III <i>b</i>	21	11	63	5
IV	20	12	63	5
V	11	19	66	4
VI	8	17	66	8
VII	16.5	8.5	71	4
VIII	17	9.5	69.5	4
X	20	12	64	4

The carbohydrate and mineral salts contents of all the diets are probably within normal limits; the fat shows a wide range, but in all cases sufficient butter was given to ensure an adequate supply of vitamins A and D. Incidentally there must have been the necessary ration of vitamin E, otherwise reproduction would not have occurred. The protein of the different diets is the factor with the greatest variation, both in amount and quality. Diet VI (potato) is obviously low in protein, while diet II, with 39 %, contains an excess, since diet III *a* provides for practically maximum growth with only 20 % of the same proteins. Although diets III *a* and IV contain equal amounts of protein, the former must be regarded as a better food because it has three proteins instead of one, the protein of bread being supplemented by the proteins of milk, while in diet IV the added protein is gluten.

Taking as a criterion the rate of growth of young rats on these foods, diets VI, I *a* and I *b* are by far the worst, yet with I *a* and I *b* there was never any loss of weight during gestation. No stress can be laid on the number of litters born, because this depended entirely on the duration of the experiment. The number per litter and the weight of the young at birth varied considerably, but in no case did the experimental animals come up to the controls in either respect; moreover, with the poorer diets many of the young were born dead. It might be expected that the rat would show the greatest gain with her first pregnancy, since she breeds young and when by no means fully grown. The gain in weight at the first gestation was usually, but by no means always, large, and the gain did not decrease with each successive pregnancy. The gain in weight of the mother rat bears no relation to the size of the litter, so the eating of the placentae cannot be put forward as an explanation of the increased weight. It appears, therefore, that the characteristic sacrificing of the mother for her offspring, a noticeable feature of the lactation period, does not occur during gestation. The low weight of the young at birth, and the fact that many are frequently born dead when the mother is given a poor diet, may also be regarded as evidence in favour of this statement.

SUMMARY.

1. Out of 403 litters born, in 364 cases the mother gained weight during gestation.
2. This gain in weight appears to be of constant occurrence and to take place when the mother is fed on a poor as well as on a good diet.

The expenses of this research were defrayed by a grant from the Medical Research Council.

REFERENCES.

- Donaldson (1924). The Rat.
Feldman (1920). Principles of Ante-natal and Post-natal Child Physiology.
Greenman and Duhring (1923). Breeding and Care of the Albino Rat for Research Purposes.
Hartwell (1922). *Biochem. J.* **16**, 78.
—— (1924, 1). *Biochem. J.* **18**, 120.
—— (1924, 2). *Biochem. J.* **18**, 1323.
—— (1924, 3). *Lancet*, ii, 956.
—— (1925, 1). *Biochem. J.* **19**, 729.
—— (1925, 2). *Brit. Med. J.* i, 1073.
—— (1926). *Biochem. J.* **20**, 751.
—— (1927). *Biochem. J.* **21** (in press).
Marshall (1922). Physiology of Reproduction.
Plimmer (1921). Analyses and Energy Values of Foods.
Smith and Chick (1926). *Biochem. J.* **20**, 131.