CLXXX. THE EFFECT OF IRRADIATION OF THE ENVIRONMENT WITH ULTRA-VIOLET LIGHT UPON THE GROWTH AND CALCIFICATION OF RATS, FED ON A DIET DEFICIENT IN FAT-SOLUBLE VITAMINS. THE PART PLAYED BY IRRADIATED SAWDUST.

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INTRODUCTORY.

IN previous publications [Hume, 1922; Hume and Smith, 1923] evidence was brought forward to show that growth can be induced temporarily in young rats, fed on a diet deficient in fat-soluble vitamins, by exposing them to a source of ultra-violet radiation, and that the same effect is produced indirectly, when the rats are not themselves irradiated, but when their immediate environment only has been exposed to ultra-violet light. It was concluded that this latter result was due to some property conferred upon the air by the ultra-violet rays. The first of these observations was made simultaneously by Goldblatt and Soames [1922] and confirmed by Steenbock and Nelson [1923], but Webster and Hill [1924] have failed to confirm the second.

In the previous experiments, glass jars of 8 litres capacity were exposed daily for 10 minutes to the radiations and the experimental rats subsequently allowed to inhabit them. Sawdust, used for bedding, was present in the jars during irradiation and afterwards, but the possibility of its complicity was completely neglected. In the experiment of Webster and Hill, sawdust was not present during irradiation. The experiments have therefore been repeated to determine whether the presence of sawdust is the cause of the discrepancy, and it may be stated at once that the result of irradiating jars without sawdust has proved negative. In the presence of sawdust, however, the effect of irradiating the jars was not significantly inferior to that obtained by irradiating the animals directly.

TECHNIQUE.

The experiments were carried out with two different diets and with two different mercury-vapour quartz lamps.

Both diets were deficient in fat-soluble vitamins and differed only in the source of protein. In the first series the protein was Chinese egg-white and 10 % caseinogen, and the diet had the following composition:

Chinese egg-white (dried)	360 g.	Marmite	100 g.
Caseinogen	40	Lemon juice	100
Starch	1000	Hardened cotton seed oil	300
Salt mixture	100	Distilled water	1800

The composition of the salt mixture was as follows:

Sodium chloride ...	51.9 g.	Calcium phosphate ...	162.0 g.
Magnesium sulphate ...	164.0	Calcium lactate... ..	390.0
Sodium acid phosphate	104.1	Ferric citrate	35.4
Potassium phosphate ...	286.2		

The growth and general condition of the rats on the diet containing egg-white¹ were not as good as had been previously observed in similar experiments when caseinogen was used as the sole source of protein. A second series of experiments was therefore set up, which only differed from the first by the substitution of an equal weight of caseinogen for the egg-white previously used. All caseinogen used had been heated in an electric oven at 120° for two days and one night and was stirred every hour throughout the day time.

The mercury-vapour quartz lamps used were both made by the Hewittic Electric Co. One was a Y 4 Pistolette lamp (to be referred to as the "old lamp"), which had been in use for some considerable time; on a 200 volt circuit it was using a current of 3.5 ampères.

The second lamp (to be referred to as the "new lamp") had a straight burner with an arc about 10 cm. in length; on a 200 volt circuit it was using a current of 4 ampères. It was perfectly new at the beginning of the experiment.

A photograph of the spectra of both lamps was taken by Messrs Adam Hilger with one of their small quartz spectrographs (photographic range 8000 Å.-1850 Å.) on Hilger Schumann plates. Their report states: "The old lamp radiates wave lengths down to 1900 Å. very feebly. The new lamp radiates as far as 1860 Å. with considerable intensity, though the strong mercury line at 1849 Å. could not be recorded." There was thus a very marked difference between the two lamps and if the plates are compared it is seen that, in order to produce the same effect with the shorter wave lengths, it was necessary to expose the plate for about twelve times as long to the old lamp as to the new.

In the first series of experiments, in which the basal diet contained both egg-white and caseinogen, both lamps were used for parallel groups of experimental animals, in order that a comparison between the lamps might be made. In the second series, in which the protein was caseinogen alone, the new lamp only was used.

¹ This commercial egg-white was subsequently found to be unsuitable and not equivalent in nutritive property to the white of fresh eggs [see Boas, 1924, 2].

The rats used were all black and white; they were bred on a not too rich basal breeding diet, consisting of milk, brown or white bread, carrot or cabbage, and scraps of lean meat. They were required to weigh 50 g. at $4\frac{1}{2}$ weeks of age, in order to be considered normal and suitable for this type of experiment. At that weight and age they started the experiment, and litters and sexes were distributed as equally as nature would permit between the different groups of an experiment, in order that the groups might all be comparable with one another and the unnecessary multiplication of controls be avoided. The latter precaution was particularly important, since every experiment required two groups of controls, one to show the performance of the animals on the deficient diet when no treatment was applied, and one to show the maximum performance possible, when direct irradiation with ultra-violet light was employed.

The experimental animals were kept in a room facing east and the blind was kept down in summer in the early hours of the morning, when there was direct sunlight. Every rat was kept separately in a cylindrical 8 litre glass jar, with sawdust at the bottom, except where it is specially stated that a round deal board, fitting the bottom of the jar, was used instead, as a part of the experiment.

Whenever the glass jars were irradiated, as previously described [Hume and Smith, 1923], the rat was lifted out and the jar was taken to the lamp in another room where it was left directly under the lamp for 10 minutes, with its base at about 70 cm. distance. It was then covered and carried back to the animal room, the animal was placed in the jar and the cover was replaced and left on for 10 minutes. The cover was then removed, the rat remained in the jar, and if the experiment was one in which the jar was irradiated without sawdust, the sawdust and food, which had previously been removed with the rat, were replaced. When the jar was irradiated with sawdust, small particles of food were also sometimes present during irradiation, but it is known from other unpublished experiments that this is not the determining factor. The sawdust used was the ordinary mixed sawdust, mainly deal, from a sawmill; no precaution has so far been taken to use only sawdust from one kind of wood.

In the experiment where deal boards were substituted for sawdust, the jar with its wooden disc was irradiated exactly as if it contained sawdust, or else the board alone was carried to the lamp and irradiated for 10 minutes, at about 70 cm. distance; it was then brought back and placed in the jar, the rat was put in also and the cover was put on for 10 minutes, after which the rat continued to live in the jar on the piece of board, exactly as in the case of sawdust.

Animals irradiated directly were exposed in an open wire cage for 10 minutes, at 70–80 cm. distance, to the old lamp, and later also in the same way for 5 minutes to the new lamp. At first, however, when the new lamp was perfectly new, it was necessary to shield the rats' eyes even during a

5 minutes' exposure, or the animals developed conjunctivitis and failed to thrive.

All irradiations took place every day except on Sunday. The experiments lasted for 60-90 days, by which time the growth response, even to direct irradiation, was ceasing.

Calcium estimations on the bones of all animals were made by the method of Aron and Sebauer [1910]. The femora, tibiae and fibulae of each animal were dissected out and the water content and proportion of calcium were determined.

DETAILS OF EXPERIMENTS.

Series I. Basal diet containing egg-white and 10 % caseinogen.

(A) *Irradiation with old lamp.* Chart I shows the growth of four groups of rats in which the irradiation was carried out with the old lamp.

Group 1 is a group of five animals which inhabited glass jars which were exposed for 10 minutes daily, with sawdust in the bottom, to the mercury-vapour lamp.

Group 2 is a control group of two animals, exposed directly to the radiations of the mercury-vapour lamp, for 10 minutes daily, in an open wire cage.

Group 3 is a group of five animals inhabiting similar jars, but in which the sawdust was not present during irradiation of the jar.

Group 4 is a control group of four animals, fed the basal diet, and receiving no additional treatment.

None of the animals shows really good normal growth, not even those exposed directly to the radiations of the lamp, but the growth in that group and in the group where the jars were irradiated with sawdust in them, is very definitely superior to that in the group of untreated controls. The growth of the group in which the jars were irradiated without sawdust, is indistinguishable from the growth in the group of untreated controls.

Early symptoms of xerophthalmia were apparent in most cases but appeared to be equally distributed throughout all groups. The general condition of the animals, towards the close of the experiment, which had lasted about two months, was very poor; their coats were often bad, with bald patches, particularly in the group directly irradiated, while some animals in all groups had sore, swollen and oedematous paws, ears or lips. The general condition of the animals in Series I B, also on the egg-white basal diet, was entirely similar and the condition is attributed in large part to that diet [cf. Boas, 1924, 1]. The symptoms described were not observed in Series II, in which Chinese egg-white was not used as source of protein.

(B) *Irradiation with new lamp.* Chart II shows the growth of four groups of rats in which the irradiation was carried out with the new lamp.

Group 1 is a group of five animals, inhabiting jars irradiated with sawdust for 10 minutes daily.

Chart I. Growth of rats in Series I A, fed on a diet deficient in fat-soluble vitamins, in which the protein was Chinese egg-white and 10 % caseinogen. Irradiation with the old lamp.

- (1) Rats inhabiting jars irradiated with sawdust in them.
- (2) Rats irradiated directly.
- (3) Rats inhabiting jars irradiated without sawdust in them.
- (4) Untreated controls.

Members of the same litter are indicated by the same small letter.

Grams

Chart II. Growth of rats in Series I B, fed on a diet deficient in fat soluble vitamins, in which the protein was Chinese egg-white and 10 % caseinogen. Irradiation with the new lamp.

- (1) Rats inhabiting jars irradiated with sawdust in them.
- (2) Rats irradiated directly.
- (3) Rats inhabiting jars irradiated without sawdust.
- (4) Untreated controls.

Members of the same litter are indicated by the same small letter.

Group 2 is a control group of three animals, exposed for five minutes daily to the direct rays of the lamp, with the eyes shielded.

Group 3 comprises five animals, inhabiting jars irradiated without sawdust for 10 minutes daily.

Group 4 is the same group of untreated controls as is shown in Chart I.

The result obtained in these four groups, in which the new lamp was used, corresponds with that obtained when the old lamp was used, save that, in the two groups where a growth response took place, that response is distinctly better than in the corresponding groups treated with the old lamp. This result is no doubt due to the greater potency of the new lamp; an exposure

Table I. *Data of the growth and calcification of the bones of the rats in Series I A and I B, fed on the basal diet containing egg-white and 10 % caseinogen as source of protein, and receiving various kinds of irradiation with mercury-vapour quartz lamp.*

Experimental group	Rat no.	Litter no.	Sex	Maximum weight (g.)	% water in bone	% Ca in dry bone	Duration (days)
Untreated controls	26	b	♂	93	41.0	15.5	74
	28	c	♀	75	44.8	13.5	67
	21	a	♀	107	39.5	Lost	74
	51	d	♂	88	47.0	16.6	62
	Av.			91	43.1	15.2	
Jars irradiated without sawdust. "Old lamp"	35	b	♂	90	42.6	15.8	72
	31	c	♀	75	47.5	16.0	67
	32	c	♂	73	45.6	14.1	60
	23	a	♂	88	39.4	15.4	70
	54	d	♂	88	44.3	15.6	62
	Av.			83	43.8	15.4	
Jars irradiated without sawdust. "New lamp"	43	b	♀	61	41.4	14.2	70
	40	c	♀	71	50.7	14.6	60
	42	c	♀	71	47.0	15.4	66
	25	a	♀	85	38.9	17.6	75
	57	d	♂	103	43.5	15.8	61
	Av.			78	44.3	15.5	
Jars irradiated with sawdust. "Old lamp"	27	b	♂	108	43.5	16.5	73
	29	c	♀	119	40.2	18.2	74
	30	c	♀	79	43.9	16.6	74
	22	a	♀	140	38.4	18.6	74
	53	d	♀	190	45.3	19.3	63
	Av.			107	42.2	17.8	
Jars irradiated with sawdust. "New lamp"	44	b	♂	124	38.6	18.3	70
	38	c	♀	137	40.6	19.3	74
	39	c	♀	109	42.3	19.9	74
	24	a	♀	118	32.3	21.8	74
	56	d	♂	117	39.9	17.7	61
	Av.			121	38.7	19.4	
Rats irradiated directly. "Old lamp"	33	b	♀	113	36.6	20.1	73
	52	d	♂	123	37.8	19.7	62
	Av.			118	37.2	19.9	
Rats irradiated directly. "New lamp"	36	b	♀	138	35.7	21.7	75
	37	b	♂	134	33.8	19.7	73
	53	d	♂	124	45.3	19.2	62
	Av.			132	38.3	20.2	

of only 10 minutes might well be an insufficient time to enable the old lamp to evoke the maximum growth response possible from the rats.

The general condition of the rats and the incidence of xerophthalmia were as has already been described for Series I A.

The values for the calcium estimations on the bones of each individual rat in Series I A and I B are set out in Table I, together with the value for the maximum weight attained. The values for calcification are seen to follow the values for growth very closely, though the unequal distribution of the sexes, as between the different groups, disturbs the comparison somewhat. Females show, as a rule, better calcification for less degrees of growth than do males. In experiments of this type, *i.e.* carried out within the first 60 days after the rat has been placed upon the deficient diet, it would appear that the response by growth and by calcification to the methods of irradiation applied are very closely parallel, when the rats have been bred as described.

Series II. Basal diet containing caseinogen as sole source of protein.

Irradiation with the new lamp only. Chart III shows the growth of six groups of rats, in which the irradiation was carried out with the new lamp.

Group 1: five animals inhabiting jars, irradiated with sawdust for 10 minutes daily.

Group 2: six untreated controls.

Group 3: five control animals exposed directly to the radiations of the lamp for 5 minutes daily in an open wire cage.

Group 4: five animals inhabiting jars, irradiated without sawdust for 10 minutes daily.

Group 5: three animals inhabiting jars, irradiated for 10 minutes daily, with a circular piece of deal board instead of sawdust in the bottom.

Group 6: three animals inhabiting jars into which a piece of deal board, irradiated for 10 minutes daily, was placed, upon which the rats lived.

The animals irradiated directly or inhabiting jars irradiated with sawdust in them, show good normal growth for about 10 weeks; those irradiated directly are if anything ultimately slightly inferior to those whose jars were irradiated while containing sawdust.

The animals inhabiting jars irradiated without sawdust differ little from the untreated controls. In Table III, the maximum weights of the animals in all the groups are set out and the individuals are so arranged that those of the same sex and litter can be directly compared.

The last two groups in Series II, in which wooden boards were used instead of sawdust, are not perfectly comparable, either in the distribution of the sexes or in the litters used, with the first four groups of that series. Both groups contain a preponderance of females and they appear to show a growth response intermediate between the maximum and minimum effects obtained in the other groups, if the growth is compared with that of the corresponding female controls. It is pretty clear that there is some effect, but it appears to be the

Chart III. Growth of rats in Series II, fed on a diet deficient in fat-soluble vitamins, in which the protein of the diet was caseinogen only. Irradiation with the new lamp.

- (1) Rats inhabiting jars irradiated with sawdust in them.
 - (2) Untreated controls.
 - (3) Rats irradiated directly.
 - (4) Rats inhabiting jars irradiated without sawdust in them.
 - (5) Rats inhabiting jars irradiated with discs of deal board in the bottom of them.
 - (6) Rats inhabiting jars in which pieces of deal board irradiated separately were placed.
- Members of the same litter are indicated by the same small letter.

Table II. *Data of the growth and calcification of the bones of the rats in Series II, fed on the basal diet, containing caseinogen as source of protein, and receiving various kinds of irradiation with mercury-vapour quartz lamp.*

Experimental group	Rat no.	Litter no.	Sex	Maximum weight (g.)	% H ₂ O in bone	% Ca in dry bone	Duration (days)
Untreated controls	72	<i>e</i>	♂	129	40.5	19.0	89
	73	<i>e</i>	♀	105	39.0	18.3	89
	82	<i>f</i>	♂	138	38.9	19.0	87
	83	<i>f</i>	♀	108	36.5	18.8	88
	64	<i>g</i>	♂	130	39.1	17.3	89
	65	<i>g</i>	♀	114	39.0	18.4	90
Av.				121	38.8	18.4	
Jars irradiated without sawdust	76	<i>e</i>	♂	147	39.2	19.9	88
	87	<i>f</i>	♀	153	39.5	19.8	87
	86	<i>f</i>	♂	112	42.4	19.2	88
	68	<i>g</i>	♀	139	39.3	18.6	89
	79	<i>g</i>	♂	120	36.0	20.3	88
Av.				134	39.3	19.5	
Jars irradiated with wooden board	77	<i>e</i>	♀	122	34.7	20.8	84
	88	<i>f</i>	♂	126	37.9	21.0	84
	70	<i>g</i>	♂	159	35.3	20.3	86
Av.				136	35.9	20.7	
Wooden board irradiated alone and placed in jar	78	<i>e</i>	♀	127	34.7	21.5	85
	89	<i>f</i>	♂	127	36.1	21.5	84
	81	<i>g</i>	♀	121	36.6	20.4	85
Av.				125	35.8	21.1	
Jar irradiated with sawdust	74	<i>e</i>	♂	215	35.2	21.1	88
	85	<i>f</i>	♀	210	33.2	21.6	86
	84	<i>f</i>	♂	137	31.9	21.9	86
	66	<i>g</i>	♀	215	33.7	22.1	88
	67	<i>g</i>	♂	151	30.0	22.9	88
Av.				186	32.8	21.9	
Rats irradiated directly	75	<i>e</i>	♂	179	36.3	22.5	88
	71	<i>f</i>	♀	220	32.8	22.8	89
	90	<i>f</i>	♂	124	36.3	22.7	86
	69	<i>g</i>	♀	205	33.4	22.8	88
	80	<i>g</i>	♂	151	35.2	22.7	87
Av.				176	34.8	22.7	

Table III. *Maximum growth in g. of the animals in Series II, arranged according to litter.*

Litter no.	Sex	Untreated Control	Jar irradiated without sawdust	Jar irradiated with wooden board	Wooden board irradiated alone	Jar irradiated with sawdust	Rat irradiated directly
<i>e</i>	♂	129	147	—	—	215	179
	♀	105	—	122	127	—	—
<i>f</i>	♂	138	153	—	—	210	220
	♀	108	112	126	127	137	124
<i>g</i>	♂	130	139	159	—	215	205
	♀	114	120	—	121	151	151

same, whether the board and jar are irradiated together or whether the board is irradiated separately.

It should be noted that the rats from time to time gnawed the boards or consumed some of the sawdust in those experiments in which sawdust was used. It is possible at times to identify quite considerable quantities of sawdust, both macroscopically and microscopically in the faeces of rats bedded on sawdust. Even when the animals do not actually pick the particles of wood up and eat them intentionally, it is not possible for them to avoid ingesting a certain amount, sticking to their food.

Symptoms of xerophthalmia, often only very slight, were apparent in most animals and occurred indiscriminately in all the groups. The general condition of the animals was much better in Series II than in Series I A and I B, in which the protein of the diet was principally Chinese egg-white. This may be explained by the unfortunate use of a particular sample of dried egg-white (see note to p. 1335).

The values for the calcium estimations on the bones of each individual rat, and for the maximum weight attained by each animal, are set out in Table II. As in Series I A and I B, the values for calcification follow those for growth very closely, but in the present series both sets of values are higher. In the first series the average maximum values for growth, throughout all the groups, ranged from 78 to 132 g., and for calcification from 15.4 to 20.2 % Ca in the dry bone. In the second series the corresponding values were 121 to 186 g. and 18.4 to 22.7 % Ca. The second series was carried on slightly longer than the first, but not sufficiently so to affect the calcification significantly, and both series were continued until it was deemed that the full growth response had been obtained.

The calcification of the bones of the animals irradiated directly in Series II is normal or even super-normal. Korenchevsky [1922, p. 65] gives the normal average calcification at the age of from 80 to 120 days as 21.5 % Ca in the dry bone. The animals which inhabited jars irradiated with sawdust in them give an average value of 21.9 %, which must therefore be regarded as normal also, though it is slightly inferior to that given by the animals irradiated directly, *i.e.* 22.7 %.

DISCUSSION.

The results so far obtained throw no light upon the question of how the presence of sawdust in the jars during irradiation influences the growth of rats subsequently in contact with it. While the present paper was in preparation, a communication by Steenbock and Black [1924] was published, showing that an effect upon growth and calcification, similar to that here described, can be obtained by irradiating the food upon which the rats are fed. These workers advance no theory as to the mechanism but it would seem probable that the underlying phenomena are the same in both cases. In the present series of experiments, the rats undoubtedly consumed some of the sawdust,

but experiments now in progress suggest that actual ingestion of the irradiated sawdust is not necessary.

The recent observations of Kugelmass and McQuarrie [1924], that substances curative of rickets are capable of fogging a photographic plate through a quartz screen, are also interesting in this connection.

SUMMARY.

1. The interpretation of a previous series of experiments, in which the increased growth obtained with rats fed on a diet deficient in fat-soluble vitamins, and inhabiting jars previously irradiated, was ascribed to some property impressed upon the air contained therein, has now been found to be unjustified.

2. It has now been found that when sawdust was present in the jars during irradiation, the rats subsequently inhabiting them showed growth as good as that shown by directly irradiated animals.

3. When sawdust was not present during irradiation of the jars, the animals showed growth similar to that of untreated controls.

4. When a piece of deal board was irradiated instead of sawdust, either in the glass jar or separately, the rats gave an intermediate growth response.

5. Estimation of the calcium content of the bones showed that the degree of calcification, when sex was duly taken into account, was directly proportional to the amount of growth.

6. No evidence has so far been obtained as to how the sawdust cooperates. Further experiments are in progress to investigate the problem.

The thanks of the writers are in particular due to Professor C. J. Martin for much wise advice, to Dr Harriette Chick for very kindly supervising the calcium estimations in Series I, and to the Medical Research Council for the remuneration of the workers.

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ADDENDUM.

*(Received November 24th, 1924.)***NOTE UPON THE EFFECT ON THE GROWTH OF RATS,
RECEIVING A DIET DEFICIENT IN FAT-SOLUBLE
VITAMINS, OF EXPOSING THEIR ENVIRONMENT
TO THE EMANATION FROM RADIUM BROMIDE.**

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THE following observations were made shortly after the publication of an earlier paper by Hume and Smith [1923]. The object was to examine the suggestion made by these authors that the stimulating effect upon the growth of rats upon a — *A* diet, observed when their environment (glass jars containing sawdust litter) was irradiated with ultra-violet light, might be due to increased ionisation of the air contained in the jar. Increased ionisation is an effect of exposing air and other substances to ultra-violet radiations. X-rays and the γ rays from radium compounds are, however, much more powerful ionising agents than ultra-violet light, and the following experiments, in which rats on a — *A* diet occupied an air space exposed daily to the emanation from radium bromide, were made to determine whether ionisation of the air was concerned in the effect observed by Hume and Smith. Since our experiments were carried out, these authors, on the basis of the later experimental work contained in the above paper, have altered the opinion expressed in their first paper and have reached the conclusion that the beneficial effect upon growth was due to the irradiation of the sawdust present in the glass jars. The negative results detailed in this note indicate that a temporary ionisation of the air has no effect in promoting growth, and played no part therefore in producing the effect observed by Hume and Smith.

The experiments were carried out as follows.

The rats inhabited glass jars of 8 litres capacity, containing sawdust at the bottom for bedding and closed at the top with gauze metal lids. The rat, sawdust and any scraps of food were removed from the jar and the empty vessel carried to another room where radium was suspended in the jar for ten minutes, the jar being covered with a glass lid. The radium used was 10 mg. of radium bromide, enclosed in a glass tube. The radium being removed, the glass cover was replaced and the jar carried back immediately to the rat room. The rat was at once placed in the covered jar and allowed to remain for ten minutes; the glass cover was then taken away, the sawdust replaced and the rat continued to live in the jar. This procedure was carried out on six days in the week and the observations lasted for five to seven weeks.

The rats whose homes were thus treated were compared with control animals from the same litters, also receiving — *A* diet, but living in glass jars subjected to no form of radiation.

The effect upon the growth of the rats of treating the jars with the radium emanation was negative in every case.

Three experiments were made with three separate litters of young rats, during the months of April and May. The three litters were somewhat differently bred and the young animals of the respective litters presumably possessed differing reserves of fat-soluble vitamins, for they reacted differently, as regards their growth, when placed upon the deficient diet. The observations were begun with animals of about 50 g. weight in each case. The diet was the — *A* diet usually employed in this Institute, with the protein given in the form of casein, and was the same as that used by Hume and Smith in series II of the foregoing paper.

Exp. I. The control male rats of litter 1 (seven rats) grew at almost the normal rate during the seven weeks of the experiment (see Table I); those living in jars exposed daily to the radium emanation grew no better. In the case of the females there was also no difference between the two groups of animals.

Exp. II. In Exp. II (litter 2, three rats), the growth of the control animal showed an immediate check when placed upon the — *A* diet; the growth of the animals in the exposed jars was similar (see Table I).

Exp. III. In Exp. III (litter 3, eight rats), there was also no significant difference in the growth shown by the two different groups of rats. It is always necessary, of course, to compare males with males and females with females.

Table I. *The effect of exposing the air in jars, inhabited by young rats on — A diet, to the emanation from radium bromide. Time of exposure, 10 minutes daily.*

Rat no.	Sex	Time of expt. (days)	Body weight, g.			
			Initial	Final	Difference	
<i>Exp. I. Litter 1</i>						
1	♀	44	51	113	62	Exposure of jar to radium after 7th day
2	♀	44	49	110	61	" " " " "
3	♀	44	59	123	64	Control, no exposure
4	♂	48	53	146	93	Exposure of jar to radium after 7th day
5	♂	48	54	135	81	" " " " "
6	♂	48	57	120	63	Control, no exposure
7	♂	48	56	173	117	" "
<i>Exp. II. Litter 2</i>						
8	♀	38	49	83	34	Exposure of jar to radium
9	♀	38	50	81	31	" " " "
10	♀	38	51	87	36	Control, no exposure
<i>Exp. III. Litter 3</i>						
13	♀	35	51	91	40	Exposure of jar to radium
14	♀	35	49	92	43	" " " "
17	♀	35	48	88	40	Control, no exposure
18	♀	32	50	89	39	" "
12	♂	35	51	103	52	Exposure of jar to radium
19	♂	29	49	86	37	" " " "
15	♂	35	52	104	52	Control, no exposure
16	♂	35	52	113	61	" "

SUMMARY.

In order to examine the suggestion that ionised air might have the effect of stimulating growth in young rats upon a — *A* diet, the glass vessels in which they were housed were exposed, when empty, for ten minutes daily to the emanation from radium bromide. The growth of these animals did not differ appreciably from that of animals from the same litters whose homes were not so treated.