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The Relation of Inadequate Rations to the Weights of the Internal Organs of Chicks

ALBERT G. HOGAN, CHARLES L. SHREWSBURY, AND H. L. KEMPSTER

ABSTRACT.—Numerous attempts to rear chicks on synthetic rations have been reported, but complete success has not been attained in any case. Persistent egg yolks were frequently noted in post mortem examinations, so an attempt was made to correlate delayed resorption with nutritional failures. No casual relation could be established. All nutritional factors as yet recognized were incorporated in the experimental rations, but it seemed possible that at least one might be present in insufficient quantity. In order to obtain a hint as to such a possibility the internal organs of a large number of chicks were weighed. The adrenal glands of those receiving synthetic diets, and weighing over 800 grams, were, on the average, much heavier than the average for chicks on adequate rations. This difference in weight suggests that the synthetic diets previously used are deficient in at least one factor of the vitamin B complex.

This laboratory has been attempting for several years^{1*} to define the nutritional requirements of the chick, but complete success has not been attained as yet. Simplified diets almost invariably fail to support normal growth, and a considerable number of individuals develop characteristic abnormalities. In some the symptoms are typical of polyneuritis, and a large proportion of the affected birds may be cured by the administration of large doses of yeast, one gram or more daily. Untreated birds, or those in which treatment is ineffective, usually pass into a state of coma, and die within three or four days. Other individuals never develop acute symptoms, but become unthrifty, emaciated, and unsteady in gait. Many of these, too, are relieved by large doses of yeast; otherwise they may linger for weeks, or may die at any time.

It was the custom to make post mortem observations on all chicks that died, and at the close of experimental periods many were killed for autopsy. One feature that could not fail to attract attention was the frequent presence of unabsorbed yolk, even in chicks that were two or three weeks old. It is the common opinion that persistent egg-yolks are associated with disease, so it seemed possible that the poor growth and other abnormalities encountered were correlated with failure to absorb the yolk, and were altogether unrelated to nutritional factors. It was decided, therefore, to make a special study of that point. At the time the yolk observations were made, weights were also taken of

*Numerals refer to corresponding numbers in bibliography.

some of the internal organs. It was hoped that if the rations were inadequate such observations would indicate the type of deficiency.

Observations on the rate of yolk absorption are not numerous, and apparently very few reports have been made on that topic. Gwatkin² examined healthy chicks to see what period of time is required for yolk absorption. There was considerable variation in the rate of absorption, but in some instances the yolk persisted as long as 13 days, the end of the experimental period. A similar study has been reported by the Arkansas Station. For example, at 9 days of age the weight of yolk in individual chicks varied from 0.004 to 4.80 grams, and at 14 days the weight varied from 0.001 to 0.08 grams. Underfeeding did not affect the rate at which the yolk disappeared.

As indicated previously, some interest is attached to the size of the internal organs, in connection with deficient rations. A number of such studies have been described, but for the present the class *aves* will receive special consideration. Funk and Douglas⁴, McCarrison⁵, Dutcher and Wilkins⁶, and Souba⁷ observed atrophy of the testes of birds, pigeon or fowl, on rations deficient in vitamin B. Allen⁸ made a similar observation on the testes of the rat.

Although there is general agreement that the testes atrophy in periods of vitamin B deficiency, the evidence indicates that the adrenals increase in size. This observation was apparently first made by McCarrison⁵ on pigeons and has been confirmed by many others. A more recent discussion of this topic, with a summary of the literature, may be found in the paper of Marrian, Baker, Drummond, and Woollard⁹. Marrian¹⁰ attempted to decide what relative part in the enlargement was due to each of the recognized factors in the vitamin B complex. He decided it is due chiefly to vitamin B₁ (antineuritic), though a deficiency of B₂ (growth promoting) may be a contribution factor. Findlay¹¹ obtained similar findings with the rat. Though vitamin C is of no immediate concern it is of interest that LaMer and Campbell¹² noted an enlargement of the adrenals of scorbutic guinea pigs.

Similar studies of other types of such deficiencies are not numerous; Marine¹³ reported that chicks receiving a ration deficient in calcium had enlarged thyroid glands. Luce¹⁴ has made a similar observation on rats. Students of rickets have frequently reported enlargement of the parathyroid glands. Pappenheimer and Minor¹⁵ noted an enlargement of these glands in rachitic children. These authors summarize earlier work in this field. More recent workers have made similar studies on the chick, with the same result. Thus Doyle¹⁶, and Nonidez and Goodale¹⁷ have described enlarged parathyroid glands in rachitic chicks. Doyle observed hyperplasia only, while Nonidez and Goodale noted both hyperplasia and hypertrophy.

EXPERIMENTAL

In the studies here reported only White Leghorns were used, and the conditions as to care and environment have been previously described¹.

The rations were made up of natural foodstuffs in some cases, and in others the simplified type of diet was employed. Of the latter type, No. 503, one of our basal diets, is given as an example, but it was modified so frequently that the changes can not now be described in detail. Most of the changes consisted in the inclusion of extracts that were being examined for nutritional properties. These supplements were prepared from a variety of materials, such as maize, egg yolk, and wheat germ. Also various solvents were used, chiefly water, ether, and ethyl alcohol. These extracts will be described in greater detail in a subsequent publication. For the present it will be sufficient to say that in rare instances these supplements seemed to make the ration adequate, and capable of supporting normal growth. Such cases were rare, were not reproducible, and ordinarily the rations were improved only slightly or not at all. The chicks described in Table 8 were reared on a number of variations of Ration 503, but judging by the results, the changes were immaterial. A description of the rations appears in Table 1.

TABLE 1.—COMPOSITION OF EXPERIMENTAL RATIONS

Components of Ration	Ration Number				
	752 ^{1 2 3}	753 ^{1 2 4}	754 ^{1 5}	755 ⁷	503 ⁶
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
Yellow corn.....	81	--	81	--	--
White corn.....	--	81	--	--	--
Hominy grits.....	--	--	--	81	--
Calcium carbonate.....	2	2	2	2	--
Sodium chloride.....	1	1	1	1	--
Casein.....	10	10	10	10	20
Dried yeast.....	6	6	6	4	15
Cod liver oil.....	--	--	--	2	5
Lard.....	--	--	--	--	10
Corn starch.....	--	--	--	--	43
Cellulose.....	--	--	--	--	3
Salt mixture.....	--	--	--	--	4

- 1 Skim milk to drink, ad libitum.
- 2 The chicks were irradiated for 15 minutes daily, with a quartz-mercury vapor arc.
- 3 Control ration.
- 4 Deficient in Vitamin A.
- 5 Deficient in Vitamin D.
- 6 Typical of our synthetic rations.
- 7 Deficient in Vitamin B. After 28 days the yeast was removed entirely from the ration and replaced by an equal quantity of grits. Slight modifications of this ration were employed in earlier trials, but since they gave approximately the same result a detailed description seems unnecessary.

After the frequent presence of unabsorbed yolk was noted it became the practice to search each chick autopsied for the possible presence of this body. At first merely the presence, or absence, of yolk was recorded, with occasional references to size; but in later observations an attempt was made to correlate the rate of growth with the rate of yolk absorption, and all yolks were weighed. The first weights secured were taken on a small group of chicks receiving the basal ration, No. 503. As soon as these came to the laboratory each chick was assigned a date when it was to be sacrificed for autopsy, thus eliminating the possibility of unconscious selection later. The report of Gwatkin had not yet appeared at that time, so the variability noted, and the frequent delay in the time of yolk absorption, were quite surprising. These observations were then repeated, and other groups provided on Ration 634 as controls. Ration 503 is composed of simplified foodstuffs, and so is typical of the diets used in studying the nutritional requirements of the chick. Ration 634 is composed of natural foodstuffs, and supports a fairly rapid rate of growth.¹⁸

In view of the great variability of individual chicks it is difficult to draw definite conclusions, but there was no correlation between the rate of growth and the rate of absorption. Retarded absorption was noted both in rapidly and in slowly growing chicks. It seemed possible that the delay in absorption may have been due to disease, so a number of chicks were sent to the Department of Veterinary Medicine for examination.* Infection of any kind was rarely observed, and the idea has been discarded that bacterial disease may be a factor in the nutritional failures observed. What factors do determine the rate of yolk absorption are undertermined. It seems certain, however, that these factors are not of primary importance in fixing the rate of growth, or in developing the untoward symptoms associated with our synthetic rations. The data appear in Table 2.

*We are greatly indebted to Dr. A. J. Durant for his kindness in making post mortem examinations, and in taking bacterial cultures.

TABLE 2.—TIME REQUIRED BY THE BABY CHICK FOR YOLK ADSORPTION

Age days	Weights of Yolks			
	Adequate Diet; grams		Synthetic Diet; grams	
	♂	♀	♂	♀
1		4.62	5.60	
2	2.47			7.55, 0.36
3	6.70, 0.83		5.50, 0.53	1.03
4	6.70	1.00	3.95	0.50, 0.88
5		0.20, 0.36, 4.15, 0.50	1.99, 0.05	1.10, 0.53, 0.35, 0.27
6	4.25, 0.13		2.42, 0.15	4.20, 0.15, 0.00
7		0.00, 0.12		0.07, 0.00
8	0.50, 1.50	0.05	0.03	0.035, 0.02
9	2.00	0.015 tr.	0.095, 0.00	tr., 0.02
10	0.00	0.00	0.02, tr.	0.00
11	0.18, tr.	0.00	0.00	0.05, tr. 0.00
12	0.00	0.00	0.00, 0.00	0.00
13	0.00 tr.,	0.015	0.33, 0.015	0.095, 0.00
14		0.00, tr.	0.00 0.025, 0.00 tr.	0.17
15	0.00	0.00	0.00	0.00
20		0.00	0.00	
22	0.001			0.00
23	tr.			0.35
24		0.00		3.80, 0.75
26	0.00			3.65
27	0.005, 0.20		tr.	0.09

As mentioned previously, unabsorbed yolks were frequently noted in other experimental chicks that were autopsied. Few of them were weighed, and it is impossible to assign them any special significance; but the facts seem worthy of record and appear in Table 3.

TABLE 3.—INCIDENCE OF PERSISTENT EGG YOLK, IN THE CHICK

No. of Chick	Sex	Weight; grams	Age; days	Observations
		Adequate Rations		
651	♀	35	3	+
119	♀	28	3	+
121	♀	30	3	+
128	♀	33	4	+
122	♀	35	4	+
118	♀	40	4	+
126	♀	34	4	+
149	♀	26	4	+
163	♀	25	5	+
157	♀	32	5	+
181	♀	27	5	+
184	♀	26	5	+
183	♀	32	5	+
185	♀	26	5	+

TABLE 3.—INCIDENCE OF PERSISTENT EGG YOLK, IN THE CHICK.—Continued

No. of Chick	Sex	Weight; grams	Age; days	Observations
189	♀	26	5	+
191	♀	27	5	+
204	♀	32	5	+
120	♀	40	5	+
123	♀	33	5	+
659	♀	33	5	+
663	♀	35	5	+
124	♀	34	6	+
2599	♀	33	6	+
174	♀	26	7	+
159	♀	39	13	+
75	♀	58	25	+, size of pea
74	♀	60	25	+, size of pea
76	♀	70	26	large amount of viscous yolk
71	♀	80	26	large amount of caseous yolk
652	♀	95	35	—
2531	♀	510	56	—
2527	♀	630	56	—
321	♀	526	58	—
315	♀	500	58	—
1026	♀	1172	91	trace
1040	♀	890	93	—
7077	♀	1020	103	+, 0.7 grams
7052	♀	960	103	—
7032	♀	1100	104	—
1041	♀	990	116	—
1485	♀	1565	119	—
1027	♀	830	122	—
808	♀	1600	148	—
1034	♀	1350	151	—
838	♀	1410	162	—
Ration Deficient in Vitamin A				
7094	♀	555	88	—
1048	♀	820	91	—
1046	♀	630	91	—
1031	♀	430	91	+, 1.0 grams
1030	♀	500	91	trace
941	♀	215	96	—
7032	♀	370	97	—
7077	♀	440	101	—
Ration Deficient in Vitamin B				
998	♀	345	79	+, 0.7 grams
7066	♀	210	89	—
7067	♀	200	90	—
7046	♀	510	97	+, 0.85 grams
7064	♀	370	99	—
1037	♀	620	147	—
842	♀	760	148	—
Ration Deficient in Vitamin D				
7020	♀	540	102	—
7012	♀	550	102	+, 0.63 grams
1054	♀	740	112	+, 0.70 grams
1051	♀	900	113	—
1056	♀	940	114	—
1055	♀	750	115	—
849	♀	1520	149	—
847	♀	1030	162	—
Synthetic Rations				
118	♂	26	1	+

TABLE 3.—INCIDENCE OF PERSISTENT EGG YOLK, IN THE CHICK.—Continued

No. of Chick	Sex	Weight; grams	Age; days	Observations
Synthetic Rations (Continued)				
441	♂	30	1	+, 4.05 grams
450	♂	28	2	+, 1.20 grams
485	♂	30	3	+, 2.10 grams
606	♂	32	3	+
613	♂	33	3	+
123	♂	28	3	+
141	♂	33	4	+
108	♂	32	4	+
110	♂	38	4	+
111	♂	32	4	+
120	♂	30	4	+
132	♂	32	4	+
133	♂	30	4	+
680	♂	32	4	+
2557	♂	37	4	+
2561	♂	32	4	+
484	♂	28	4	+
480	♂	28	4	+
128	♂	31	5	+
131	♂	30	5	
135	♂	28	5	
136	♂	29	5	+
138	♂	29	5	++
137	♂	29	5	++
139	♂	28	5	++
141	♂	52	5	++
148	♂	37	5	++
134	♂	36	5	++
137	♂	30	5	++
138	♂	32	5	++
139	♂	36	6	++
24	♂	41	6	++
59	♂	35	6	++
2985	♂	39	6	++
491	♂	31	6	+, 2.1 grams
544	♂	45	7	+
573	♂	42	7	++
145	♂	42	7	++
305	♂	35	8	-
2549	♂	30	8	++
343	♂	36	9	+, 0.15 grams
309	♂	36	9	-
328	♂	35	9	-
307	♂	39	9	+, 3.81 grams
304	♂	44	9	+, 0.015 grams
4	♂	35	11	++
1	♂	50	11	+
6	♂	30	11	-
45	♂	45	12	-
458	♂	60	12	-
44	♂	44	13	+
603	♂	41	14	-
112	♂	62	14	+
132	♂	48	14	-
2	♂	47	15	+, 10 grams
561	♂	60	15	-
206	♂	71	17	+, size of pea
70	♂	78	18	-

TABLE 3.—INCIDENCE OF PERSISTENT EGG YOLK, IN THE CHICK.—Continued

No. of Chick	Sex	Weight; grams	Age; days	Observations
Synthetic Rations (Continued)				
594		54	18	—
116		95	19	+, size of walnut
63		85	19	+, large amount
100		63	19	+
611		70	21	—
65		115	21	—
448		58	21	+
549		60	21	—
569		59	21	—
96		60	22	+
8		77	22	—
2581		103	22	—
592		65	23	—
189		99	23	—
97		70	24	+, large amount
98		70	24	—
1012		151	24	+
84		80	25	+, size of robin egg
85		72	25	+, size of pea
90		73	25	+, large amount
124		80	25	—
471		90	25	—
468		85	25	—
453		65	25	—
455		58	25	+, 0.5 grams
465		90	25	trace
466		60	25	—
87		98	26	+, large amount
92		73	26	—
69		80	26	+, large amount
106		84	26	+, small amount
109		196	26	+, small amount
1009		120	26	—
89		90	27	+, small amount
338		90	28	+, small amount
340		70	28	+, 1.8 grams
336		80	28	—
474		95	28	+, 7.5 grams
2580		218	28	—
620		90	28	—
616		75	28	—
91		115	28	—
596		60	28	—
476		110	29	trace
2545		125	30	—
66		130	34	—
675		125	35	—
190		85	37	+, 1.05 grams
217		90	37	—
182		102	37	+, 0.15 grams
227		118	37	—
207		100	39	trace
1265		210	39	—
194		90	39	—
211		110	39	—
235		98	39	+, 1.6 grams
237		80	39	—
449		70	39	—

TABLE 3.—INCIDENCE OF PERSISTENT EGG YOLK, IN THE CHICK.—Continued

No. of Chick	Sex	Weight; grams	Age; days	Observations
		Synthetic Rations (Continued)		
481	♀	80	40	—
470	♀	120	42	—
232	♀	175	46	+, 0.5 grams
553	♀	110	47	—
480	♀	90	47	—
145	♀	130	47	—
83	♀	265	48	—
479	♀	165	49	—
333	♀	140	49	—
192	♀	220	52	+, 0.2 grams
198	♀	290	56	—
303	♀	210	56	—
297	♀	175	56	—
299	♀	250	56	—
294	♀	355	56	+, 0.005 grams
301	♀	295	56	—
2584	♀	600	56	—
2583	♀	575	56	—
2553	♀	390	56	—
2537	♀	365	56	—
303	♀	500	58	—
335	♀	280	58	—
2546	♀	475	58	—
2554	♀	375	58	—
2556	♀	375	58	—
2562	♀	610	58	—
2566	♀	565	58	—
334	♀	528	58	—
2541	♀	500	59	—
2536	♀	486	59	—
2573	♀	740	59	—
341	♀	521	59	—
325	♀	590	59	—
331	♀	595	59	—
347	♀	600	59	+, 1.005 grams
228	♀	140	59	—
332	♀	430	60	+, 1.050 grams
2571	♀	445	60	—
2547	♀	230	60	—
3	♀	77	77	—
62	♀	1450	98	—
64	♀	----	111	+, 0.5 grams

A considerable number of the chicks autopsied do not appear in Table 3, and it is not certain that the chicks there described are a representative sample. This is due to the fact that when the earlier autopsies were made there was no special interest in yolk absorption, and no expectation of finding it in chicks more than a few days old. In many such cases no mention is made of yolk, so those individuals have been omitted. It is impossible now to decide whether the yolks had been absorbed, or were small and only unnoticed. It is certain, however, that there is great variability in the rate of absorption, since in a few cases unabsorbed yolks persisted for at least 16 weeks. Such persistence was unexpected and it has not been possible to correlate retarded absorption with the ration, with disease, or with the rate of growth.

An abnormal color of the liver is commonly regarded as a result of disease, so special note was made of the condition of that organ in post mortem records. The liver of chicks examined within a few days of hatching has invariably been light yellow or tan in color, and this gradually darkens until a normal color is attained on about the 10th day². In diseased chicks it is well known that the yellow color of the liver may persist much longer, two weeks or more.

Mention has already been made of a considerable body of evidence that the size of some of the internal organs may be greatly modified by a ration deficient in certain respects. Thus a ration deficient in vitamin B may lead to a reduction in the weight of the testes, and to an increase in weight of the adrenals. A deficiency of vitamin D results in enlargement of the parathyroid. No evidence is available that a deficiency of vitamin A leads to any such abnormality.

It was decided, therefore, as previously mentioned, to weigh the internal organs of a number of chicks that had been reared on synthetic diets. The chicks examined were, with few exceptions, selected from those that had developed the most extreme symptoms of a deficiency disease.

Some of these had developed typical symptoms of leg-weakness, others were merely subnormal in weight. The organs weighed were yolk, if present, also alimentary tract, lungs and trachae, liver, heart, pancreas, spleen, kidneys, adrenals, testes or ovary, and thyroid.

At approximately the same time there were three small lots of chicks under observation, each of which received a ration deficient in one of the following vitamins, A, B, or D. Another group was receiving a control diet adequate in all respects. These chicks were being used for blood analysis, so when they were ready to be discarded, they too were autopsied and the internal organs weighed. In so far as organ weights are concerned, no great interest pertains to these latter groups,

except the controls. The number of individuals on any one of the deficient diets was too small for the results to be of much significance.

Inspection of the data makes it quite evident that the weights of the internal organs are highly variable. This may be explained by the fact that aside from the controls, practically all the chicks studied were distinctly abnormal; some were quite emaciated, others were in fair condition, aside from gross deformities. Studies by other workers, notably Latimer¹⁹, and Juhn and Mitchell²⁰, however, show that even in stock selected for uniformity, a high degree of variability is to be expected. The data appear in Tables 4 to 8 of the Appendix, and in Figs. 1 and 2.

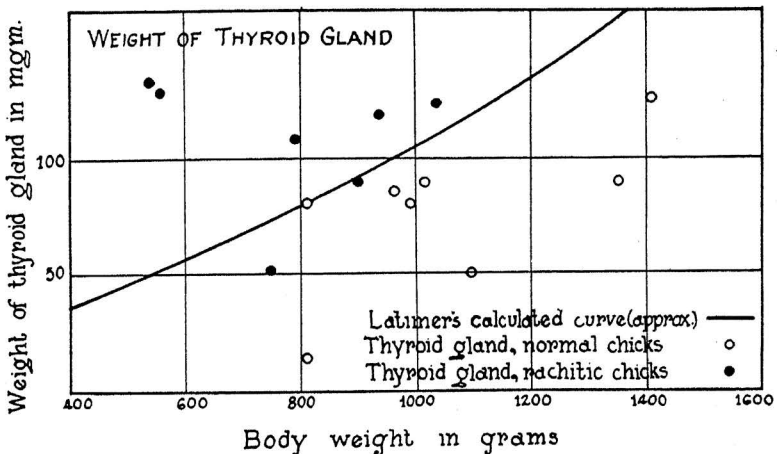


Fig. 1.—Chicks reared on rachitogenic diets have heavier thyroid-para-thyroid glands than those reared on adequate diets.

Tables 5 to 7, including the chicks on rations 753, 754, and 755, will be considered first. Group II (Table 5) received a ration deficient in vitamin A, and as expected, the weights are indistinguishable from the controls (Table 4).

The weights of the organs of the few chicks on Ration 755, deficient in vitamin B (Table 6), were so few and scattered that they are of little significance. It has been stated that such rations produce atrophy of the testes, but no such effect was observed. It is also commonly believed that such a ration produces enlargement of the adrenals, but the data are indecisive on that point. Most of these chicks were killed when rather small, at weights of 600 grams or less, and according to Fig. 2 enlarged adrenals are not to be expected until the chicks have passed 800 grams.

In connection with vitamin D (Table 7), it was observed that the parathyroid is much enlarged, and so the weight of the thyroid-parathyroid complex is increased. In the chick the parathyroid is readily distinguished from the thyroid gland, and the extreme increase in size is easily noted. The results are shown graphically in Fig. 1.

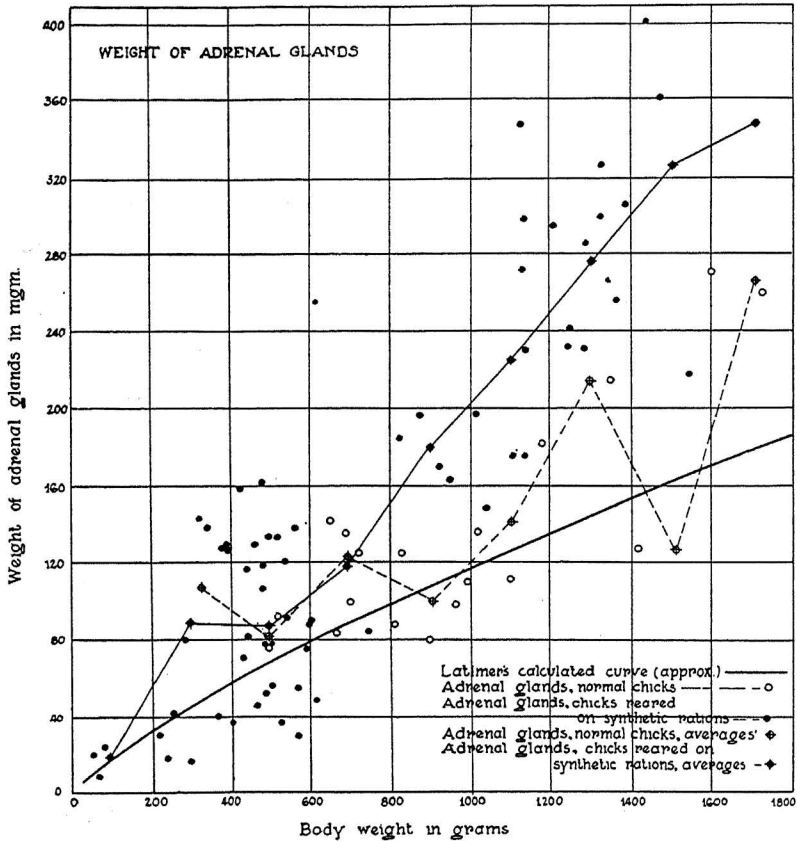


Fig. 2.—The adrenal glands of chicks reared on synthetic diets are heavier than those of chicks reared on adequate diets.

As regards the chicks on the synthetic diets (Table 8), only one abnormality was noted. The adrenal glands of chicks weighing over 800 grams were, on the average, distinctly heavier than those of the other chicks. This conclusion seems obvious from Fig. 2, though there are not enough control chicks to justify treating the data by statistical methods. Because the controls are so few, an estimate was made of the approximate average weights (not shown) if to the controls were

added the chicks reared on Ration 753, 754, and 755. These averages, however, are practically the same as those shown in Fig. 2. In order to obtain additional evidence as to whether these controls were representative, they were compared with the calculated weights given in Latimer's paper¹⁹. This comparison yields additional evidence that the chicks reared on simplified diets have enlarged adrenals.

Both males and females are included in Fig. 2, as the data do not indicate that any sex differences exist. Latimer¹⁹ reported no sex differences in the adrenal gland of chicks, but Marrian¹⁰ reported that the adrenals of the pigeon do vary with sex.

The primary interest in the weights of organs was due to the possibility of obtaining some clue as to the nature of the deficiency in our synthetic ration. No evidence of any kind as to the possibility of a deficiency of vitamin A was obtained. Some students regard leg-weakness as indicating rickets with great certainty. Leg-weakness was frequently observed, but since the parathyroid glands were of normal weight, we believe rickets is excluded. This deduction is confirmed by unpublished analyses of the blood and bone.

A form of leg-weakness is also associated with a deficiency of vitamin B. Since, however, the basal diets regularly contain 15 per cent of yeast, it seems improbable that any of the vitamin B components could be lacking. Several workers have used similar rations, with similar results, but apparently none found reason to suspect that a deficiency of vitamin B might be responsible. On the other hand the observations reported here yield many instances of enlarged adrenal glands, and this may indicate a deficiency in at least one component of the vitamin B complex. This interpretation is in harmony with other observations. For example, these chicks frequently develop head retraction and paralysis. Furthermore scattered blood sugar analysis on such individuals, to be published elsewhere, have in some instances been distinctly high. The available data, therefore, indicate that the inadequacy of synthetic diets for the chick is due to insufficient provision of one or more components of the vitamin B complex. It is hoped that future studies may yield more definite evidence.

SUMMARY

Numerous attempts to rear chicks on synthetic rations have been reported, but complete success has not been attained in any case.

Persistent egg yolks were frequently noted in post mortem examinations, so an attempt was made to correlate delayed resorption with nutritional failures. No causal relation could be established.

All nutritional factors as yet recognized were incorporated in the experimental rations, but it seemed possible that at least one might be

present in insufficient quantity. In order to obtain a hint as to such a possibility, the internal organs of a large number of chicks were weighed. The adrenal glands of those receiving synthetic diets, and weighing over 800 grams, were, on the average, much heavier than the average for chicks on adequate rations. This difference in weight suggests that the synthetic diets previously used are deficient in at least one factor of the vitamin B complex.

BIBLIOGRAPHY

- (1) Hogan, A. G., Guerrant, N. B., and Kempster, H. L. 1925. Mo. Agr. Exp. Sta. Res. Bul. 81.
- (2) Gwatkin, R. 1925. Report of the Ontario Veterinary College, p. 62.
- (3) Anonymous. 1927. Arkansas Agr. Exp. Sta. Bul. 221, p. 33.
- (4) Funk, C., and Douglas, M. 1914. Jour. Physiol. xxxvii, 475.
- (5) McCarrison, R. 1919. Brit. Med. Jour. i, 177.
- (6) Dutcher, R. A., and Wilkins, S. D. 1921. Amer. Jour. Physiol. lvii, 437.
- (7) Souba, A. J. 1923. Amer. Jour. Physiol. lxiv, 181.
- (8) Allen, Ezra. 1919. Anat. Rec. xvi, 93.
- (9) Marrian, G. F., Baker, L. C., Drummond, J. C., and Woollard, H. 1927. Biochem. Jour. xxi, 1336.
- (10) Marrian, G. F. 1928. Biochem. Jour. xxii, 836.
- (11) Findlay, G. M. 1928. Jour. Path. and Bact. xxxi, 353.
- (12) LaMer, V. K., and Campbell, H. L. 1921. Proc. Soc. Exp. Biol. Med. xviii, 32.
- (13) Marine, D. 1913. Proc. Soc. Exp. Biol. Med. xi, 117.
- (14) Luce, Ethel M. 1923. Jour. Path. and Bact. xxvi, 200.
- (15) Pappenheimer, A. M., and Minor, J. 1920-21. Jour. Med. Res. xxxii, 391.
- (16) Doyle, L. P. 1925. Poultry Science iv, 146.
- (17) Nonidez, J. F., and Goodale, H. D. 1926-27. Amer. Jour. Anat. xxxviii, 319.
- (18) Hogan, A. G., Hunter, J. E., and Kempster, H. L. (1928). Jour. Biol. Chem., lxxvii, 431.
- (19) Latimer, H. B. 1924. Jour. Agr. Res. xxix, 363.
- (20) Juhn, Mary, and Mitchell, J. B., Jr. 1929. Amer. Jour. Physiol. lxxxviii, 177.

APPENDIX

TABLE 4.—WEIGHTS OF THE INTERNAL ORGANS OF CHICKS
Group I. Control Ration

No. of Chick	Organs Weighed		Alimentary Tract	Liver	Heart	Lungs and Trachea	Kidney	Pancreas	Gonads	Spleen	Adrenals	Thyroid	
	Sex	Age											Body Weight
2728	♂	days	grams	grams	grams	grams	grams	grams	grams	grams	grams	grams	
2537	♂	60	320	20.0	4.516	1.326	1.490	1.325	0.752	0.406	0.604	-----	
2553	♂	56	365	45.6	9.532	2.476	1.950	4.123	1.501	0.198	0.752	-----	
315	♂	56	390	42.7	10.729	2.582	2.411	3.579	1.600	0.234	0.425	-----	
2531	♂	58	500	87.0	10.855	3.532	4.025	4.580	1.965	0.165	0.828	0.075	
321	♂	56	510	57.4	16.894	3.497	3.452	5.188	2.013	0.233	1.254	-----	
2527	♂	58	526	98.5	15.705	3.695	3.472	5.315	2.420	0.205	0.952	0.093	
779	♂	56	630	73.4	16.053	4.601	3.557	6.005	1.952	0.404	2.152	-----	
780	♂	77	660	30.2	10.185	5.900	5.005	5.055	0.752	0.525	1.042	0.143	
6829	♂	77	670	65.5	18.055	3.985	4.605	6.050	1.770	0.220	1.000	0.085	
778	♂	101	695	67.0	9.920	2.418	2.075	2.652	0.968	3.068	1.290	0.176	
782	♂	77	705	76.5	18.200	4.150	6.870	6.160	2.050	0.265	1.240	0.101	
781	♂	77	760	73.7	23.750	4.652	4.775	5.750	2.215	0.600	1.575	0.105	
1027	♂	73	810	101.5	21.750	5.110	6.315	5.955	2.015	1.630	1.355	0.087	0.0145
1040	♂	122	830	75.0	20.105	5.855	5.375	7.500	2.650	5.455	1.100	0.125	0.0852
7052	♂	93	890	70.0	18.000	4.000	4.750	5.850	2.070	0.250	1.530	0.080	-----
1041	♂	103	960	82.1	29.255	5.525	4.800	7.240	2.720	0.740	1.920	0.096	0.0879
7077	♂	116	990	76.9	28.255	5.100	7.500	8.515	2.585	0.555	2.105	0.108	0.0812
7032	♂	103	1020	85.0	26.500	5.625	5.640	6.425	2.455	1.935	1.255	0.135	0.0903
6017	♂	104	1100	84.2	25.700	5.094	5.903	8.405	2.920	0.500	3.400	0.110	0.0500
1043	♂	136	1192	72.0	20.134	5.390	5.642	5.285	1.710	7.126	2.212	0.180	-----
838	♂	151	1350	106.5	34.400	7.045	5.150	10.125	3.390	-----	1.595	0.212	0.0928
808	♂	162	1410	126.8	27.750	5.855	8.285	10.755	3.350	-----	1.530	0.126	0.1273
3627	♂	148	1600	127.0	32.290	7.950	11.500	18.405	3.290	4.200	2.130	0.271	-----
		184	1720	105.0	28.965	7.689	8.061	7.553	2.445	10.178	3.276	0.258	-----

TABLE 5.—WEIGHTS OF THE INTERNAL ORGANS OF CHICKS
Group II. Ration Deficient in Vitamin A

Organs Weighed				Alimentary Tract	Liver	Heart	Lungs and Trachea	Kidney	Pancreas	Gonads	Spleen	Adrenals	Thyroid
No. of Chick	Sex	Age	Body Weight										
		<i>days</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>
7033	♂	97	370	54.0	13.950	2.070	3.620	4.100	1.125	0.145	0.225	0.135	0.0308
1031	♂	91	430	65.0	12.860	3.840	2.450	2.350	1.770	0.145	0.720	0.065	-----
7077	♀	101	440	59.7	15.050	3.152	1.950	6.125	1.855	0.215	0.522	0.046	0.0317
1030	♀	91	500	65.5	13.105	3.560	2.760	3.650	2.040	2.995	0.795	0.099	-----
7094	♂	88	550	63.2	16.945	3.800	2.775	4.650	1.565	0.185	0.600	0.075	0.045
1046	♀	91	630	69.7	17.000	3.040	3.115	4.310	1.910	0.305	0.945	-----	-----
835	♂	120	725	84.5	16.710	5.220	5.555	5.110	2.170	3.000	0.770	0.121	-----
1048	♂	91	820	96.2	18.695	5.710	5.700	5.606	2.565	0.300	1.420	0.085	-----

TABLE 6.—WEIGHTS OF THE INTERNAL ORGANS OF CHICKS
Group III. Rations Deficient in Vitamin B

Organs Weighed				Alimentary Tract	Liver	Heart	Lungs and Trachea	Kidney	Pancreas	Gonads	Spleen	Adrenals	Thyroid
No. of Chick	Sex	Age	Body Weight										
		<i>days</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>
7067	♀	90	200	28.7	5.245	1.305	1.125	1.650	0.880	0.103	0.110	0.073	0.0123
7066	♀	81	210	23.7	7.400	2.145	1.755	2.385	0.865	0.100	0.199	0.044	0.0169
941	♀	96	215	22.3	7.600	2.010	1.700	3.140	0.800	0.105	0.125	0.064	0.0085
998	♂	79	345	45.5	10.995	3.650	2.975	3.350	1.270	0.132	0.325	0.071	0.0240
7064	♂	99	370	41.1	9.805	3.700	2.745	3.855	1.050	0.145	0.215	0.087	0.0200
7046	♀	97	510	61.2	16.850	3.475	4.115	5.735	1.575	0.600	0.200	0.042	0.0201
841	♂	105	570	58.5	14.395	3.950	8.600	6.680	1.590	0.121	0.645	0.137	-----
1037	♀	147	620	76.5	15.825	4.935	4.225	6.240	2.050	0.245	0.645	0.083	0.0396
842	♀	148	760	100.0	19.215	5.455	2.400	7.050	2.200	0.950	1.050	0.116	-----
849	♂	149	1520	135.5	35.500	8.212	2.900	12.165	3.550	1.330	2.940	0.158	-----

TABLE 7.—WEIGHTS OF THE INTERNAL ORGANS OF CHICKS
Group IV.—Rations Deficient in Vitamin D

No. of Chick	Organs Weighed			Alimentary Tract	Liver	Heart	Lungs and Trachea	Kidney	Pancreas	Gonads	Spleen	Adrenals	Thyroid
	Sex	Age	Body Weight										
797	♀	<i>days</i> 62	<i>grams</i> 360	<i>grams</i> 43.2	<i>grams</i> 16.722	<i>grams</i> 4.745	<i>grams</i> 2.710	<i>grams</i> 4.675	<i>grams</i> 1.342	<i>grams</i> 0.125	<i>grams</i> 1.570	<i>grams</i> 0.074	-----
799	♀	77	460	55.8	15.648	3.395	3.700	4.700	1.475	0.990	0.200	0.052	-----
7020	♀	102	540	66.2	16.100	4.700	2.305	5.895	2.545	0.300	0.116	-----	0.1352
796	♀	77	550	80.9	11.000	5.115	3.585	6.755	2.225	0.265	1.862	0.111	-----
1058	♀	98	560	54.4	17.200	4.900	4.150	6.585	2.200	0.265	0.805	0.117	-----
7012	♂	102	560	70.9	19.500	6.410	4.955	6.000	2.370	0.431	0.865	0.102	0.1294
800	♀	77	575	67.5	12.555	3.272	2.850	5.200	1.960	0.222	1.675	0.070	-----
1055	♂	115	750	75.5	24.850	5.050	4.020	6.670	2.970	0.355	1.120	0.129	0.0526
1054	♂	112	790	96.5	26.670	5.920	5.000	9.200	3.355	0.420	1.290	0.174	0.1097
1051	♂	113	900	82.0	24.700	5.070	4.165	8.100	3.255	1.125	1.170	0.130	0.0912
1056	♂	114	940	93.5	29.550	6.770	2.062	7.665	3.320	1.810	1.295	0.184	0.1206
847	♀	162	1030	79.5	19.650	4.200	6.225	6.250	2.270	1.060	1.400	0.116	0.1242

TABLE 8.—WEIGHTS OF THE INTERNAL ORGANS OF CHICKS
Group V.—Synthetic Ration

No. of Chick	Organs Weighed			Alimentary Tract	Liver	Heart	Lungs and Trachea	Kidney	Pancreas	Gonads	Spleen	Adrenals	Thyroid
	Sex	Age	Body Weight										
		days	grams	grams	grams	grams	grams	grams	grams	grams	grams	grams	grams
107	♀	25	61	11.3	1.902	0.630	0.422	1.225	0.370	0.018	0.052	0.021	-----
109	♂	25	65	10.1	2.702	0.502	0.202	1.085	0.395	0.023	0.055	0.008	-----
124	♂	25	83	14.5	3.265	0.760	0.732	1.500	0.532	0.013	0.082	0.024	-----
297	♂	56	175	39.0	9.005	1.775	1.205	2.100	0.945	0.099	0.265	0.018	-----
303	♂	56	210	48.5	8.700	1.622	1.455	3.000	0.995	0.500	0.135	0.032	-----
3727	♂	85	220	18.0	3.429	1.614	1.360	1.419	0.251	-----	0.257	0.109	-----
1964	♂	85	220	17.0	3.517	1.698	1.304	1.426	0.265	-----	0.265	0.118	-----
2547	♂	59	230	32.7	8.050	1.962	1.362	2.792	0.797	0.113	0.415	0.017	-----
299	♂	56	250	58.0	10.335	2.022	1.577	3.505	1.105	0.099	0.319	0.042	-----
2000	♂	85	260	19.0	3.972	1.925	1.450	1.397	0.276	-----	0.390	0.114	-----
3746	♂	85	265	20.0	4.016	1.982	1.426	1.516	0.298	-----	0.297	0.116	-----
311	♂	58	280	63.3	14.060	2.135	2.105	4.055	1.760	0.146	0.715	0.080	-----
301	♂	56	295	80.0	10.043	1.845	1.146	3.826	1.850	0.129	0.509	0.015	-----
216	♂	72	315	30.0	5.880	2.098	2.720	1.315	0.402	-----	0.496	0.142	-----
1993	♂	85	320	24.0	4.960	2.741	1.940	1.846	0.371	-----	0.369	0.103	-----
3781	♂	85	320	22.0	5.019	2.451	1.750	1.842	0.347	-----	0.342	0.105	-----
206	♂	72	335	31.0	5.890	2.167	2.169	1.304	0.316	-----	0.417	0.138	-----
294	♂	56	355	73.0	14.958	2.302	3.950	4.555	1.599	0.155	0.758	0.040	-----
2537	♂	56	365	45.6	9.532	2.467	1.950	4.123	1.501	0.198	0.752	-----	-----
2554	♂	58	375	56.5	8.770	1.384	2.165	4.008	1.386	0.295	0.462	-----	-----
2556	♂	58	375	62.6	10.446	2.631	2.115	4.759	1.100	0.166	0.412	-----	-----
202	♂	72	380	32.0	6.149	2.078	2.270	1.214	0.412	-----	0.468	0.129	-----
1982	♂	85	385	31.0	6.029	2.016	2.014	1.204	0.394	-----	0.415	0.129	-----
1958	♂	85	390	30.0	6.219	2.116	2.014	2.000	0.442	-----	0.446	0.127	-----
2553	♂	56	390	42.7	10.729	2.582	2.411	3.579	1.600	0.234	0.425	-----	-----
335	♂	56	400	75.5	12.820	2.555	2.722	4.258	1.657	0.144	0.269	0.038	-----
212	♂	72	420	32.0	6.279	2.197	2.416	1.297	0.428	-----	0.509	0.159	-----
332	♂	60	430	92.5	16.400	2.550	2.620	-----	1.755	0.170	0.650	0.070	-----
1996	♂	85	440	30.0	6.701	3.207	2.197	2.207	0.498	-----	0.472	0.116	-----
2571	♀	60	445	60.0	12.610	2.639	2.539	5.605	1.051	0.143	0.818	0.082	-----

TABLE 8.—WEIGHTS OF THE INTERNAL ORGANS OF CHICKS—(CONTINUED)
Group V. Synthetic Ration

No. of Chick	Organs Weighed			Alimen- tory Tract	Liber	Heart	Lungs and Trachea	Kidney	Pancreas	Gonads	Spleen	Adrenals	Thyroid
	Sex	Age	Body Weight										
		<i>days</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>
3	♀	77	452	59.6	16.755	4.543	3.997	6.175	1.445	0.263	0.407	0.045	-----
2039	♀	106	460	31.0	7.964	3.607	3.089	3.045	0.637	-----	0.499	0.129	-----
2546	♂	58	475	62.8	15.428	2.777	2.890	6.000	1.709	0.411	0.785	0.103	-----
2010	♀	106	475	30.0	7.435	3.602	2.319	2.260	0.527	-----	0.502	0.161	-----
1972	♀	85	480	31.0	7.215	3.615	2.260	2.192	0.516	-----	0.496	0.119	-----
2536	♀	59	486	61.4	13.586	4.767	2.083	6.424	1.440	0.153	0.721	0.053	-----
1963	♂	85	495	35.0	7.554	3.760	2.593	2.601	0.516	-----	0.546	0.132	-----
330	♀	58	500	107.5	16.250	3.505	3.455	5.655	2.312	0.265	0.800	0.054	-----
315	♀	58	500	87.0	10.853	3.532	4.025	4.580	1.965	0.828	0.165	0.075	-----
2541	♂	59	500	58.3	14.200	3.278	2.833	6.134	1.722	0.200	0.775	0.075	-----
2531	♀	56	510	57.4	16.894	3.497	3.452	5.188	2.013	0.233	1.254	-----	-----
1965	♀	85	510	36.0	7.624	3.890	2.619	1.572	0.560	-----	0.544	0.132	-----
334	♂	58	520	87.5	15.805	3.900	4.000	5.250	3.058	0.135	0.905	0.035	-----
321	♀	58	526	98.5	15.705	3.695	3.472	5.315	2.420	0.452	0.205	0.093	-----
3729	♀	85	535	35.0	7.910	3.864	2.934	3.091	0.542	0.259	0.507	0.120	-----
2012	♀	106	555	34.0	8.160	3.967	3.016	3.106	0.621	-----	0.610	0.136	-----
2566	♂	58	565	67.2	13.712	2.958	3.382	7.301	1.970	0.259	1.086	0.054	-----
2583	♀	56	575	52.4	12.740	3.315	3.323	6.206	1.820	0.232	1.221	-----	-----
341	♀	59	575	86.0	13.250	3.075	3.628	4.825	1.878	0.150	1.445	0.031	-----
331	♂	59	590	87.0	19.010	3.250	4.650	5.600	1.768	0.245	1.059	0.075	-----
325	♀	59	595	120.0	22.950	3.440	4.560	5.940	2.070	0.245	1.555	0.088	-----
2584	♀	56	600	63.9	19.027	4.312	3.393	7.820	1.973	0.924	0.898	-----	-----
347	♂	59	600	118.0	27.595	3.205	4.345	6.005	2.095	0.120	0.905	0.089	-----
2562	♀	58	610	70.0	15.100	4.038	3.875	7.740	1.663	1.065	1.070	0.049	-----
1943	♀	118	615	65.0	10.413	4.870	3.127	3.065	1.165	0.437	1.019	0.256	-----
2527	♂	56	630	73.4	16.053	4.601	3.557	6.005	1.952	0.404	2.152	-----	-----
3740	♀	136	680	36.0	12.440	3.890	4.108	3.212	1.051	2.082	0.996	0.116	-----
2537	♀	59	740	77.5	17.634	3.941	4.514	8.095	1.995	0.391	1.240	0.085	-----
2049	♀	89	825	72.0	12.864	5.018	4.170	5.168	1.002	3.098	1.168	0.184	-----

837	o	559	885	67.0	13.219	5.002	4.092	4.996	1.106	4.078	1.008	0.196	-----
3791		347	932	72.0	14.316	5.078	4.178	5.046	1.346	3.614	1.117	0.170	-----
3731	o	316	955	66.0	13.916	4.986	4.160	4.872	1.018	3.092	1.004	0.165	-----
3742	o	136	1010	59.0	17.917	5.163	6.085	5.720	1.297	4.635	1.690	0.198	-----
3728	o	316	1037	78.0	14.615	5.160	4.234	5.176	1.072	2.164	1.072	0.146	-----
813	o	559	1105	81.0	15.796	6.127	4.968	6.025	1.043	2.016	1.463	0.176	-----
3784	o	136	1120	60.0	26.000	5.432	5.369	8.272	1.887	8.412	1.406	0.298	-----
3734	o	184	1120	90.0	26.468	6.587	6.773	9.283	2.987	1.849	1.209	0.270	-----
3703	o	184	1125	92.0	23.840	7.524	8.280	6.770	2.021	4.602	1.245	0.228	-----
836	o	559	1125	76.0	14.682	5.196	4.865	4.880	1.146	6.028	1.167	0.176	-----
3782	o	136	1127	62.0	26.296	5.131	5.502	8.724	1.042	5.567	1.593	0.346	-----
3745	o	136	1205	68.0	26.650	5.839	7.963	6.823	1.557	8.317	2.278	0.296	-----
3795	o	184	1235	90.0	21.400	7.273	7.947	7.231	2.030	7.023	1.476	0.231	-----
3771	o	136	1240	65.0	24.629	6.547	7.610	7.252	2.331	8.690	1.315	0.241	-----
3775	o	136	1282	66.0	21.790	6.572	7.126	7.587	2.297	5.272	1.376	0.230	-----
3749	o	136	1290	72.0	23.300	5.817	7.781	6.649	1.658	9.207	2.577	0.286	-----
3773	o	136	1317	74.0	24.452	7.079	8.280	7.736	2.408	7.805	2.009	0.302	-----
3772	o	136	1327	72.0	24.815	6.891	8.492	7.935	2.594	12.826	1.966	0.327	-----
3704	o	184	1357	96.0	25.531	10.074	6.994	8.090	2.452	10.234	1.295	0.254	-----
3713	o	184	1390	110.0	31.100	10.170	9.501	9.323	2.639	4.393	1.547	0.308	-----
3770	o	136	1435	75.0	23.675	7.159	8.502	8.803	2.830	14.316	2.077	0.401	-----
3721	o	184	1475	124.0	28.190	8.531	8.239	9.149	2.707	3.877	1.903	0.360	-----
1041	o	559	1547	97.0	25.146	8.432	6.849	7.524	2.016	3.018	2.174	0.218	-----
3748	o	136	1675	92.0	27.521	6.215	8.808	7.158	2.368	6.175	2.334	0.349	-----