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A STUDY OF THE GASTRIC RESIDUUM

BY

THEODORE H. MORRISON AND W. HORSLEY GANTT

Baltimore, Maryland

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A Study of the Gastric Residuum¹

By THEODORE H. MORRISON AND W. HORSLEY GANTT, *Baltimore, Maryland*

OUR knowledge of the gastric residuum has been gained largely from a study of the gastric contents removed from the stomach in the fasting state by means of the ordinary stomach tube.

According to Loeper (1), Kemp (2), Riegel (3), Gaither (4) and others the quantity of residuum obtained from the normal fasting stomach should not exceed 20 to 25 cc., according to Boas (5), 50 to 100 cc.; while all agree that it should not contain food remnants. Some doubt was cast upon the truth of these figures by the observations of Harner and Dodd (6), who demonstrated by means of the X-ray that the complete removal of the residuum from the stomach was not always possible by means of the ordinary stomach tube. This fact has been confirmed by Rehfuss and his co-workers (7) who removed the fasting gastric contents by means of the Rehfuss tube and found that the quantity of contents in 100 normal cases averaged 52.14 cc., the largest 160 cc., and the smallest 23 cc. The total acidity noted averaged 29.9, the highest being 77.6; the lowest 2.4, the free HCl averaged 18.50, the highest 65.8, the lowest 0. Micro-

scopically, no food residue or meat fibers were noted, though leucocytes were almost always observed. The residuum was colorless in 43 per cent of these cases, and yellow or green in 56 per cent. These observers were thus able to demonstrate that the usually accepted limit of the normal residuum of 20 to 25 cc. is incorrect. They furthermore showed, that the fasting contents always presented the qualities of a physiologic active secretion, and that these appeared even in the absence of a normal stimulus.

Having convinced ourselves of the impossibility of obtaining the entire fasting contents of the stomach with the ordinary stomach tube, we concluded to study the residuum by means of the Rehfuss tube. The tube was swallowed without water and the gastric contents aspirated while the subject was placed in various positions. When aid in swallowing was necessary the tube was coated with a film of mineral oil. Observations were made upon 10 normal individuals, and upon 50 patients affected with various disorders.

Table 1 presents the normal cases in which a comparison is made of the results obtained by employing the Rehfuss tube, and results obtained by employing the ordinary stomach tube, as to the amount of residuum obtained. A similar comparison following a fractional analysis and an Ewald test meal, was obtained in the same

¹From the Gastro-Enterological Clinic of the Department of Medicine, University of Maryland.

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TABLE I
 Normal Cases

CASE NUMBER	REHFUSS TUBE											ORDINARY STOMACH TUBE				
	Volume of residuum	Residuum		Fractional analysis after test meal								Volume of residuum	Residuum		Ewald test break-fast 1 hour removal	
		Free HCl	Total acidity	15 minutes		30 minutes		45 minutes		1 hour			Free HCl	Total acidity	Free HCl	Total acidity
				Free HCl	Total acidity	Free HCl	Total acidity	Free HCl	Total acidity	Free HCl	Total acidity					
	cc.											cc.				
1	56	32	50	22	34	28	46	24	44	28	56	24	0	6	12	38
2	82	12	20	24	38	26	32	38	56	36	62	18	0	8	14	22
3	44	0	8	0	22	14	28	22	34	20	38	12	0	6	20	32
4	20	0	10	0	18	20	32	18	48	24	42	10	0	0	36	48
5	95	12	24	28	46	26	34	32	46	28	40	28	4	10	25	36
6	72	28	48	30	52	22	48	34	54	36	48	25	8	14	34	42
7	28	0	6	0	12	18	32	26	38	22	44	12	0	0	30	46
8	46	4	12	0	18	10	28	26	44	28	38	20	0	10	24	32
9	88	24	42	38	58	40	42	34	42	22	34	24	10	22	26	38
10	56	20	44	26	48	34	50	40	48	24	38	14	6	12	36	42
Average.....	58	13	26									18	28	88		
Maximum.....	95	32	50									28	10	22		
Minimum.....	20	0	6									10	0	0		

individual. In all instances in which fractional analyses were made in order to obtain more accurate results, advantage was taken of the mixing of the contents before withdrawal, as has been advised by White (8) as well as by Friedenwald and Gantt(9).

These figures indicate that the average volume of residuum obtained with the Rehfuss tube is 58 cc., the maximum amount 95 cc., the minimum 20; the average of free HCl is 13; maximum 32; minimum 0; the average total acidity is 26; maximum 50 and minimum 6. These figures are considerably higher than those obtained under similar conditions with the ordinary tube as may be observed in the table.

It has been suggested by Kopeloff (10) and others that there is a daily variation in the total amount of fasting contents obtained from the same individual.

Table 2 presents the daily variations in the volume of the residuum obtained in 3 normal individuals.

These tables indicate that the daily variations in the volume of the residuum as well as in the free HCl and total acidity of this secretion are not marked when obtained under identical conditions; the maximum variation in volume in the 3 examinations was 12 cc.; the minimum 2 cc.; the maximum variation in free HCl 12; minimum 2; the maximum variation in total acidity is 12, minimum 2.

TABLE 2

EXAMINATIONS	VOLUME OF RESIDUUM	ACIDITY OF RESIDUUM	
		Free HCl	Total acidity
Case 1			
cc.			
1	52	54	58
2	46	42	46
3	54	48	50
Average.....	50	48	51
Maximum variation...	8	12	14
Minimum variation....	6	6	4
Case 2			
1	48	28	30
2	42	26	36
3	54	30	34
Average.....	48	24	33
Maximum variation...	12	4	6
Minimum variation....	6	2	2
Case 3			
1	28	18	26
2	34	22	28
3	30	20	24
Average.....	30	20	26
Maximum variation...	6	4	4
Minimum variation....	2	2	2

APPEARANCE OF THE RESIDUUM

The appearance of the normal fasting contents varies; it is usually colorless or turbid, but it may also be greenish or yellow. The green and yellow coloration is due to biliary regurgitation, and may be absent at one examination and present at another in the same individual. When mucus is present, it has usually been swallowed, and floats upon the surface of the contents, and can easily

be separated; differing in this respect from that observed in pathological conditions as will be noted later.

On microscopic examination, the normal residuum presents cell nuclei in larger or smaller numbers, either free or arranged in clumps produced by the action of the digestive fluids upon the epithelial cells. In addition, normal epithelial cells are noted, which are derived from the mouth, respiratory tract, or the stomach itself. In cases of duodenal regurgitation round or cubical cells may frequently be observed and occasionally bile-stained columnar epithelium derived from the biliary tract may be seen. Leucocytes in small numbers are always seen in the fasting contents, but when present in large numbers they indicate disease. A frequent finding is the presence of the spiral cells first described by Jaworski, which are actually produced by the precipitation of mucin by the hydrochloric acid of the gastric secretion. Bacteria of various types always occur in the fasting secretion, but are only found singly or grouped in small masses. Gross or microscopic food residues in the form of meat or vegetable fibers are never noted under normal condition.

In our study of the residuum of various digestive disturbances the fasting contents were examined in 50 cases in which 2 were cases of chronic gastritis, 8 of cancer of the stomach, 10 of ulcer of the stomach and duodenum, 12 of achylia gastrica, 4 of dilatation with pyloric stenosis, 5 of gastric neuroses including hypersecretion, 4 of chronic cholecystitis, 2 of secondary gastric disturbances due to pulmonary tuberculosis, and 3 of enteroptosis.

TABLE 3

CASE NUMBER	DIAGNOSIS	VOLUME OF RESIDUUM cc.	ACIDITY OF RESIDUUM		FRACTIONAL ANALYSIS AFTER TEST MEAL					
			Free HCl	Total acidity	15 minutes		30 minutes		1 hour	
					Free HCl	Total acidity	Free HCl	Total acidity	Free HCl	Total acidity
1	Chronic gastritis.....	38	0	20	0	18	0	24	0	28
2	Cancer.....	85	0	12	0	14	8	26	12	22
3	Dilatation (pyloric stenosis).....	525	20	32	12	46	42	52	40	48
4	Achylia gastrica.....	25	0	6	0	8	0	14	0	12
5	Enteroptosis.....	130	18	24	6	12	28	36	24	38
6	Ulcer.....	100	46	62	26	38	32	54	58	74
7	Neurosis.....	40	28	54	24	36	30	48	54	62
8	Achylia gastrica.....	20	0	8	0	10	0	16	0	14
9	Cancer.....	120	4	18	12	26	22	34	20	52
10	Enteroptosis.....	85	0	20	0	18	20	42	18	48
11	Achylia gastrica.....	15	0	6	0	12	0	16	0	10
12	Dilatation (pyloric stenosis).....	610	26	48	34	42	56	62	50	74
13	Neurosis (hypersecretion).....	195	54	68	42	58	64	78	66	72
14	Ulcer.....	115	22	38	24	32	30	38	32	46
15	Chronic cholecystitis.....	85	12	20	18	22	26	34	28	30
16	Achylia gastrica.....	25	0	8	0	10	0	8	0	10
17	Secondary gastritis to pulmonary tuberculosis.....	90	0	16	12	26	18	32	14	30
18	Cancer.....	315	6	18	8	12	16	22	12	20
19	Chronic cholecystitis.....	100	0	22	14	32	26	48	28	42
20	Achylia gastrica.....	35	0	6	0	8	0	10	0	8
21	Secondary gastritis to pulmonary tuberculosis.....	110	0	22	0	20	12	28	10	24
22	Ulcer.....	125	34	48	22	52	38	48	54	68
23	Chronic cholecystitis.....	115	22	56	28	50	32	54	36	50
24	Achylia gastrica.....	25	0	12	0	10	0	14	0	12
25	Chronic gastritis.....	45	0	24	0	38	0	42	0	40
26	Cancer.....	235	0	34	0	26	0	48	0	30
27	Dilatation (pyloric stenosis).....	420	52	64	44	60	66	82	72	88
28	Ulcer.....	100	20	36	32	40	32	62	38	50
29	Achylia gastrica.....	40	0	12	0	10	0	10	0	8
30	Ulcer.....	130	42	56	52	62	54	76	58	70
31	Neurosis.....	155	26	32	32	40	22	34	28	26
32	Chronic cholecystitis.....	110	0	26	0	34	0	42	0	30
33	Achylia gastrica.....	20	0	10	0	18	0	40	0	14
34	Cancer.....	245	0	42	0	32	0	58	0	64
35	Neurosis.....	45	24	36	18	28	20	32	24	32
36	Cancer.....	95	10	40	0	32	0	20	0	46
37	Achylia gastrica.....	15	0	6	0	12	0	18	0	16
38	Ulcer.....	125	18	28	28	34	36	46	32	54
39	Dilatation (pyloric stenosis).....	380	46	52	38	42	62	75	78	84
40	Enteroptosis.....	195	10	32	18	22	24	42	26	38

TABLE 3—Continued

CASE NUMBER	DIAGNOSIS	VOLUME OF RESIDUUM cc.	ACIDITY OF RESIDUUM		FRACTIONAL ANALYSIS AFTER TEST MEAL					
			Free HCl	Total acidity	15 minutes		30 minutes		1 hour	
					Free HCl	Total acidity	Free HCl	Total acidity	Free HCl	Total acidity
41	Ulcer.....	145	32	48	26	38	54	72	46	58
42	Achylia gastrica.....	25	0	10	0	10	0	12	0	12
43	Neurosis (hypersecretion).....	185	46	58	44	52	56	82	64	76
44	Ulcer.....	180	28	34	22	38	46	54	58	66
45	Cancer.....	80	0	52	0	42	12	56	18	50
46	Achylia gastrica.....	30	0	10	0	10	0	16	0	18
47	Ulcer.....	130	38	48	34	42	58	62	50	66
48	Ulcer.....	115	42	56	28	32	22	30	46	54
49	Cancer.....	110	8	24	0	12	10	26	14	34
50	Achylia gastrica.....	20	0	6	0	18	0	16	0	12

Table 3 presents the volume and acidity of the residuum, as well as fractional analyses of the gastric contents in the 50 patients affected with various forms of digestive disturbances.

CASES OF CHRONIC GASTRITIS

Table 4 presents our cases of chronic gastritis in which the residuum was obtained both by the Rehfuß and ordinary stomach tubes.

It will be noted that the volume of gastric residuum obtained is 3 or 4 times as great when obtained by means of the Rehfuß tube as when obtained with the ordinary stomach tube, and yet, on the other hand, these figures are not in excess of the normal values when obtained by either method.

There is usually present in chronic gastritis therefore a fairly normal motility. The gastric residuum contains a large quantity of mucus of two varieties; the part swallowed floating upon the surface and easily separated

TABLE 4
Cases of chronic gastritis

CASE NUMBER	VOLUME OF RESIDUUM		ACIDITY OF RESIDUUM	
	Rehfuß tube	Ewald tube	Free HCl	Total acidity
	cc.	cc.		
1	38	15	0	20
25	45	10	0	24
Average.....	41	12	0	22
Maximum.....	45	15	0	24
Minimum.....	38	10	0	20

from the remaining contents, while in addition to this, there is considerable mucus of a gelatinous and ropy type thoroughly intermingled with the contents. The secretion may be colorless or tinged green or yellow with bile. Microscopically, leucocytes and epithelial cells (often degenerated) are found in fair numbers frequently clumped together or occurring singly, in addition to buccal epithelium, salivary corpuscles and detritus containing bacteria.

TABLE 5
Cases of cancer

CASE NUMBER	VOLUME OF RESIDUUM		ACIDITY OF RESIDUUM	
	Rehfuss tube	Ewald tube	Free HCl	Total acidity
	cc.	cc.		
2	85	15	0	12
9	120	35	4	18
18	315	150	6	18
26	235	165	0	34
34	245	110	0	42
36	95	20	10	40
45	80	15	0	52
49	110	35	8	24
Average.....	160	68	2	30
Maximum.....	315	165	10	52
Minimum.....	80	15	0	12

CASES OF CANCER

The findings in the cases of carcinoma varied according to whether pyloric obstruction existed or not. In cases 18, 26, and 34, well marked stenosis was present, and in these the volume of contents obtained by means of the Ewald tube was about one-half of that obtained by means of the Rehfuss tube. On the other hand, in the non-obstructive cases the quantity of contents obtained with the Rehfuss tube was 3 to 4 times the quantity obtained with the Ewald tube. In 4 of the 8 cases, free HCl was still present; and in the remaining 4 in which it was absent, lactic acid was found. The color of the gastric residuum is usually brown, or coffee ground in appearance and in the obstructive cases many undigested meat fibers and other food particles are noted. Microscopically, undigested muscle and vegetable fibers, starch granules, fat drops, red blood cells, pus cells and bacteria are seen, and in those cases

accompanied by an absence of free HCl the Oppler-Boas bacilli were observed; while in the obstructive cases with free HCl sarcinae and yeast cells are usually found.

TABLE 6
Cases of ulcer

CASE NUMBER	VOLUME OF RESIDUUM		ACIDITY OF RESIDUUM	
	Rehfuss tube	Ewald tube	Free HCl	Total acidity
	cc.	cc.		
6	100	35	46	62
14	115	40	22	38
22	125	45	34	48
28	100	40	20	36
30	130	55	42	56
38	125	42	18	28
41	145	68	32	48
44	180	34	28	34
47	130	64	38	48
48	115	40	42	56
Average.....	126	46	32	45
Maximum.....	180	68	42	62
Minimum.....	100	34	18	28

CASES OF ULCER

In the 10 cases of ulceration presented in table 6 there was no evidence of pyloric stenosis, and yet the volume of the residuum was about twice that ordinarily noted in normal cases. This is due largely to the hypersecretion of gastric juice so commonly observed in this affection. The quantity of contents obtained with the Rehfuss tube is two or three times as great as that secured through the Ewald tube. It is usually cloudy in appearance, has an extremely acid odor, and is free of food remnants. Microscopically, it contained buccal epithelial cells often partly digested, nuclear remains of digested gastric epithelial cells, and of

leucocytes as well as mucus spirals. At times red blood corpuscles are noted.

CASES OF ACHYLIA GASTRICA

In the cases of achylia gastrica the volume of residuum obtained with the Rehfuß tube is usually 3 or 4 times that secured with the Ewald tube; in 4 instances there was no secretion whatever to be obtained through the ordinary stomach tube. In this affection one usually notes but a very small quantity of contents revealing a slight evidence of fermentation. It has but little odor, and contains but a slight quantity of mucus. Microscopically, an excessive number of gastric epithelial cells, (often degenerated), and many buccal epithelial cells, leucocytes with swelling of the protoplasm, and bacteria are noted; however, comparatively few nuclei are observed in this affection.

TABLE 7
Cases of achylia gastrica

CASE NUMBER	VOLUME OF RESIDUUM		ACIDITY OF RESIDUUM	
	Rehfuss tube	Ewald tube	Free HCl	Total acidity
	cc.	cc.		
4	25	6	0	6
8	20	0	0	8
11	15	5	0	6
16	25	0	0	8
20	35	8	0	6
24	25	5	0	12
29	40	0	0	12
33	20	5	0	10
37	15	0	0	6
42	25	8	0	10
46	30	6	0	10
50	20	0	0	6
Average.....	24	3.5	0	8
Maximum.....	40	8	0	12
Minimum.....	15	0	0	6

CASES OF GASTRIC DILATATION

In the 4 cases of pyloric stenosis of non-malignant origin the volume of contents obtained by means of the Rehfuß tube was somewhat in excess of that secured by means of the Ewald tube. In all there was a retention of food residue from the day previous, and free HCl was constantly present.

The odor was sour and pungent, and occasionally an admixture of bile was noted and the well known three-layered contents were produced on standing.

Microscopically, muscle fibers are observed in small amounts, as well as many starch remnants, bacteria, yeast cells and sarcinae.

TABLE 8
Cases of gastric dilatation

CASE NUMBER	VOLUME OF RESIDUUM		ACIDITY OF RESIDUUM	
	Rehfuss tube	Ewald tube	Free HCl	Total acidity
	cc.	cc.		
3	525	320	20	32
12	610	354	26	48
27	420	268	52	64
39	380	242	46	52
Average.....	483	271	36	40
Maximum.....	610	320	52	64
Minimum.....	380	242	20	32

CASES OF GASTRIC NEUROSES

Among the cases of gastric neuroses there were 3 of hypersecretion. In these the volume of the residuum was far greater than is noted under normal conditions, due to the excessive gastric secretion. The fluid is watery and usually clear, though it may be cloudy or yellowish green from the admixture of bile. Microscopically,

numerous nuclei of epithelial cells, both buccal and gastric, mucus spirals and clumps of bacteria are observed. However, neither sarcinae, yeast cells nor food remnants can be detected.

In the residuum obtained from the 2 remaining cases of gastric neuroses, the findings were identical with those observed under normal conditions.

CASES OF CHRONIC CHOLECYSTITIS

In the cases of chronic cholecystitis, the volume of residuum obtained with the Rehfuss tube was in excess of that ordinarily noted under normal conditions, with the exception of 1 case; while with the Ewald tube the quantities secured were perfectly normal in amount. The characteristics of the fasting contents differed but little from that observed normally both microscopically and macroscopically.

CASES OF SECONDARY GASTRIC DISTURBANCES

The cases of secondary gastric disturbances included 2 due to pulmonary tuberculosis. In one instance the volume of residuum was normal; in the other, slightly greater than normal. The quantity of residuum secured with the Rehfuss tube was from four to six times as great as that secured with the Ewald tube. The contents was cloudy, and contained a considerable amount of mucus. Microscopically, there was present an excessive number of degenerated gastric epithelial cells, many buccal epithelial cells, leucocytes and bacteria.

CASES OF ENTEROPTOSIS

Of the 3 cases of enteroptosis 2 presented a perfectly normal volume of

TABLE 9
Cases of gastric neuroses

CASE NUMBER	VOLUME OF RESIDUUM		ACIDITY OF RESIDUUM	
	Rehfuss tube	Ewald tube	Free HCl	Total acidity
	cc.	cc.		
7	40	15	28	54
13	195	55	54	68*
31	155	64	26	32*
35	45	18	24	36
43	185	72	46	58*
Average.....	124	44	35	49
Maximum.....	195	72	54	68
Minimum.....	40	15	28	32

*Hypersecretion.

TABLE 10
Cases of chronic cholecystitis

CASE NUMBER	VOLUME OF RESIDUUM		ACIDITY OF RESIDUUM	
	Rehfuss tube	Ewald tube	Free HCl	Total acidity
	cc.	cc.		
15	85	20	12	20
19	100	15	0	22
23	115	40	28	56
32	110	20	0	26
Average.....	102	20	8	31
Maximum.....	115	40	20	36
Minimum.....	85	15	0	20

TABLE 11
Cases of secondary gastric disturbances

CASE NUMBER	VOLUME OF RESIDUUM		ACIDITY OF RESIDUUM	
	Rehfuss tube	Ewald tube	Free HCl	Total acidity
	cc.	cc.		
17	90	15	0	16
21	110	28	8	22
Average.....	100	21	4	19
Maximum.....	110	28	8	22
Minimum.....	90	15	0	16

TABLE 12
Cases of enteroptosis

CASE NUMBER	VOLUME OF RESIDUUM		ACIDITY OF RESIDUUM	
	Reh fuss tube	Ewald tube	Free HCl	Total acidity
	cc.	cc.		
5	130	35	18	24
10	85	10	0	20
40	95	25	10	32
Average.....	103	23	9	25
Maximum.....	130	35	18	32
Minimum.....	85	10	0	20

residuum; in the third, the fasting contents was somewhat increased in quantity. The amount of residuum obtained through the Reh fuss tube was far in excess of that removed by means of the ordinary stomach tube.

Microscopically, the residuum in this condition presented perfectly normal findings.

CONCLUSIONS

From a study of the gastric residuum in normal as well as in pathological conditions, the following conclusions may be drawn:

1. The examination of the gastric residuum is an extremely important method of examination from which

valuable information regarding the functions of the stomach may be obtained.

2. Only a fraction of the fasting contents can be obtained by means of the ordinary stomach tube, in fact, the quantity secured in this way may represent but one-quarter to one-half of the entire fasting secretion of the stomach. It is therefore important, when exact information regarding the volume of the residuum is desired, that the Reh fuss tube should be used in preference to the Ewald tube.

Ordinarily, however, the volume of the residuum secured by means of the Ewald tube is relatively constant, so that the results obtained in this manner may be assumed to be sufficiently accurate for clinical purposes.

3. The microscopic examination of the fasting contents is by far more important than the estimation of the volume secured. The secretion can usually be as well obtained for this purpose by means of the Ewald tube as with the Reh fuss tube.

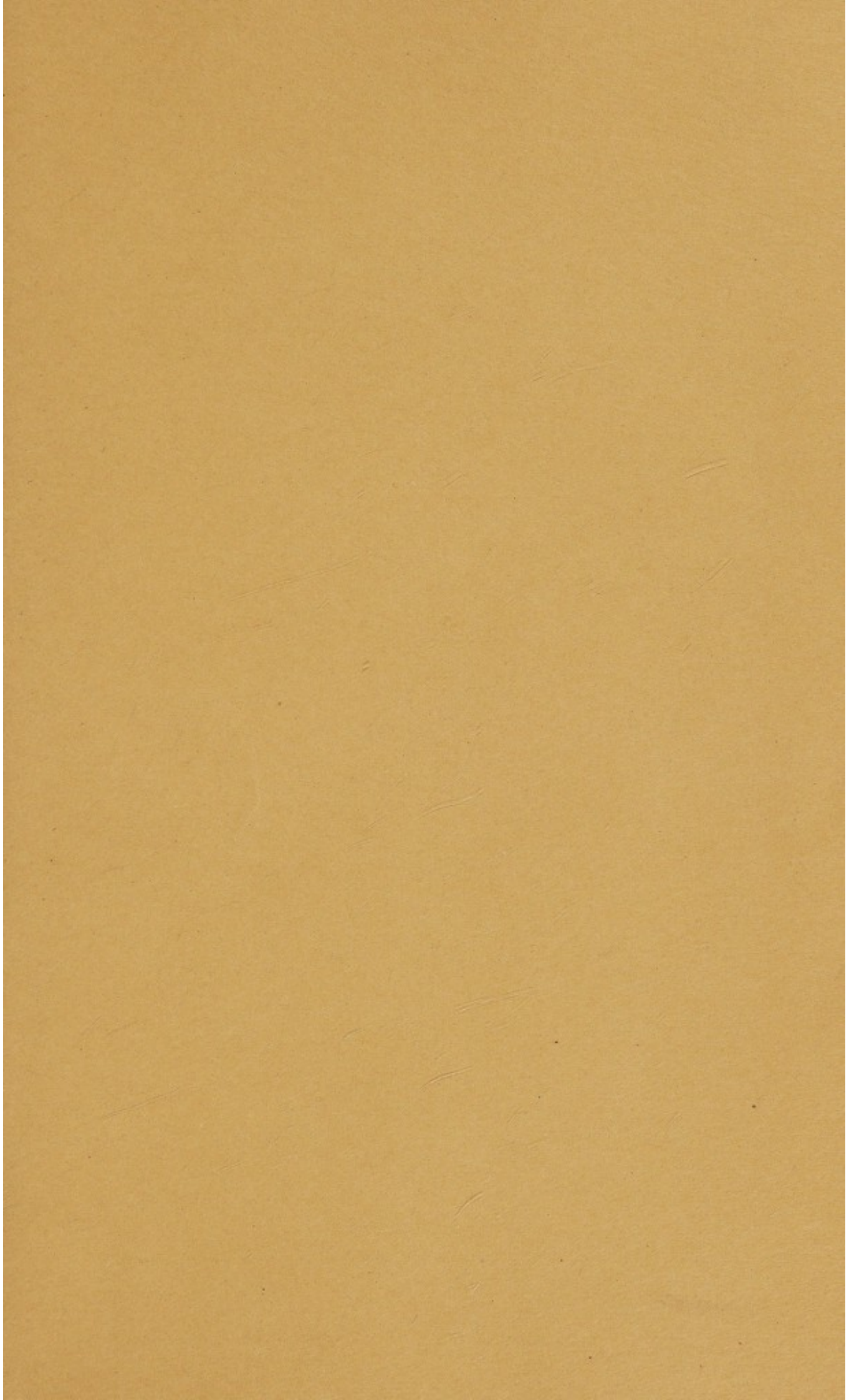
We desire to acknowledge our thanks to Dr. Julius Friedenwald through whose advice and under whose direction this work was conducted.

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The first part of the report deals with the general situation of the country and the progress of the work done during the year. It is found that the country is generally well governed and that the people are happy and contented. The progress of the work done during the year is also satisfactory. The second part of the report deals with the details of the work done during the year. It is found that the work done during the year is of a high quality and that the people are well satisfied with the results. The third part of the report deals with the financial statement of the year. It is found that the financial statement is in a sound and healthy condition and that the people are well satisfied with the results.

Particulars		1911-12	1910-11
Revenue		1,00,00,000	95,00,000
Expenses		80,00,000	75,00,000
Surplus		20,00,000	20,00,000
Debt		1,00,00,000	1,00,00,000
Assets		1,00,00,000	1,00,00,000
Liabilities		1,00,00,000	1,00,00,000
Reserves		1,00,00,000	1,00,00,000
Income		1,00,00,000	1,00,00,000
Expenditure		1,00,00,000	1,00,00,000
Balance		1,00,00,000	1,00,00,000



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