SOME OBSERVATIONS ON THE CYTOLOGY AND CHEMISTRY OF OVINE BLOOD IN HEALTH AND DISEASE

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Chemistry

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THESIS

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by
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1 9 3 7

CONTENTS

SOME OBSERVATIONS ON THE CYTOLOGY AND CHEMISTRY OF OVINE BLOOD IN HEALTH AND DISEASE.

Human medical literature contains an enormous number of records of cytological and chemical studies on blood in health and disease. Much apparently has been added to information needed to properly diagnose and treat disease conditions. These two fields have been much neglected in animal work. Some values have been set down in text books, but many of these apparently represent work on small numbers of animals. The purpose of the following study has been to establish normal values in blood cytology and chemistry of sheep blood and to determine what changes present themselves in various pathological processes.

BLOOD CYTOLOGY

In this phase of the work some difficulties were experienced in the matters of procuring blood and making satisfactory blood smears. An attempt was made to use the ear veins of the animal. Blood could be obtained in this way, but the procedure was very unsatisfactory as it was difficult to keep the animal properly restrained. Blood was also being drawn from the jugular vein for use in chemical determinations, and the belief arose that this might be used for cytological study as well.

Blood is quite readily obtained from the jugular vein. The wool is clipped from a small area over either jugular

groove, and the area is swabbed with alcohol. Pressure over the lower part of the jugular groove distends the vein so that it may be seen or may be located by tapping above the point of pressure. A hypodermic needle may then be inserted. A 16 gauge hypodermic needle was found suitable for this purpose. The blood was collected in test tubes containing potassium oxalate and graduated for 15 cc of blood.

In order to facilitate handling of the oxalate, the following procedure was adopted. 3.0 gms. of potassium oxalate was weighed and dissolved in distilled water in a 50 cc volumetric flask. 0.5 cc of this solution (containing 30 mgms. of oxalate) was placed in each test tube, the total amount being sufficient for 100 tubes. The tubes were then placed in a drying oven at 60 to 70 degrees Centigrade. When dried, they were stoppered and set aside for future use.

To establish the dependability of using oxalated whole blood for cytological study, a large number of determinations were made using both types of blood. The results checked very well in all cases. Soon after completing this comparison it was found that Osgood and Haskins (1) highly recommended the use of oxalated blood in human hematology.

HEMOGLOBIN

For the determination of hemoglobin the Sahli method was selected. The accuracy of this method has been well determined by Alt (2) in a comparison of iron determina-

tions with the Newcomer, Sahli, and Dare methods on 35 cases. The Sahli method appeared to be the most accurate.

The procedure is as follows. Approximately N/10 hydrochloric acid is placed in the Sahli tube, the amount depending on the appearance of the blood. For normal blood the tube may be filled to the 8 gm. mark. Less than this must be used for anemic bloods. Oxalated blood is drawn into the special pipette to the 20 cmm. mark, the end is wiped with cheese cloth, and the blood is slowly blown into the tube containing the hydrochloric acid. The pipette is rinsed by drawing the acid into it 2 or 3 times. After mixing its contents, the tube is placed in a water bath at 55 to 60 degrees C. for 7 minutes to complete formation of acid hematin. The tube is then placed in the Sahli instrument between two standard prisms, and N/10 hydrochloric acid is added, stirring after each addition, until the colors match. The hemoglobin value is then read directly in both grams per 100 cc. and percentage.

To determine normal values, several animals were used. Blood samples were taken at various periods over a considerable length of time, and the results are presented in Tables 1 and 2 and Charts 1, 2, 3, 4, and 5.

Case 58 was a female, born May 6, 1932 and raised on a bottle. On August 2, 1932 she was severely injured by a dog, but made a good recovery. Blood studies were started October 10, 1932 at 5 months of age, and continued until after the termination of pregnancy April 21, 1934. She was sold to a farmer May 26, 1934. 65 hemoglobin readings on the animal showed values ranging from 10.2 to 15.2 gms,

averaging 12.5 gms per 100 cc of blood. Considering 14.5 gms per cent as 100 per cent, the values ranged from 70 to 106, averaging 86.37 per cent.

Case 60 was a lamb born in March, 1932, purchased from a farmer. Blood studies were started October 10, 1932, at the age of about 6 months. 61 determinations were made up to May 26, 1934, when she was sold. She lambed March 14, 1934. In terms of grams per cent her hemoglobin values ranged from 10.4 to 15.9 grams, averaging 12.33 grams per cent. In terms of percent the values ranged from 72 to 109, averaging 85 per cent.

Case 61 was obtained from the same source as case 60. She lambed April 21, 1934 and was killed for meat May 26, 1934. Blood studies were started October 11, 1932 at about 6 months of age. In terms of grams per cent, 60 hemoglobin values ranged from 10.4 to 16.2, averaging 13.3 grams per cent. In terms of per cent the values ranged from 72 to 112, averaging 91.9 per cent.

Case 62 was obtained from the same source as case 60. She lambed March 27, 1934, and was sold to a farmer May 26, 1934. Blood studies were started October 12, 1932, at about 6 months of age. In terms of grams per cent, 60 hemoglobin values ranged from 10.6 to 15.4, averaging 12.6 grams per cent. In terms of per cent, values ranged from 74 to 105 , averaging 86.2 per cent.

Case 63 was obtained from the same source as case 60. She lambed on April 16, 1934 with some difficulty, and had caked udder of mild degree. She was sold May 26, 1934. Blood

studies were started October 13, 1932 at about 6 months of age. In terms of grams per cent, 59 hemoglobin values ranged from 10.6 to 15.3, averaging 12.9 grams per cent. In terms of per cent, values ranged from 73 to 108, averaging 89 per cent.

Case 64 was one of twin females from case 62, born March 27, 1934. She did well from the time of birth. Blood studies were started on June 1, 1934. In terms of grams per cent, 15 hemoglobin values ranged from 12.4 to 15 grams per cent, averaging 13.8 grams per cent. In terms of per cent, values ranged from 84 to 104, averaging 95 per cent.

Case 65 was the twin of case 64, and also did well from the time of birth. Blood studies were started on May 25, 1934. In terms of grams per cent, 14 hemoglobin values ranged from 12.4 to 14.2 grams per cent, averaging 13.25 grams per cent. In terms of per cent, values ranged from 86 to 98, averaging 91.7 per cent.

Case 66 was a female lamb from case 60, born March 15, 1934. She had some diarrhea for 3 or 4 days, but did well from then on. Blood studies were started on May 17, 1934. In terms of grams per cent, 15 hemoglobin values ranged from 11.0 to 13.2 grams per cent, averaging 12.3 grams per cent. In terms of per cent, values ranged from 76 to 92, averaging 85 per cent.

Case 67 was a male lamb from case 63, born April 16, 1934. He was a large lamb and did well from the time of birth. Blood studies were started June 6, 1934. In terms of grams per cent, 14 hemoglobin values ranged from 11.2 to

to 13.2 grams per cent. In terms of per cent, values ranged from 78 to 92 per cent, averaging 87 per cent.

Case 68 was a male lamb from case 61, born April 4, 1934. The lamb was very small at birth, but was active and did well. Blood studies were started June 5, 1934. In terms of grams per cent, 15 hemoglobin values ranged from 11.6 to 15.8 grams per cent, averaging 12.9 grams per cent. In terms of per cent, values ranged from 80 to 108, averaging 88.7 per cent.

Case 69 was a male lamb from case 58, born April 21, 1934. He did well from the time of birth. Blood studies were started May 25, 1934. In terms of grams per cent, 17 hemoglobin values ranged from 10.6 to 14.2 grams per cent. In terms of per cent, values ranged from 74 to 97 per cent, averaging 84.4 per cent.

Case 31 was a female lamb about 5 months of age, one of four lambs which were showing evidence of sunstroke, obtained for observation October 15, 1933. Symptoms disappeared, and it was considered permissible to include her with the normal animals. Blood studies were started October 27, 1933. In terms of grams per cent, 39 hemoglobin values ranged from 10.2 to 14.3 grams per cent, averaging 12.82 grams per cent. In terms of per cent, values ranged from 70 to 99, averaging 88.48 per cent.

The twelve animals above show hemoglobin values ranging from 10.2 to 16.2 grams per cent or 70 to 112 per cent, these representing a total of 434 samples taken at various ages up to two years of age. The average from these animals is estimated at 12.76 grams per cent and 87.97 per cent.

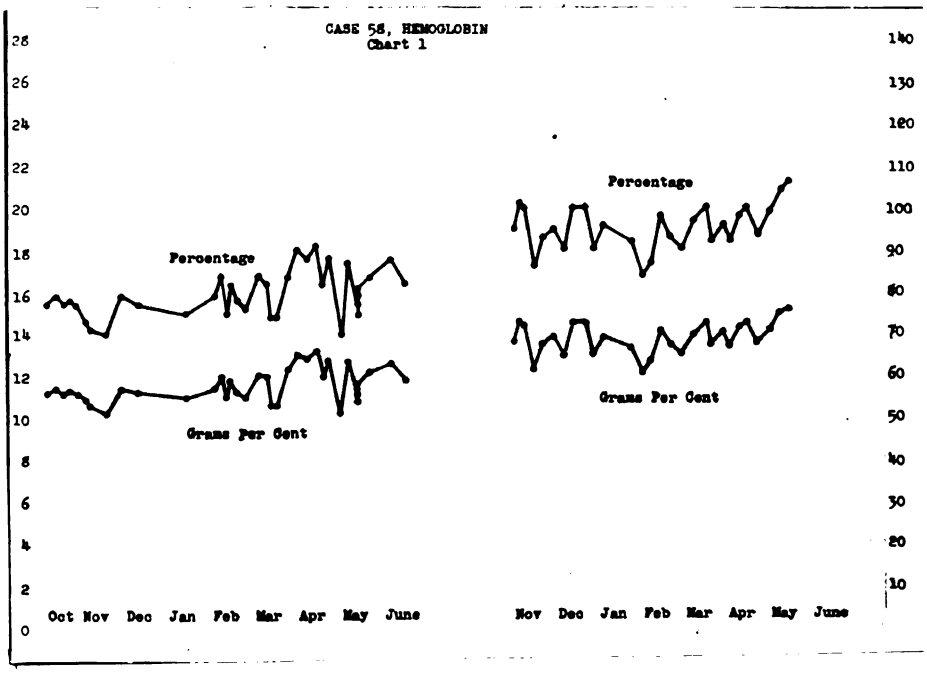
HEMOGLOBIN---GRAMS PER CENT

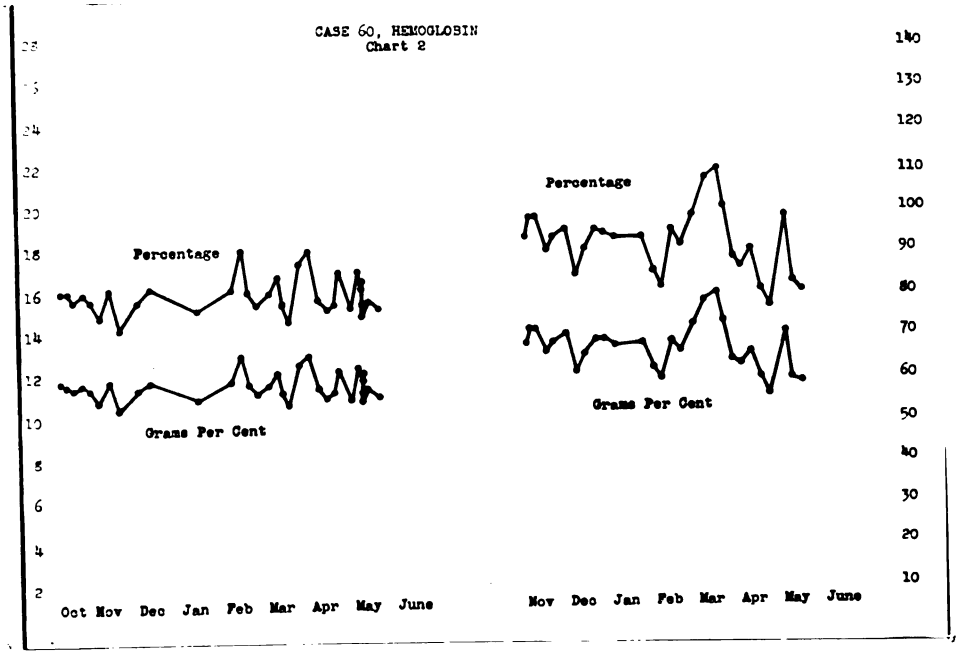
Table 1.

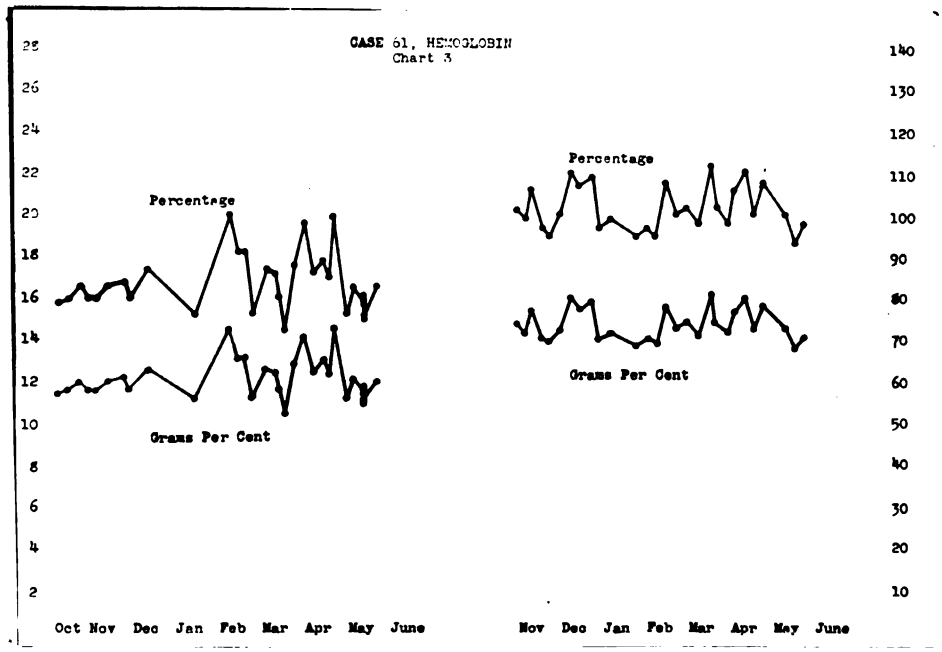
Case	No.Readings	Low Reading	High Reading	Average Reading
58	65	10.2	15.2	12.5
60	61	10.4	15.9	12.33
61	60	10.4	16.2	13.3
62	60	10.6	15.4	12.6
63	59	10.6	15.3	12.9
64	15	12.4	15.0	13.8
65	14	12.4	14.2	13.25
66	15	11.0	13.2	12.3
67	14	11.2	13.2	12.6
68	15	11.6	15.8	12.9
69	17	10.6	14.2	12.27
31	39	10.2	14.3	12.82

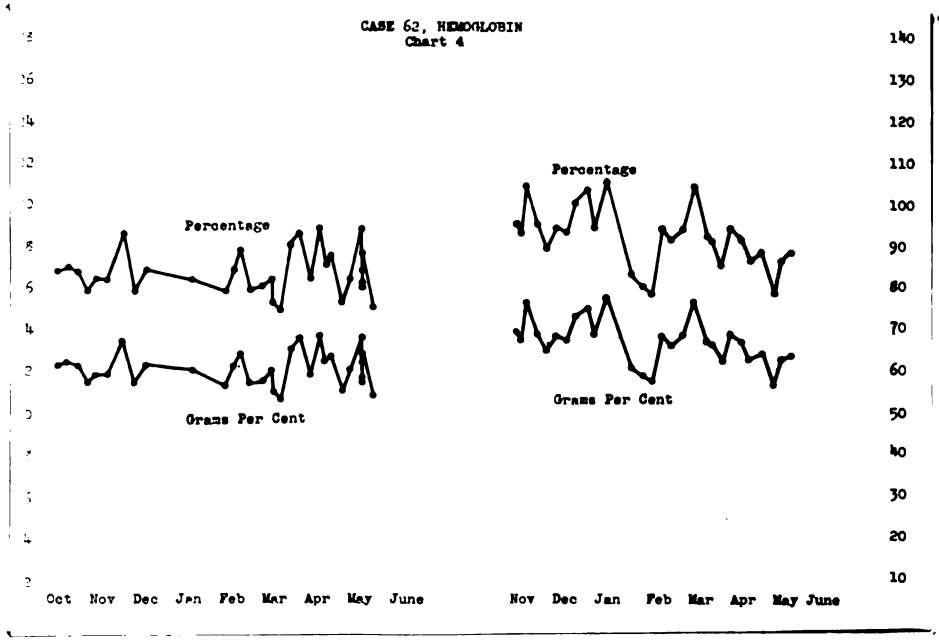
HEMOGLOBIN---PER CENT
Table 2.

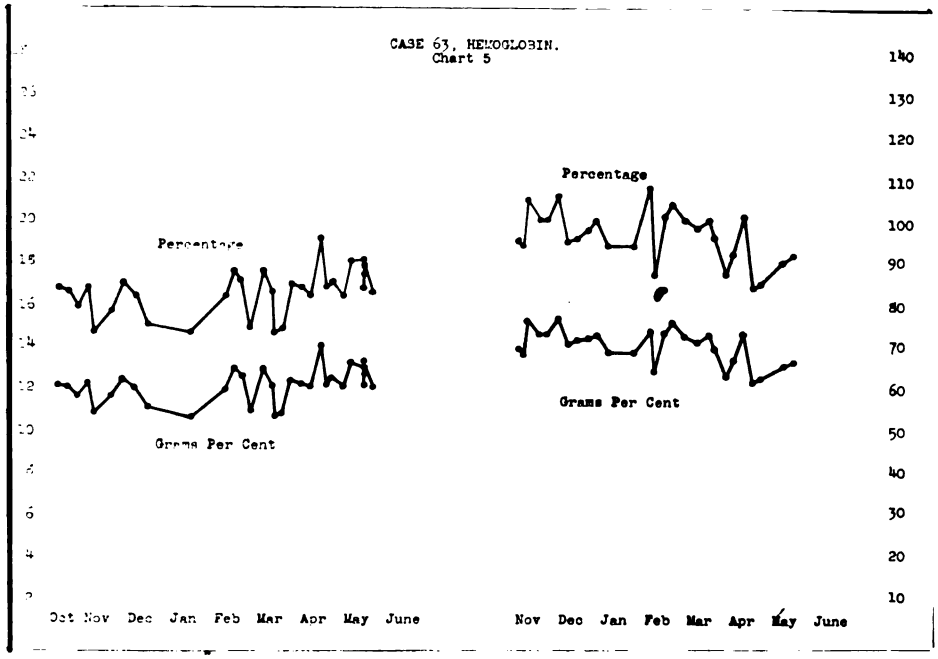
Case	No.Readings	Low Reading	High Reading	Average Reading
58	65	70	106	86.37
60	61	72	109	85.0
61	60	72	112	91.9
62	60	74	105	86.2
63	59	73	108	89.0
64	15	84	104	95.0
65	14	86	98	91.7
66	15	76	92	85.0
67	14	78	92	87.0
68	15	80	108	88.7
69	17	74	97	84.4
31	39	70	99	88.48


CASE 58, HEMOGLOBIN
Chart 1
Percentage
Grams Per Cent
Percentage
Grams Per Cent
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June


CASE 60, HEMOGLOBIN
Chart 2
Percentage
Grams Per Cent
Percentage
Grams Per Cent
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June


CASE 61, HEMOGLOBIN
Chart 3
Percentage
Grams Per Cent
Percentage
Grams Per Cent
28
26
24
22
20
18
16
14
12
10
8
6
4
2
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June


CASE 62, HEMOGLOBIN
Chart 4
Percentage
Grams Per Cent
Percentage
Grams Per Cent
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June


CASE 63, HEMOGLOBIN.
Chart 5
Percentage
Grams Per Cent
Percentage
Grams Per Cent
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June
140
130
120
110
100
90
80
70
60
50
40
30
20
10

RED BLOOD CELLS

In making red cell counts, the following procedure was adopted. Oxalated blood was drawn up to the .5 mark on the red cell pipette and diluted to the 101 mark with Toisson's fluid made up according to the method of Osgood and Haskins (1). Cells were counted in 80 squares of the counting chamber. The results are presented in Table 3 and Charts 6, 7, 8, 9 and 10.

65 counts on case 58 ranged from 8,000,000 to 11,920,000 per cmm., averaging 9,341,000 per cmm.

61 counts on case 60 ranged from 8,230,000 to 12,800,000 per cmm., averaging 10,573,114 per cmm.

60 counts on case 61 ranged from 7,200,000 to 13,920,000 per cmm., averaging 10,382,100 per cmm.

60 counts on case 62 ranged from 7,300,000 to 12,840,000 per cmm., averaging 10,156,900 per cmm.

59 counts on case 63 ranged from 8,000,000 to 13,400,000 per cmm., averaging 10,774,100 per cmm.

15 counts on case 64 ranged from 9,890,000 to 12,520,000 per cmm., averaging 11,326,000 per cmm.

14 counts on case 65 ranged from 9,520,000 to 13,100,000 per cmm., averaging 11,085,715 per cmm.

15 counts on case 66 ranged from 9,500,000 to 12,400,000 per cmm., averaging 10,732,000 per cmm.

14 counts on case 67 ranged from 8,360,000 to 12,850,000 per cmm., averaging 10,562,857 per cmm.

15 counts on case 68 ranged from 9,350,000 to 13,200,000 per cmm., averaging 11,273,600 per cmm.

17 counts on case 69 ranged from 8,380,000 to 12,900,000 per cmm., averaging 10,184,117 per cmm.

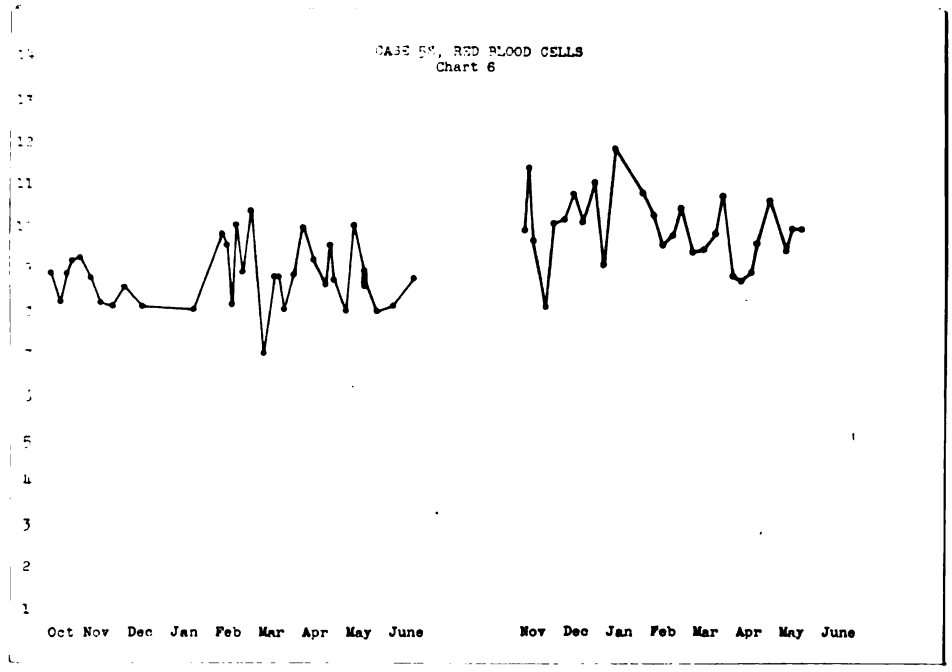
39 counts on case 31 ranged from 8,520,000 to 13,260,000 per cmm., averaging 10,797,436 per cmm.

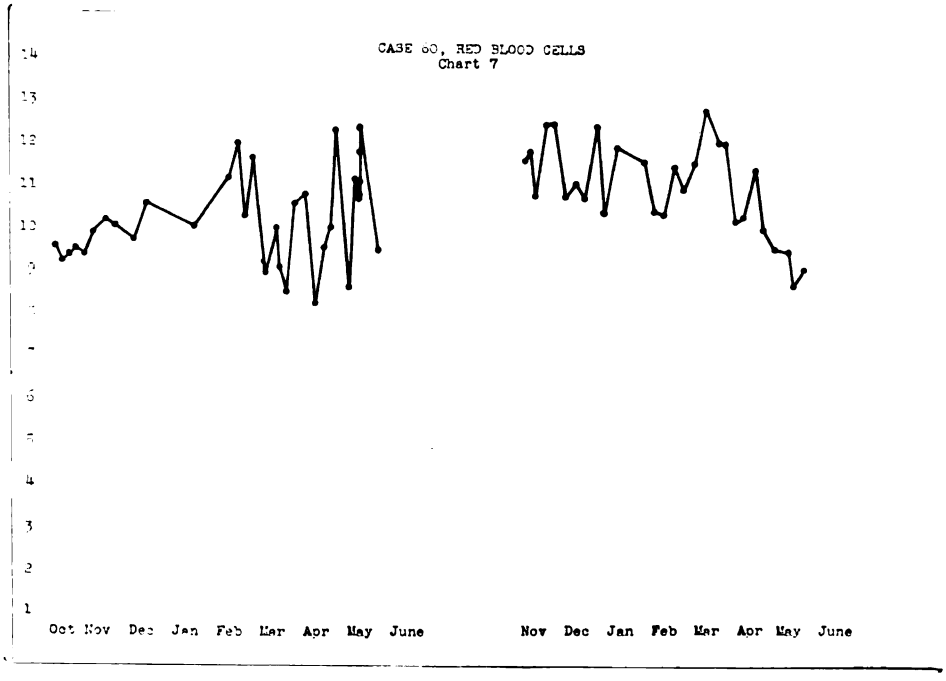
The 434 samples listed above range from 7,200,000 to 13,920,000 per cmm., the estimated average being 10,429,977 per cmm.

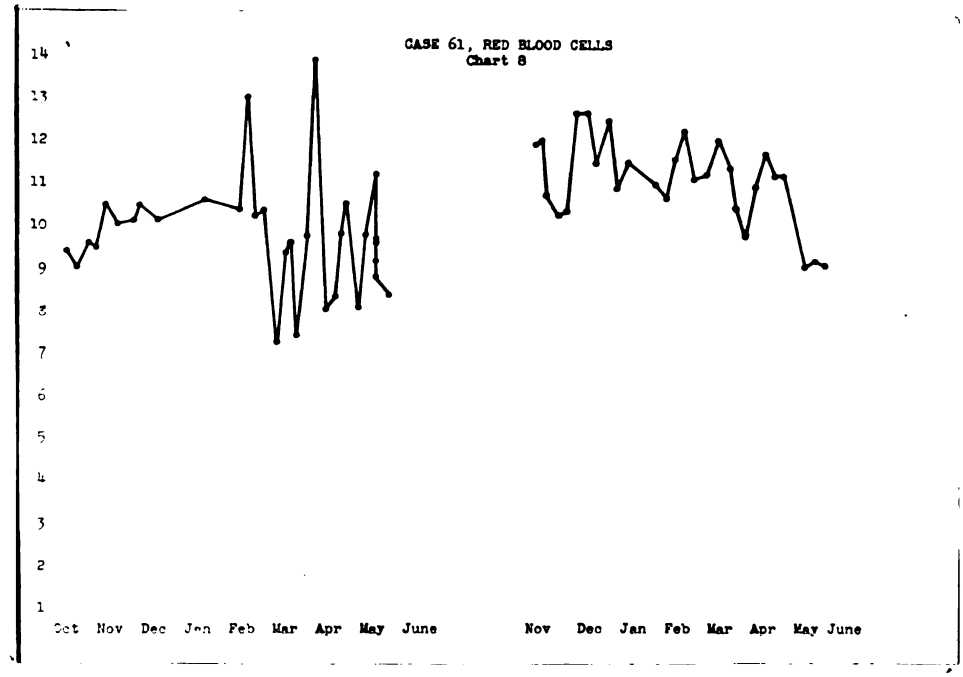
RED BLOOD CELLS PER C.M.

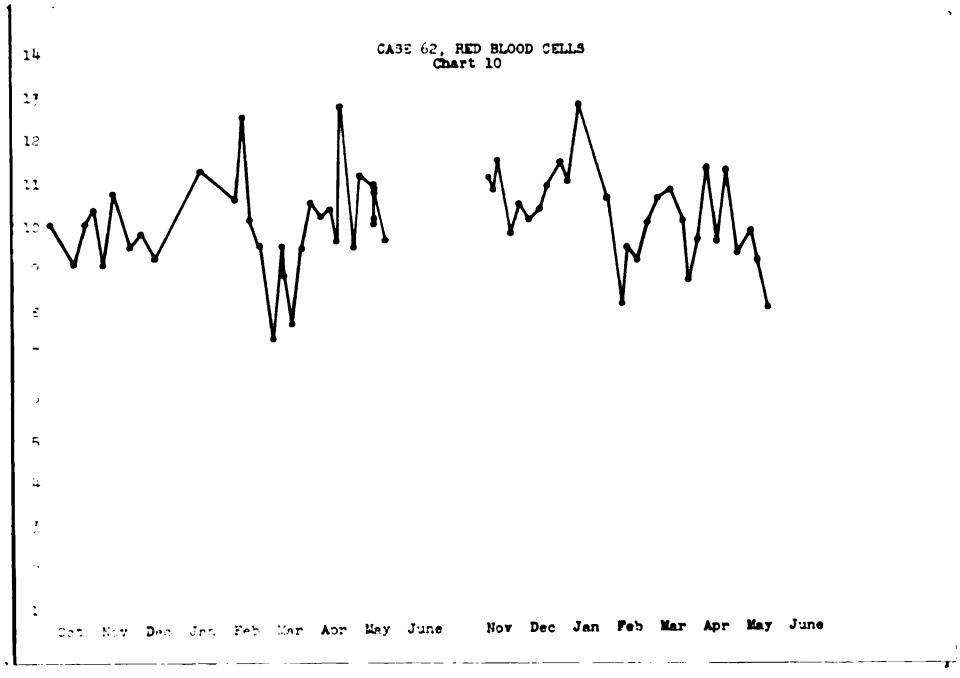
Table 3.

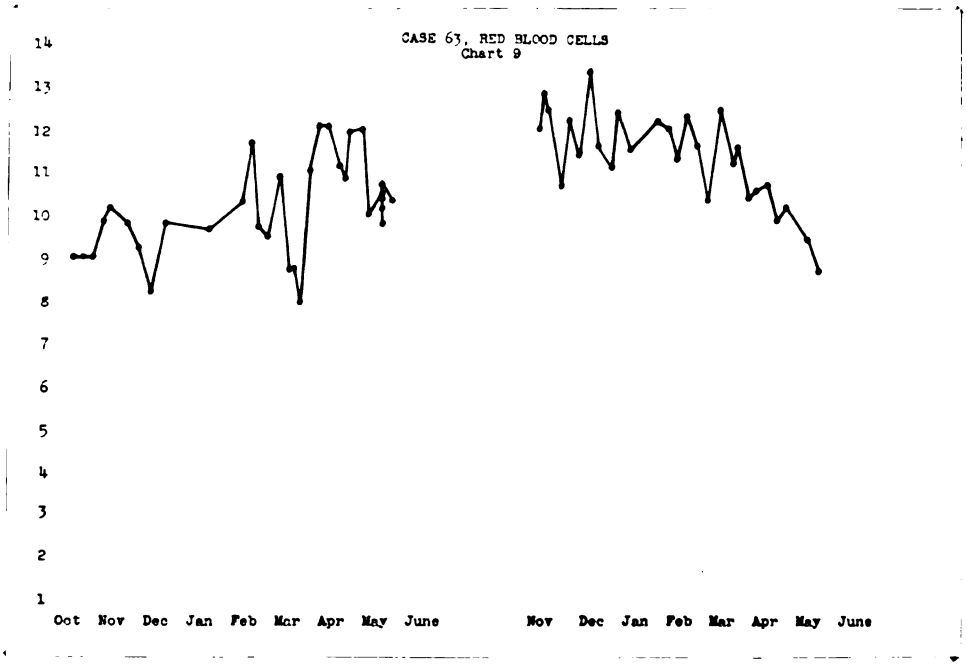
Case	No.Readings	Low Reading	High Reading	Average Reading
58	64	8,000,000	11,920,000	9,341,969
60	61	8,230,000	12,800,000	10,573,114
61	60	7,200,000	13,920,000	10,382,000
62	60	7,300,000	12,840,000	10,156,900
63	59	8,000,000	13,400,000	10,774,000
64	15	9,890,000	12,520,000	11,326,000
65	14	9,520,000	13,100,000	11,085,715
66	15	9,500,000	12,400,000	10,732,000
67	14	8,360,000	12,850,000	10,562,857
68	15	9,350,000	13,200,000	11,273,600
69	17	8,380,000	12,900,000	10,184,117
31	39	8,520,000	13,260,000	10,797,436


CASE 59, RED BLOOD CELLS
Chart 6
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June


CASE 60, RED BLOOD CELLS
Chart 7
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June


CASE 61, RED BLOOD CELLS
Chart 8
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June


CASE 62, RED BLOOD CELLS
Chart 10
14
12
11
10
5
1
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June


CASE 63, RED BLOOD CELLS
Chart 9
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June

WHITE BLOOD CELLS

White blood cell counts were made by use of the special white cell pipette, drawing oxalated blood up to the .5 mark. A 1 per cent solution of acetic acid was used at first, but a 2 per cent solution of oxalic acid, recommended by Jones (3), was considered more desirable. This destroys the red cells and causes the white cells to stand out more clearly. In the counting chamber the white cells were counted in all four of the large corner squares of the ruled area. The results of white cell counts are presented in Table 4 and Charts 11, 12, 13, 14 and 15.

65 white cell counts on case 58 ranged from 5,000 to 12,200 per cmm. of blood, averaging 7,923 per cmm.

61 white cell counts on case 60 ranged from 5,900 to 13,000 per cmm. of blood, averaging 9,157 per cmm.

60 white cell counts on case 61 ranged from 5,400 to 13,300 per cmm. of blood, averaging 9,768 per cmm.

60 white cell counts on case 62 ranged from 5,400 to 13,800 per cmm. of blood, averaging 9,177 per cmm.

59 white cell counts on case 63 ranged from 5,650 to 14,100 per cmm. of blood, averaging 9,393 per cmm.

15 white cell counts on case 64 ranged from 7,300 to 10,450 per cmm. of blood, averaging 8,930 per cmm.

15 white cell counts on case 65 ranged from 5,500 to 10,500 per cmm. of blood, averaging 7,210 per cmm.

15 white cell counts on case 66 ranged from 7,000 to 16,650 per cmm. of blood, averaging 9,623 per cmm. Although

no evidence of sickness was noted, the first two white cell counts on this case, 16,650 and 16,500 per cmm., were much too high to be considered as normal. Discarding these two, 13 counts ranged from 7,000 to 10,250 per cmm., averaging 8,554 per cmm.

14 white cell counts on case 67 ranged from 7,350 to 10,450 per cmm. of blood, averaging 8,475 per cmm.

15 white cell counts on case 68 ranged from 6,450 to 9,400 per cmm. of blood, averaging 8,354 per cmm.

17 white cell counts on case 69 ranged from 5,900 to 9,170 per cmm. of blood, averaging 7,257 per cmm.

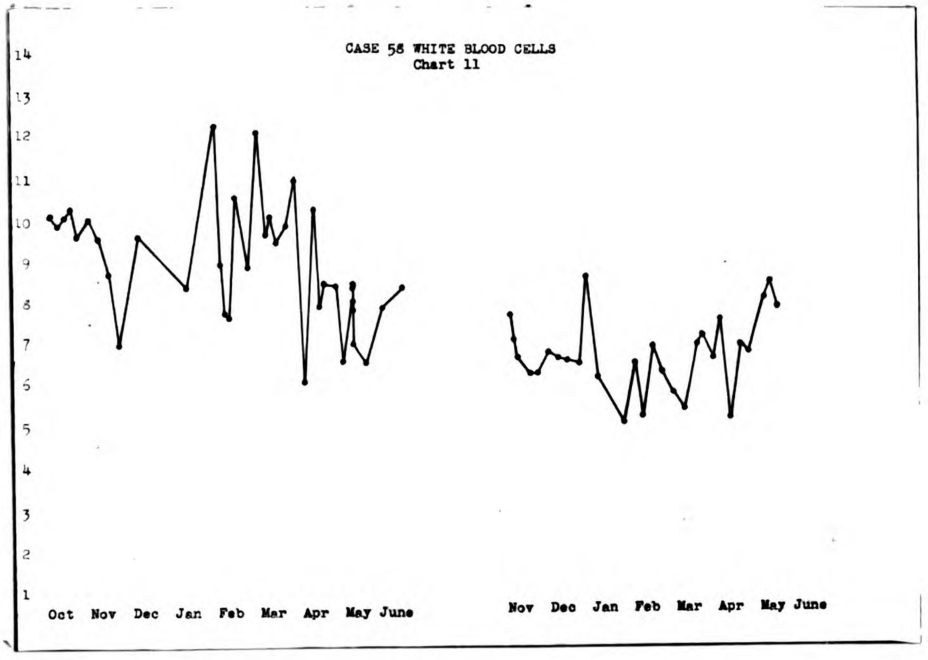
39 white cell counts on case 31 ranged from 6,800 to 16,700 per cmm. of blood, averaging 9,329 per cmm. In this case, as in case 66, the single reading of 16,700 is thought to be pathological.

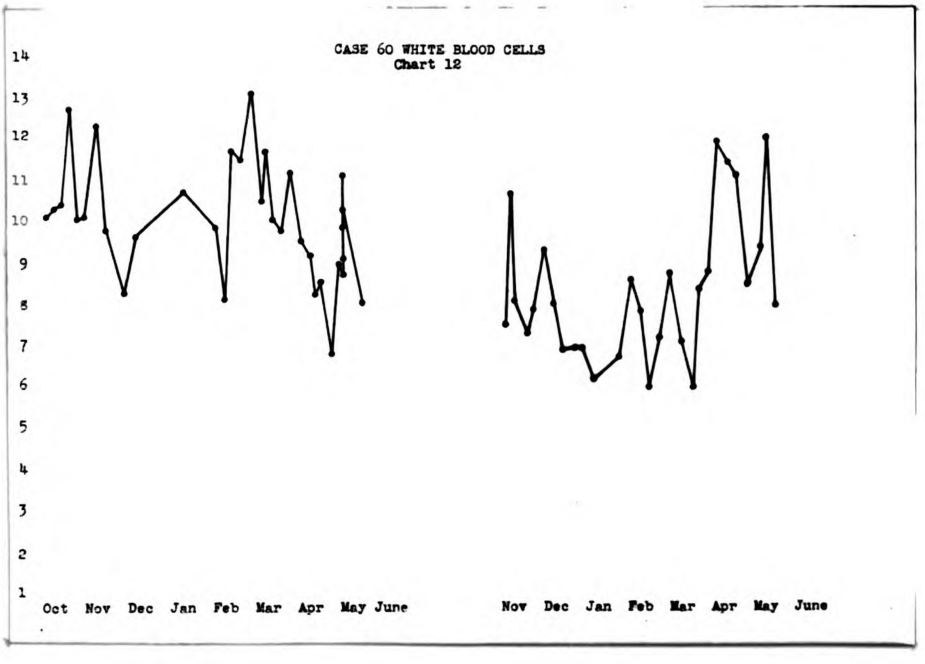
The 434 samples listed above thus range from 5,000 to 16,700 per cmm. of blood, the grand average being estimated as 8,948 per cmm.

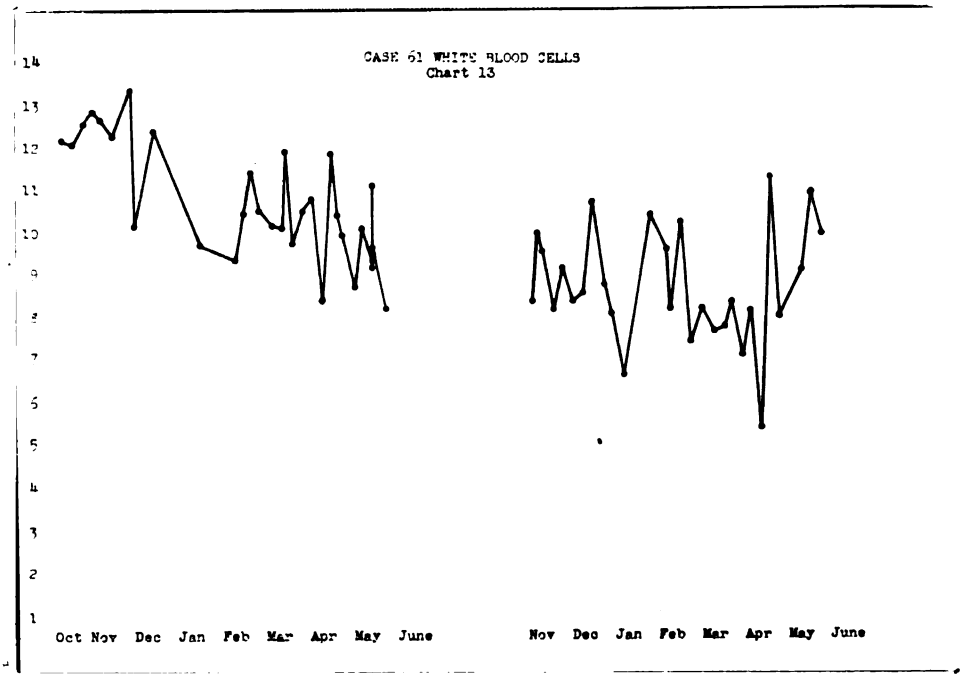
WHITE BLOOD CELLS PER CMM.

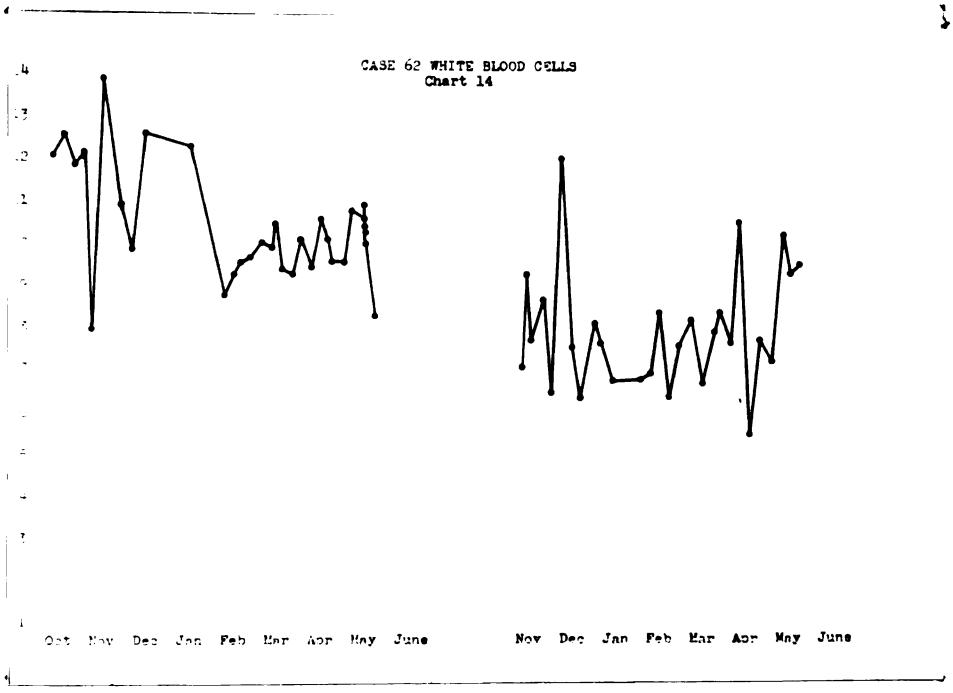
Table 4.

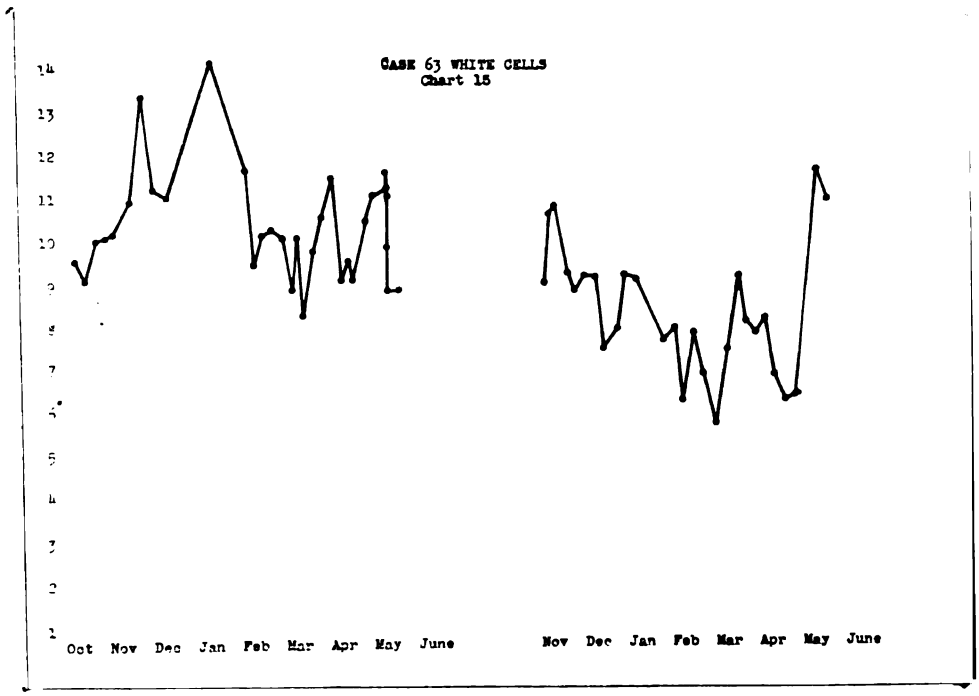
Case	No.Samples	Low Reading	High Reading	Average Reading
58	65	5,000	12,000	7,923
60	61	5,900	13,000	9,157
61	60	5,400	13,300	9,768
62	60	5,400	13,800	9,177
63	59	5,650	14,100	9,393
64	15	7,300	10,450	8,930
65	15	5,500	10,500	7,210
66	15	7,000	16,650	9,623
67	14	7,350	10,450	8,475
68	15	6,450	9,400	8,354
69	17	5,900	9,170	7,257
31	39	6,800	16,700	9,329


CASE 58 WHITE BLOOD CELLS
Chart 11
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June


CASE 60 WHITE BLOOD CELLS
Chart 12
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June


CASE 61 WHITE BLOOD CELLS
Chart 13
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June


CASE 62 WHITE BLOOD CELLS
Chart 14
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June


CASE 63 WHITE CELLS
Chart 15
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
June
Nov
Dec
Jan
Feb
Mar
Apr
May
June

DIFFERENTIAL WHITE CELL BLOOD COUNTS

Much difficulty was experienced in making satisfactory smears for differential counts. The smears were being attempted with slides, but in practically all cases the smears were of no value due to the fact that most of the white cells went to the margins. The cover glass method recommended by Haden (4) was then tried. Haden recommends the use of 7/8 inch square cover glasses, held by the corners, but they are somewhat difficult to handle. Number 1 cover glasses 22 by 40 mm. were tried and were found to be much more convenient to handle. They also allow making a much larger smear. A small drop of blood is placed on a cover glass by means of a dropper, a second cover glass is placed over the drop, the blood is allowed to spread, and the two cover glasses are slipped apart. This procedure gives even, thin films with good distribution of cells, but has the objectionable feature that occasionally some of the cells are distorted or broken. The smears were stained with Wright's stain, and the differential counts were based on 100 cells counted in each smear. Cells were classified as neutrophils, lymphocytes, monocytes, eosinophils and basophils, and in a large number of counts a division of neutrophils into segmented and non-segmented forms was carried out.

NEUTROPHILS. The results of neutrophil counts are presented in Tables 5, 6 and 7 and in Charts 16 to 25 inclusive.

63 differentials on case 58 ranged from 16 to 47 per cent, averaging 30.2 per cent.

60 differentials on case 60 ranged from 19 to 54 per cent, averaging 34.7 per cent.

59 differentials on case 61 ranged from 14 to 39 per cent, averaging 26.25 per cent.

59 differentials on case 62 ranged from 9 to 58 per cent, averaging 30 per cent.

58 differentials on case 63 ranged from 13 to 73 per cent, averaging 31,34 per cent.

34 differentials on case 31 ranged from 13 to 55 per cent, averaging 29.73 per cent.

The 334 counts represented above show a very surprisingly wide range from 9 to 73 per cent, but this range is quite consistent in all of the six animals, and the averages show a range of only 26.25 to 34.7 per cent. The general average is 30.36 per cent.

Tabulation of the neutrophils into segmented and non-segmented forms was carried out on a considerable number of the smears from the above cases. Segmentation is considered to be evidence of maturation of the neutrophil, and the above tabulation gives the relation of mature to immature forms.

NON-SEGMENTED NEUTROPHILS. In 53 counts on case 58, the non-segmented neutrophils ranged from 1 to 19 per cent, averaging 7.94 per cent.

49 counts on case 60 ranged from 1 to 25 per cent, averaging 9.6 per cent.

48 counts on case 61 ranged from 2 to 16 per cent, averaging 8.16 per cent.

50 counts on case 62 ranged from 2 to 28 per cent,

averaging 8.2 per cent.

49 counts on case 63 ranged from 1 to 18 per cent, averaging 7.9 per cent.

34 counts on case 31 ranged from 1 to 15 per cent, averaging 6 per cent.

SEGMENTED NEUTROPHILS. In 53 counts on case 58, the segmented neutrophils ranged from 9 to 36 per cent, averaging 23 per cent.

49 counts on case 60 ranged from 14 to 37 per cent, averaging 24.8 per cent.

48 counts on case 61 ranged from 8 to 33 per cent, averaging 17.7 per cent.

50 counts on case 62 ranged from 7 to 36 per cent, averaging 21 per cent.

49 counts on case 63 ranged from 8 to 59 per cent, averaging 23.4 per cent.

34 counts on case 31 ranged from 12 to 50 per cent, averaging 23.7 per cent.

NEUTROPHILS, PERCENTAGE

Table 5.

Case	No.Samples	Low Reading	High Reading	Average Reading
58	63	16	47	30.2
60	60	19	54	34.7
61	57	14	39	26.25
62	59	9	58	30.0
63	58	13	73	31.34
31	34	13	55	29.73

NON-SEGMENTED NEUTROPHILS, PERCENTAGE

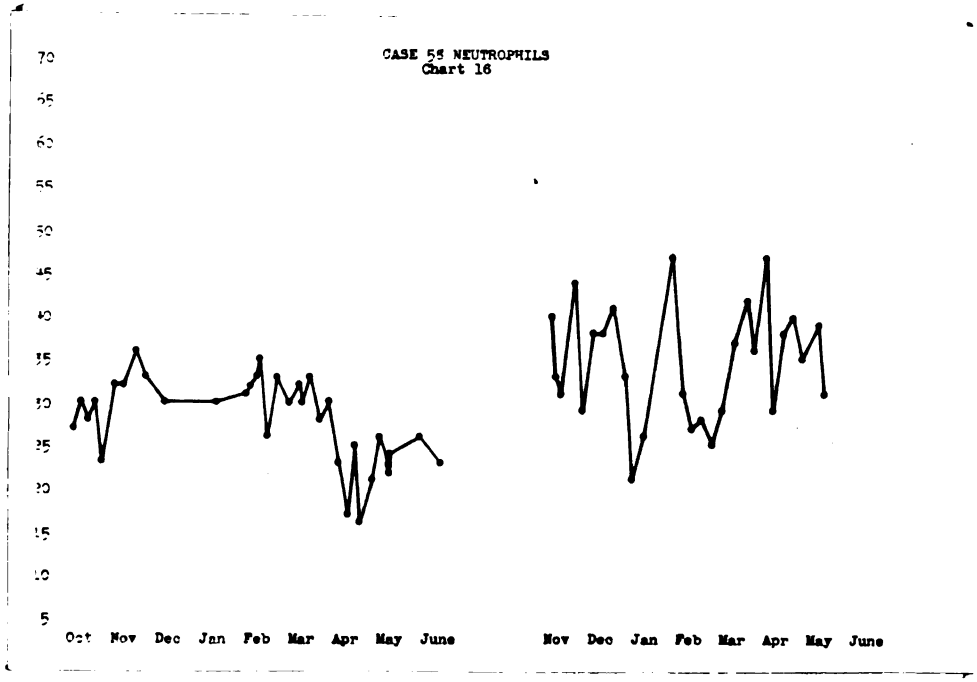
Table 6.

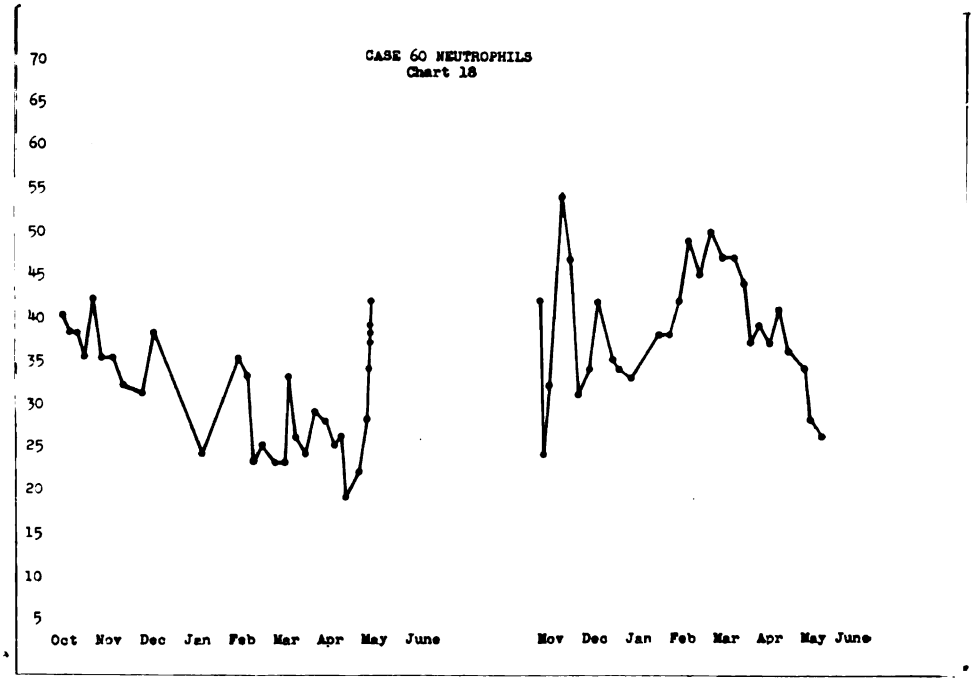
Case	No.Samples	Low Reading	High Reading	Average Reading
58	53	1	19	7.94
60	49	1	25	9.6
61	48	2	16	8.16
62	50	2	28	8.2
63	49	1	18	7.9
31	34	1	15	6.0

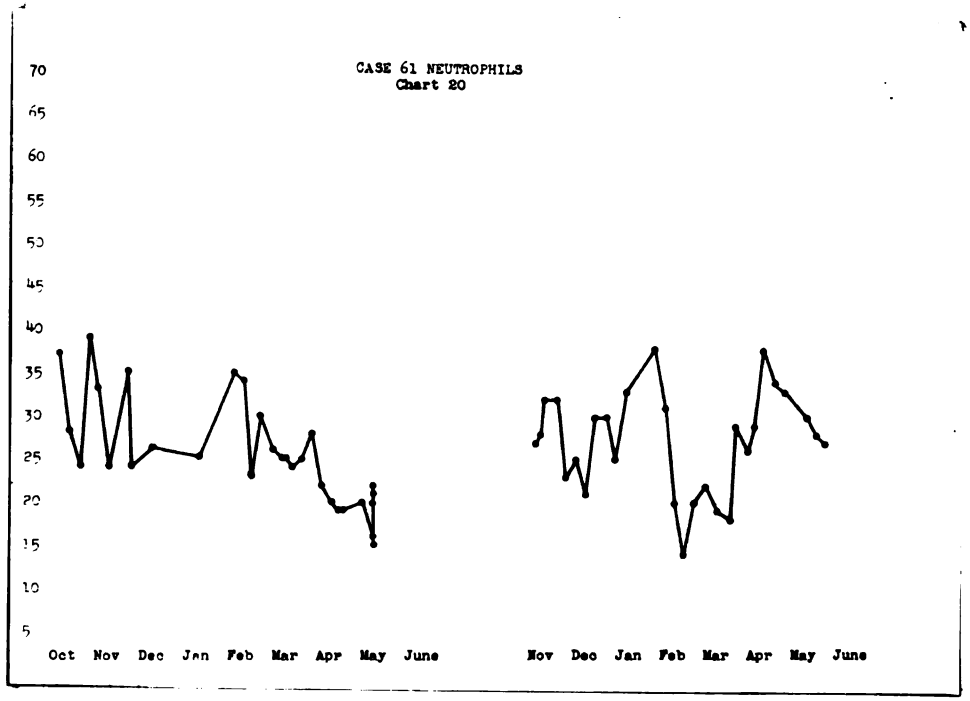
SEGMENTED NEUTROPHILS, PERCENTAGE

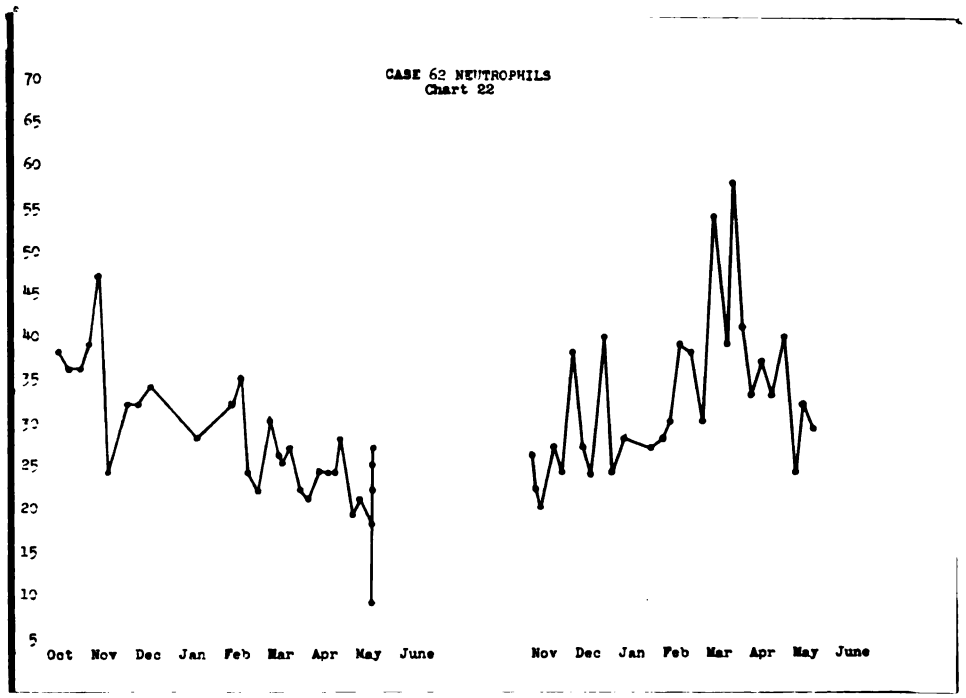
Table 7.

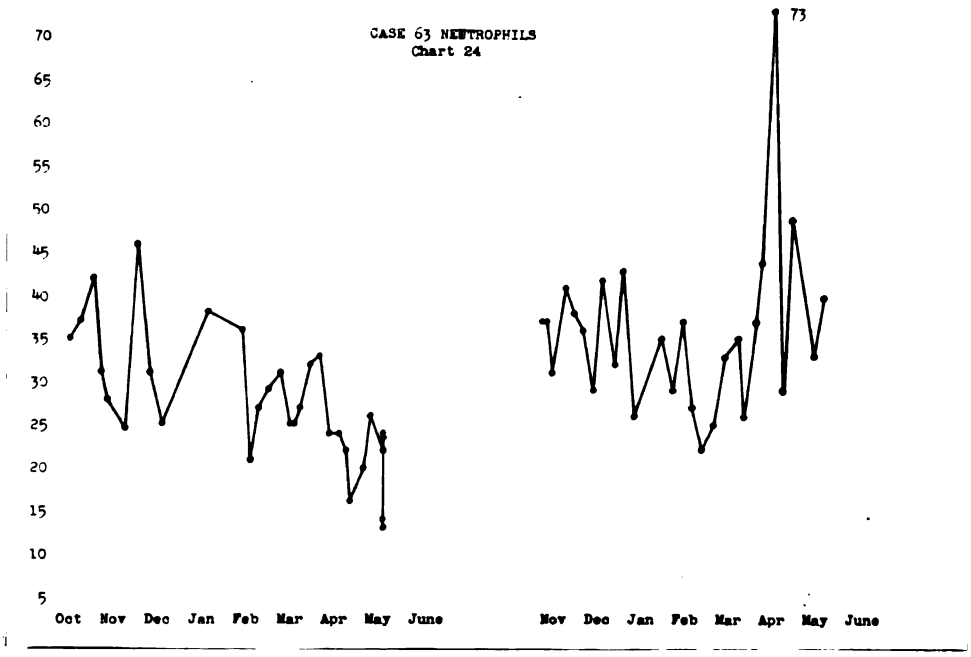
Case	No.Samples	Low Reading	High Reading	Average Reading
58	53	9	36	23.0
60	49	14	37	24.8
61	48	8	33	17.7
62	50	7	36	21.0
63	49	8	59	23.4
31	34	12	50	23.7

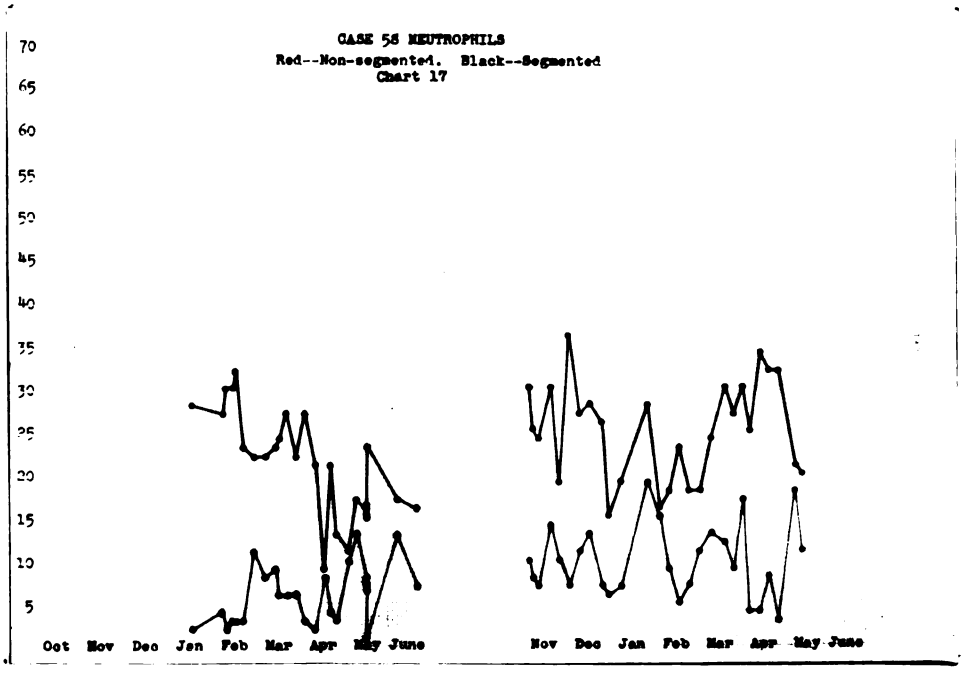

CASE 55 NEUTROPHILS
Chart 16
70
65
60
55
50
45
40
35
30
25
20
15
10
5
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June


CASE 60 NEUTROPHILS
Chart 18
70
65
60
55
50
45
40
35
30
25
20
15
10
5
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June

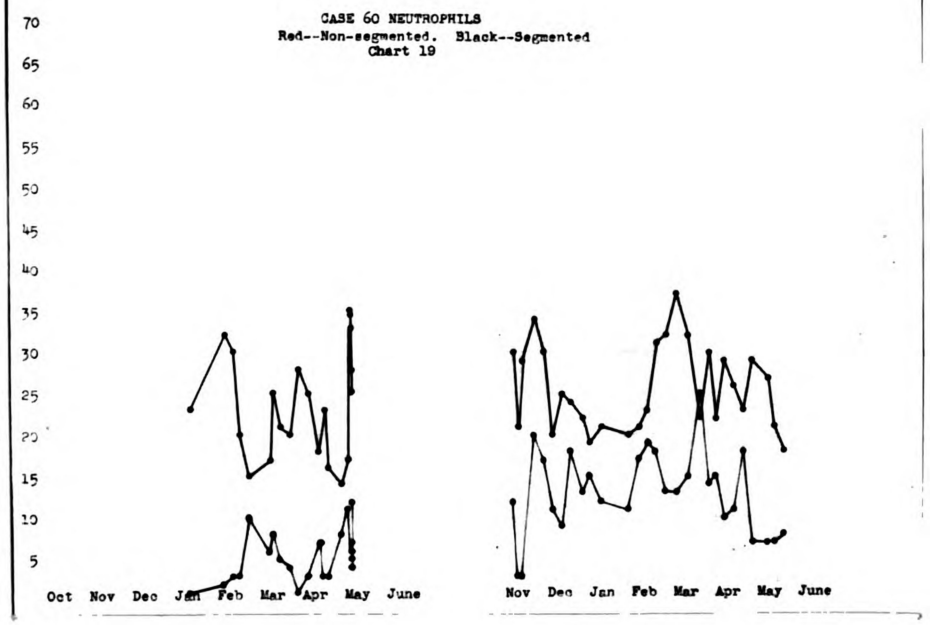

CASE 61 NEUTROPHILS
Chart 20
70
65
60
55
50
45
40
35
30
25
20
15
10
5
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June


CASE 62 NEUTROPHILS
Chart 22
70
65
60
55
50
45
40
35
30
25
20
15
10
5
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June

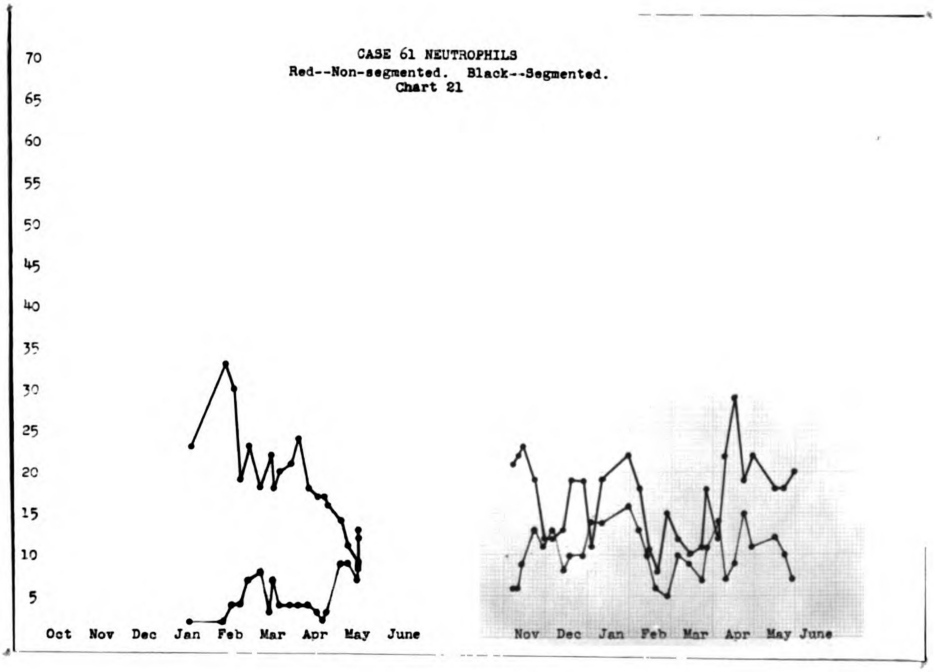

CASE 63 NEUTROPHILS
Chart 24
73
70
65
60
55
50
45
40
35
30
25
20
15
10
5
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June

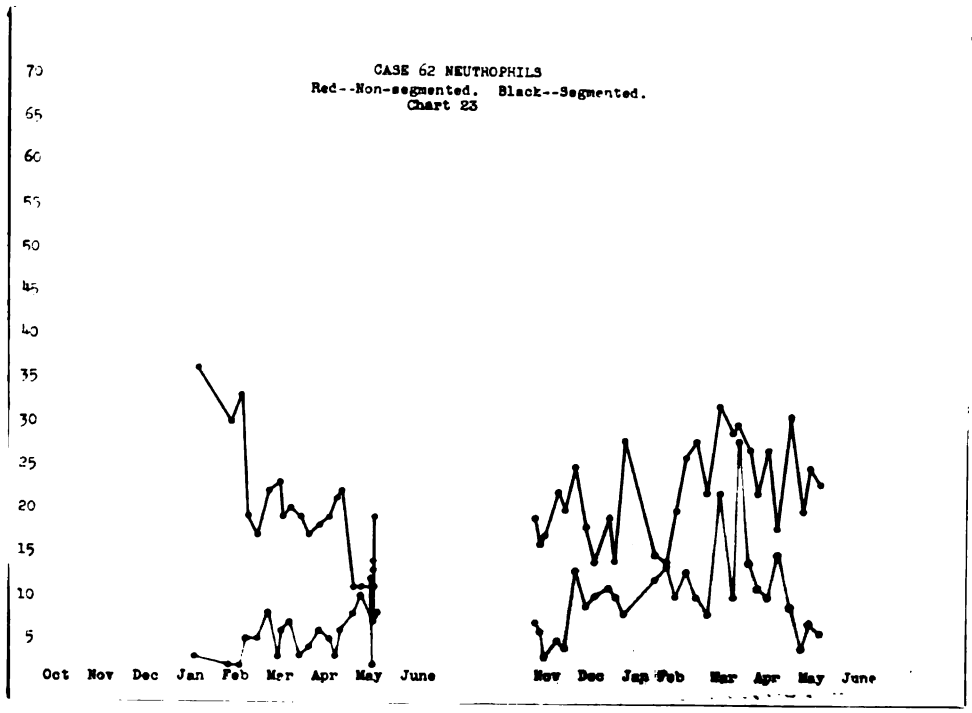

CASE 58 NEUTROPHILS
Red--Non-segmented. Black--Segmented
Chart 17
70
65
60
55
50
45
40
35
30
25
20
15
10
5
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June

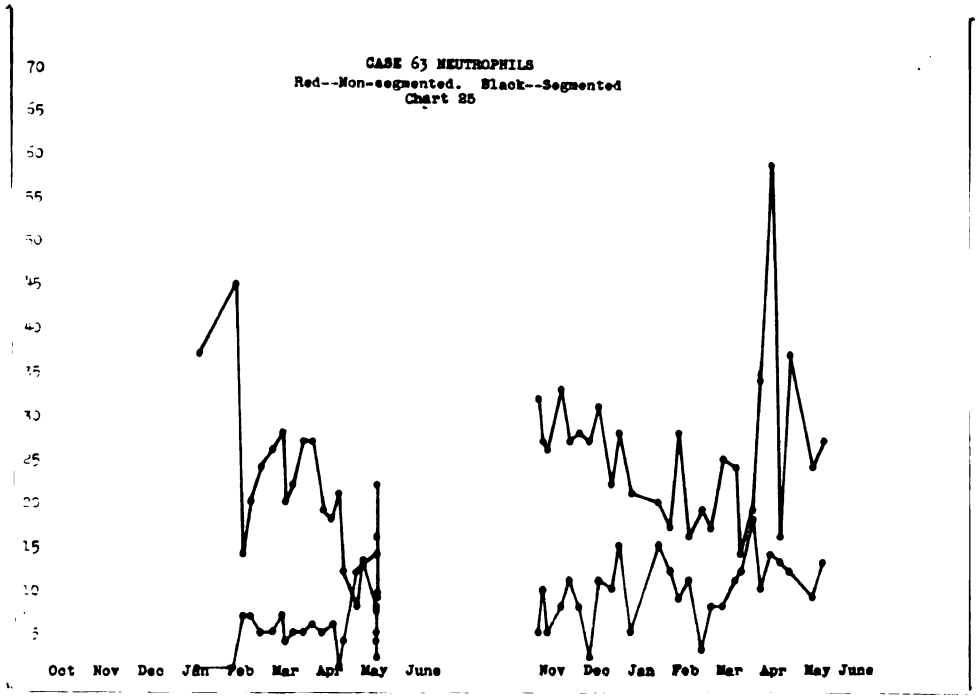
CASE 60 NEUTROPHILS
Red--Non-segmented. Black--Segmented
Chart 19



CASE 61 NEUTROPHILS
Red--Non-segmented. Black--Segmented.
Chart 21




CASE 62 NEUTROPHILS
Red--Non-segmented. Black--Segmented.
Chart 23
70
65
60
55
50
45
40
35
30
25
20
15
10
5
Oct Nov Dec Jan Feb Mer Apr May June
Nov Dec Jan Feb Mar Apr May June


CASE 63 NEUTROPHILS
Red--Non-segmented. Black--Segmented
Chart 25
70
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June

LYMPHOCYTES. The results of lymphocyte counts are presented in Table 8 and Charts 26 to 30 inclusive.

In 63 counts on case 58 the lymphocytes ranged from 37 to 79 per cent, averaging 58.2 per cent.

60 counts on case 60 ranged from 36 to 72 per cent, averaging 53.4 per cent.

57 counts on case 61 ranged from 41 to 78 per cent, averaging 62.5 per cent.

59 counts on case 62 ranged from 41 to 76 per cent, averaging 60.4 per cent.

58 counts on case 63 ranged from 24 to 83 per cent, averaging 58.4 per cent.

34 counts on case 31 ranged from 43 to 79 per cent, averaging 61.38 per cent.

MONOCYTES. The results of monocyte counts are presented in Table 9 and Charts 31 to 35 inclusive.

63 counts on case 58 ranged from 0 to 21 per cent, averaging 3,95 per cent.

60 counts on case 60 ranged from 0 to 11 per cent, averaging 4.3 per cent.

57 counts on case 61 ranged from 0 to 16 per cent, averaging 4.8 per cent.

59 counts on case 62 ranged from 0 to 10 per cent, averaging 3.7 per cent.

58 counts on case 63 ranged from 0 to 13 per cent, averaging 3.7 per cent.

34 counts on case 31 ranged from 1 to 14 per cent, averaging 4.64 per cent.

LYMPHOCYTES, PERCENTAGE

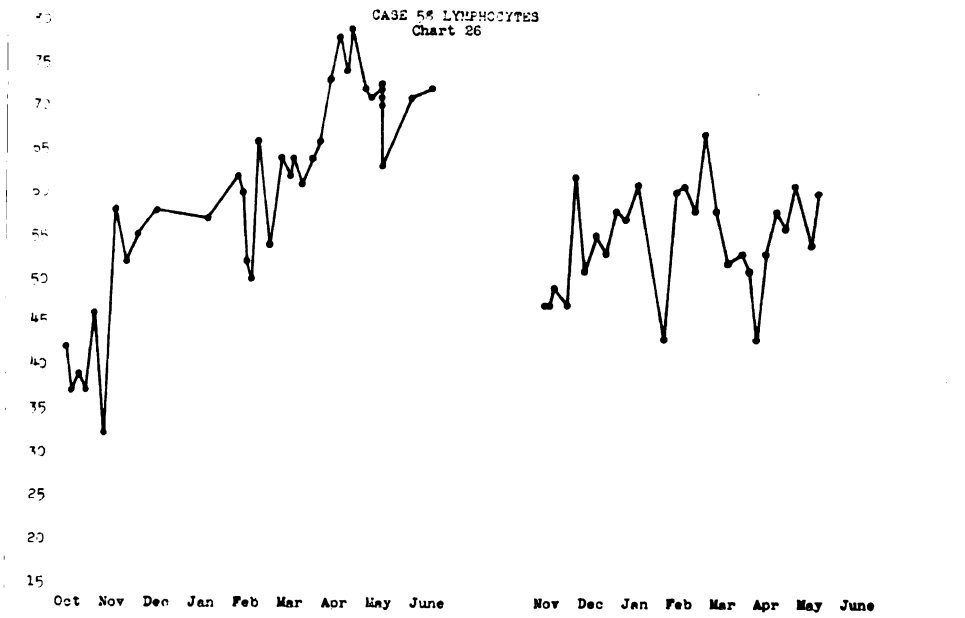
Table 8.

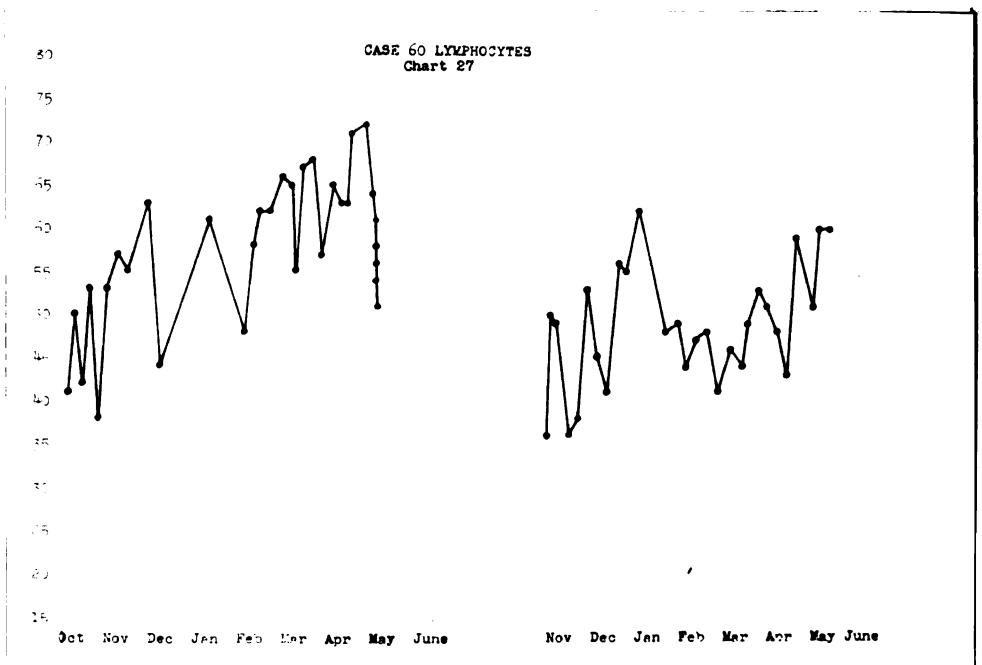
Case	No.Readings	Low Reading	High Reading	Average Reading
58	63	37	79	58.2
60	60	36	72	53.4
61	57	41	78	62.5
62	59	41	76	60.4
63	58	24	83	58.4
31	34	43	79	61.38

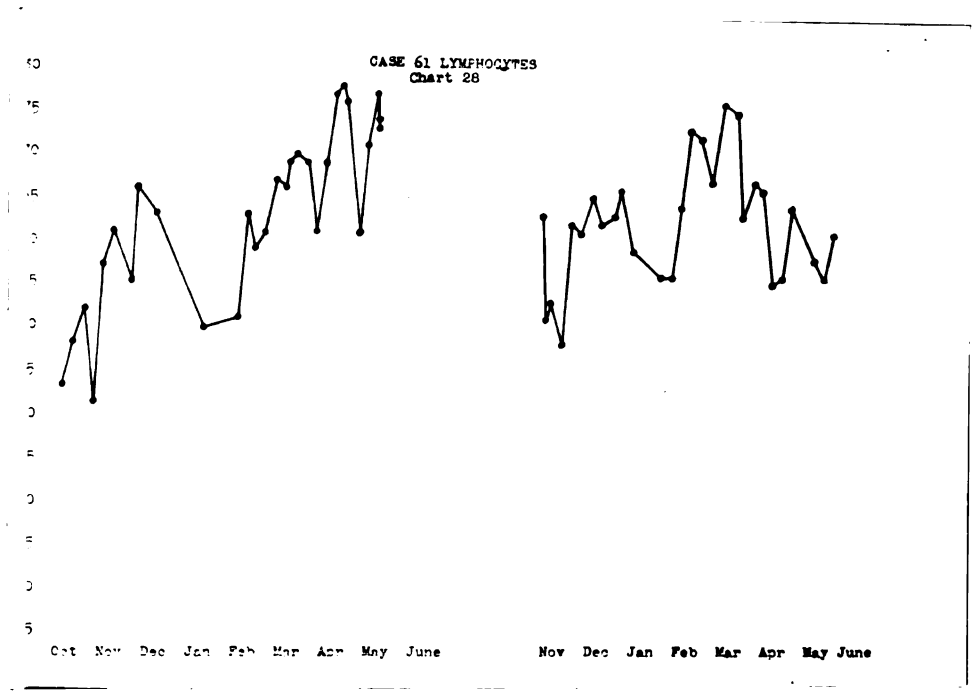
MONOCYTES, PERCENTAGE

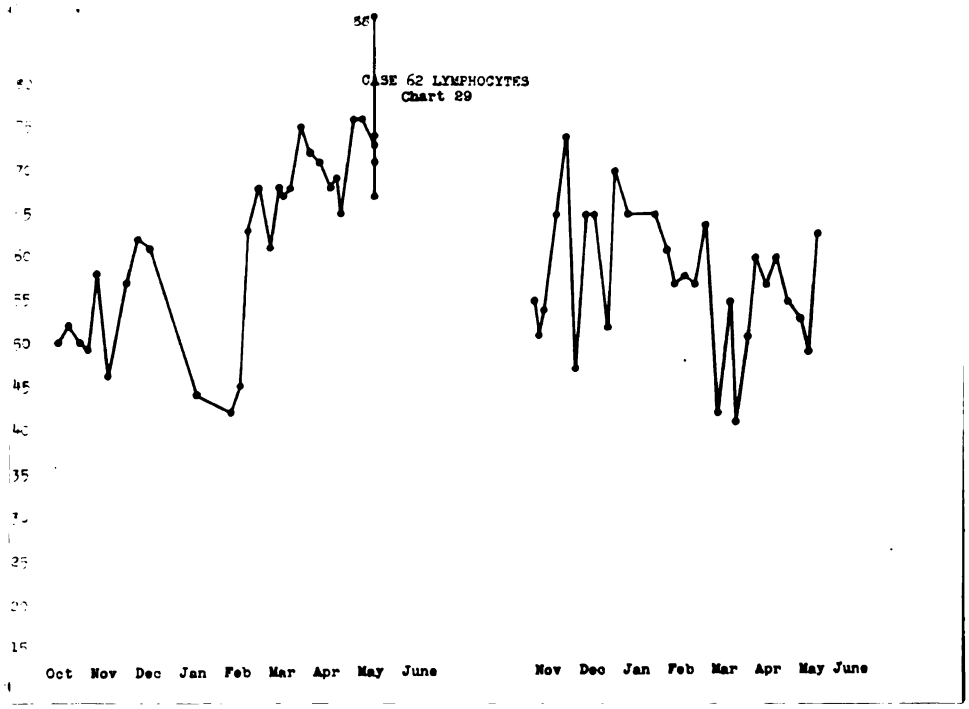
Table 9.

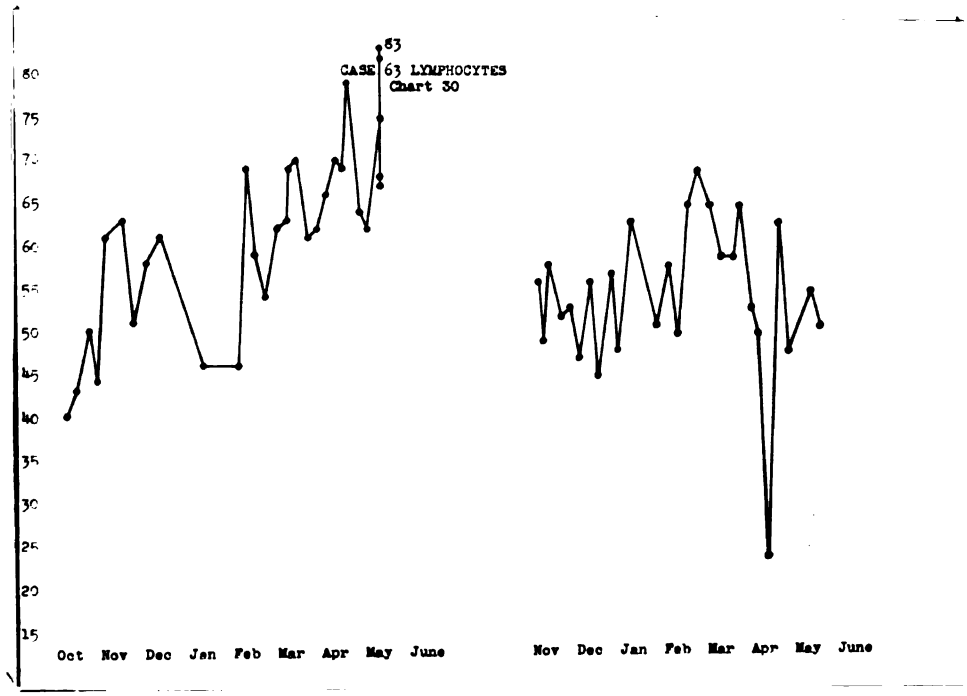
Case	No.Readings	Low Reading	High Reading	Average Reading
58	63	0	21	3.95
60	60	0	11	4.3
61	57	0	16	4.8
62	59	0	10	3.7
63	58	0	13	3.7
31	34	1	14	4.64


CASE 58 LYMPHOCYTES
Chart 26
75
70
65
60
55
50
45
40
35
30
25
20
15
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June

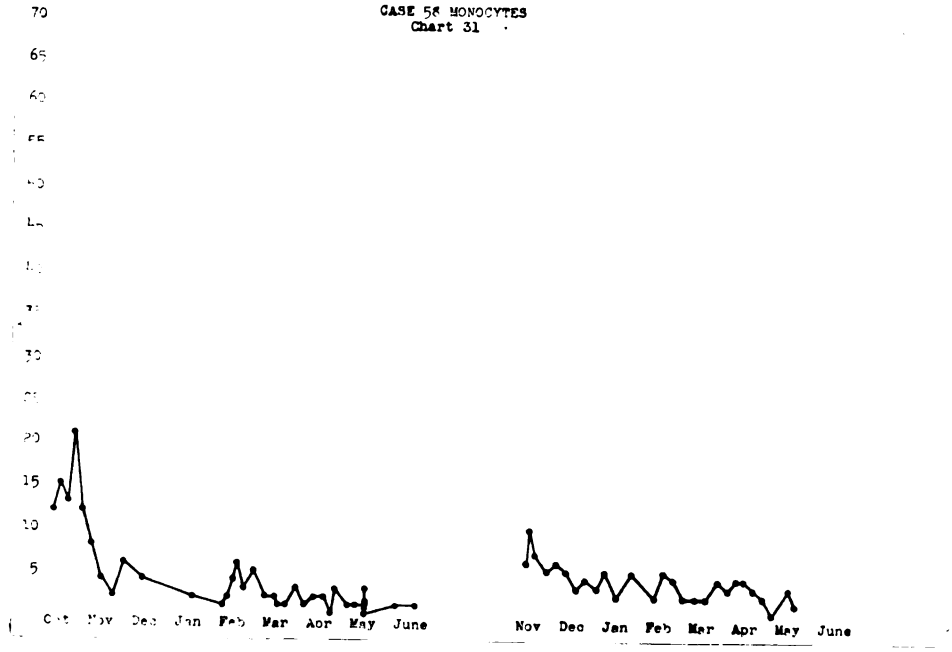

CASE 60 LYMPHOCYTES
Chart 27
80
75
70
65
60
55
50
45
40
35
30
25
20
15
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June


CASE 61 LYMPHOCYTES
Chart 28
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June

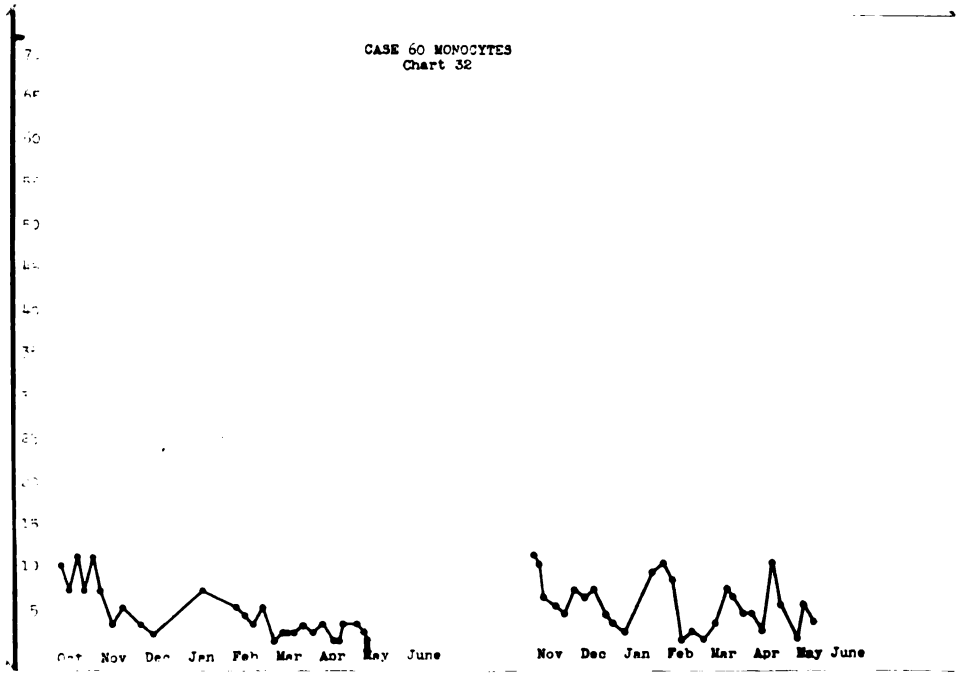

CASE 62 LYMPHOCYTES
Chart 29
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June


83
CASE 63 LYMPHOCYTES
Chart 30
80
75
65
50
45
40
35
30
20
15
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June

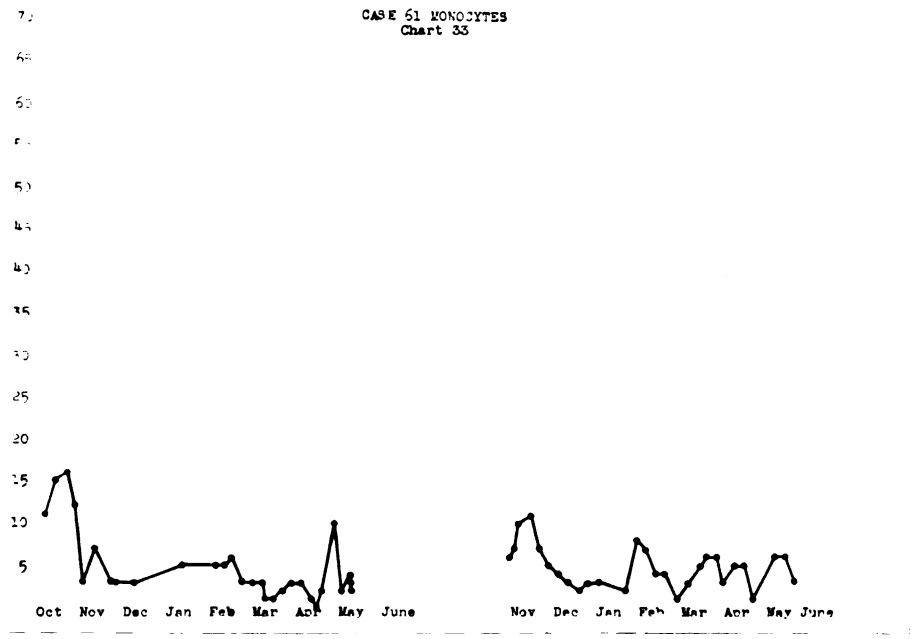
CASE 58 MONOCYTES
Chart 31



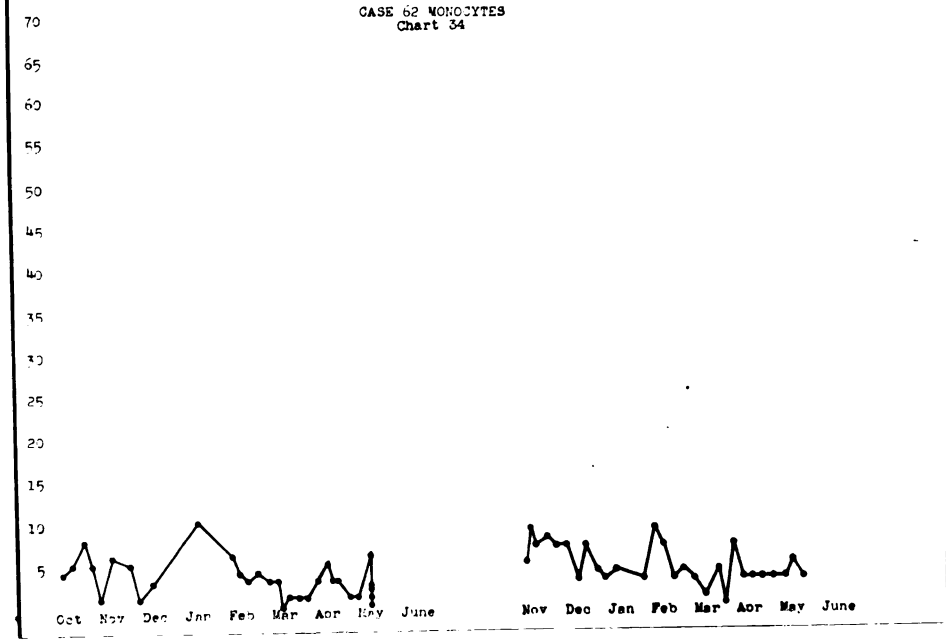
CASE 60 MONOCYTES
Chart 32



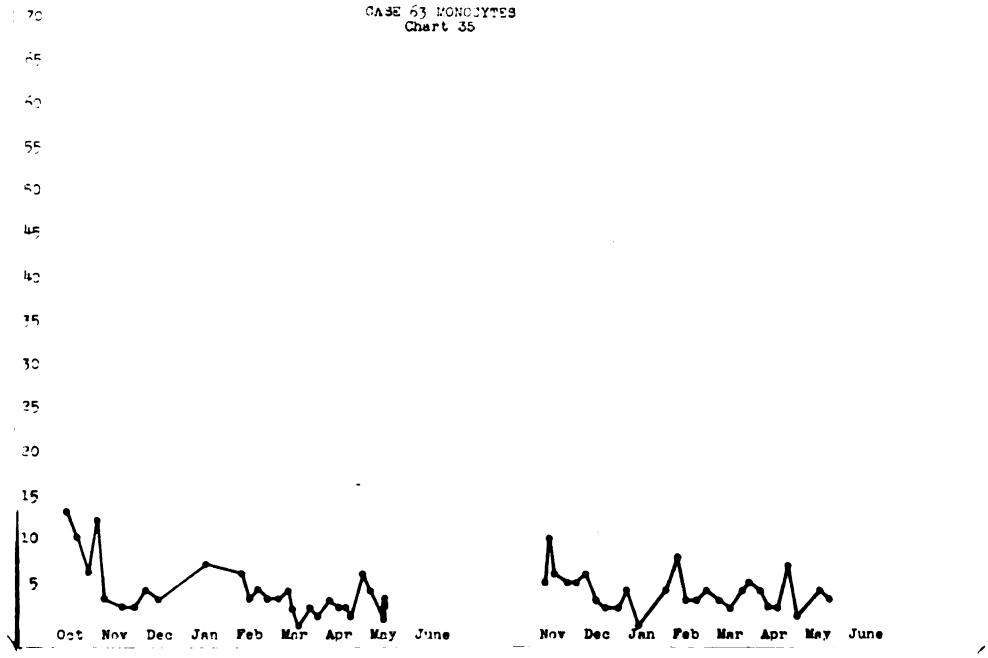
CASE 61 MONOCYTES
Chart 33



CASE 62 MONOCYTES
Chart 34



CASE 63 MONOCYTES
Chart 35



EOSINOPHILS. The results of eosinophil counts are presented in Table 10 and Charts 36 to 40 inclusive.

63 counts on case 58 ranged from 0 to 19 per cent, averaging 6.34 per cent.

60 counts on case 60 ranged from 0 to 16 per cent, averaging 7.1 per cent.

57 counts on case 61 ranged from 1 to 19 per cent, averaging 5.5 per cent.

59 counts on case 62 ranged from 0 to 23 per cent, averaging 5.3 per cent.

58 counts on case 63 ranged from 0 to 13 per cent, averaging 5.8 per cent.

34 counts on case 31 ranged from 0 to 17 per cent, averaging 4.65 per cent.

BASOPHILS. The results of basophil counts are presented in Table 11 and Charts 36 to 40 inclusive.

63 counts on case 58 ranged from 0 to 3 per cent, averaging 0.79 per cent.

60 counts on case 60 ranged from 0 to 2 per cent, averaging o.5 per cent.

57 counts on case 61 ranged from 0 to 4 per cent, averaging 0.5 per cent.

59 counts on case 62 ranged from 0 to 2 per cent, averaging 0.4 per cent.

58 counts on case 63 ranged from 0 to 3 per cent, averaging 0.48 per cent.

34 counts on case 31 ranged from 0 to 4 per cent, averaging 1.1 per cent.

EOSINOPHILS, PERCENTAGE

Table 10.

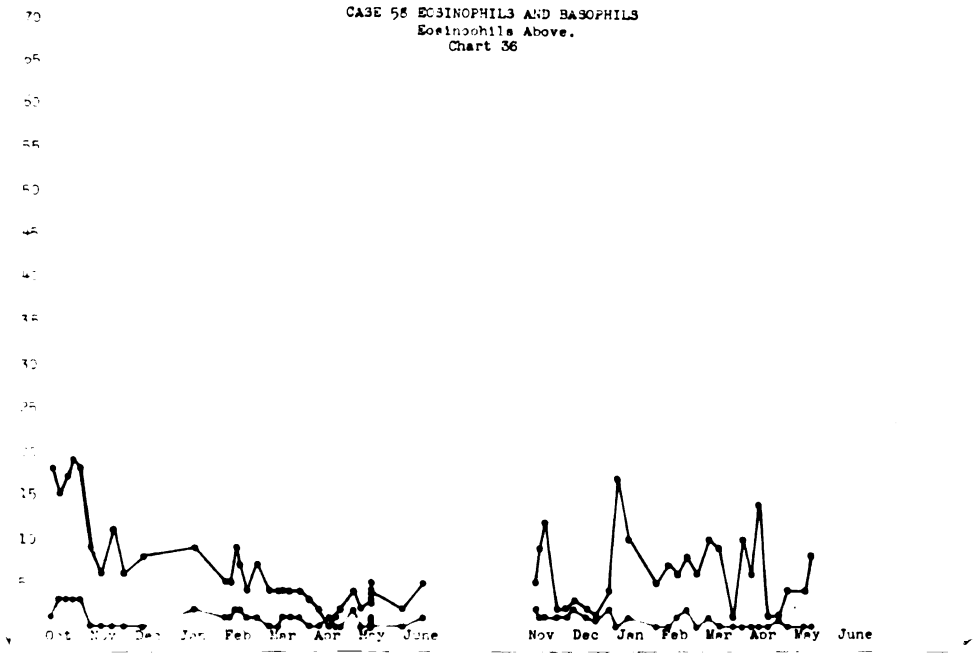
Case	No.Samples	Low Reading	High Reading	Average Reading
58	63	0	19	6.34
60	60	0	16	7.10
61	57	1	19	5.5
62	59	0	23	5.3
63	58	0	13	5.8
31	34	0	17	4.65

BASOPHILS, PERCENTAGE

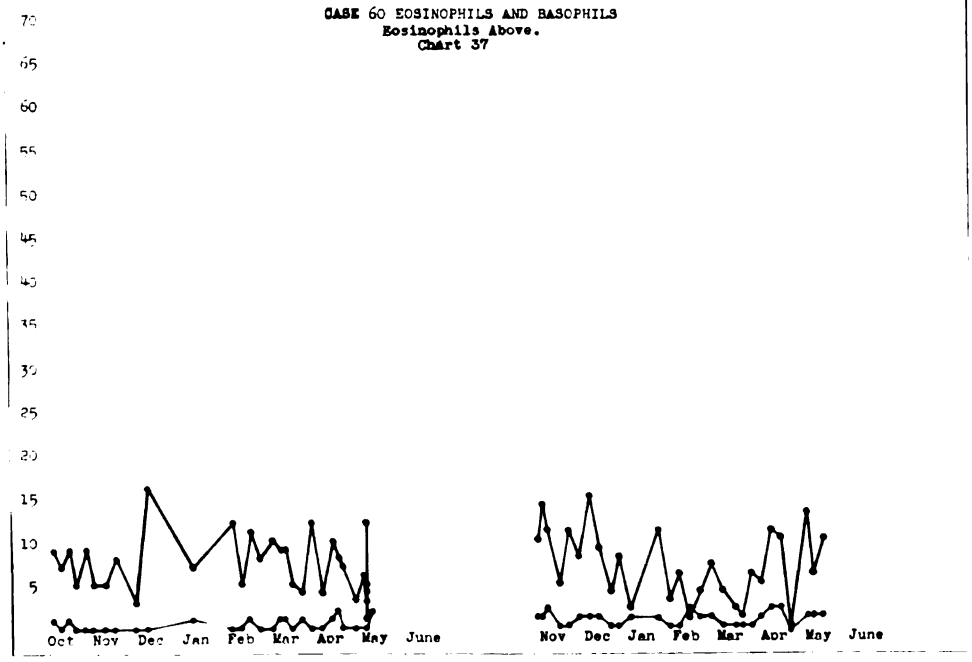
Table 11.

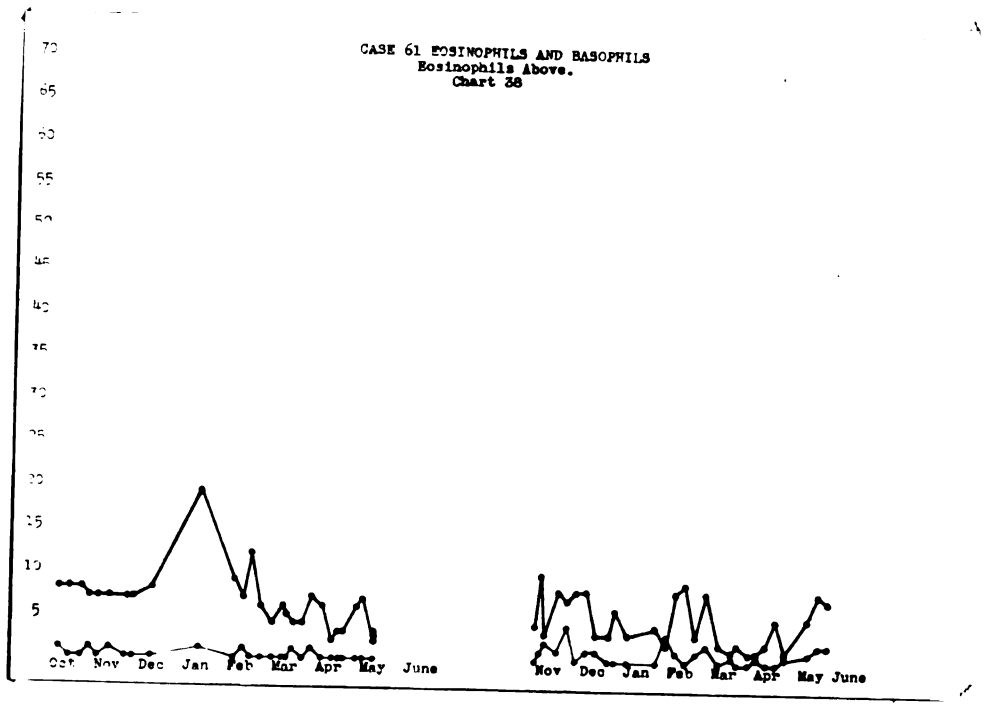
Case	No.Samples	Low Reading	High Reading	Average Reading
58	63	0	3	0.79
60	60	0	2	0.5
61	57	0	4	0.5
62	59	0	2	0.4
63	58	0	3	0.48
31	34	0	4	1.1

CASE 58 EOSINOPHILS AND BASOPHILS
Eosinophils Above.
Chart 36

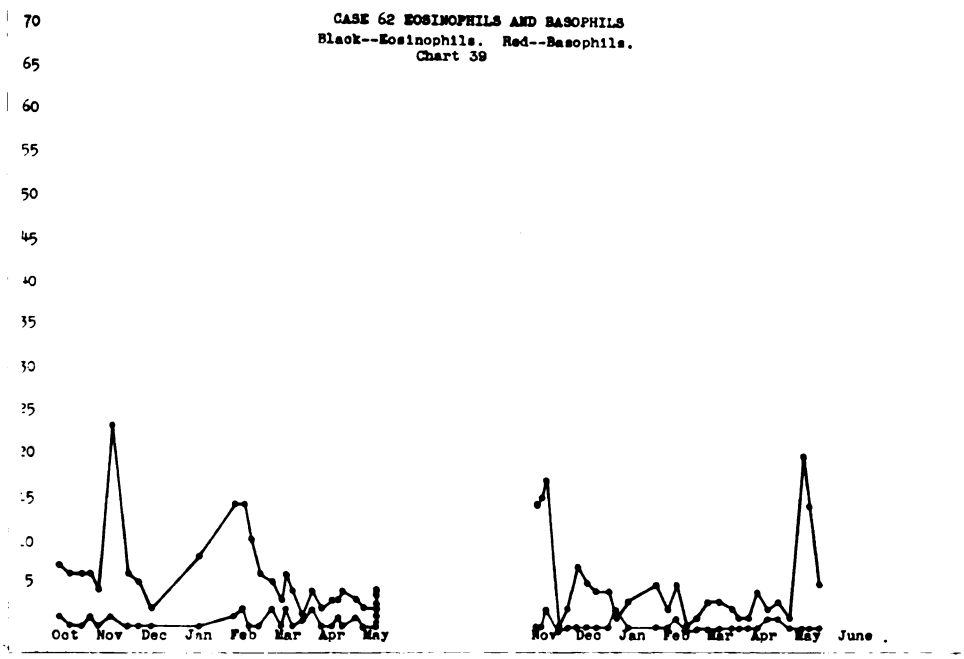


CASE 60 EOSINOPHILS AND BASOPHILS
Eosinophils Above.
Chart 37





CASE 61 EOSINOPHILS AND BASOPHILS
Eosinophils Above.
Chart 38

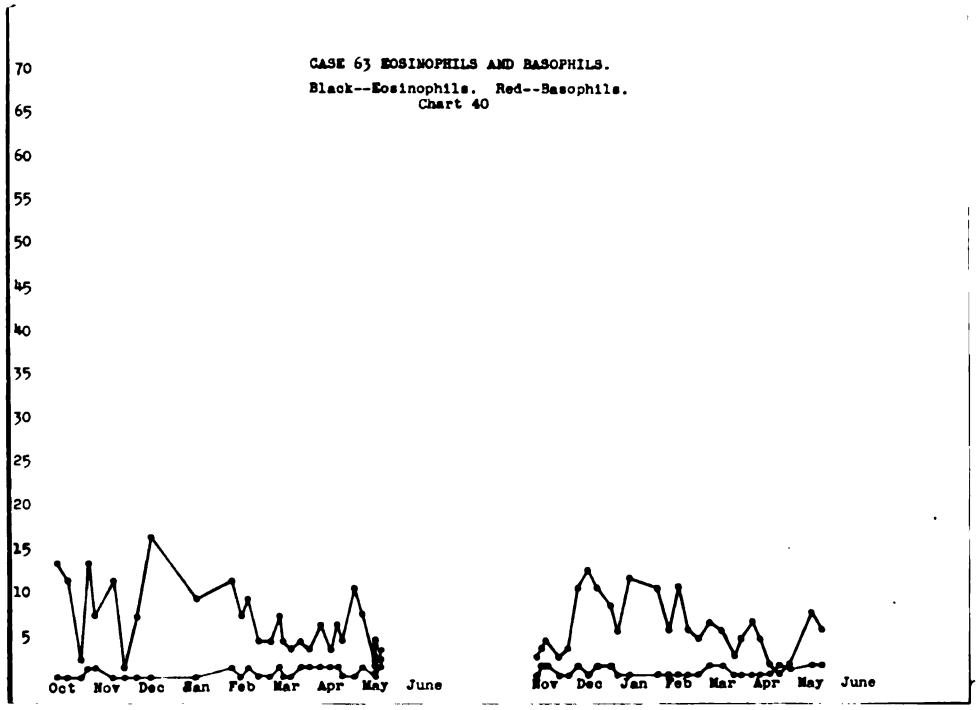


CASE 62 EOSINOPHILS AND BASOPHILS
Black--Eosinophils. Red--Basophils.
Chart 39

CASE 63 EOSINOPHILS AND BASOPHILS.

Black--Eosinophils. Red--Basophils.

Chart 40



BLOOD CHEMISTRY

It was also desired to determine some of the normal chemical values for blood in order to study possible changes occurring under pathological conditions. With this in mind, the author made a large number of determinations including glucose, non-protein nitrogen, creatinine, chlorides and uric acid. The oxalated blood described in the discussion of blood cytology was used for chemical study also.

BLOOD FILTRATE. This was made according to the method of Folin and Wu (5), the total proteins of the blood being precipitated by tungstic acid (formed by the interaction of sodium tungstate and sulphuric acid). The filtrate contains the blood constituents to be determined.

10 cc. of oxalated blood was laked with 70 cc. of distilled water. 10 cc. of 10% sodium tungstate was added, followed by 10 cc. of 2/3 N sulphuric acid. After thorough shaking, the material was allowed to stand for 10 to 20 minutes and filtered.

BLOOD GLUCOSE

For determination of glucose, the method of Folin and Wu (5) was used. 2 cc. of the protein-free blood filtrate was placed in a Folin-Wu sugar tube graduated at 25 cc. 2 cc. of glucose standard (containing 0.2 mg. of glucose) was placed in a similar tube. 2 cc. of alkaline copper solution was added to each tube. The tubes were heated for 8 minutes in a boiling water bath and then cooled in running water. 4 cc.

of acid molybdate solution was added to each, and the solution was then made up to 25 cc. with diluted molybdate reagent (1 part of reagent to 4 parts of water). After mixing well, the standard and unknowns were compared in the colorimeter. The results obtained are summarized below and presented in Table 12 and Charts 41 to 45 inclusive.

62 blood sugar determinations on case 58 ranged from 45.66 to 94.33 mgms. per cent, averaging 62.11 mgms. per cent.

61 determinations on case 60 ranged from 48.78 to 99.00 mgms. per cent, averaging 63.74 mgms. per cent.

60 determinations on case 61 ranged from 50.00 to 83.33 mgms. per cent, averaging 62.37 mgms. per cent.

60 determinations on case 62 ranged from 46.40 to 83.33 mgms. per cent, averaging 64.61 mgms. per cent.

59 determinations on case 63 ranged from 44.27 to 89.68 mgms. per cent, averaging 61.53 mgms. per cent.

15 determinations on case 64 ranged from 62.89 to 84.74 mgms. per cent, averaging 72.92 mgms. per cent.

14 determinations on case 65 ranged from 62.30 to 91.74 mgms. per cent, averaging 72.38 mgms. per cent.

15 determinations on case 66 ranged from 66.22 to 98.52 mgms. per cent, averaging 76.73 mgms. per cent.

14 determinations on case 67 ranged from 57.47 to 78.12 mgms. per cent, averaging 67.31 mgms. per cent.

15 determinations on case 68 ranged from 56.65 to 87.33 mgms. per cent, averaging 72.44 mgms. per cent.

17 determinations on case 69 ranged from 59.52 to 100.00 mgms. per cent, averaging 71.09 mgms. per cent.

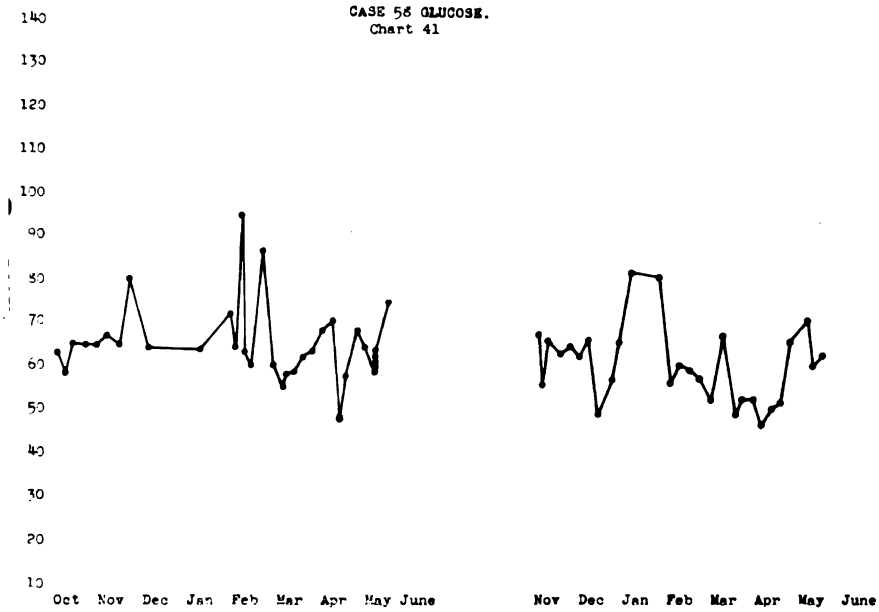
39 determinations on case 31 ranged from 49.26 to 90.09 mgms. per cent, averaging 63.30 mgms. per cent.

BLOOD GLUCOSE, MGMS. PERCENT

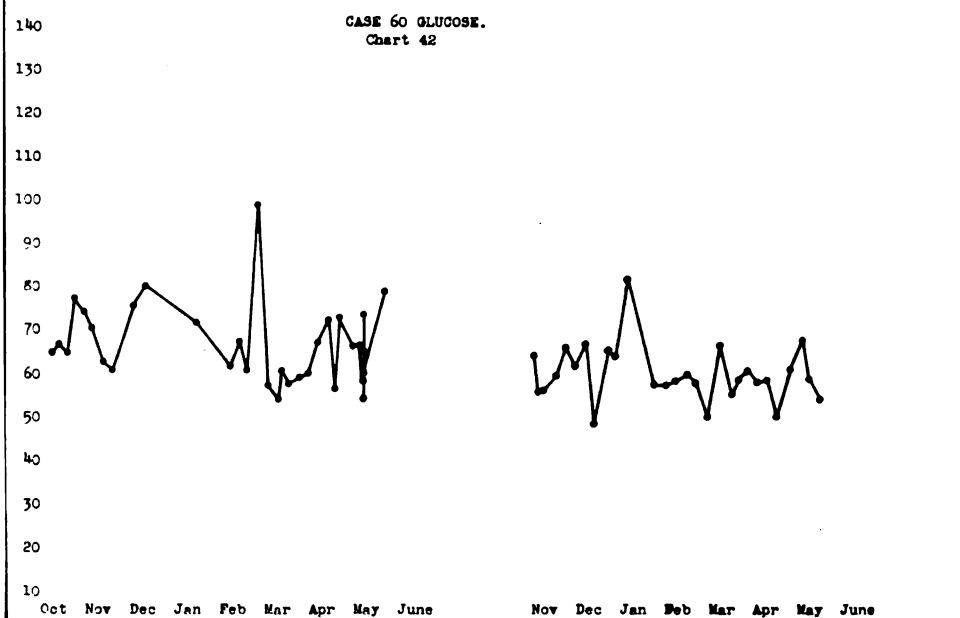
Table 12.

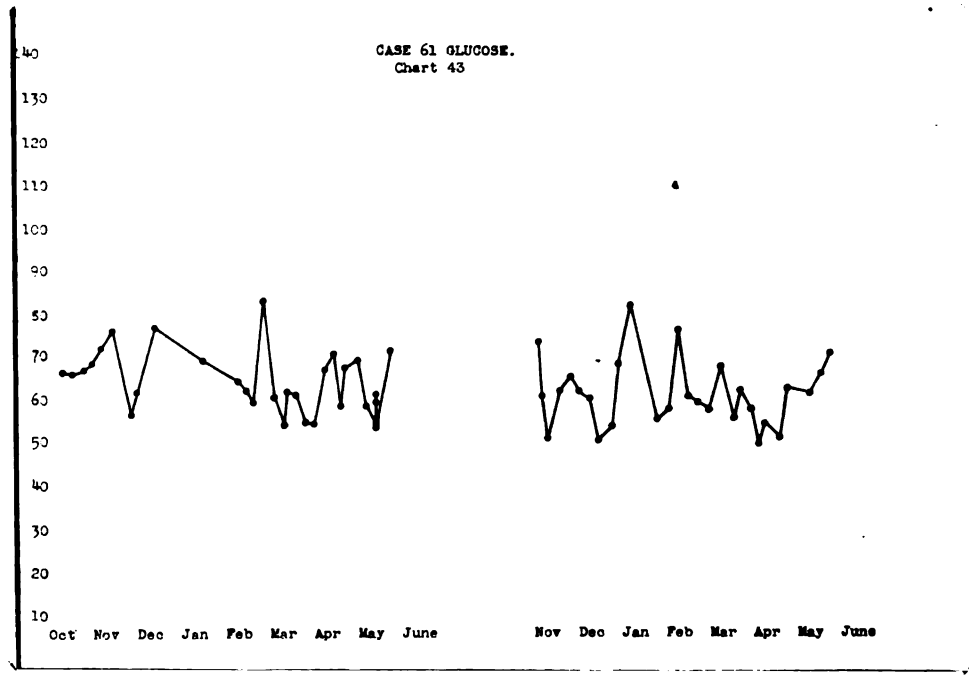
Case	No.Samples	Low Reading	High Reading	Average Reading
58	62	45.66	94.33	62.11
60	61	43.78	99.00	63.74
61	60	50.00	83.33	62.37
62	60	46.40	83.33	64.61
63	59	44.27	89.68	61.53
64	15	62.89	84.74	72.92
65	14	62.30	91.74	72.38
66	15	66.22	98.52	76.73
67	14	57.47	78.12	67.31
68	15	56.65	87.33	72.44
69	17	59.52	100.00	71.09
31	39	49.26	90.09	63.30

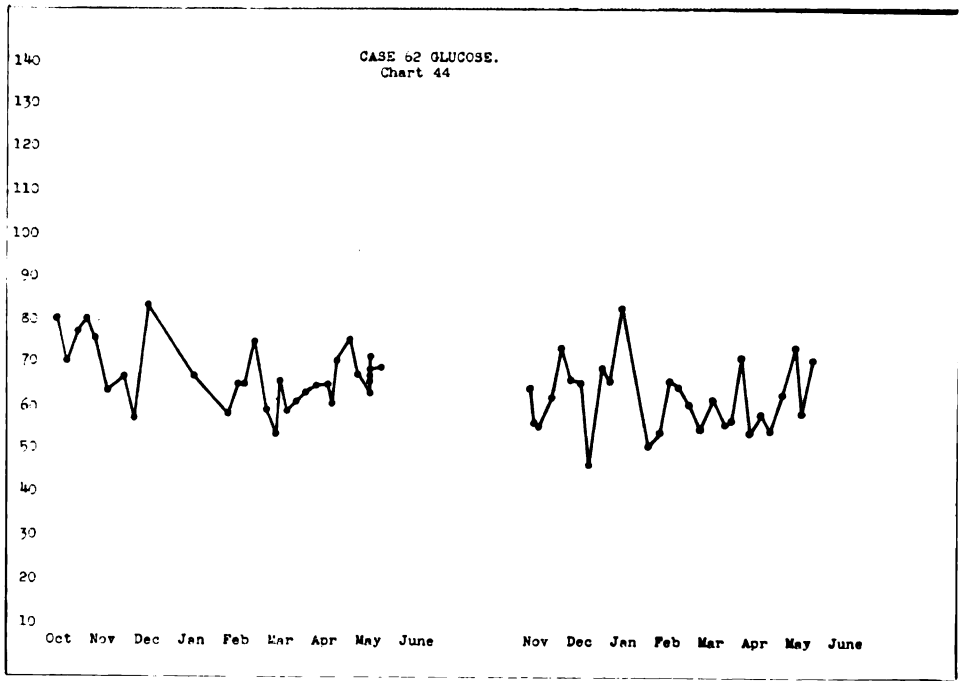
CASE 56 GLUCOSE.
Chart 41



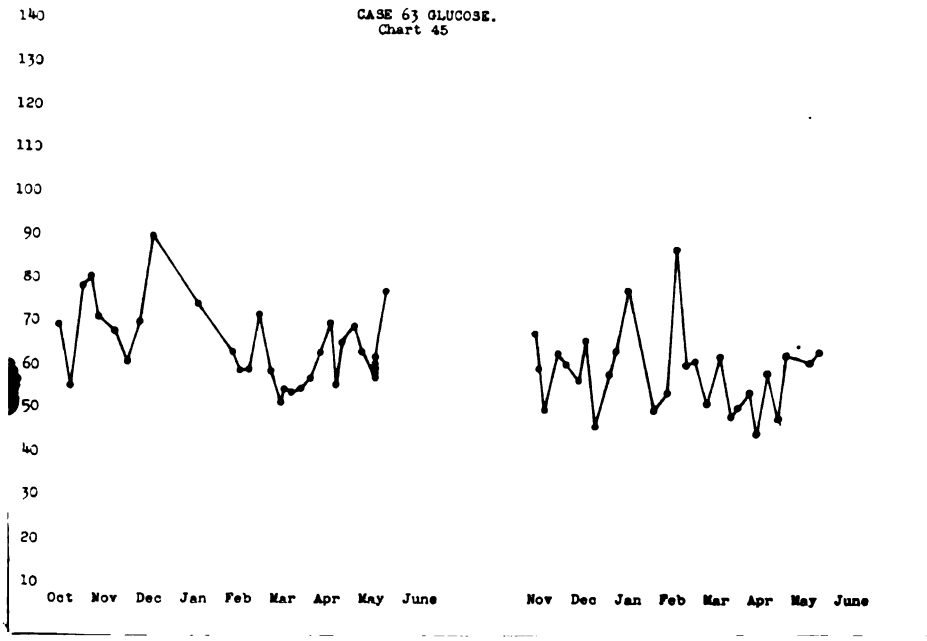
CASE 60 GLUCOSE.
Chart 42




CASE 61 GLUCOSE.
Chart 43
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June


CASE 62 GLUCOSE.
Chart 44
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June

CASE 63 GLUCOSE.
Chart 45



NON-PROTEIN NITROGEN. The method used for determination of non-protein nitrogen was that of Folin and Wu (5). 5 cc. of blood filtrate was put into a large pyrex tube graduated at 35 and 50 cc. and containing 2 glass beads to prevent bumping. Using a micro-burner, the mixture was boiled vigorously until characteristic dense fumes began to fill the tube. The mouth of the tube was then covered with a watch glass, and the mixture was boiled gently until the brown to brownish-black color was replaced by greenish-yellow. The tube was then allowed to cool for 70 to 90 seconds, after which 20 cc. of distilled water was added, very cautiously at first. After cooling further, water was added to the 35 cc. mark. The contents of the tube were then thoroughly mixed, and 15 cc. of Nessler's solution was added. The standard was made up at the same time, using 3 cc. of standard ammonium sulphate solution (containing 1 mgm. of N per 10 cc.), 2 cc. of diluted acid mixture, distilled water, and 30 cc. of Nessler's solution, making the solution up to 100 cc. in a volumetric flask. The samples were then compared with the standard in the colorimeter. The results of non-protein nitrogen determinations are summarized below and presented in Table 13 and Charts 46 to 50 inclusive.

62 non-protein nitrogen determinations on case 58 ranged from 16.22 to 49.18 mgms. per cent, averaging 33.96 mgms. per cent.

61 determinations on case 60 ranged from 24.00 to 60.00 mgms. per cent, averaging 36.95 mgms. per cent.

60 determinations on case 61 ranged from 21.27 to 65.93 mgms. per cent, averaging 34.62 mgms. per cent.

60 determinations on case 62 ranged from 22.64 to 50.00 mgms. per cent, averaging 36.68 mgms. per cent.

59 determinations on case 63 ranged from 21.66 to 54.05 mgms. per cent, averaging 34.37 mgms. per cent.

15 determinations on case 64 ranged from 22.81 to 44.77 mgms. per cent, averaging 36.63 mgms. per cent.

14 determinations on case 65 ranged from 30.00 to 48.78 mgms. per cent, averaging 38.59 mgms. per cent.

15 determinations on case 66 ranged from 26.90 to 44.44 mgms. per cent, averaging 38.57 mgms. per cent.

14 determinations on case 67 ranged from 27.90 to 39.21 mgms. per cent, averaging 33.35 mgms. per cent.

15 determinations on case 68 ranged from 22.30 to 50.84 mgms. per cent, averaging 35.91 mgms. per cent.

17 determinations on case 69 ranged from 21.98 to 48.78 mgms. per cent, averaging 36.00 mgms. per cent.

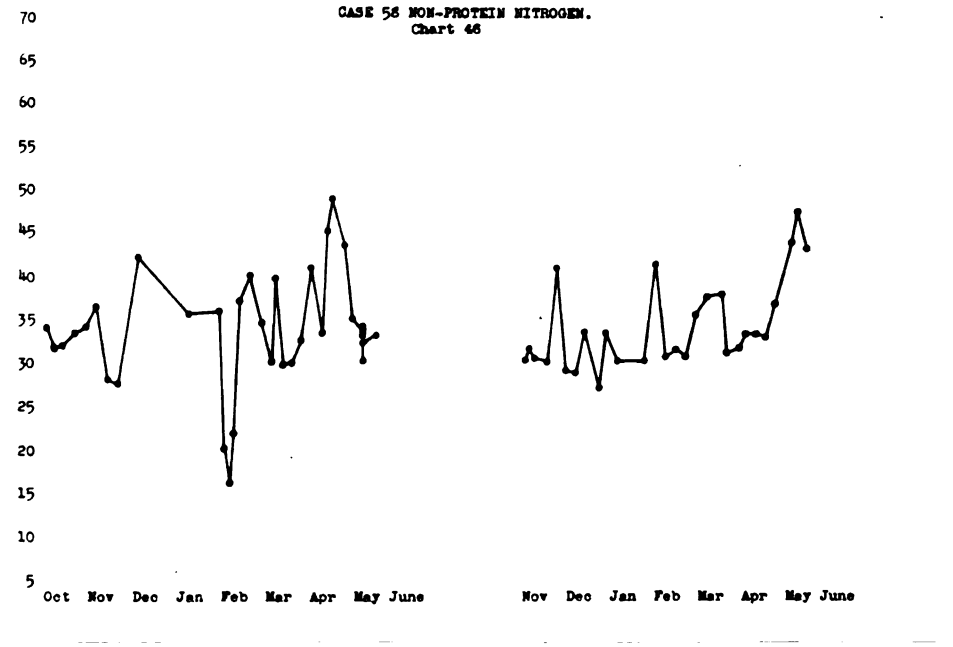
39 determinations on case 31 ranged from 22.55 to 52.16 mgms. per cent, averaging 38.02 mgms. per cent.

Table 13.

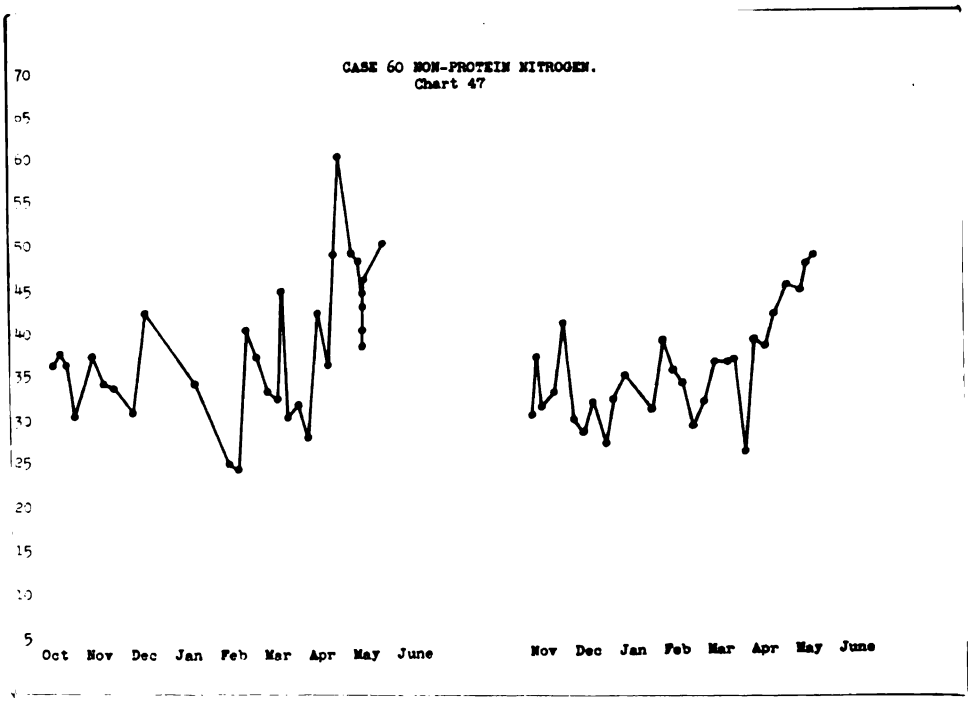
NON-PROTEIN NITROGEN, MGS. PER CENT

Case	No.Samples	Low Reading	High Reading	Average Reading
58	62	16.22	49.18	33.96
60	61	24.00	60.00	36.95
61	60	21.27	65.93	34.62
62	60	22.64	50.00	36.68
63	59	21.66	54.05	34.37
64	15	22.81	44.77	36.63
65	14	30.00	48.78	38.59
66	15	26.90	44.44	38.57
67	14	27.90	39.21	33.35
68	15	22.30	50.84	35.91
69	17	21.90	48.78	36.00
31	39	22.55	52.16	38.02

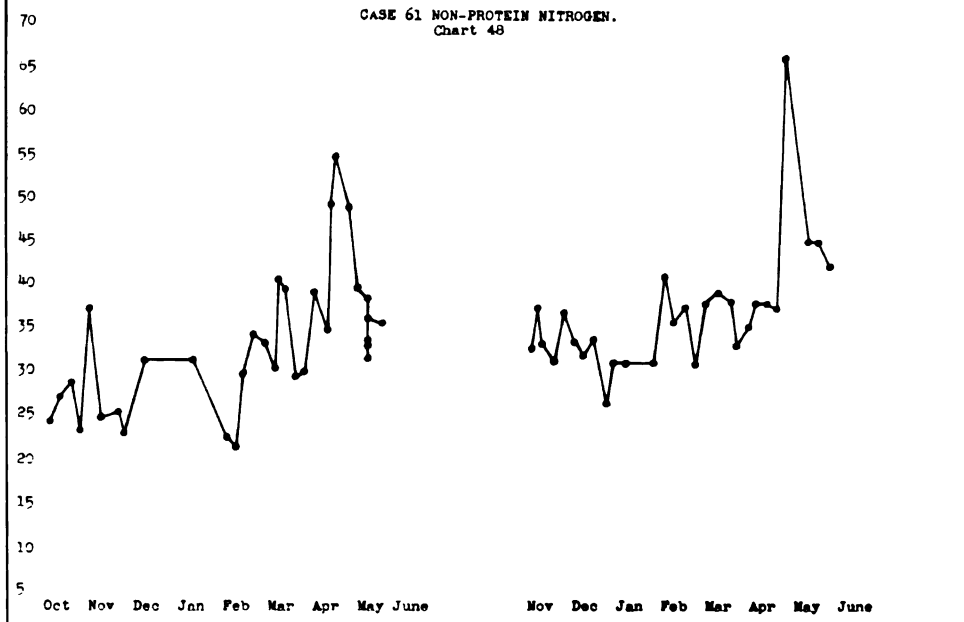
CASE 58 NON-PROTEIN NITROGEN.
Chart 46



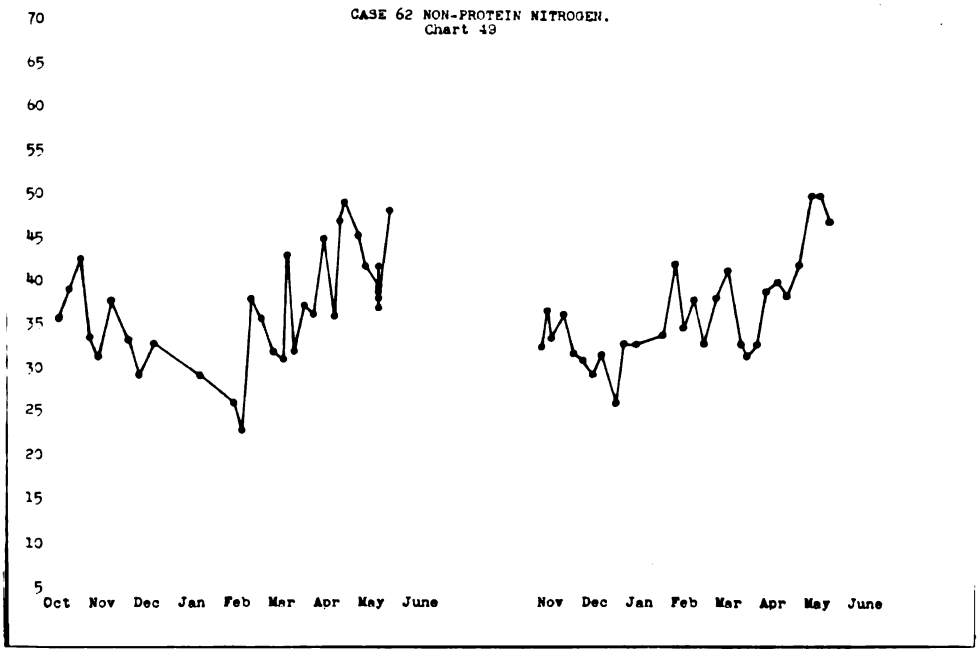
CASE 60 NON-PROTEIN NITROGEN.
Chart 47

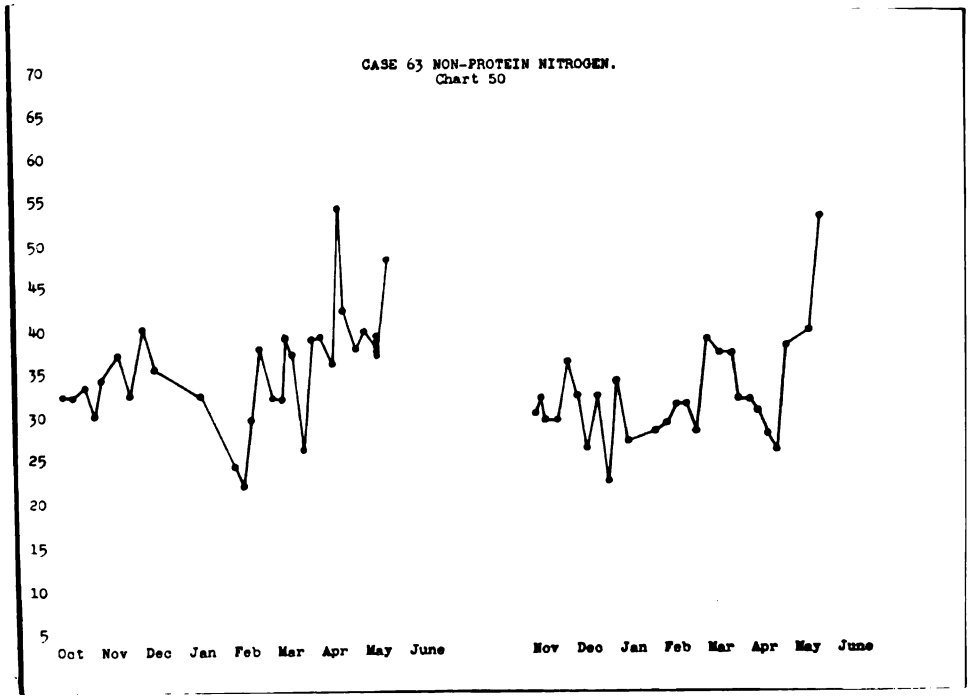


CASE 61 NON-PROTEIN NITROGEN.
Chart 48



CASE 62 NON-PROTEIN NITROGEN.
Chart 49




CASE 63 NON-PROTEIN NITROGEN.
Chart 50
70
65
60
55
50
45
40
35
30
25
20
15
10
5
Oct Nov Dec Jan Feb Mar Apr May June
Nov Dec Jan Feb Mar Apr May June

PREFORMED CREATININE. Determinations of creatinine were made by use of the method given by Hawk and Gergeim (5). 10 cc. of blood filtrate was pipetted into a 50 cc. Florence flask. 5 cc. of standard creatinine solution was placed in a similar flask and diluted to 20 cc. 5 cc. of freshly prepared alkaline picrate solution was added to the unknown and 10 cc. to the standard. The flasks were allowed to stand for 8 to 10 minutes before comparison of colors in the colorimeter. The results of creatinine determinations are summarized below and presented in Table 14 and Charts 51 to 55 inclusive.

62 creatinine determinations on case 58 ranged from 0.98 to 1.53 mgms. per cent, averaging 1.21 mgms. per cent.

61 determinations on case 60 ranged from 1.02 to 1.56 mgms. per cent, averaging 1.26 mgms. per cent.

60 determinations on case 61 ranged from 1.11 to 1.77 mgms. per cent, averaging 1.37 mgms. per cent.

60 determinations on case 62 ranged from 1.06 to 1.83 mgms. per cent, averaging 1.34 mgms. per cent.

59 determinations on case 63 ranged from 1.06 to 1.73 mgms. per cent, averaging 1.31 mgms. per cent.

15 determinations on case 64 ranged from 1.02 to 1.68 mgms. per cent, averaging 1.35 mgms. per cent.

14 determinations on case 65 ranged from 1.02 to 1.51 mgms. per cent, averaging 1.27 mgms. per cent.

15 determinations on case 66 ranged from 1.19 to 1.57 mgms. per cent, averaging 1.33 mgms. per cent.

14 determinations on case 67 ranged from 1.01 to 1.58

mgms. per cent, averaging 1.24 mgms. per cent.

15 determinations on case 68 ranged from 1.05 to 1.64 mgms. per cent, averaging 1.33 mgms. per cent.

17 determinations on case 69 ranged from 1.14 to 1.53 mgms. per cent, averaging 1.3 mgms. per cent.

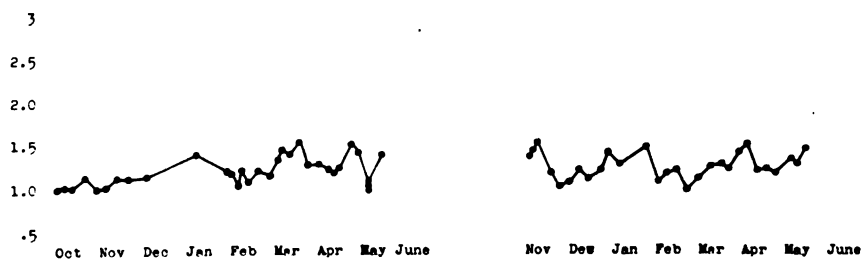
36 determinations on case 31 ranged from 0.91 to 2.17 mgms. per cent, averaging 1.28 mgms. per cent.

PREFORMED CREATININE, MGMS. PER CENT

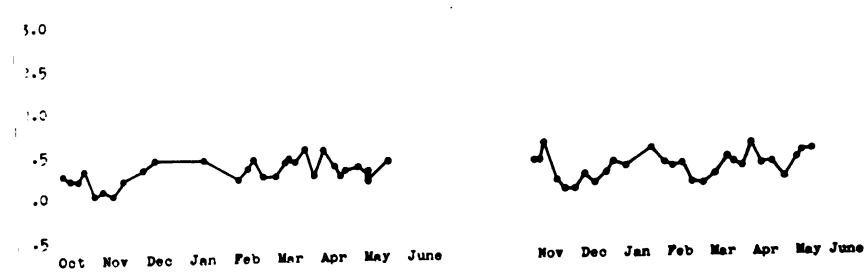
Table 14.

Case	No. Samples	Low Reading	High Reading	Average Reading
58	62	0.98	1.53	1.21
60	61	1.02	1.56	1.26
61	60	1.11	1.77	1.37
62	60	1.06	1.83	1.34
63	59	1.06	1.73	1.31
64	15	1.02	1.68	1.35
65	14	1.02	1.51	1.27
66	15	1.19	1.57	1.33
67	14	1.01	1.58	1.24
68	15	1.05	1.64	1.33
69	17	1.14	1.53	1.30
31	36	0.91	2.17	1.28

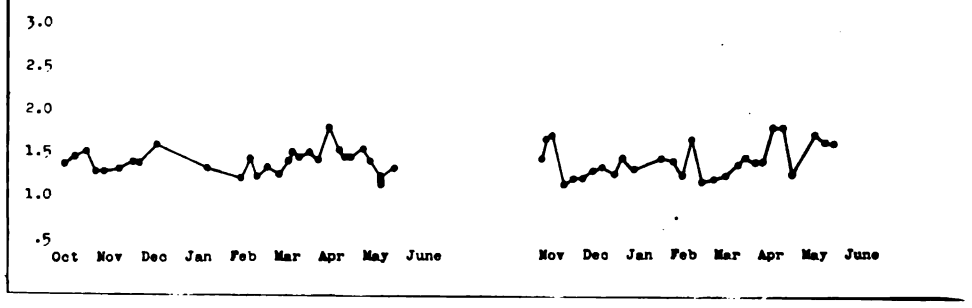
CASE 58 CREATININE.
Chart 51



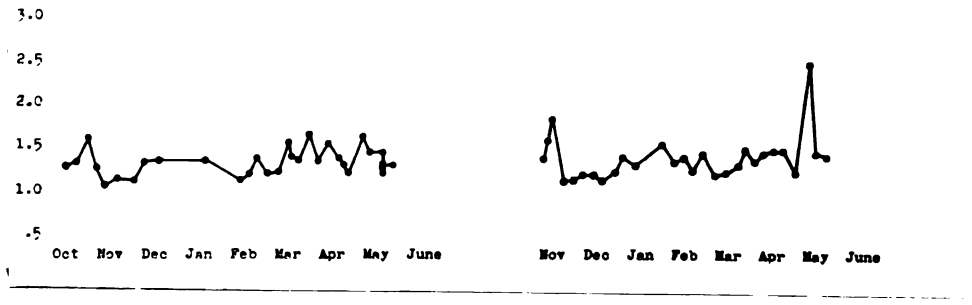
CASE 60 CREATININE
Chart 52



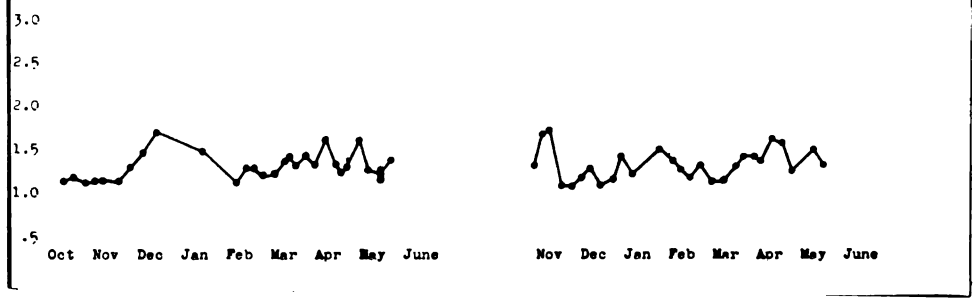
CASE 61 CREATININE
Chart 53



CASE 62 CREATININE.
Chart 54



CASE 63 CREATININE.
Chart 55



BLOOD CHLORIDES. The method of Whitehorn (5) was used for determination of chlorides. 10 cc. of blood filtrate was pipetted into a 50 cc. Florence flask. The Florence flask was much easier to handle than the porcelain dish and more available. 5 cc. of standard silver nitrate was added, the contents mixed, and 5 cc. of concentrated nitric acid added. After standing for 5 minutes, about .3 gram of ferric ammonium sulphate was added as indicator, and the excess silver nitrate was determined by titration with standard thiocyanate solution. A white glass plate was used under the burette to facilitate the determination of the end point. Results of blood chloride determinations are summarized below and presented in Table 15 and Charts 56 to 60 inclusive.

62 determinations on case 58 ranged from 455 to 495 mgms. per cent, averaging 484.6 mgms. per cent.

61 determinations on case 60 ranged from 460 to 495 mgms. per cent, averaging 485.7 mgms. per cent.

60 determinations on case 61 ranged from 450 to 495 mgms. per cent, averaging 483.1 mgms. per cent.

60 determinations on case 62 ranged from 455 to 495 mgms. per cent, averaging 484 mgms. per cent.

59 determinations on case 63 ranged from 470 to 495 mgms. per cent, averaging 486.4 mgms. per cent.

15 determinations on case 64 ranged from 455 to 495 mgms. per cent, averaging 480.8 mgms. per cent.

14 determinations on case 65 ranged from 465 to 495 mgms. per cent, averaging 485 mgms. per cent.

15 determinations on case 66 ranged from 480 to 495 mgms. per cent, averaging 487.8 mgms. per cent.

14 determinations on case 67 ranged from 475 to 495 mgms. per cent, averaging 487.5 mgms. per cent.

15 determinations on case 68 ranged from 475 to 497.5 mgms. per cent, averaging 485.3 mgms. per cent.

17 determinations on case 69 ranged from 460 to 497.5 mgms. per cent, averaging 485.4 mgms. per cent.

36 determinations on case 31 ranged from 470 to 495 mgms. per cent, averaging 487.7 mgms. per cent.

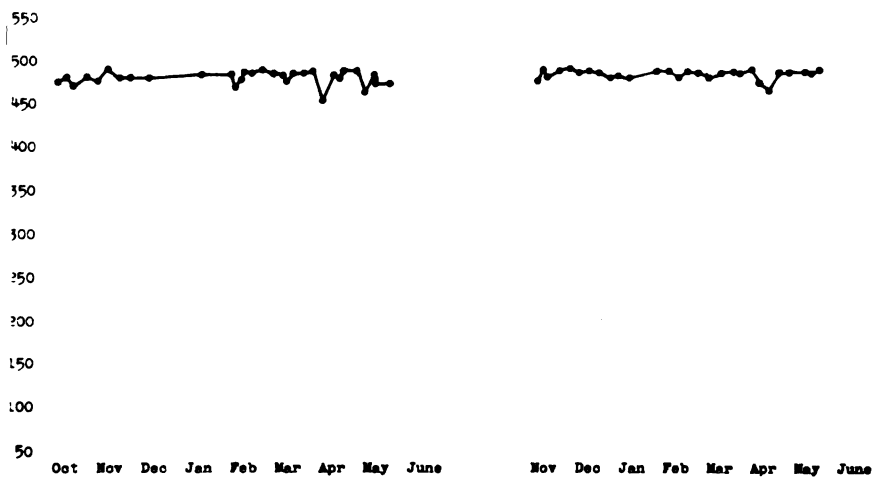
BLOOD CHLORIDES, MGMS. PERCENT

Table 15.

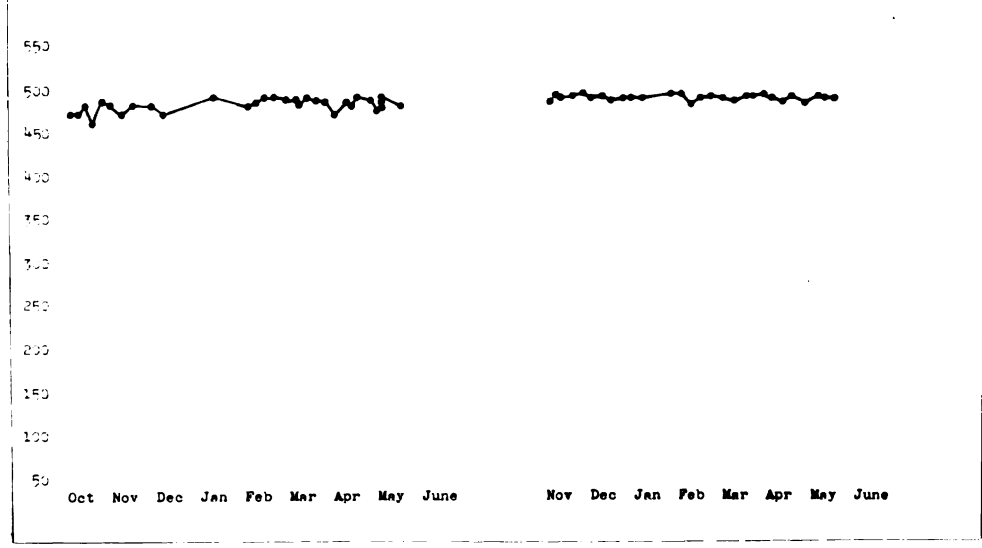
Case	No. Samples	Low Reading	High Reading	Average Reading
58	62	455	495	484.6
60	61	460	495	485.7
61	60	450	495	483.1
62	60	455	495	484
63	59	470	495	486.4
64	15	455	495	480.8
65	14	465	495	485
66	15	480	495	487.8
67	14	475	495	487.5
68	15	475	497.5	485.3
69	17	460	497.5	485.4
31	36	470	495	487.7

After running the blood chloride determinations listed, it was found that in some of the cases where only one drop of standard thiocyanate produced an end-point the results were incorrect. When 6 cc of standard silver nitrate was added instead of the 5 cc called for in the procedure, it was found that some of the samples previously recorded as 495 mgms per cent or above showed values somewhat over 500 mgms per cent. The comparatively small number of high readings would not greatly alter the average values, but the upper range should be placed at somewhat more than 500 mgms per cent rather than 495 mgms per cent.

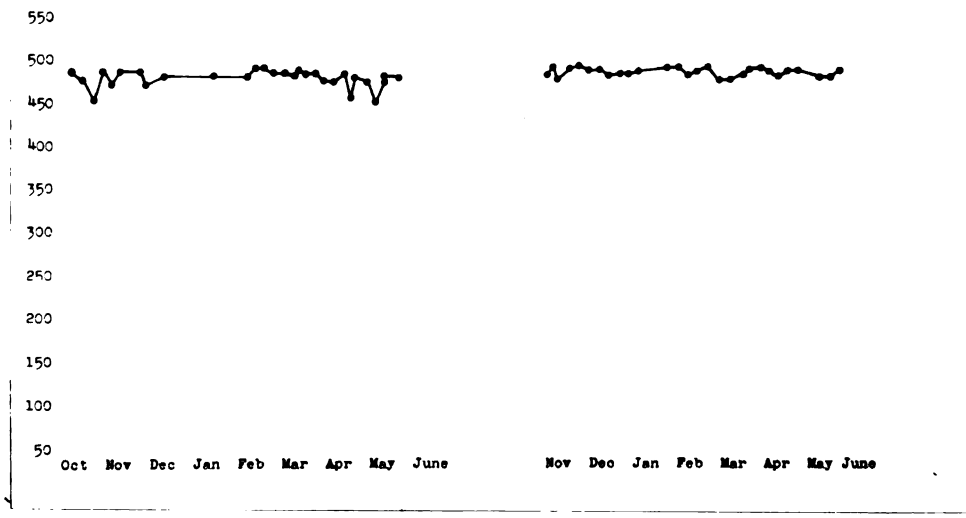
CASE 56 CHLORIDES.
Chart 56



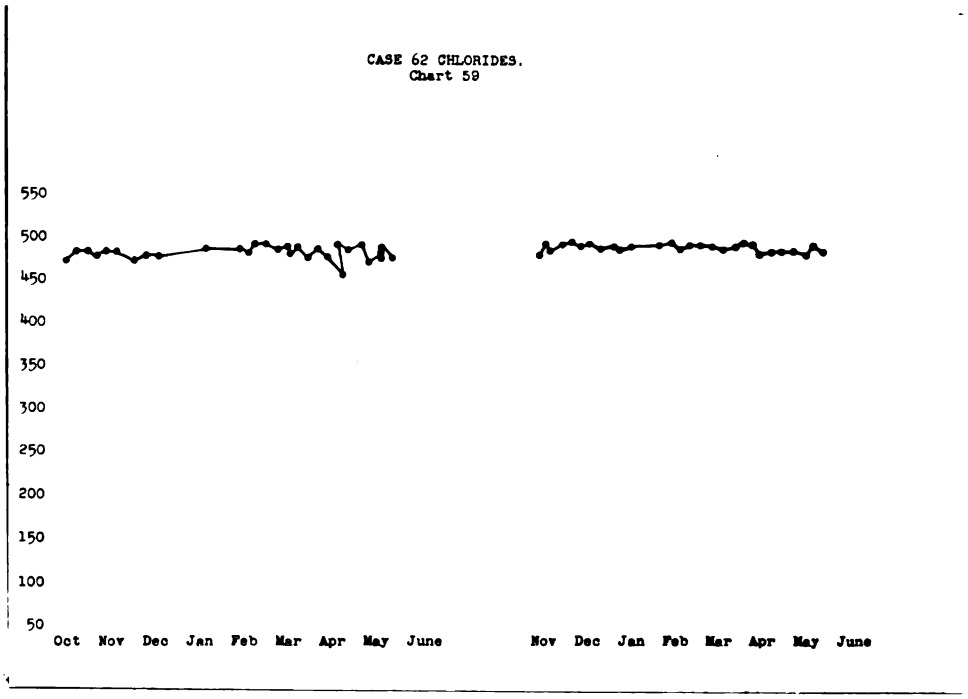
CASE 60 CHLORIDES.
Chart 57



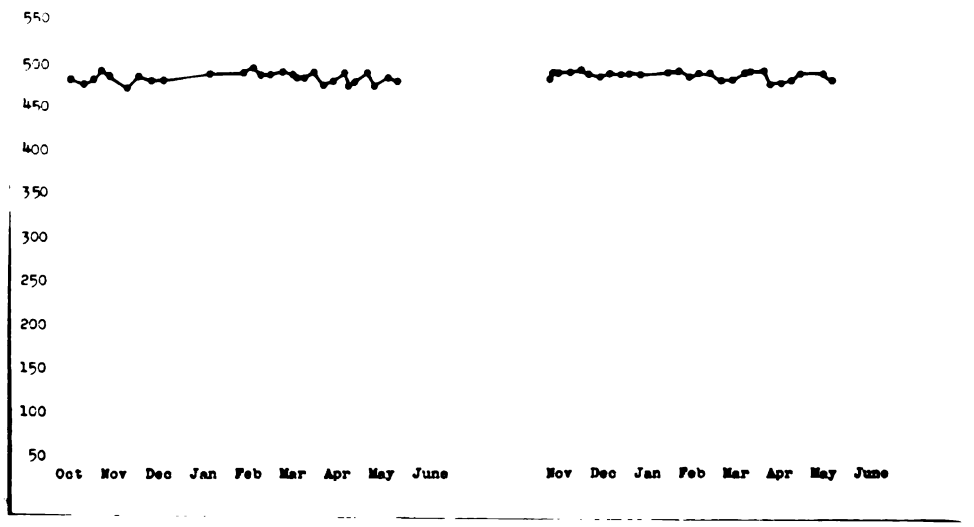
CASE 61 CHLORIDES.
Chart 58



CASE 62 CHLORIDES.
Chart 59



CASE 63 CHLORIDES.
Chart 60



BLOOD URIC ACID. Considerable difficulty was encountered in attempting to determine uric acid in the blood of sheep. The Folin Direct Method (5) was the first procedure tried. All samples failed to show readable amounts of uric acid. The author then ran comparative trials of the Folin Direct Method (5), a modification of the Folin Isolation Method (6), Benedict's Direct Colorimetric Method (7), the Colorimetric Method of Benedict and Behre (7), and the Method of Brown (8). The results were very much alike in all cases. Uric acid in all normal blood filtrates was apparently present in an amount too small to read. In using the 5 methods mentioned above, the Brown Method was selected as a routine test.

10 cc. of blood filtrate was pipetted into a 50 cc. Florence flask with 5 cc. of distilled water. Into another similar flask 5 cc. of uric acid standard was placed, with 10 cc. of distilled water. 5 cc. of sodium cyanide solution was added to each flask, followed by .5 cc. of uric acid reagent. After mixing, the flasks were allowed to stand for 20 minutes and compared in the colorimeter. When the above procedure was followed, none of the samples could be read. The results could be recorded only as traces. It was then decided to try addition of standard to the unknown. This procedure appeared to serve the purpose for comparative work. 5 cc. of the uric acid standard was added to the unknown in place of the 5 cc. of distilled water, and the standard was then taken into consideration in calculating results. Results of blood uric acid determinations are summarized below and presented in Table 16.

18 such determinations on case 58 ranged from 1.02 to 1.22 mgms. per cent, averaging 1.11 mgms. per cent.

18 determinations on case 60 ranged from 1.01 to 1.35 mgms. per cent, averaging 1.13 mgms. per cent.

18 determinations on case 61 ranged from 1.02 to 1.41 mgms. per cent, averaging 1.13 mgms. per cent.

18 determinations on case 62 ranged from 0.9 to 1.72 mgms. per cent, averaging 1.18 mgms. per cent.

17 determinations on case 63 ranged from 0.98 to 1.22 mgms. per cent, averaging 1.11 mgms. per cent.

15 determinations on case 64 ranged from 0.90 to 1.96 mgms. per cent, averaging 1.17 mgms. per cent.

14 determinations on case 65 ranged from 0.86 to 1.61 mgms. per cent, averaging 1.08 mgms. per cent.

15 determinations on case 66 ranged from 0.87 to 1.42 mgms. per cent, averaging 1.04 mgms. per cent.

14 determinations on case 67 ranged from 0.85 to 1.35 mgms. per cent, averaging 0.99 mgms. per cent.

15 determinations on case 68 ranged from 0.89 to 1.48 mgms. per cent, averaging 1.02 mgms. per cent.

17 determinations on case 69 ranged from 0.88 to 1.28 mgms. per cent, averaging 1.02 mgms. per cent.

18 determinations on case 31 ranged from 1.03 to 1.26 mgms. per cent, averaging 1.12 mgms. per cent.

BLOOD URIC ACID, MGS. PERCENT

Table 16.

Case	No.Samples	Low Reading	High Reading	Average Reading
58	18	1.02	1.22	1.11
60	18	1.01	1.35	1.13
61	18	1.02	1.41	1.13
62	18	0.90	1.72	1.18
63	17	0.98	1.22	1.11
64	15	0.90	1.96	1.17
65	14	0.86	1.61	1.08
66	15	0.87	1.42	1.04
67	14	0.85	1.35	0.99
68	15	0.89	1.48	1.02
69	17	0.88	1.28	1.02
31	18	1.03	1.26	1.12

DISEASED CONDITIONS IN SHEEP

DYSTOKIA. One ewe, about 6 years old, was brought in for examination because of dystokia. A mummified fetus was removed. The ewe was kept for observation, and two blood samples were taken from the jugular vein, one week elapsing between samples.

Hemoglobin readings were 12.0 and 11.4 gms. per cent, or 82 and 77 per cent.

Red cell counts were 12,280,000 and 10,400,000 per cmm.

White cell counts were 5,500 and 7,300 per cmm.

Neutrophil counts were 63 and 28 per cent, with about 25 per cent non-segmentated in the first sample and none in the second.

Lymphocyte counts were 34 and 69 per cent. Monocyte counts were 0 and 1 per cent. Eosinophil counts were 3 and 2 per cent. No basophils were noted in either count.

Glucose values were 90.90 and 66.66 mgms. per cent. Non-protein nitrogen values were 41.09 and 17.91 mgms. per cent. Creatinine values were 1.47 and 1.40 mgms. per cent. Uric acid determinations run without addition of standard to the sample were not readable.

In this case it will be noted that at the time of dystokia there was increase in neutrophils with rather low total white cell count. Glucose and non-protein nitrogen values were somewhat elevated at the time of dystokia.

BOTULISM. One ewe suffering from botulism was studied. She was a five-year-old grade. 5 of a flock of 26 ewes died.

The animals showed drooping ears and vertigo, with death in 3 to 4 days. One dead animal was autopsied and a sick one was kept for observation. The animals were kept in a shed, had access to a rather muddy barnyard, and were being fed oats, bean pods, corn silage and alfalfa hay.

The ewe was in good flesh. Her temperature was 103.7 degrees F. She was drooling considerably, held her head low, and staggered when forced to walk around. There was evidence of some facial paralysis.

One half pound of epsom salts and 15 grains of potassium permanganate were given in a large amount of water by stomach tube. Another 15 grains of permanganate was given later in the day. The next morning the ewe was down and in a state of coma. The temperature was 104.2 degrees F. Reflexes were entirely absent. 5 cc. of comphorated oil was injected subcutaneously. About 200 cc. of alcohol was given by stomach tube in a large amount of water. The feces were liquid in nature, but the rumen was still very firm. Contractions of the rumen started soon after administration of the stimulant. 6 cc. of camphorated oil was injected subcutaneously later in the day, but no response was noted. The animal was killed.

A large amount of rather firmly packed, highly fermented material, apparently largely silage, was present in the rumen. No gross lesions were noted in the internal organs. A few parasites were noted in the stomach and intestine.

During the two days four samples of blood were taken from the jugular vein.

Hemoglobin values ranged from 12.5 gms. (86%) to 13.6 gms. (94%), the higher readings being found in the first two samples.

Red cell counts ranged from 9,600,000 per cmm. to 11,740,000 per cmm., showing increase with each successive sample.

White cell counts ranged from 9,000 to 10,800 per cmm., the higher counts being present in the later stages. Neutrophil counts ranged from 61 to 65 per cent, with a majority of non-segmented forms. Lymphocytes ranged from 31 to 35 per cent, monocytes 0 to 8 per cent, eosinophils 0 to 2 per cent, and basophils 0 to 1 per cent.

Glucose values were 163.93, 185.17, 194.27 and 204.00 mgms. per cent, showing a steady increase. Non-protein nitrogen values were 49.58, 42.85, 50.00 and 79.76 mgms. per cent. Creatinine values ranged from 1.11 to 1.35 mgms. per cent. Chloride values ranged from 460 to 480 mgms. per cent. With no standard add to the unknown, uric acid values were not readable.

The changes observed in the blood picture thus consisted of increase in neutrophils, marked increase in blood glucose and considerable increase in non-protein nitrogen.

ENDOMETRITIS AND SEPTICEMIA. One case was studied. The animal became listless, and aborted twin lambs two days prior to autopsy. When brought in, she was in a state of coma.

Most of the lymph nodes were congested and swollen. There was some pleurisy and adhesions on the right side. Numerous

light clay-colored areas 2 to 5 mm. in diameter were scattered through the myocardium. The peritoneum showed marked congestion over the reproductive organs. In the liver there was marked congestion, considerable mottling suggestive of fatty changes, and considerable involvement by light grayish foci of necrosis.

Hemoglobin was 16.5 gms. per cent or 114 %. Red cells were 13,400,000 per cmm. White cells were 5,500 per cmm. The differential count showed 47 per cent neutrophils (33 per cent non-segmented and 14 per cent segmented), 48 per cent lymphocytes and 5 per cent monocytes.

The following were the blood chemistry values obtained. Glucose 62.5 mgms. per cent. Non-protein nitrogen 113.2 mgms. per cent. Creatinine 3.83 mgms. per cent. Chlorides 492.5 mgms. per cent. Uric acid 1.18 mgms. per cent.

Autopsy findings indicated pyometra and septicemia. There was no leucocytosis, but the neutrophils were somewhat increased and present mainly as young forms. A very marked increase of non-protein nitrogen and considerable increase in creatinine were found.

MENINGITIS AND HYDROCEPHALUS. One such case was brought in alive for examination. This was a lamb which developed wry-neck about five weeks after birth, and was going down in condition. A blood sample was taken from the jugular vein just prior to killing. The right eye was blind and there was some purulent discharge. No gross lesions were noted in the eye. On the ventral floor of the cranial cavity there was an abscess just posterior to the optic chiasma, with firm

adhesions of the meninges to the cranial wall. The abscess cavity contained greenish-yellow caseous material. The right lateral ventricle was markedly distended with fluid. The left hemisphere of the cerebrum showed edema and softening. The liver and kidneys showed some evidence of fatty changes.

The hemoglobin reading was 11.1 gms. per cent or 77 per cent. Cell counts revealed 10,160,000 red cells per cmm. and 10,950 white cells per cmm. Differential count showed 52 per cent neutrophils (2 per cent non-segmented and 50 per cent segmented), 44 per cent lymphocytes and 4 per cent monocytes.

Blood chemistry determinations revealed 55.55 mgms. per cent glucose, 33.33 mgms. per cent non-protein nitrogen, 1.35 mgms. per cent creatinine, 495 mgms. per cent chlorides, and 1.37 mgms. per cent uric acid.

It will be noted that the only abnormality is possibly a very slight increase in neutrophils.

PARASITISM. A considerable number of animals was studied with the idea of noting the blood pictures in various intensities of parasitism. Based on autopsy findings or on fecal examinations, these animals were placed in four groups; negative, mild, moderate or marked.

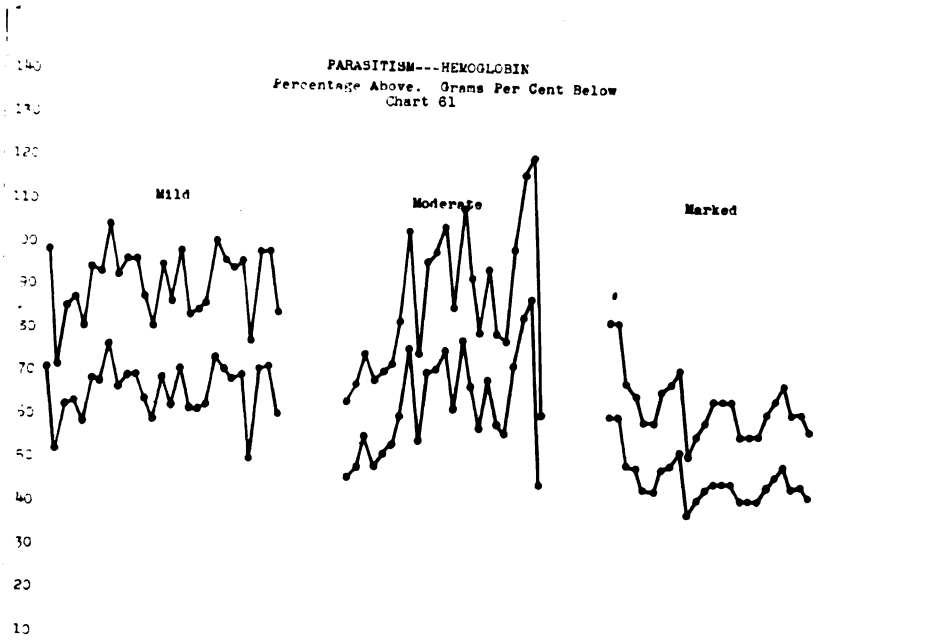
Results of determinations of hemoglobin, red blood cells, white blood cells, neutrophils, lymphocytes, monocytes, eosinophils and basophils are presented in charts 61 to 66 inclusive. Results of determinations of glucose, non-protein

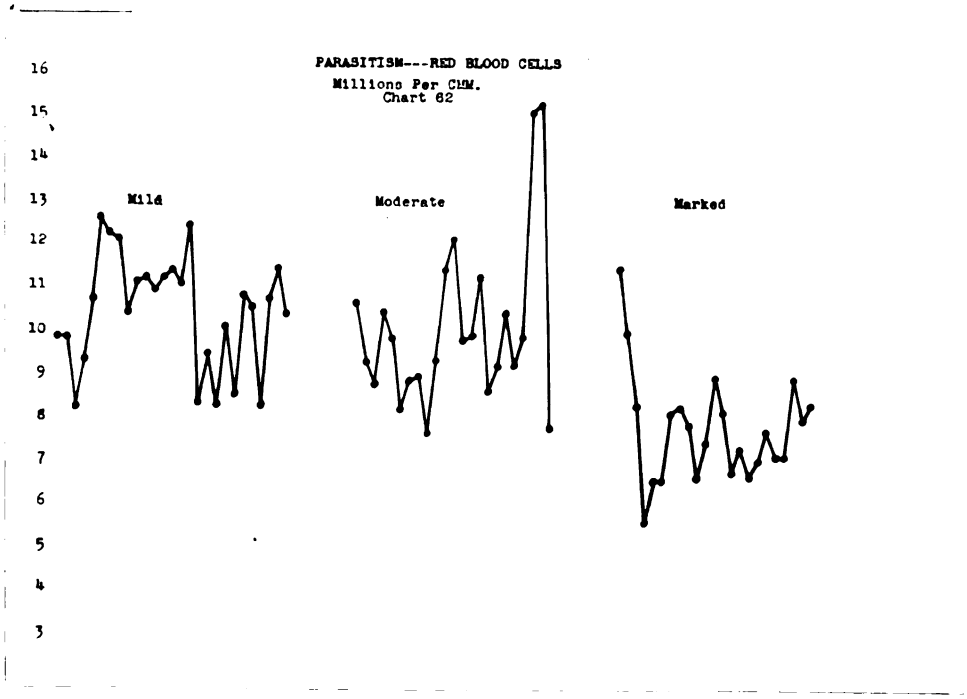
nitrogen, creatinine and chlorides are presented in Charts 67 to 70 inclusive.

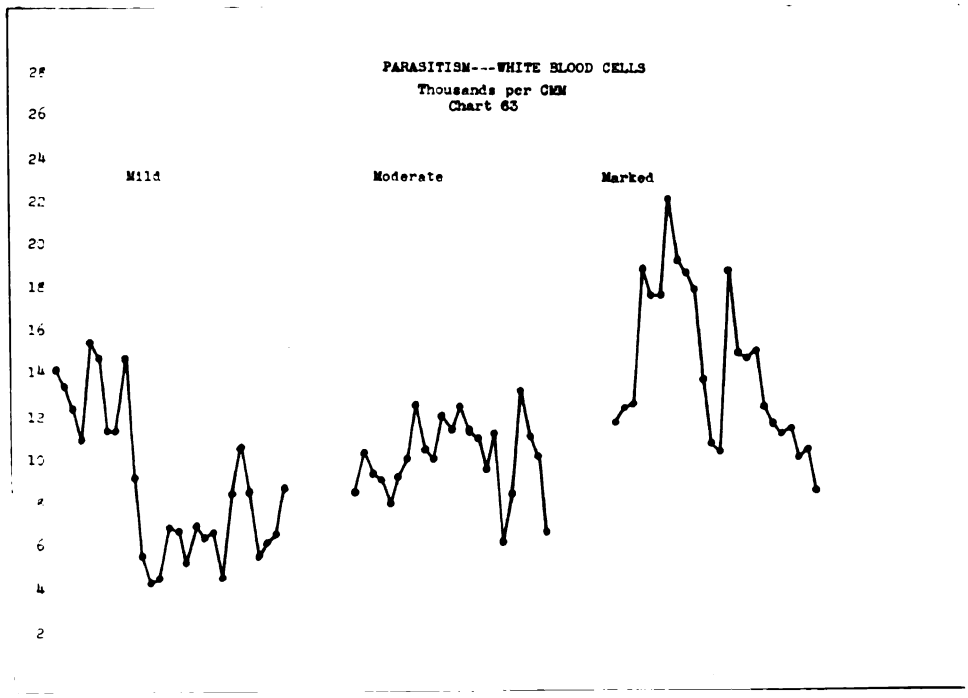
Only two animals were listed as negative, and these are the first two cases in the mild group.

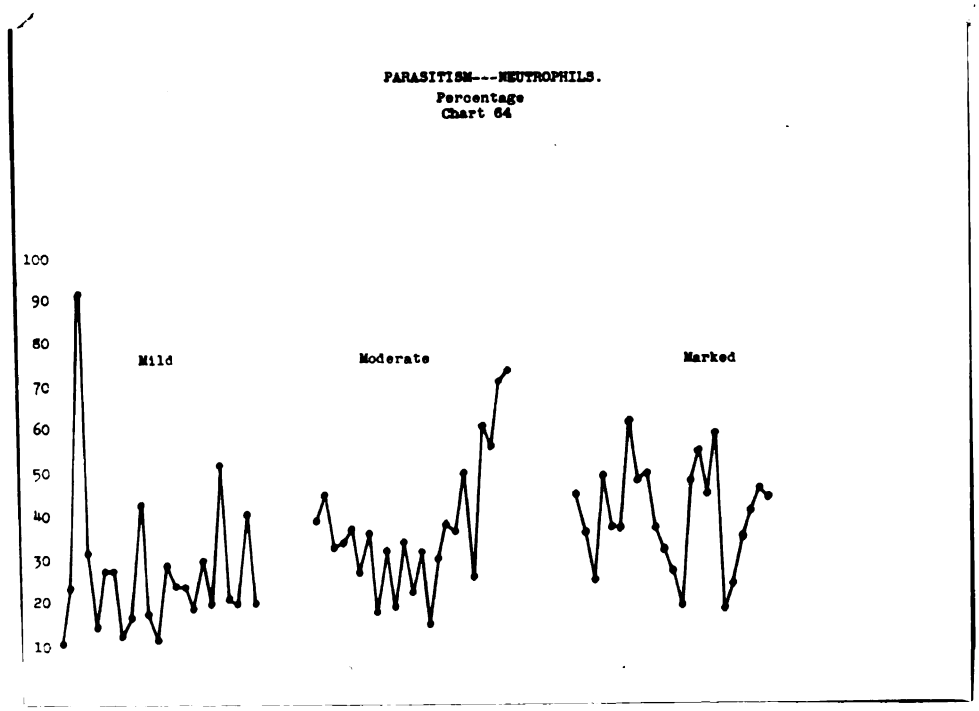
Hemoglobin values in the marked group were definitely lower than in the other groups, as were the red cell values. White blood cell counts were definitely higher in the marked group, but differential counts showed little or no difference.

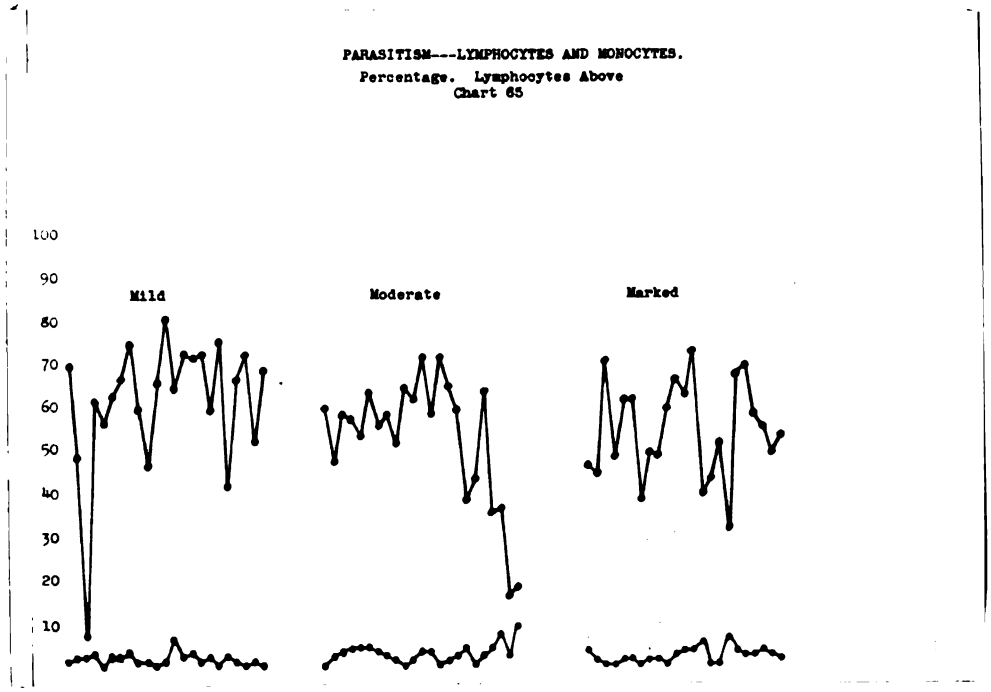
Blood chemistry values showed nothing of importance. The animal having the high glucose value was a feeder lamb suffering from food intoxication and coccidiosis. The animals represented by the high non-protein nitrogen values were ewes which had recently lambed. No evidence of sickness was noted in any of these animals. The ewe with the chloride reading of 430 mgms. per cent was apparently in perfect health. The one with the chloride reading of 425 mgms. per cent had an extensive necrotic inflammation of the lower jaw. These studies indicate that heavy infection with parasites causes reduction of hemoglobin and red cells.

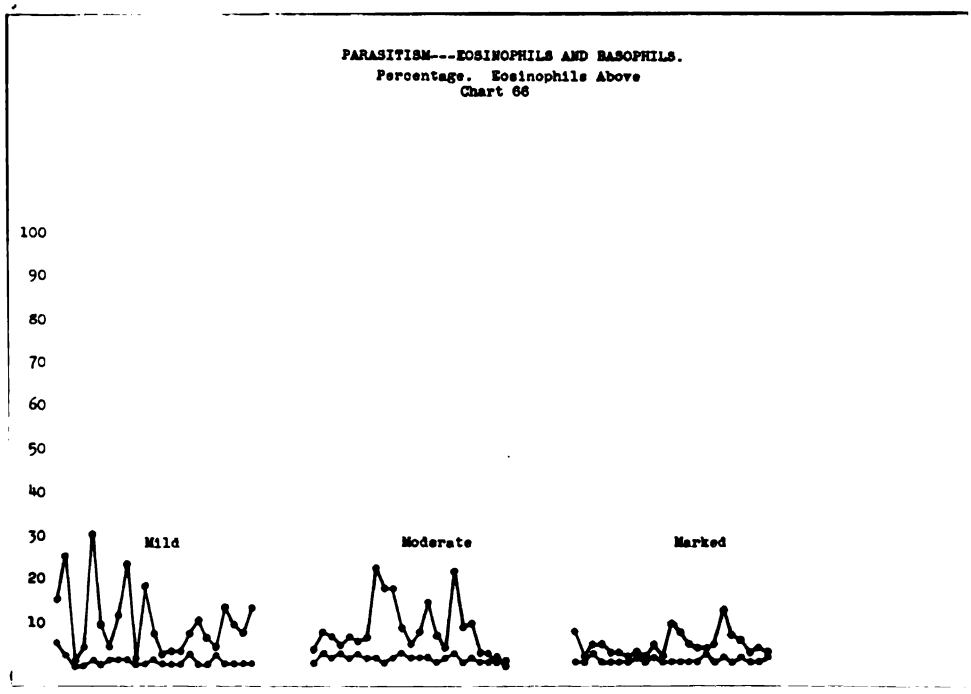

PARASITISM---HEMOGLOBIN
Percentage Above. Grams Per Cent Below
Chart 61
Mild
Moderate
Marked
140
130
120
110
100
90
80
70
60
50
40
30
20
10

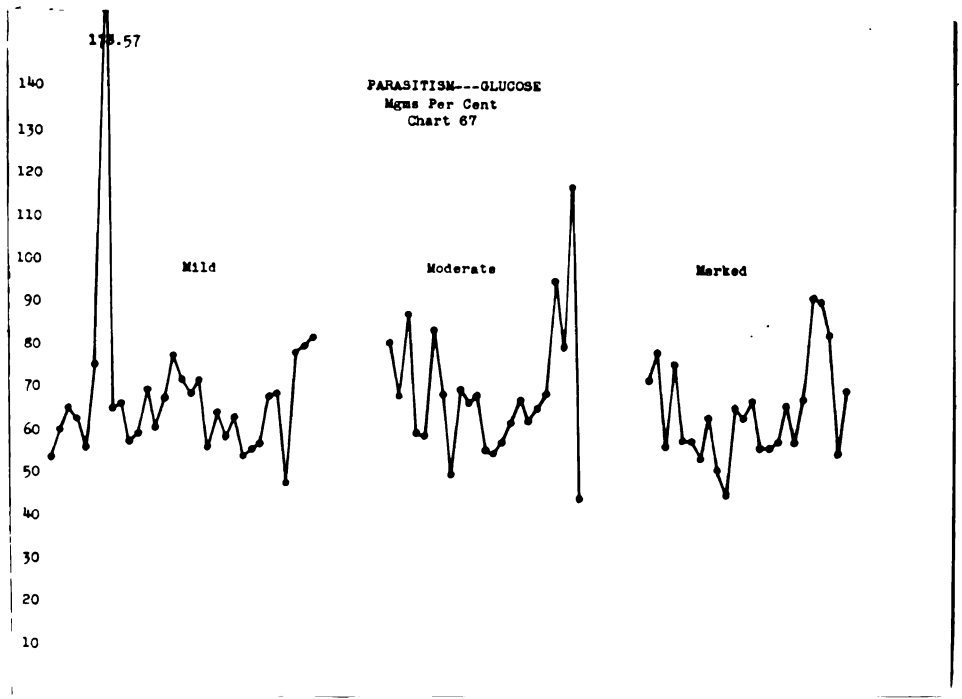

PARASITISM---RED BLOOD CELLS
Millions Per C.M.M.
Chart 62
Mild
Moderate
Marked
16
15
14
13
12
11
10
9
8
7
6
5
4
3

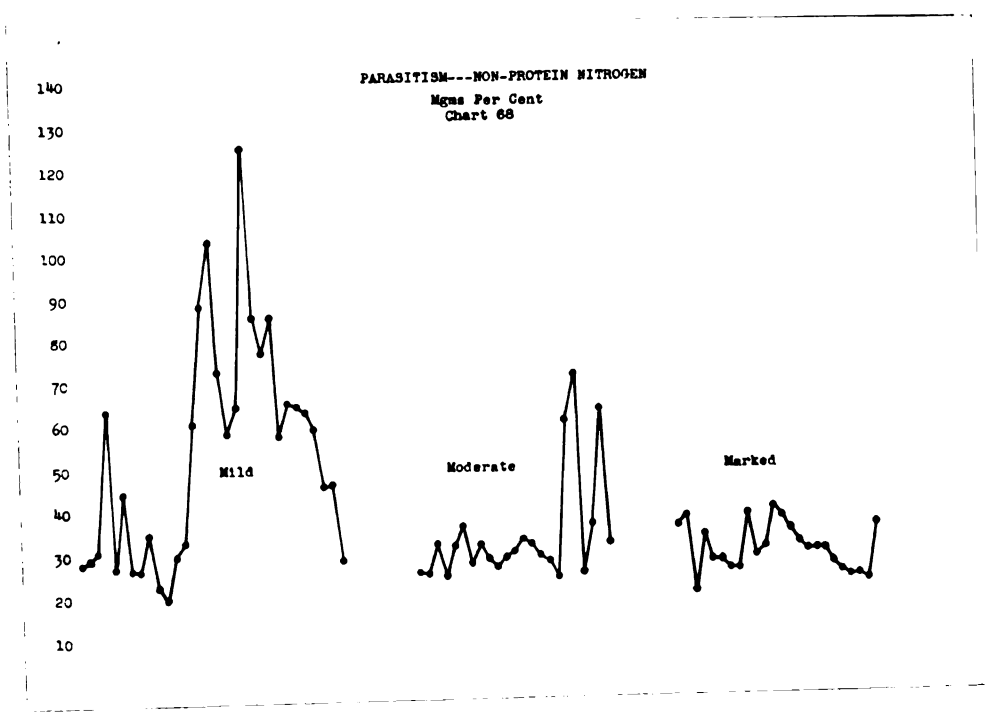

PARASITISM---WHITE BLOOD CELLS
Thousands per CMM
Chart 63
Mild
Moderate
Marked
26
24
22
20
16
14
10
6
4
2


PARASITISM---NEUTROPHILS.
Percentage
Chart 64
Mild
Moderate
Marked
100
90
80
70
60
50
40
30
20
10

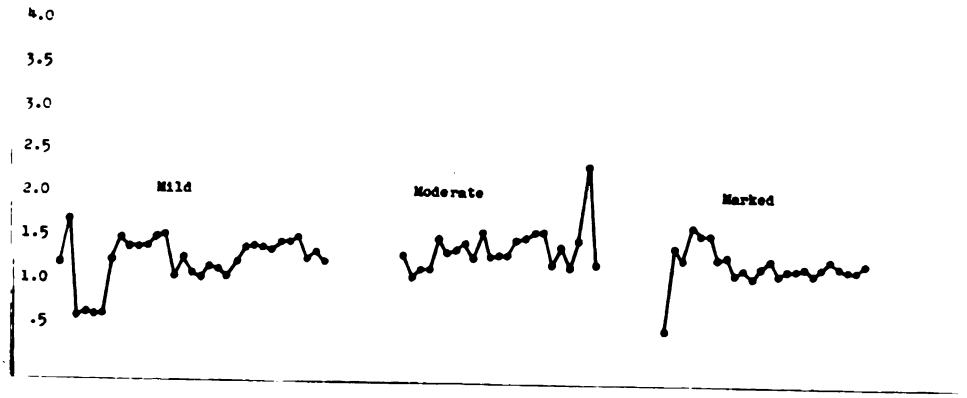

PARASITISM---LYMPHOCYTES AND MONOCYTES.
Percentage. Lymphocytes Above
Chart 65
100
90
80
70
60
50
40
30
20
10
Mild
Moderate
Marked


PARASITISM---EOSINOPHILS AND BASOPHILS.
Percentage. Eosinophils Above
Chart 66
100
90
80
70
60
50
40
30
20
10
Mild
Moderate
Marked

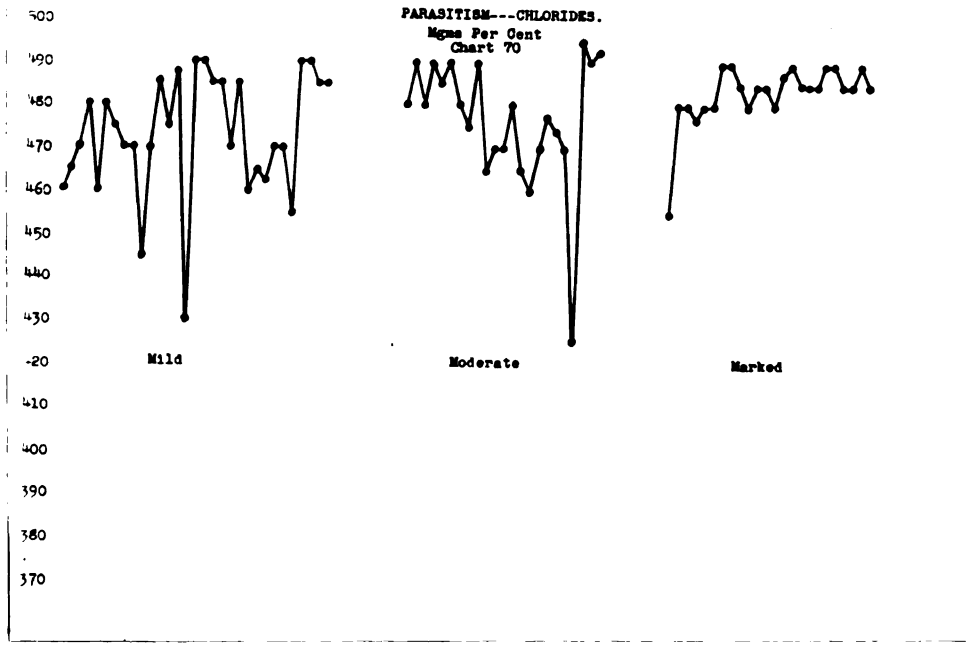

178.57
140
130
120
110
100
90
80
70
60
50
40
30
20
10
PARASITISM---GLUCOSE
Mgms Per Cent
Chart 67
Mild
Moderate
Marked


140
130
120
110
100
90
80
70
60
50
40
30
20
10
PARASITISM---NON-PROTEIN NITROGEN
Mgms Per Cent
Chart 68
Mild
Moderate
Marked

PARASITISM---CREATININE
Mgms Per Cent
Chart 69



PARASITISM---CHLORIDES.
Mgms Per Cent
Chart 70



PARASITISM AND DENTAL CARIES. Two ewes were brought in for examination because of unthriftiness. The owner believed them to be four or five years old. They were found to be aged ewes with extremely bad teeth. One was killed at once and autopsied. There was considerable root infection and dental caries, and many parasites were present in the lungs and digestive tract, including lungworms, stomach worms, thread-neck strongyles, hookworms, and nodular worms.

Slight anemia was evidenced by the hemoglobin reading of 9.5 gms. per cent (65 per cent) and the red blood cell count of 7,150,000 per cmm. The white blood cell count was 15,400 per cmm. Differential white cell count revealed 58 per cent neutrophils (20 per cent non-segmented), 34 per cent lymphocytes, 3 per cent monocytes, 4 per cent eosinophils and 1 per cent basophils.

Blood glucose was increased to 108.10 mgms. per cent. The other blood constituents were present in normal amounts.

The second animal was kept under observation for a week before killing her. The teeth in this animal showed very similar trouble, and two abscesses were present in the tongue. Stomach worms, thread-neck strongyles, whipworms and nodular worms were present in considerable numbers.

Results of studies on two samples of blood were somewhat similar to those in the other animal. Hemoglobin values were 9.4 grams per cent (76 per cent) and 8.2 grams per cent (56 per cent). Red cell counts were 9,100,000 and 8,570,000 per cmm. White cell counts were 11,100 and 10,950 per cmm. Differential cell counts revealed 37 and 35 per cent neutrophils

(16 and 15 per cent non-segmented), 42 and 43 per cent lymphocytes, 3 per cent monocytes, 17 and 18 per cent eosinophils and 1 per cent basophils.

Blood analysis gave normal values for glucose, non-protein nitrogen, creatinine, chlorides and uric acid.

These two animals showed slight anemia, mild to moderate leucocytosis, some relative increase in neutrophils, and an abnormal number of non-segmented neutrophils. One animal showed eosinophilia. Some hyperglycemia was noted in the first animal.

PARASITISM AND GASTRO-ENTERITIS. The owner brought twenty ewes and lambs which had been on poor pasture. At the time this yearling lamb was brought in he had lost 3, and 3 others were sick. They had access to a shed. The feed consisted of clover hay, bean pods, and corn stalks.

The animal was poor, anemic and prostrate. A blood sample was taken from the jugular vein just prior to killing. There was considerable rhinitis. Numerous lungworms were noted in the bronchi of both diaphragmatic lobes of the lung. Chronic bronchopneumonia involved the entire left cardiac lobe and patches of both diaphragmatic lobes. The liver was swollen, quite friable, and rather yellow in color. The rumen and reticulum contained considerable fluid and ground feed. The omasum was practically empty. A few trichostrongyles were present in the abomasum which showed congestion and edema of the mucosa. A moderate number of Nematodirus and hookworms were found in the small intestine, the

mucosa showing numerous hemorrhagic hookworm foci. There was follicular enteritis throughout most of the small intestine. Nodules were fairly numerous in the small intestine, cecum and large intestine. The kidneys showed some swelling and congestion.

Blood findings were as follows: hemoglobin 12.4 gms. per cent (85 per cent); red cells 11,260,000 per cmm.; white cells 45,600 per cmm.; neutrophils 92 per cent (42 non-segmented); lymphocytes 8 per cent; glucose 135.13 mgms. per cent; non-protein nitrogen 22.90 mgms. per cent; and uric acid 1.08 mgms. per cent.

The abnormalities in this case were marked leucocytosis, marked relative neutrophilia with high percentage of non-segmented forms, and hyperglycemia.

PERITONITIS. The case was a feeder lamb which was found very sick and was brought in for examination.

The chest showed no gross lesions. There was some excess fluid in the peritoneal cavity, with some clumps of fibrin. A considerable amount of fibrous and fibrinous adhesion was noted in the region of the pyloris, due to perforation of the duodenum by a large ulcer. The liver showed considerable evidence of fat. The kidneys were congested and swollen.

Blood values were as follows: hemoglobin 16.3 grams per cent (111 per cent); red cells 10,800,000 per cmm.; white cells 21,400 per cmm.; neutrophils 50 per cent; lymphocytes 37 per cent; monocytes 13 per cent; glucose 71.94

mgms. per cent; non-protein nitrogen 63.96 mgms. per cent; creatinine 3.33 mgms. per cent; chlorides 450 mgms. per cent; and uric acid 4.57 mgms. per cent.

Although the red cell count was about normal, the hemoglobin value was high. The leucocytosis with some relative neutrophilia was a change to be expected. Non-protein nitrogen showed considerable increase. Creatinine and uric acid both showed marked elevation.

PNEUMONIA. Five cases were diagnosed as pneumonias. The blood cytology and chemistry values are recorded in Tables 17, 18 and 19.

Case 1 was a month old lamb which was raised by hand. Because of ophthalmitis and unthriftiness, the lamb was brought in for autopsy. Both eyes were markedly involved. The thoracic lymph nodes showed marked edema and congestion. Numerous pleuritic adhesions were noted. Patchy pneumonia involved much of the left anterior lobes and about one quarter of the diaphragmatic lobe. On the right side most of the lung was destroyed, only a thin shell of atelectatic tissue remaining, adherent to the chest wall. A large cavity filled with foul-smelling fluid was present. The liver showed some evidence of degenerative changes, and considerable icterus was noted. Some degenerative changes were noted in the kidneys.

This case showed marked anemia, marked leucocytosis, marked relative neutrophilia, and moderate hyperglycemia.

Case 2 was a yearling lamb which showed evidence of marked

pneumonia after dipping 3 or 4 weeks before examination, and remained unthrifty. Chronic bronchopneumonia involved a large part of the left anterior lobes and a portion of the diaphragmatic lobe. An encapsulated abscess about 1 cm. in diameter was present in the right diaphragmatic lobe.

Blood studies revealed moderate leucocytosis with moderate neutrophilia. All other values were about normal.

Case 3 was a five year old caracul ewe brought into Michigan from New Mexico about 2 months prior to autopsy. She showed evidence of respiratory trouble soon after arrival. The animal was thin, prostrate, and showed much discharge from both the eyes and nose. The temperature was 102.2 degrees F. The thoracic lymph nodes were swollen, edematous and congested. On the right side the diaphragmatic lobe of the lung was covered by sero-fibrinous exudate about 1 cm. thick. Considerable fibrinous and fibrous adhesions were noted in both pleural cavities. On the left side the anterior lobes were almost completely solidified, and many abscesses 2 to 4 mm. in diameter were noted. About half of the diaphragmatic lobe was involved by pneumonia, lobar in type and in the stage of gray hepatization. Some necrotic foci were noted. The right anterior lobes were similar to the left, and a similar condition involved a small anterior portion of the diaphragmatic lobe. The liver and kidneys showed much congestion and swelling. Much fluid material was noted in the digestive tract.

Blood study of this case revealed some anhydremia, neutropenia with few young neutrophils and many myelocytes, high

non-protein nitrogen, high creatinine, low chloride, and high uric acid.

Case 4 was a four year old ewe showing lassitude, drooping ears and emaciation. There was labored breathing and some bloat. Considerable edema involved the substernal tissues. The visceral pleura on the right side was much thickened to form the wall of a large cavity containing dirty brownish, foul-smelling fluid. Only a small fibrotic portion of the lung remained, and this contained many small cavities. The left lung showed some congestion. The peritoneal cavity contained a large quantity of serous fluid and much fibrin, with some adhesions. Some congestion and fatty areas were noted in the liver. The abomasum showed some congestion and a moderate number of H. contortus. The kidneys were somewhat swollen and congested.

In this case, blood studies revealed a moderate leucocytosis as the only marked abnormality.

Case 5 was a western feeder lamb which had been noticed sick for 3 or 4 days prior to autopsy. The temperature was 103.4 degrees F., and respiration was somewhat labored. The prescapular, bronchial and mediastinal lymph nodes showed some swelling and edema. Some fibrinous pleurisy involved the right lobes. On the right side, the anterior lobes and a portion of the diaphragmatic lobe were much enlarged and solidified, and much early necrosis was noted. The right cavities of the heart were dilated. The liver showed passive congestion. Some H. contortus were present in the abomasum, and the mucosa contained a moderate number of petechiae.

Moderate inflammation involved the small intestine, and numerous coccidia lesions were present. The kidneys showed some swelling and indication of fatty degeneration.

Some indication of anhydremia, moderate leucocytosis, very high non-protein nitrogen, high creatinine, and moderately low chloride were found in the blood study.

PNEUMONIA

Table 17.

Case	Hemoglobin Gms %	%	Red Blood Cells Per cmm	White Blood Cells Per cmm
1	7.8	54	5,960,000	55,400
2	10.4	79	10,210,000	14,900
3	16.0	110	14,300,000	2,550
4	11.6	80	8,400,000	14,000
5	16.9	116	12,260,000	16,550

Table 18.

Case	Neutrophils	Lymphocytes	Monocytes	Eosinophils	Basophils
1	86%	11%	3%	0%	0%
2	60%	38%	1%	1%	0%
3	4% Myelocytes 28%	64%	2%	2%	0%

Table 19.

Case	Glucose Mgms %	Non-protein N Mgms %	Creatinine Mgms %	Chlorides Mgms %	Uric Acid Mgms %
1	105.81	26.90	1.02	475	
2	70.67	26.43	1.21	485	
3	75.47	150.00	5.45	380	2.27
4	65.14	45.80	1.04	488	1.64
5	77.22	206.89	3.12	445	1.37

INTOXICATIONS. Seven cases were placed under the heading of intoxications.

Case 1 was a four year old ewe brought in for examination. The animals were on pasture of quack and June grass, with no grain. Some bean pods were fed. The temperature was normal, the respiration somewhat labored, and there was a tendency to throw her head backward. She had difficulty in standing.

The liver was somewhat congested. The rumen contained a mass of matted, rather dry material, mainly hay, some of which was very firmly adherent to the mucosa. All of the other compartments were practically empty. Many Oe. columbianum and one M. expansa were noted in the small intestine. The cecum and large intestine contained much soft feces, and the mucosa was markedly congested. The kidneys showed congestion and some softening.

Blood study revealed rather high hemoglobin, somewhat high red cell count, moderate leucocytosis and marked hyperglycemia.

Case 2 was a ram lamb which had been failing for several weeks. The bowels were very loose and there were symptoms indicative of intoxication. The feed consisted of shredded corn fodder, alfalfa hay and oats. Iodized salt and bone meal were before them at all times. The owner lost six animals. This animal was kept under observation for 8 days during which 7 blood samples were studied. The animal showed some improvement.

Anemia and moderate leucocytosis were the only abnormalities noted in blood studies, and the table indicated some

improvement.

Case 3 was a ten month old wether lamb on rather long-continued heavy feeding. It was down and showing nervous disturbances.

The brain showed marked congestion. Much congestion of the peritoneum was noted over the stomach and intestine. The rumen contained a large amount of fluid in which there was only a small of food. Over a considerable area of the mucosa a mat of food material was quite firmly adherent. Some patchy necrosis of the mucosa was noted. The remainder of the stomach and the small intestine were negative. Considerable fluid containing many very firm, dark brown clumps of fecal material, was present in the cecum and large intestine. The kidneys showed no gross lesions.

Blood study revealed moderate leucocytosis with relative neutrophilia, moderate hyperglycemia and very high non-protein nitrogen.

Case 4 was a nine month old female lamb, one of a flock being fed corn and alfalfa in self-feeders. The owner had lost 22 animals. The animal brought in was undersized and poor, but no definite symptoms were noted. A considerable number of D. filaria were found in the bronchi of each diaphragmatic lobe of the lungs and some bronchopneumonia was noted. The liver was congested. A moderate amount of food material in the rumen consisted almost entirely of alfalfa hay, with only a few kernels of corn noted. The abomasum contained a few Trichostrongyles.

Blood study revealed moderate leucocytosis, relative

neutrophilia, very marked hyperglycemia, and rather marked increase of non-protein nitrogen.

Case 5 was a feeder lamb brought in for examination. The owner had lost 18, the main symptoms being diarrhea.

The temperature was 104.6 degrees F. Some nasal discharge, weakness, emaciation and diarrhea were noted. Some rhinitis was present. The liver was congested and contained a few Oe.columbianum nodules. In the rumen there was much corn and green feed with much fermentation and a strong odor. Some congestion was noted in the mucosae of the abomasum and small intestine. Numerous N. spathiger and many coccidia lesions were present in the small intestine.

Blood study revealed moderate leucocytosis with neutrophilia, hyperglycemia, very high non-protein nitrogen, high creatinine and low chlorides.

Case 6 was a six year old ewe, one of a flock on pasture and a ration of alfalfa and oats. One animal had died and another was sick.

The animal showed anorexia, weakness and some mucopurulent exudate in the nasal passages. The temperature was 104.6 degrees f. Numerous ticks were noted, the skin was dry and scaly, and large patches of wool had been shed. There was some rhinitis. Three grubs were present in the frontal sinuses. The brain was much congested. Some fibrinous pleurisy and excess fluid were noted in the pleural cavity. A spherical mass in the right apical lobe of the lung showed bronchopneumonia with some necrosis. A few lungworms were noted in the bronchi of the diaphragmatic lobes. Much of the peritoneal fat was involved by so-called

fat necrosis, most marked around the kidneys. The liver was a very light yellowish clay color and extremely friable. The rumen contained a large amount of fluid and some finely ground feed. Many Trichostrongyles were present in the abomasum. Except for a few nodules, the small intestine was negative. A few nodules and Oe. columbianum were noted in the cecum and large intestine. Some large masses of very firm, dry feces suggested previous constipation.

Blood study revealed marked anemia, moderate leucocytosis with relative neutrophilia, and mild hyperglycemia.

Case 7 was a female feeder lamb which was showing some respiratory symptoms and was down most of the time. Pneumonia involved the right anterior lobes and some patches in the diaphragmatic lobe. Some patchy pneumonia was present in the left anterior lobes. The only gross changes noted in the abdomen were in the cecum and colon. Considerable congestion and some hemorrhages were present in the mucosa. The fecal material consisted of some fluid and considerable rather firm, dark brown material.

Blood study of this case showed no changes other than a mild leucocytosis.

The results of blood studies on cases diagnosed as intoxications are presented in Tables 20, 21 and 22.

INTOXICATIONS
Table 20.

Case	Hemoglobin Gms %	%	Red Blood Cells Per cmm.	White Blood Cells Per cmm.
1	15.4	106	12,550,000	13,800
2	5.0	35	6,990,000	14,500
	4.8	33	8,740,000	14,400
	5.0	36	8,100,000	10,600
	5.0	36	8,890,000	12,200
	5.0	35	9,600,000	15,600
	5.0	35	9,190,000	9,700
	6.8	48	9,100,000	8,800
3	12.6	87	9,696.000	15,000
4	7.2	54	8,800,000	17,500
5	14.3	99	12,160,000	20,200
6	5.4	56	3,920,000	18,200
7	14.4	100	10,500,000	14,300

Table 21.

Case	Neutrophils	Lymphocytes	Monocytes	Eosinophils	Basophils
3	69%	18%	13%	0%	0%
4	70%	24%	3%	3%	0%
5	74%	21%	5%	0%	0%
6	81%	18%	1%	0%	0%
7	20%	70%	3%	1%	1%

Table 22.

Case	Glucose Mgms %	Non-protein N Mgms %	Creatinine Mgms %	Chlorides Mgms%	Uric Acid Mgms %
1	165.25	48.00	1.34	475	1.24
2	72.72	37.03	1.51	495	1.40
	74.34	29.70	1.27	499	1.76
	73.73	30.30	1.38	485	1.90
	81.32	26.66	1.13	490	1.08
	77.22	26.20	1.35	485	1.25
	76.33	31.41	1.14	490	1.09
	76.84	30.15	1.19	485	1.17
3	93.02	171.40	4.61	450	2.08
4	266.66	95.23	1.72	450	
5	153.84	133.33	3.1	335	1.91
6	95.69	27.02	1.5	490	1.48
7	53.33	39.21	1.5	455	

PREGNANCY DISEASE. Nine cases were classed under this heading based on history, symptoms and autopsy findings.

Case 1 was a six year old ewe. The owner put the ewes in a barn two weeks prior to examination and was feeding alfalfa, mixed hay and sweet clover hay. Three had died and five were sick; all pregnant ewes. The symptoms noted were inability to rise, hind legs stretched out to the rear, grinding of the teeth, and death in three to four days.

Autopsy revealed very little marked changes in the internal organs. The brain showed marked congestion. Considerable congestion and edema of the lungs were noted. The liver was a light, rather even yellow clay color and very friable. The rumen contained a mass of rather firm food material, entirely hay. Both kidneys were congested and mottled in appearance, apparently involved by degenerative changes. The uterus contained two well developed lambs.

Blood cytology revealed nothing abnormal. Blood chemistry study revealed marked increase in non-protein nitrogen and in creatinine.

Case 2 was a two year old Western female. Three pregnant ewes had died and two were sick. Until two weeks prior to this examination the ewes had been in a field of corn stalks. They were put in the barn and fed beans, oats and mixed hay according to the owner.

The ewe was down and in a state of partial coma. The temperature was 103.4 degrees F. Some verminous bronchopneumonia was noted in each diaphragmatic lobe, and numerous D. filaria were present in the bronchi. The liver was yellow and friable, very similar to that described in Case 1. The

rumen contained a rather sour, firm mass of food material, apparently entirely hay. Some Trichostrongyles were noted in the abomasum, and the mucosa was congested. The large intestine contained some sticky mucus and many Chabertia ovina. No gross lesions were noted in the kidneys. The uterus contained two well developed lambs.

Blood study revealed moderate leucopenia with relative neutrophilia, and hypoglycemia.

Case 3 was a five year old ewe in advanced pregnancy. Due to severe weather conditions the animals were in the barn most of the time. Three ewes had died. According to the owner the feed consisted of oats and alfalfa hay. The animal brought in was in a state of partial coma, with rotating eyes and a tendency to keep the head swung around to the left side. Her temperature was 105.3 degrees F. 22 grams of glucose in 100 cc. of distilled water was injected intravenously, followed by some response of short duration. No response followed similar treatment the next morning. She died a few hours later while being prepared for a Caesarian operation.

The brain showed much congestion. Some congestion was noted in the lungs. A small amount of patchy bronchopneumonia involved the anterior lobes of the lungs. The liver was similar to those in previous cases. A rather large amount of fluid containing some finely ground hay was present in the rumen. The abomasum contained similar material. The intestinal mucosa was congested. Some nodules were present in the intestinal and cecal walls, and a few Oe.

columbianum were found in the large intestine. Both kidneys showed congestion, swelling and evidence of fat. The uterus contained two well developed lambs.

Two blood samples taken on entry and the next morning gave very similar values. Slight neutrophilia and slight hypoglycemia were the only abnormalities.

Case 4 was a five year old ewe in advanced pregnancy, brought in for examination early in April. The animals had been in the barn and were receiving cornstalks and some mixed clover and alfalfa hay. The animal was very thin and in a state of partial coma. The temperature was 104.2 degrees F. Intravenous injection of 100 cc. of 20 per cent glucose solution containing 8 per cent sodium bicarbonate apparently did no good. A Caesarian operation was performed the following morning, but the ewe died five hours later.

There were some subcutaneous hemorrhages over the abdomen. The lungs showed considerable congestion and edema. The peritoneum showed much congestion over the small intestine. The liver had an appearance similar to that in the previous cases. A considerable quantity of feed, apparently entirely hay, was present in the rumen. The abomasum contained much fluid, some feed, and some excess mucus. The mucosa was congested. Marked hemorrhagic inflammation involved most of the small intestine. A few nodules were noted. Marked congestion was present in the cecum and large intestine. The kidneys showed some congestion and cloudy swelling.

Blood study revealed very slight leucocytosis, mild neutrophilia, hypoglycemia and high creatinine. The blood

sample was taken prior to treatment.

Case 5 was a six year old ewe in advanced pregnancy. The flock of 135 ewes had been kept in the barn. The ration per day was claimed to consist of 8 bushels of silage, 1 bushel of oats, 1 bushel of barley, and some alfalfa hay. Four ewes had died. They went down in condition, became groggy, lay with their mouths open, and went into a state of coma, dying in one to three days.

In the morning 20 cc. of calcium chloride solution was given intravenously with no beneficial results. In the afternoon about 30 cc. of 0.1 per cent colloidal iodine was injected intravenously. A considerable quantity of sodium bicarbonate solution was given by mouth. The ewe died four hours later.

The animal was very fat. Marked congestion and some hemorrhages were noted in the subcutaneous tissues. The lymph nodes were edematous and congested. Some congestion and edema were noted in the lungs. The liver was similar to all of the previous ones. The rumen contained a large amount of the mixture of oats, barley, hay and silage. In the abomasum there was a small amount of food in considerable fluid. Rather marked congestion involved the mucosa of the abomasum and small intestine. The cecum and large intestine showed congestion and some small hemorrhages. Some excess sticky mucus was noted. The kidneys showed marked congestion and some swelling. The uterus contained two fetuses about four to six weeks from maturity.

Two blood samples were studied, one taken soon after

arrival and the other four hours after injection of calcium chloride. In the first sample the only abnormality noted was a slight neutrophilia. The second sample revealed anhydremia, mild leucocytosis with relative neutrophilia, slight hypoglycemia, increase in non-protein nitrogen and high creatinine.

Case 6 was a six year old ewe in advanced pregnancy. According to the owner the ewes had been closely confined and were being fed bean pods and hay.

The ewe was down, showed rolling of the eyeballs, some tendency to throw the head backward, grinding of the teeth and salivation. Twin lambs were removed the morning after arrival by a Caesarian operation, and both lived. 10 cc. of camphorated oil was injected into the ewe intramuscularly. On the following morning she was comatose and was killed.

All of the abdominal lymph nodes were very edematous. The lungs were congested. Some excess pericardial fluid was noted. About 1 quart of bloody fluid was contained in the peritoneal cavity, and generalized fibrinous peritonitis was present. The liver was similar to the previous ones. Considerable rather firm food material was present in the rumen. The abomasum and intestine showed congestion. The operative wound in the uterus had opened, and some of the fetal membrane protruded into the peritoneal cavity.

Three blood samples were obtained from the animal. The first sample, taken at the time of arrival, revealed nothing abnormal except for some neutrophilia. The second sample, taken just prior to the operation, showed some increase in

hemoglobin and red cells, some reduction of leucocytes, slight hypoglycemia, and slight increase in non-protein nitrogen. The third sample, taken at the time of killing, showed much elevation of hemoglobin and red cells, marked leucopenia, marked reduction of neutrophils, hyperglycemia and much increase in non-protein nitrogen.

Case 7 was a six year old ewe in advanced pregnancy. The owner had lost three pregnant ewes, and was feeding bean pods and mixed hay. The animal was autopsied by Dr. Coburn, and the findings were characteristic.

Blood studies revealed leucopenia with relative neutrophilia and hypoglycemia.

Case 8 was a seven year old ewe in advanced pregnancy. The owner had lost one, and two others were sick. They became listless, appeared blind and went down. The feed consisted of beans and corn fodder.

On the day after being brought in, she was given 1 pound of cane sugar and about 2 ounces of steamed bone meal with water by stomach tube. On the following day she was given 2 pounds of sugar, 2 ounces of bone meal and 1 quart of ground mixed feed. She appeared brighter for a time, but became worse and died during the night.

Most of the lymph nodes showed some congestion. The pleura and lungs showed congestion and edema. Some excess pericardial fluid was noted, and the heart showed some subepicardial and subendocardial hemorrhages. The rumen contained considerable food material consisting of bean pods and hay. There was patchy congestion of the small intestine.

The cecum and large intestine contained a few nodules. Both kidneys were soft and swollen. The uterus contained one well developed lamb.

Two blood samples were obtained, one at the time of entrance and one just prior to the second treatment. The first sample revealed slight leucocytosis, relative neutrophilia, slight hypoglycemia, increase in non-protein nitrogen, high creatinine. The second sample showed increase in hemoglobin and red cells, more marked leucocytosis and neutrophilia, normal glucose, high non-protein nitrogen, and high creatinine.

Case 9 was a five year old ewe in advanced pregnancy. According to the owner the ewes had been closely confined and fed on bean pods, alfalfa hay and corn silage. Ten ewes had died. The only symptom reported was loss of appetite.

The ewe brought in was in a state of coma. There was some congestion of the lungs. The liver had the same appearance as those previously discussed. The rumen contained considerable rather firm, soggy food consisting of silage, hay and bean pods. The remainder of the digestive tract was almost empty. Some congestion of the abomasum was noted, and a few Trichostrongyles were present. Both kidneys showed much congestion and swelling. The uterus contained two well developed lambs.

A blood sample taken just prior to killing the ewe, showed high hemoglobin and red cells, moderate leucocytosis with relative neutrophilia, hyperglycemia, and very marked elevation of non-protein nitrogen and creatinine.

The results of blood studies on cases diagnosed as pregnancy disease are presented in Tables 23, 24 and 25.

PREGNANCY DISEASE

Table 23.

Case	Hemoglobin Gms %	%	Red Blood Cells Per Cmm.	White Blood Cells Per Cmm.
1	14	96	11,500,000	8,200
2	10.8	76	8,000,000	3,900
3	10.2 10.3	70 71	8,400,000 9,440,000	9,200 9,200
4	9.6	66	10,000,000	11,000
5	13.8 22.0	94 140	11,050,000 14,440,000	8,050 11,200
6	12.8 12.5 15.4	88 87 106	9,240,000 9,900,000 13,460,000	8,400 6,250 2,700
7	11.1	76	8,620,000	3,700
8	13.1 15.3	91 105	10,440,000 10,800,000	11,150 15,200
9	17.0	117	13,080,000	15,900

Table 24.

Case	Neutrophils Percent	Lymphocytes Percent	Monocytes Percent	Eosinophils Percent	Basophils Percent
2	71	25	3	1	0
3	63 59	35 43	2 1	0 2	0 0
4	60	36	3	1	0
5	66 63	32 35	2 2	0 0	0 0
6	71 68 22	27 30 72	2 2 5	0 0 1	0 0 0
7	87	12	1	0	0
8	75 89	23 7	2 4	0 0	0 0
9	87	12	1	0	0

PREGNANCY DISEASE

Table 25.

Case	Glucose Mgms %	Non-Protein N Mgms %	Creatinine Mgms %	Chlorides Mgms %	Uric Acid Mgms %
1	86.95	95.23	2.54	485.0	Trace
2	29.41	45.11	1.71	490.0	Trace
3	42.91 43.85	32.25 32.78	1.71 1.67	485.0 447.5	Trace Trace
4	24.26	44.44	2.63	485.0	Trace
5	71.42 40.98	48.38 82.19	1.64 2.30	495.0 495.0	Trace Trace
6	64.10 42.10 96.61	44.77 48.00 72.28	1.13 1.17 1.21	490.0 485.0 482.5	1.40 1.10 1.21
7	35.26	45.11	1.20	465.0	1.11
8	42.37 60.60	60.00 75.00	2.05 3.70	492.5 495.0	1.07 1.13
9	109.88	200.00	3.00	475.0	1.66

RHINITIS. The case listed under this heading was a seven month old lamb brought in for examination. The animal had been exposed to a storm and had showed discharge from the nose for three weeks. This was bloody at first and then muco-purulent. The animal was held ten days for treatment, chlorotone being used in the nose.

The results of blood studies are tabulated in Tables 26, 27 and 28. The hemoglobin and red cells showed some fluctuation. The white cell counts showed definite response of the animal to treatment. Blood chemistry values also showed rather interesting returns to normal values except that the chlorides remained somewhat low. The animal was returned to the owner in apparently normal condition.

Table 26.

Hemoglobin Gms %	%	Red Blood Cells Per Cmm.	White Blood Cells Per Cmm.
14.2	98	13,500,000	26,000
15.5	107	11,960,000	20,000
15.7	108	10,750,000	14,250
15.9	110	11,860,000	10,200

Table 27.

Neutrophils Percent	Lymphocytes Percent	Monocytes Percent	Eosinophils Percent	Basophils Percent
74	22	4	0	0
49	43	7	2	0
51	43	6	0	0
41	49	10	0	0

Glucose Mgms %	Non-protein N Mgms %	Creatinine Mgms %	Chlorides Mgms %	Uric Acid Mgms %
123.45	63.15	2.12	455.0	Trace
63.09	52.16	1.61	400.0	Trace
56.49	28.57	1.46	455.0	Trace
53.53	23.84	1.81	455.0	Trace

SPINAL ABSCESS. This case was a six month old female lamb. She had been on pasture and was noticed to be rather humped up for three days.

The temperature was 105.5 degrees F. When brought in she was in a state of partial coma. There was some muco-purulent rhinitis. The brain showed marked congestion, and some excess cerebral fluid was noted. A large abscess cavity about one inch in diameter was present ventral to the first two vertebrae. The vertebrae were much eroded, and the abscess had extended up around the spinal cord, resulting in inflammation and pressure. The liver was somewhat swollen and friable. Numerous coccidia lesions involved the intestinal mucosa, and many N. spathiger were present.

Blood study on this case showed only slight leucocytosis, neutrophilia, and moderate hyperglycemia. The following are the values obtained. Hemoglobin 14 grams per cent (96 per cent), red blood cells 13,610,000 per cmm., white blood cells 11,800 per cmm., neutrophils 61 per cent (54 per cent segmented), lymphocytes 32 per cent, monocytes 6 per cent, eosinophils 0 per cent. basophils 1 per cent, glucose 94.78 mgms. per cent, non-protein nitrogen 28.03 mgms. per cent, creatinine 1.35 mgms. per cent, chlorides 480 mgms. per cent, and a trace of uric acid.

Summary

The results of a large number of cytological and chemical studies on sheep blood are summarized below.

Hemoglobin. 434 estimations showed a range of 10.2 to 16.2 gms per cent or 70 to 112 per cent. Individual averages ranged from 12.27 to 13.8 gms per cent or 85 to 95 per cent. The average for all samples was 12.76 gms per cent or 87.97 per cent. The values were slightly higher in adults than in young animals.

Red Blood Cells. 434 determinations ranged from 7,200,000 to 13,920,000 per cmm., individual averages ranging from 9,341,969 to 11,326,000 per cmm. The average for all samples was 10,429,977 per cmm. The values were slightly higher in adults than in young animals.

White Blood Cells. 434 determinations ranged from 5,000 to 16,700 per cmm, individual averages ranging from 7,210 to 9,738 per cmm. The average for all samples was 8,949 per cmm. Values were slightly lower in adults than in younger animals. Somewhat higher counts were encountered in the adults at the time of lambing.

Neutrophils. 331 determinations ranged from 9 to 73 per cent, this range being rather consistent in the six animals. Individual averages ranged from 26.25 to 34.7 per cent, the general average being 30.36 per cent. There was no appreciable difference between adults and young animals.

Lymphocytes. 331 determinations ranged from 24 to

83 per cent, individual averages ranging from 53.4 to 62.5 per cent. The general average was 59.05 per cent. Adults and young animals were very much the same.

Monocytes. 331 determinations ranged from 0 to 21 per cent, individual averages ranging from 3.7 to 4.8 per cent. The general average was 4.18 per cent, with little difference between adults and young animals.

Eosinophils. 331 counts ranged from 0 to 23 per cent, individual averages ranging from 4.65 to 7.1 per cent. The general average was 5.78 per cent, with little difference between adults and young animals. The reason for the high counts was not determined.

Basophils. 331 counts ranged from 0 to 4 per cent, individual averages ranging from 0.4 to 1.1 per cent. The general average was 0.63%.

Blood Glucose. 431 determinations ranged from 44.27 to 100 mgms per cent, individual averages ranging from 61.53 to 76.73 mgms per cent. The general average was 67.54 mgms per cent.

Blood Non-protein Nitrogen. 431 determinations ranged from 16.22 to 65.93 mgms per cent, individual averages ranging from 33.35 to 38.59 mgms per cent. The general average was 36.14 mgms per cent.

Blood Preformed Creatinine. 428 determinations ranged from 0.91 to 2.17 mgms per cent, individual averages ranging from 1.21 to 1.37 mgms per cent. The general average was 1.29 mgms per cent.

Blood Chlorides. 428 determinations ranged from 450 to 497.5 mgms per cent, individual averages ranging from 480.8 to 487.3 mgms per cent. The general average was 485.3 mgms per cent.

Blood Uric Acid. 197 determinations ranged from 0.85 to 1.96 mgms per cent, individual averages ranging from 0.99 to 1.18 mgms per cent. The general average was 1.09 mgms per cent.

In the blood chemistry determinations there was little or no difference between adults and young animals.

Dystokia. One case showed relative neutrophilia and some increase in glucose and non-protein nitrogen, all transient in nature.

Botulism. Four blood samples from one case revealed relative neutrophilia, marked hyperglycemia and considerable increase in non-protein nitrogen.

Endometritis and Septicemia. One case was studied. The animal was in a state of coma. There was mild leucopenia, with some neutrophilia, the neutrophils being present mainly as young forms. Marked increases in non-protein nitrogen and creatinine were noted.

Meningitis and Hydrocephalus. One case was studied. The only abnormality in the blood picture was possibly a very slight increase in neutrophils.

Parasitism. A considerable number of animals was studied. Blood chemistry values showed nothing of note. Hemoglobin and red cells were much reduced in animals

with marked parasitism. White cell counts were somewhat increased. Eosinophil counts were lower with marked infection than with mild or moderage infections.

Parasitism and Dental Caries. Two cases studied came under this heading. They showed slight anemia, mild to moderate leucocytosis, some relative neutrophilia, and a high percentage of non-segmenters. One animal showed eosinophilia. Some hyperglycemia was noted in one.

Parasitism and Gastro-enteritis. One case was studied. There was marked leucocytosis, marked relative neutrophilia with high percentage of non-segmented forms, and hyperglycemia.

Peritonitis. One lamb studied showed normal red cell count, high hemoglobin, marked leucocytosis with relative neutrophilia, moderate increase in non-protein nitrogen, and marked increase in creatinine and uric acid.

Pneumonia. Five cases were studied, representing various types of respiratory involvement.

Case 1 with necrotic pneumonia showed marked anemia, marked leucocytosis, marked relative neutrophilia, and moderate hyperglycemia.

Case 2 with chronic bronchopneumonia showed moderate leucocytosis with moderate neutrophilia.

Case 3 with very marked pleuropneumonia showed some anhydremia, leucopenia, high non-protein nitrogen, high creatinine, low chloride, and high uric acid.

Case 4 with unilateral destruction of the lung showed no marked changes except moderate leucocytosis.

Case 5 with pleuropneumonia showed some indication of anhydremia, moderate leucocytosis, very high non-protein nitrogen, high creatinine and moderately low chloride.

Intoxications. Seven cases were placed under this heading and varied considerably.

Case 1 showed profound nervous disturbance. Blood examination revealed rather high hemoglobin, somewhat high red cell count, moderate leucocytosis and marked hyperglycemia.

Case 2 showed diarrhea and intoxication. Anemia and moderate leucocytosis were the only blood changes noted.

Case 3 was a feeder lamb showing marked digestive and nervous disturbance. Blood study revealed moderate leucocytosis with relative neutrophilia, moderate hyperglycemia and very high non-protein nitrogen.

Case 4 was a poor and undersized lamb, with no definite symptoms of disease. Blood study revealed moderate leucocytosis, relative neutrophilia, very marked hyperglycemia, and rather marked increase of non-protein nitrogen.

Case 5 was a feeder lamb showing diarrhea. Blood study revealed moderate leucocytosis with neutrophilia, hyperglycemia, very high non-protein nitrogen, high creatinine and low chloride.

Case 6 was a six year old ewe showing intoxication

and parasitism. Blood study revealed anemia, moderate leucocytosis with relative neutrophilia, and mild hyperglycemia.

Case 7 was a feeder lamb with some pneumonia and intoxication. Blood study showed no abnormalities other than mild leucocytosis.

Pregnancy Disease. Eight cases were placed under this heading. Two cases showed somewhat high hemoglobin values. Three had abnormally high red cell counts. One showed neutropenia and two showed moderate leucocytosis. In all but one there was some degree of neutrophilia. Glucose values were somewhat high in two cases, and low in the others. Non-protein nitrogen was extremely high in one case, and above normal in all but one of the others. Creatinine was normal in two cases and moderately to markedly increased in the others. Chlorides and uric acid showed nothing of significance.

Rhinitis. This case showed leucocytosis with neutrophilia, hyperglycemia, high non-protein nitrogen and some increase in creatinine. Under treatment the animal returned to normal.

Spinal Abscess. One case studied showed only slight leucocytosis, neutrophilia, and moderate hyperglycemia.

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