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By

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The production of a large portion of the farm products and the movement of a considerable portion of the freight on the highways of Japan depend on horsepower. The spread of "infectious anemia" throughout the country has become a serious problem. When horses are first striken with this disease they exhibit symptoms of severe anemia and high fever, however, if given careful nursing, most of them apparently gradually recover, regain an appearence of health, and pass into a chronic stage. Since to date no effective method of prevention or therapy has been developed, it becomes imperative that a practical method of determining which of the horses are capable of doing normal work.

The above named members planned and conducted the experiments to determine suitable criteria.

In our experiments thirty-six chronically infected and ten healthy control animals were subjected to controlled exercise periods preceded and followed by a physiological and seriological examination.

a. The controlled exercise periods.

All horses were subjected to a "short period exercise" consisting of being ridden for five minutes at a walk, five minutes at a trot, and five minutes at a gallop, repeated four times in that order so that each horse was given a total of one hour of exercise. Those horses completing the short period exercise were subjected to the long period exercise repeated daily for thirty days.

b. Physiological and seriological examinations were made just befere, immediately after, three hours after and twenty-four hours after completion of the exercise period to observe the following characteristics: (1) body temperature; (2) rate of respiration; (3) rate of pulse; (4) blood pressure;

(5) number of erythrocytes; (6) rate of sedimentation of erythrocytes; (7) volume of hemoglobin; (8) number of leucocytes; (9) rate of eosinophile leucocytes; (10) rate of neutrophile polynuclear leucocytes. (11) rate of lymphocytes; (12) rate of large mononuclear leucocytes; (13) rate of basophile leucocytes; (14) appearance of syderocytes in blood; (15) specific gravity of blood; (16) viscosity of blood; (17) water in blood, (18) dried matter of blood; (19) carbon dioxide (plasma); (20) chlorine (blood); (21) calcium (serum); (22) magnesium (serum); (23) iron (blood); (24) total phosphorous (serum); (25) lipoid phosphorous (serum); (26) inorganic phosphorous (serum); (27) blood sugar; (28) bilirubin (serum); (29) total nitrogen (serum); (30) protein nitrogen (serum); (31) globulin nitrogen (serum); (32) albumin nitrogen (serum); (33) non-protein nitrogen (serum); (34) ratio of albumin and globulin: A/G, (35) phosphatase (serum); (36) diastase (serum) and (37) lipase (serum).

During the experiment it was found that fourteen of the thirty-six infected horses could not complete the short period exercise. Of the twenty-two which completed the initial short period exercise six were judged to be in no condition to continue, but sixteen were subjected to the long period exercise. Of these sixteen, six were unable to complete the course because of a relapse due to the accumulation of fatigue.

It was confirmed afterwards by the injection test of bloods of all thirty six examined horses to the horses brought from Saishu-island, where is free from the virus of infectious anemia, that the horses, which had been rather healthy in appearance and endured the severe exercise in long period, had yet carried the virus of infectious anemia without exception. For the comparison of the results of the examinations, the horses have been grouped as follows: (1) healthy control horses; (2) those horses which were unable to complete the short period exercise; and (3) those horses which completed the short period exercise.

Results

In comparing the results obtained from the examination of the above groups of horses before exercise, it was found that higher values were obtained from the infected horses in the fourteen characteristics listed below: (1) body temperature; (2) pulse rate; (3) blood pressure; (4) rate of sedimentation of erythrocytes; (5) rate of lymphocytes; (6) number of large mononuclear leucocytes; (7) water in blood; (8) rate of syderocytes; (9) carbon dioxide; (10) magnesium; (11) lipoid phosphorous; (12) bilirubin; (13) non-protein nitrogen and

(14) globulin nitrogen.

Lower values were obtained from the infected animals for each of the eight characteristics listed below; (1) respiration rate; (2) iron content; (3) inorganic phosphorous; (4) number of erythrocytes; (5) blood sugar; (6) albumin nitrogen; (7) A/G and (8) lipase.

The values obtained for the remaining characteristics showed little difference between the healthy and infected animals. A statistical summary of the above statements is shown below:

Table 1. Comparison of physiological characters in calm state.

Characteristics \ Horses tested	Control	F. S. T.(1)	A. S. T.(2)
	10	14	22
Body Temperature	37.5	37.9	37.8
No. Respiration	17	14	14
No. Pulse	32	41	39
Blood Pressure	143	152	148
Sedimentation	27	44	33
Erythrocytes $\times 10^4$	641	557	469
Hemoglobin	70	67	77
Leucocytes	9510	8800	10100
Eosinophile %	6.1	5.2	4.5
Basophile %	0.9	0.5	0.3
Neutrophile %	51.5	47.0	43.4
Lymophocytes %	34.7	43.7	45.8
Monocytes %	2.9	7.9	4.2
Syderocytes	0/10	6/14	6/22
Specific gravity B (3)	1.050	1.052	1.060
Viscosity B	3.8	3.8	4.0
Water B	81.7	82.5	81.3
Dried material B	18.3	17.5	18.5
CO_2 P (4)	63.9	66.8	66.7
Cl B	256	285	272
Ca S (5)	12.0	12.3	12.7
Mg S	2.83	2.08	2.42
Fe B	44.2	36.8	43.8
Total P. S	23.5	25.9	26.7
Lipoid P. S	6.77	8.76	9.55
Inorganic P. S	6.72	5.71	5.42
Blood Sugar	97	90	93
Bilirubin S	0.70	1.58	1.30
Total N. S	1182	1221	1189
Protein N. S	1146	1171	1143
Non Protein N. S	39	42	48
Alubumin N. S	510	441	497
Globulin N. S	636	745	643
A/G S	0.80	0.61	0.79
Phosphatase S	20.0	18.7	15.8
Diastase S	3.2	3.1	8.0
Lipase S	21.0	15.7	17.0

(1) F. S. T.-Fell from the ranks in the short time exercise.
(2) A. S. T.-Accomplished the short time exercise.
(3) B-Blood.
(4) P-Blood Plasma.
(5) S-Serum.

It was noted that the infected animals had noticeable disorders of the circulatory system, particularly fatigue of the heart, in that after exercise the pulse greatly increased while the increase in blood pressure was slight.

a. The mineral content of the blood, with the exception of magnesium, decreased noticeable after exercise in the healthy horses, but this decrease was much smaller in the infected ones. Therefore, we suppose, that a functional changes in the permeability of the muscular tissue may have been occured. The permeability of the tissue of the infected horses may have been less than in the healthy horses during the exercise. It was found that the volume of the serum albumin and globulin, (which has a larger molecule) changed very little in either the healthy or infected horses. The content of the serum globulin increased in all cases after exercise, but the recovery was slower in the infected horses. The rate of sedimentation of erythrocytes of healthy horses showed larger values after exercise than before, but in the infected ones it fell at first and then gradually rose in proportion to the lapse of time after exercise. In the healthy horses the lymphocytes always increased just after the exercise, but the neutrophile leucocytes were less changeable. At three hours after the exercise the lymphocytes had decreased below their normal level, while the neutrophile leucocytes had remarkably increased. On the other hand, in the infected horses, the lymphocytes increased which the eosinophile leucocytes decreased after exercise. These conditions indicate acidosis.

Conclusions

By comparing the data on sixteen horses which completed the initial short period of exercise with the data obtained from both healthy and infected horses which completed the long period of exercise it was found that horses which exhibited the following characteristics were unable to endure long periods of exercise:

(1) Extremely high pulse rate immediately after exercise, remaining comparatively high even three hours after exercise.

(2) Great increase in the number of neutrophile polynuclear leucocytes after exercise, remaining high for twenty-four hours.

Adding three more items, we chose five factors as the minimum criteria for judging the labouring ability of horses infected with chronic infectious anemia.

(3) Change of blood pressure.

(4) Change of blood viscosity.

(5) Change of number of erythrocytes.

If the values of items 1, 3, 4 and 5, vary over 10% or number 2 varies more than 20% three hours after the animal is subjected to the short period exercise when compared with those of healthy animals, it will not be capable of the sustained long period exercise.

We recommend subjecting a suspected horse to a period of exercise followed by seriological tests to detect the presence of syderocytes in the blood in order to diagnose latent infection since syderocytes do not always appear in the blood when the horse is calm, but will appear after exercise as is shown in Table 2.

Table 2. Appearance of syderocytes by exercise.

	Healthy Controls	Infected Unable	Infected Able
Horses	A B C D E F G H I J	K L M N O	P Q R S T U V W X Y
Just before	− − − − − − − − − −	⫴ ⫴ − + −	− − − − − − − − − +
Just after	− − + − − − − − − −	⫴ ⫴ + + −	+ − − − + − − − − +
3 hrs. after	− − + − − − − − − −	⫴ ⫴ − − −	− − + − − − − − − +
24 hrs. after	− − − − − − − − − −	⫴ ⫴ − − −	− − + − − − + − − +

C was tested to be the infected.

It was found that horses infected with chronic infectious anemia the unable ones showed more marked fluctuations in the values of several factors which indicated incomplete oxidation of substances in tissues due to the circulatory disorders or anemia. Even in the healthy horses slight symptoms of anemia were caused by such exercise. Therefore it was considered to be natural that horses, attacked by the anemia virus can not work at any exercise owing to the duplicated effects of anemia.

Acknowledgment

The authors wish to express their hearty thanks to Dr. Prof. Sigeo Matsuba for his valuable suggestions for this work.

Thanks are also due to our old comrades who helped us with much kindness during the work.

Illustration of Figures

F. L. P.	Value of Characters of Horses "Fallen in Long Period Exercise".
A. L. P.	Value of Characters of Horses "Accomplished Long Period Exercise".
Av.	Average Value of Characters.
A. B. C...Y.	Number of Horses Used.
EXC	Duration of Exercise (1 hour).

Fig. 1. Changes in number of pulse. Control and A. L. P. get readily to the normal state after the exercise, but in F.L.P. the increase of pulse hardly recovers.

Fig. 2. Changes in neutrophile polynuclear leucocytes: F. L. P. show a higher average value than that of the other horses even in 24 hours after exercise.

Fig. 3. Changes in blood pressure: F. L. P. show a high blood pressure, when Control and A. L. P. almost recovered their normal value in 24 hours after exercise.

Fig. 4. Changes in viscosity of blood: In 3 hours after exercise, Control and A. L. P. show a higher average value of blood viscosity than which they do at their calm state, whereas that of the sick ones is lower.

Fig. 5. Changes in number of erythrocytes: In F. L. P., the number of erythrocytes is apt to decrease below the normal level in 3 hours after exercise.

Fig. 6. Changes in rate of sedimentation of erythrocytes: In Control, the average value of sedimentation of erythrocytes never decreases below the normal level, but in other two cases it decreases immediately after exercise.

Fig. 7. Changes in bilirubin content in serum: The average value of bilirubin in serum always increases after exercise in all cases, but it recovers only in the case of control.

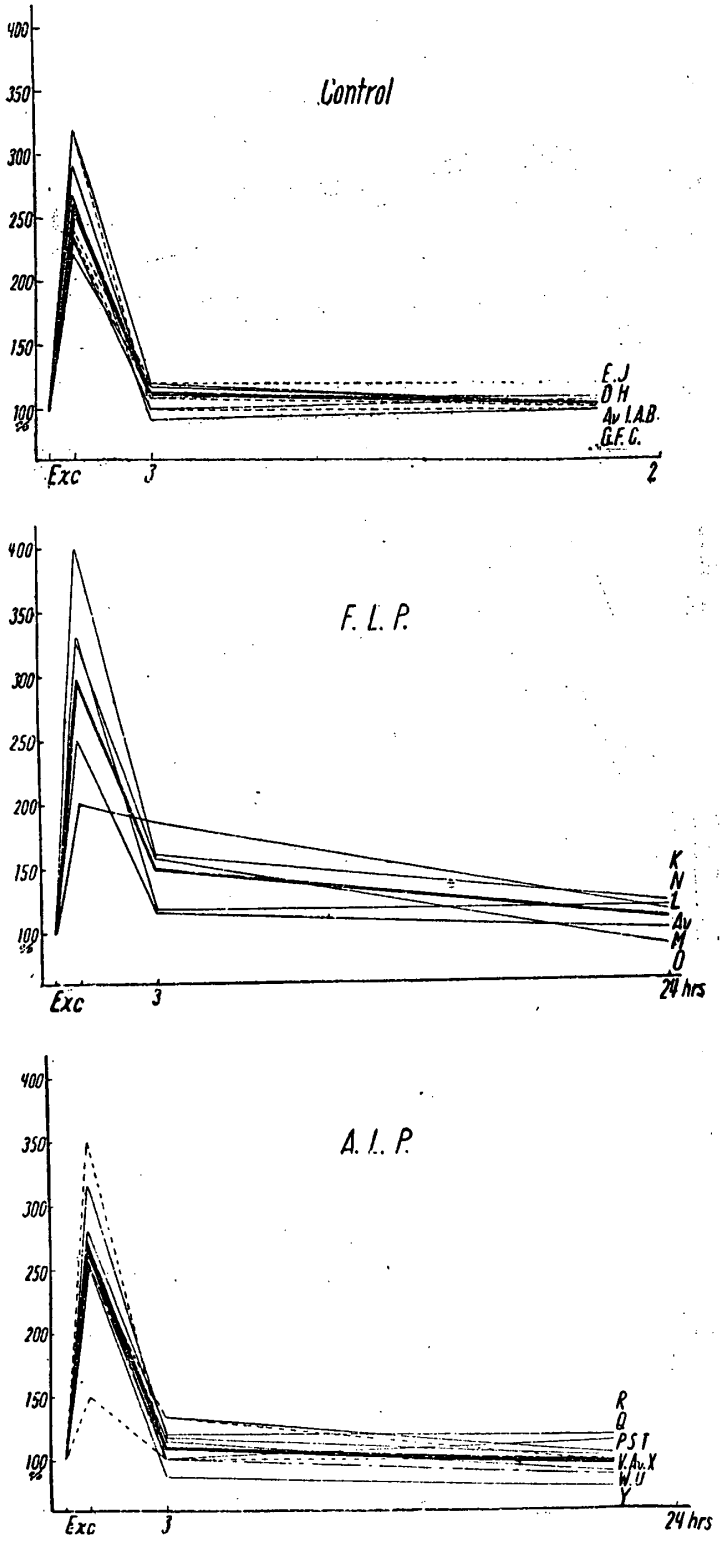

Fig. 1. Number of pulse

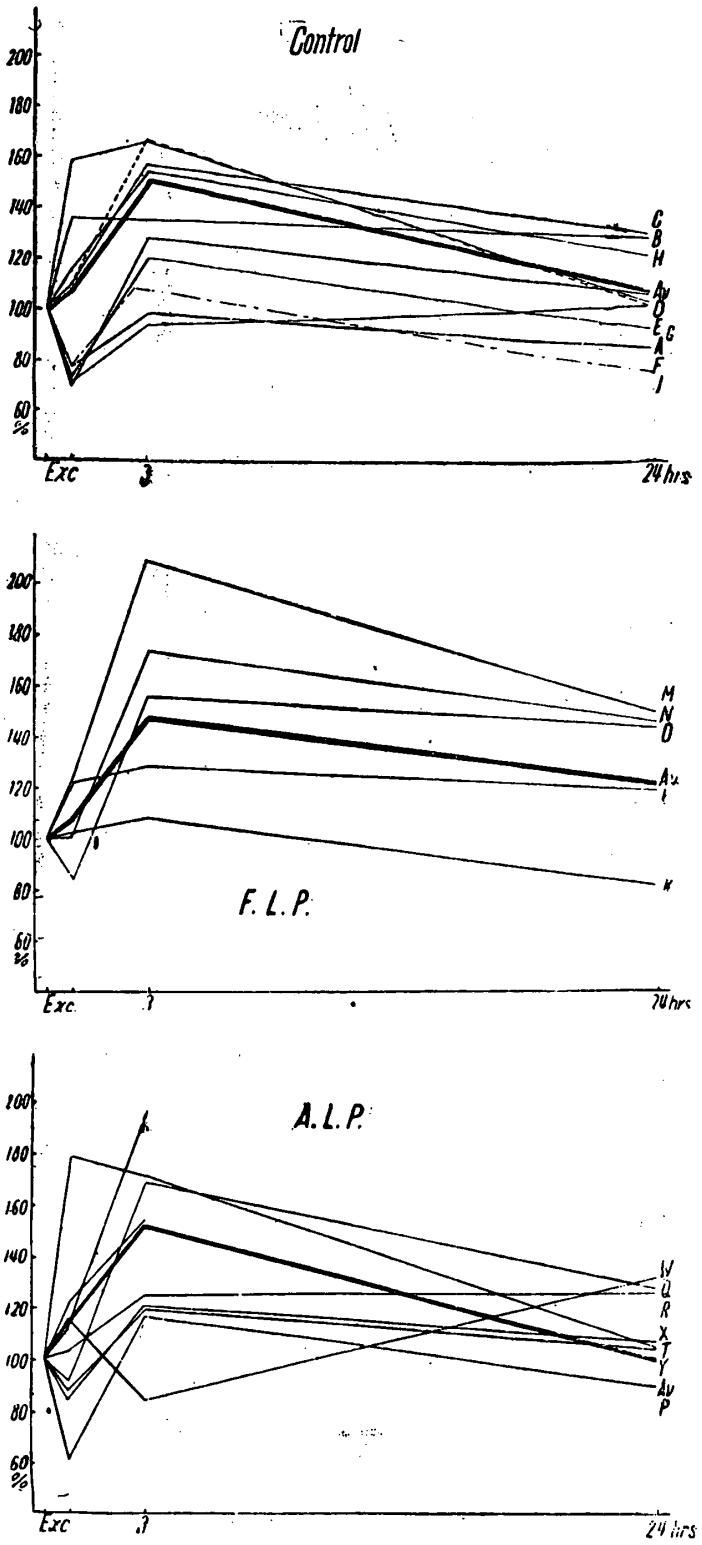

Fig. 2. Neutrophile polynuclear leucocytes

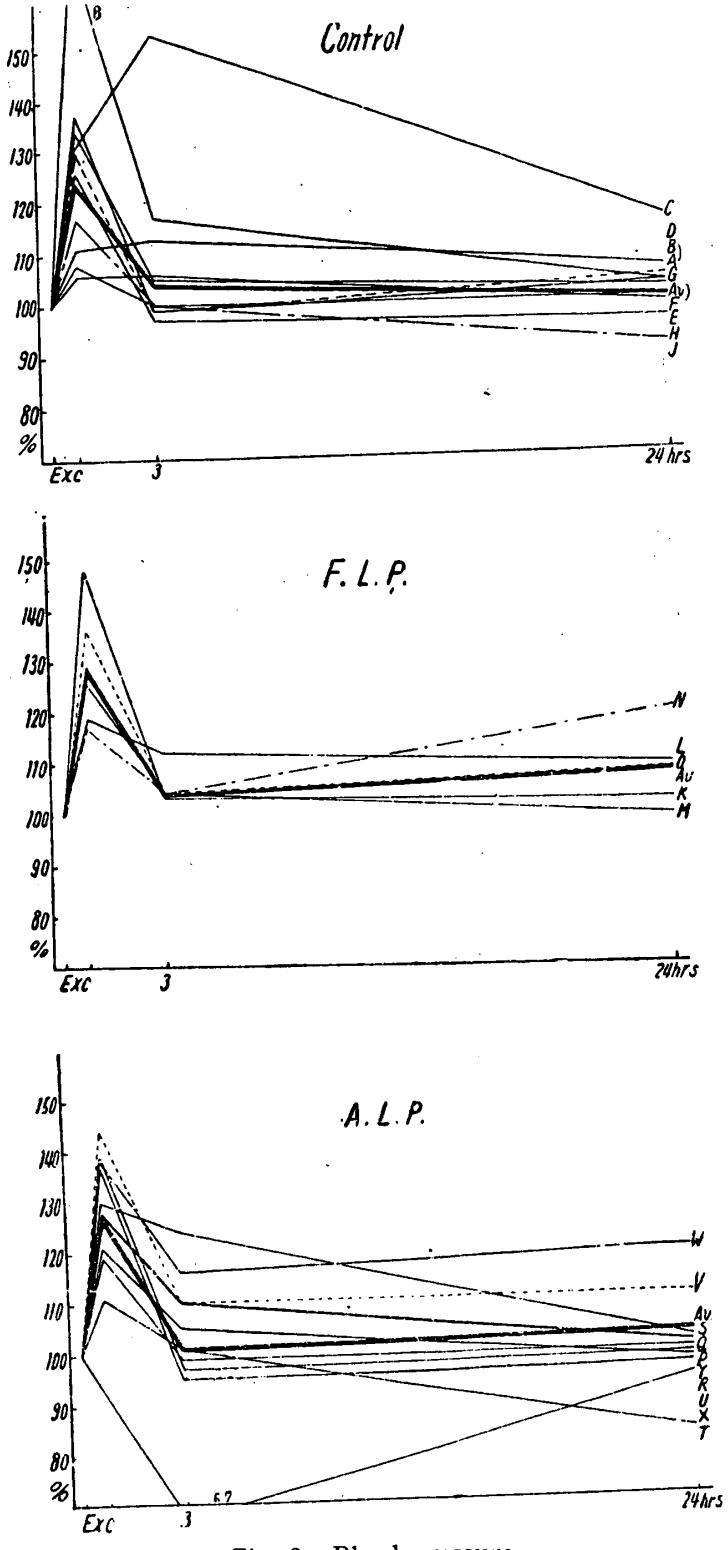

Fig. 3. Blood pressure

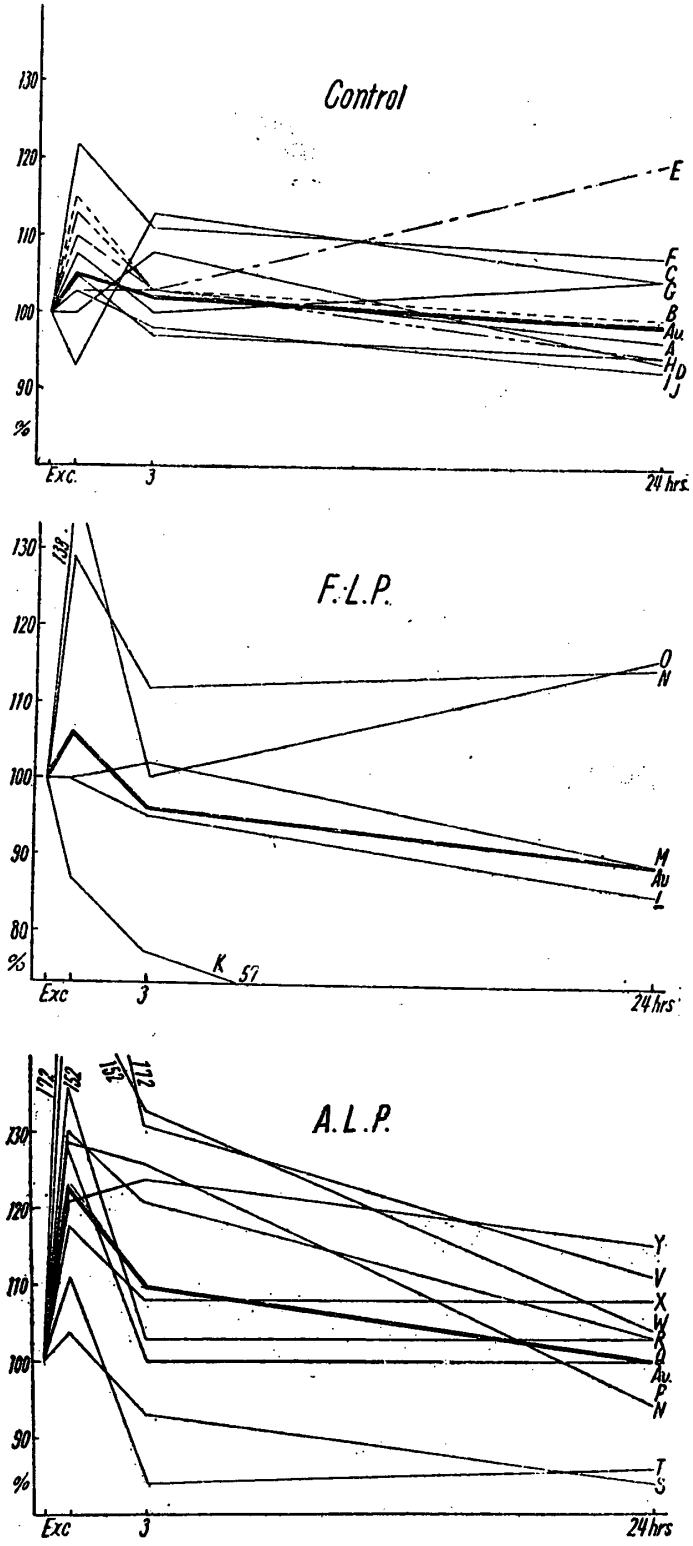

Fig. 4. Viscosity of blood

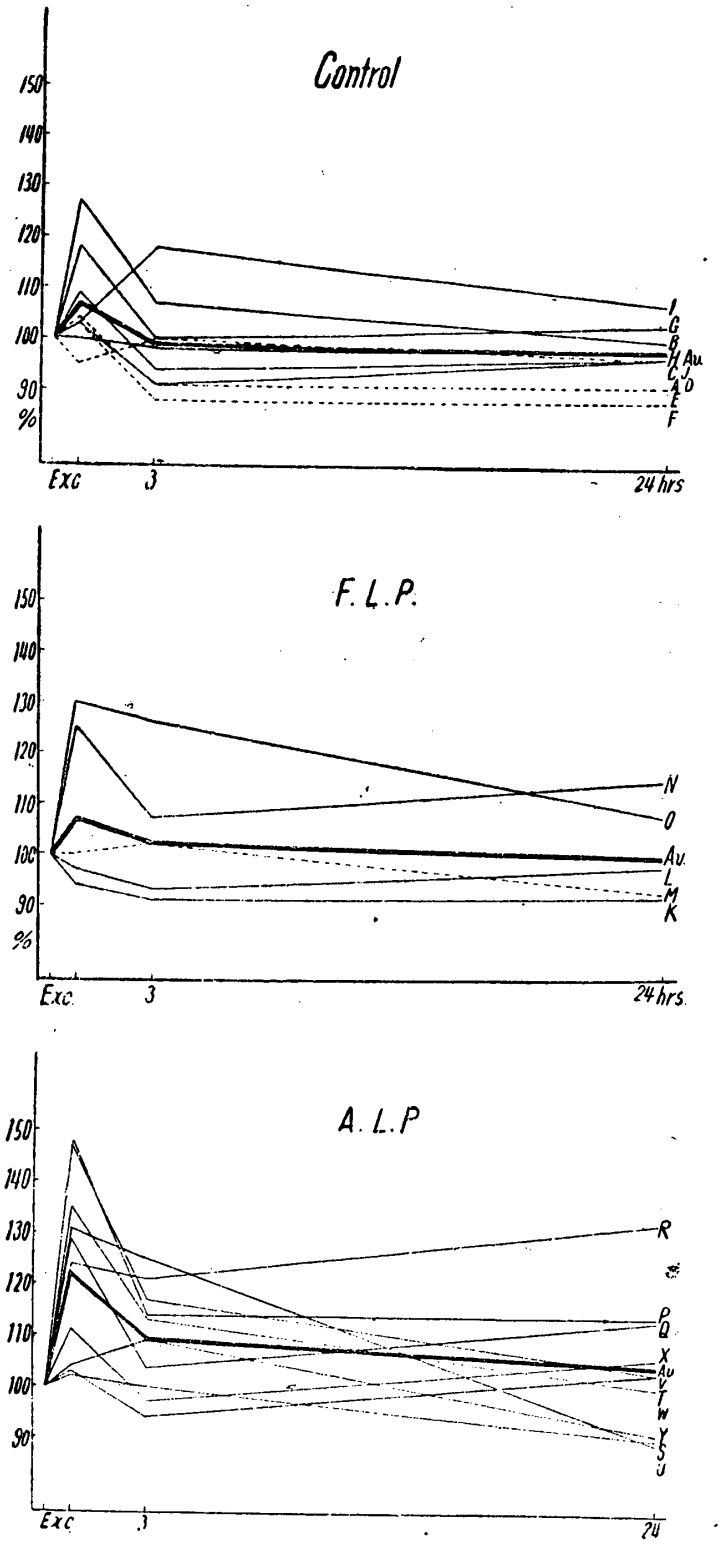

Fig. 5. Number of erythrocytes

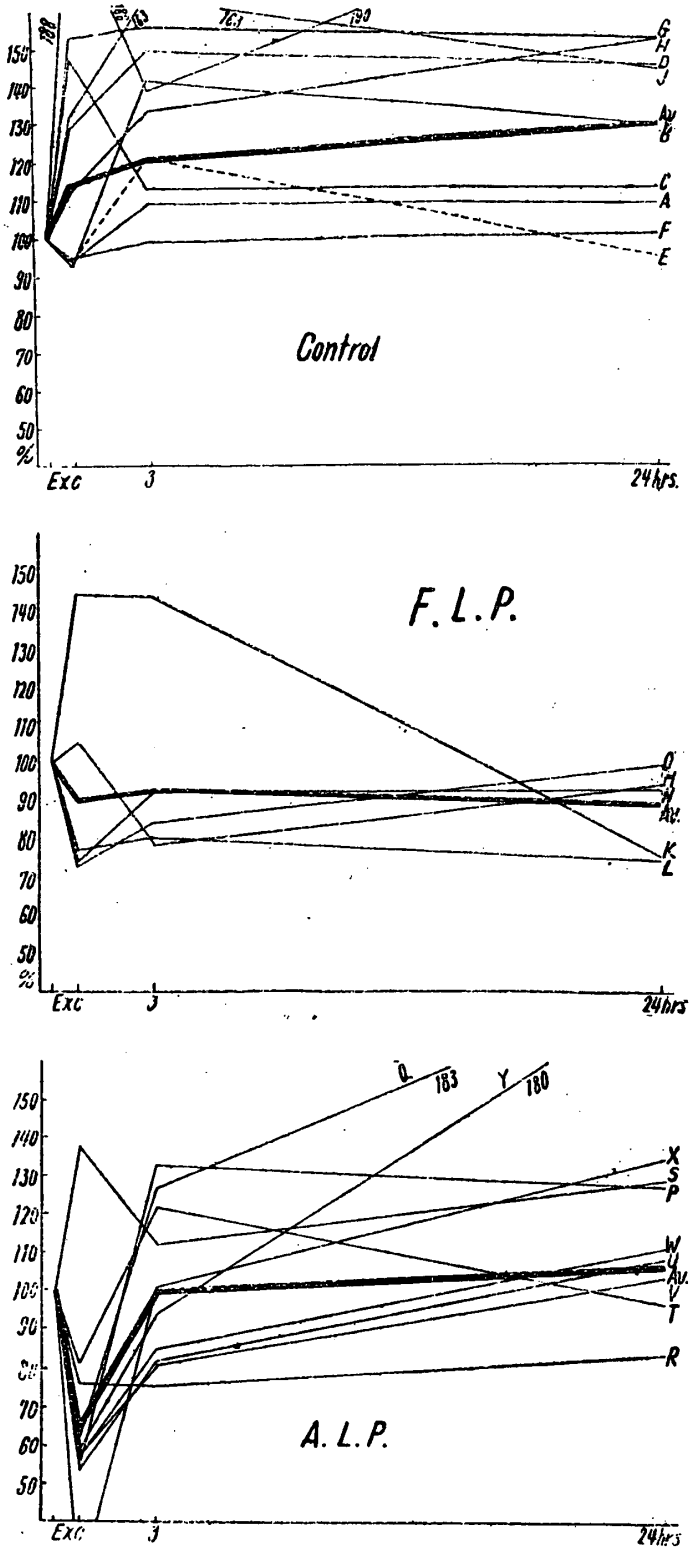

Fig. 6. Rate of sedimentation of erythrocytes

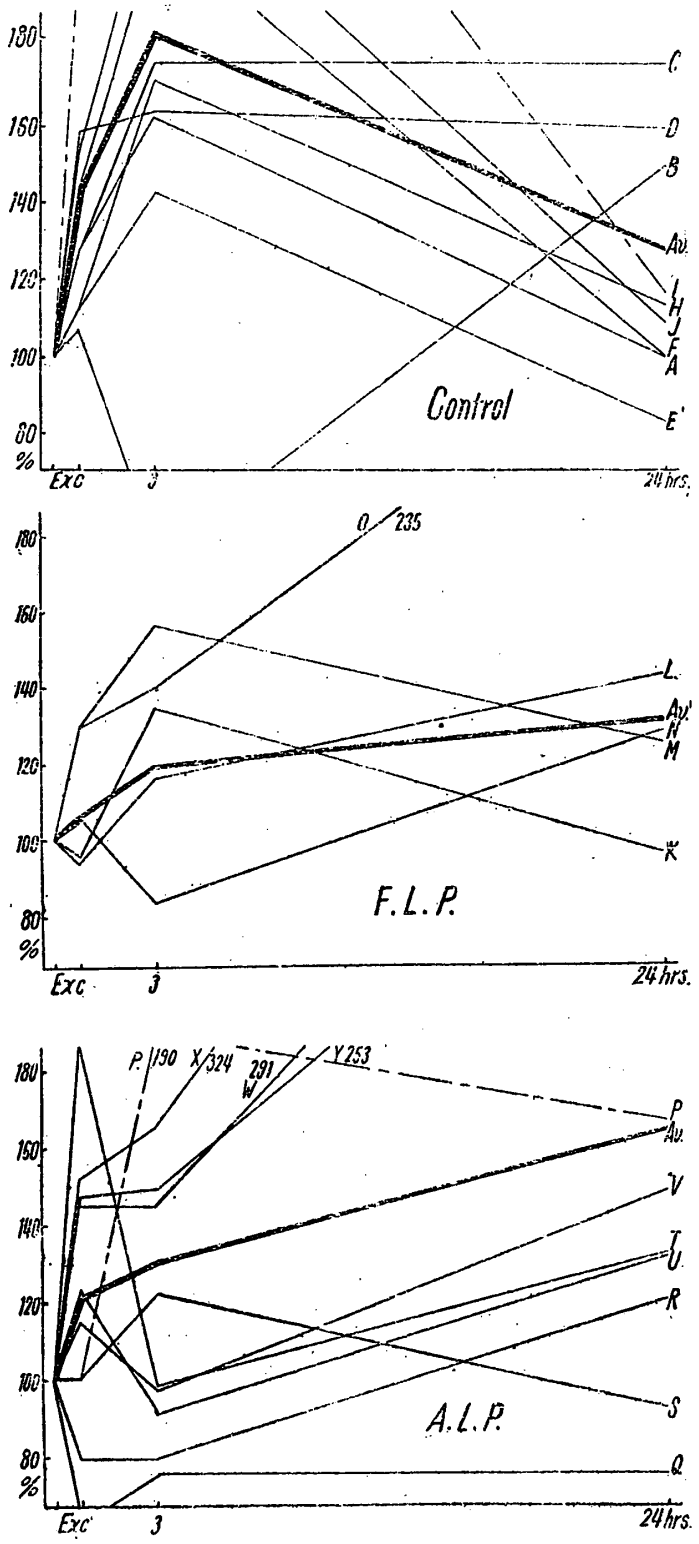

Fig. 7. Bilirubin in serum