TABLE 21.

Statistical analysis of lymphocyte counts.

Bird No. [1]	Sex	No. of counts	Minimum percentage.	Maximum percentage.	Mean percentage	Standard error of the mean	Standard deviation.	Coefficient of variability.
1	Male	15	21.0	32.5	26.3	1.0	4.0	15.2
2	"	15	22.0	37.0	28.3	0.9	3.5	12.4
3	"	12	23.0	36.2	27.6	0.9	3.4	12.3
4	Female	15	19.2	35.5	28.2	0.9	3.7	13.1
5	"	13	17.0	33.5	23.1	1.2	4.4	19.0
1, 2 and 3	Males	42	21.0	37.0	27.4	0.5	3.6	13.1
4 and 5	Females	28	19.2	35.5	25.9	1.0	4.6	17.8
1 to 5	Males & Females	70	19.2	37.0	26.8	0.5	4.1	15.3
6	Female	14	14.2	28.2	21.4	1.4	5.4	25.2
7 to 11	Males	5	8.7	15.7	12.8	1.2	2.7	21.0
12 to 17	Females	6	4.0	13.7	8.3	1.6	3.8	45.8
7 to 17	Males & Females	11	4.0	15.7	10.3	1.2	4.0	38.8
18 to 22	Males & Females	6	7.2	45.7	26.3	0.6	14.0	53.2

[1] For particulars of birds see pages 9 - 11.

TABLE 22.

Statistical analysis of monocyte counts.

Bird No. [1]	Sex	No. of counts	Minimum percentage	Maximum percentage	Mean percentage.	Standard error of the mean	Standard deviation.	Coefficient of variability.
1	Male	15	1.7	8.5	3.5	0.4	1.5	42.8
2	"	15	1.7	6.0	3.5	0.3	1.3	37.1
3	"	12	1.2	4.2	2.8	0.2	0.8	28.5
4	Female	15	0.5	5.5	2.5	0.3	1.2	48.0
5	"	13	1.5	4.2	2.7	0.2	0.9	33.3
1, 2 and 3	Males	42	1.2	8.5	3.3	0.2	1.3	39.3
4 and 5	Females	28	0.5	5.5	2.6	0.2	1.1	42.3
1 to 5	Males & Females	70	0.5	8.5	3.0	0.3	1.2	40.0
6	Female	14	0.7	6.2	3.4	0.4	1.6	47.0
7 to 11	Males	5	1.0	4.5	3.1	0.6	1.3	41.9
12 to 17	Females	6	2.0	4.5	3.2	0.4	1.1	34.3
7 to 17	Males and Females.	11	1.0	6.2	3.2	0.3	1.1	34.3
18 to 22	Males and Females	6	2.0	9.5	4.4	1.2	2.8	63.6

[1] For particulars of birds see pages 9 - 11.

TABLE 23.

Statistical analysis of heterophile counts.

Bird No. [1]	Sex	No. of counts	Minimum percentage	Maximum percentage.	Mean percentage	Standard error of the mean	Standard deviation.	Coefficient of variability.
1	Male	15	41.5	64.0	54.2	1.5	6.0	11.1
2	"	15	46.3	63.2	56.1	1.4	5.6	10.0
3	"	12	54.2	65.5	60.4	1.1	3.7	6.1
4	Female	15	40.5	71.5	58.0	2.0	7.9	13.6
5	"	13	53.0	78.5	68.1	1.8	6.6	9.7
1,2 and 3	Males	42	41.5	64.0	56.6	0.9	5.8	10.2
4 and 5	Females	28	40.5	78.5	62.7	1.7	8.9	14.2
1 to 5	Males & Females	70	40.5	78.5	59.1	0.9	7.7	13.0
6	Female	14	61.0	81.0	71.1	1.8	6.7	9.4
7 to 11	Males	5	62.0	73.0	68.3	1.8	4.0	5.8
12 to 17	Females	6	68.7	83.2	74.4	2.4	5.8	7.8
7 to 17	Males & Females	11	62.0	83.2	71.6	1.7	5.7	8.0
18 to 22	Males & Females	6	47.5	89.7	63.0	6.8	16.4	26.0

[1] For particulars of birds see pages 9 - 11.

TABLE 24.

Statistical analysis of eosinophile counts.

Bird No. [1]	Sex	No. of counts.	Minimum percentage.	Maximum percentage.	Mean percentage.	Standard error of the mean.	Standard deviation.	Coefficient of variability.
1	Male	15	2.7	19.7	7.8	1.3	5.0	64.1
2	"	15	3.5	14.7	7.6	0.8	3.0	39.4
3	"	12	3.0	8.7	6.4	0.5	1.7	26.6
4	Female	15	2.0	16.5	7.3	1.2	4.6	63.0
5	"	13	0	3.7	1.9	0.3	1.2	63.1
1,2 and 3	Males	42	2.7	19.7	7.3	0.5	3.5	47.9
4 and 5	Females	28	0	16.5	4.8	0.8	4.4	91.7
1 to 5	Males & Females	70	0	19.5	6.3	0.5	4.0	63.5
6	Female	14	0.2	4.5	1.7	0.4	1.6	94.1
7 to 11	Males	5	6.0	18.0	12.4	2.2	4.8	38.7
12 to 17	Females	6	3.2	18.7	10.1	2.2	5.2	51.5
7 to 17	Males & Females	11	3.2	18.7	11.1	1.5	4.9	44.1
18 to 22	Males & Females	6	0.2	13.7	4.4	1.5	5.3	120.4

[1] For particulars of birds see pages 9 - 11.

TABLE 25.

Statistical analysis of basophile counts.

Bird No. [1]	Sex	No. of counts	Minimum percentage.	Maximum percentage.	Mean percentage.	Standard error of the mean.	Standard deviation.	Coefficient of variability.
1	Male	15	3.5	10.5	8.1	0.5	1.8	22.2
2	"	15	1.7	8.5	4.4	0.5	2.0	45.4
3	"	12	1.0	4.0	2.7	0.3	1.0	37.0
4	Female	15	1.2	6.5	4.0	0.1	1.7	42.5
5	"	13	1.0	6.5	4.0	0.5	1.8	45.0
1,2 and 3	Males	42	1.0	10.5	5.2	0.4	2.8	53.8
4 and 5	Females	28	1.0	6.5	4.0	0.3	1.7	42.5
1 to 5	Males & Females	70	1.0	10.5	4.7	0.3	2.5	53.2
6	Female	14	1.0	4.5	2.3	0.3	1.1	47.8
7 to 11	Males	5	1.2	4.0	3.0	0.5	1.2	40.0
12 to 17	Females	6	0.5	10.0	3.7	1.4	3.4	91.9
7 to 17	Males & Females	11	0.5	10.0	3.4	0.8	2.6	76.5
18 to 22	Males & Females	6	0	3.0	1.5	0.4	1.1	73.3

[1] For particulars of birds see pages 9 - 11.

far from satisfactory but there is no better method of obtaining total thrombocyte counts of ostrich blood.

The counts are listed in tables 3 - 10 and statistical determinations are given in table 26. The results from the normal birds (1 - 5) ranged from 2,478 to 20,086, averaging 10,521 ± 427 (standard deviation 3,545; coefficient of variability 33.6 per cent.). The numbers of thrombocytes and leucocytes stand in a ratio of about 1 to 2.

Kleineberger and Carl (1912) record a thrombocyte count of 22,000 to 130,000 per c.mm. for the fowl while according to Fritsch (1920), cited by Wirth (1934), fowl blood contains very few thrombocytes, and Blain (1928), as already stated, apparently did not see any. Magath and Higgins (1934) reported for the duck an average thrombocyte count of 30,706 ± 703 with a coefficient of variability of 32 per cent. Hayem 1879 and 1889) recorded counts of 11,500 and 11,600 for the ostrich. It will be seen that these figures come very near to the averages obtained by the writer.

VISCOSCITY.

Hess's viscosimeter was used. Naegeli (1921) and others give a detailed description of the apparatus. The readings listed in table (27) are those of citrated blood but tests carried out with whole, citrated, and heparinised blood showed no significant differences. The necessary corrections were made when tests were conducted outside the temperature range of 17°C. - 23°C. in which the apparatus gives correct readings.

The viscoscity of the blood of the normal ostriches (1 - 5) varied from 4.0 to 5.0, with an average of 4.5, the corresponding figures for the plasma being 1.5 to 1.8 and 1.6.

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The results from the worm-infested birds (18 - 22) are comparatively low. These birds showed also low erythrocyte counts (table 10) and on post-mortem were found to be severely infested with worm parasites.

Wirth (1931), quoting Kruger (1925), states that the viscosity of fowl serum is 1.4 and that of duck serum 1.24, but figures for avian blood or plasma are not given.

SPECIFIC GRAVITY.

The specific gravity was determined at a temperature of 15°C. with the use of a pycnometer. The blood and plasma were brought to the desired temperature in a thermostat on occasions when the atmospheric temperature in the room was not exactly 15°C. It will be noted from the determinations given in table (28) that the specific gravity of the blood of the ostrich varies from 1.060 to 1.065, the average being 1.063 The corresponding figures for the plasma are 1.021 to 1.024 and 1.022.

According to Kruger, cited by Wirth (1931), the specific gravity of the blood of the fowl is 1.0545 and that of its serum 1.0232. The corresponding figures as given by him for the blood and the serum of the goose are 1.0549 and 1.0202 - for the duck 1.0563 and 1.0202 and for the guinea-fowl 1.0577 and 1.0214.

Wirth (1931) gives a number of specific gravity determinations - by various workers-of the blood and the serum of a number of animals. The average figure obtained for the blood of the ostrich exceeds the average figures listed by Wirth, the nearest to the average being that given by Augsburger (1919), viz., 1.062 for the horse. Other workers, however, give lower values for the horse.

TABLE 26.

Statistical analysis of thrombocyte counts.

Bird No. [1]	Sex	No. of counts	Minimum count per c.mm.	Maximum count per c.mm.	Mean count per c.mm.	Standard error of the mean	Standard deviation.	Coefficient of variability.
1	Male	15	6014	14076	10073	725	2807	27.8
2	"	15	2478	19623	10456	960	3718	35.5
3	"	12	5562	14803	10802	792	2741	25.3
4	Female	15	4752	20086	11758	1156	4476	38.0
5	"	13	2686	15958	9428	1103	3971	42.1
1, 2 and3	Males	42	2478	19623	10418	476	3084	29.6
4 and 5	Females	28	2686	20086	10677	793	4198	39.4
1 to 5	Males & Females	70	2478	20086	10521	427	3545	33.6
6	Female	14	4061	26650	12439	1667	6235	50.1
7 to 11	Males	5	8946	17415	13091	1375	3026	23.1
12 to 17	Females	6	7720	15336	12693	1250	3002	23.6
7 to 17	Males & Females	11	7720	17415	12890	867	2864	22.2
18 to 22	Males & Females.	6	4650	15394	11135	1780	4274	38.3

[1] For particulars of birds see pages 9 - 11.

TABLE 27.

Viscosity Determinations.
Nos 1 to 5 - Ostriches clinically healthy and found free from disease on post-mortem examination.
No.6 - Ostrich with club-foot (see pages 9 - 10).
Nos. 18 - 22 - Unthrifty ostrich chicks which on post-mortem examination showed marked verminosis.

Bird No.	Sex	Date	Age	Viscosity blood	Viscosity plasma
1	Male	30/11/35	13 mths.	4.6	
		12/12/35	13 " 12 days	4.8	
		24/3/36	16 " 24 "	4.7	1.7
		9/5/37	18 " 9 "	4.8	1.7
2	Male	7/12/35	13 " 7 "	4.1	1.7
		12/12/35	13 " 12 "	4.4	1.6
		9/5/36	18 " 9 "	4.6	1.7
		26/8/36	21 " 26 "	4.3	
3	Male	7/12/35	13 " 7 "	4.5	
		9/12/35	13 " 9 "	4.2	1.6
		12/12/35	13 " 12 "	4.3	1.6
		7/9/36	22 " 7 "	4.9	1.7
4	Female	29/11/35	12 " 29 "	4.1	
		12/12/35	13 " 12 "	4.3	1.6
		24/3/36	16 " 24 "	4.6	1.5
		9/5/36	18 " 9 "	4.6	1.6
5	Female	15/11/35	12 " 15 "	4.0	1.7
		20/11/35	12 " 20 "	4.7	1.8
		12/12/35	13 " 12 "	4.7	1.8
		7/9/36	22 " 7 "	5.0	
Av. 1,2 & 3	Males	... ...		4.5	1.6
Av. 4 and 5	Females	... ...		4.5	1.6
Av. 1 to 5		... ...		4.5	1.6
6	Female	20/11/35	12 mths.20 days	5.5	
		29/11/35	12 " 29 "	4.1	1.7
		7/9/36	22 " 7 "	5.4	1.8
		1/12/36	25 " 1 "	4.8	1.7
18		15/3/36	4 "	3.2	
19		19/3/36	4 "	2.3	
20		20/3/36	4 "	2.3	
21		22/3/36	4 "	2.0	
22		8/2/37	4 "	3.5	

TABLE 28.

Specific Gravity Determinations.
Ostriches clinically healthy and found free from disease on post-mortem examination.

Bird No. & Sex.	Date	Age	Temperature at which sp.gravity determined	Sp. gravity blood	Sp. gravity plasma.
1 Male	24/3/36	16 mths. 24 days	15°C.	1.064	
	5/6/36	19 " 5 "	"	1.065	1.023
2 Male	9/5/36	18 " 9 "	15°C.	1.060	1.022
3 Male	9/5/36	18 " 9 "	15°C.	1.064	1.023
4 Female	24/3/36	16 " 24 "	15°C.	1.064	
	31/16/36	19 " 3 "	"	1.066	1.021
5 Female	9/5/36	18 " 9 "	15°C.	1.062	1.022
	27/5/36	19 "		1.062	1.024
Av. Males	... ...			1.063	1.022
Av. Females	... ...			1.063	1.022
Av. 1 to 5 Males & Females	... ...			1.063	1.022

INORGANIC PHOSPHORUS, CALCIUM, SODIUM, POTASSIUM AND MAGNESIUM CONTENT.

Theiler, Green, du Toit ~~Malan~~ and others in the series of articles "Studies in Mineral Metabolism" 1927, et. seq., have shown that in many parts of South Africa cattle and sheep suffer from marked aphosphorosis resultant on phosphorus deficiency in the pastures and that phosphorus feeding is an essential factor in successful cattle and sheep farming. It seems, therefore, that phosphorus feeding to ostriches grazing over areas where other animals show aphosphorosis might profitably be investigated. Malan (1930) has shown that phosphorus deficiency even in the earliest stages may be diagnosed by determining the inorganic phosphorus content of the blood.

As the ostriches Nos. 1 to 5 could be regarded as entirely free from disease and as they always received a liberal supply of bones and other necessary foodstuffs, there was a good opportunity for obtaining data which might contribute toward establishing what levels of phosphorus and of the other mineral elements mentioned above may be considered normal in the blood of the ostrich. Blood analyses were, therefore, made from these birds and - for the purpose of comparison - ~~also~~ from bird No.6 and also from birds (Nos. 7 - 17) grazing on natural pasture in the Bredasdorp district.

The calcium content was determined particularly with the object of ascertaining whether the prolonged coagulation time could be associated with a low calcium content of the blood, but, as has been shown under "Coagulation of the Blood", this would not appear to be so.

The analyses were carried out under the supervision of Dr. A.I. Malan, Head of the Department of Bio-chemistry, Onderstepoort Laboratories, Pretoria, by his staff. The methods advocated by Malan and van der Lingen (1931) were employed.

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The writer collected the blood, precipitated the proteins and forwarded the trichloracetic acid filtrate to Onderstepoort.

The results are tabulated in table 29 and the following are the average values per 100 c.c. blood of all the results obtained from the normal birds (1 -5). Inorganic phosphorus 9.1 ± 0.3 mgm., calcium 10.1 ± 0.4 mgm., magnesium 7.6 ± 0.4 mgm. sodium 273.7 ± 13.0 mgm. and potassium 196.6 ± 6.0 mgm.

The inorganic phosphorus content of the blood of all five birds was comparatively low on 29/7/35, and it is not apparent why they showed relatively low values on that date. At no time was any alteration made in their food and it does not seem as if the values can be associated with their age, for bird No.6 at the age of six months and sixteen days - before it had sustained the injury - showed a higher value than it did at the age of nine months and two days. The results are, however, suggestive of a seasonal variation.

It will be noted that the average values of all the above-named elements obtained from bird No.6 and those of inorganic phosphorus and calcium shown by the results from the clinically healthy birds (7 - 17) do not differ appreciably from the mean values of all the results from birds 1 - 5.

Malan (1930) recorded for the ostrich a value of 5.5 mgm. inorganic phosphorus per 100 c.c. blood (table 1) and, according to this writer, fowl blood contains 2 mgm. and pigeon blood 1.6 mgm. inorganic phosphorus per 100 c.c. blood. Under the heading "Preventing Coagulation of the Blood" the calcium value obtained for the ostrich has already been referred to.

Magnesium, sodium and potassium values from other birds were not available, but it is interesting to note that the potassium content of ostrich blood is high when compared with that of the blood of some mammals. Groenewald (1935) records an average figure of 58.7 mgm. potassium per 100 c.c. bovine blood, and the following - given by Dukes (1934) - are potassium values per 1000 parts by weight of blood: Cow 0.407, Sheep 0.405, Goat 0.396.

TABLE 29.

ANALYTICAL RESULTS.

Nos. 1 to 5 - Ostriches clinically healthy and found free from disease on post-mortem examination. Kept on farm Mariendahl, Stellenbosch district (see pages 9-10).
No. 6 - Ostrich with club-foot. Kept on farm Mariendahl, Stellenbosch district (see pages 9-10).
Nos 7 to 13 - Clinically healthy semi-wild ostriches on which post-mortem examinations were not conducted. From farm Nagwag, Bredasdorp district (see page 11).

Bird No	Sex	Date	Age	Mgm. per 100 c.c. blood. Inorg. P.	Ca.	Mg.	Na.	K.
1	Male	29/7/35	9 mths 2 days	5.8	10.0			
		12/12/35	13 " 17 "	10.2	8.2	7.8	250.0	211.5
		17/4/36	17 " 24 "	8.9	8.5			
		20/2/37	28 " 4 "	10.2	8.1			
2	Male	29/7/35	9 " 2 "	6.7	11.0			
		12/12/35	13 " 17 "	10.2	10.3	8.4	270.0	177.5
		17/4/36	17 " 24 "	9.2	9.4			
		20/2/37	28 " 4 "	10.1	8.9			
3	Male	29/7/35	9 " 2 "	7.6	10.7			
		12/12/35	13 " 17 "	11.4	13.3	7.1	256.2	202.0
		17/4/36	17 " 24 "	9.3	10.0			
		20/2/37	28 " 4 "	10.4	8.3			
4	Female	29/7/35	9 " 2 "	6.7	10.1			
		12/12/35	13 " 17 "	10.2	11.6	7.7	270.0	189.0
		17/4/36	17 " 24 "	9.2	10.3			
		20/2/37	28 " 4 "	10.3	8.6			
5	Female	29/7/35	9 " 2 "	6.9	10.0			
		12/12/35	13 " 17 "	10.2	14.0	7.4	322.5	203.0
		17/4/36	17 " 24 "	9.0	14.2			
		20/2/37	28 " 4 "	10.1	8.3			
Averages	1, 2,3	Males	--------	9 " 2 "	6.7	10.5		
"	" " "	"	--------	13 " 17 "	10.6	10.6	7.7	258.7	197.0
"	" " "	"	--------	17 " 24 "	9.1	9.3			
"	" " "	"	--------	28 " 4 "	10.2	8.4			
Averages	4, 5	Females	--------	9 " 2 "	6.8	10.5		
"	" "	"	--------	13 " 17 "	10.2	12.8	7.5	296.2	196.0
"	" "	"	--------	17 " 24 "	9.1	12.2			
"	" "	"	--------	28 " 4 "	10.2	8.4			
Averages	1 to 5	Males &	--------	9 " 2 "	6.7	10.3		
"	" " "	Females	--------	13 " 17 "	10.4	11.4	7.6	273.7	196.6
"	" " "	do.	--------	17 " 24 "	9.1	10.4			
"	" " "	do.	--------	28 " 4 "	10.2	8.4			
all Averages/results	1 to 5	----------			9.1	10.1	7.6	273.7	196.6
Standard error	- - - -	----------			0.3	0.4	0.4	13.0	6.0
" deviation	- - - -	----------			1.5	1.6	0.9	28.6	13.3
Coefficient of variability.	- - - -	----------			16.4	15.8	11.8	10.4	6.7
6	Female	15/5/35	6 mths. 16 days	8.2	10.5	8.2	238.0	181.5
		29/7/35	9 " 2 "	6.9	10.1			
		12/12/35	13 " 17 "	11.6	13.1	7.7	270.0	212.0
		17/4/36	17 " 24 "	9.9	10.2			
		20/2/37	28 " 4 "	10.4	8.1			
Averages	----------				9.4	12.4	7.9	254.0	196.7
Standard error	----------				0.6	0.7			
" deviation	----------				1.5	1.7			
Coefficient of variability	----------				15.9	13.7			
7	Male	1/5/36	Over 3 years		10.5	10.2			
8	"	1/5/36	" " "		7.3	8.6			
9	"	1/5/36	" " "		9.7	9.8			
10	"	1/5/36	" " "		8.6	8.7			
11	Female	1/5/36	" " "		8.1	9.3			
12	"	1/5/36	" " "		7.9	8.7			
13	"	1/5/36	" " "		10.0	9.3			
Averages	7 to 13	----------			8.9	9.2			
Standard error		----------			0.4	0.2			
" deviation		----------			1.2	0.6			
Coefficient of variability		----------			13.4	6.0			

TOTAL BLOOD VOLUME.

For determining the approximate amount of blood in the ostrich four adult birds were used. Narcosis was induced by the administration of chloroform of which 60-80 c.c. were poured on cotton wool placed in a jar. After the right jugular vein had been severed, bleeding continued for about 45 minutes before death resulted.

The blood remaining in the heart and large vessels - about 500 c.c. - was also collected.

The average total blood volume was 5,466 c.c. and its weight constituted 0.058 per cent. of the average body weight: (Table 30).

TABLE 30.

Total Blood Volume.

Bird No. and Sex	Age	Live weight in kilo-grams	Weight of blood in grams	Calcu-lated blood volume in cubic centi-metres (Sp.Gra-vity 1.063)	Weight of blood - expressed as per-centage of body weight
3 M.	33 mths.	111.659	5,901	5,551	0.052
4 M.	3 yrs.	108.936	5,787	5,444	0.053
23 M.	Over 3 yrs.	84.879	5,787	5,444	0.068
5 F.	33 mths.	108.936	6,355	5,978	0.058
24 F.	Over 3 yrs	82.156	5.220	4,911	0.063
Av. ----------		99.313	5,810	5,466	0.058

GENERAL DISCUSSION.

The erythrocyte count of the ostrich appears to be the lowest of the counts recorded for birds and mammals, but the ostrich erythrocyte is exceptionally large and, according to available results, it is exceeded in size only by that of the emu (Casuarius emu). Ponder (1919) remarks: "In general the larger the bird the larger the cell." In the moist state the cells are larger than in the dried state.

Although horse blood contains four times as many erythrocytes per c.mm. as ostrich blood, the relative volume of plasma and corpuscles of horse blood is considerably less than that of ostrich blood, and the haemoglobin content of ostrich blood is more than that of horse blood. The ostrich erythrocyte, therefore, is about four times the size of that of the horse and contains about four times as much haemoglobin. It weighs about four times as much as that of the horse, for the specific gravity of ostrich blood is about the same as that of horse blood. The points of minimum and maximum resistance of the ostrich erythrocyte are about the same as those of the erythrocyte of the fowl. The erythrocyte count of the fowl is much higher than that of the ostrich, but the haemoglobin content of fowl blood is much lower.

It is of particular interest that regeneration of erythrocytes is most clearly marked in ostrich blood. The percentage which in Romanowsky stained preparations show polychromatophilia, is considerably higher than that observed in the blood of other animals. In vitally stained

smears/.....