Morphology of Various Strains of the Trypanosome causing Disease in Man in Nyasaland.—The Wild-game Strain.

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Introduction.

Trypanosomes of this species, isolated from five antelope, are here described and compared with the Human strains which formed the subject of a previous paper.* The Wild-game strains were isolated by injecting blood of antelope into susceptible animals. The blood was, as a rule, injected into a healthy goat, monkey, and dog, and from these other animals were inoculated.

Trypanosomes from the following species were studied: reedbuck, waterbuck, oribi, and hartebeeste. In these experiments, with the exception of the oribi, the three inoculated animals became infected. In the case of the oribi the blood was inoculated into a monkey and dog, no goat being available, and the monkey alone took the disease.

I. *Morphology of Strain I, Reedbuck.*

The following table gives the average length of this trypanosome as found in the rat, 500 trypanosomes in all, and also the length of the longest and shortest:—

Table I.—Measurements of the Length of the Trypanosome of Strain I, Reedbuck.

Date.	Method of fixing.	Method of staining.	In microns.		
			Average length.	Maximum length.	Minimum length.
1912	Osmic acid	Giemsa	21·7	34·0	16·0

* *Supra*, p. 285.

Table II.—Distribution in respect to Length of 500 Individuals of the Trypanosome of Strain I, Reedbuck.

	In microns.								
	16.	17.	18.	19.	20.	21.	22.	23.	24.
Total	5	30	57	90	81	53	27	17	16
Percentages.....	1·0	6·0	11·4	18·0	16·2	10·6	5·4	3·4	3·2

	In microns.									
	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.
Total	18	23	18	25	18	9	8	2	2	1
Percentages.....	3·6	4·6	3·6	5·0	3·6	1·8	1·6	0·4	0·4	0·2

CHART 1.—Curve representing the Distribution, by Percentages, in respect to Length, of 500 Individuals of the Trypanosome of Strain I, Reedbuck, taken on nine consecutive days from Rat 847.

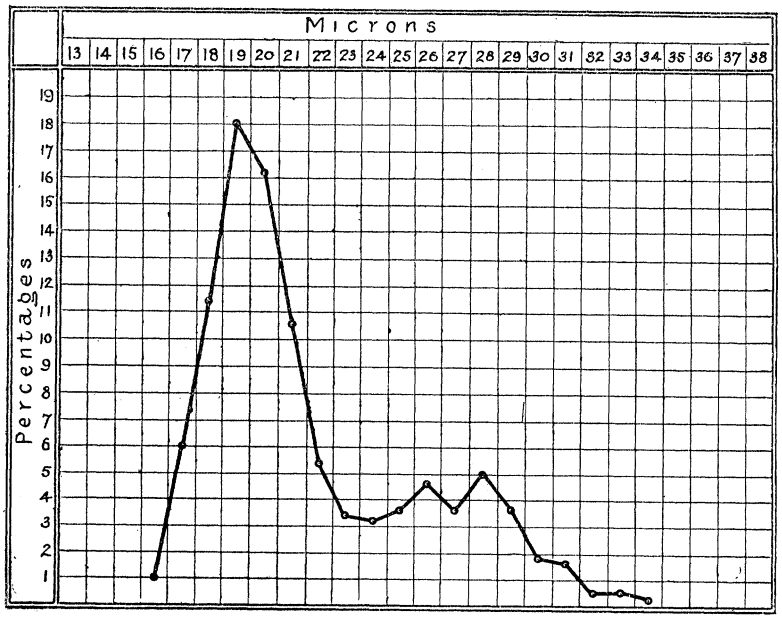


Table III.—Percentages of Posterior-nuclear Forms found among the Short and Stumpy Varieties of the Trypanosome of Strain I, Reedbuck.

Date.	Experiment No.	Animal.	Percentage among short and stumpy forms.
1912.			
July 17	847	Rat	4
„ 20	847	„	2
„ 22	847	„	2
„ 23	847	„	4
„ 24	847	„	9
„ 25	847	„	10
„ 26	847	„	19
„ 27	847	„	22
„ 29	847	„	4
		Average	8·4

II. *Morphology of Strain II, Waterbuck.*

The following table gives the average length of this trypanosome as found in the rat, 500 trypanosomes in all, and also the length of the longest and shortest :—

Table IV.—Measurements of the Length of the Trypanosome of Strain II, Waterbuck.

Date.	Method of fixing.	Method of staining.	In microns.		
			Average length.	Maximum length.	Minimum length.
1912	Osmic acid	Giemsa	23·5	33·0	16·0

Table V.—Distribution in respect to Length of 500 Individuals of the Trypanosome of Strain II, Waterbuck.

	In microns.								
	16.	17.	18.	19.	20.	21.	22.	23.	24.
Total	1	2	8	26	59	74	58	58	44
Percentages	0·2	0·4	1·6	5·2	11·8	14·8	11·6	11·6	8·8
	In microns.								
	25.	26.	27.	28.	29.	30.	31.	32.	33.
Total	27	34	33	26	17	19	9	3	2
Percentages	5·4	6·8	6·6	5·2	3·4	3·8	1·8	0·6	0·4

CHART 2.—Curve representing the Distribution, by Percentages, in respect to Length, of 500 Individuals of the Trypanosome of Strain II, Waterbuck, taken on nine consecutive days from Rat 1220.

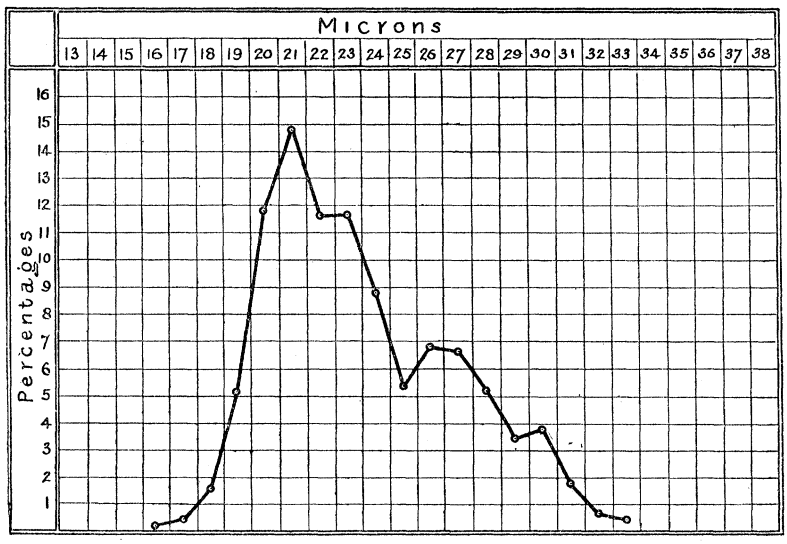


Table VI.—Percentages of Posterior-nuclear Forms found among the Short and Stumpy Varieties of the Trypanosome of Strain II, Waterbuck.

Date.	Experiment No.	Animal.	Percentage among short and stumpy forms.
1912.			
Sept. 7	1220	Rat	7
„ 8	1220	„	2
„ 12	1220	„	12
„ 16	1220	„	48
„ 17	1220	„	39
„ 18	1220	„	45
„ 19	1220	„	21
„ 20	1220	„	50
„ 23	1220	„	36
„ 24	1220	„	47
		Average	30·7

III. *Morphology of Strain III, Oribi.*

The following table gives the average length of this trypanosome as found in the rat, 500 trypanosomes in all, and also the length of the longest and shortest :—

Table VII.—Measurements of the Length of the Trypanosome of Strain III, Oribi.

Date.	Method of fixing.	Method of staining.	In microns.		
			Average length.	Maximum length.	Minimum length.
1912	Osmic acid	Giemsa	21·6	33·0	16·0

Table VIII.—Distribution in respect to Length of 500 Individuals of the Trypanosome of Strain III, Oribi.

	In microns.								
	16.	17.	18.	19.	20.	21.	22.	23.	24.
Total	1	10	22	77	109	90	57	28	19
Percentages	0·2	2·0	4·4	15·4	21·8	18·0	11·4	5·6	3·8
	In microns.								
	25.	26.	27.	28.	29.	30.	31.	32.	33.
Total	23	15	21	14	6	5	2	—	1
Percentages	4·6	3·0	4·2	2·8	1·2	1·0	0·4	—	0·2

CHART 3.—Curve representing the Distribution, by Percentages, in respect to Length, of 500 Individuals of the Trypanosome of Strain III, Oribi, taken on nine consecutive days from Rat 992.

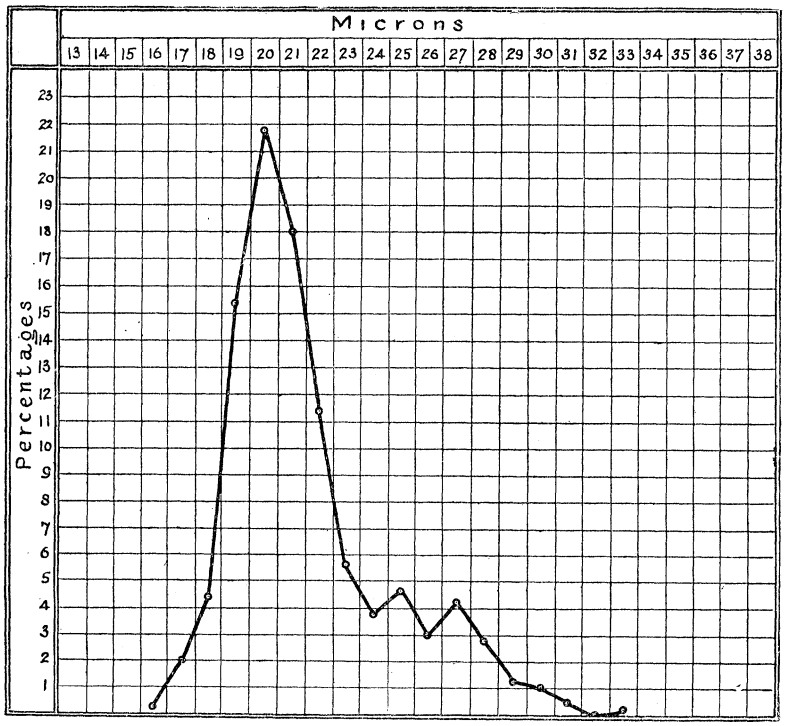


Table IX.—Percentages of Posterior-nuclear Forms found among the Short and Stumpy Varieties of the Trypanosome of Strain III, Oribi.

Date.	Experiment No.	Animal.	Percentage among short and stumpy forms.
1912.			
Aug. 1	992	Rat	12
„ 2	992	„	14
„ 3	992	„	10
„ 5	992	„	34
„ 6	992	„	15
„ 7	992	„	42
„ 9	992	„	29
„ 10	992	„	52
„ 12	992	„	42
„ 13	992	„	53
		Average	30·3

IV. *Morphology of Strain IV, Hartebeeste.*

The following table gives the average length of this trypanosome as found in the rat, 500 trypanosomes in all, and also the length of the longest and shortest :—

Table X.—Measurements of the Length of the Trypanosome of Strain IV, Hartebeeste.

Date.	Method of fixing.	Method of staining.	In microns.		
			Average length.	Maximum length.	Minimum length.
1912	Osmic acid	Giemsa	23·5	35·0	18·0

Table XI.—Distribution in respect to Length of 500 Individuals of the Trypanosome of Strain IV, Hartebeeste.

	In microns.								
	18.	19.	20.	21.	22.	23.	24.	25.	26.
Total	1	12	53	80	92	53	46	45	28
Percentages	0·2	2·4	10·6	16·0	18·4	10·6	9·2	9·0	5·6
	In microns.								
	27.	28.	29.	30.	31.	32.	33.	34.	35.
Total	25	21	10	19	6	6	2	—	1
Percentages	5·0	4·2	2·0	3·8	1·2	1·2	0·4	—	0·2

CHART 4.—Curve representing the Distribution, by Percentages, in respect to Length, of 500 Individuals of the Trypanosome of Strain IV, Hartebeeste, taken on nine consecutive days from Rat 849.

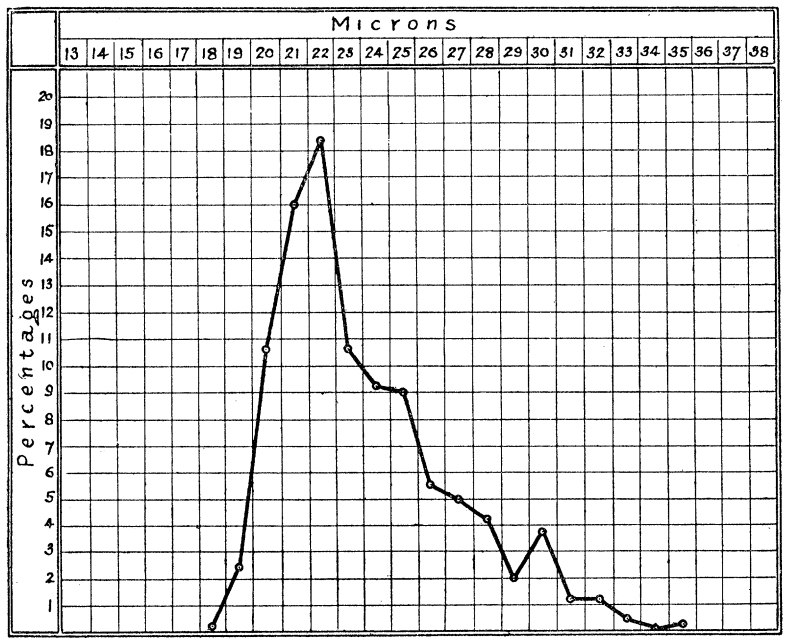


Table XII.—Percentages of Posterior-nuclear Forms found among the Short and Stumpy Varieties of the Trypanosome of Strain IV, Hartebeeste.

Date.	Experiment No.	Animal.	Percentage among short and stumpy forms.
1912.			
July 19	849	Rat	15
„ 20	849	„	18
„ 22	849	„	8
„ 23	849	„	16
„ 24	849	„	26
„ 26	849	„	49
„ 29	849	„	16
„ 30	849	„	38
„ 31	849	„	52
Aug. 1	849	„	45
Average			28·3

V. *Morphology of Strain V, Hartebeeste.*

The following table gives the average length of this trypanosome as found in the rat, 500 trypanosomes in all, and also the length of the longest and shortest :—

Table XIII.—Measurements of the Length of the Trypanosome of Strain V, Hartebeeste.

Date.	Method of fixing.	Method of staining.	In microns.		
			Average length.	Maximum length.	Minimum length.
1912	Osmic acid.	Giemsa	22·6	34·0	15·0

Table XIV.—Distribution in respect to Length of 500 Individuals of the Trypanosome of Strain V, Hartebeeste.

	In microns.									
	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
Total	1	1	11	30	47	79	51	51	44	37
Percentages	0·2	0·2	2·2	6·0	9·4	15·8	10·2	10·2	8·8	7·4
	In microns.									
	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.
Total	36	35	28	24	11	3	8	1	—	2
Percentages	7·2	7·0	5·6	4·8	2·2	0·6	1·6	0·2	—	0·4

CHART 5.—Curve representing the Distribution, by Percentages, in respect to Length, of 500 Individuals of the Trypanosome of Strain V, Hartebeeste, taken on nine consecutive days from Rat 1022.

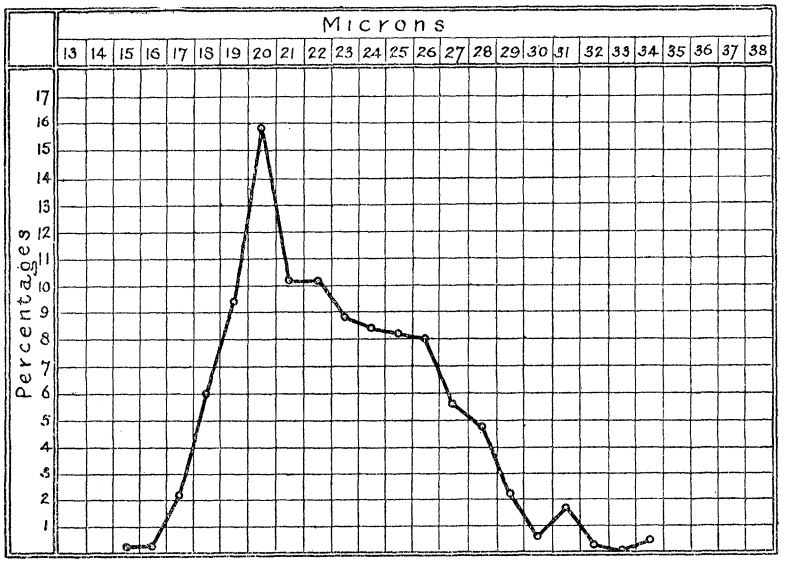


Table XV.—Percentages of Posterior-nuclear Forms found among the Short and Stumpy Varieties of the Trypanosome of Strain V, Hartebeeste.

Date.	Experiment No.	Animal.	Percentage among short and stumpy forms.
1912.			
Aug. 21	1022	Rat	18
„ 22	1022	„	7
„ 23	1022	„	11
„ 24	1022	„	30
„ 26	1022	„	42
„ 27	1022	„	55
„ 28	1022	„	34
„ 29	1022	„	54
Sept. 2	1022	„	50
		Average	33·4

Comparison of the Wild-game Strains with one another.

Table XVI.—Measurements of the Length of the Trypanosome of the Wild-game Strains.

Date.	Experiment No.	Animal.	No. measured.	From what animal.	In microns.		
					Average length.	Maximum length.	Minimum length.
1912	783	Reedbuck	500	Rat	21·7	34·0	16·0
1912	1180	Waterbuck	500	„	23·5	33·0	16·0
1912	863	Oribi	500	„	21·6	33·0	16·0
1912	799	Hartebeeste	500	„	23·5	35·0	18·0
1912	957	„	500	„	22·6	34·0	15·0
			2500	Average	22·6	35·0	15·0

Comparison of the Curves of the Wild-game Strains.

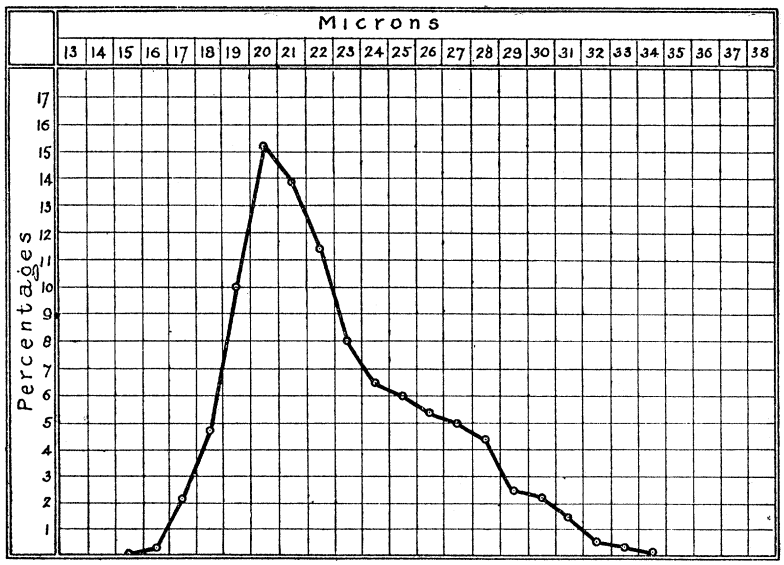
Unlike the curves of the Human strains, these are all remarkably alike, and there can be little doubt that the same species of trypanosome is being dealt with in all five of the Wild-game strains. The Wild-game curves resemble Strains II, IV, and V of the Human strains, described in a former paper, and also those found by Kinghorn and Yorke in the Luangwa Valley.

Table XVII.—Distribution in respect to Length of 2500 Individuals of the Trypanosome of the five Wild-game Strains.

	In microns.									
	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
Total	1	8	53	118	252	381	348	285	200	162
Percentages	—	0·3	2·1	4·7	10·0	15·2	13·9	11·4	8·0	6·5

	In microns.										
	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.
Total	149	135	125	110	62	55	53	12	7	3	1
Percentages	6·0	5·4	5·0	4·4	2·5	2·2	1·5	0·5	0·3	0·1	—

CHART 6.—Composite Curve representing the Distribution, by Percentages, in respect to Length, of 2500 Individuals of the Trypanosome of the Wild-game Strains.



This composite curve resembles the human Strain II, E——.

Table XVIII.—Comparison of the Percentages of Posterior-nuclear Forms found among the Short and Stumpy Varieties of the Trypanosomes of the five Wild-game Strains.

Date.	Experiment No.	Animal.	Percentage among short and stumpy forms.
1912	783	Reedbuck	8·4
1912	1180	Waterbuck	30·7
1912	863	Oribi	30·3
1912	779	Hartebeeste	28·3
1912	957	„	33·4
		Average	26·2

It is evident from these tables and charts that the various strains of this trypanosome, as they occur in wild game, are remarkably alike. This is what might be expected. Here the trypanosome is at home: it is leading a natural life. It may be supposed to be saved from variation by constantly passing and repassing between the antelope and the tsetse fly.

Comparison of the Human Strain with the Wild-game Strain.

Table XIX.—Average Length of the Trypanosome of the Human and Wild-game Strains.

Strain.	Number of trypanosomes measured.	Animal.	In microns.		
			Average length.	Maximum length.	Minimum length.
Human	3600	Rat	24·2	38·0	15·0
Wild-game	2500	„	22·6	35·0	15·0

The length of the trypanosomes of the Human strain found in white rats only is included in this table, in order to permit of comparison with the Wild-game strain, which is also taken from rats.

The curves (Chart 7) differ from each other in such a marked manner as to be of no use in deciding as to the identity of the Human and Wild-game strains. In spite of this, however, by a comparison of the two strains morphologically and by the susceptibility of the different experimental animals to their pathogenic action, the Commission are driven for the present to the decision that the two strains belong to the same species of trypanosome.

CHART 7.—Curves representing the Distribution, by Percentages, in respect to Length, of 3600 Individuals of the Trypanosome of the Human Strain, and 2500 of the Wild-game Strain.

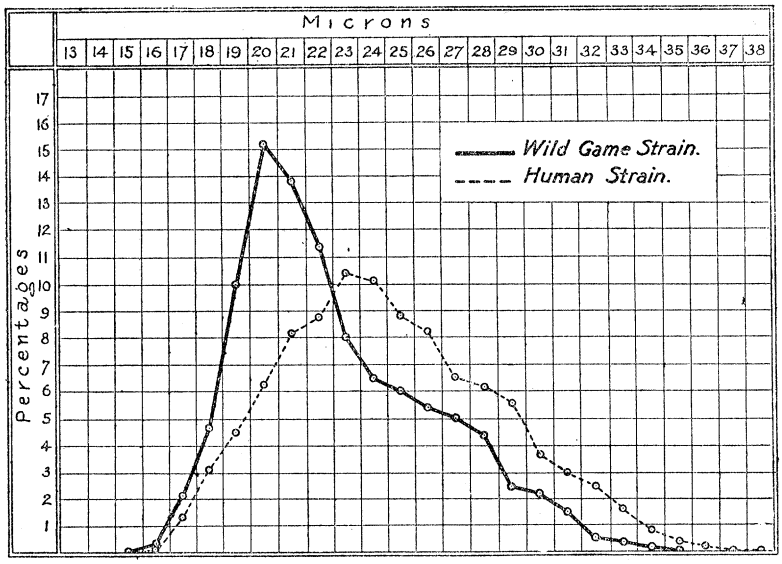


Table XX.—Percentages of Posterior-nuclear Forms found among the Short and Stumpy Varieties of the Trypanosome of the Human and Wild-game Strains.

Date.	Strain.	Average, percentage.	Maximum, percentage.	Minimum, percentage.
1912	Human	21·1	52·0	2·0
1912	Wild-game	26·2	33·4	8·4

Conclusions.

1. The five Wild-game strains resemble each other closely, and all belong to the same species of trypanosome.

2. The Wild-game strains and the Human strains, although they differ to some extent, also belong to the same species.

3. This species is *T. rhodesiense* (Stephens and Fantham).

4. There is some reason for the belief that *T. rhodesiense* and *T. brucei* (Plimmer and Bradford) are one and the same species.