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THE MULTIPLICATION STAGES OF *Trypanosoma (Herpetosoma) xeri* IN THE LIVER OF THE SUDANESE GROUND SQUIRREL *Xerus (Euxerus) erythropus*

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Abstract: Blood and organ smears from 24 of 98 ground squirrels *(Xerus erythropus)* from the Sudan were infected with a trypanosome resembling *Trypanosoma (Herpetosoma) xeri*. The developmental stages are described from the liver of one heavily infected ground squirrel. Multiplication was by binary fission and numerous triangular amastigotes, sphaeromastogotes and trypomastigotes were observed. A tentative development cycle in the final host is presented.

INTRODUCTION

Trypanosoma (Herpetosoma) xeri was described in 1922 by Leger and Baury[2] from the ground squirrel, *Xerus erythropus*, from Senegal. Division forms were not observed in the blood or in the tissues by these authors. Multiplication stages have been described for only 11 species of trypanosomes belonging to the subgenus *Herpetosoma* from mammals. In six species multiplication occurs in the blood stream, and in five species, namely *T. evotomys, T. nabiasi, T. microti, T. tamiasi* and *T. zapi*, division forms are nearly exclusively present in tissues and visceral capillaries[1,3]. In this paper, division forms of a trypanosome resembling *T. xeri* are described from the liver of a heavily infected ground squirrel.

MATERIALS AND METHODS

Giemsa stained preparations of blood smears and organ impression preparations (heart, liver, spleen, lung and skin) of 98 ground squirrels from the Dinder area near the city of Sennar in central Sudan were examined for hemoflagellates. Measurements of trypanosomes and their multiplication stages were obtained by stepping of the desired distances with a pair of calibrated dividers on camera lucida drawings of well-stained flagellates.

RESULTS

Trypanosomes resembling *T. xeri* were found in the blood of 24 of 98 ground squirrels. Measurements of 208 blood forms are given in Table 1. Parasitemia was usually from one to 25 parasites per 50 fields in thin blood smears examined under high power magnification. However, one ground squirrel showed a very high parasitemia with more than 100 forms per field. The same animal had numerous flagellates in an impression smear of the liver, but no parasites in other organs. Most flagellates in the liver smear were trypomastigotes similar to those found in the peripheral blood, and some forms were dividing. All flagellates found were extracellular. A large variety of division forms were observed and are illustrated in Fig. 1. Division stages never contained more than two nuclei or kinetoplasts; triangular-shaped amastigotes, sphaeromastigotes and trypomastigotes were frequent. A few small epimastigote-

TABLE 1. Measurements (in μm) of *Trypanosoma xeri* in the liver and heart blood of the Sudanese ground squirrel.

IN THE LIVER:	PK	KN	PN	NA	N	F	W	L	NI	KI	Number measured
Amastigotes	-	1.2- 4.7	-	-	1.2-2.4	-	2.4-6.0	3.6- 7.2	-	-	40
Sphaeromastigotes	-	1.8- 4.3	-	-	1.2-2.5	0.4-10.1	3.6-6.0	6.2-20.9	-	-	50
Triangular trypomastigotes	1.6-5.0	1.2- 7.8	3.6-10.4	1.8-6.0	1.4-2.5	3.0-10.4	5.0-7.8	9.6-28.1	1.8-2.2	1.3-3.4	30
Large trypomastigotes	4.4-7.1 5.4[a]; 0.5[b]	6.0-11.0 8.1; 1.0	11.4-18.9 15.0; 1.3	3.5-5.1 4.3;0.3	2.4-3.0 2.7;0.1	10.0-16.0 12.8; 1.1	1.6-3.6 2.6;0.3	24.0-33.6 28.2; 1.9	3.3-3.9 3.5;0.1	1.6-2.1 1.8;0.3	100
Small trypomastigotes	1.2-3.8	0.9- 5.2	2.1-9.0	0.8-5.2	0.8-1.0	2.3- 4.8	1.2-3.0	10.8-13.7	1.8-2.6	1.9-3.2	15
Epimastigotes	4.0-4.1	0.7- 0.8	4.2- 4.3	3.0-3.1	1.4-1.6	4.3- 4.4	1.5-1.7	11.4-11.7	1.4-1.5	5.1-5.9	3
IN HEART BLOOD:											
Large trypomastigotes	3.4-7.3 4.6[a]; 0.3[b]	6.0-13.9 9.1; 0.2	10.8-19.4 15.2; 0.2	3.5-5.2 4.5;0.03	2.0-3.1 2.5;0.03	8.4-16.3 12.0; 0.2	1.6-3.1 2.5;0.03	24.2-36.2 28.8; 0.8	3.0-4.5 3.5;0.1	1.3-2.0 1.7;0.03	200
Small trypomastigotes	1.2-2.4	3.5- 7.0	4.7- 9.4	2.3-3.4	1.2-1.8	5.2-11.4	1.6-1.7	15.9-20.5	2.0-2.9	1.2-1.4	8
T. xeri of Leger and Baury, 1922	6.5	12.3	18.8	8.8	2.5	7	1.75	33 -36.5	2.1	1.5	?

PK = distance from posterior end to kinetoplast; KN = from kinetoplast to middle of nucleus;
PN = from posterior end to middle of nucleus;
NA = from middle of nucleus to anterior end; N = length of nucleus; F = length of free flagellum; W = maximum width;
L = total length; NI = (nuclear index) = PN/NA;
KI = (Kinetoplastic index) = PN/KN; a = mean; b = standard deviation.

like forms and some very small trypomastigotes were observed, as well as some presumably abnormal forms. No flagellates were found in the organs of the other ground squirrels.

DISCUSSION

The trypanosomes found in the blood of the ground squirrels are considered to be *Trypanosoma (Herpetosoma) xeri* Leger and Baury, 1922. Although our blood forms are in average somewhat smaller than the measurements given by Leger and Baury[2] of an unknown number of trypanosomes, the small mensural differences are considered insufficient criteria for description of a new species. Following the criteria of Hoare[1] for the subgenus *Herpetosoma*, we prefer to consider the parasite as *T. xeri*. Since no other trypanosomes were found in the mammals, the division stages observed in the liver are considered to be the yet undescribed multiplication states of *T. xeri*.

In the subgenus *Herpetosoma*, reproduction forms in the blood, have been described for *T. blanchardi, T. grosi, T. lewisi, T. musculi, T. primatum* and *T. rabinowitchae*, and reproduction in organs for *T. evotomys, T. lewisi, T. microti, T. nabiasi, T. tamiasi* and *T. zapi*. In *T. zapi* of the jumping mouse (*Zapus* spp.), some amastigotes dividing into eight individuals were found in the liver; however, epimastigotes also were present in the blood. The only

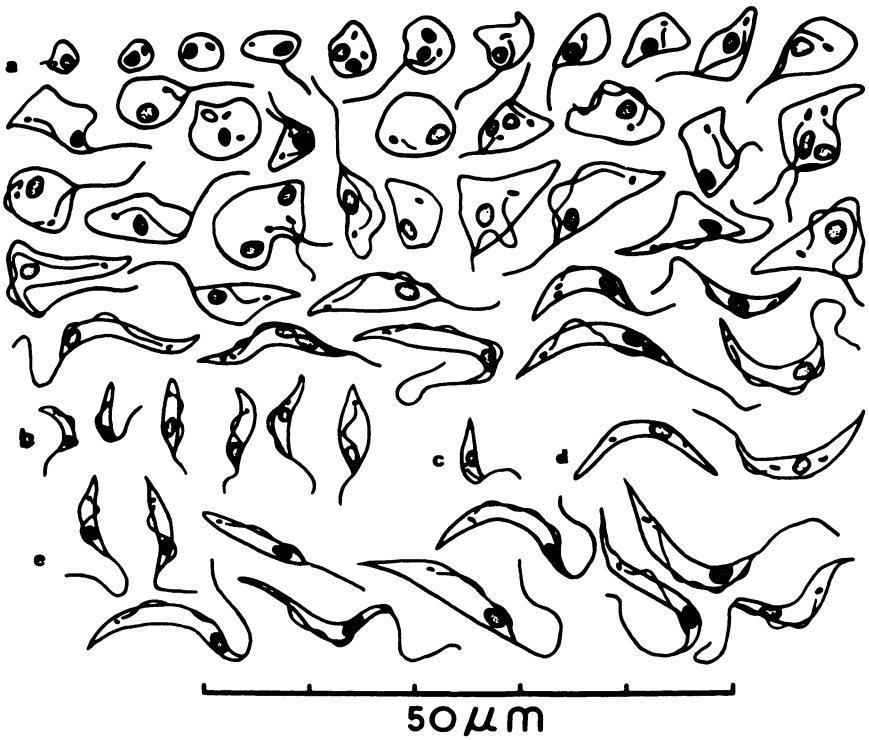

FIGURE 1. Camera lucida drawings of *Trypanosoma xeri*.
Various multiplication stages in liver (after a); small trypomastigotes from liver (after b); epimastiogote-like flagelalate (c); abnormal forms (after d); small and large trypomastigotes from blood stream (after e).

Herpetomonas which divides exclusively in tissues by binary fission in the amastigote stage is *T. evotomys* of voles (*Clethrionomys* spp.). In the latter trypanosome species, the division stages, measuring 3-7 μm, were found in the spleen and lymphoid tissues, and sphaeromastigotes were absent[1,3]. The division forms of *T. xeri* are peculiar because of the great variety of shapes and sizes, the numerous triangular forms not touching other cells, and the absence of typical epimastigotes.

Although the available material is not sufficient to explain the total life cycle of the trypanosome in its host, it can be deduced that at least one of the pathways seems to be by binary fission of amastigotes, sphaeromastigotes and trypomastigotes. These forms often develop via a triangular phase into long slender trypomastigotes. Trypanosomes carried to the liver seem to round up into amastigotes or sphaeromastigotes prior to division.

The Sudanese ground squirrel is active during the day when temperature of the sand may rise to 84 C[4]. It is well known that trypanosomes of mammals do not survive at temperatures above 37 C in *vitro* or at 42 C in *vivo*, and that *T. cruzi* and *T. brucei* disappear from the blood of naturally or experimentally infected mammals when environmental temperatures are high. It is surprising that a high trypanosome parasitemia occurred in a ground squirrel exposed to very high environmental temperatures, especially when it is considered that a proportion of the circulating trypanosomes will pass through capillaries where temperatures will be above 46 C[4].

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