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A BRIEF REVIEW OF *TRYPANOSOMA* (*MEGATRYPANUM*) INFECTIONS IN RUMINANTS IN NORTH AMERICA AND EUROPE

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ZWIĘZŁY PRZEGLĄD ZARAŻEŃ *TRYPANOSOMA* (*MEGATRYPANUM*) U PRZEŻUWACZY W AMERYCE PÓŁNOCNEJ I EUROPIE

In order to characterize, and accomodate, morphologically similar but biologically divergent forms, members of the genus *Trypanosoma* (*Protozoa*: *Kinetoplastida*) infecting mammals were separated into two sections by Hoare (1964), viz., the *Stercoraria* and the *Salivaria*. Members of the *Stercoraria* are so designated primarily because they show a pattern of discontinuous multiplication in the vertebrate host and development to the infective stage in the vector occurs in the posterior station; infection is contaminative. Certain morphological features also characterize this section. With some exceptions (*T. lewisi* at times, *T. cruzi*) stercorarian trypanosomes are considered nonpathogenic to their hosts. No members of the *Salivaria* show a pattern of continuous multiplication in the vertebrate host and development to the infective stage in the vector in the anterior station with infection inoculative (with the exception of *T. equiperdum*). The majority of salivarian species are transmitted by tsetse flies and, with some exceptions, e.g., *T. evansi*, *T. vivax*, are to be found only on the African continent. Some salivarian species are highly pathogenic to their vertebrate hosts (including man) causing conditions referred to as surra, ngana, African sleeping sickness and other diseases; often, there is high mortality among their vertebrate hosts. Because of their mainly African distribution, they will not be further considered here. Members of both groups may be transmitted mechanically.

The stercorarian section is further subdivided into three subgenera: subgenus *Herpetosoma* Doflein, 1901 the majority of which are parasitic in rodents; subgenus *Schizotrypanum* Chagas, 1909 which includes *T. cruzi*, a pathogenic parasite with a wide host range, including man; some other species are found in primates and bats; the remaining species are placed in the

TABLE 1

A partial list of species, hosts, vectors and distribution of *Trypanosoma* (*Megatrypanum*)

Species and vector (s)	Vertebrate Host(s)	Distribution	References
T. theileri Laveran, 1902 Vector: *Tabanidae*	*Bovidae*, mainly dom. cattle (*Bos taurus*) also, *Bison bison*, *Bison bonasus*	Cosmopolitan North America Poland	Hoare, (1972) Kingston et al. (1986) Wrublewski (1909)
T. melophagium (Flü, 1908) Vector: *Hippoboscidae*, *Melophagus ovinus*	Domestic sheep (*Ovis aries*)	Cosmopolitan	Hoare (1972)
T. theodori Hoare, 1931 Vector: *Hippoboscidae*, *Lipoptena capreoli*	Palestinian goat (*Capra hircus mambrica*)	Palestine (Israel)	Hoare (1972)
T. ingens Bruce, Hamerton, Bateman and Mackie, 1909 Syn. *tragelaphi* (Kinghorn et al., 1913) Vector: unknown	Dom. cattle, various antelope, chevrotains	Africa, Asia	Hoare (1972)
T. mazamarum Mazza et al., 1932 Vector: unknown	Brocket deer (*Mazama rufa*, *M. simplicornis*)	Argentina Brazil	Mazza et al. (1932) Deane (1961)
T. cervi Kingston and Morton, 1975 Vector: unknown, possibly *Tabanidae*	Elk (*Cervus canadensis*)	North America	Kingston and Morton (1975)
	White-tail deer (*Odocoileus virginianus*)	North America	Kingston and Crum (1977)
	Mule deer (*O. hemionus*)	North America	Matthews et al. (1977)
	Moose (*Alces alces*)		Kingston et. al. (1985)
	Reindeer (*Rangifer tarandus*)	North America (Alaska) Finland	Kingston et al. (1982) Kingston and Nikander (1985)

T. theileri-like Vector: unknown	White-tail deer	Colombia	Deane (1961)
T. sp.[1] Vector: unknown	Musk ox (*Ovibos moschatus*)	North America (Alaska)	Kingston, unp. data
T. sp. Vector: unknown	Mountain goat (*Oreamnos americanum*)	North America	Seville and Kingston (1987)
T. sp. Vector: unknown	Red deer (*Cervus elaphus*)	Germany Poland	Hoffman et al. (1984) Kingston et al. (1985)
T. sp. Vector: *Tabanidae*	Fallow deer (*Cervus dama*)	Germany	Hoffman et al. (1984) Böse et al. (1987)
T. sp. Vector: unknown	Roe deer (*Capreolus capreolus*)	Germany Poland Austria	Hoffman et al. (1984) Kingston and Bobek (1985) Hinaidy (1987)
T. sp.[2] Vector: unknown	Elk (*Alces alces*)	Poland	Kingston et al. (1985)
T. sp. Vector: unknown	Wisent (*Bison bonasus*)	Poland	Kingston et al. (1987)
T. sp.[2] Vector: unknown	Pronghorn (*Antilocapra americana*)	North America	Kingston et al. (1981)

[1] too few specimens to describe
[2] seen in culture only

subgenus *Megatrypanum* Hoare, 1964 and differ from the foregoing species not only morphologically but, also, in that they infect mainly ruminants with some species in bats and tropical primates. The members of this subgenus show varying but, generally, a close host restriction. It is among members of this subgenus infecting ruminants that is the subject of this review. A list of species of parasite, hosts, vectors and their distribution is given in table 1.

Members of the deer family (*Cervidae*) have been hunted extensively, since ancient times till now, and studied intensively in modern times. Much was, and is, known about some of the parasites and diseases of these animals, particularly of large easily observed forms or acute disease conditions. Little attention had been given, however, to more cryptic parasites, especially those not causing acute or pathological changes, until the discovery by Kistner and Hanson in 1969 of the occurrence of trypanosomes in blood cultures from white-tail deer in the southeastern United States. Their finding of this parasite in this wide-spread host in North America prompted similar studies, especially in western North America, where Clark (1972) found trypanosomes in blood cultures from mule deer in Colorado and New Mexico. Infections in mule deer were detected in Wyoming (Kingston et al. 1975). Kingston and Morton (1973) reported trypanosomes from elk in Wyoming, and Davies and Clark (1974) in elk and horseflies in New Mexico. The species in elk was described, on morphological grounds, as a new species and named, with little originality, *Trypanosoma cervi* Kingston and Morton, 1975. Subsequently, Kingston and co-workers identified the species in mule deer (M. Matthews et al. 1977), white-tail deer (Kingston and Crum 1997), reindeer (Kingston et al. 1982; Kingston and Nikander 1985), and moose (Kingston et al. 1985) as conspecific with *T. cervi.*

Other work during this period resulted in the redescription of *Trypanosoma theileri* and the pattern of development of the parasite in experimentally infected Wyoming cattle (D. Matthews et al. 1979); successful transplacental transmission of *T. theileri* in cattle (Kingston et al. 1982); and experimental transmission of cryopreserved bovine trypanosomes (*T. theileri*) to bison and the subsequent description and identification of the forms found in the latter host as *T. theileri* (Kingston et al. 1986).

Bovine and ovine trypanosomes, *Trypanosoma theileri* Laveran, 1902 and *Trypanosoma melophagium* (Flü, 1908) Nöller, 1917, respectively, had long been known from North America (Crawley 1912, Swingle 1911) though morphological characterization of the blood stream forms of the latter species was inadequate (Hoare 1972) until recently (Büscher and Friedhoff 1984). It was necessary to compare these ruminant parasites with those from deer. Bovid and cervid trypanosomes were considered as distinct and separate species denominated as above.

Pronghorn antelope from North America have been found by culture to be infected with trypanosomes but no bloodstream stages have been recovered on

slides. Hence this species remains species inquirenda until evidence is forthcoming to relate it/or not to one of the known North American species of trypanosome.

An interesting report was published (Hoffman et al. 1984) giving the description of blood stream forms of *Trypanosoma* sp. from red deer, fallow deer, and roe deer in Germany, elk were not found to be infected. The authors declined to identify the species on morphological grounds alone wishing to conduct cross-transmission and vector transmission studies before committing themselves on species identity. This was the first report of stercorarian trypanosomes in *Cervidae* on the European continent. In the next year 7 of 8 roe deer in Poland were reported to be infected with trypanosomes (Kingston and Bobek 1985) and red deer and elk (by culture) in Poland were similarly found to be infected (Kingston et al. 1985).

Böse et al. (1987) in Germany, reported on the results of an interesting vector transmission experiment using blooded tabanids from an area with cattle but free of deer and other tabanids from an area with deer but free of cattle. The gut contents of flies from the deer-free area infected cattle but not deer. Conversely, the gut contents of flies from the cattle-free area infected deer but not cattle. The authors concluded from their study that trypanosomes from deer and those from cattle represented distinct, and different, species but they still applied no specific epithet(s) to their material.

During this same period Büscher and Friedhoff (1984) recovered and redescribed *Trypanosoma melophagium* from 111 specimens from a splenectomized and immunosuppressed lamb using a combination of microhaematocrit methods (Bennett 1962) and a cytospin centrifuge to concentrate the trypanosomes in a small area for study. The previous descriptions of this species was based on a total of 12 organisms (Hoare 1972).

In a short review on the current status of trypanosome studies in Poland Kingston et al. (1987) reported on the rediscovery by Rutkowska, one of the authors, of a trypanosome of wisent in Puszcza Białowieska. The only previous report on trypanosomes from this host had been that of Wrublewski (1909) from the same area although the almost total eradication of this host from the area during World War I makes it difficult to consider that the parasites recovered in 1986 had been maintained to the time when the bison herds were reestablished (ca 1927). Wrublewski identified his material as *T. theileri.*

In table 2 mensural values and indices are given for trypanosomes from deer and cattle in North America and for trypanosomes from roe deer from Germany. When trypanosomes from NA deer are compared with those from German deer differences are seen in BL, FF and the FF : BL ratio; similarity occurs in the KI index. Trypanosomes from German deer resemble trypanosomes from NA cattle in PN, NA, BL and the FF: BL ratio. Values for NI are similar for all three groups of trypanosomes. Mean FF length of trypanosomes from German roe deer is 21% greater than the mean FF value for trypanoso-

TABLE 2

Comparison of the certain mensural values (in μm) and indices of Trypanosomes from North American cattle and deer with those from roe deer Trypanosomes from Germany

Specification	PK[1]	KN	PN	NA	BL	FF	L	W	FF:BL	PN:KN	PN:NA
North American cattle ($n = 304$), composite *T. theileri*	7.4	8.9	16.2	20.2	36.4	14.2	50.5	3.3	1:2.8	1:1.9	1:0.9
Deer ($n = 174$), composite[2] *T. cervi*	11.5	7.0	18.5	23.3	42.0	8.2	50.1	5.5	1:6.1	1:2.7	1:0.8
Germany Roe deer ($n = 86$) *Trypanosoma* sp.	9.8	5.8	15.5	18.1	33.6	10.4	44.0	–	1:2.9	1:2.9	1:0.9

[1] PK – posterior end to kinetoplast, KN – kinetoplast to nucleus, PN – posterior end to nucleus, NA – nucleus to anterior end of body, BL – body length, FF – length of free flagellum, L – BL + FF, W – width of body.

[2] Includes elk + mule, deer + white-tail deer + moose + reindeer.

mes from North American deer but does not reach the length of that organelle in NA cattle (the mean value for FF is 27% greater in NA cattle than in German roe deer). The lack of correspondence in mensural values between trypanosomes from NA and German deer may well indicate fundamental differences in the haemoparasite fauna of these widely separated hosts. Such differences may have resulted from the long term separation of the North American and Euroasian continents and thus of the hosts, which precluded transfer of parasites and maintenance of homogenity among these parasites. It is not possible in this paper to further discuss the parasite material from Poland as its analysis is not yet complete. It will be of great interest to see what similarities, or differences, will be found when comparisons can be made between Polish, German and North American parasites form, in some cases, the some hosts NA elk and red deer, European elk and NA moose, as well as from quite different hosts, e.g., roe deer and white-tail and mule deer.

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