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Blood parasites of livestock in certain Regions in Saudi Arabia ☆

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**SUBJECT
CLASSIFICATION**

Blood parasites of livestock

KEYWORDS

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Trypanosoma evansi;
Dipetalonema evansi;
Eperthroozoon wenyoni;
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Theileria annulata;
Theileria hirci;
Theileria ovis;
Anaplasma ovis;
Anaplasma marginale;

Abstract Blood samples from camels, sheep, goats and cattle from six Regions in Saudi Arabia were examined for blood parasites. Asir Region camels were disinfected while those of the Eastern, Jazan, Northern Frontiers, Riyadh and Tabouk Regions were infected with *Trypanosoma evansi* (5–40%), those of Riyadh and the Eastern Regions were infected with *Dipetalonema evansi* (1–6%) and those of the Eastern, Jazan and Riyadh Regions were infected with *Eperthroozoon* species (8–20%). Sheep and goats of all tested regions were infected with *Theileria hirci* (4–20% and 6–14%, respectively), *Theileria ovis* (5–19% and 6–24%, respectively) and *Eperthroozoon ovis* (2–9% and 2–8%, respectively). Sheep of the Eastern and Northern Frontiers Regions were also infected with *Anaplasma ovis* (2%) and also those of the Eastern Region were infected with *Babesia motasi* (4%) as well. Cattle of Asir and Eastern Regions were infected with *Anaplasma marginale* (1–3.4%) and those of the Eastern, Jazan and Riyadh Regions were infected with *Theileria annulata* (11.3–25%) and *Eperthroozoon wenyoni* (1–4%). Moreover, Jazan cattle were infected with *Babesia bigemina* (6%) and a benign *Theileria* species (27%). Some of these parasites are recorded in new localities indicating that they are spreading in the country. Also, this is the first report in Saudi Arabia of *D. evansi* in camels, *A. ovis* and *B. motasi* in sheep and *A. marginale* and *B. bigemina* in cattle. These parasites may be introduced into the country with infected livestock infested with the vectors of these parasites. The suspected vectors of the detected parasites in Saudi Arabia is discussed. Follow

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Babesia bigemina;
Babesia motasi

up surveys of blood parasites are recommended to assess their distribution and infection rates in the livestock of all Regions of Saudi Arabia, to make plans for control measures against their vectors.

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1. Introduction

A nation wide survey of ticks infesting livestock was carried out in the Kingdom of Saudi Arabia during the years 1990 and 1991 (Diab et al., 2006). Many tick species, known to be vectors of diseases of man and his livestock, were found to infest camels, cattle, sheep and goats in the different Kingdom Regions (Diab et al., 2006). During that survey, blood samples were also collected from these animals to survey the blood parasites that may have been transmitted to these animals by the collected ticks or by other arthropod parasites. In the present study, we report the blood parasites detected in camels, cattle, sheep and goats in six Regions in Saudi Arabia.

2. Materials and methods

Blood samples were randomly collected each season from the ear veins of 8–28 of each of camels, sheep and goats from Asir, Jazan, Riyadh, Tabouk, Eastern and Northern Frontiers during the years 1990 and 1991 except for camels which were sampled for one year only. Blood samples were also collected from all available cattle in these Regions. Wet blood films were examined in the field using a field light microscope (Wilde 11, Switzerland). Heparinized microhaematocrit tubes (Fisher Scientific Company, Pennsylvania, USA) were also filled with ear vein blood from these animals and examined in the field for trypanosomes and microfilariae using the method of Kelly and Schillinger (1983). Thin blood smears were air-dried, fixed in absolute methanol, stained with Giemsa stain and examined microscopically for blood parasites.

3. Results

Blood samples from a total number of 700 camels, 548 sheep, 454 goats and 116 cattle were examined. The blood parasites detected in these samples are presented in Table 1.

3.1. Camels

Camels were infected with three parasites (Table 1), with a total infection rate of 8.8%. Camels of Asir Region were disinfecting with any blood parasite while those of Tabouk and the Northern Frontiers Regions were infected with *Trypanosoma evansi* only, with a total infection rate of 2.3% and 1.7%, respectively. Camels of Jazan Region were infected with *T. evansi* and an *Eperythrozoon* species, with a total infection rate of 20%, while those of Riyadh and the Eastern Regions were infected with *Dipetalonema evansi* in addition to the *T. evansi* and *Eperthrozoon*, with a total infection rate of 10.7% and 18.7%, respectively. Many tabanid flies were observed around and feeding on camels in the Regions where camels were infected with *T. evansi*.

3.2. Sheep

Sheep were infected with five parasites (Table 1), with a total infection rate of 6.8%. Sheep of the Eastern Region were infected with *Theileria hirci*, *Theileria ovis*, *Babesia motasi*, *Anaplasma ovis* and *Eperthrozoon ovis* while those of the Northern Frontiers Region were infected with *Th. hirci*, *Th. ovis*, *E. ovis* and *A. ovis*, with a total infection rate of 5.4% and 4.8%,

Table 1 Percentages of infection of camels, sheep, goats and cattle with blood parasites in six Regions in Saudi Arabia during the years 1990 and 1991.

Host: Blood parasites	Percentage of infection in the Regions of					
	Asir	Eastern	Jazan	Northern Frontiers	Riyadh	Tabouk
<i>Camels</i>						
<i>Trypanosoma evansi</i>	0.0	38.0	40.0	5.0	21.8	7.0
<i>Dipetalonema evansi</i>	0.0	6.0	0.0	0.0	1.0	0.0
<i>Eperythrozoon</i> sp.	0.0	12.0	20.0	0.0	8.0	0.0
<i>Sheep</i>						
<i>Theileria hirci</i>	20.0	14.0	9.0	4.0	8.1	8.0
<i>T. ovis</i>	19.0	5.0	11.0	9.0	5.6	8.0
<i>Eperythrozoon ovis</i>	4.0	2.0	8.0	9.0	8.3	7.0
<i>Babesia motasi</i>	0.0	4.0	0.0	0.0	0.0	0.0
<i>Anaplasma ovis</i>	0.0	2.0	0.0	2.0	0.0	0.0
<i>Goats</i>						
<i>Theileria hirci</i>	7.0	11.0	14.0	7.0	10.6	6.0
<i>Theileria ovis</i>	24.0	10.0	18.0	6.0	6.7	7.0
<i>Eperythrozoon ovis</i>	8.0	7.0	5.0	2.0	3.3	5.0
<i>Cattle</i>						
<i>Theileria annulata</i>	0.0	13.0	25.0	–	11.3	–
<i>Theileria</i> sp.	0.0	0.0	27.0	–	0.0	–
<i>Eperythrozoon wenyoni</i>	0.0	1.0	4.0	–	1.7	–
<i>Babesia bigemina</i>	0.0	0.0	6.0	–	0.0	–
<i>Anaplasma marginale</i>	1.0	3.4	0.0	–	0.0	–

respectively. On the other hand, sheep of Asir, Jazan, Riyadh and Tabouk Regions were infected with *Th. hirci*, *Th. ovis* and *E. ovis* only, with a total infection rate of 8.6%, 5.6%, 4.4% and 4.6%, respectively.

Differentiation between *Th. hirci* and *Th. ovis* was based on prevalence the latter of Koch's blue bodies in the former and scarcity or absence in Uilenberg (1981) and Soulsby (1986). In *Th. hirci* infections, the schizonts were prevalent in the blood smears. Some of the animals (sheep and goats) which positive for this parasite had enlarged prescapular and pre-femoral lymph nodes. On the other hand, schizonts were not detected in blood smears of animals infected with *Th. ovis*, and all of these animals were healthy looking.

3.3. Goats

Goats in all of the six Regions were infected with *Th. hirci*, *Th. ovis* and *E. ovis* (Table 1) with a total infection rate of 10.8%. The total infection rate in Asir Region was 13.0%, in Jazan Region was 12.3%, in the Eastern Region was 9.3%, in Riyadh Region was 6.9%, in Tabouk Region was 6% and in the Northern Frontiers Region was 5.0%.

3.4. Cattle

Cattle were found only in Asir, Eastern, Jazan and Riyadh Regions. They were infected with five parasites (Table 1), with a total infection rate of 3.6%. In addition to an unidentified *Theileria* species found only in Jazan Region, cattle of this Region were infected with *Theileria annulata*, *Eperythrozoon wenyoni* and *B. bigemina* with a total infection rate of 12.4%. Cattle of Asir Region were infected with *A. marginale* only, while those of Riyadh Region were infected with *Theileria annulata* and *E. wenyoni*, with a total infection rate of 0.2% and 2.9%, respectively. In addition to the latter two parasites, cattle of the Eastern Region were infected with *A. marginale* as well, with a total infection rate of 3.4%.

In blood smears of some cattle positive for *Th. annulata*, Koch's blue bodies were prevalent. On the other hand, blood samples of Jazan cattle were positive for the unidentified *Theileria* species showed scarce erythrocytic forms and no schizonts were detected. These cattle were healthy looking, which suggested that this species is nonpathogenic to cattle.

4. Discussion

In the present study, *T. evansi* was detected in camels in five of the six tested Regions of Saudi Arabia with a considerably high rate of infection (40%) in Jazan, which much higher than that reported by Hussein et al. (1991) for the same Region (18.3%). Camel trypanosomiasis probably has been introduced into the Kingdom from the neighboring countries since it has been reported from all countries bordering Saudi Arabia (Boyd et al., 1985). Hussein et al. (1991) and Al-Khalifa et al. (2008) found high incidence of this disease in localities known to be among the best-developed agricultural regions in the Kingdom, with prevailing conditions favorable for multiplication of tabanid flies, which is known as mechanical vectors of *T. evansi* (Rutter, 1967; Mahmoud and Gray, 1980; Soulsby, 1986; Boyd et al., 1985). In their study, Hussein et al. (1991) observed that the camels were heavily infested with tabanid flies

in the areas with the high incidence of trypanosomiasis and suggested that these tabanids were the mechanical vectors of *T. evansi* in the Kingdom. During examination of some ticks for parasites that may infect livestock in Saudi Arabia, *Trypanosoma* developmental stages were found in the tick *Hyalomma dromedarii* salivary glands (unpublished data). However, many tabanid flies were observed feeding on camels in the Regions where camels showed infection with *T. evansi*.

During the present study, microfilariae of *D. evansi* were detected in blood films of camels in the Eastern and Riyadh Regions. Hussein et al. (1991) did not report this parasite in their study of the blood parasite of camels in Saudi Arabia. This parasite has been reported from Egypt, the Far East and eastern parts of the previous USSR (Soulsby, 1986) and probably has been introduced recently into the Kingdom from one of these countries.

Similar to the report by Hussein et al. (1991), the present work demonstrated that benign *Th. ovis* of sheep and goats is widespread in the Kingdom. On the other hand, the latter authors reported that *Th. hirci* was restricted to the eastern and northern parts of the Kingdom while during the present study it was found in all of the tested Regions. While *Th. ovis* is a nonpathogenic parasite, *Th. hirci* is highly pathogenic to sheep and goats with mortalities of up to 100% being reported (Uilenberg, 1981; Soulsby, 1986). Several tick species have been reported as vectors of *Th. ovis*, but Uilenberg (1981) had dismissed all of these reports. However, according to Bhattacharyulu et al. (1972) and Hooshmand-Rad and Hawa (1973) experimental transmission studies, *Hyalomma anatolicum anatolicum* could be the vector of both parasites in Saudi Arabia. This tick has consistently been found infesting sheep, goats and cattle in the Kingdom (Al-Khalifa et al., 1987; Diab et al., 1987, 2006; Hussein et al., 1988).

In the present study, *E. ovis* was detected in goats and sheep of the six Regions. With the exception of *Eperythrozoon suis* which causes anaemia and jaundice in pigs (Splitter, 1950), eperythrozoa are considered to be generally nonpathogenic (Gothe and Kreier, 1977, and Soulsby, 1986). However, *E. ovis* has been incriminated in several parts of the world as the cause of anaemia and chronic unthriftiness in sheep (Littlejohns, 1960; Overas, 1962), but Ilemobade and Blotkamp (1978) suggested that this parasite might assume clinical significance only under conditions of endemic instability. In addition to *E. ovis*, *E. wenyoni* were detected during the present study in cattle in the Eastern and Jazan Regions, and for the first time in Riyadh Region as well. This parasite was reported previously from cattle in the Eastern and Jazan Regions only (Hussein et al., 1991; Al-Khalifa et al., 2008). The eperythrozoon parasites are known to be transmitted by lice (Soulsby, 1986) and horse flies (Overas, 1959), but the vector of *E. Ovis* and *E. wenyoni* in Saudi Arabia remains to be determined.

In the present study, *A. marginale*, *A. ovis* and *B. motasi* were detected for the first time in the Kingdom. *A. ovis* is non-pathogenic and was considered as a form of *A. marginale* of cattle in the abnormal sheep host (Soulsby, 1986). On the other hand, both of *A. marginale* and *B. motasi* are known to be highly pathogenic to cattle and sheep, respectively, and rank among the most important pathogens of both hosts (Siddig, 1982; Soulsby, 1986). The detection of *A. marginale* in cattle in Saudi Arabia could answer for a long held suspicion that this parasite does occur in the Kingdom. Further work, especially seroepidemiological investigations, is needed to assess

the spread of this serious pathogen in the Kingdom. Blood smear examination is not sufficient in this respect because autoimmunity is very common in the pathogenesis of anaplasmosis (Ristic, 1961; Kreier et al., 1964; Siddig, 1982), and the parasitaemia in this disease is never commensurate with the anaemia. Generally, only few parasites appear in the red cells while the accompanying anaemia is extremely high (Hussein et al., 1991).

In the present study, *B. bigemina* was found in cattle of Jazan Region; it has not been previously detected in Saudi Arabia or the Arabian Peninsula. *B. bigemina* is common in Africa, India, Central Asia, Central and Southern America and Australia (Mahoney, 1977; Ristic and Kreier, 1981; Soulsby, 1986; Young and Morzaria, 1986). This blood parasite has been probably introduced with infected livestock infested with vector ticks and imported from one of these areas. The vector of this parasite, the tick *Boophilus annulatus*, has been reported from cattle in Jazan by Al-Khalifa et al. (1987) who suggested that this tick might have introduced its pathogen too into the Kingdom.

The present study has clarified that tropical theileriosis (*Th. annulata*) is present in the eastern, central and southwestern parts of the Kingdom while the nonpathogenic *Theileria* sp. is restricted to Jazan. The distribution of *Th. annulata* coincides with the distribution of *H. a. anaticum* which was reported to be the probable vector of *Th. annulata* (Al-Khalifa et al., 1987). *H. a. anaticum* was also prevalent with all life stages feeding on cattle infected with the nonpathogenic *Theileria* sp. in Jazan Region (Diab et al., 2006). However, this tick species has failed to transmit the *Theileria* sp. of Jazan in experimental trials (unpublished data). Similar to other nonpathogenic *Theileria* species, the vector of the *Theileria* sp. infecting cattle in Jazan Region may be a *Rhipicephalus* tick species (Uilenberg, 1981). During the present survey, larvae, nymphs and adults belonging to this tick group were found infesting cattle in Jazan Region, a situation that seems to be unique to this Region since elsewhere in Saudi Arabia the *Rhipicephalus sanguineus* group ticks feed almost exclusively on sheep and goats (Diab et al., 2006). A strain of the nonpathogenic *Theileria* sp. was inoculated into both intact and splenectomized calves in the laboratory; this parasite attained high parasitaemia levels without causing their hosts, intact or splenectomized, any ill effects (unpublished data). The status of the benign *Theileria* sp. in Saudi Arabia requires more detailed investigation. Also, follow up surveys of blood parasites are necessary to assess their distribution and rate of infection in the livestock of all Regions of Saudi Arabia.

5. Conclusions

D. evansi of camels, *A. ovis* and *B. motasi* of sheep and *A. marginale* and *B. bigemina* of cattle have been introduced in Saudi Arabia, and their probable vectors are present in the country, which endangers the livestock of the Kingdom.

The highly pathogenic *Th. hirci* of sheep and goats and *Th. annulata* of cattle are spreading in new localities in Saudi Arabia.

Follow up surveys of the blood parasites of the livestock and their possible vectors are recommended to assess their distribution and infection rates in all Regions of Saudi Arabia, and to plan control measures against their vectors.

References

- Al-Khalifa, M.S., Hussein, H.S., Al-Asgah, N.A., Diab, F.M., 1987. Ticks (Acari: Ixodidae) infesting local domestic animals in Western and Southern Saudi Arabia. Arab Gulf J. Scient. Res. Agric. Biol. Sci. (B) 5, 301–319.
- Al-Khalifa, M.S., Khalil, G.M., Hussein, H.S., Diab, F.M., 2008. A preliminary study on the effect of a concurrent infection with *Eperythrozoon wenyonii* on the development of *Theileria annulata* in calves. Saudi J. Biol. Sci. 15, 73–79.
- Bhattacharyulu, Y., Dhar, S., Gautam, O.P., Malik, P.D., 1972. Experimental transmission of theileriosis in sheep. A preliminary report. Haryana Agric. Univ. Res. 2, 202–205.
- Boid, R., Jones, T.W., Luckins, A.G., 1985. The camel in health and disease. 3. Protozoal diseases of camels. Brit. Vet. J. 141, 87–105.
- Diab, F.M., Al-Khalifa, M.S., Hussein, H.S., Al-Asgah, N.A., 1987. Ticks (Acari: Ixodidae) parasitizing indigenous livestock in northern and eastern Saudi Arabia. Arab Gulf J. Scient. Res. Agric. Biol. Sci. (B) 5, 273–286.
- Diab, F.M., Al-Khalifa, M.S., Al-Asgah, N.A., Hussein, H.S., Khalil, G.M., 2006. Ticks infesting livestock in Saudi Arabia. Fauna of Arabia 22, 233–244.
- Gothe, R., Kreier, J.P., 1977. *Aegyptianella*, *Eperythrozoon*, and *Haemobartonella*. In: Kreier, J.P. (Ed.), . In: Parasitic Protozoa, vol. IV. Academic Press, New York, pp. 251–294.
- Hooshmand-Rad, P., Hawa, N.J., 1973. Transmission of *Theileria hirci* in sheep by *Hyalomma a. Anaticum*. Trop. Anim. Health Prod. 5, 103–109.
- Hussein, H.S., Al-Asgah, N.A., Al-Khalifa, M.S., Diab, F.M., 1991. The blood parasites of indigenous livestock in Saudi Arabia. Arab Gulf J. Scient. Res. 9, 143–160.
- Hussein, H.S., Al-Khalifa, M.S., Diab, F.M., Al-Asgah, N.A., 1988. The distribution, host range and seasonal abundance of the Arabian goat and sheep tick *Boophilus kohlsi* (Acari, Ixodidae) in Saudi Arabia. Arab Gulf J. Scient. Res. Agric. Biol. Sci. (B) 6, 275–287.
- Ilemobade, A.A., Blotkamp, C., 1978. *Eperythrozoon ovis*: serological diagnosis of infection by the indirect immuno-fluorescent antibody test. Tropenmed. Parasitol. 29, 307–310.
- Kelly, S., Schillinger, D., 1983. Improved field diagnostic technique for trypanosomiasis by the use of a minicentrifuge. Vet. Res. 113, 219.
- Kreier, J.P., Ristic, M., Schroeder, W., 1964. Anaplasmosis. The pathogenesis of the anaemia caused by infection with *Anaplasma*. Am. J. Vet. Res. 25, 343–352.
- Littlejohns, I.R., 1960. Eperythrozoonosis in sheep. Austr. Vet. J. 36, 260–265.
- Mahmoud, M.M., Gray, A.R., 1980. Trypanosomiasis due to *Trypanosoma evansi* (Steele, 1885) Balbiani, 1888. A review of recent research. Trop. Anim. Health Prod. 12, 35–47.
- Mahoney, D.F., 1977. *Babesia* of domestic animals. In: Kreier, J.P. (Ed.), . In: Parasitic Protozoa, vol. 4. Academic Press, New York, pp. 1–5.
- Overas, J.L., 1959. *Eperythrozoon ovis*, a new blood parasite in sheep in Norway. Nord. Vet. Med. 11, 791–800.
- Overas, J.L., 1962. Hemolytisk anemi hos sau-*Eperythrozoon ovis*. Medl. Bl. Den Norsk Veterinaerforening 7, 187–200.
- Ristic, M., 1961. Studies on anaplasmosis. III. An autoantibody and asymptomatic macrocytic anaemia. Am. J. Vet. Res. 22, 871–876.
- Ristic, M., Kreier, J.P., 1981. Babesiosis. Academic Press, New York, 559p.
- Rutter, T.E.G., 1967. Diseases of camels, Part 2. Protozoal diseases. Vet. Bull. 37, 611–618.
- Siddig, H.A., 1982. Immunity to Bovine Anaplasmosis, M.Sc. Thesis, Brunel University.
- Soulsby, E.J.L., 1986. Helminths, Arthropods and Protozoa of Domestic Animals, seventh ed. Bailliere, Tindall, London, 807p.

Splitter, E.J., 1950. Ictero-anaemia of swine. In: Proc. 5th Ann. Meet. US Livest. Sanit. Ass. Phoenix, pp. 279–386.

Uilenberg, G., 1981. Theilerial species of domestic livestock. In: Irving, A.D., Cunningham, M.P., Young, A.S. (Eds.), Advances in the

Control of Theileriosis. Martinus Nijhoff Publishers, The Hague, pp. 4–37.

Young, A.S., Morzaria, S.P., 1986. Biology of *Babesia*, *Parasitol. Today* 2, 211–219.