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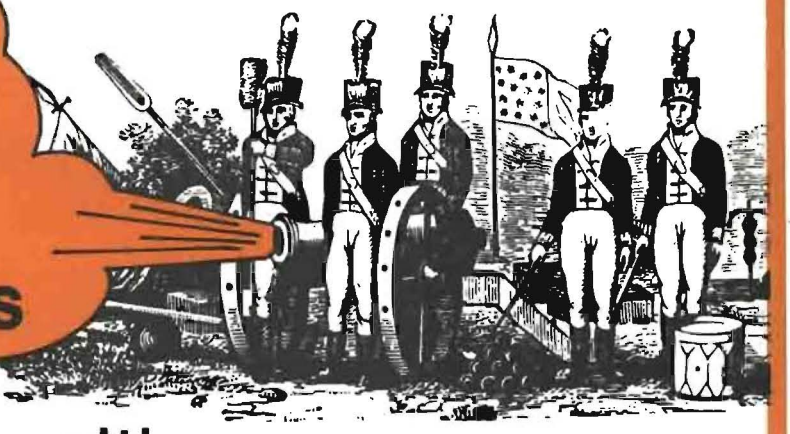

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SOUTH AFRICA'S SECOND VETERINARY FACULTY

The newly established Faculty of Veterinary Science, the second in the Republic of South Africa, is shortly to admit its first complement of students to the first year of study. The faculty is part of the Medical University of Southern Africa (acronym: MEDUNSA) which is situated approximately 30 km north-west of the centre of Pretoria and adjacent to the Republic of Bophuthatswana's border town of Ga-Rankuwa.

The University is Africa's first comprehensive health science centre whereby faculties of medicine, veterinary science and dentistry are being established in close association to provide training facilities which shall cater primarily for the health needs of the Black population. The University came into being on 21 August 1976 and the first full-time Rector, Professor F.P. Retief, was appointed on 1 January 1979. Students were admitted to the Faculty of Medicine in January 1978 and each year the spectrum of para-medical courses continues to unfold.

The establishment of the Faculty of Veterinary Science at Medunsa is truly an historic event which deserves closer scrutiny. The faculty will, for the first time, enable Black persons to graduate as veterinarians at a South African University and thus swell the ranks of our profession which from all accounts are still severely lacking in numbers.

The establishment of this faculty also brings to an end the protracted campaign by the Association and others to bring about a second training centre for veterinarians in South Africa. Admittedly, the faculty may not represent all that some spokesmen for the Association have fought for over the last 20 years.

Nevertheless, the Association can claim considerable credit for the creation of the second faculty by persistently bringing the need for increased training facilities to the notice of the authorities. The first person to have identified the need for training facilities for Black veterinarians in South Africa in recent times was Professor Owen Horwood (currently the Minister of Finance) in his capacity as Principal of the University of Natal, when opening the congress of the Association in 1967. It is of interest, however, to note that the very first South African to qualify as a veterinarian was Jotella Festiri Soga of Xhosa/Scottish parentage from the Transkei. He qualified at the Royal (Dick) School of Veterinary Studies and became a member of the Royal College of Veterinary Surgeons in 1886, whereafter he worked as a veterinarian in South Africa until his death in 1906.

Although the University was established to provide training facilities primarily for Black candidates, the Medical University of Southern Africa Act (Act 78 of 1976) as amended, makes provision for the enrolment of students from all population groups. The official admission policy of the University Council is therefore an open one, with the proviso that preference shall be given to deserving Black candidates.

In view of the fact that Black farmers in the Republic of South Africa and the adjacent National States own in excess of 4,5 million cattle, 5 million sheep and numerous other domesticated animals and birds, the need to train veterinarians to see to the health of these animals is self-evident.

The Faculty of Veterinary Science at Medunsa is to offer a comprehensive training programme towards a fully-fledged veterinary degree (B.V.M., Ch) comparable in standard to that already offered by the University of Pretoria. The approved course occupies six academic years and incorporates all the recognised veterinary disciplines including a strong animal production bias. The University aims to obtain full recognition for the degree by the Veterinary Board in order to ensure the right of graduates to practise within the Republic of South Africa and the adjacent National States. In addition, the faculty is to make every effort in order that the training, by virtue of academic excellence, shall receive international recognition on as wide a front as possible.

In order to start with the training of veterinarians at an early stage, the faculty plans to make use initially of interim facilities at Medunsa on a limited scale. Comprehensive permanent facilities are currently being planned for an ultimate intake of 50 students per annum.

In addition to the B.V.M.,Ch. degree, the faculty plans to introduce training courses for para-veterinary personnel to ensure the necessary technical back-up for efficient regulatory veterinary health services in the National States.

The establishment of the veterinary faculty at Medunsa is an important milestone in the development of our profession and deserves the wholehearted support of all persons and organisations which have genuine interest in the welfare of man and animal in Southern Africa.

ATTEMPTED TREATMENT OF CANINE EHRLICHIOSIS WITH IMIDOCARB DIPROPIONATE

J. VAN HEERDEN* and ANNALINE VAN HEERDEN*

ABSTRACT: Van Heerden J.; Van Heerden A. **Attempted treatment of canine ehrlichiosis with imidocarb dipropionate.** *Journal of the South African Veterinary Association* (1981) **52** No. 3, 173–175 (En) Department of Medicine, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

Six clinical and 10 experimentally-induced cases of canine ehrlichiosis were treated with imidocarb dipropionate. The treatment did not result in clinical cure and failed to sterilize the infection. The infection was successfully transmitted from treated dogs to splenectomized and non-splenectomized dogs.

INTRODUCTION

Imidocarb dipropionate (3,3'-bis(2-imidazolin-2 yl)-carbanilide dipropionate) (Forray 65, Coopers) has been found to be effective in the treatment of canine ehrlichiosis by Price & Dolan[5]. The pesent study was undertaken in order to confirm this finding in experimental and natural cases of canine ehrlichiosis.

MATERIALS AND METHODS

Two experiments were conducted, each in 3 successive stages and each involved 3 groups of dogs (Groups A1, B1, C1, A2, B2 and C2). All the dogs in the experiments with the exception of those in Group A2 were held in kennels with concrete floors and were treated regularly with acaricidal drugs.

Before infection of the animals, peripheral blood smears were examined and haematological studies were undertaken. Peripheral blood smears were stained with Quik-stain (Diff-Quik, Harleco).

Experiment 1

Donor: The infected blood used in this experiment to initiate infection was obtained from a 3-month-old Pyrinean Mountain Dog puppy showing clinical and haematological evidence of canine ehrlichiosis. Morulae of *Ehrlichia canis* were demonstrated in the cytoplasm of monocytes in peripheral blood smears stained with Quik-stain. Infection had been acquired naturally. After withdrawal of blood in heparin for transmission to experimental animals, this dog was treated with oxytetracycline (Terramycin capsules, 250 mg, Pfizer) orally at a dosage rate of 100 mg/kg, once daily for 10 days.

Group A1: This group consisted of 11 mongrel puppies all of which were approximately 14 weeks old. The pups had all been vaccinated at the age of about 8 weeks with canine distemper-measles vaccine (Enduracell DM, Smith Kline Animal Health Products). Ten of them (No's 1–10) were each inoculated intravenously with 2 ml of heparinized blood from the donor dog. One puppy (No. 11) was left as a non-infected control. After infection of the puppies, peripheral blood smears were examined and haematological studies were undertaken at regular intervals until the expriment was concluded after 6 weeks. All puppies were examined daily for signs of disease and rectal temperatures were recorded daily.

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Five of the infected puppies (Nos 1–5) were injected subcutaneously with imidocarb dipropionate at a dosage rate of 6 mg/kg and the remaining pups were left as untreated controls. Treatment was initiated once they had shown clinical signs of disease and/or whenever morulae of *E. canis* were demonstrated in peripheral blood smears. Survivors were retreated with imidocarb dipropionate after 14 days.

Post-mortem examinations were carried out on all dogs that died or that were euthanased.

Group B1: This group consisted of 2 6-month-old splenectomized Beagle dogs. These animals had been splenectomized 3 months prior to the commencement of this experiment and regular clinical check-ups thereafter, as well as examinations of peripheral blood smears, failed to show the presence of *Babesia* and/or *Ehrlichia* parasites at any stage.

Blood was collected from 2 treated individuals from Group A1 (Nos 1 and 2) 12 days after the second treatment with imidocarb dipropionate; it was heparinized and inoculated intravenously in 2 ml quantities into both the Group B1 animals (i.e. one Beagle received 2 ml from Pup 1 and the other Beagle received 2 ml from Pup 2). After infection, rectal temperatures were recorded daily, blood smears were examined 3 times a week and haematological studies were undertaken at regular intervals.

When peripheral blood smears revealed typical morulae of *E. canis*, one animal was treated with imidocarb dipropionate at a dosage rate of 6 mg/kg. This treatment was repeated after an interval of 14 days. Two weeks after the second treatment with imidocarb dipropionate, blood from this animal was inoculated intravenously into the Group C1 experimental animals.

Group C1: This group consisted of 2 splenectomized Beagles about 8 months old. Similar blood smear examinations and haematological investigations were done before and after infection as were done for the animals in Group B1.

All the animals in Groups B1 and C1 were treated with doxycycline (Doxyvet capsules, Samvet) orally at a dosage rate of 10 mg/kg for 10 days after *E. canis* morulae were demonstrated in peripheral blood smears of the animals in Group C1 and after blood was collected from the animal in Group B1.

Expriment 2

Clinical cases (Group A2): Six clinical (i.e. naturally infected) cases showing evidence of typical ehrlichiosis and belonging to members of the public were treated once only with imidocarb dipropionate at a dosage rate

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of 6 mg/kg. The clinical diagnosis in all the cases was confirmed by the demonstration of morulae of *E. canis* in peripheral blood smears. These dogs were not hospitalized but returned home with their owners after treatment. The owners were instructed to present them for re-examination if no, or inadequate, improvement was noticed during the days following treatment. Heparinized blood from one of the cases was collected prior to treatment with imidocarp dipropionate and aliquots of 4 ml were injected intravenously into each of the animals in Group B2.

Group B2: This group consisted of 4 animals: 3 Beagles and a Bull Terrier. Two Beagles were 2-month-old puppies and the other 2 dogs were adult females. After infection of these animals they were examined daily for signs of disease and rectal temperatures were recorded daily. Peripheral blood smears were made and examined daily after the onset of a fever reaction.

Treatment was initiated when morulae of *E. canis* were demonstrated in peripheral blood smears. Treatment consisted of imidocarb dipropionate given twice at a dosage rate of 6 mg/kg, and at an interval of 14 days. Two weeks after the second treatment heparinized blood from these animals was subinoculated intravenously into the dogs in Group C2 (i.e. 4 ml from the adult female Beagle was injected into one dog; 4 ml from the Bull Terrier was injected into another; 2 ml blood was collected from each Beagle pup and mixed, and 4 ml mixture was injected into the third dog.

Group C2: This group consisted of 4 mongrel dogs about 8 months old. Three animals were infected with blood from the Group B2 animals while the remaining one served as a non-infected control. After infection, the animals were subjected to daily physical examination as well as the recording of rectal temperatures. Peripheral blood smears were made and examined each day after a rise in rectal temperature had been recorded.

RESULTS

Experiment 1

Donor: This dog made an uneventful recovery after treatment with oxytetracycline. Seven months later the dog was reported still to be in good physical health.

Group A1: All the infected animals in this group showed a temperature reaction within 4 to 17 days. The results of haematological studies undertaken before infection as well as the results of the examination of peripheral blood smears are given in Table I. Blood smears were found to be positive in all the infected animals from 11 to 20 days after infection. The results of the last haematological investigation for each experimental animal are also indicated in Table I. Most of the animals developed an anaemia but a leukopaenia was demonstrated in only one experimental animal. All the infected puppies demonstrated weight loss, depression and enlarged peripheral lymph nodes.

Treatment of Puppies 1–5 with imidocarb dipropionate was instituted as soon as they had shown typical signs of ehrlichiosis such as fever reaction, weight loss and enlarged peripheral lymph nodes. In 3 instances treatment with the drug was actually initiated before a positive peripheral blood smear was obtained.

After the fairly typical initial clinical signs of ehrlichiosis, 5 of the puppies also developed mucopurulent nasal and ocular discharges as well as a dyspnoea.

Puppy No. 10 died suddenly 13 days after infection without having shown signs of an ocular or nasal discharge. Puppies Nos 3, 4, 5, 8 and 9 were euthanased in the terminal stages of the disease. Control (uninfected) Pup No. 11 remained healthy throughout the experiment.

Post mortem examinations confirmed the diagnosis of canine ehrlichiosis which in all cases was complicated by purulent bronchopneumonia. No canine distemper inclusion bodies were demonstrated on histopathological investigation.

Thus 2 of the 5 untreated dogs and 2 of the 5 treated dogs survived the experimental infection. The 2 treated survivors remained slightly potbellied in appearance and the peripheral lymph node enlargement persisted (until the dogs eventually were euthanased) yet their habitus was good.

Group B1: Both dogs developed a fever reaction

Table 1: RESULTS OF THE HAEMATOLOGICAL INVESTIGATIONS BEFORE AND AFTER INFECTION AS WELL AS THE EFFECT OF TREATMENT IN GROUP A1 EXPERIMENTAL DOGS

	Dogs										
	Treated					Untreated					Uninfected control
Results of Clinical Investigations	1	2	3	4	5	6	7	8	9	10	11
Before infection:											
Haemoglobin g/ℓ	112	91	125	125	120	107	104	124	120	93	107
Red cell count 10^{12}/ℓ	5,16	4,27	5,59	5,63	5,35	4,98	4,96	5,89	5,41	4,61	5,75
Haematocrit	0,36	0,28	0,38	0,38	0,35	0,35	0,32	0,40	0,37	0,30	0,39
White cell count 10^9/ℓ	14,0	8,5	13,0	13,1	9,3	15,6	6,1	16,4	21,6	8,6	8,9
Blood smear	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg
After infection											
Day first temperature reaction	10	9	6	4	8	9	17	6	14	8	
Day first blood smear positive	20	20	16	11	13	13	15	14	16	11	
Day(s) treatment given	14,28	16,30	14	14	13	–	–	–	–	–	–
Day last haematological investigation	40	40	21	21	19	21	21	19	21		28
Haemoglobin g/ℓ	111	75	92	92	97	97	92	106	87		127
Red cell count 10^{12}/ℓ	4,78	3,35	4,19	4,19	4,19	4,40	4,22	4,55	3,61		5,56
Haematocrit	0,32	0,21	0,26	0,26	0,28	0,30	0,30	0,30	0,23		0,35
White cell count 10^9/ℓ		7,5	14,3	14,3	16,8	8,6	10,8	5,2	29,9		16,4
Day of euthanasia/death	*	*	21	21	19	*	*	19	21	13	*

– No treatment given * survivors

within 7 days. Morulae of *E. canis* were demonstrated in peripheral blood smears within 11 to 17 days after infection.

Despite treatment of one of the dogs with imidocarb dipropionate, it continued to lose weight. Its lymph nodes became and remained enlarged, and it became progressively anaemic and listless.

The successful infection of these dogs with blood from treated dogs from Group A1 revealed the inability of imidocarb dipropionate to cause sterilization of the infection.

Group C1: Both dogs developed a high temperature within 6 days of artificial infection. Morulae were demonstrated 14 days after infection in peripheral blood smears.

The successful infection of these 2 dogs with blood from the treated dog from Group B1 again demonstrated the inability of imidocarb dipropionate to sterilize the infection.

Treatment of Group B1 and C1 animals: All these animals were completely cured after treatment with doxycycline. They were reported to be in good health 6 months later.

Experiment 2

Group A2: No clinical improvement was achieved after treatment with imidocarb dipropionate in the 6 cases. They remained listless, suffered from partial anorexia and 2 of them became more anaemic. All 6 animals were presented for re-examination and treatment within 5 to 14 days after treatment with imidocarb dipropionate. Treatment with doxycycline at a dosage rate of 10 mg/kg once daily for 10 days was then instituted. All of them thereafter made an uneventful recovery.

Group B2: All 4 animals showed a fever (39–41°C) within 8 to 10 days after inoculation of infected blood. Morulae of *E. canis* were demonstrated in peripheral blood smears within 11 days of infection.

At the time of collection of blood for transmission to the Group C2 animals, the dogs showed the following clinical signs: periodic listlessness, a very slight loss in condition, and a dull coat. None of the animals ever exhibited overt signs of disease at any stage until the experiment was concluded 60 days after infection.

Group C2: All infected animals developed a fever (40°C) within 9 to 10 days after infection and morulae of *E. canis* were demonstrated in peripheral blood smears within 10 to 12 days. The control animal remained asymptomatic and morulae of *E. canis* were never found in peripheral blood smears.

It was thus possible to transmit *E. canis* from dogs suffering from ehrlichiosis which had received 2 treatments of imidocarb dipropionate at an interval of 14 days to other animals by means of intravenous inoculation of their blood.

After morulae of *E. canis* were demonstrated in their peripheral blood smears, all the animals (in Group C2) were successfully treated with oxytetracycline.

DISCUSSION

The results of the experiments described in this article indicate that treatment of dogs suffering from ehrlichiosis with imidocarb dipropionate results neither in their clinical cure nor in the sterilization of the *E. canis* infection. These findings are supported by the observations of Immelman & Button[4] who treated dogs with imidocarb dipropionate in order to prevent the simultaneous transmission of *Babesia canis* in successful experiments concerning the transmission of *E. canis*. These findings are therefore not in agreement with those of Price & Dolan[5].

The use of puppies in experimental canine ehrlichiosis is advantageous in that they tend to show more severe signs of the disease[3]. Puppies, on the other hand, are more likely to contract secondary infections which might complicate the investigation. In the present experiment the presence of ocular and nasal discharges as well as pneumonia in the experimental animals of Group A1 resembled the clinical signs of canine distemper. Ocular and nasal discharges have, however, been observed by Ewing[2], Bool & Sutmöller[1] and Troy et al[6], in some cases of canine ehrlichiosis.

Critical evaluation of the efficiency of a drug used in the treatment of ehrlichiosis becomes extremely difficult if it does not result in an improvement in clinical signs within a reasonable period (1–2 days). The acute stage of ehrlichiosis is followed by the so-called subclinical phase. In this latter phase the patient appears to be clinically cured. Only careful observation of the patient at this stage might reveal non-specific signs of disease such as slight inappetance and slight weight loss. It is also extremely difficult to demonstrate morulae of *E. canis* in peripheral blood smears during this relatively asymptomatic period.

Oxytetracycline[4] and doxycycline[7] usually cause remission of clinical signs within 24 to 48h. These antibiotics are also beneficial to the animal in that simultaneous bacterial infections might be controlled at the same time.

In the present investigation it was demonstrated that the transmission of the disease by means of the transfusion of blood from dogs in the subclinical (subacute) phase of ehrlichiosis to susceptible animals can be successfully achieved. It is probable therefore that this method can be used to prove whether or not an animal is a carrier of the infection during this particular stage of the disease.

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ENDEMIC ENTERIC DISEASE IN VERVET MONKEYS

J.E. FINCHAM* and J.V. SEIER*

ABSTRACT: Fincham J.E.; Seier J.V. **Endemic Enteric Disease in Vervet Monkeys.** *Journal of the South African Veterinary Association* (1981) **52** No. 3 177–179 (En) National Research Institute for Nutritional Diseases, Medical Research Council, P.O. Box 70, 7505 Tygerberg, Republic of South Africa.

Comprehensive bacteriological investigation indicates Shigellae as the probable aetiological bacteria in one endemic enteric disease situation. One species and four serotypes have been detected. In vitro antibiotic sensitivity spectra have been determined. Epidemiology, pathology and pathogenesis in relation to the experimental animal situation and experimental results are considered. A rationale for treatment and control is suggested.

Endemic enteric disease characterised by recurrent episodes of mucoid, haemorrhagic stools has persisted in a vervet monkey *(Cercopithecus pygerethrus pygerethrus* = African green monkey) colony in the Cape for more than three years, despite various treatments. Clinical records summarised in Table I show that increased treatment became necessary during a 3 year study period.

Table 1: ANNUAL DIARRHOEA TREATMENTS

Year	Treatments	No. of Vervets	Treatments per Monkey
1978	345	140	2,47
1979	558	199	2,80
1980	1 473	200	7,37
Total	2 376	—	—

The diarrhoea often contained whole blood and mucus in large amounts. Anorexia and dehydration were sometimes features but seldom pyrexia. Under the treatment regimens applied, which occasionally needed to be intensive, mortality has been rare.

Exposure of new batches of monkeys to enteric pathogens endemic in the colony was associated with disease flare-ups. These subsided in time probably as a result of combined immune response, psychological conditioning and treatment. However, there are many examples of individuals showing persistent diarrhoea over the study period. Some of these have been listed in Table 2, which also shows the diarrhoea to be independent of source of origin and date of arrival of monkeys.

AETIOLOGY

After capture from the wild, monkeys are often infested with the helminth *Abbreviata caucasica.* After elimination of these with broad spectrum anthelmintics, microscopic examination of faecal material in wet smears and after floatation has not detected any other pathogens such as *Entamoeba, Balantidium, Giardia, Toxoplasma* or coccidial oocysts. No virology or special bacteriology (such as culture for mycoplasmas or chlamydias) has been done.

Bacterial culture of faecal material to detect enteropathogenic organisms was started on the 25th July 1980 with the help of the Department of Medical Microbiology of Tygerberg Hospital. Material was plated out directly onto MacConkeys and SS agars and simultaneously tetrathionate broth, a selective medium for *Salmonella,* was inoculated. Twenty-four hours later this was also plated out *vide supra.* Organisms which grew were further identified by standard bacteriological methods.

This report is based on results from 84 rectal swabs, 9 faecal swabs and 4 bile samples (collected direct from gall bladders at laparotomy). These came from 53 monkeys over the period 25 July 1980 to 6 February 1981.

Sixteen monkeys yielded 19 cultures positive for enteric bacteria considered pathogenic by bacteriologists (human criteria). All bile cultures were negative even when from monkeys with positive faecal material *(Shigella).* Thirteen of the positive cultures were *Shigella flexneri* and 4 serotypes were detected. *Escherichia coli* (2 type 044K and 1 type 0124K72) and a *Klebsiella* were each isolated 3 times. Thus approximately 18% of the material and 30% of the monkeys cultured positive.

Table 2: INDIVIDUAL RECORDS OF DIARRHOEA EPISODES

Vervet	Source	*Shigella* culture	1978	1979	1980	Arrived
12	KB		7/8	15/2 1/8 29/8 10/9 25/9 19/12	26/3 5/7 8/7	12/8/75
78	P		10/4 30/5 30/6 24/7 19/9	30/1 20/3 26/6 13/7 7/8 30/8 13/9 2/10	20/2 23/4 23/12	27/1/69
203	P	+	10/4 31/5 14/6 21/7 7/8 21/8	15/1 19/3 8/8 19/8 10/9 26/9 2/10	23/3 30/7 6/9 11/9 1/10 5/12	24/6/70
288	P		26/5 28/6 19/7 5/8 12/12	13/2 14/3 29/8 13/9 3/10 24/11	15/2 17/3 17/4 16/7 1/8	1/1/71
363	KB		25/5 20/7	1/8 28/8 5/9 18/12	14/3 24/3 10/4 22/4 24/5	4/5/77
495	PKL	+		19/6 28/8 5/9 28/9 25/10	20/3 18/6 16/8 9/9	13/6/79
525	PKL	+		9/8 28/8 14/9 4/10	29/3 6/8 9/9 19/12	7/8/79

(P = Pretoria KB = Karl Bremer Hospital PKL = P.K. le Roux Dam)

Material was only submitted where the appearance of stools indicated enteric pathology might be present and in a few asymptomatic cases with a long history of recurrent diarrhoea. Two of these latter cultured positive *(Shigella).*

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The bacteriological results suggest *Shigella flexneri* as the most likely cause of enteric disease in this monkey colony. It is widely recorded as an enteropathogenic bacterium of primates in international and South African literature. Old World monkeys, which include vervets, are considered particularly susceptible [1 3 5 6 10].

In vitro antibiotic sensitivities of the *Shigella* cultures are listed in Table 3.

In an attempt to confirm the role of Shigellae, the serotype 6 isolated on 2 January 1981 (Table 3) was used to deliberately infect three monkeys which had no previous histories of diarrhoea. It should be noted that this isolate was made after a long diarrhoea-free period in the colony and was from a young monkey showing loose stools but not frank illness. Massive doses of this organism were given by the intravenous, per os and per rectum routes separately (i.e. one route per monkey). Completely negative results followed intravenous administration (blood and faecal cultures). Positive rectal cultures of the same serotype developed after per os and per rectum infection and were accompanied by mild pyrexia and transient fluid stools containing a little blood. After 6 days, faecal cultures cleared spontaneously, and the monkeys were given a precautionary course of treatment and kept under observation. All blood cultures were negative.

This result does not mean Shigellae were not the main enteropathogens involved. The serotype used had a much wider spectrum of antibiotic sensitivity than previous isolates (Table 3) and other serotypes. It was not isolated from a sick animal, hence it may have been relatively apathogenic. It was put into animals with no history of enteric disease despite exposure. This may have reflected a high level of resistance.

CULTURE MATERIAL

Methodology for handling material for isolation of *Shigella* is important because no spores are formed and rapid die-off of vegetative forms in faeces is reported [2 4 5 9]. Agreement therefore exists on avoidance of delay in culturing, and the use of transport media suggested by one reference seems logical [5]. There is no agreement in the references consulted on the use of rectal versus faecal swabs.

Rectal swabs taken through a sterile anal speculum inserted after thoroughly disinfecting the perianal area, minimise the chances of contamination by extraneous organisms. However, the procedure is time-consuming and requires anaesthesia in animals. Also, even swabs inserted deep into the colon, rotated and held in a long time, in some cases contain only a transparent mucus exudate (a characteristic of Shigella colitis). This tends to dry out rapidly and is confusing to those responsible for culture because no faecal material is visible on the swabs.

Direct faecal swabs from fresh uncontaminated stools avoid some of the above disadvantages and may in fact be just as good. In all cases negative results are not proof that no infection exists.

EPIDEMIOLOGY

Caged monkeys invariably contaminate their hands with their own faeces, and a route for continual ano-oral reinfection exists. A temporary asymptomatic carrier state occurs with *Shigella* (2 were detected in this study) with organisms carried in and shed from the colonic mucosa [1 3 8]. In the animal house the natural sterilising effects of sunlight and dessication are absent. Despite barriers, lateral contact occurs between animals mainly from splashing off floors during washing. These factors explain the endemic situation.

PATHOLOGY AND PATHOGENESIS

In shigellosis there is invasion of tissue in the distal ileum and colon by the bacteria as well as endotoxin

Table 3: *IN VITRO* ANTIBIOTIC SENSITIVITIES OF *SHIGELLA* ISOLATES

Date	Bacteria	Serotype	Neomycin	Streptomycin	Kanamycin	Gentamycin	Tobramycin	Chloramphenicol	Tetracycline	Erythromycin	Furazolidone	Cotrimoxazole	Sulphonamide	Amoxycillin	Monkey	Source
5.8.80	*Shig. flexneri*	3c	+		+	+	+	+				−	−	−	603	PKL
7.8.80	*Shig. flexneri*	4a	+	−	+	+	+	−	−			+	−	−	568	PKL
8.8.80	*Shig. flexneri*	4a	−	−	−	+	+	−	−			+	−	−	570	PKL
10.9.80	*Shig. flexneri*	4a	+	−	+	+	+	+		+	+	−		−	525	PKL
16.9.80	*Shig. flexneri*	4b			+	+	+	+		+	+	+		+	646	PKL
10.9.80	*Shig. flexneri*	6	−		−	+	+	−		+	+	−		−	203	P
26.10.80	*Shig. flexneri*	6	−		−	+	+	+	+	±	+	−		−	467	PKL
2.1.81	*Shig. flexneri*	6	+		+	+	+	+	+	+	+	−		+	JUV	BRED
25.7.80	*Shig. flexneri*		−		−	+	+	−				+		−	603	PKL
28.7.80	*Shig. flexneri*		−		−	+	+	+				+		−	644	PKL
28.7.80	*Shig. flexneri*		−		−	+	+	+				−		−	553	PKL
7.8.80	*Shig. flexneri*		−	−	−	+	+	−	−			+	−	−	556	PKL
27.8.80	*Shig. flexneri*		−		−	+	+	−				−		−	495	PKL
17.9.80	*Shig. flexneri*				+	+	+	+	+	−	+	−		−	541	PKL
9.12.80	*Shig. flexneri*				+	+	+	+	−	−	+	−		+	203	P

(+ = sensitive ± = less sensitive − = not sensitive)
(P = Pretoria PKL = P.K. le Roux Dam JUV = Juvenile BRED = Laboratory Bred)

production *(Shigella dysenteriae)* also produces a heat labile exotoxin/enterotoxin)[1 2 3 4 9]. The tissue invasion results in focal disseminated degeneration, inflammation, necrosis, pseudomembranes, cellular infiltration, exudation (pus and plasma = mucus), erosions and ulcers, haemorrhage and scarring. Some references mention a concentration of lesions in the terminal ileum[2 4 9]. The secondary complications possible from this sort of pathology could be numerous and serious and emphasise the need to keep laboratory animals free of infection to avoid confusing the lesions of disease with experimental effects. A local example exists where colonic lesions ascribed to a dietary effect may have been complicated by chronic shigellosis[7].

To investigate this further, colon and ileum tissue from three monkeys autopsied in 1980 at termination of experiments was examined microscopically. In all cases chronic lesions were present fitting the pathology described for shigellosis and also including proliferation and hyperplasia of goblet cells which goes well with the mucoid diarrhoeas. The monkeys concerned had been present throughout the study period and one had a history of chronic recurrent diarrhoea.

TREATMENT RATIONALE

Prior to late 1980, cases were handled individually as they arose. According to *in vitro* results (Table 3) antibiotics to which the *Shigella* isolates were consistently sensitive were gentamycin, tobramycin and furazolidone. Since the latter lends itself to mixing in the food a new policy of blanket treatment of the whole colony was started in late 1980 and early 1981. Medicated food was also inoculated with *Saccharomyces boulardii* ("Interflora", Restan laboratories) to provide competitive displacement of pathogens, prevent sterilisation of intestinal flora and avoid super infection. Treated food was fed for 5 days at a time and this has been done four times at intervals of approximately a month. Sick individuals are removed from their cages to isolation where they are given additional treatment. Their contaminated cage is autoclaved and after responding to treatment they are returned to it following bathing in surgical scrubs. At the time of writing no cases of haemorrhagic diarrhoea are occurring and there have been no positive cultures since 2 January 1981.

CONTROL

Antibodies against Shigellae are formed in serum and intestinal secretions, but increased titres do not confer strong immunity and are of short duration; hence use of attenuated strains in vaccines has not been successful[1 2 4 9].

Control therefore depends on breaking cycles of infection and transmission by prophylactic treatment and the use of hygiene and physical barriers. Monkeys are housed in individual and gang cages in a conventional animal house. There is limited environmental control: temperature, 24·C, humidity 50%, 25 air changes per hour, dark : light ratio 12 : 12. The hygiene barrier consists of restricted entry, protective clothing, disinfectant foot baths, positive air pressure in rooms, filtered air, automatic chlorinated water supply and metal barriers between cages to limit lateral contact. Personnel avoid direct contact with animals, excreta or blood. Floors were washed down twice a day with chlorinated water and twice a week with disinfectant. All raw fruit or vegetables fed are washed in a chlorine bleach ("Biocide", Pall Mall Manufacturing Company, Cape Town).

Definite weak points exist in the barriers:

1. During hosing of the floors pressure is necessary to move the debris and this can splash contaminated material onto monkeys. On many occasions it has been possible to watch the spread of diarrhoea along a line of monkeys probably as a result of this splashing.
2. Some cages are placed too low and monkeys are able to reach down to debris lying on the floor.
3. Cage accommodation is usually full. It is impossible to clean cages properly with monkeys *in situ*. Autoclaving is the best way to clean a cage. There should be a full row or whole room of spare cages so that monkeys can rotate regularly through autoclaved cages.
4. Barriers against lateral contact within the colony are not fully effective.
5. Facilities for isolation of sick animals should be improved.
6. Batches of fully susceptible monkeys are introduced periodically. This could be prevented by breeding requirements within suitable facilities, in preference to using animals trapped from the wild and would incidentally ensure a much better experimental animal from other points of view.

These weaknesses explain why the cycle of re-infection has not been broken and why the endemic situation has arisen and persisted. Experimental animal facilities should be planned and operated in such a way that these factors are avoided.

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PLASMA PROGESTERONE LEVELS IN THE MARE DURING THE OESTROUS CYCLE AND PREGNANCY

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ABSTRACT: Terblanche H M; Maree L. **Plasma progesterone levels in the mare during the oestrous cycle and pregnancy.** *Journal of the South African Veterinary Association* (1981) **52** No. 3, 181–185 (En) Department of Genesiology, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

Plasma progesterone was determined with the aid of a competitive protein-binding assay in mares during the oestrous cycle, early pregnancy (45–60 days) and later pregnancy (2–10 months). Progesterone levels were low during oestrus (< 1 ng per mℓ) (3,18 nmol/ℓ) and reached high levels (often in excess of 10 ng per mℓ) (31,8 nmol/ℓ) within 3–4 days after ovulation. The high luteal levels were maintained for approximately 5–8 days and then declined sharply over a period of approximately 24–48 hours to reach low levels at the subsequent oestrus period.

In mares conceiving after service, the progesterone levels rose rapidly to 5–9 ng per ml (15,9–28,6 nmol/ℓ) 21 days after service. Levels of 4–10 ng per mℓ (12,7–31,8 nmol/ℓ) were found between 30 and 60 days after successful service with a tendency towards lower levels from 30–42 days and higher levels from 42–60 days. Progesterone levels remained between 7 and 10 ng per ml (22,3–31,8 nmol/ℓ) from 60–110 days and thereafter fell to a relatively constant level of 3–6 ng per mℓ (9,5–19,1 nmol/ℓ) until the tenth month of pregnancy.

INTRODUCTION

The biochemical nature and physiological functions of progesterone are well known following the tremendous amount of research performed since its isolation in pure form in 1934 as reported by Greep[7]. It is known to be of importance in the oestrous cycle as well as in pregnancy and various studies have therefore been performed to elucidate the hormonal state of the non-pregnant[11 12] and pregnant mare[2 3 8 10] as far as progesterone is concerned.

These studies have resulted in a better understanding of the physiological processes during both the oestrous cycle and pregnancy and this knowledge will enable scientists and veterinarians to improve the reproductive efficiency of domestic animals including the horse. Due to the different methods used for the assay of progesterone levels, e.g. gas chromatography[10], radioimmunoassay (RIA)[3 5 6 11] and competitive protein-binding assay (CPBA)[1 2 5 6 8 9 16] and the variation in progesterone levels reported as a result thereof, individual researchers will have to interpret their results according to the assay used.

The present study was undertaken to establish the applicability of a recently developed rapid CPBA for bovine progesterone[14 15] to the measurement of progesterone levels during the oestrous cycle and pregnancy of mares and to establish a range of normal values in the mare during the oestrous cycle and pregnancy.

MATERIALS AND METHODS

Animals and samples

Blood samples were collected in heparin at 08h00 at 2 day intervals from 2 mares (B2 and A2) during 3 consecutive oestrus cycles and from 2 mares (G11 and G2) from oestrus and service to early pregnancy at 45–60 days. Similar samples were collected from a mare (A3) between the 22nd and 52nd day of pregnancy; from one mare (B9) between the second and sixth month of pregnancy; from one mare (B8) between the fourth and eighth month of pregnancy and from one mare (A2) between the sixth and tenth month of pregnancy.

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The blood samples were centrifuged within one hour of collection and the plasma transferred to 10 mℓ plastic bottles. The samples were stored at –15° C until assayed for progesterone content.

Progesterone assay

A rapid CPBA of proven reliability for bovine progesterone[14 15] was used for the determination of progesterone levels in the samples. Duplicate determinations were done on all samples and these are represented by vertical bars in Figs. 1–6. Where identical values were obtained vertical bars were omitted from the figures. The curvilinear standard curve allowed values to be read from it with a maximum of 10 ng/mℓ (31,8 nmol/ℓ).

RESULTS

Progesterone levels determined during oestrus were generally very low (<0,5 ng per ml) (1,6 nmol/ℓ) except in the case of 2 oestrus periods of mare A2 where the levels averaged approximately 1,0 ng per ml (3,2 nmol/ℓ). Three to 4 days after ovulation progesterone reached high levels, often in excess of 10 ng per ml (31,8 nmol/ℓ), where it remained for approximately 5–8 days. A rapid decline then occurred over a period of 24–48 hours to the previously described low levels during the subsequent oestrus (Fig. 1 and 2).

In mares conceiving the progesterone levels 21 days after service ranged between 5,0 and 9,0 ng per mℓ (15,9 and 28,6 nmol/ℓ) with a slight drop thereafter to 3,0 to 7,0 ng per mℓ (9,5–22,3 nmol/ℓ) until the 35th to 42nd day. Thereafter the progesterone levels increased again to 7,0–10,0 ng per mℓ (22,3–31,8 nmol/ℓ) at approximately 60 days (Fig. 2 and 3).

The progesterone levels remained between 7,0 and 10,0 ng per mℓ (22,3–31,8 nmol/ℓ) between days 60 and 110 and then declined slowly over a period of approximately 20 days to a relatively constant level of 3,0 to 6,0 ng per mℓ (9,5–19,1 nmol/ℓ) until the tenth month of pregnancy (Fig. 4–6).

DISCUSSION

The rapid CPBA used with success for the determina-

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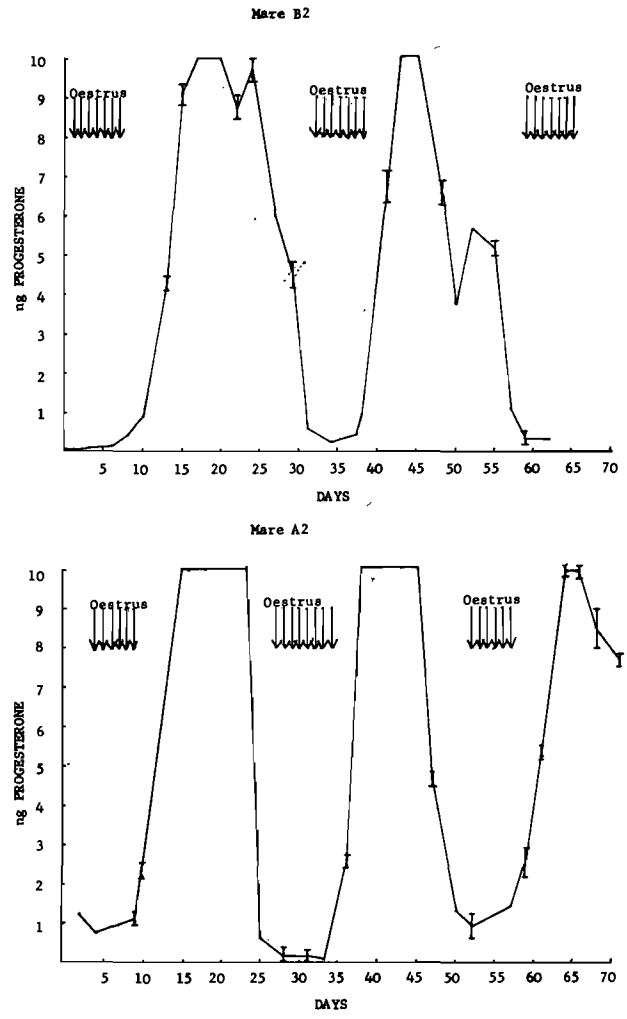

Fig. 1 Progesterone levels in two mares during the oestrous cycle

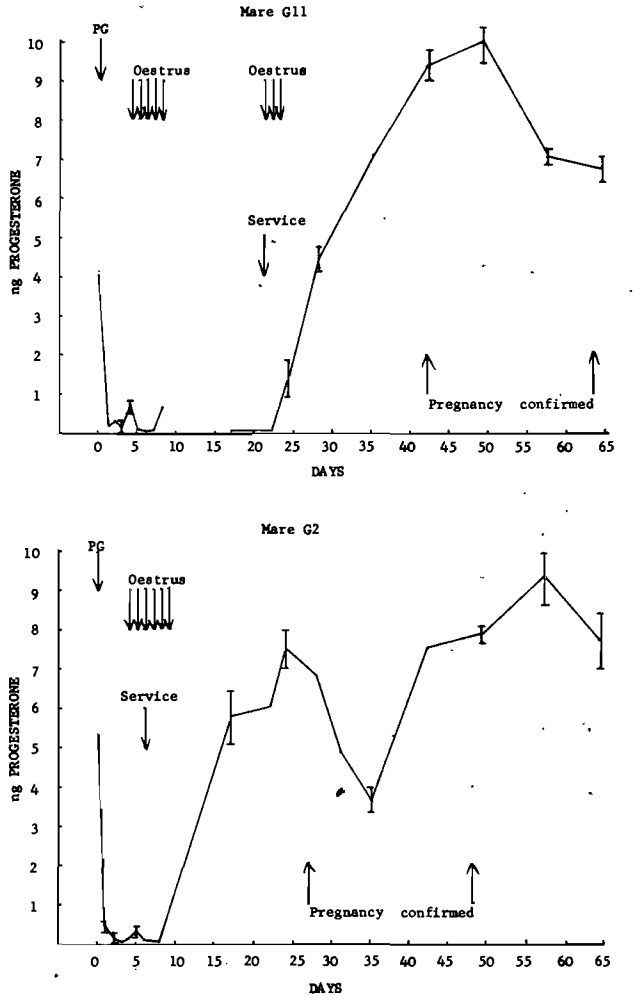

Fig. 2 Progesterone levels in two mares from oestrus to early pregna

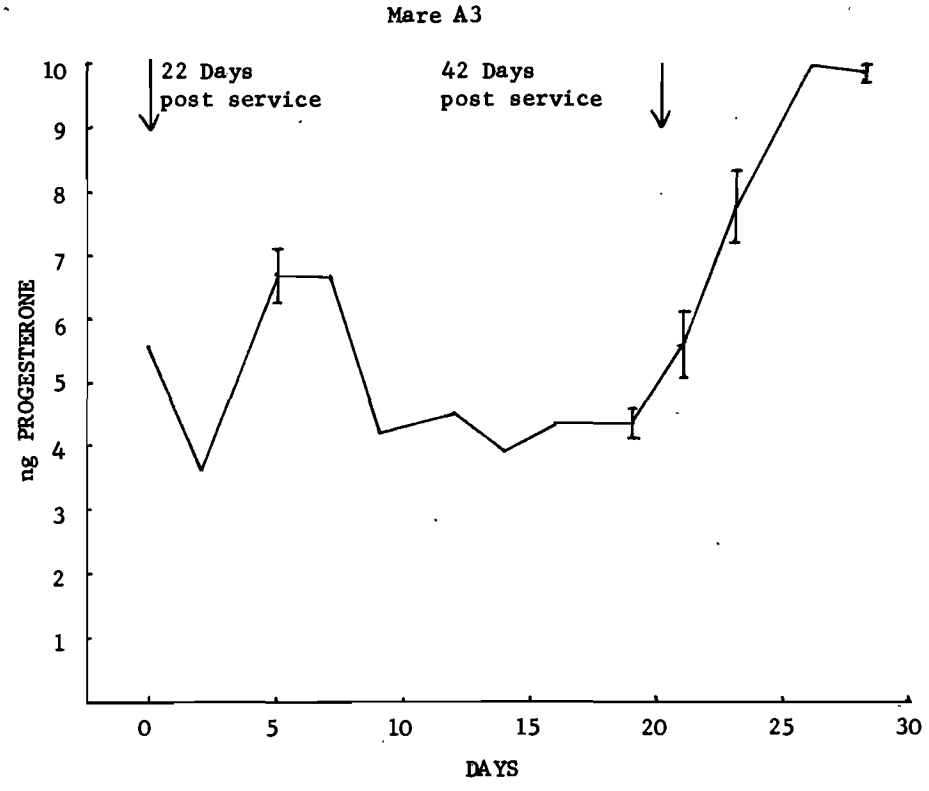

Fig. 3 Progesterone levels in a mare during early pregnancy

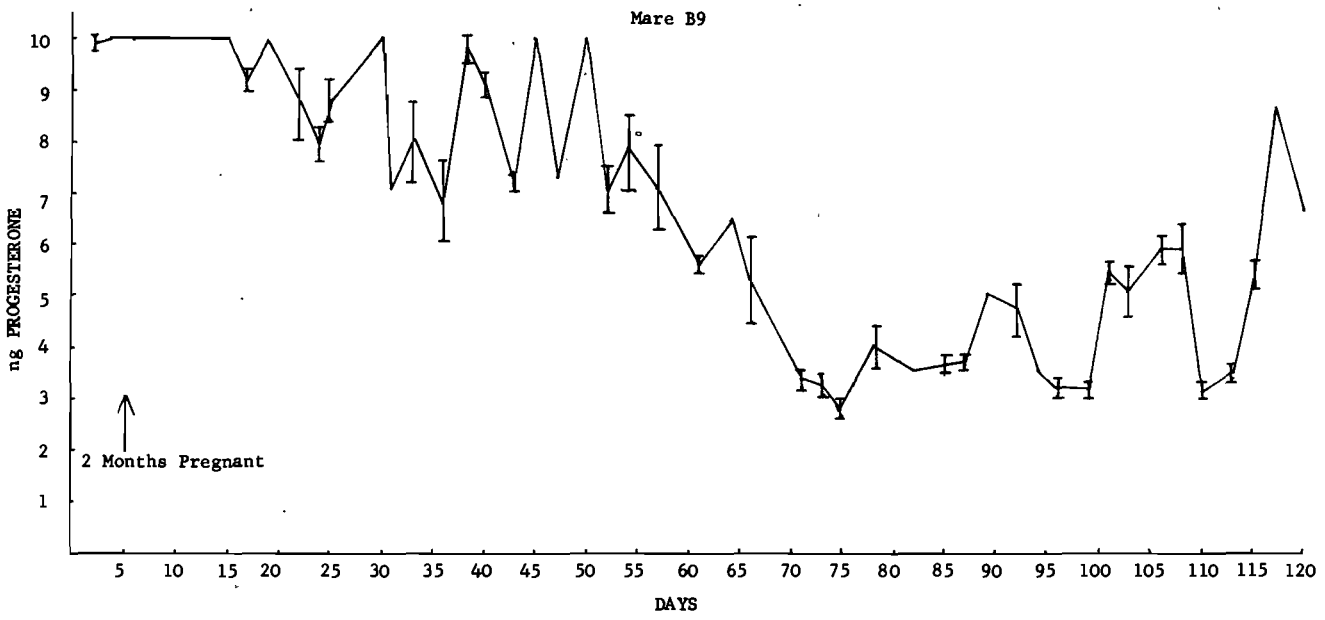

Fig. 4 Progesterone levels in a mare between the second and sixth month of pregnancy

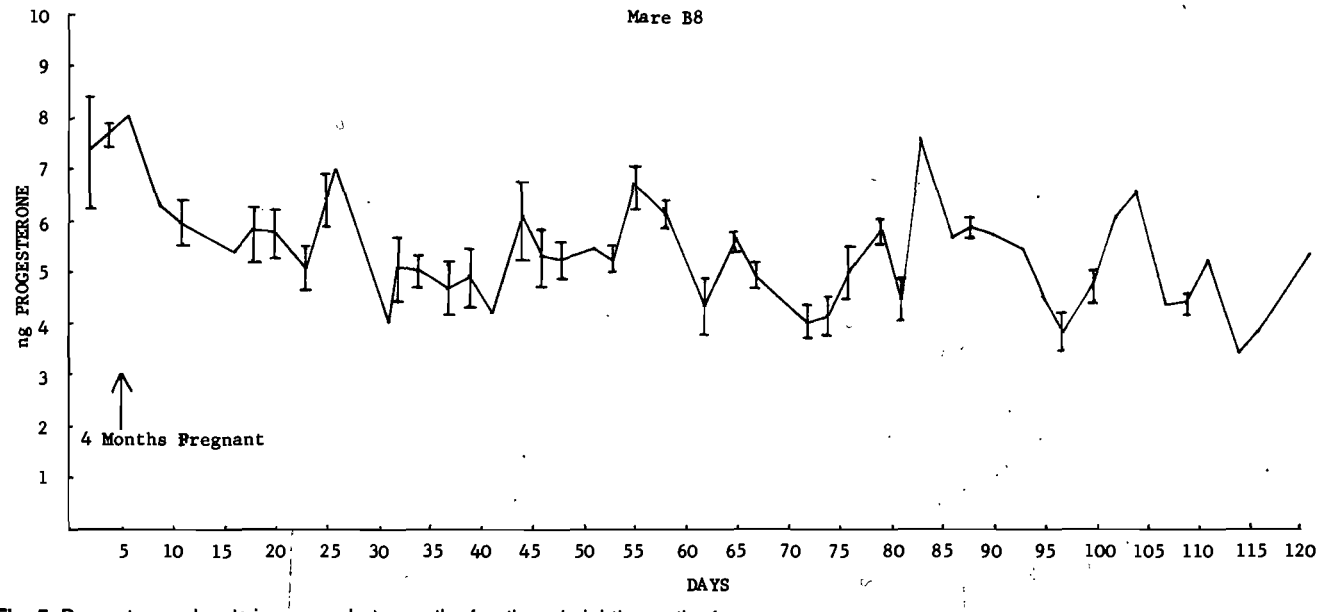

Fig. 5 Progesterone levels in a mare between the fourth and eighth month of pregnancy

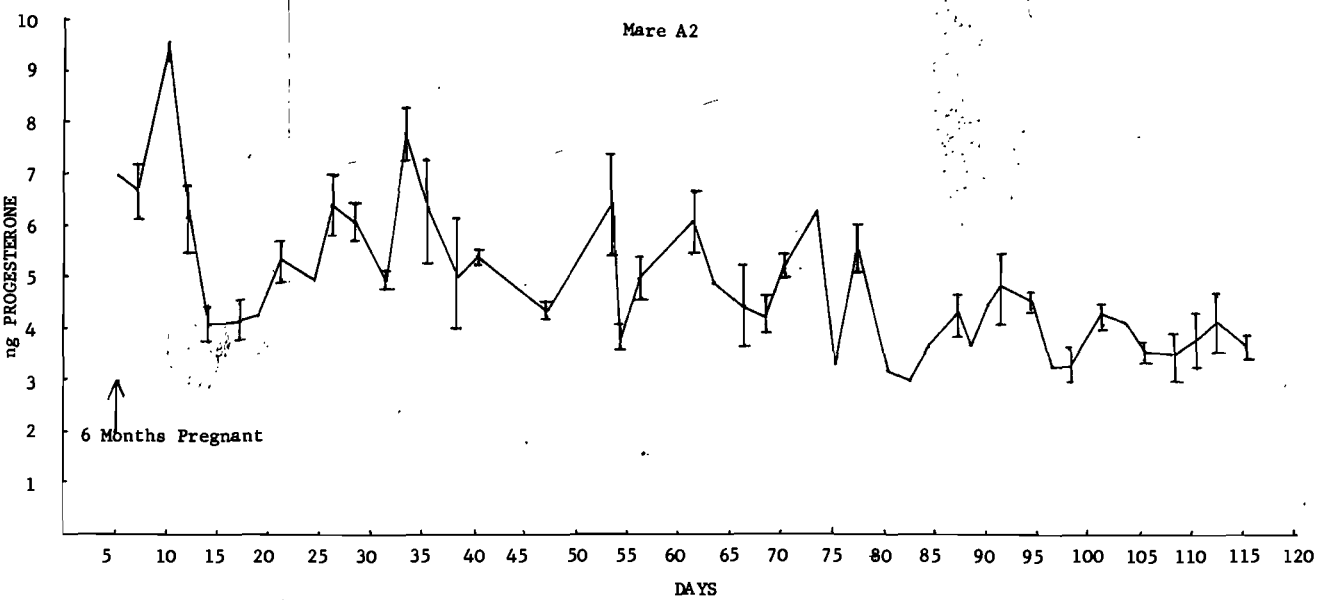

Fig. 6 Progesterone levels in a mare between the sixth and tenth month of pregnancy

tion of bovine progesterone[15] was successfully applied to the determination of plasma progesterone in the mare during the oestrous cycle and pregnancy. This conclusion is based on the good correlation found between the present results and those reported by others as will be discussed below.

The time consuming column chromatographic step employed by Van Niekerk, Morgenthal, Sanders & Malan[16] was omitted in the present assay without sacrifice in the reliability of the assay. The steroid of major importance in the mare as far as interference and competition with progesterone is concerned and therefore of importance in the reliability of the assay, is 17α-hydroxy-progesterone[16]. According to Short[13] this steroid however occurs in low levels in the mare and this would tend to lessen its competitive effect which was reported by van Niekerk et al[16]. In addition, Fassora and Luisi[4] have reported on its limited displacement affinity for progesterone in the binding system employed and this, together with the relatively low recovery rate of the steroid after petroleum ether extraction [15], has led us to ignore its possible influence on the progesterone assay employed.

The progesterone levels reported in the present study during oestrus in the mare are in very good agreement with the results of many other workers[1 5 6 10 11] but are not as low as those reported by Plotka, et al[12] and Van Niekerk et al[16]. The former authors, however, used the more sensitive RIA.

The peak luteal levels of 10 ng per mℓ (31,8 nmol/mℓ) reported in this study are somewhat higher than the levels reported by Allen & Hadley[1], Ganjam & Kenney[5], Ganjam, Kenney & Flickinger[6] and van Niekerk et al[16] but are comparable to the mid-dioestrous average of 13,6 ng per mℓ (43,25 nmol/ℓ) reported by Noden, Oxender & Hafs[11]. The levels in excess of 10 ng per mℓ (31,8 nmol/ℓ) reported in this study never exceeded 14 ng per mℓ (44,5 nmol/ℓ) when read from a log/logit plot[15].

Progesterone levels in early pregnancy reported in the present study are in good agreement with those reported by Benjaminsen & Tomasgaard[2] and Holtan, Nett & Estergreen[8 9] but are slightly lower than those of Allen & Hadley[1] and higher than those of van Niekerk et al[16]. At 30 days after ovulation and service, present results correspond well with those of Allen & Hadley[1] and Holtan, Nett & Estergreen[8 9] but are again higher than those of van Niekerk et al[16].

The decrease in progesterone levels observed by Allen & Hadley[1] at day 30, by Ganjam & Kenney[5] and Ganjam, Kenney & Flickinger[6] between 9 and 21 weeks and by van Niekerk et al[16] between days 37 and 42 were seen in the present study between days 25 and 42. The levels at this stage of 3–7 ng per mℓ (9,5–22,3 nmol/ℓ) are in good agreement with the 5 ng per mℓ (15,9 nmol/ℓ) reported by Allen & Hadley[1] and Holtan, Nett & Estergreen[8 9] but are slightly higher than the 1,5–3,5 ng per mℓ (4,8–11,1 nmol/ℓ) reported by van Niekerk et al[16] between days 10 and 42.

The present results of 7–10 ng per mℓ (22,3–31,8 nmol/ℓ) measured between day 42 and 110 are comparable at the higher levels with the results of Allen & Hadley[1] but are lower than those of Ganjam & Kenney[5] and Ganjam, Kenney & Flickinger[6] at 2 months as well as those reported by Holtan, Nett & Estergreen[8 9]. Present results compare favourably with those of van Niekerk et al[16] although their results only go as far as day 52.

The levels of 3–6 ng per mℓ (9,5–19,1 nmol/ℓ) recorded in the present study from approximately 4–10 months are in good agreement with the 4–5 ng per mℓ (12,7–15,9 nmol/ℓ) reported by Ganjam & Kenney[5] and Ganjam, Kenney & Flickinger[6] but are higher than the levels reported by Holtan, Nett & Estergreen[8 9] and lower than the higher levels reported by Allen & Hadley[1]. The very high levels of 12,5 to 20 ng per mℓ (39,8–63,6 nmol/ℓ) in the first 3 months of pregnancy and 25–60 ng per ml (79,5–190,8 nmol/ℓ) in the last 3 months of pregnancy reported by Burns & Fleeger[3] were not found in the present study. These authors, however, used RIA for total progestagens compared to the present CPBA which is relatively specific for progesterone due to the use of petroleum ether for extraction of progesterone[15]. The varying results of Nitschelm & van der Horst[10] using gas chromatography, could not be correlated with the results of the present study.

The decline in progesterone levels observed during early pregnancy in this study around the 42nd day is consistent with the results of van Niekerk et al[16] and those of van Rensburg & van Niekerk[17]. The increase observed after the 42nd day of pregnancy is again in accordance with the results of van Niekerk et al[16] and is probably due to the ovulation of tertiary follicles and formation of tertiary corpora lutea at this time.

The decline in progesterone levels reported in this study after day 110 is in agreement with the results of Ganjam & Kenney[5], Ganjam, Kenney & Flickinger[6] and Holtan, Nett & Estergreen[8 9] and could be explained by the well-known transition from luteal to placental progesterone control of pregnancy at approximately this time, although there still appears to be considerable doubt concerning the actual mechanism involved[5].

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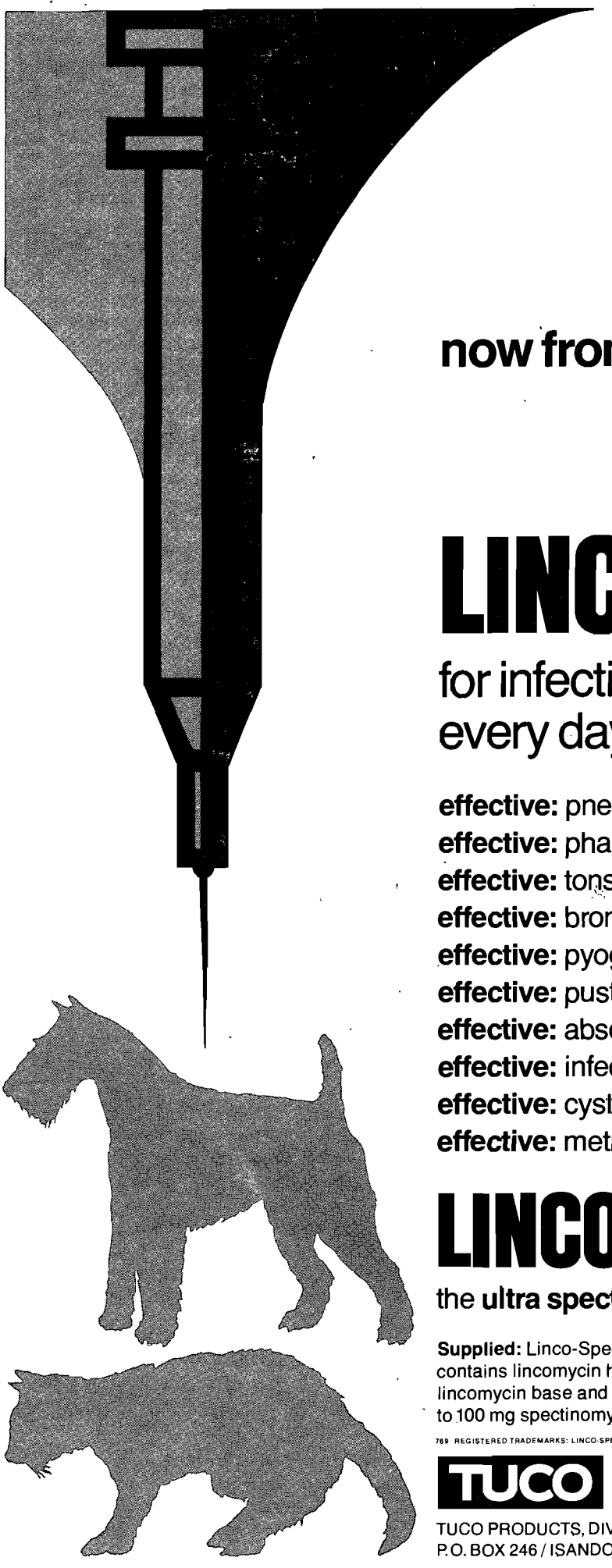

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PLASMA PROGESTERONE IN CATTLE. II. LEVELS DURING THE OESTROUS CYCLE, PREGNANCY AND PARTURITION

H.M. TERBLANCHE* and J.M. LABUSCHAGNE*

ABSTRACT: Terblanche H.M.; Labuschagne J.M. **Plasma progesterone in cattle. II. Levels during the oestrous cycle, pregnancy and parturition.** *Journal of the South African Veterinary Association* (1981) **52** No. 3, 187–189 (En) Department of Genesiology, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

Plasma progesterone was determined in cattle with a competitive protein binding assay during the oestrous cycle, pregnancy and parturition. Peak luteal phase levels of 4–7 ng/mℓ (12,7–22,2 nmol/ℓ) were found 12–16 days after clinical oestrus followed by a rapid decline to less than 0,5 ng/mℓ (1,6 nmol/ℓ) on the day of oestrus. Levels of 3–7 ng/mℓ (9,5–22;3 nmol/ℓ) were found 3 weeks after artificial insemination while levels of 3,8–6,5 ng/mℓ (12,1–20,7 nmol/ℓ) and 3–7 ng/mℓ (9,5–22,3 nmol/ℓ) were found at 6 and 7–8 weeks respectively.

Between the second and third month of pregnancy levels of 3,5–6,5 ng/mℓ (11,1–20,7 nmol/ℓ) were measured increasing to 3–8 ng/mℓ (9,5–25,4 nmol/ℓ) from the fifth month until shortly before parturition. Levels of approximately 3–4 ng/mℓ (9,5–12,7 nmol/ℓ) were found until 3 d before parturition with a drop to 2 ng/mℓ (6,4 nmol/ℓ) 1 d before calving. Less than 1 ng/mℓ (3,2 nmol/ℓ) was measured on the day of parturition and during the first 3 d after calving.

INTRODUCTION

Progesterone is today a well-known biochemical and physiological entity and its role in the oestrous cycle and in maintaining pregnancy is a well accepted fact following the pioneer work of many workers as reported by Greep[7]. Knowledge of the levels of progesterone during the various reproductive phases of the cow could be of tremendous benefit to the clinician in early pregnancy diagnosis, gynaecological examinations, etc.

This information has been available for the last 10 years[4 5 6 8 11 12 13] and the present study was undertaken to determine the progesterone levels in cows during the oestrous cycle, pregnancy and parturition with the aid of a recently developed competitive protein binding assay[16] as proof of its applicability to the bovine reproductive cycle as well as to establish a range of normal values.

MATERIALS AND METHODS

Animals and samples

Blood samples were collected in heparin from 5 cows of various breeds every second day during 3 consecutive oestrous sycles at 08h00. The cows were observed for signs of oestrus twice a day during this period. Samples were also collected from 6 Friesland cows of various ages (4–7 years) and from 1 Simmenthaler cow (age 5 years) from oestrus to confirmed pregnancy at 7–8 weeks.

Similar samples were collected from 4 cows between the eight and thirteenth week of pregnancy. Weekly samples were collected from 3 cows between the twenty second week of pregnancy and parturition.

At the time of parturition samples were collected from 6 cows at 1–3 day intervals from an average of 8 d before parturition to approximately 3 d after parturition. All samples were centrifuged within 1 h of collection and the plasma stored at –15° C until assayed for progesterone content.

Progesterone assay

A rapid competitive protein binding assay of proven reliability[16] was used for the determination of progesterone levels in the samples. No corrections have been made for extraction losses.

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RESULTS

Oestrous cycle

Peak levels of 4–7 ng/mℓ (12,7–22,3 nmol/ℓ) were found during the luteal phase of the cycle 12 to 16 d after clinical oestrus. A rapid decline was observed in the last 5 d of the cycle and the lowest levels (generally less than 0,5 ng/mℓ) (1,6 nmol/ℓ) were reached on the day of clinical oestrus.

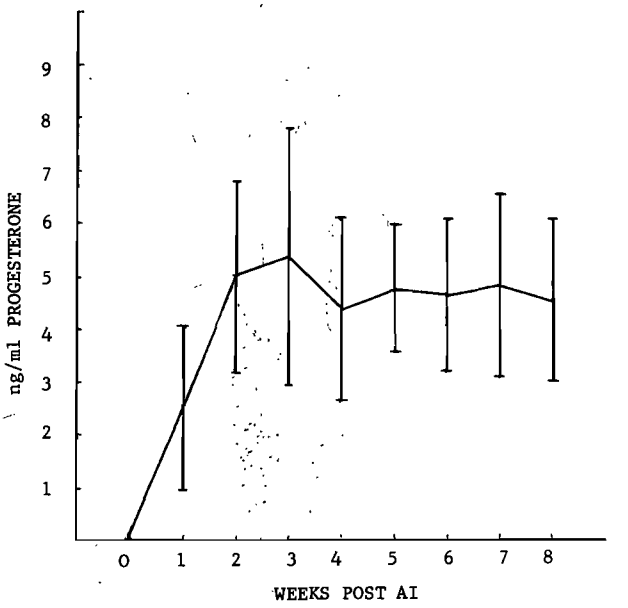

Fig. 1 Progesterone concentrations in 7 cows from oestrus to pregnancy detection at 7–8 weeks

Early pregnancy

Progesterone levels of 3–7 ng/mℓ (9,5–22,3 nmol/ℓ) were found 3 weeks after AI with levels of 3,8–6,5 ng/mℓ (12,1–20,7 nmol/ℓ) being recorded 6 weeks after AI and 3–7 ng/mℓ (9,5–22,3 nmol/ℓ) at the time of rectal confirmation of pregnancy at 7–8 weeks. These results are represented graphically in Fig. 1 which is a

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combined graph of the values found for the 7 cows. In this graph concentrations are only shown at weekly intervals and vertical bars indicate the standard deviation.

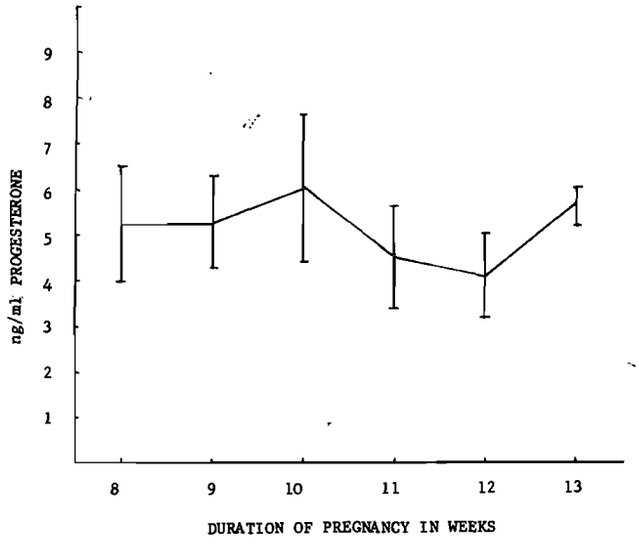

Fig. 2 Progesterone concentrations in 4 cows from the eighth to thirteenth week of pregnancy

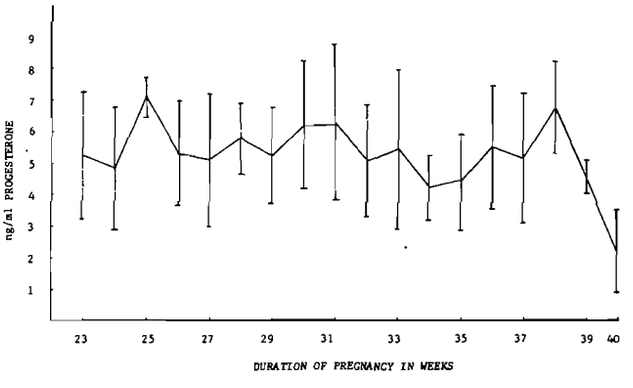

Fig. 3 Progesterone concentrations in 3 cows from the fifth month of pregnancy

Pregnancy to parturition

From the eighth to thirteenth week of pregnancy progesterone levels of 3,5–6,5 ng/mℓ (11,3–20,7 nmol/ℓ) were recorded. On the average, levels in excess of 4 ng/mℓ (12,72 nmol/ℓ) were found during this period. Between the fifth month of pregnancy and parturition progesterone levels ranged between 3 and 8 ng/mℓ (9,5 and 25,4 nmol/ℓ). On the average the levels ranged between 4 and 6,5 ng/mℓ (12,7 and 20,7 nmol/ℓ) with occasional drops to 3–4 ng/mℓ (9,5–12,7 nmol/ℓ) and occasional peaks in excess of 7 ng/mℓ (22,3 nmol/ℓ). These results are represented in Fig. 2 which is a graph of the combined values found in 4 cows between the eighth and thirteenth week of pregnancy and in Fig. 3 which represents the combined values found in 3 cows between the fifth month of pregnancy and parturition. In both, vertical bars represent the standard deviation.

Parturition

Progesterone levels of 3–4 ng/mℓ (9,5–12.7 nmol/ℓ) were found until approximately 3 d before parturition. These levels decreased to approximately 2 ng/mℓ (6,4 nmol/ℓ) on the day preceeding parturition and reached low levels of less than 1 ng/mℓ (3,2 nmol/ℓ) on the day of parturition and for up to 3 d after parturition when sampling was discontinued. Fig. 4 represents a combined graph of the levels found in the 6 cows in this group, with vertical bars representing the standard deviation.

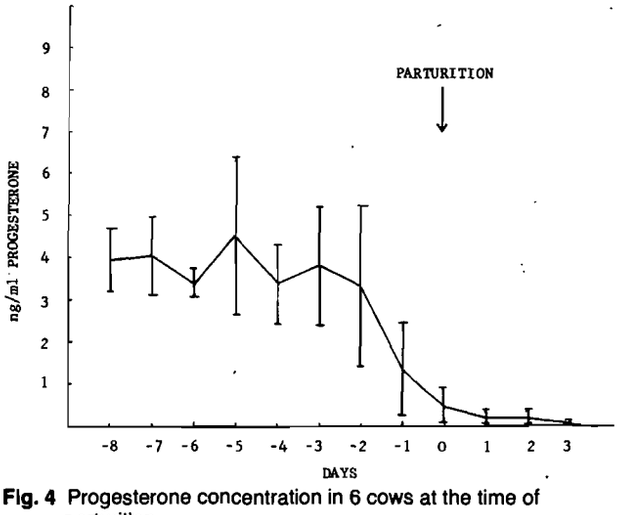

Fig. 4 Progesterone concentration in 6 cows at the time of parturition

DISCUSSION

The progesterone values found with the present assay during the oestrous cycle of normal cows compare well with the results obtained with other protein binding assays. This holds true for the luteal phase levels of 4–7 ng/mℓ (12,7–22,3 nmol/ℓ) as well as the low level of 0,5 ng/mℓ (1,6 nmol/ℓ) and less found during oestrus[4 5 8 9 12]. The high levels of up to 12 ng/mℓ (38,2 nmol/ℓ) reported by Smith, Fairclough, Payne & Peterson[14] were not found in the present study.

These results are in very good agreement with the results of other workers using radioimmunoassay techniques[2 6 9] and gas – liquid chromatography[15]. Poor correspondence was found with the spectrophotometric[3] and the double isotope dilution methods[10].

The results obtained 3 weeks after artificial insemination correspond favourably with those of Donaldson, Bassett & Thorburn[4], Kindahl, et al[9] and Thirapatsukun, Entwistle & Gartner[17]. The levels found in this study between the second month of pregnancy and parturition correlate well with those of many other workers[4 13 15] but are slightly lower than those reported by Robertson[12] and considerably lower than those found by Randel[11].

During the last month of pregnancy present results are in good agreement with those reported by some authors[15]. The decline in progesterone during the last 3 days before parturition and the low levels immediately before and at the time of parturition are in accordance with the results of others[4 13]. The high levels of 6 ng/ml (19,1 nmol/ℓ) reported on the day of parturition by Arije, Wiltbank & Hoopwood[1] were not observed in the present study.

It is our contention that the assay used in this study[16] is capable of measuring progesterone throughout the bovine reproductive cycle and that it can be routinely used for this purpose as an aid in the improvement of bovine reproductive efficiency.

ACKNOWLEDGEMENT

The authors are grateful to Miss L. Maree for technical assistance and to the University of Pretoria and Atomic Energy Board for generous financial assistance.

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OXYTETRACYCLINE PLASMA LEVELS IN DOGS AFTER INTRAMUSCULAR ADMINISTRATION OF TWO FORMULATIONS

A. IMMELMAN* and GILLIAN DREYER*

ABSTRACT: Immelmann A., Dreyer G. **Oxytetracycline plasma levels in dogs after intramuscular administration of two formulations.** *Journal of the South African Veterinary Association* (1981) **52** No. 3, 191–193 (En) Department of Physiology, Pharmacology and Toxicology, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

Plasma levels of oxtetracycline in dogs were compared in a cross-over study. A long-acting formulation and a polyvinylpyrrolidone formulation were injected intramuscularly. Symptoms of histamine release were recorded after the use of polyvinylpyrrolidone formulation. Higher peak plasma concentrations but shorter maintenance of therapeutic concentrations were recorded in the case of the polyvinylpyrrolidone formulation than with the long-acting formulation.

INTRODUCTION

The use of oxytetracycline (OTC) for the treatment of bacterial infections in the dog is common veterinary practice. The successes achieved with this antibiotic in the treatment and prophylaxis of *Ehrlichia canis*[3 6] makes it an important drug in South Africa where this disease is widespread. For this purpose the drug is usually given daily as an intravenous injection at a dosage of 10 mg/kg body mass for a period of 10 days[6], making it a cumbersome treatment. Oral dosing at a dosage of 100 mg/kg body mass daily for 10 days is also an effective treatment but vomition after dosing of oxytetracycline is not uncommon in the dog[10].

For disease control in the dog a long-acting formulation of oxytetracycline that can be administered parentally once every few days would be of great benefit. Such a compound is available for use in cattle, sheep and pigs. It was demonstrated in cattle that a single injection of this formulation at a dosage of 20 mg/kg body mass gave detectable blood levels up to 105 h[9].

The purpose of this study was to determine plasma OTC concentrations in dogs after the intramuscular administration of this long-acting formulation and to compare these concentrations with those obtained after administering a standard oxytetracycline formulation at the same dosage.

Oxytetracycline formulations injected intramuscularly may cause severe tissue damage. It was also established that formulations using polyvinylpyrrolidone (PVP) as a vehicle were far less irritant than those using propylene glycol (PG)[7]. As the pain and muscle damage caused by the PG formulations are not acceptable in dogs it was decided to use a PVP formulation in this investigation.

MATERIALS AND METHODS

Five healthy female Beagle dogs were used in this cross-over study. One bitch (No. 4) was not available for the second study and was replaced with a similar bitch (No. 14). The bitches had an average mass of 12 kg (8,5–13 kg). These animals were housed in individual pens and fed a standard commercial ration once a day. Water was freely available.

A period of 14 days was allowed between the 2 trials and during this time the animals were kept in open pens.

The long-acting formulation of oxytetracycline used in this study was Terramycin LA (Pfizer Laboratories, Johannesburg). The exact formulation is not known to us, but the manufacturer states that the long action is due to controlled precipitation of the antibiotic in the muscle at the injection site and that slow absorption takes place from this site. The recommended dose for ruminants is 20 mg/kg body mass, and so this dose was injected intramuscularly into *M. gluteus* of the experimental Beagles using a fine needle.

The polyvinylpyrrolidone formulation used was Terramycin 100 (Pfizer Laboratories, Johannesburg). This formulation was administered in the same way and at the same dosage as the other formulation.

After injecting these compounds the dogs were observed for any signs of pain, swelling, discomfort or loss of appetite. Heparinized blood specimens were collected from the cephalic vein at fixed time intervals as recorded in Table 1. The samples were immediately centrifuged, the plasma collected and stored at –20° C until the analyses were done.

The technique used for analysis was the spectrofluorometric method described by Ibsen et al[5].

Table 1: MEAN PLASMA CONCENTRATION OF OXYTETRACYCLINE (μg/mℓ) IN 5 DOGS AFTER ADMINISTRATION OF A LONG-ACTING AND A PROPYLENE GLYCOL FORMULATION (± STANDARD DEVIATION)

Time in hours	Long-acting formulation Mean	± SD	PVP formulation Mean	± SD
½	3,78	1,53	2,02	0,72
1	5,04	0,96	5,38	1,02
2	5,24	0,66	5,44	0,39
3	5,03	0,54	5,94	0,35
4	4,58	0,52	6,00	0,57
5	4,30	0,48	5,70	0,58
6	4,10	0,44	5,36	0,70
24	2,80	0,70	1,74	0,58
30	2,02	0,43	1,02	0,40
48	1,38	0,24	0,60	0,30
54	1,10	0,30	0,38	0,17
72	0,70	0	0,32	0,24
78	0,54	0,21	0,18	0,16
96	0,24	0,13	0,12	0,16
102	0,12	0,16	0	0

RESULTS

The results of the different treatments are given in Fig. 1 as the mean values and the standard deviation.

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The administration of the long-acting formulation did not lead to any immediate signs of pain or discomfort. Twenty four hours later one dog (No. 6) showed signs of pain and refused to put weight on the leg that was injected. The following day she did put slight pressure on the leg and 72 h after administration she was completely normal. Her appetite remained normal throughout this period.

When the PVP formulation was administered, one dog (No. 12) yelped and showed symptoms of pain immediately after the injection, but this passed over within a very short while. After 1 h 4 of the 5 dogs showed signs of pruritus and oedema of the face and feet. Respiration was increased and they showed great distress. These syptoms lasted for 5 h and all the affected dogs recovered completely. Their appetites during this reaction period remained normal. The mean plasma concentrations of oxytetracycline are given in Fig. 1. The concentrations rose rapidly after administration of the long-acting formulation, and the peak value of 5,2 μg/mℓ was reached after 2 h, whereafter there was a slow decline in plasma level and the antibiotic could still be detected 102 h after administration. When the PVP formulation was injected, the plasma levels rose just as fast but, after 1 h, were higher than those obtained with the long-acting formulation. The peak concentration of 6 μg/mℓ was only reached after 4 h. Although the plasma level at 6 h was 2,6 μg/mℓ higher than the long-acting formulation, the drop was much more marked and at 24 h it was 1,1 μg/mℓ lower. Oxytetracycline could be detected in plasma up to 96 h after administration, but it always remained lower than with the long-acting treatment.

DISCUSSION

Polyvinylpyrrolidone (PVP) is accepted as a non-toxic substance for humans where it is used as a plasma expander[8], but in dogs it caused a histamine release, leading to symptoms of pruritus, oedema and hypotension[4]. The symptoms seen in these bitches when injectected with the PVP formulation of oxytetracycline correspond to the histamine release as recorded. As this reaction may be lethal the use of this formulation at this high dosage cannot be recommended. The administration of antihistamine beforehand could be successful in controlling this reaction.

In other unreported studies done at this laboratory, a severe pain reaction lasting up to 72 h after administration of the long-acting formulation was found. The apparent mild pain experienced by dogs during this trial was unexpected and cannot be explained. Further studies are required to elucidate these findings.

The advantage of a long-acting formulation is that daily therapy can be avoided, but it is also essential that the plasma levels must be maintained above the minimum inhibitory concentration for the particular organism involved in any disease. It is generally accepted that 0,5–1 μg/mℓ is the minimum inhibitory concentration required for the most common bacterial infections[2]. Baggot et al. state that serum levels of 1,25–5 μg/mℓ is the therapeutic concentration for the majority of susceptible micro-organisms and that this level can be maintained by giving oxytetracycline intravenously at a priming dose of 10 mg/kg followed by a maintenance dose of 7,5 mg/kg at 12 h intervals[1]. No minimum inhibitory concentrations are available for organisms like *Ehrlichia canis*.

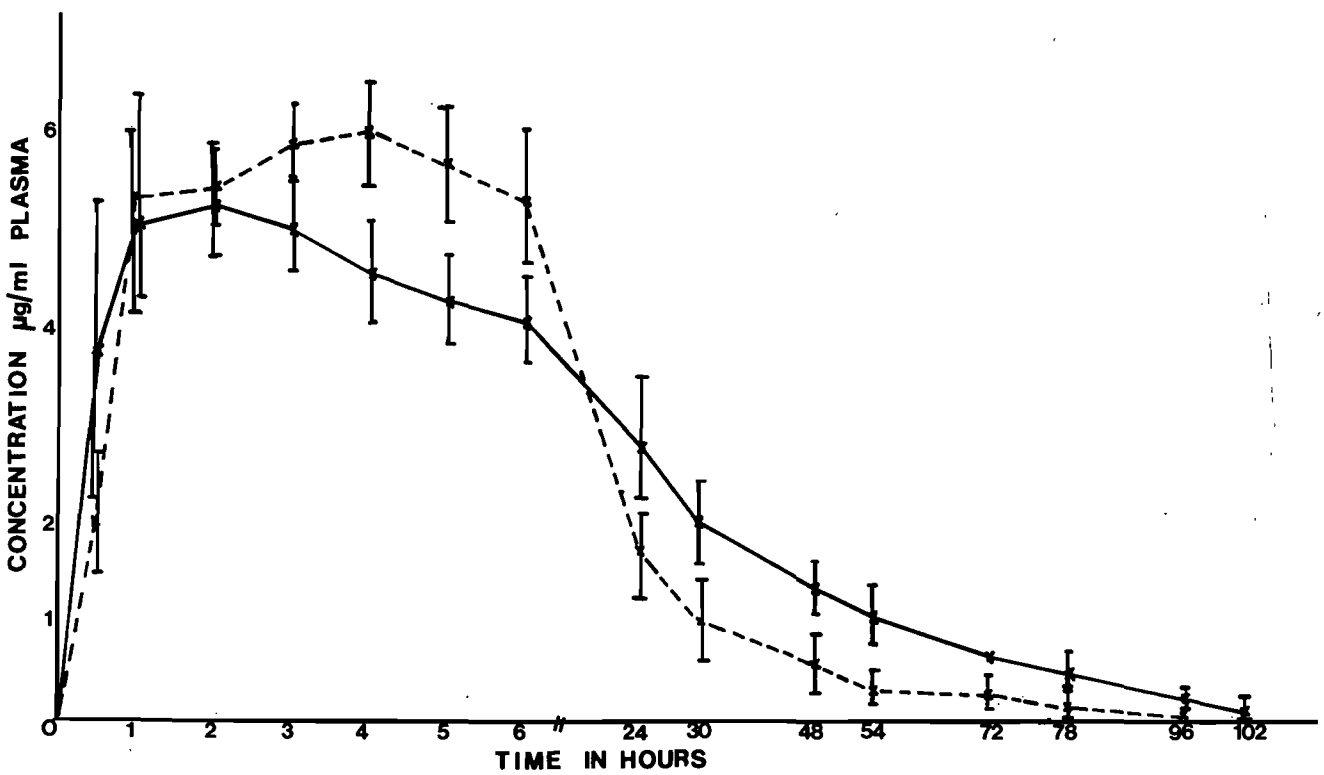

Fig. 1 The mean plasma levels and standard deviation of oxytetracycline after the administration of a PVP formulation (- - -) and a long acting formulation (——) in 5 dogs.

When the graphs in Fig. 1 are compared and 1,25 $\mu g/m\ell$ is taken as the lowest therapeutic concentration required then the long-acting formulation will maintain that concentration for 50 h and the PVP formulation will only maintain it for 28 h. Both products will reach the required therapeutic concentration within 20 minutes. In the case of the more resistant organism, requiring a blood concentration of 5 $\mu g/m\ell$, both products will reach that concentration within 1 h. The long-acting formulation will, however, only maintain that concentration for 2 h, whereas the PVP formulation will maintain that concentration for 5 h.

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BOOK REVIEW **BOEKRESENSIE**

THERE WAS A MAN
THE LIFE AND TIMES OF SIR ARNOLD THEILER K.C.M.G. OF ONDERSTEPOORT

THELMA GUTSCHE

Howard Timmins, Cape Town 1979, pp. 487, Figs. 116, Maps 4, Publ. Price R27,50 (tax excl.)

This work may be described in one word: "monumental". It is a monumental piece of documentation about a monumental man, moving in monumental times (if one may so extend the metaphor), times of beginning major impact of science on man's efforts at survival, of societies of widely different levels of sophistication on one another, of colonialism, the latter with horrendous immediate effects.

The authoress has taken infinite pains to paint a Breughelian picture of people and events around Theiler. The "Select Bibliography and Sources" (pp. 458–464), extensive as they are, hardly do credit to her meticulous documentation. In this respect one should refer the research worker who wishes to make full use of this book to the copy in possession of the Human Sciences Research Council, in which Gutsche has carefully annotated each datum by marginal reference number referring to an exhaustive typed list of sources accompanying that copy.

As to the true nature of the man himself, she wisely lets his own words (as expressed in his letters) and his own deeds speak for themselves; she limits her opinions to occasional remarks. Thus as objective a picture as possible is created of a man of incredible ebullience and driving force, with an insatiable thirst for knowledge far beyond the commonly accepted confines of his profession. That Theiler drove himself to the utmost, becomes clear; that he was a hard – but fair – taskmaster perhaps less so. Despite her lucid and lively style, so many facts are crammed into the pages, that the going is not easy. Only one historical discrepancy was noted. On page 89 Gutsche states that Theiler only made acquaintance with Paul Kruger *after* his visit to Rhodesia to establish the presence of rinderpest with certainty: "for the first time shook the old man's hand". As one of the final year students in 1936, to which student body Gutsche refers, your reviewer clearly remembers Sir Arnold's vivid account of his first meeting with the President *before* being sent on his Rhodesian mission, how the President was puzzled that Theiler could know all the symptoms of the disease without ever having seen a case, but nevertheless had decided to trust him, and how Paul Kruger had warned him not to confuse the disease with another one that he described to Theiler, a disease which Theiler would later establish as being malignant catarrhal fever.

It stands to Thelma Gutsche's credit that, as a lay person, she could wend her way so successfully through all the scientific intricacies of animal diseases, many aspects of which are not quite clear, even today. It must be borne in mind that she had to rely entirely on the writings of those days. The few slips, indicated below, only serve to emphasise how well she has acquitted herself of a task that even to a scientist would have been quite formidable.

1. Confusion of trypanosomiasis with piroplasmosis (p. 5 and elsewhere).
2. Mentioning the popular name of the gousiektebossie *(Vangueria pygmaea,* now known as *Pachystigma pygmaeum)* as "sand apple" (p. 303).
3. Mentioning *osteophagia* as a bone disease, instead of being a sign of phosphorus deficiency (p. 410).
4. "Shortly it (Onderstepoort) would become the only veterinary college in Africa" (p. 303). The Veterinary Faculty of the University of Cairo is reported to have been established by the French in 1828; according to the "World Directory of Veterinary Schools" (WHO) instruction started there in 1901.

There is misspelling of some technical terms, e.g. "pemphagus" instead of "pemphigus" (p. 60); "podopyllin" instead of "podophyllin" (p. 69); "osteomalachia" instead of "osteomalacia" (p. 75). Some German and Netherlands words are either misspelled – even allowing for changes with passage of time – or expressions are incorrect grammatically. Fortunately there is only a sprinkling of printers' errors.

By introducing the anecdotal element, Gutsche adds colour and interest. It is a pity that she missed out on the one leading to the essential clue to the cause of lamsiekte, namely, how Theiler's lay assistant, "Barnie" Badenhorst, sick and tired of life at Armoedsvlakte and of the daily chore of feeding carcase material, not too pleasant odourwise, to experimental cattle, decided to get it over and done with by feeding all the material in one fell swoop. To his horror, lamsiekte declared itself and "Barnie" already saw himself "sacked". After much soul-searching he confessed to Sir Arnold. Great was his relief when he received praise instead of discharge. (Personal communication by the late Mr. Badenhorst, confirmed by Professor B.C. Jansen).

In the final summing up, this book is more than just a biography of a great man; it is a sober account of the ways and vagaries of Science and of the men who serve her, of their hopes and frustrations, of their struggles, sometimes with, sometimes against those who govern, who, within the limits of their abilities and vision, have to decide priorities in the face of financial stringencies and political manoevring.

The veterinary profession in South Africa owes Thelma Gutsche a profound debt of gratitude for this major task she has completed, particularly in view of the paucity of historical accounts concerning veterinary science in this country.

H.P.A. de Boom

A RESIDUAL ANTHELMINTIC 2,6-DIIODO-4-NITROPHENOL (DISOPHENOL). METHODS OF TESTING ITS ANTHELMINTIC EFFICACY

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ABSTRACT: Reinecke R.K.; Bruckner C.; De Villiers I.L. **A residual anthelmintic 2,6-diiodo-4-nitrophenol (Disophenol). Methods of testing its anthelmintic efficacy.** *Journal of the South African Veterinary Association* (1981) **52** No. 3 (En) Department of Parasitology, Faculty of Veterinary Science, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

A subcutaneous injection of 2,6-diiodo-4-nitrophenol (Disophenol) at 10 mg/kg sheep leaves a residue bound to serum albumin which is lethal to *Haemonchus contortus* for 3 months after treatment.

In the larval anthelmintic test, susceptible worm free sheep are dosed so that either third stage larvae (L_3), or fourth stage larvae (L_4) or 5th and adult stages are present on the day of treatment but slaughter is delayed to allow these larval stages to develop to adults because the larger worms are more easily seen, identified and counted. The larval anthelmintic test in sheep had to be altered and sheep killed within a few days of treatment, because the residues may be more effective against subsequent stages of development. Disophenol was > 60% effective against L_3 of *Oesophagostomum columbianum* and L_4 of *H. contortus* in > 60% of sheep (Class B). It rose to > 80% effective against adult *H. contortus in* > 80% of sheep (Class A).

Against *H. contortus* it maintained Class A for 32 days, fell to Class B from 45–76 days and Class C (> 50% effective in > 50% of sheep) at 91 days after treatment respectively.

In the RSA a treatment in December followed by another in March would protect sheep adequately against *H. contortus* for the entire season.

INTRODUCTION

Some compounds are not excreted at once but residues remain in the host and may still be lethal for worms months after dosage. Disophenol (Trimintic, SA Cyanamid) leaves a residue bound to the serum albumin of sheep and is effective against *H. contortus* 3 months after treatment[1 8].

The name residual anthelmintic will be used to refer to compounds of this nature with a prolonged effect.

Disophenol injected subcutaneously at 10 mg/kg live mass is claimed to have a residual effect and presents some problems in experimental design when the following questions are posed:

(i) How can efficiency be tested against third stage larvae (L_3) fourth stage larvae (L_4) fifth (5th) stages and adults?
(ii) What test can be used to assess the residual effect?

(I) Larval stages and adults

In the larval anthelmintic test, with the exception of the "indicator control" killed on Day 0 to indicate the stage of development of worms at treatment, slaughter should take place when nematodes have developed to the 5th or adult stage[6 7].

The great advantage of allowing worms to develop to adults is that it increases the ease with which the worms can be seen, the accuracy of the worm counts and the subsequent microscopic identification.

This experimental design had to be altered and sheep slaughtered within a few days of treatment, because the disophenol residue may be more effective against the subsequent stage(s) of development. The design and results of tests against L_3, L_4, 5th stages and adults are presented below.

MATERIALS AND METHODS

Sixty-one weaned Dorper and Persian sheep were purchased, transferred to the laboratory and on arrival treated with mebendazole (Multispec Ethnor (Pty) Ltd.) at 23 mg/kg live mass. Two weeks later they were divided at random into groups of 20, 20 and 21 sheep each, for use in 3 experiments.

EXPERIMENT 1 EFFICACY OF DISOPHENOL AGAINST L_3

Materials and Methods

Twenty sheep were orally infested with infective larvae of *O. columbianum, H. contortus* and *T. colubriformis* and percutaneously with *G. pachyscelis*. The days of infestation, number of infective larvae dosed to each sheep, treatment and slaughter are presented in Table 1.

Worms were recovered at necropsy from the gastrointestinal tract in the modified Baermann apparatus[6 7]. This apparatus was also used to recover *G. pachyscelis* from the lungs using the same technique previously described for *D. filaria* in the Day 0 control[7].

At necropsy worms from 1/20 aliquots of the residues were examined with the aid of a stereoscopic microscope. If *O. columbianum* were present the whole of the residue was examined microscopically. Four 1/20 aliquots of the abomasal filtrates and the entire filtrates of the small intestine, caecum and colon as well as the digests were examined microscopically.

The median counts of the controls and highest reduced median for *O. columbianum* were the results of recounts of all specimens. In this case the entire residues of the ingesta of the small intestine, caecum and colon were examined for worms and the entire digests and filtrates recounted. These are indicated by * in Table 1 and subsequent Tables.

RESULTS

These are summarized in Table 1.

Only 7 *G. pachyscelis* were recovered from the lungs of the Day 0 control (Sheep 7) but none from the small intestine 5 days later. This confirms the observations of Ortlepp[4 5] that L_4 of this species only begin to arrive in

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Table 1: RESIDUAL ANTHELMINTIC EXPERIMENT 1. THIRD STAGE LARVAE. THE DAYS ON WHICH INFECTIVE LARVAE WERE DOSED, SHEEP TREATED AND SLAUGHTERED. ANTHELMINTIC EFFICACY ASSESSED BY THE MODIFIED NPM

H. contortus		*T. colubriformis*		*O. columbianum*		*G. pachyscelis*
Days on which infective larvae were dosed						
Day −1 to Day −2		Day −1 to Day −3		Day −1 to Day −6		Day −6 only
Day 0 11 sheep injected subcutaneously with disophenol on Day 0 at 10 mg/kg Killed Sheep 7 Day 0 control.						
Worms recovered from Sheep 7 Day 0 control						
L_3	L_4	L_3	A	L_3		L_3
965	95	839	11	58		7
Day +4 killed 11 sheep treated on Day 0						
Day +5 killed 8 sheep undosed controls						
Anthelmintic efficacy						
Controls	Treated	Controls	Treated	Controls	Treated	Controls Treated
1 990	349	675	395	124	11	No worms
2 036	807	714	637	168	17	recovered from
2 247	843	814	796	183	30	either the
2 340	899	882	877	*217	43	controls or the
2 541	1 010	970	1 188	*220	*47	treated sheep
3 188	1 545	1 140	1 176	*243	48	
3 570	1 562	1 707	1 299	268	58	
4 025	1 986	2 104	1 302	319	*64	
	2 038		1 305	Median	136	
	2 043		1 330	x̄ of 217		
	2 370		1 437	& 220	209	
					3/11	
				= 218,5	> 87	
				X 0,4	Class	
				= 87,4	B	
Disophenol is > 60 % effective against L_3 of *O. colombianum* in > 60 % of sheep.						

*Recounted

Table 2: RESIDUAL ANTHELMINTIC EXPERIMENT 2. FOURTH STAGE LARVAE. THE DAYS ON WHICH INFECTIVE LARVAE WERE DOSED, SHEEP TREATED AND SLAUGHTERED. ANTHELMINTIC EFFICACY ASSESSED BY THE MODIFIED NON PARAMETRIC METHOD

H. contortus		*T. colubriformis*		*O. columbianum*			*G. pachyscelis*	
Days on which infective larvae were dosed								
Day −3 to Day −11		Day −4 to Day −10		Day −7 to Day −21			Day −16 only	
Day −1 Sheep 47 died used as a Day 0 control.								
Day 0 11 sheep injected subcutaneously with disophenol at 10 mg/kg.								
Worms recovered from Sheep 47 killed on Day 0.								
L_4		L_4		L_3	L_4	5th	L_4	
1 218		2 111		125	291	15	14	
Day +3 killed 7 sheep treated on Day 0								
Day +4 killed 4 sheep treated on Day 0 and 2 controls								
Day +5 killed 6 controls								
Anthelmintic efficacy								
Controls	Treated	Controls	Treated	Controls	Treated		Controls	Treated
*1 552	26	1 214	1 127	*235	*44		*41	*107
*1 588	36	1 596	1 902	*260	*98		*80	*115
*1 639	47	1 945	1 952	*289	102		135	*159
*1 711	61	2 009	2 017	*407	*211		*165	167
*1 960	75	2 185	2 219	*426	*219		*168	221
2 438	85	2 195	2 271	*519	225		280	*227
2 522	99	2 606	2 296	752	239		*285	*239
2 593	211	2 710	2 386	775	*325		*326	303
median	*349		2 482		*334			359
1 835,5	*494		2 683		341			*448
x 0,4	*987		3 072		*345			660
= 734,20	1/11							
	exceed							
	734 Class B							

*Recounted

Disophenol is > 60 % effective against L_4 of *H. contortus* in > 60 % of sheep ie Class B.

Table 3: RESIDUAL ANTHELMINTIC. EXPERIMENT 3. FIFTH STAGE AND ADULTS. THE DAYS ON WHICH INFECTIVE LARVAE WERE DOSED, SHEEP TREATED AND SLAUGHTERED. ANTHELMINTIC EFFICACY ASSESSED BY THE MODIFIED NON PARAMETRIC METHOD

	H. contortus		*T. colubriformis*		*O. columbianum*			*G. pachyscelis*	
Days on which infective larvae were dosed	Day −12 to Day −25		Day −11 to Day −25		Day −22 to Day −42			Day −42 only	
Day 0	11 sheep injected subcutaneously with disophenol at 10 mg/kg Killed Sheep 26 Day 0 control								
Worms recovered from Sheep 26 killed on Day 0	L_4 505	5th 808	A 697	L_4 87	5th 458	A 1 198	L_3 85	L_4 16	5th 138	A 141	L_4 54	5th 145
Day +3 Killed 6 sheep treated on Day 0												
Day +4 Killed 5 sheep treated on Day 0 and 2 controls												
Day +5 Killed 7 controls												
Anthelmintic efficacy	Controls	Treated	Controls	Treated	Controls	Treated	Controls	Treated				
	1 863	23	2 648	1 464	106	52	8	15				
	2 370	41	2 841	2 349	109	83	18	26				
	2 505	71	3 081	2 579	142	146	34	41				
	2 677	97	3 216	2 848	148	147	47	47				
	2 743	98	3 394	2 864	178	199	50	48				
	2 822	108	3 456	2 929	189	237	82	71				
	3 124	122	3 505	2 990	201	265	115	93				
	3 129	142	3 696	3 215	295	295	153	118				
	3 776	152	3 738	3 357	298	331	181	131				
	Median	206		3 726		418		197				
	2 743 X	250		3 790		424		209				
	0,25	0/11										
	= 685,75	exceed										
		686 Class A										

Disophenol is > 80 % effective against adult *H. contortus* in > 80 % of sheep.

the small intestine by the 13th day. Only a single L_4 was recovered on the 12th day from the lungs in our life-cycle studies (Reinecke & Verster, unpublished observations 1974). Moreover the technique for hookworm recovery from the lungs is poor when compared with the same technique for *D. filaria*[7]. This experimental design is therefore not suitable for L_3 of *G. pachyscelis*.

In confirmation of previous trials[7] both *H. contortus* and *T. colubriformis* were all L_4 on the sixth day whereas L_3 were dominant in *O. columbianum*. Since this was the only species in which the anthelmintic was effective (Class B), confidence was established in interpretation of the results (Table 1).

EXPERIMENT 2 EFFICACY OF DISOPHENOL AGAINST L_4

Materials and Methods

Twenty sheep were used, infested, treated and slaughtered as shown in the experimental design (Table 2). Worm recovery, method of counting etc. have been described in Experiment 1. Total counts are indicated in Table 2 by *.

Results

Data are summarized in Table 2. Fifteen days after infestation (Day −1), only 14 *G. pachyscelis* were recovered from the small intestine. By the 20th day (Day +4) the numbers ranged from 41–326 in the controls but in the treated group they rose to range from 107–660. This shows that most of the worms arrived in the intestine between the 16th and 20th day. Only L_4 of *H. contortus* and *T. colubriformis* were present on Day −1 but L_3, L_4 and 5th stages of *O. columbianum* were present on this day (Sheep 47). By the 10th to the 12th day after the last larval dose distribution was similar to the worms present on Day −1 for *O. columbianum* but there were more 5th stages present. Disophenol at 10 mg/kg live mass reached Class B efficacy against *H. contortus* but was ineffective against L_4 of the other worms (Table 2).

EXPERIMENT 3 EFFICACY OF DISOPHENOL AGAINST 5TH AND ADULT STAGES

Materials and Methods

Twenty sheep were infested, treated and slaughtered as summarized in Table 3. Because adult *H. contortus* were present ingesta of the abomasum were not placed in the modified Baermann Apparatus, but washed directly into buckets with physiological saline, worms heat killed (60° C), fixed in formalin, sieved and placed in storage jars and preserved with formalin.

Total microscopic worm counts were done on the digested abomasal and gut wall and on worms in 4, 1/20 aliquots of the abomasal ingesta; 1, 1/20 aliquot of the small intestinal, caecal and colonic residue and filtrate. Macroscopic counts were done on all the *G. pachyscelis* and *O. columbianum* in the entire filtrate and 19/20 of the residue of the ingesta of the small intestine, caecum and colon.

Results

Worms recovered and data are analysed in Table 3. In the treated sheep no 5th stages and only 5 adults of *H. contortus* were recovered in each of 3 sheep (Sheep 28,

Table 4: RESIDUAL ANTHELMINTIC. EXPERIMENT 4. EXPERIMENTAL DESIGN INDICATING DAYS ON WHICH SHEEP WERE TREATED, DOSED WITH INFECTIVE LARVAE, SAMPLED FOR WORM EGG COUNTS, KILLED AND RESULTS OF THE FAECAL WORM EGG COUNTS

Day	Procedure
−91	Group B: Injected subcutaneously with disophenol at 10 mg/kg
−76	Group C: Injected subcutaneously with disophenol at 10 mg/kg
−61	Group D: Injected subcutaneously with disophenol at 10 mg/kg
−29	Sheep 348 (Group C) died
0	Group A, B, C, D: All animals dosed with 6 200 (range 5 450–6 850) infective larvae of *H. contortus*
+20	Faeces of all sheep examined for worm egg counts
+21	All sheep slaughtered

Day +20 Faecal worm egg counts

Group A		Group B		Group C		Group D	
Sheep No.	epg	Sheep No.	epg	Sheep No.	epg	Sheep No.	epg
304	2 700	303	400	316	50	321	0
315	4 550	320	0	327	0	338	0
318	5 250	335	0	351	200	345	100
341	2 800	361	100	390	50	346	0
370	6 350	420	50	425	0	402	0
387	6 200	436	100	437	0	430	0
391	3 900	439	0	445	0	443	0
394	1 650	448	300	446	1 350	455	0
399	9 700	451	100	452	0	458	0
		461	100	464	0	462	0
		465	0	470	800	463	0
		467	100			468	0

Table 5: RESIDUAL ANTHELMINTIC. EXPERIMENT 4. ANTHELMINTIC EFFICACY ASSESSED BY THE MODIFIED NPM

GROUP A Controls	GROUP B 91 days	GROUP C 76 days	GROUP D 61 days
1 686	209	183	60
1 716	276	275	70
1 985	497	352	253
*2 109	537	459	266
*2 320	661	485	329
*2 343	664	519	353
3 174	748	519	446
3 929	*1 044	785	464
4 237	*1 121	929	482
median 2 320	*1 273	1 290	506
X 0,25 = 580 Class A	*1 307	1 798	660
X 0,4 = 928 Class B	1 545		868
X 0,5 = 1 160 Class C	3/12 exceed 1 160 Class C	3/11 exceed 928 Class B	0/12 exceed 928 Class B

*Recounted

The worm burdens in Group C are significantly higher than those in Group D by the Mann-Whitney U test ($p < 0,05$)

Treatment 91 days before dosing with infective larvae of *H. contortus* was > 50 % effective in > 50 % of sheep (Class C).

Treatment 76 and 61 days before dosing with infective larvae of *H. contortus* was > 60 % effective in > 60 % of sheep (Class B).

Table 6: RESIDUAL ANTHELMINTIC. EXPERIMENT 5. EXPERIMENTAL DESIGN INDICATING DAYS ON WHICH SHEEP WERE TREATED, DOSED WITH INFECTIVE LARVAE, SAMPLED FOR WORM EGG COUNTS, KILLED AND RESULTS OF FAECAL WORM EGG COUNTS

Day	Procedure
−45	Group F: Injected subcutaneously with disophenol at 10 mg/kg
−32	Group G: Injected subcutaneously with disophenol at 10 mg/kg
0	Group E, F, G: All animals dosed with 6 725 (range 6 000–7 300) infective larvae of *H. contortus*
+2	Sheep 367 (Group F) died
+21	Sheep 442 (Group E) died
+28	Faeces of all sheep examined for worm egg counts
+32	All sheep slaughtered

Day +28 Faecal worm egg counts

Group E		Group F		Group G	
Sheep No.	epg	Sheep No.	epg	Sheep No.	epg
305	5 500	302	500	331	0
364	10 400	323	0	342	0
372	9 000	326	0	343	0
375	5 400	336	100	344	0
407	1 300	358	100	416	0
422	10 300	369	700	432	0
433	2 300	393	0	441	0
457	8 100	395	0	449	0
		403	1 400	453	0
		438	0	469	100
		459	0	473	0
				474	100

Table 7: RESIDUAL ANTHELMINTIC. EXPERIMENT 5. ANTHELMINTIC EFFICACY ASSESSED BY THE MODIFIED NPM

GROUP E Controls	GROUP F 45 days	GROUP G 32 days
528	0	0
*536	30	4
*757	97	16
*831	122	21
*873	197	22
*963	*201	52
*1 047	222	60
2 130	225	62
2 265	*256	67
median	*421	*79
= 873	*434	*88
X 0,25 = 218 Class A	2/11 exceed	0/12 exceed
X 0,4 = 349 Class B	349 Class B	218 Class A
X 0,5 = 436 Class C		

*Recounted

Treatment 45 days before dosing with infective larvae of *H. contortus* was > 60 % effective in > 60 % of sheep. It rose to > 80 % effective in > 80 % of sheep 32 days before infective larvae of *H. contortus* were dosed.

37 and 40) but L_4 varied from 23–245. Obviously disophenol is highly effective against 5th stage and adult worms and less effective against L_4. This is confirmed

by the analysis in which disophenol at 10 mg/kg live mass reached Class A efficacy against 5th and adult *H. contortus* despite the fact that most of the worms that survived were L_4.

The results of Experiment 1 showed that disophenol at 10 mg/kg live mass was > 60% effective in > 60% of sheep against L_3 of *O. columbianum* (Class B, Table 1). In Experiment 2 a similar result was noted against L_4 of *H. contortus* (Class B, Table 2) but it rose to > 80% effective in > 80% of sheep, against 5th and adult *H. contortus* (Class A, Table 3).

Little purpose would be served in continuing experiments with *O. columbianum* but the long term anthelmintic activity of disophenol remained to be investigated against *H. contortus*.

II Residual Efficacy

Two experiments were done to establish the prolonged effect of disophenol.

EXPERIMENT 4 RESIDUAL EFFICACY OF DISOPHENOL AGAINST 61-, 76- AND 91 DAY-OLD *H. CONTORTUS* IN MERINO LAMBS

Materials and Methods

Forty five weaned Merino lambs were purchased and on arrival at the laboratory treated with mebendazole at 20 mg/kg live mass and vaccinated with blue tongue and enterotoxaemia vaccine.

They were divided at random into 4 groups:
Group A, 9 untreated controls,
Group B, C and D, 12 sheep each, which were treated.

The days on which sheep were treated, challenged with infective larvae of *H. contortus,* faeces examined for worm eggs and sheep were slaughtered are summarized in Table 4. On Day –29, Sheep 348 (Group C) died but no examination post mortem was performed.

Results

Faecal examination

Worm egg counts ranged from 1 650 to 9 700 epg in the controls. In group B (treated on Day –91) 4 out of 12, in Group C (treated on Day –76) 6 out of 11 and in Group D (treated on Day –61) 11 out of 12 sheep were negative (Table 4).

H. contortus recovered post mortem (Table 5)

Sheep were killed on Day +21 (Table 4) and worm burdens ranged from 1 686 – 4 237 in the controls (Group A). This total fell to range from 209 – 1 545 in Group B, 183 – 1 798 in Group C and 60 – 868 in Group D respectively, most of them being adult worms.

Efficacy (Table 5)

In spite of a three month gap (91 days) between treatment with disophenol and challenge with *H. contortus* efficiency was still class C (Group B) improving to Class B at 76 and 61 days in Group C and D respectively. The Mann-Whitney U test[10] shows that worm burdens of Group C are significantly higher than those in Group D ($p < 0,05$).

EXPERIMENT 5 RESIDUAL EFFICACY OF DISOPHENOL AGAINST 32- AND 45-DAY OLD *H. CONTORTUS* IN MERINO LAMBS

Materials and Methods

Thirty three weaned Merino lambs were used and divided at random into 3 groups:

Group E, 9 untreated controls
Group F and G, 12 sheep each which were treated.

The days of treatment, challenge, faecal examination and slaughter are listed in Table 6. On Day +2 Sheep 367 (Group F) died and no necropsy was performed; on Day +21 Sheep 442 died (Group E) and its worm burden was counted at necropsy.

Results

Faecal examination (Table 6)

In the controls egg counts varied from 1 300 – 10 400 epg. In Group F (treated on Day –45) six out of 11, and in Group G (treated on Day –32) 10 out of 12 sheep respectively, were negative.

H. contortus recovered at necropsy

Worm counts in the controls ranged from 528 – 2 265. These were lower than those in Experiment 4 and to be certain that the median counts were accurate total worm counts were done on six out of nine controls.

In the treated groups total worm burdens ranged from 0 – 434 in Group F and 0 to 88 in Group G, respectively.

Efficacy (Table 7)

The efficacy of disophenol at 10 mg/kg live mass 45 days before challenge with infective larvae of *H. contortus* was Class B but improved to Class A at 32 days.

At this time no worm burdens in the 12 treated animals exceeded the reduced median of 218.

If the data of Experiments 4 and 5 are combined the efficiency of disophenol at 10 mg/kg body mass has been proved to be effective against subsequent infestation with *H. contortus* long after treatment. The results have shown:

(a) For at least one month after treatment Disophenol is > 80% effective in > 80% of the flock (Class A).
(b) If a period of 3 months, however, between treatment and infestation elapses it falls to > 50% effective in > 50% of the flock (Class C).

DISCUSSION

In the highveld (Transvaal)[2,3] and eastern Cape Province[9] *H. contortus* is dominant, total worm burdens reaching peaks from December to April or May. Adults are dominant in summer and retarded L_4 from March to reach a peak in June [2,3]. Climatic conditions are totally unsuited for the development of the free-living stages from June to November[2].

In December 1976 we treated the flock at the Experimental farm of the University of Pretoria with disophenol and checked their acquisition of infestation under natural challenge. When compared with controls which showed a rising worm egg count from January onwards,

treated sheep remained negative until March 1977. This confirmed that treatment with disophenol at 10 mg/kg will protect sheep for at least three months against natural challenge with *H. contortus*[1]. In addition to treatment in December we suggest a further treatment in March.

A major advantage of a residual anthelmintic is that the farmer need only treat sheep twice during the height of the worm season in summer and reduces his costs and labour to a minimum.

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HOST SPECIFICITY AND THE DISTRIBUTION OF THE HELMINTH PARASITES OF SHEEP, CATTLE, IMPALA AND BLESBOK ACCORDING TO CLIMATE*

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ABSTRACT: Horak I.G. **Host specificity and the distribution of the helminth parasites of sheep, cattle, impala and blesbok according to climate.** *Journal of the South African Veterinary Association* (1981) **52** No. 3, 201–206 (En) Department of Parasitology, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

The helminth parasites recovered from sheep, cattle, impala and blesbok during several surveys conducted in the Republic of South Africa are listed as definitive, occasional or accidental parasites of their respective hosts. Their distributions according to the various climatic zones of the Republic are also listed.

INTRODUCTION

It has been stated that host specificity is one of the fundamental characteristics of parasitism but it is seldom absolute, and to a variable degree it is relative[4]. Moreover when hosts have evolved from a common ancestor, the parasites of that ancestor will evolve with the hosts, so that the modern descendants of that ancestor will tend to have descendants of its parasites. Host specificity also reflects the interplay of ecological factors, host behaviour and intrinsic determinants such as the physiology, nutrition and immunological status of the host[18].

Because of their common ancestor the various ruminant species are likely to harbour parasites from the same family or even genus. Cross-transmission with these helminths will occur provided the hosts are fairly closely related and intrinsic determinants in the new host permit a viable association to develop. This will also occur between more distantly related species which regularly utilize the same habitat and harbour related species of parasites. It is well-illustrated in sheep and cattle in which certain species can give rise to viable infestations in the alternate host[9 14 15].

Many old host-parasite associations have developed because of geographic isolation, while new associations have occurred because of the migration of man and his livestock.

The parasites of domestic livestock in Europe have developed with their hosts and because of the paucity of wild animals in the last centuries, most associations are comparatively old and the parasitic fauna of sheep and of cattle clearly defined. The same is not true of Africa where domestic animals, some of which originate from Europe, often mingle with wild animals and old and new associations may exist in the same animal.

Climate was probably an important factor in the geographical isolation that led to the evolution of helminth species. Its role today is as important in determining the distribution of these species as it was in the past. Thus generic and even specific climatic requirements may determine the distribution of parasites within a given region. These climatic requirements not only directly influence the distribution of helminths by their effect on the free-living stages but also indirectly in that they influence the habitat of the hosts and hence their distribution.

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DEFINITIVE, OCCASIONAL AND ACCIDENTAL PARASITES

Host-specificity is not easy to determine; it requires the examination of a large number of animals in various localities, the recovery of both adult and immature parasites, their enumeration and identification and possibly also artificial cross-transmission to determine their infectivity for other hosts. Most host-parasite check-lists merely indicate that a particular parasite has been recovered from a particular host, but cannot be considered to indicate host-specificity because their compilation usually does not meet the requirements listed above.

To make these lists more meaningful I suggest that the parasites should be grouped as follows:

(i) Definitive parasites: These are prevalent in a large percentage of the population, often in fairly large numbers and are capable of reproduction and a long period of survival.

(ii) Occasional parasites: Are present in variable numbers in some of the population. They may be capable of reproduction but their survival period in the host is often limited. When related host species, harbouring related parasites, mingle in the same habitat this type of association is frequently encountered.

(iii) Accidental parasites: These are usually present in only a small percentage of the population and then usually in small numbers. They may not be capable of development to adulthood and if they are, may not reproduce, and their period of survival in the host may be very limited. Accidental parasitism occurs when different hosts mingle in the same habitat and large numbers of infective larvae are available. Neither the hosts nor their parasites need be closely related.

Grazing experiments conducted in Australia by Barger & Southcott[2] and Southcott & Barger[28] demonstrated the difference between definitive and occasional host-parasite associations. They utilized sheep or cattle to decontaminate the pastures previously grazed by the alternate host and found that the sheep parasites *Haemonchus contortus* and *Trichostrongylus colubriformis* were present in calves grazed for one month on pastures previously contaminated by sheep, but not when they were grazed for two months. They suggested that the longer period of grazing may have permitted development of resistance and consequent elimination of infestation. Similarly *Cooperia* spp. recovered from sheep in surveys on the Transvaal Highveld can be

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considered occasional parasites although no attempt was made to determine their longevity in the sheep[9,14].

PARASITE DISTRIBUTION ACCORDING TO CLIMATE

Because of climatic differences, host-parasite checklists drawn for particular regions within a country will differ from those for other regions. It is therefore important when compiling such a list for a country as a whole that the regional distributions of the parasites be given.

The RSA is divided into 12 climatological regions (Fig. 1). It can also be divided into six biotic zones[23]. These biotic zones have been defined as "zones and subzones (that) have been empirically derived by considering main vegetation types and how they best fit the distribution of species, initially of birds and later of mammals"[23].

Whereas the conditions within a single or a number of biotic zones will determine the distribution of free-ranging antelope, the same conditions will only affect the density of domestic livestock and not their presence within a zone as man has largely ignored the zonal boundaries in his quest for grazing. In many instances he has also introduced the antelope into regions outside their normal biotic zones[1].

Thus in broad terms it can be stated that the distribution of parasites of domestic livestock will be influenced mainly by climate, while that of helminths of free-rang-

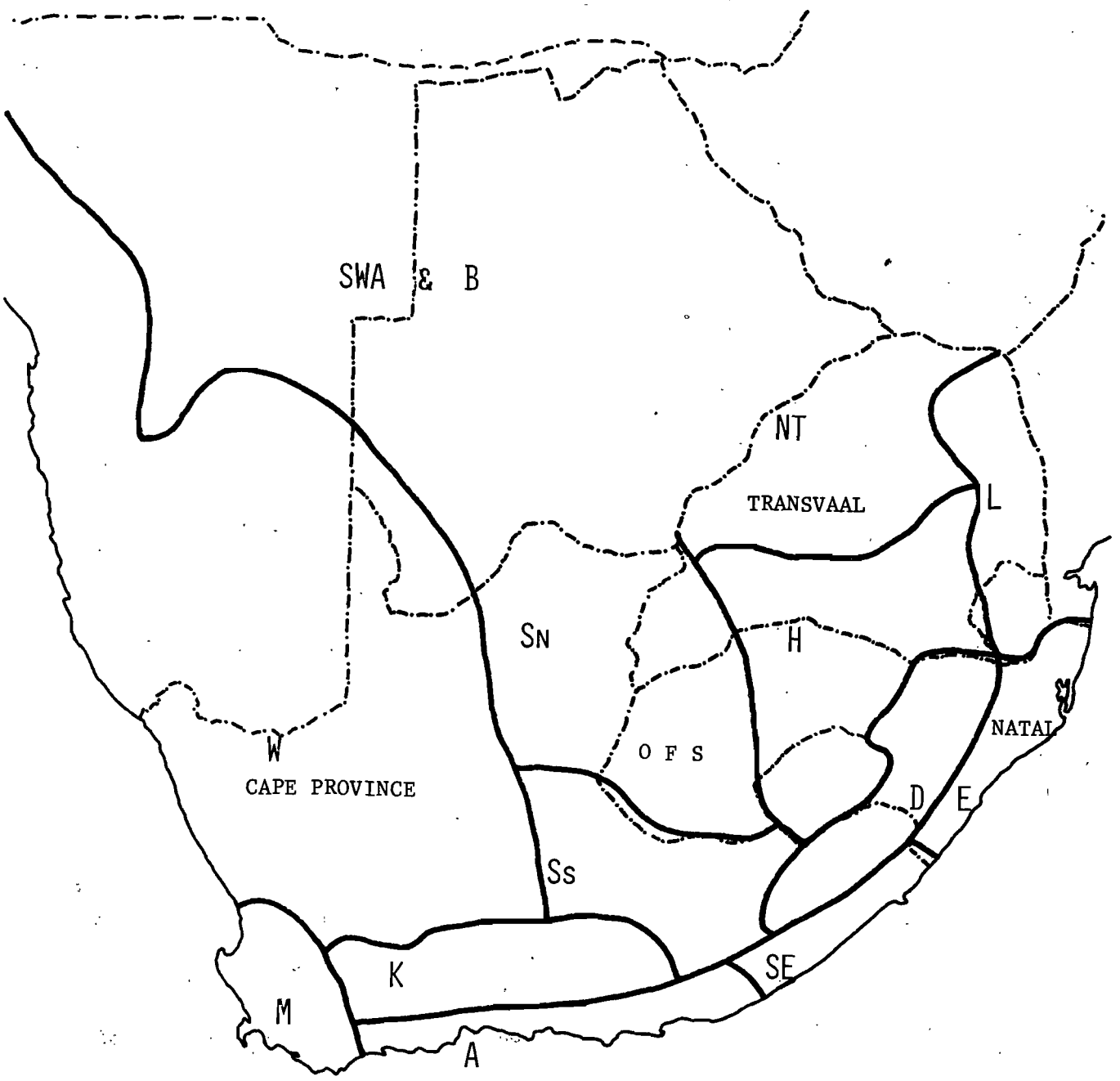

Fig. 1 The climatological regions of the Republic of South Africa (Compiled by the Climatology Branch, Weather Bureau, Pretoria 1956) M = Winter rains, hot dry summer. A = Temperate, warm and moist, occasional hot and dry "bergwinds". K = Desert and transition zone from winter to summer rains. SE = Warm, temperate and moist. E = Warm and moist. D = Warm, temperate monsoonal type of climate. L = Subtropical, warm and muggy except in midwinter. NT = Subtropical, semi-arid. H = Warm, temperate monsoonal type of climate, dry winter. Ss and Sn = Semi-arid, summer rains. SWA and B = Climate similar to that of Ss and Sn. W = Desert

ing antelope will be influenced by climate and the biogeographical distribution of their hosts.

Combining the findings of several surveys conducted in the RSA[3 7 8 13 21 24 25 27 29 30 32] with numerous unpublished personal observations, it is possible to compile host-parasite check-lists for sheep, cattle, impala and blesbok in the RSA. In these lists the helminths are classified as definitive, occasional and accidental parasites and their distribution according to climate is given.

THE HELMINTH PARASITES OF SHEEP

The helminths of sheep and their distribution based on the climatic regions given in Fig. 1 are listed in Table 1.

Table 1: DEFINITIVE AND OCCASIONAL HELMINTH PARASITES OF SHEEP AND THEIR DISTRIBUTION IN THE RSA ACCORDING TO CLIMATE. FOR DISTRIBUTION CODE SEE FIG. 1

Helminth species	Distribution
Definitive	
Bunostomum trigonocephalum	H,A
Chabertia ovina	A,M
Cooperia curticei	A
Dictyocaulus filaria	H,D,E,SE,A,M
Gaigeria pachyscelis	Sn,W
Haemonchus contortus	NT,H,D,E,SE,A,Ss,Sn,W
Marshallagia marshalli	A,K,Ss
Muellerius capillaris	A
Nematodirus filicollis	A
Nematodirus spathiger	A,K,Ss,W
Oesophagostomum columbianum	NT,H,D,E,SE,K,Ss,Sn,W
Oesophagostomum venulosum	A,M
Ostertagia circumcincta	SE,A,M,K,Ss
Ostertagia trifurcata	SE,A,K,Ss
Strongyloides papillosus	H,Sn,W,A
Trichostrongylus axei	SE,A
Trichostrongylus colubriformis	H,D,SE,A,M
Trichostrongylus falculatus	NT,H,Sn,Ss,W,K,A
Trichostrongylus pietersei	A,SE
Trichostrongylus rugatus	H,Ss,SE,A
Trichostrongylus vitrinus	A
Trichuris globulosa	H,Sn,SE,A
Trichuris ovis	H,Sn
Avitellina sp.	H
Moniezia expansa	H
Stilesia hepatica	Sn,Ss
Fasciola hepatica	H,D,Ss,K,A,M
Paramphistomum microbothrium	H,D,Sn,M
Occasional	
Cooperia pectinata	H,A
Cooperia punctata	H,A
Fasciola gigantica	NT,L,E
Schistosoma mattheei	NT,L,E

Fasciola gigantica is listed as an occasional parasite of sheep for although it can complete its life cycle in this host it is highly pathogenic for sheep and many may succumb to even moderate infestations[17]. Similarly *Schistosoma mattheei* is pathogenic for sheep and even small residual worm burdens may eventually lead to death (Van Wyk: Personal communication). Such unstable relationships cannot be considered typical of a definitive association and consequently are classified as occasional. It is perhaps significant to note that few sheep are found in the regions in South Africa inhabited by these two parasites and that definitive associations may not have had time to develop.

THE HELMINTH PARASITES OF CATTLE

The helminth parasites of cattle are presented in Table 2.

Table 2: DEFINITIVE, OCCASIONAL AND ACCIDENTAL HELMINTH PARASITES OF CATTLE AND THEIR DISTRIBUTION IN THE RSA ACCORDING TO CLIMATE. FOR DISTRIBUTION CODE SEE FIG. 1

Helminth species	Distribution
Definitive	
Bunostomum phlebotomum	H,L,D,E,SE
Cooperia pectinata	NT,H,D,E,SE,A,Sn,W
Cooperia punctata	NT,H,D,E,SE,A,Sn,W
Dictyocaulus viviparus	H,D
Haemonchus placei	NT,H,L,D,E,SE,Sn,W
Nematodirus helvetianus	E
Oesophagostomum radiatum	NT,H,D,E,SE,Sn,W
Ostertagia ostertagi	A,M,Ss,K
Toxocara vitulorum	H,E
Moniezia benedeni	NT,H,Sn
Fasciola gigantica	NT,L,E,SE
Fasciola hepatica	H,D,Ss,K
Paramphistomum microbothrium	NT,H,D,E,SE,Sn
Schistosoma mattheei	NT,L,E
Occasional	
Haemonchus contortus	H
Nematodirus spathiger	
Strongyloides papillosus	H
Trichostrongylus axei	H
Trichostrongylus colubriformis	NT,H
Trichostrongylus falculatus	NT
Stilesia hepatica	
Accidental	
Cooperioides hamiltoni	NT,L,E
Impalaia tuberculata	NT,L,E
Longistrongylus sabie	NT,L
Ostertagia circumcincta	

Although *Strongyloides papillosus* is listed as an occasional parasite it may well be a definitive parasite adapted to transmammary transmission with adult worms being found only in young calves. A similar situation exists with *Toxocara vitulorum* which is a definitive cattle parasite occurring in cattle and buffalo[26]. Transmammary transmission also occurs[31] and adult *T. vitulorum* are usually found only in young calves.

The other parasites listed as occasional or accidental are those that have been encountered in cattle utilizing the same habitat as sheep or impala[12 15].

THE HELMINTH PARASITES OF IMPALA AND BLESBOK

The helminths of impala and blesbok and their distributions are listed in Tables 3 and 4. These check-lists for impala and blesbok are certainly not complete as few detailed studies from which these lists can be compiled have been conducted in these hosts.

The distribution of impala within the RSA[1], corresponds closely to the climatological regions described

Table 3: DEFINITIVE, OCCASIONAL AND ACCIDENTAL HELMINTH PARASITES OF IMPALA AND THEIR DISTRIBUTION IN THE RSA ACCORDING TO CLIMATE. FOR DISTRIBUTION CODE SEE FIG. 1

Helminth species	Distribution
Definitive	
Cooperia fuelleborni	NT,L,E
Cooperia hungi	NT,L,E
Cooperioides hamiltoni	NT,L,E
Cooperioides hepaticae	NT,L,E
Gaigeria pachyscelis	L,E,
Haemonchus bedfordi	L,E
Impalaia tuberculata	NT,L,E
Longistrongylus sabie	NT,L
Oesophagostomum columbianum	NT,L
Pneumostrongylus calcaratus	L,E
Strongyloides papillosus	NT,L,E
Trichostrongylus colubriformis	NT,L,E
Moniezia expansa	NT
Occasional	
Cooperia connochaeti	L
Haemonchus placei	NT
Trichostrongylus axei	NT,E
Trichostrongylus falculatus	NT
Moniezia benedeni	L
Stilesia hepatica	L,E
Accidental	
Bunostomum trigonocephalum	L
Fasciola gigantica	NT

Table 4: DEFINITIVE, OCCASIONAL AND ACCIDENTAL HELMINTH PARASITES OF BLESBOK AND THEIR DISTRIBUTION IN THE RSA ACCORDING TO CLIMATE. FOR DISTRIBUTION CODE SEE FIG. 1

Helminth species	Distribution
Definitive	
Cooperia hungi	H
Cooperia yoshidai	H,E
Dictyocaulus magnus	H
Haemonchus bedfordi	H
Haemonchus contortus	NT,H
Impalaia nudicollis	NT,H
Impalaia tuberculata	H
Longistrongylus albifrontis	H
Skrjabinema alata	NT,H
Trichostrongylus thomasi	H
Occasional	
Oesophagostomum columbianum	H
Trichostrongylus axei	NT,H
Trichostrongylus falculatus	NT,H
Avitellina sp.	NT,H
Accidental	
Agriostomum equidentatum	H

as subtropical and semi-arid (NT), subtropical, warm and muggy except in mid-winter (L) and warm and moist (E) (Fig. 1). These regions plus the region designated warm, temperate and moist (SE)(Fig. 1) comprise the Southern savanna Woodland biotic zone[23]. Blesbok are distributed mainly within the boundaries of the climatological regions described as having a warm, temperate monsoonal type of climate (D and H) (Fig. 1)[1]. These regions very nearly constitute the Southern Savanna Grassland biotic zone[23].

Taking these facts and the distribution of parasites according to climatological region (Tables 3 and 4) into consideration, it can be seen that impala and blesbok and hence their helminth parasites are confined within the respective biotic zones of the antelope. Within these zones, however, the distribution of the helminths is determined by climate.

Three definitive nematode parasites of impala and blesbok warrant discussion in that they are also listed as definitive parasites of sheep. *Haemonchus contortus* is a parasite of sheep in most parts of the world[19], and its recovery from a large number of antelope species[26] and its presence in many blesbok in the present surveys confirm its definitive nature in these animals. I suggest that this is a new association, that *H. contortus* evolved in sheep and that its presence in wild ruminants is due to the introduction of sheep into the habitats of these animals and to the large numbers of eggs laid by this worm[5] thus exposing sympatric species to infestation. Furthermore many antelope have definitive *Haemonchus* spp. of their own[26] and it seems unlikely that *H. contortus* would evolve in sheep and at the same time in a large number of other hosts.

Gaigeria pachyscelis has been recovered from sheep and goats in Africa and India[22]. It has been found also in a number of antelope in Africa, in the African buffalo[26] and in a single Indian antelope that had recently been imported into the then Union of South Africa[22]. In sheep in the RSA the distribution of this parasite is confined to the semi-arid north-western regions[22] while in impala[7] and blue wildebeest (Horak: Unpublished data) it is found in the sub-tropical eastern regions of Natal and the Transvaal. These regions have never been extensively used for sheep farming and this may explain why *G. pachyscelis* has not been recovered from sheep in these areas. This parasite, even in small numbers, is highly pathogenic for sheep[6] and I suggest that, although the association is definitive, it is a new association and that an antelope is the original host.

The fact that *Oesophagostomum columbianum* occurs in sheep in the RSA[3,29], and also in Australia[3], where there are no antelope to sustain it, confirms that it is a definitive parasite of these animals. However, I consider the association to be of recent origin. Infestation in sheep frequently results in considerable reaction in the gut wall which may give rise to caseous or even calcified nodules. This does not signify a well-adapted host-parasite relationship, while I have seldom seen even mild reactions in infested impala, which I also consider to be definitive hosts.

All blesbok examined in a survey conducted in the eastern Transvaal were infested with *O. columbianum*[13], yet I classify it as an occasional parasite of this species as very few adult worms were recovered, indicating an inability to complete its life cycle. If, however, development was seasonally arrested in the fourth larval stage, a phenomenon previously only suggested for this nematode[20], this may account for the low numbers of adults found, and not because it was in an occasional host. Future observations may well demonstrate *O. columbianum* to be a definitive parasite of blesbok.

Trichostrongylus falculatus is considered an occasional parasite of impala as not all animals examined in

a survey in the northern Transvaal were infested and the worm burdens in those that were infested were not large[11]. In addition it was not recovered from impala examined in the north eastern Transvaal[13] or from Zululand[7]. The same applies to blesbok, for the animals that were infested in a survey conducted in the northern Transvaal had only small burdens[10], and in the eastern Transvaal only 2 of 33 animals were infested, while a springbok in the same reserve harboured a large burden of this parasite[13].

Haemonchus placei probably evolved with cattle breeds of the species *Bos indicus* and is encountered in cattle of this species particularly in parts of the world where the climate is hot and moist[19]. Its presence in nearly all impala examined in a survey in the northern Transvaal is a result of their sharing their habitat with cattle for many years rather than a definitive association[11]. Furthermore, although larval burdens were high in impala, few adult worms were recovered, thus implying an occasional rather than a definitive association.

Cestodes of the genus *Avitellina* have been recovered from blesbok near Pretoria and in the northern Transvaal[10]. Their lengths even when mature segments were present, rarely exceeded 100 mm in buck at either locality compared with 1,0 m or more in sheep on the Transvaal Highveld[9] and hence they can be considered no more than occasional parasites of blesbok.

The presence of a single *Agriostomum equidentatum,* a parasite of springbok[26], in only one blesbok of 33 examined in the eastern Transvaal is an example of an accidental association resulting from the sympatry of blesbok and springbok in a comparatively small reserve[13]. The recovery of *Bunostomum trigonocephalum,* a hook worm of sheep, from impala in the north eastern Transvaal[13] is not as easy to explain. There were no sheep in the region to serve as a reservoir of infestation, but the facts that only four worms were recovered and that this parasite has not been recovered from impala before both point to an accidental association, with some other antelope possibly serving as a reservoir of infestation.

DISCUSSION

The geographical distribution of parasites given in each of the checklists must be regarded as incomplete because of the absence of detailed survey records from many regions of the RSA. In this regard the recovery of *Ostertagia curcumcincta* from sheep at Tonteldoos [9] is interesting. This is the first time that this parasite has been recovered from sheep on dry-land pasture on the Transvaal Highveld, and although the numbers recovered were not large enough to warrant inclusion of this region in the geographic distribution of *O. circumcincta,* future observations may determine that it has become well-established there.

The role of man-created environments in the distribution of parasites must also be considered. These have resulted in isolated parasite populations atypical of the region concerned. Thus irrigated lucerne pastures in the Karoo are ideal for the free-living stages of *Haemonchus contortus,* a parasite encountered normally only in small numbers in parts of this region[30]. Likewise the irrigated pastures at Hennops River on the Transvaal Highveld created conditions suitable for *Ostertagia circumcincta*[14] a parasite of sheep and usually unknown in this region. Such localised foci of exotic parasites would not be recorded on a map illustrating geographic distribution, but their existence may nevertheless be of considerable importance from the control point of view in the locality concerned.

A knowledge of the geographic distribution and seasonal occurrence of helminths is of practical importance when devising control programmes for a particular region. Thus the programmes suggested for the control of nematodes in sheep in the eastern Cape Province[3 25] differ from that used in sheep on the Transvaal Highveld[16]. Data on both aspects still have to be gathered from such important regions as the western Cape Province, Natal, the Orange Free State and the Transvaal Lowveld before control programmes covering the entire country can be devised.

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THE EFFICACY OF ANTHELMINTICS AGAINST *THYSANIEZIA GIARDI* IN SOUTH AFRICA

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ABSTRACT: Van Schalkwyk P.C.; Geyser T.L.; Davies P.V.A.; Récio M. **The efficacy of anthelmintics against *Thysaniezia giardi* in South Africa** *Journal of the South African Veterinary Association* (1981) **52** No. 3, 207–209 (En) SmithKline Animal Health, Terenure Research Station, P.O. Box 38, 1600 Isando, Republic of South Africa.

Two field cases of apparent inefficacy of albendazole against cestodes in lambs were investigated. In both farms *Thysaniezia giardi* was identified and 2 critical controlled trials were conducted to determine the efficacy of 5 anthelmintics against *T. giardi*. Albendazole dosed at 3,8 mg/kg or 7,6 mg/kg live mass, mebendazole at 15 mg/kg were totally ineffective against *T. giardi*. Treatment with resorantel at 65 mg/kg or niclosamide at 50 mg/kg however, caused expulsion of the strobilae within 16–24 hours after treatment and at autopsy, lambs were free of scoleces of *T. giardi*.

INTRODUCTION

Benzimidazole anthelmintics are commonly used by South African farmers to control nematode parasites in sheep and cattle. Most of these benzimidazoles also have a cestocidal effect. Cambendazole[2], parbendazole (P.C. van Schalkwyk & T.L. Geyser, SmithKline, Isando RSA unpublished data 1976), mebendazole[1] and albendazole[8] are effective against *Moniezia* and *Avitellina*[9] while fenbendazole[7] is reported to be effective against *Moniezia*.

In the Republic of South Africa (RSA), *Moniezia expansa* and *Avitellina* spp. are common parasites of sheep while *Thysaniezia giardi* is reported to be the most common tapeworm of adult cattle[3]. The importance of tapeworms as pathogens is generally accepted in South Africa[4,6].

Field reports of inefficacy of anthelmintics against cestodes are frequently received. Two cases where farmers reported an apparent inefficacy of albendazole were investigated.

MATERIALS AND METHODS

Two critical controlled trials were conducted to determine the efficacy of anthelmintics against cestodes present on these farms. In this paper the dosage is expressed as milligram of active ingredient of the anthelmintic per kilogram live mass of the lamb and is abbreviated to mg/kg.

Trial 1

A farmer from the Venterstad district reported inefficacy of albendazole against cestodes in Dorper sheep. These sheep were infested with *Thysaniezia giardi* identified by examining excreted mature proglottids for the presence of typical eggs in the paruterine organs (Fig. 1). Fourteen infested lambs were transported to Terenure Research Farm near Kempton Park. Seven days after the arrival the infestation was still present and confirmed by the presence of proglottids in the faeces. The lambs were then divided into 4 groups as follows:

3 untreated controls,
3 treated with albendazole at 3,8 mg/kg,
3 treated with albendazole at 4,75 mg/kg, and
5 treated with albendazole at 7,6 mg/kg.

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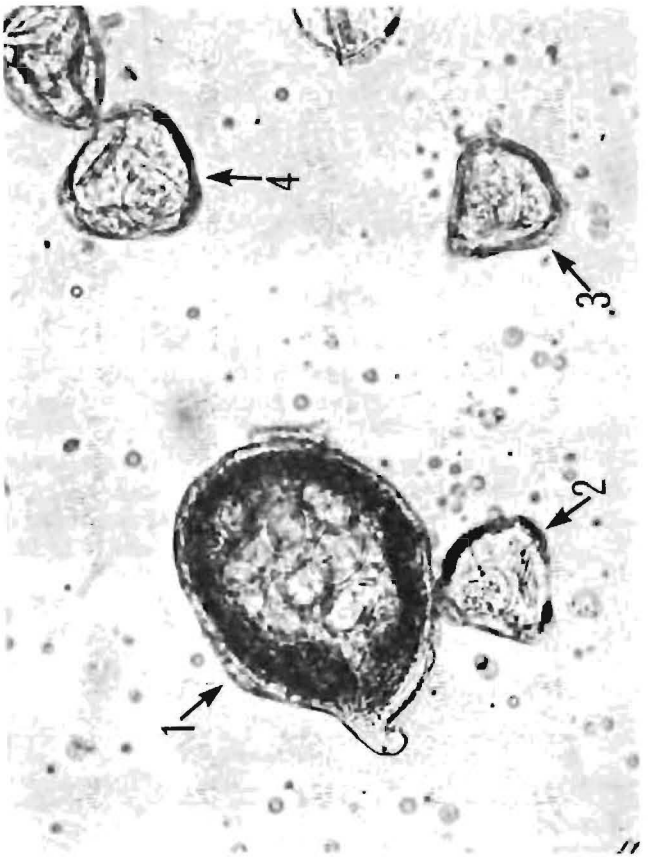

Fig. 1 Paruterine body containing eggs from squashed mature proglottid of *T. giardi* (1) and *Moniezia expansa* eggs (2, 3 and 4)

Treatment was done orally using a calibrated syringe with a short tube fitted to the nozzle. McMaster faecal collection bags were attached to the hind quarters to collect the faeces for 42 h following treatment and examined macroscopically for excreted strobilae and proglottids. Five days after treatment 2 control animals and 4 animals treated with albendazole at 7,6 mg/kg were slaughtered. At autopsy the small intestines were cut open and the ingesta collected. After thorough washing of the mucosa the ingesta was washed through a 150 μm sieve. The residue recovered on the sieve was mixed with water, poured into a black tray and then examined macroscopically for strobilae and scoleces. The mucosa was also macroscopically examined for scoleces. The volume of strobilae and scoleces was determined by displacement of water in a measuring cylinder.

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The remaining 8 animals were re-allocated to 4 groups and treated as follows:

2 treated with mebendazole at 15 mg/kg,
2 treated with cambendazole at 20 mg/kg,
2 treated with resorantel at 65 mg/kg, and
2 treated with niclosamide at 50 mg/kg.

Faeces were examined for 42 h following treatment as described above and 7 days following treatment all 8 animals were slaughtered and processed to recover cestodes.

Trial 2

Twelve Merino lambs infested with *T. giardi* were purchased near Barkly East. The animals were transported to Terenure and treated as follows:

3 untreated controls,
3 treated with albendazole at 3,8 mg/kg,
3 treated with mebendazole at 15,0 mg/kg, and
3 treated with cambendazole at 20 mg/kg.

Examinations were done as described in Trial 1 and the 12 animals were slaughtered 7 days after treatment.

RESULTS

Trial 1: The results are summarized in Table 1. Animals treated with either albendazole, mebendazole or cambendazole were still infested at autopsy. There was no apparent reduction in the number of scoleces nor the volume of strobilae compared with the untreated controls. All animals treated either with resorantel or niclosamide were free of cestodes at autopsy. Strobilae of *T. giardi* were excreted in the latter 2 groups 16 to 24 h after treatment.

Table 1: RESULTS OF TRIAL 1: *T. GIARDI* RECOVERED AT AUTOPSY

Group	Animal No.	Number of scoleces	Volume of strobilae (mℓ)
Untreated Controls	1	17	53
	2	3	30
Albendazole 7,6 mg/kg	3	4	19
	4	8	55
	5	4	20
	6	3	35
Mebendazole 15 mg/kg	7	7	22
	8	3	20
Cambendazole 20 mg/kg	9	12	45
	10	5	30
Resorantel 65 mg/kg	11	0	0
	12	0	0
Niclosamide 50 mg/kg	13	0	0
	14	0	0

Trial 2: Results are summarized in Table 2. All animals treated with albendazole, mebendazole or cambendazole were still infested with *T giardi* at autopsy. There was no apparent reduction in number of scoleces nor in the volume of strobilae in the treated groups when compared with the controls.

Table 2: RESULTS OF TRIAL 2: *T. GIARDI* RECOVERED AT AUTOPSY

Group	Animal No.	Number of scoleces	Volume of strobilae (mℓ)
Untreated Controls	1	5	22
	2	1	10
Albendazole 3,8 mg/kg	4	1	3
	5	5	48
	6	3	40
Mebendazole 15 mg/kg	7	1	24
	8	1	12
	9	1	2
Cambendazole 20 mg/kg	10	5	35
	11	1	28
	12	2	9

DISCUSSION

Efficacy studies with new cestocides have been concentrated on *Moniezia* and *Avitellina*, which are the most common cestodes of sheep in the RSA. The only record of trials against *T giardi* is that of Stampa & Terblanche[5] who found niclosamide effective against *Moniezia, Avitellina* and *Thysaniezia* in sheep. Benzimidazole cestocides have been tested locally against *Moniezia* and *Avitellina* but no information is available as to their efficacy against *T. giardi.*

The distribution of *T. giardi* amongst sheep in the RSA is unknown but Mönnig[3] describes it as the most common cestode of adult cattle in this country and states that it also occurs in sheep and goats. Stampa & Terblanche[5] reported the presence of this cestode in sheep and calves in widely distributed areas. We have confirmed the presence of *T. giardi* in sheep in many parts of the country (Fig. 2). These cases were found during routine faecal examinations and do not represent results of a survey.

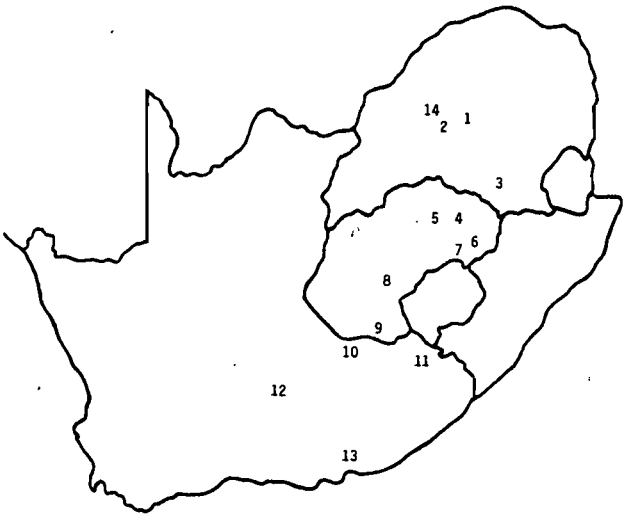

Fig. 2 Distribution of *T. giardi* in sheep in die Republic of South Africa

1. Pretoria
2. Krugersdorp
3. Perdekop
4. Vrede
5. Tweeling
6. Harrismith
7. Witsieshoek
8. Dewetsdorp
9. Rouxville
10. Venterstad
11. Barkly East
12. Middelburg*
13. Grahamstown*
14. Hekpoort*

*Stampa & Terblanche, 1961

Benzimidazoles were found to be totally ineffective against *T. giardi* in two trials. At twice the therapeutic dose albendazole was also ineffective. Both resorantel and niclosamide were effective although the numbers of animals were small in the groups treated with these compounds. The inefficacy of benzimidazoles against *T. giardi* may explain reports of failure of treatment against cestodes often received from farmers. It becomes necessary to identify the cestodes when investigating these cases. The typical morphology of the eggs of *T. giardi* was easily observed when mature proglottids were squashed and examined microscopically. Identification of strobilae was found to be more difficult unless specimens were fixed and stained (Fig. 3). Unstained strobilae of *T. giardi* usually require careful examinations to distinguish them from those of *Moniezia* spp.

Fig. 3 Strobilus of *T. giardi* showing irregularly alternating unilateral genital organs in proglottids

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BOOK REVIEW BOEKRESENSIE

INTERNATIONAL JOURNAL FOR THE STUDY OF ANIMAL PROBLEMS VOLUME 1, NUMBER 1, JANUARY/FEBRUARY 1980

Published bi-monthly. Six 64-page issues. Subscription: Individual $25,00; Institution $45,00; Student $17,50.
Published by The Institute for the study of Animal Problems, 2100 St. NW. Washington D.C. 20037, U.S.A.
Editors in Chief: Michael W. FOX and Andrew N. ROWAN.

This review of the contents of the first volume of this journal is given so as to indicate what type of material will be published.

The editorials set out the scope and goals of the journal, the contents envisaged, the potential interest and requirements for success and the necessity for developing a science of animal welfare.

This issue contains short news items and reviews which include training for standardbreds, U.K. statistics on animal experimentation, the type of cage and floor preferred by hens, dairy cow housing systems and the effect of inbreeding on ungulate mortality.

In a part headed "Comments" the desirability of establishing a common ground between animal welfare societies and research scientists on the present and future welfare of animals is discussed. The history and impact of the Universities Federation for Animal Welfare is described.

An original article on "Benign Uses of Wildlife" mentions the attitude developing in the American people towards unharmful use of wild animals, legislation in this connection, increased interest in wildlife observation, the impact of tourism and the growth of concern about animal rights.

A review article "Livestock Behaviour as Related to Handling Facility Design" deals with the factors governing animal behaviour and their reactions so as to enable satisfactory handling facilities to be built which promote efficiency of movement, reduce stress and prevent undesirable reactions. It includes errors made by human handlers. Recommendations for the improvement of facilities are given.

Particulars about existing and proposed laws about horse racing and drug abuse as well as U.K. animal experimentation are given.

The journal ends with a business section about forthcoming meetings, announcements, book reviews and instructions to authors.

This journal will serve a useful purpose for all those associated with animal behaviour and welfare.

G.D. Sutton

STROBILOESTRUS SP. LARVAE IN CATTLE

I.G. HORAK* and J. BOOMKER*

ABSTRACT: Horak I.G., Boomker J. ***Strobiloestrus* sp. larvae in cattle.** *Journal of the South African Veterinary Association* (1981) **52** No. 3, 211–212 (En) Department of Parasitology, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

A number of calves and a two year-old heifer in the Middelburg District of the Transvaal were found to harbour *Strobiloestrus* sp. larvae in nodules along their sides. Each nodule contained a single larva and these larvae developed from the early second stage to the third stage during the 25 day period between the first and last visit to the district.

A particular set of circumstances involving the presence of klipspringers, which are considered to be the normal hosts of *Strobiloestrus clarkii,* grazing practice, hair colour of the calves and tick control probably resulted in the cattle becoming infested. A pour-on formulation of an insecticide was highly effective against the larvae.

INTRODUCTION

The larvae of the warble flies, *Hypoderma bovis* and *Hypoderma lineata,* are parasites of the cutaneous and subcutaneous tissue of cattle in the Northern Hemisphere[3]. They are occasionally encountered in imported cattle in southern Africa but there is no record of their having become established in this region.

Warble flies do, however, occur in the Republic of South Africa. These belong to the genus *Strobiloestrus,* and their larvae are found in the skin and subcutaneous tissue of reedbuck, klipspringer and kudu and have also been recovered from a domestic goat[3] and from cattle[1].

The present paper describes an investigation following the earlier recovery of *Strobiloestrus* sp. larvae from warble-like lesions in the skin of cattle in the Middelburg District of the Transvaal[1].

HISTORY

During a visit to the farm Buffelskloof in the Middelburg District, raised, circumscribed nodules in the skin of the sides of a number of young calves were noticed[1]. A single oestrid larvae belonging to the genus *Strobiloestrus* was expressed from each of some of these nodules.

The farm was visited on two subsequent occasions. These visits revealed that a steep rocky cliff effectively divided it into a section of Highveld grasslands and another of Bushveld Savanna. Several klipspringers lived on this cliff.

The cattle on the farm were mainly Africander-type cows which were bred to a Charolaise and to two Brahman bulls. The age of the crossbred calves at the time of the investigation ranged between approximately five and nine months. During the summer months the cattle were sprayed once weekly with amitraz (Triatix: Coopers SA (Pty) Ltd), a tick detaching agent, administered by means of a spray race.

INVESTIGATION

The farm was originally visited on 3 March 1979 and the larvae expressed on that occasion were identified as being in the early second stage of development (Fig. 1). The farm was again visited on 9 March 1979 and it was found that 13 of 57 calves in one herd and one of 52 calves in another were infested. The majority of calves in each of the herds was red in colour and had short hair but with the exception of one of the latter calves, the infested calves were yellow to fawn in colour and had medium length hair and were probably offspring of the Charolaise bull. No adult cattle appeared to be infested.

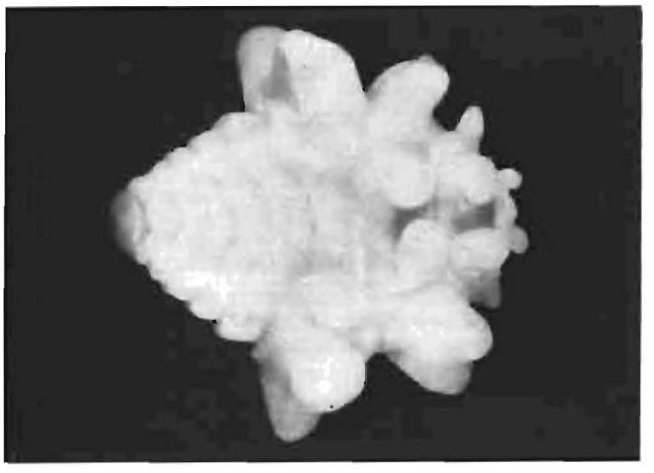

Fig. 1 Early second stage larva of *Strobiloestrus* sp. expressed from the skin of a calf. Actual length of larva 9,5 mm

Infestation was characterized by the presence of circumscribed, raised nodules, approximately 15 mm in

Fig. 2 Circumscribed, raised nodules caused by the larvae of *Strobiloestrus* sp. in the skin of a calf.

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diameter and 4 mm high, in the skin of the upper halves of the shoulders and sides (Fig. 2). Approximately two to 12 nodules were present in the skins of the infested calves, but one had 31 nodules.

A small opening was present in the centre of each nodule and a single larva could be expressed through this opening (Fig. 3). The larvae recovered from the nodules on this occasion were late second stage larvae.

Fig. 3 Second stage larva of *Strobiloestrus* sp. expressed from a nodule in the skin of a calf.

The calf with the 31 nodules was treated with a pour-on formulation of famphur (Warbex: Coopers SA (Pty) Ltd.) administered on its hide along the length of its back.

The farm was visited again on 28 March 1979. The nodules on the treated animal had regressed in size and while larvae were still present these were in an advanced stage of decomposition. No nodules were seen on any of the other calves. A neighbouring farm was also visited on this occasion and a single, red-coloured two year-old heifer was found to be infested. Immature third stage larvae were expressed from the nodules on this heifer.

DISCUSSION

No specific identification of the *Strobiloestrus* infesting the calves could be made as according to Zumpt[3] these flies are not yet separable in the larval stage.

The life cycle of flies of the genus *Strobiloestrus* is unknown[3] and consequently the sites on which the eggs are deposited and the route by which the larvae reach the skin are also not known. The opening in the skin in the centre of each nodule serves both for respiration, as the larval spiracles are applied to it, and as exit for the mature third stage larvae. The fact that at each visit to the farm the larvae recovered were in a more advanced state of development and in one animal on an adjoining farm had reached the third stage indicates that the larval life cycle could probably be completed in cattle. The absence of nodules on the untreated calves on the third visit to Buffelskloof was probably due to the fact that the larvae had left the skin either as mature third stage larvae or perhaps as immature larvae. If these larvae had died in the skin, nodules containing dead larvae would possibly still have been present as they were in the case of the treated calf.

The infestation of calves at Buffelskloof probably resulted from a particular set of circumstances prevailing on the farm. Firstly the presence of a large number of klipspringers, a definitive host of the larvae of *Strobiloestrus clarkii*[3]. Secondly the cattle grazed part of the cliff on which the klipspringers occurred thus presumably entering the habitat of the flies. Thirdly the presence of calves somewhat similar in colour to the klipspringers, a fact which may have led to the flies laying eggs on these calves. Lastly the cattle were regularly sprayed with a tick-detaching agent which had no insecticidal effect. If such an insecticidal effect had been present the larvae would probably have been killed in an early stage of development before they caused the formation of nodules.

The fact that warbles caused by the larvae of *Strobiloestrus* spp. have not become an economic problem in cattle in South Africa can probably be ascribed to the regular application of acaricides, which usually also have an insecticidal effect, to cattle in extensive regions of the subcontinent.

Pour-on formulations of insecticides are used extensively for the control of warbles, caused by *Hypoderma* spp., in the Northern Hemisphere[2] and famphur in a pour-on formulation was highly effective against the larvae of *Strobiloestrus* sp. in the present investigation. In addition the stockowner was advised to alternate tick-detaching agents and acaricides with an insecticidal effect in his tick control programme in order to prevent a recurrence of the condition.

ACKNOWLEDGEMENTS

We wish to thank Mr. J.P. van Heerden, on whose farm the infestation occurred, for his cooperation with the investigation and for use of the facilities on the farm.

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THE SEASONAL INCIDENCE OF THE MAJOR NEMATODE GENERA RECOVERED FROM SHEEP, CATTLE, IMPALA AND BLESBOK IN THE TRANSVAAL*

I.G. HORAK**

ABSTRACT: Horak I.G. **The seasonal incidence of the major nematode genera recovered from sheep, cattle, impala and blesbok in the Transvaal.** *Journal of the South African Veterinary Association* (1981) **52** No. 3, 213–223 (En) Department of Parasitology, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

The seasonal incidence of helminth infestation in sheep, cattle, impala and blesbok was determined from fluctuations in the worm burdens of these animals exposed to natural infestation at particular localities in the Transvaal and slaughtered at various fairly regular intervals.

The nematodes considered to be of major importance were *Haemonchus* spp. and *Trichostrongylus* spp. in all four hosts, *Ostertagia* spp. in sheep, *Longistrongylus* spp. in impala, *Cooperia* spp. in sheep, cattle and impala, *Cooperioides* spp. in impala, *Impalaia* spp. in impala and blesbok and *Oesophagostomum* spp. in sheep, cattle and impala.

INTRODUCTION

It has been estimated that helminth infestation in domestic livestock costs the South African agricultural industry between R80 and R100 million annually[12]. It is difficult to estimate the effect of infestation on the productivity of free-ranging antelope but confinement may result in helminthosis[12] which in turn would reduce productivity.

In the Transvaal nematodes are generally the most important helminths infesting domestic livestock and free-ranging antelope[8 14]. Certain nematodes, because of their numerical preponderance or presence in a large percentage of animals, can be considered of major importance. These nematodes may belong to particular genera such as *Haemonchus, Trichostrongylus* or *Oesophagostomum*. Other genera, because of morphological and organ preference similarities can be grouped. This can be done in the case of *Ostertagia* and *Longistrongylus* which inhabit the abomasum and *Cooperia, Cooperioides* and *Impalaia* which are found in the small intestine.

The present paper discusses the seasonal incidence of the major nematode genera recovered from sheep, cattle, impala and blesbok running in regions of the Transvaal where frost is possible during the winter. As the seasonal incidence of parasitic nematodes is closely coupled to the ecology of their free-living stages this topic will also be discussed for each of the major genera. Arrested development, a phenomenon encountered in several nematodes, will also be briefly discussed as it effects each of the major genera.

MATERIALS

The findings presented in this paper have been derived from the results of surveys conducted on the seasonal incidence of helminth parasites of sheep, cattle, impala and blesbok in the Transvaal. These surveys were conducted in sheep (Survey 1) and cattle (Survey 3) on irrigated pastures at Hennops River[13 14], a region classified as Bankenveld[1], in sheep (Survey 2) on dry-land pasture near Tonteldoos[8], a region classified as North-Eastern Sandy Highveld[1], in cattle (Survey 4) and impala (Survey 5) on dry-land pasture near Boekenhout[10 11], a region classified as Mixed Bushveld[1], and in blesbok (Survey 6) on dry-land pasture near Lunsklip[8], a region classified as Sour Bushveld[1]. Two surveys on the prevalence of helminths in antelope were also conducted. The one was done in impala[12] near Pafuri in the north-eastern Transvaal, a region classified as Mixed Bushveld[1], and the other in blesbok[12] at Badplaas, a region classified as Piet Retief Sourveld[1].

In the surveys in sheep and cattle tracer animals were used to determine the seasonal availability of infestation. These were worm-free animals exposed in the survey areas in consecutive groups of two or three and slaughtered after predetermined periods. The surveys in impala and blesbok were conducted in continuously exposed animals.

The study areas or nearest reference points to these areas are indicated in Fig. 1.

Haemonchus spp.

Worms of this genus were present in ruminants in each of the surveys and their seasonal incidence is graphically illustrated in Fig. 2

The sheep in Surveys 1 and 2 and blesbok in Survey 6 were infested with *H. contortus*. Peak burdens were recovered from February to April or May in sheep and during February, September and October in blesbok. Burdens were at a low level from June or July until November or December in sheep and from April to July in blesbok.

The cattle in Surveys 3 and 4 and impala in Survey 5 were infested with *H. placei*. Peak burdens in Survey 3 were recovered during June and July with low numbers present in January, October and November. In Survey 4 the greatest numbers of worms were present in January and December and none were recovered from August to October. The impala harboured peak burdens from April to October and few worms during February and December.

Despite this fairly considerable variation certain constant features emerge. In Surveys 1 to 4, in which tracer animals were used, few larvae were available on pasture for some time during the period July to October. With the possible exception of Survey 6 a large proportion of the worm burden was arrested in the fourth

*Part of a thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in the Department of Zoology, Faculty of Science, University of Natal.

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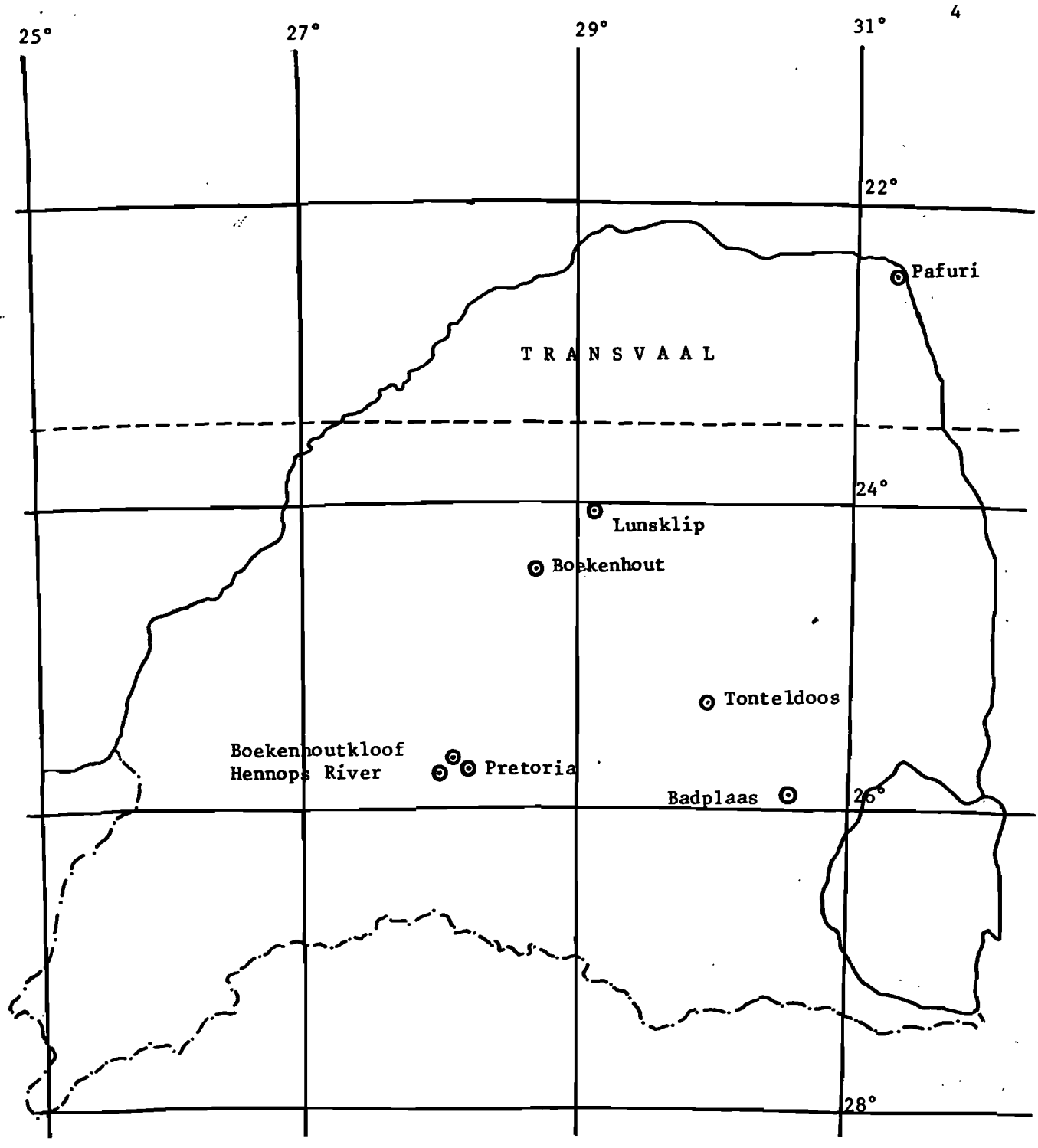

Fig. 1 The localities at which helminth surveys were conducted in the Transvaal, RSA

larval stage from May to September, and adult worms always outnumbered fourth stage larvae during January and frequently also during November and December.

Gordon[6] showed that optimal conditions for the free-living stages of *H. contortus* were monthly rainfall in excess of 50,8 mm (2 in) and mean atmospheric temperatures above 17,7° C (63,9° F). Viljoen[28] however, has shown that development can proceed at lower temperatures. Levine[15] records the temperature limits for optimum development as mean monthly temperatures of 15 to 37° C and monthly rainfall as in excess of 50 mm. But Viljoen[29], working in the Karoo, felt that it was more realistic to regard 25 mm as the minimum requirement. This variation in the requirements of the free-living stages may, however, be the result of ecological selection with various strains having different requirements.

In each of the survey areas temperature and rainfall or irrigation were probably suitable from October or November to March or April. Yet the relationships between larval development and adequate temperature and moisture are reflected only in the December to April burdens in Surveys 1 and 4, January to April burdens in Survey 2, December burden of Survey 3,

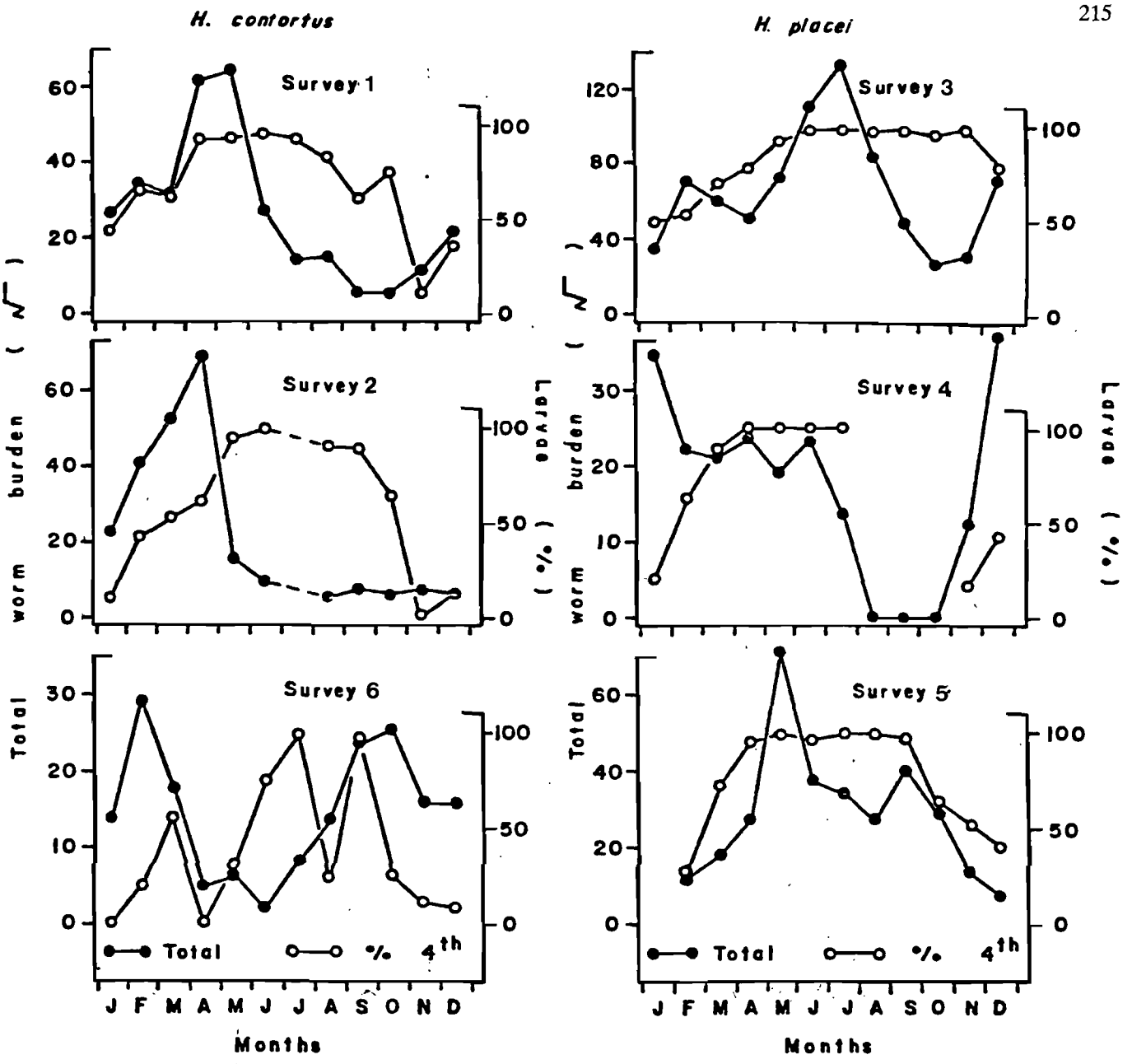

Fig. 2 The seasonal incidence of *Haemonchus* spp. in sheep, cattle, impala and blesbok slaughtered in surveys conducted in the Transvaal. Surveys 1 and 2 – sheep, Surveys 3 and 4 – cattle, Survey 5 – impala, Survey 6 – blesbok

and November to March burdens of Survey 6. At other times burdens were either higher or lower than environmental conditions seemed to dictate. Possible reasons for these differences will be suggested below.

At Armidale in Australia it was found that contamination of the pasture with eggs from December to January was rapidly translated to peak numbers of larvae while contamination in autumn and spring was less effective[25]. Judging by differential faecal worm egg counts that were done on infested animals running with the present survey animals, *Haemonchus* spp. eggs were being deposited on pasture in fair numbers during the period October to April and it was particularly the eggs deposited in spring that were not being effectively translated to larvae. The inability of larvae to survive on pasture during spring is probably due to climatological stresses[25]. The most important of these stresses in the Transvaal would seem to be solar radiation because of poor pasture cover at that time.

Thomas[26], working near Ermelo on the Transvaal Highveld, has commented on the role played by moisture in the survival of infective larvae, pasture infestation dropping markedly within two to three weeks of the onset of dry conditions. The results of Survey 2, conducted in an area fairly close and similar to the Ermelo district, would seem to confirm this observation, but in Survey 1, where moisture was regularly supplied, cold would seem to have been responsible for the decline in pasture infestation.

It has been demonstrated that *H. contortus* larvae could overwinter on pasture at Armidale, Australia, but that this occurred in substantial numbers only if the pastures were contaminated during January and February[25].

Larval availability can only be accurately determined in those surveys in which tracer animals were used and the findings in Surveys 1, 2 and 4 indicate that very few or no larvae overwintered on pasture. The difference between this result and that obtained at Armidale can be explained by the environmental stress to which the

larvae in the South African surveys were subjected during winter. Not only is the pasture cover poor, but daily atmospheric temperature variation is at its greatest and evaporation and radiation are high because of the usually cloudless skies. In support of the latter hypothesis, at Hennops River where regular irrigation was supplied, the pasture cover was greater and winter temperatures were higher than at Tonteldoos, larger numbers of larvae were recovered from tracer lambs grazed during winter than at the latter venue.

The important role played by the cattle dungpat in the survival of larvae is well illustrated by the results of Surveys 3 and 4. In Survey 4 the last substantial rainfall was recorded during April and yet comparatively large numbers of larvae were recovered from tracers until June, while in Survey 3 the regular supply of moisture ensured that large numbers of larvae were available until August and overwintering of larvae on the pastures probably occurred in this survey. These observations confirm the findings of Reinecke[20] who recorded that *H. placei* larvae could survive for 105 days in the dungpat and 41 days on the surrounding grazing during autumn in the semi-arid north-western Cape Province. In Survey 4 the dungpat probably eventually became a prison for the larvae as its surface was baked by the sun while in Survey 3 it served as an effective reservoir[19] as it was regularly moistened.

A marked difference between the burdens of *H. placei* in cattle in Survey 4 and impala in Survey 5 occurred. These animals grazed the same area albeit in different years and while the highest worm counts in cattle were recorded during January and December the lowest in impala were recorded during February and December. This may be due either to the presence of adult *Longistrongylus sabie* in the abomasa of impala from November onwards, these worms thus occupying the preferred site of *Haemonchus placei*, or that *H. placei* is not a definitive parasite of impala and hence, although larval burdens may be large, few adult worms develop.

Ostertagia spp. and *Longistrongylus sabie*

Ostertagia spp. were present in each of the surveys conducted in sheep, while *Longistrongylus sabie* was recovered from cattle and impala near Boekenhout. The mean worm burdens of these species are graphically reproduced in Fig. 3.

In Australia it was found that larvae of *Ostertagia* spp. were abundant on pasture from June to October when the mean maximum temperature was 15,5° C[25]. At Hennops River larvae were available on pasture in greater numbers from autumn to spring than at other times (Survey 1) confirming the observations made in Australia[25]. A reasonably similar pattern was observed at Tonteldoos (Survey 2), but worm burdens were very low, as well as in impala near Boekenhout where, however, the animals were continuously exposed to infestation and exact times of larval acquisition could not be determined.

There is a considerable difference between pasture contamination patterns in warm and cold climates. At

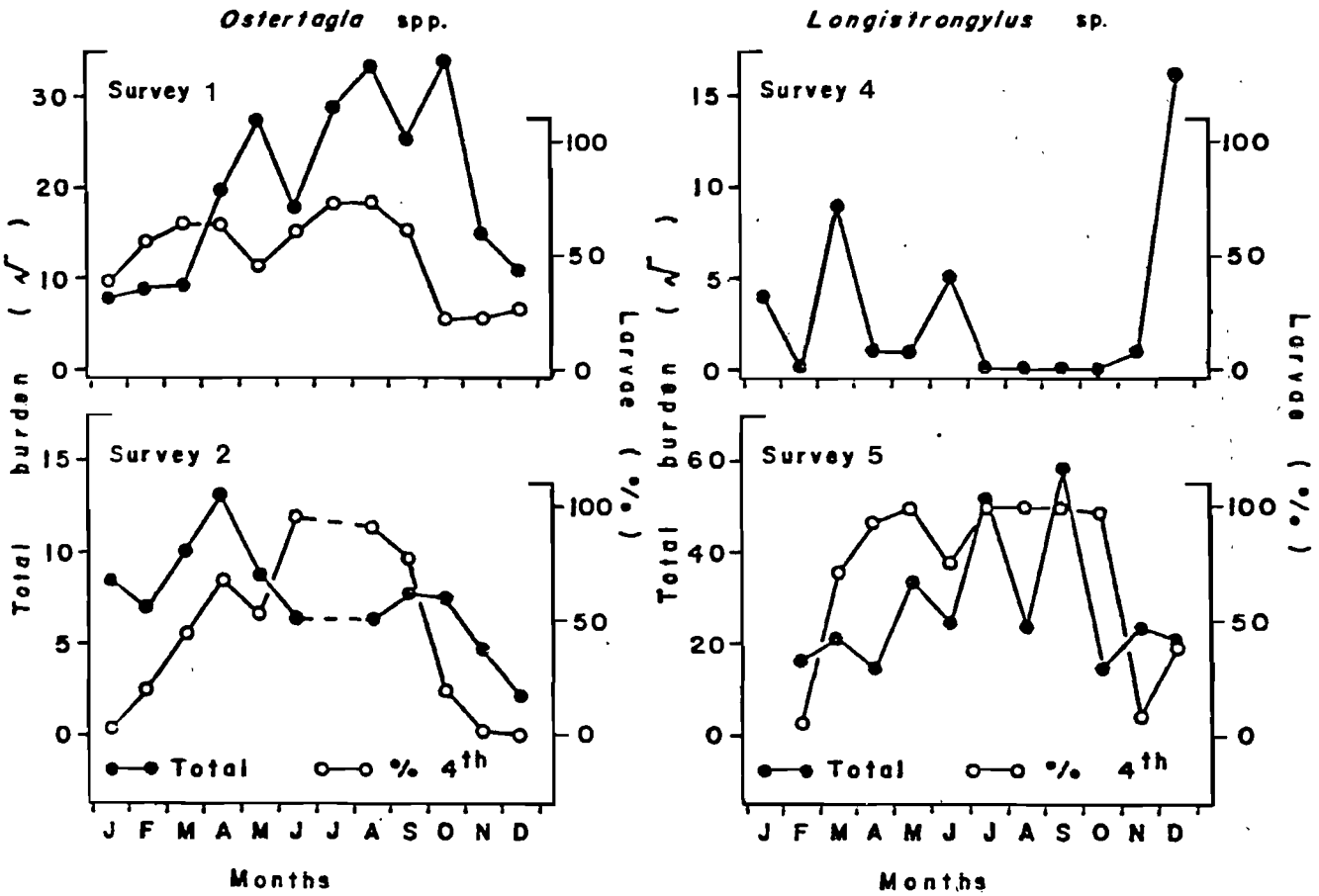

Fig. 3 The seasonal incidence of *Ostertagia* in sheep and *Longistrongylus sabie* in impala and cattle slaughtered in surveys conducted in the Transvaal. Surveys 1 and 2 – sheep, Survey 4 – cattle, Survey 5 – impala

Armidale in Australia, where winters are not too severe, autumn contamination of pastures with *Ostertagia* spp. eggs resulted in peak larval recoveries in late winter and early spring, while spring or summer contamination never resulted in high larval numbers[25]. At Weybridge in southern England where winters are cold development time on the pasture was long and larval yields small from winter to early spring, while during the rest of the year development was rapid and larval yields were high[5]. Thus in warm climates *Ostertagia* spp. produces a winter and spring infestation while in cold climates it produces a summer and autumn infestation. The findings at Hennops River confirm this observation in that the climate was warm and peak burdens were present in winter and spring.

It has been demonstrated that *O. circumcincta* could overwinter on pasture at Weybridge and that this infestation survived until summer[5]. At Armidale although *Ostertagia* spp. appeared capable of development on pasture throughout the year and survival was good, the larvae rapidly declined from October to December[25]. Thus in England overwintered larvae disappeared in summer yet newly developed larvae declined during spring and summer. At Hennops River and Tondeldoos *Ostertagia* spp. larvae developed to infectivity on pasture during autumn to spring and could probably overwinter, but declined rapidly during November and December (Surveys 1 and 2). The environmental stresses of temperature, high evaporation and exposure to direct sunlight were probably responsible for their disappearance.

At both Hennops River and Tonteldoos a fairly large percentage of the worm burden was arrested in the fourth larval stage from February or March until September. At both localities a temporary decline in the percentage of arrested larvae took place during May or June.

Although *L. sabie* is in many respects similar to

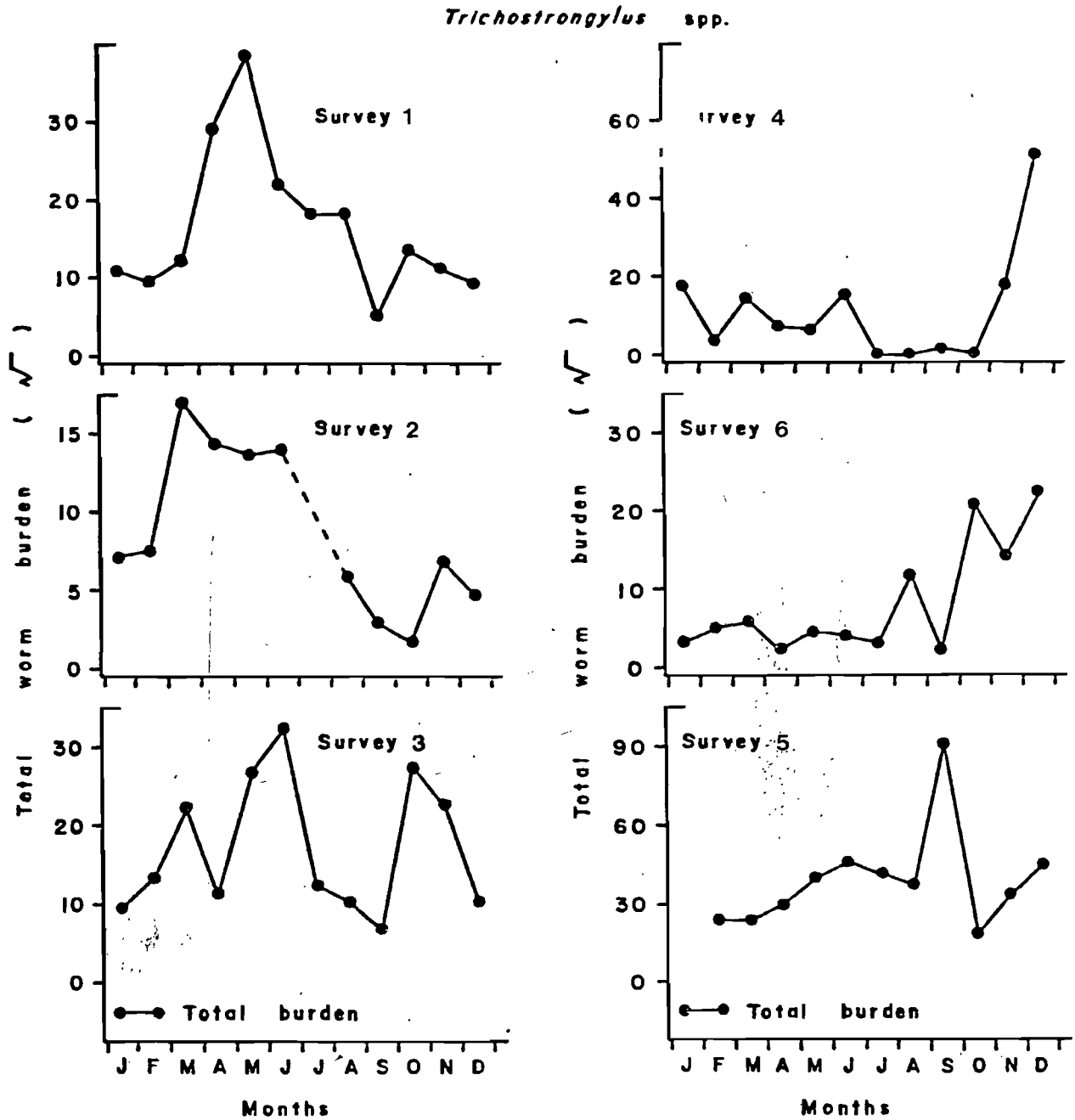

Fig. 4 The seasonal incidence of *Trichostrongylus* spp. in sheep, cattle, impala and blesbok slaughtered in surveys conducted in the Transvaal. Surveys 1 and 2 – sheep, Surveys 3 and 4 – cattle, Survey 5 – impala, Survey 6 – blesbok

Ostertagia spp., its epizootiology differs markedly from that of the latter genus in sheep in the Transvaal. At Hennops River the greatest mean total numbers of *Ostertagia* spp. larvae were available on pasture from April to October and the greatest mean numbers of adult worms were recovered during May and from July to October (Survey 1). Near Boekenhout the largest numbers of adult *L. sabie* were recovered from November to February (Survey 5) and infestation on pasture was available from November to June if one considers the results obtained from the tracer calves (Survey 4).

Thus *Ostertagia* spp. produced an autumn to spring infestation at Hennops River whereas near Boekenhout *L. sabie* produced a summer to early winter infestation. At Hennops River a fairly large percentage of the worm burden was arrested in the fourth larval stage during winter (Survey 1), to avoid exposure of the free-living stages to the external cold temperature, while near Boekenhout (Survey 5), where the winters were considerably warmer, arrested development was essential to survive during the dry winter months.

In many respects the epizootiology of *L. sabie* near Boekenhout closely resembles that of *Ostertagia ostertagi* in calves near Glasgow, Scotland[2]. At both localities infective larvae are available in summer and autumn, adult worms are present in summer, and infestation overwinters in the host as arrested fourth stage larvae. The reason for overwintering in the host, however, differs. In Scotland it is to ensure survival during a period of considerable cold; near Boekenhout during a time of drought.

Trichostrongylus spp.

Worms of this genus were present in each of the surveys and their seasonal fluctuations are graphically illustrated in Fig. 4.

The magnitude of the worm burdens encountered in the present surveys is a clear indication that the Transvaal climate is not ideal for the survival of free-living stages of *Trichostrongylus* spp. With the single exception of the worm burden of a single impala, mean burdens did not exceed 3 000 worms and usually not 1 000 worms. In contrast the burdens recovered from sheep in the Cape Province usually exceeded 5 000 worms and frequently 10 000 worms[23,28].

In the surveys conducted in sheep and cattle on the Transvaal Highveld (Surveys 1 to 3) a major peak of infestation occurred during the period March to June, while infestation was at its lowest during September or October, picked up slightly for one month and dropped to a low level during December to February. In the northern Transvaal infestation in cattle and blesbok was at its highest during December (Surveys 4 and 6), while no clear pattern emerged in impala (Survey 5).

Roberts *et al.*[22] stated that the optimal requirements for the free-living stages of *Trichostrongylus* spp. were mean maximum temperatures from 12,8 to 18,3° C (55 to 65° F) and monthly rainfall of 76,2 mm (3 in) or more. While agreeing with the temperature requirements Gordon[7] concluded that a monthly rainfall of 50,8 mm (2 in) or more was adequate as did Levine[15], who recorded the temperature limits for optimum development of the free-living stages as being mean monthly mean temperatures of 6 to 20° C.

The survey conducted in sheep in the Karoo by Viljoen[29] indicated that the environmental requirements of various *Trichostrongylus* spp. may differ. In contrast with the findings of Gordon[7] and Levine[15] he found that in the case of *T. falculatus* a monthly rainfall below 25 mm was still adequate provided a good fall occurred in autumn and the winter was cold. The findings of Southcott *et al.*[25] confirm these differences in that they found peak pasture larval availability for *Trichostrongylus* spp. parasitic in the small intestines during March, and for the abomasal parasite *T. axei* during September.

The seasonal fluctuations in infestation in Surveys 1 to 3 can probably be explained in relation to the temperature requirements of the free-living stages. Infestation during January and February was at a low level because of summer temperatures, increasing thereafter as the late summer and autumn temperatures favoured the free-living stages. During winter development slowed down or ceased and available infestation died off, resulting in very low worm burdens in September or October. The rise in temperature during October or November resulted in a slight increase in available larvae but thereafter summer temperatures became too warm and infestation declined.

The same arguments, however, cannot be used to explain findings in cattle near Boekenhout (Survey 4). Slaughter in this survey commenced during March 1976, and small numbers of *T. colubriformis* and *T. falculatus* were recovered until June, whereafter both temperature and drought prevented further larval development or escape of larvae from dungpats. Although temperatures rose during spring no larvae became available until after the rain in October and considerably more rain in November, resulting in the highest worm burdens in the calves slaughtered on 1 December 1976[11]. This infestation could be of threefold origin, developing either from embryonated eggs which in the case of *Trichostrongylus* spp. are resistant to adverse conditions[18] and have overwintered, or from infective larvae trapped in the dungpats and unable to escape because of lack of moisture, or from newly deposited eggs. Despite further rainfall, summer temperatures were probably too high and worm burdens declined markedly thereafter.

It is quite probable that regular irrigation at Hennops River prevented cattle dungpats from acting as prisons as they would be kept moist and larvae would not become trapped[19]. If this indeed was so it would explain the difference in infestation patterns in cattle at Hennops River (Survey 3) and Boekenhout (Survey 4).

Work at Weybridge in the south of England, showed that larvae developing from *T. colubriformis* eggs placed outside during March and April 1963 did not survive for long although they had in the previous year[4]. Larvae developing from eggs deposited from May to September were capable of overwintering but disappeared the following spring. These findings are corroborative evidence of the short-lived spring rise in infestation encountered in Surveys 1 to 4.

It is apparent that infestation in blesbok at Lunsklip (Survey 6) increased from August to December and declined markedly thereafter. This rise could have been due to rainfall, but as no data are available and these animals and impala near Boekenhout (Survey 5) were continuously exposed to infestation, it is difficult to draw conclusions on the seasonal availability of larvae.

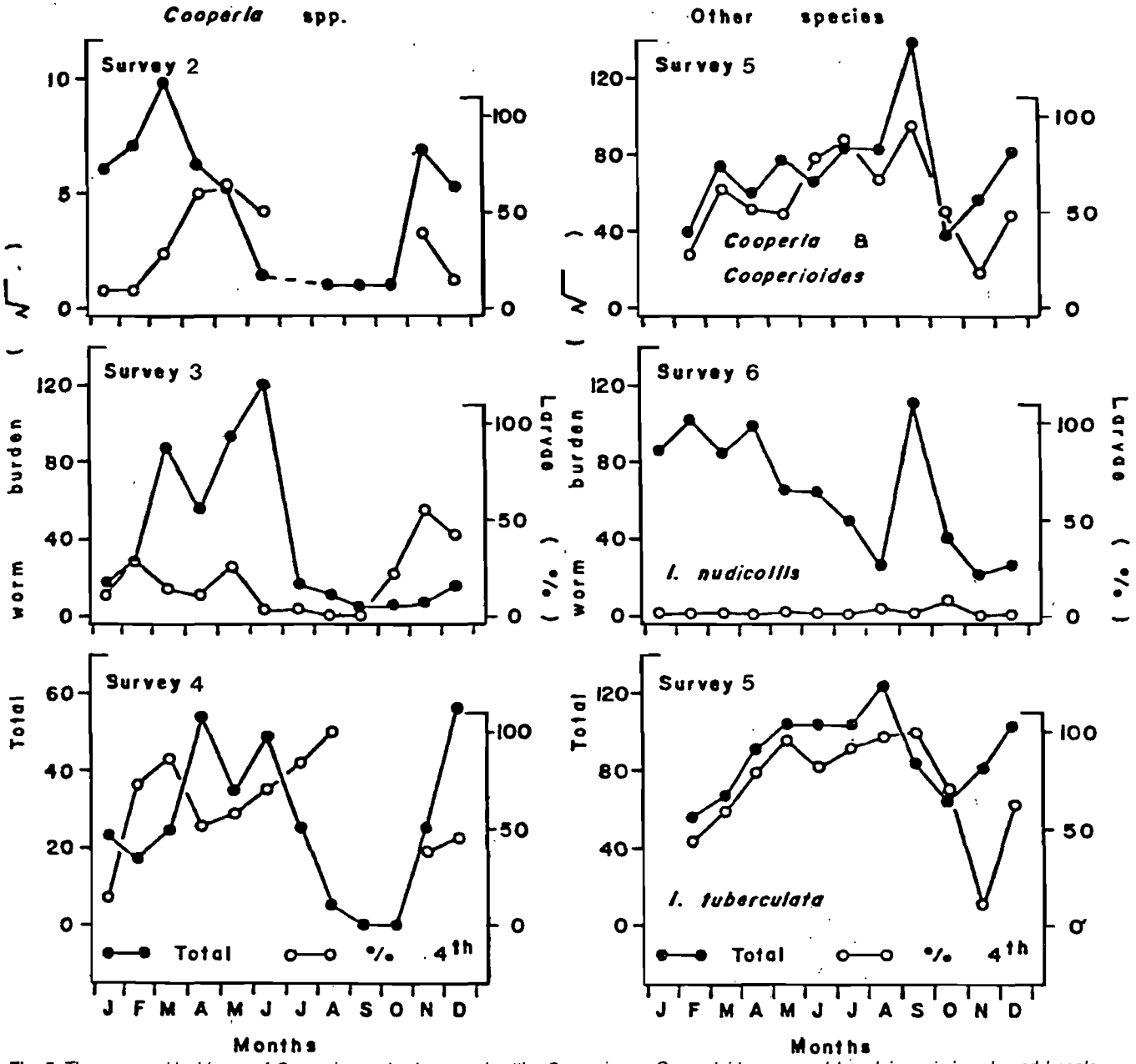

Fig. 5 The seasonal incidence of *Cooperia* spp. in sheep and cattle, *Cooperia* sp., *Cooperioides* spp. and *Impalaia* sp. in impala and *Impala* sp. in blesbok slaughtered in surveys conducted in the Transvaal. Survey 2 – sheep, Surveys 3 and 4 – cattle, Survey 5 – impala, Survey 6 – blesbok

Cooperia spp., *Cooperioides* spp. and *Impalaia* spp.

The mean monthly burdens of these species in animals in Surveys 2 to 6 are reproduced in Fig. 5.

Acquisition of *Cooperia* spp. infestation by tracer lambs in Survey 2 and tracer cattle in Surveys 3 and 4 was reasonably similar, and although not graphically illustrated, acquisition of *I. tuberculata* by cattle in Survey 4 at times closely resembled that of *Cooperia* spp. by the same animals[11]. Worm burdens increased from January or February and infestation was acquired until May by lambs and until June by cattle, followed by a marked decline and very small burdens for a period of three to five months. A marked increase in worm burden during November was evident in the lambs, and in cattle in Survey 4,and a slight increase during December in cattle in Survey 3. More than 50 per cent of total worm burdens consisted of arrested fourth stage larvae, from April to June in lambs, in November in calves in Survey 3 and from February to August in calves in Survey 4.

The *Cooperia*/*Cooperioides* spp. and *Impalaia tuberculata* burdens of impala in Survey 5 followed generally similar patterns to each other, rising from February to a peak in either September or August, followed by a decline to October and an increase thereafter. More than 45 per cent of total worm burdens from March to October and during December consisted of fourth stage larvae, the greatest proportion of larvae being present during September. The decline in total worm burden in October was accompanied by a decline in the proportion of fourth stage larvae and a rise in the actual number of adult worms present.

With the exception of September, burdens of *I. nudicollis* in blesbok in Survey 6 declined erratically from January to December. Very few fourth stage larvae were recovered from these animals.

The two most common *Cooperia* spp. of cattle are probably *C. oncophora* and *C. pectinata*. The former is a parasite of colder climes and is found in the United Kingdom[2], the northern states of the United States of America[16] and cooler regions of Australia[24]. The latter

species prefers warmth and is present in the southern states of the United States[16], the summer rainfall regions of the RSA[20] (Surveys 3 and 4) and the warmer regions of Australia[22].

In England it has been shown that after contamination of pasture with eggs of *C. oncophora* during May, infective larvae were able to survive until the following April[17]. At Armidale, Australia it was found that the larvae of *C. oncophora* persisted on pasture for at least 24 weeks during summer and autumn[24].

Ecological studies done on the free-living stages of *C. pectinata* have usually been combined with observations on the free-living stages of the other cattle nematodes. Thus in Queensland, Australia it was found that larvae of *Cooperia* spp. (*C. pectinata* and *C. punctata*) and *Oesophagostomum radiatum* could still be found in dungpats three months after exposure during the warmer seasons of the year[22]. Research in the semi-arid north-western Cape Province, showed that the larvae of *Cooperia pectinata* were well adapted to extremes of heat and cold and to dessication[20]. They persisted longer in dungpats and their surrounds than larvae of *Haemonchus placei, Bunostomum phlebotomum* and *Oesophagostomum radiatum,* and migrated and survived when no other species were found.

The findings at Hennops River (Survey 3) indicate that cold does play a role in the development or survival of *Cooperia* spp. on pasture. Regular irrigation should have supplied sufficient moisture for the free-living stages, yet a decline in infestation was evident in tracer calves slaughtered during August and September 1969 compared with that in calves examined in the previous months. Unfortunately the survey was terminated in June 1970 at the height of infestation, hence no counts for the succeeding months are available[14].

Near Tonteldoos (Survey 2) and Boekenhout (Survey 4) both temperature and lack of rainfall probably accounted for the decline in available infestation. Yet at both these localities the free-living stages apparently survived on pasture during winter, judging from the rapid increase in infestation in tracer animals during November. The role of cattle dungpats in survival of infestation was probably important at both sites. (Cattle grazed with or before sheep near Tonteldoos[8]). Larvae were probably trapped in dungpats of which the crusts had become hard during the dry winter months[19] and were then liberated in November and December after the first rainfall. Temperatures thereafter near Tonteldoos were probably suitable for development and survival, while near Boekenhout, with a considerably warmer summer, a marked decline in infestation was evident in January.

Near Tonteldoos and Boekenhout a fairly large proportion of the worm burdens consisted of fourth stage larvae, particularly during the cooler, drier months. A similar phenomenon was not evident at Hennops River (Survey 3), possibly because the regular supply of moisture during the winter months reduced the pressure to overwinter in the host and a non-inhibition prone strain was rapidly selected.

Acquisition of *Impalaia tuberculata* by cattle near Boekenhout although not graphically illustrated is similar to that of *Cooperia* spp., but differed markedly during January and February, however, when no infestation was available, compared with a reduced level for *Cooperia* spp.[11]. Lack of infestation is confirmed by the worm burdens of impala, in which the lowest burdens of *Impalaia tuberculata* were recovered during February (Survey 5), indicating the absence of infective larvae on pasture. A remarkably similar pattern of infestation is evident for the *Cooperia/Cooperioides* complex in impala.

Combining the findings for the tracer cattle and sheep with those of continuously exposed impala I would suggest the following epizootiology for *Cooperia* spp., *Cooperioides* spp. and *Impalaia* spp. in the Transvaal: at elevated altitudes infective larvae are available from November to April, while in warmer areas they are present in November and December and from February or March to June or July.

Notable exceptions to this pattern were *Cooperia* spp. on irrigated pasture at Hennops River (Survey 3) where large numbers of larvae were available from March to June, and *Impalaia nudicollis* on natural pasture near Lunsklip (Survey 6) where in addition to larvae apparently being available from January to April large numbers were present during September.

The free-living stages can overwinter on pasture, resulting in available larvae after the first rainfall at the start of the following spring or summer. Adult worms account for the major portion of the worm burden from November to February or March, when they are superseded by arrested fourth stage larvae overwintering in the host because of the cold and dry external environment.

At Hennops River (Survey 3) and Lunsklip (Survey 6) arrested development did not occur.

During October these larvae developed to adulthood, many larvae or adults being eliminated at the same time. The surviving adults contaminate the pastures with eggs, and these eggs and the overwintered free-living stages give rise to November infestations which rapidly mature in the host.

Although infestation of blesbok with *Impalaia nudicollis* during the first few months of the year agreed with the abovementioned observations I can give no reason for the erratically declining population thereafter, other than that the reduction of blesbok numbers from approximately 780 to 34 during the course of the survey similarly affected their worm burdens[9]. The fact that only two blesbok were examined at each occasion may also account for the fluctuating nature of the results.

Oesophagostomum spp.

No worms of this genus were recovered from blesbok at Lunsklip (Survey 6), very few from sheep near Tonteldoos (Survey 2) and cattle at Hennops River (Survey 3), fair numbers from sheep at Hennops River (Survey 1), impala near Boekenhout (Survey 5) and Pafuri and blesbok at Badplaas, and reasonably large numbers from cattle near Boekenhout (Survey 4). Fig. 6 graphically illustrates the worm burdens of animals in Surveys 1, 4 and 5.

Peak burdens of *O. columbianum* were recovered from sheep during April and May, while small burdens and large fluctuations made the determination of seasonal prevalence in impala impossible. In cattle *O. radiatum* reached peak numbers from June to January. The apparent major peaks observed during August and January are coupled to six-week grazing periods as

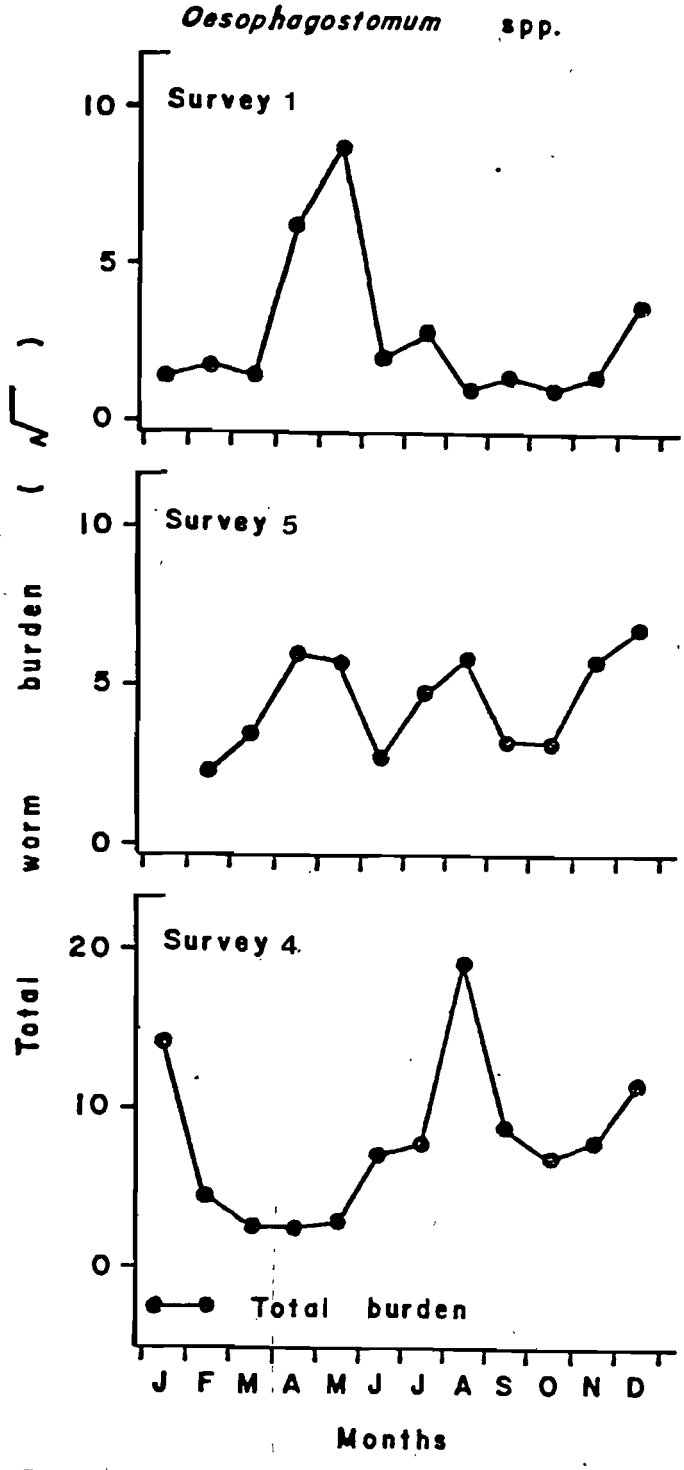

Fig. 6 The seasonal incidence of *Oesophagostomum* spp. recovered from sheep, cattle and impala slaughtered in surveys conducted in the Transvaal. Survey 1 – sheep, Survey 4 – cattle, Survey 5 – impala

opposed to periods of four weeks for cattle slaughtered during other months of the survey[11].

Few critical experiments on the development and survival of *Oesophagostomum* spp. on pasture seem to have been conducted. It was found that infective larvae of *O. radiatum* could survive in the dungpat for 105 days during the autumn and winter months in the semi-arid north-western Cape Province, but for only 41 days on grass adjacent to the pat[20]. It has been suggested that infective larvae of *O. columbianum* probably prefer cooler conditions and hence infestation with fourth stage larvae increased in sheep in the Karoo from autumn to spring[28]. According to Thomas[27], however, the free-living stages of *O. columbianum* are limited to the summer months, particularly during the high rainfall period on the Transvaal Highveld. It has also been demonstrated that infective larvae of *O. venulosum*, a parasite of sheep in the winter and non-seasonal rainfall areas of the Cape Province, were present on pastures in peak numbers during a period of high rainfall from September 1965 to January 1966[23].

The findings in the present surveys tend to confirm previous observations that infective larvae of *O. columbianum* prefer cooler conditions[28]. It may also be that excessive moisture is detrimental to the survival of *O. columbianum* and *O. radiatum*. Peak burdens of *O. columbianum* were recovered from sheep slaughtered near Middelburg in the Karoo from May to August 1963, a period during which only 21,4 mm of rain fell[28]. At Hennops River (Survey 1), *O. columbianum* did not flourish on the pastures except for a brief spell during April and May, thus indicating that the amount of moisture supplied may have been excessive as well as that the free-living stages preferred the cooler autumn months. Nor did the moist conditions at Hennops River suit *O. radiatum*, as infestation virtually disappeared in tracer calves after a quite promising start[14].

Near Boekenhout the first infestations of *O. columbianum* were encountered in young impala culled during the first eight days of September 1975[10], the previous months being cool with a total of only 20,8 mm of rain having fallen from May to August[10], thus indicating that the larvae were able to develop to infectivity under these conditions.

In Queensland, Australia it was found that mid-summer temperatures were unfavourable for the development of the free-living stages of *O. radiatum*, which thrived under the more moderate temperatures of spring and early summer[3].

Near Boekenhout (Survey 4), *O. radiatum* clearly preferred the cooler dryer months of winter and spring. This seasonal preference is even more dramatic if one considers that until May 1976 90 untreated animals had been present to seed the pastures with infestation and that only eight such animals were present from May to January 1977[11]. It is, however, also important to consider the role of the cattle dungpat in the survival of infestation on pasture[19,20]. When this is taken into account it is possible that infestation acquired during one month could result from eggs deposited one to three months previously. Consequently the large burdens of *O. radiatum* in the calves slaughtered during January 1977 could have resulted from larvae that had been freed from dungpats by the good rains which fell during November 1976[11].

In the light of the preceding observations I suggest that the free-living stages of *O. columbianum* and *O. radiatum* prefer cool conditions with a mean temperature probably not exceeding 15° C. They can survive when rainfall is less than 10 mm a month, and appear to be adversely affected by continuous high rainfall or irrigation.

The parasitic life cycles of the immature stages of *O. columbianum* and *O. radiatum* are longer than those of most common nematode parasites of sheep or cattle. The first fourth stage larvae moult to fifth stage worms 21 days after infestation for the former and 19 days for the latter helminth[21]. Consequently no reliable obser-

vations on arrested larval development could be made in the tracer lambs and cattle slaughtered in Surveys 1 and 4, as the majority of worms would in any event still be larvae because of the short period (33 or 28 days) of exposure before necropsy.

The findings of Viljoen[28], although pertaining to continuously exposed sheep, appear to indicate that in *O. columbianum* an arrest in development in the fourth larval stage does occur, and that this takes place from January to June or even September. If this is indeed so it agrees in part with my suggestion that the period January to March is too hot and moist for optimal survival of the free-living stages; hence the parasite bridges this period by arresting its development in the host until external conditions are more favourable. It does not explain however, why the period of arrested development apparently extended to June or September when conditions on pasture should have been favourable for larval development and survival.

CONTROL MEASURES

Although these surveys were conducted primarily to ascertain the epizootiology of helminth infestation in certain domestic and wild ruminants in the Transvaal, an important consideration is the application of the knowledge so obtained to the control of helminth infestation. Despite husbandry playing an important part in any control programme it is in the development of highly effective anthelmintics and their application that the greatest strides have been made, and I will concentrate on this aspect of control.

Sheep

All animals should be treated during July with a broad-spectrum anthelmintic effective against arrested larvae. This treatment will control arrested fourth stage larvae of *Haemonchus contortus,* adult and arrested *Ostertagia* spp., adult *Trichostrongylus* spp. and *Oesophagostomum columbianum* acquired during April and May. It will also have an extended effect, for with the possible exception of *Ostertagia* spp., little reinfestation will take place before November or December.

A strategic drench, utilizing a broad-spectrum anthelmintic with a special effect in that it must also control cestodes, should be administered during November. This will control *Ostertagia* spp., *Moniezia expansa* and the small number of nematodes acquired during the preceding months.

From January to April broad- and narrow-spectrum anthelmintics effective against *Haemonchus contortus* can be administered alternately. The intervals between dosing will depend on the intensity of infestation and on the occurrence of warm wet weather, and will vary between four and eight weeks. This amounts to alternation between tactical and strategic drenching and is aimed at *H. contortus,* but will also control other nematodes. A broad-spectrum anthelmintic with a cestocidal effect should be incorporated into this programme during February or March for the strategic control of nematodes and *Moniezia expansa.*

Cattle

A broad-spectrum anthelmintic should be administered during July and provided it is effective against arrested larvae, it will have an extended effect against *Haemonchus placei, Cooperia* spp. and *Trichostrongylus* spp. and act as a strategic drench against *Oesophagostomum radiatum.* A broad-spectrum anthelmintic administered strategically during December will control immature and adult forms of the same parasites, and during March will control *Haemonchus placei* and *Cooperia* spp. If infestationn with adult *Haemonchus placei* is particularly severe from January to May, treatments with narrow-spectrum anthelmintics effective against this species can be alternated with the latter treatments during this time.

Antelope

The large-scale treatment of free-ranging antelope is virtually impossible. If, however, these animals have to be captured for any purpose treatment can be administered then. This can be done orally if the animals are not sedated but must be administered by injection if they are, because of difficulty that may be experienced with deglutition. Treatment is particularly important if animals are captured for translocation. Not only does this eliminate the extra stress of a heavy worm burden at the new locality, but it also prevents the introduction of helminth species not already present in a particular area.

If antelope are confined on farms or in small game parks, anthelmintics can be administered by means of feed blocks or licks. Anthelmintics capable of controlling arrested larvae should be used and the ideal time to administer medication in this form is during July. Not only will antelope consume blocks or licks more readily because of the paucity of grazing, but treatment will have an extended effect on certain species until approximately October.

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BOOK REVIEW **BOEKRESENSIE**

THE VETERINARY ANNUAL – 21ST ISSUE

G.S.G. GRUNSELL and F.W.G. HILL, Editors
Scientechnica, Bristol 1981 pp xvii + 302, Fig. 84, Tab. 24, Publ. Price £15,00

The most recent issue of the Veterinary Annual is consistent with the high standards of previous issues of this publication. The usual format is adopted with sections containing articles on special, large animal (divided into sections on cattle, sheep, pigs and horses) and small animal (including birds and tortoises) topics.

The 4 special articles include some thoughts on reproduction and infertility and reviews on animal husbandry, equine antimicrobial therapeutics and, tremorgenic mycotoxins and neurological disorders. The latter 2 contributions are of particular current interest.

Large animal topics include papers on perinatal calf mortality, treatment and control of hypomagnesaemia in calves, mycoplasmal mastitis, bovine hypersensitivity, bovine and equine ocular thelaziasis, detection of bulls responsible for transmitting hereditary disease, nutritional diseases associated with grass, an effective programme for fertility control in dairy herds, long-term trends and short-term forecasts in dairy farming, hill sheep management, tooth loss in sheep, ram fertility testing, identification of stress-susceptible pigs with halothane anaesthesia, equine tendon injuries and the practicality and necessity of clinical research in practice. All these articles are particularly orientated towards the practitioner.

Canine and feline nutrition and related problems (6 articles) tend to dominate the small animal section. Other topics in this section include the control of canine diabetes mellitus, intestinal oncology in the dog and cat, nutritional problems in cage birds, osteochondritis dissecans of the hock joint in the dog, avian fractures, Collie eye anomaly syndrome, radiological features of liver disorders in the dog and cat, hydatidosis in the UK, prostaglandin therapy in uterine disorders, canine parvovirus infection, an assessment of the use of feline respiratory virus vaccines, diagnostic aids in canine neurological disorders and common problems of tortoises.

The range of contributions is not only a reflection of the scope of veterinary science but also provides a balanced perspective of the various disciplines in the science. While all 41 contributors are to be congratulated on the high quality of their articles, the editors are to be especially commended for maintaining and encouraging the scope of current interest, particularly in so far the general practitioner is concerned.

J.W. Nesbit

BOOK REVIEW **BOEKRESENSIE**

THE OCCURRENCE OF TUMORS IN DOMESTIC ANIMALS

Prepared by: W.A. PRIESTER and F.W. McKAY
NIH Publication No. 80–2046, National Cancer Institute Monograph 54
GPO Stock No. 017-042-00145-5

U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Cancer Institute, Bethesda, Maryland 20205, U.S.A. ppxi, 201, Figs 2, Graphs 92, Tables 110, Publ. Price $8,50

The book is a comprehensive statistical analysis of 41 569 spontaneously occurring neoplasms of which 23 828 were microscopically confirmed in bovine, equine, porcine, ovine, caprine, canine, feline, avian and other species. The data was contributed by 14 veterinary schools and processed to correlate it to breed, sex, age, tumour site, geographical area, etc. Graphs were compiled to indicate the relative risk for a specific breed to develop a tumour at a specific site. The book is a great achievement and a world's first in veterinary medicine and is a must for all who have an interest in tumour epidemiology.

I.B.J. v. Rensburg

REVIEW OORSIG

DIE EFFEK VAN HARTGLIKOSIEDE EN ELEKTROLIETE OP DIE SELMEMBRAAN SE NATRIUM, KALIUM-ADENOSIENTRIFOSFATASE*

J.P.J. JOUBERT**

ABSTRACT: Joubert J.P.J. **The effect of cardiac glycosides and electrolytes on cell membrane sodium, potassium-adenosine triphosphatase.** *Journal of the South African Veterinary Association* (1981 **52** No 3, 225–228 (Afr) Toxicology Section, Veterinary Research Institute, 0110 Onderstepoort, Republic of South Africa.

A brief summary is given of the structure of the cell membrane and the enzyme system which actively transports Na^+ and K^+ ions across it. The function of different ions in this process is discussed as well as the effect of cardiac glycosides on ion transport. The utilization of electrolytes to combat cardiac glycoside poisoning and an indirect method for demonstrating the presence of cardiac glycosides in the organs of ruminants, suspected of being poisoned by these toxins, is described.

INLEIDING

Hartglikosiedvergiftiging word in Suid-Afrika as een van die ses belangrikste gifplantprobleme vir herkouers beskou[5]. Dit spreek vanself as die groot verskeidenheid hartglikosiedbevattende plante wat hier voorkom en hulle wye verspreiding in aanmerking geneem word. Volgens Naudé[5] kom hartglikosiede onder andere voor in *Homeria* en *Moraea* spp (tulp), *Urginea* spp (slangkop), *Cotyledon* en *Kalanchoe* spp (plakkies), *Melianthus* spp (kruidjie-roer-my-nie), *Asclepia* spp (melktou), *Nerium oleander* en ander plante asook in sommige paddas en insekte. Aangesien veeartse hier dikwels met hierdie vergiftigings te kampe het, is dit nodig om 'n bietjie fyner te kyk na die meganisme daarvan.

DIE SELMEMBRAAN

Aangesien al die betrokke prosesse in, om en deur die selmembraan plaasvind, moet die struktuur daarvan eers beskryf word. Dit bestaan volgens Schwartz, Lindenmayer en Allen[7] uit 50% proteïene, 40% fosfolipiede en 10% koolhidrate. Dit is nie in 'n ordelike gelid gerangskik volgens die bekende "eenheid membraan" nie alhoewel daar proteïene weerskante van die fosfolipiedlagies kan wees. Daar is egter ook proteïene wat regdeur die lipiedlagies strek. Hierdie proteïene is dan in kontak met die ekstrasellulêre vloeistof sowel as met die selsitoplasma.

Die selmembraan (Fig. 1) is semi-deurlaatbaar. Verder is daar ook porieë wat waarskynlik in 'n spiraalvorm deur die membraanproteïene strek en waardeur klein wateroplosbare molekule kan diffundeer. Na^+- en K^+-, en tot 'n mindere mate Ca^{++}-, ione kan onder andere deur hierdie porieë beweeg. Met groter molekules en stowwe wat nie wateroplosbaar is nie, vind oordrag deur die selmembraan op ander wyses plaas. Een daarvan is die aktiewe oordrag van stowwe waarvoor energie verskaf word deur die hidrolise van adenosien trifosfaat (ATP).

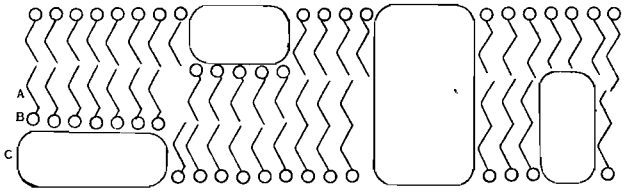

Fig. 1 Skematiese voorstelling van die selmembraan[6]

Aktiewe oordrag van Na^+- en K^+-ione

Vir normale selaktiwiteite en veral die instandhouding van die rustende membraanpotensiaal moet daar 'n hoë konsentrasie K^+- en 'n lae konsentrasie Na^+-ione intrasellulêr wees en 'n hoë konsentrasie Na^+ en lae konsentrasie K^+ ekstrasellulêr. Sonder hierdie verskil in ioonkonsentrasies kan die rustende membraanpotensiaal (–70mv intrasellulêr) nie gehandhaaf word nie. Dan sal die membraan dikwels gedepolariseerd bly, wat impulsoordrag sal belemmer. Die effek van die diffusie van ione deur die porieë moet dus teengewerk word anders sal dit neig om die selmembraan gedepolariseerd te hou. Dit word bewerkstellig deur 'n aktiewe oordragsisteem wat K^+-ione teen hulle konsentrasie helling in die sel in en Na^+-ione uit die sel uit vervoer[6,8,7]

Selmembraan – Na^+, K^+-ATPase

In 1965 het Skou[8] die volgende lys eienskappe opgestel waaraan 'n aktiewe oordragsisteem vir Na^+- en K^+-ione moet voldoen:

1. Dit moet in die selmembraan geskied.
2. Dit moet 'n bindingspunt vir Na^+ aan die intrasellulêre kant van die membraan hê, wat veel groter affiniteit vir Na^+ as vir K^+ besit.
3. 'n Soortgelyke hoë-affiniteit bindingspunt moet vir K^+ aan die ekstrasellulêre kant van die membraan bestaan.
4. Dit moet 'n ensiemsisteem insluit wat ATP kan hidroliseer met die vrystelling van energie vir die vervoer van die katione.

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5. Die ensiemsisteem moet ATP hidroliseer teen 'n tempo wat tred sal hou met die konsentrasie Na^+ intrasellulêr en K^+ ekstrasellulêr.
6. Hierdie oordragsisteem moet aangetref word in selmembrane van alle selle waar aktiewe oordrag van Na^+ en K^+ plaasvind (bv. senuvesels, miokard en spiervesels).
7. Daar moet 'n noue korrelasie bestaan tussen die effek van hartglikosiedes op die oordrag van die katione en op die ensiemsisteem.
8. Dit moet in eksperimentele gevalle (in vitro) dieselfde kwantitatiewe verhouding tot Na^+ en K^+ oordrag hê as wat die ensiemsisteem in die intakte sel (in vivo) het.

Skou[8] het voortgegaan en aan die hand van baie navorsers se werk aangetoon dat daar wel 'n selmembraan Na^+, K^+-ATPase bestaan wat aan al die bogenoemde vereistes voldoen.

Die ensiemsisteem werk waarskynlik as volg:

$$\begin{array}{lll} & & K^+ \\ e & & e \\ | & & | \\ ES + Mg + nNa + nK + ATP & \rightarrow & MgATP{-}ES \\ | & & | \\ i & & i \\ & & Na^+ \end{array}$$

n = getal ione
ES = ensiemsisteem
i = intrasellulêre bindingspunt vir katione
e = ekstrasellulêre bindingspunt vir katione.

Aktivering van die ensiemsisteem word bewerkstellig deur Mg^{++} intrasellulêr, ATP intrasellulêr en as Na^+ en K^+ ione teenoor hulle onderskeie hoë affiniteit bindingspunte stelling inneem.

Aktiewe oordrag van Na^+ en K^+ met die hulp van energie vanaf ATP vind dan só plaas:

$$\begin{array}{lll} n\,K^e & & n\,Na^i \\ e & & e \\ | & & | \\ MgATPes\sim & \longrightarrow & ES + Ng- \\ & & + ADP + Pi \\ | & & | \\ i & & i \\ n\,Na^i & & n\,K^e \end{array}$$

geaktiveerde ensiemsisteem — oordrag afgehandel, ensiemsisteem onaktief

e = ekstrasellulêr
i = intrasellulêr
n = getal ione
~ = dui geaktiveerde ensiemsisteem aan.

Hierdie bevindinge en model[8] word deur Schwartz et al[7] aanvaar en verder toegelig. Hulle vind onder andere dat daar 2 molekules K^+ en 3 molekules Na^+ vervoer word per ATP-molekule wat gehidroliseer word na ADP. Die volgende moontlike oordragsmeganisme word deur hulle voorgestel:

1. Oordrag kan plaasvind deur middel van 'n proteïn in die membraan wat roteer.
2. Die ione kan verskuif word van hoë affiniteit- na laer affiniteitbindingspunte totdat die ander kant van die membraan bereik word.
3. Die ensiemsisteem kan self 'n rotering van bindingspunte ondergaan. In so 'n geval sal die affiniteite van die bindingspunte dan verander om die ione aan die ander kant los te laat en weer die teenoorgestelde ioon te kan bind.

Om goed te fungeer, benodig die ensiemsisteem 'n hoë konsentrasie Na^+ ekstrasellulêr en K^+ intrasellulêr. Verder vind Schwartz et al[7] dat selfs 'n lae Ca^{++}-ioonkonsentrasie intrasellulêr die ensiem inhibeer. Hartglikosiede aan die ekstrasellulêre kant van die membraan inhibeer die ensiemsisteem ook.

HARTGLIKOSIEDE

Dit is reeds bekend dat klein (terapeutiese) dosisse 'n positiewe inotrope (saamtrekbaarheid van 'n spier) uitwerking op die miokard het. Groter dosisse veroorsaak toksiteit wat dodelik mag wees.

Volgens Glynn [3] het vorige werkers soos Schatzman en ook Joyce & Weatherall bewys dat selfs baie klein konsentrasies van digoksien, strofantien en ander hartglikosiede die aktiewe beweging van K^+ en Na^+ deur die selmembraan kan inhibeer. So min as 10^{-7} tot 10^{-6}M hartglikosiede kan reeds 50% inhibisie van genoemde oordrag veroorsaak. Verder is die positiewe inotrope effek van die hartglikosiede geassosieer met verhoogte intrasellulêre Ca^{++} ioonkonsentrasie. Glynn[3] bevestig ook dat hartglikosiede se inhiberende effek op aktiewe ioonoordrag gekorrelleer is met afname in die aktiwiteit van die ensiemsisteem. Verder noem Schwartz et al[7] dat reeds genoeg bewyse gelewer is dat inhibisie van die ensiemsisteem slegs plaasvind as die hartglikosiede ekstrasellulêr is. Dit beteken dat die selmembraanreseptor vir hartglikosiede ekstrasellulêr is. Die ensiemsisteem moet 'n nou verbintenis hê met die hartglikosiedreseptor, want selfs hoogs gesuiwerde fraksies van die ensiemsisteem is steeds gevoelig vir hartglikosiede. Die effek van die hartglikosiede is dus allosteries van aard omdat dit ekstrasellulêr bind en 'n uitwerking het op die ATP wat aan die intrasellulêre kant aan die membraan gekoppel is. Moontlik sal verdere navorsing aantoon dat die hartglikosiede aan die ensiemsisteem bind en dalk in kompetisie met K^+ is vir bindingspunte.

Volgens Schwartz et al[7] gaan die positiewe inotrope effek van hartglikosiede gepaard met verhoging van intrasellulêre Ca^{++} en Na^+ ioonkonsentrasies en 'n verlaging van die K^+ ioonkonsentrasie. Met geleidelike verhoging van die hartglikosiedkonsentrasie het hierdie veranderings in die intrasellulêre konsentrasies van die ione voortgeduur in dieselfde rigting. Hiervan kan dus afgelei word dat die hartglikosiede teen terapeutiese en toksiese vlakke op dieselfde wyse inhibisie van die ensiemsisteem veroorsaak; die reaksie neem net toe in hewigheid namate die dosis vergroot word. Die intrasellulêre ioonkonsentrasieveranderings tydens hartglikosiedinhibisie word nie weerspieël in die serum nie. Die Ca^{++}-, Mg^{++}-, Na^+-, en K^+-ioonkonsentrasies bly binne normale perke, want die verandering in konsentrasies is baie klein[3].

INVLOED VAN IONE

Kalsium-ione

Volgens Meyer[6] is die Ca^{++}-ione normaalweg rondom en in die porië van die selmembraan aan die ekstrasellulêre kant te vinde. Hulle word waarskynlik deur elek-

triese affiniteit daar gehou. Hartglikosiedinhibisie van die aktiewe oordrag van Na^+-en K^+-ione laat die polariteit van die membraan verander en Ca^{++}-ione kan dan blykbaar makliker deur die porieë in die sel in beweeg. Intrasellulêr het klein konsentrasies Ca^{++}-ione 'n inhiberende effek op die ensiemsisteem[7]. Dit kan geskied deur kompetisie met Mg^{++}-ione (wat intrasellulêr optree as 'n kofaktor om die ensiemsisteem te aktiveer).

Volgens Hajdu & Leonard[4] het Ringer reeds in 1883 gevind dat hartspiervesels nie saamtrek in 'n Ca^{++}-vrye medium nie. Die byvoeging van Ca^{++} tot die medium laat sametrekkings weer plaasvind. Indien die Ca^{++}-ione bo normaal verhoog word in die medium, lei dit tot aansienlik sterker en langduriger sametrekkings as wat gevind word met normale Ca^{++}-ioonkonsentrasies.

Hartglikosiede (in baie klein dosisse) kan die saamtrekbaarheid (aanspanning) van hartspiervesels in die afwesigheid van Ca^{++} bewerkstellig. Slegs nadat Ca^{++} by die medium gevoeg is, tree die positiewe inotrope (kragtiger sametrekking) effek in werking (Hajdu & Leonard[4]). Die drumpelwaarde vir die inotrope effek (en toksisiteit) van die hartglikosiede word verlaag deur Ca^{++}-toevoeging.

Die omgekeerde is ewe waar; die verwydering van Ca^{++}-ione deur bv. Na-etileen-diamien-tetra-asetaat (Na-EDTA) intraveneus toe te dien, veroorsaak 'n onmiddellike verbetering in die toestand van 'n digitalis-vergiftigde pasiënt[2]. Die uitwerking is egter van korte duur en as groot dosisse Na-EDTA te dikwels gebruik word kan dit nierskade en 'n daling in bloeddruk tot gevolg hê.

Kalium-ione

Hartglikosiedinhibisie van die Na^+, K^+-ATPase het 'n verlaging van die K^+-ioonkonsentrasie intrasellulêr tot gevolg. Dit veroorsaak versterking van die sametrekbaarheid van spiervesels (en miokard) volgens Hajdu & Leonard[4]. Hulle sê verder dat Loewi reeds in 1917 gevind het dat intraveneuse toediening van kaliumsoute, hartglikosiedvergifting kan uitskakel. Voorts noem hulle dat Sampson in 1943 aangetoon het dat ektopiese hartslae wat deur digitalis veroorsaak word, uitgeskakel kan word deur kaliumasetaat oraal toe te dien. Die kaliumasetaat is toegedien totdat 'n 10–30% styging in die K^+-ioonkonsentrasie in serum bereik is, en hierdie verhoogde waardes was binne 60 minute bereik. 'n Pasiënt met digitalisvergiftiging kan volgens Chung[2] kaliumchloried per os ontvang teen 20 tot 80 milli-ekwivalente per dag, of intraveneus teen 40 tot 60 milli-ekwivalente oor 2 tot 3 uur. Hy beskou kaliumterapie as teenaangewese in gevalle met hiperkalemie of nierskade en voortdurende monitoring per EKG word as noodsaaklik geag.

Hajdu & Leonard[4] dui ook daarop dat 'n hipokalemie veroorsaak dat digitalisvergiftiging teen 'n laer dosis kan intree.

Volgens Skou[8] is daar ook ander katione wat nes kalium die Na^+, K^+-ATPase kan aktiveer as dit in die ekstrasellulêre medium teenwoordig is. Die katione is ammoniak (NH_4), rubidium (Rb), cesium (Cs) en lithium (Li). Hierdie inligting word verder bespreek onder die toetsmetode.

Natrium-ione

Die Na^+, K^+-ATPase het 'n spesifieke affiniteit vir Na^+, en dit benodig onder andere Na^+-ione aan die intrasellulêre bindingspunt vir aktivering van die ensiemsisteem. Drie Na^+-ione word aktief per molekuul ATP wat gehidroliseer word, uit die sel gedra. Soos reeds genoem, word hierdie proses deur hartglikosiede geïnhibeer. Die Na^+-ione wat dan saam met Ca^{++}-ione intrasellulêr aansamel, mag bydra tot die versterkte kontraksie van bv. hartspiervesels, wat dan plaasvind[7].

Magnesium-ione

Dit word intrasellulêr benodig as 'n kofaktor vir die aktivering van die Na^+, K^+ ATPase. Hipomagnesemie lei tot 'n verlaagde drumpelwaarde vir hartglikosiedvergiftiging. By die mens word magnesiumsulfaat intraveneus en per os toegedien in die behandeling van hartglikosiedvergiftiging indien die pasiënt ook hipomagnesemies is[2]. Die aktiveringseffek van Mg^{++}-ione kan deur kompetisie deur Ca^{++}-ione uitgeskakel word[8].

TOETSMETODE VIR HARTGLIKOSIEDE

Omdat so 'n groot verskeidenheid hartglikosiede vergiftiging by herkouers kan veroorsaak, is 'n toetsmetode wat gebaseer is op die algemene effek van hartglikosiede op die liggaam van groot waarde vir veterinêre diagnostiek. 'n Toets wat dus spesifiek een hartglikosied kan aandui (bv. digoksien) sal nie in veeartsenykunde van nut wees nie.

Die bevinding dat katione soos rubidium net soos kalium kan optree in hierdie aktiewe oordragproses van K^+- en Na^+ -ione, het die weg gebaan vir die ontwikkeling van 'n toetsmetode wat die effek van hartglikosiede in die algemeen kan aandui.

Volgens die periodieke tabel van die elemente val rubidium en kalium in dieselfde groep en is hulle ook ewe veel elektronegatief. Dit is waarskynlik die rede waarom rubidium net soos kalium kan optree. Verder kom rubidium nie normaalweg in die liggaam voor nie. Hierdie inligting het daartoe gelei dat Bourdon & Mercier[1] in 1969 'n toetsmetode ontwikkel het waarmee hartglikosiede se algemene effek op die selmembraan aangedui word en wat dus die teenwoordigheid van enige hartglikosied sal kan aandui. Die beginsels waarop hierdie toets gebaseer is, is as volg: Rooibloedselle word gebruik as die model van liggaamselle omdat dit maklik beskikbaar is en voldoende Na^+, K^+-ATPase bevat. Die rooibloedselle word in 'n gebufferede fisiologiese oplossing gehou. Eers word die normale rubidiumopnamewaardes uitgewerk deur 'n aantal verskillende standaardverdunnings van rubidium (tussen 0 en 100 mg/ℓ saam met 'n vasgestelde hoeveelheid rooibloedselle te inkubeer by 37°C vir sowat 2 uur. Na die inkubasieperiode word die monsters gesentrifugeer en word slegs die rubidiuminhoud van die boliggende vloeistof per atoomabsorpsiespektrofotometer bepaal. Hierdie lesings word dan op 'n grafiek aangedui.

Die volgende fase van die toets is die verkryging van 'n standaardinhibisiekurwe ten opsigte van 'n bekende hartglikosied. Hiervoor word verskillende standaardverdunnings van bv. digoksien gemaak. Dit word bygevoeg by rooibloedselle en geïnkubeer. Hierdie inkubasieperiode gee die digoksien tyd om die Na^+, K^+-ATPase te inhibeer. Daarna word 'n enkele standaardverdunning rubidium (50 mg/ℓ) by al die verdunnings digoksien gevoeg en weer eens word dit geïnkubeer. Die rooibloedselle word dan afgeswaai en die

boliggende vloeistof per atoomabsorpsie-spektrofotometer vir die teenwoordigheid van rubidium getoets.

Laastens word 'n ekstrak van die toetsmonster (nier, rumeninhoud of lewer) gemaak. Dit word saam met rooibloedselle geïnkubeer en dan kom daar sowat 50 mg/ℓ rubidium by en die inkubasie word herhaal. Weer eens is dit die rubidiuminhoud van die boliggende vloeistof wat na sentrifugasie bepaal word. Elke keer is dit dus die konsentrasie rubidium wat nie deur die rooibloedselle opgeneem is nie wat bepaal word. Hierdie lesing van die rubidiuminhoud van die toetsmonster moet dan vergelyk word met die grafiek van die standaardinhibisie teenoor standaard absorpsie van rubidium, om sodoende te bepaal of die toetsmonster enigsins in staat was om rubidiumopname deur die rooibloedselle te inhibeer.

BEHANDELING VAN HARTGLIKOSIEDVERGIFTIGING IN HERKOUERS

Die literatuur wat in hierdie artikel gebruik is, is van mediese of mensgerigte navorsingswerk afkomstig. Daarom moet in ag geneem word dat hartglikosiede soos digitalis by die mens terapeuties gebruik word. Toksisiteit wat ontstaan, vind dus meestal plaas met dosisse wat nie veel hoër is as 'n terapeutiese dosis nie, of selfs met terapeutiese dosisse indien 'n pasiënt se algemene toestand verswak. Vergiftigings by die mens is dus meestal teen lae dosisse en nie soos by beeste met tulpvergiftiging as gevolg van inname van massale oordosisse hartglikosiede nie. Die middels wat gebruik word om digitalisvergiftiging by die mens te bestry, sal dus nie noodwendig doeltreffend wees teen tulpvergiftiging in beeste nie. Hier moet ook in gedagte gehou word dat slegs elektroliete wat in die behandeling van hartglikosiedvergiftiging by herkouers gebruik kan word, binne die bestek van hierdie artikel val.

Die dosisse van kaliumasetaat of kaliumchloried vir gebruik in herkouers is nog nie bekend nie. Dosisse wat op die mens van toepassing is, kan as uitgangspunt dien om herkouers te behandel totdat daar, indien moontlik, doeltreffende dosisse vir hulle uitgewerk kan word. Die voortdurende elektrokardiografie om die invloed van kaliumtoediening te monitor, is onprakties by vergiftigde herkouers. Deur intraveneuse toediening egter stadig toe te pas en dikwels tydens toediening na die dier se hart te luister, kan oordosering verhoed word.

Die dosering van kaliumchloried of kaliumasetaat per maagbuis kan maklik in herkouers toegepas word. Gewoonlik tree rumenstase baie vroeg in by herkouers met hartglikosiedvergiftiging, maar omdat die kaliumsoute wateroplosbaar is, behoort dit nogtans opgeneem te word uit so 'n statiese rumen.

Daar kan ook van Na-EDTA gebruik gemaak word om CA^{++}-ione uit die bloedstroom te verwyder. Dit kan slegs intraveneus toegedien word. Hierdie effek is net van korte duur en kan moontlik in die eerste behandeling van akute gevalle van waarde wees. Groot versigtigheid sal aan die dag gelê moet word met die toediening hiervan en herhalings sal sover moontlik vermy moet word omdat dit tot nierversaking of verlaagde bloeddruk kan lei[2].

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REVIEW OORSIG

DIE ABSORPSIE VAN ANTIMIKROBIESE STOWWE VANUIT DIE UTERUS VAN DIE KOEI

A. IMMELMAN*

ABSTRACT: Immelman A. **The absorption of antimicrobial substances from the uterus of the cow.** *Journal of the South African Veterinary Association* (1981) **52** No 3, 229–231 (Afr) Department of Physiology, Pharmacology and Toxicology, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

The influence of antimicrobial administration into the uterus of the cow are considered under 3 headings: (i) The influence on the oestrus cycle; (ii) The factors that may influence absorption through the endometrium; (iii) Contamination of milk with antimicrobial substances after intra-uterine administration.

Die geslagskanaal se vermoë om middels te absorbeer word dikwels in die veeartsenykunde uit die oog verloor. Met proefdiere is reeds in 1918 bewys dat verskeie stowwe waaronder morfien, apormorfien, atropien en kaliumsianied deur die vagina van die hond, kat en konyn geabsorbeer word[9]. Dit is ook bewys dat hierdie absorpsie genoegsaam is om sistemiese uitwerking te verkry.

Die gebruik van antimikrobiese stowwe in die beheer van infeksies in die uterus word algemeen toegepas deur sowel veeartse en vee-eienaars. Daar moet steeds in gedagte gehou word dat intrauteriene terapie met 'n antimikrobiese middel 'n invloed mag hê op die estrussiklus van die dier en dat residue van die middel in die vleis en melk mag voorkom.

Invloed op estrussiklus

Ginther en Meckley[6] het 'n studie gemaak van die invloed van antimikrobiese middels op die estrussiklus. Hulle het 40 ml van 'n 0,2% nitrofurasoonoplossing intrauterien geplaas op die eerste, tweede en derde dag van diëstrus. Daar is gevind dat koeie wat op die derde dag van diëstrus behandel is, 'n korter estrussiklus gehad het; die gemiddelde duur van die siklus was 15 d teenoor die 20 d van die kontrole groep. Behandeling op die ander dae het geen invloed uitgeoefen op die duur van die estrussiklus nie. Hierdie outeurs stel voor dat nitrofurasoon moontlik die duur van die oestrussiklus beïnvloed deur die aktivering van die luteolitiese meganisme van die uterus en dat dit kon geskied deur stimulering van 'n plaaslike sowel as 'n sistemiese baan.

Die plasing van 40 ml oksitetrasiklienoplossing (50 mg/mℓ) in propileenglikol in die uterus het ook 'n invloed op die lengte van estrussiklus. Die antibiotikum is op dag 4 en 15 van die siklus in die uterus geplaas. 'n Gelyke volume normale soutoplossing is in die uteri van kontrole koeie geplaas. Slegs by koeie wat op die vierde dag met die oksitetrasiklienoplossing behandel was, is 'n aanmerklik verkorte estrussiklus waargeneem nl. 10,7 d. In die kontrole groepe het die siklus 21 d geduur. In die gevalle waar die oksitetrasiklien op Dag 15 toegedien is het die estrussiklus 23d geduur[14]. Biopsies van die endometrium na die toediening van die oksitetrasiklienoplossing aan hierdie koeie het oppervlakkige nekrose van die endometrium getoon. Die finale gevolgtrekking was dat met aanwending van irriterende middels vroeg in die estrussiklus (3–9 d), die siklus verkort word. Indien dieselfde middels laat in estrus (14–17 d) aangewend word, word die siklus verleng. Aanwending in die middel van die siklus of net kort voor estrus het geen invloed op die verloop van die siklus nie. Hierdie outeurs stel dit dan ook dat die invloed op die siklus te weeggebring word as gevolg van die irritasie van die endometrium en nie as gevolg van dilatasie van die uterus nie omrede hulle met klein dosisse (1–5 mℓ) jodium soortgelyke resultate verkry het. Vorige resultate het reeds aangetoon dat die irriterende eienskappe van jodium gebruik kan word om die estrussiklus van koeie te sinchroniseer[12].

Latere navorsing het angetoon dat die substans wat regressie van die corpus luteum te weeg bring, prostaglandien $F_2\alpha$ is. Dit word in die wand van die uterus gevorm. Die aanwending van die irriterende substanse veroorsaak 'n inflammatoriese reaksie wat nodig is om hierdie prostaglandienvrystelling te bewerkstellig. In die merrie kon hierdie reaksie verkry word deur die aanwending van slegs 'n fisiologiese soutoplossing maar hierdie behandeling is in die koei nie suksesvol nie[15].

Absorpsie deur die endometrium

Die absorpsie van 'n middel vanuit weefsel word bepaal deur verskeie faktore. Die fisiese vorm waarin die middel voorkom is belangrik; as 'n steekpil nie oplos in die vloeistowwe van die uterus nie, kan die aktiewe bestanddeel nie vrygestel word vir absorpsie nie. Die chemiese eienskappe van middels verskil en vir 'n middel om deur die lipïede membraan van die endometrium geabsorbeer te word is dit belangrik dat dié middel in die ongeïoniseerde vorm teenwoordig is. In die meeste gevalle is 'n middel teenwoordig in sowel die geïoniseerde as ongeïoniseerde vorm; die hoeveelheid van elk sal afhang van die dissosiasiekonstant van die middel en die pH in die uterus (bv. 'n middel wat 'n swak suur is sal minder geïoniseerd wees in 'n lae pH en meer geïoniseerd wees in die uterus as die pH hoog is.)

Die teenwoordigheid van bloed, plasma, ander liggaamsvloeistowwe of etter in die uterus kan die absorpsie beïnvloed. Antimikrobiese stowwe kan aan proteïn bind; hierdie gebonde middel kan dan nie geabsorbeer word nie.

Die fisiologiese toestand van die endometrium is van

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uiterste belang vir die proses van absorpsie. Middels beweeg hoofsaaklik d.m.v. 'n proses van diffusie deur 'n membraan; as hierdie proses belemmer word, word absorpsie ook nadelig beïnvloed. Hierdie diffusie deur die membraan vind plaas totdat ekwilibrium verkry word. Indien die middel uit die uteruswand weggevoer word, word ekwilibrium nie so spoedig verkry nie en word absorpsie bevorder; die bloedsirkulasie in die uteruswand speel dus 'n groot rol in die proses van absorpsie.

Met bestudering van absorpsie vanuit die uterus moet al hierdie faktore in ag geneem word. Die verskil in resultate wat deur verskillende outeurs beskryf word, kan moontlik aan die variasie van bogenoemde faktore toegeskryf word.

Reeds in 1955 is die eerste gekontroleerde proewe gedoen om die absorpsie van sulfametasien te bepaal na intrauteriene toediening[2]. Hoë bloedkonsentrasies is verkry en die outeur is van mening dat absorpsie vanuit die uterus beter is as vanuit die maagdermkanaal van die kalf na orale toediening van sulfametasien. Na intrauteriene toediening word plasmakonsentrasies gehandhaaf vir periodes gelykstaande aan dié verkry na intraveneuse toediening. Terapeutiese konsentrasies van sulfametasien kan in plasma bereik word na intrauteriene toediening.

Met die verskyning van die tetrasiklien antibiotika is die absorpsie van chloortetrasiklien vanuit die uterus bepaal[3]. Die absorpsie van chloortetrasiklien was gelykmatig nadat 1 g aktiewe materiaal in die uterus geplaas is. 'n Maksimum plasmakonsentrasie van 0,08 μg/mℓ is verkry; indien dieselfde dosis intraveneus aan koeie gegee word, is die maksimum konsentrasie 1,5 μg/mℓ. Na beide toedienings kon chloortetrasiklien vir 24 h in die bloed aangetoon word.

Met die intrauteriene toediening van oksitetrasiklien teen 'n dosis van 4 mg/kg is dieselfde patroon waargeneem as vir chloortetrasiklien. 'n Maksimum konsentrasie is na 2 h bereik maar die peil was aansienlik hoër, nl. 0,3 μg/mℓ en die was na 24 h nog teenwoordig[11]. In dieselfde koeie is dieselfde dosis oksitetrasiklien intrauterien geplaas maar in hierdie geval is die antibiotikum vooraf gecheleer. Die gecheleerde vorm van oksitetrasiklien het baie swakker vanuit die uterus geabsorbeer; die maksimum plasmakonsentrasie van 0,16 μg/mℓ is eers na 4 h bereik en 24 h na toediening kon geen oksitetrasiklien in die plasma gedemonstreer word nie.

Navorsers het van die standpunt uitgegaan dat die uterus net na partus antimikrobiese stowwe meer geredelik sal absorbeer as gevolg van die vergrote oppervlakte van die wand, die toename in sirkulasie en omrede die endometrium versteur of gedeeltelik verwyder is tydens loslating van die plasenta. Laasgenoemde sou tot gevolg hê dat die kapillêre bloedvate meer blootgestel is en dat penetrasie makliker kon plaasvind. In die navorsing van Righter, Mercer, Kline en Carter is gesonde Holsteinkoeie gebruik wat almal normaal gekalf het[13]. Hulle is in 3 groepe verdeel en onderskeidelik intrauterien behandel met sulfametasien (66 mg/kg), oksitetrasiklien (500 mg) en 'n kombinasie van 2 000 000 eenhede penisillien en 2,5 g dihidrostreptomisien. Die eerste behandeling is gedoen binne die eerste 6 d na partus en is weer herhaal 10,20 en 30 d later. Om absorpsie vas te stel is die konsentrasie van die middels in serum bepaal. Daar is gevind dat sulfametasien reeds met die eerste behandeling terapeutiese bloedpeile tot gevolg gehad het maar dat hoër waardes verkry is namate die periode na partus verleng; maksimum konsentrasies is verkry met behandeling na 30 d. In die geval van oksitetrasiklien is die beste absorpsie verkry na toediening op Dag 20. Bloedkonsentrasie na die eerste toediening was uiters laag en 'n groot variasie tussen die eksperimentele diere is waargeneem. Penisillienabsorpsie was ook laag na die eerste toediening. In die daaropvolgende behandelings het die absorpsie aanmerklik gestyg tot die hoogste konsentrasie na die laaste behandeling. Met die laaste 3 behandelings is terapeutiese konsentrasies bereik 0,5 h na toediening en is dit vir minstens 4 h gehandhaaf. Dihidrostreptomisien het dieselfde patroon as penisillien gevolg. Die slotsom van hierdie bevindings is dus in teenstelling met die verwagting dat in die geval van antibiotika, absorpsie toeneem namate involusie van die uterus plaasvind maar dat die absorpsie van sulfametasien nie veel deur die involusieproses bevoordeel word nie.

Antimikrobiese stowwe word nie alleen direk na partus aangewend nie maar veral as daar reeds endometritis is. Die invloed van endometritis op die absorpsie van oksitetrasiklien is bestudeer deur Masera et al[10]. Hier is gebruikgemaak van biopsies van die endometrium om die konsentrasie van oksitetrasiklien in die weefsel te bepaal en terselfdertyd is dit dan vergelyk met plasmakonsentrasies. 'n Dosis van 8 mg/kg is in die uterus geplaas. Hoë konsentrasies van 4 μg/mℓ is in die weefsel gehandhaaf gedurende die observasieperiode van 72 h. Die plasmakonsentrasie was egter baie laag (0,12–0,07 μg/mℓ) en ook net gedurende die eerste 24 h. Daarna kon geen oksitetrasiklien meer gedemonstreer word nie. In normale koeie was die plasmakonsentrasie 0,29 μg/mℓ na 12 h maar na 24 h was daar geen oksitetrasiklien meer teenwoordig in die plasma nie. Absorpsie het dus vinniger plaasgevind. Die gevolgtrekking is dus dat endometritis die absorpsie van oksitetrasiklien uit die uterus belemmer.

'n Baie interessante bevinding uit hierdie werk is verkry nadat dieselfde dosis oksitetrasiklien òf intramuskulêr òf intrauterien aan gesonde beeste gegee is en die diere 24 h later geslag is. Na intrauteriene toediening kon oksitetrasiklien slegs in die endometrium gedemonstreer word; daarteenoor het intramuskulêre toediening terapeutiese konsentrasies tot gevolg gehad in al die dele van die geslagstelsel.

Uitskeiding in melk

Antimikrobiese stowwe in melk is veral van groot belang vir die verbruiker van melk en die vervaardiger van suiwelprodukte. Die gebruik van antimikrobiese stowwe vir lokale behandeling van mastitis is die grootste bron van hierdie stowwe in die melk[1]. Aangesien dit aangetoon is dat hierdie stowwe ook uit die uterus tot 'n mindere of meerdere mate absorbeer kan word, bestaan die moontlikheid dat melk via hierdie roete kontamineer mag word.

In vroeëre studies is 'n kombinasie van penisillien en dihidrostreptomisien of oksitetrasiklien in die uterus van normale koeie geplaas terwyl hulle in verskillende stadia van die estrussiklus was. Met melkanalise kon geen een van hierdie antibiotika gedemonstreer word nie[8]. Die gevolgtrekking dat melk van koeie na intrauterine behandeling met hierdie antibiotika geskik is vir menslike gebruik, kan egter nie sonder meer aanvaar word nie: die metode wat gebruik is om penisil-

lienresidue te bepaal is nie baie sensitief nie en die metode van oksitetrasiklienbepaling was baie onakkuraat[11]. Die dosis van 100 mg oksitetrasiklien wat toegedien is, is ook besonder laag.

Die uitskeiding van prokaïenpenisillien en dihidrostreptomisien in melk na intrauteriene toediening aan koeie tydens estrus is ook deur Henningson et al. bestudeer[7]. Hulle kon ook nie positiewe resultate in melk verkry nie. Die plasing van 'n nitrofuraan ("Furacin", Eaton Laboratories) in die uterus het ook geen residue in die melk tot gevolg gehad nie. Dieselfde resultate is verkry nadat die nitrofuraan herhaaldelik in die vagina geplaas is.

In 'n latere studie is verskeie handelspreparate gebruik wat verskillende kombinasies van antibiotika en sulfonamiede bevat het. Vir die proef is koeie gebruik waarvan die meeste in estrus was. Die bepaling in melk het gelei tot positiewe bevindings vir die uitskeiding van prokaïenpenisillien (wat voorgekom het in twee verskillende handelspreparate). Die ander bestanddele van die preparate nl. dihidrostreptomisien, bensatienpenisillien, neomisien, chlooramfenikol, polimiksien, oksi- en chloortetrasiklien en sulfatolamied kon nie in die melk gedemonstreer word nie[5].

Die werk van Miller et al. het bevind dat nie-gecheleerde oksitetrasiklien vanuit die uterus opgeneem word en in die melk uitgeskei word vanaf 2 h tot 12 h na behandeling in konsentrasies wat wissel van 0,03–0,16 $\mu g/m\ell$[11]. Hulle stel dan ook voor dat melk na intrauteriene behandeling vir 24 h moet onttrek word vir menslike gebruik. Met die gebruik van gecheleerde oksitetrasiklien word geen antibiotika in die melk gevind nie.

Die mees onlangse werk van Black et al. het aangetoon dat 120 mℓ akriflavien (1 mg/mℓ) intrauterien toegedien aan 21 koeie in een koei in die melk uitgeskei is vir die 6 melkings wat hulle as observasieperiode gebruik het. Die metode wat deur hulle gebruik was, was besonder laag in sensitiwiteit (8 $\mu g/m\ell$) en dus is hulle negatiewe bevindings vir die ander monsters nie baie betroubaar nie[4]. Hibitaan kon ook deur hulle in enkele monsters demonstreer word maar weereens is die sensitiwiteit van hulle toets nie sodanig dat die ander negatiewe bevindings betroubaar is nie. Die toediening van 20 mℓ piprolidino-metiel-tetrasiklien (Reverin Hoechst) het in 4 koeie uit 20 positiewe resultate gegee tydens die eerste melking.

Die kombinasie toediening van 400 mg chlooramfenikol en 1 g dapsoon het 'n antimikrobiese aksie in melk tot gevolg gehad in 2 uit 20 koeie vir die eerste 2 melkings na toediening en die een koei wat positief tot die sesde melking na toediening. Die outeurs het egter nie bepaal watter een van die twee of albei middels verantwoordelik was vir hierdie antimikrobiese werking nie.

Die absorpsie van antibiotika vanuit die uterus sal beïnvloed word deur toestande soos beskryf onder die voorafgaande hoof maar dit kan in die algemeen gestel word dat konsentrasie van antibiotika in bloed redelik laag is. Die werk van Ziv wat die verskyning van antibiotika in melk na intramuskulêre behandeling aangetoon het, is ook hier van toepassing[16]. Hy kon aantoon dat die konsentrasieverhouding van melk tot serum in die geval van penisillien 0,26, dihidrostreptomisien 0,5, tetrasiklien 0,6–1,4 en sulfametasien 0,59 is. 'n Inflammatoriese proses van die uierweefsel kan hierdie konsentrasieverhouding beïnvloed. Dieselfde outeur het ook aangetoon dat die hoeveelheid penisillien uitgeskei in mastitismelk 250% is van dié gevind in normale melk. Sekere antibiotika bv. tilosien, spiramisien en eritromisien word in hoë konsentrasies in melk uitgeskei na intramuskulêre toediening maar huidig is daar geen data aangaande hulle absorpsie vanuit die uterus nie.

Uit die publikasie van Ziv kan dus afgelei word dat slegs baie klein hoeveelhede van die antibiotika in melk sal verskyn.

Die variërende bevindings van outeurs oor die jare mag ook daaraan toegeskryf word dat tegnieke om die middels in melk te bepaal gaandeweg meer doeltreffend geword het terwyl vroeëre negatiewe resultate aan relatief onsensitiewe metodes te wyte kon wees.

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BOOK REVIEW **BOEKRESENSIE**

THE EYE IN VETERINARY PRACTICE VOL. I: EXTRAOCULAR DISEASE

J. ROWAN BLOGG
W.B. Saunders Company, Philadelphia 1980 pp xxii 586, Figs 144 (colour plates 4), Tabs 42, Publ. Price £38,00
ISBN 0 7216 1751 4

Hierdie volume wat handel oor die ekstraokulêre toestande bevat 14 hoofstukke wat op 'n ietwat ongewone maar stimulerende wyse aangebied word.

Uitstaande is die hoofstukke oor die meer kwesbare dele van die eksterne oog naamlik die ooglede en horingvlies. Die meer beskermde dele en veral die sklera lewer weinig op en derhalwe die amper teleurstellende hoofstuk daaroor.

Myns insiens is daar te veel plek afgestaan aan anomalieë in hoofstuk 3.

In sy geheel gesien, is dit 'n voortreflike aanbieding en nie net 'n uitstekende handleiding vir student en praktisyn nie maar by uitstek vir die kieskeurige oftalmoloog.

Met groot verwagting word daar uitgesien na Vol II wat sal handel oor die intraokulêre toestande.

S.W. Petrick

BOOK REVIEW **BOEKRESENSIE**

JONES'S ANIMAL NURSING

D.R. LANE
3rd Ed. Pergamon Press, Oxford 1980 pp. 580, Figs 206, Tabs 26, Publ. Price Flexicover

This 3rd edition of Jones's Animal Nursing contains chapters on Anatomy, Physiology and Embryology; Management, Hygiene and Feeding; First Aid; Theory and Practice of Nursing; *Diagnostic Aids and Laboratory Tests;* Medical Nursing; Radiography; Surgical Nursing; Obstetrical and Paediatric Nursing, all adequately illustrated.

The sections on elementary parasitology and on the prevention of the spread of infection have been considerably expanded and the newly added section on antiseptics and disinfection will fulfil a definite need.

The section on Post-operative Care of Patients now includes post-operative emergencies, maintenance of intravenous drips and wound care. The method of application of a Robert Jones bandage could have been included in this chapter to good effect.

The new edition has a flexicover and is printed on good quality paper. It deals with dogs, cats, cage birds and small laboratory animals. As this book is published for The British Small Animal Veterinary Association, sections on the care, nursing and bandaging of large animals would be outside the scope of this very good book, which is a pity. A chapter on physiotherapy could, however, enhance its value.

This book can be recommended to all small animal veterinary nurses and student nurses as a useful, practical, quick reference work.

Ingrid Wolleschak

SHORT COMMUNICATION KORT BERIG

THE ELECTROCARDIOGRAM OF THE CHEETAH *(ACINONYX JUBATUS)*

C. BUTTON*, D.G.A. MELTZER* and MARIA S.G. MÜLDERS*

ABSTRACT: Button C.; Meltzer D.G.A.; Mülders M.S.G. **The electrocardiogram of the cheetah *(Acinonyx jubatus)*.** *Journal of the South African Veterinary Association* (1981) **52** No. 3, 233–235 (En) Department of Physiology, Pharmacology and Toxicology, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

Electrocardiograms were recorded on 19 cheetahs immobilized with the steroidal anaesthetic-hypnotic agent Saffan comprising 0,9% m/v alphaxalone and 0,3% alphadolone. Sinus rhythm was recorded in all animals and heart rate was rapid averaging 173 ± SD 18 beats per minute. The average of mean electrical axes in the frontal plane was + 76° ± SD 13°. Mean ± SD durations in milliseconds on lead II were: P 47 ± 6,5; PR 93 ± 11,5; QRS 53 ± 7,5; QT 193 ± 19,7. The amplitude of limb lead electrocardiographic complexes were low, resembling those of the domestic cat more closely than those of the dog.

INTRODUCTION

The electrocardiogram (EKG) is a useful clinical and research tool for the evaluation of cardiac rate, rhythm, and conduction. It may be of value for determining chamber enlargement (hypertrophy and/or dilatation).

To provide normal baseline values, we recorded electrocardiograms (EKGs) on cheetahs in the field.

MATERIALS AND METHODS

EKGs were recorded on 19 apparently healthy, full-grown male cheetahs. Two different single-channel heated stylus recorders were used (Birtcher Electrocardiograph-Model 339 and Fukuda Electrocardiograph-Model FJC 7110). The former recorder was powered by a portable generator and the latter by a battery pack.

Individual cheetahs were herded into a mesh-covered chute, where they were held to the ground with thin poles and immobilized by means of an intravenous injection of Saffan (0,9% m/v alphaxalone, 0,3 m/v alphadolone, Glaxo Labs) of approximately 3 mg/kg. Next they were carried to a table, electroejaculated and weighed. They were then placed in right lateral recumbency in the shade of nearby trees. Heart sounds were ausculated on both left and right sides of the thorax. Alligator clip electrodes were placed on electrode-paste prepared skin just below the elbows and stifle joints, in the 6th left lower intercostal space over the cardiac apical impulse (CV_6LL) and on the dorsal midline just behind the scapulae (V_{10}).

Standard bipolar limb leads I, II and III; augmented unipolar limb leads aVR, aVL, and aVF; and unipolar leads CV_6LL and V_{10} were recorded at a calibration of 10mm equal to 1mV at paper speeds of 25 and (in most instances) also 50 mm/s.

Cardiac rate was calculated from the mean RR interval on lead II, and the mean electrical axis (MEA) was calculated using standard methods[1,2]. Configurations of wave forms were noted for all leads, using lower case letters q, r and s if the deflection was less than 0,5 mV and capital letters Q, R and S if the deflection was 0,5 mV or more.

Amplitudes of the P wave, QRS complex and T wave were measured on lead II to the nearest 0,5 mm (0,05 mV) with the aid of an illuminated magnifying viewer. Durations of P, PR, QRS and QT were likewise measured to the nearest 0,5 mm (10 ms) on 50 mm/s strips for lead II. At least 5 complexes were measured to determine amplitudes and durations.

RESULTS

All the cheetahs were in sinus rhythm and had normal heart sounds. Most had rapid heart rates: mean 173 ± SD 18 beats per minute with a range of 124–195. There was no sign of sinus arrhythmia at this heart rate. The average MEA was 76 ± SD 13° with a range of 48–94°.

On lead II for 12 cheetahs durations were: P wave 47 ± SD 6,5 ms (40–60); PR interval 93 ± SD 11,5 ms (70–110); QRS 53 ± SD 7,5 ms (40–60) and QT was 193 ± SD 19,7 ms (160–230). The P wave on lead II was always positive averaging 0,18 ± SD 0,05 mV (0,10–0,25) N = 19. Q and q waves on lead II averaged 0,13 ± SD 0,09 mV (0,05–0,4) N = 14; and R and r waves averaged 0,81 ± SD 0,24 mV (0,45–1,3) N = 19. T waves were usually negative on lead II, averaging 0,11 ± SD 0,06 mV (0,05–0,25) N = 14.

The configuration and polarity of P waves, QRS complexes and T waves are detailed in tables 1–3 respectively and representative electrocardiographic complexes for 12 cheetah are reproduced in figure 1.

DISCUSSION

The results indicate that myocardial conduction of the cheetah is similar to that of the cat and the dog. Atrial depolarization (Table 1) is in a net leftward (positive P waves I and CV_6LL), backward (positive P waves on II, III and aVF, negative P waves on aVR and aVL) and downward (negative P waves on V_{10}) direction. The major forces of ventricular depolarization (Table 2) are likewise leftward (predominance of r waves on I and R waves on CV_6LL), backward (predominance of R waves on II, III and aVF, predominance of S and s waves on aVR and aVL) and downward (predominance of Q and q waves on V_{10}). The leftward and backward orientation of ventricular depolarization is

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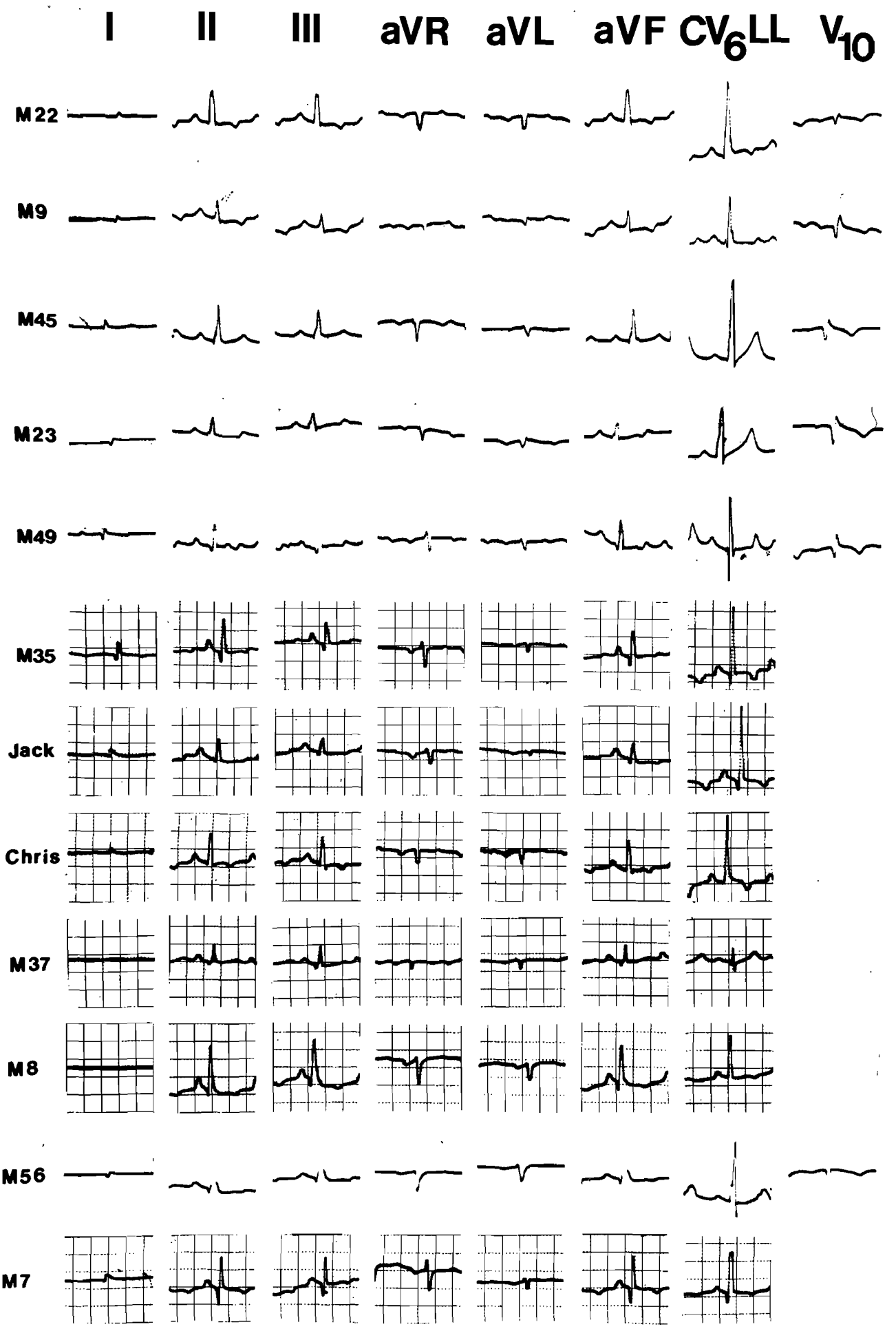

Fig. 1 Representative electrocardiographic complexes for various leads recorded at 50 mm/s for 12 cheetah. 1 cm = 1mV

Table 1: CONFIGURATION OF P WAVES ON VARIOUS LEADS

Lead	+	−	i.e.	N
I	5		14	19
II	19			19
III	18			18
aVR		19		19
aVL		17	2	19
aVF	19			19
CV_6LL	18			18
V_{10}		5	1	6

i.e. = isoelectric, that is, no waveform visible
N = sample number

The major forces of ventricular repolarization were more varied (Table 3) and were mostly forward (predominance of negative T waves on II, III, and aVF and positive T waves on aVR and aVL) and downward (negative T waves on V_{10}). There was no clear indication of a right- or leftward tendency, although T waves were usually larger and more often positive on aVR than on aVL, indicating a rightward bias.

Like the domestic cat[3], the cheetah has a low amplitude EKG. This was especially apparent on leads I and aVL where P and T waves were frequently isoelectric.

This study suffers from limitations imposed by the use of single channel heated stylus recorders (thick lines, lower frequency response and lack of high paper speeds) but it may nevertheless provide adequate baseline data for future interpretation of EKGs in this species.

Table 2: CONFIGURATION OF QRS COMPLEXES ON THE VARIOUS LEADS

Lead	qr	qR	Qr	qrs	qRs	QRs	r	R	rs	Rs	rS	qs	QS	i.e.	N
I	12						3	1						3	19
II	1	13			2		1	1		1					19
III	3	10			2			1	2						18
aVR									6		10	2	1		19
aVL	2						1		12		2	2			19
aVF	2	12			2			1	1	1					19
CV_6LL	1	6		2	2	1		3		3					18
V_{10}	4		2												6

Lower case letters designate waveforms of less than 0,5 mV
Upper case letters designate waveforms equal to or greater than 0,5 mV
i.e. = isoelectric, that is, no waveform visible
N = sample number

Table 3: CONFIGURATION OF T WAVES ON THE VARIOUS LEADS

Lead	+	−	±	∓	i.e.	N
I	1	2			16	19
II	3	14		1	1	19
III	4	12			2	18
aVR	12	4	1		3	19
aVL	7	3	1		8	19
aVF	3	13		2	1	19
CV_6LL	9	7		1	1	18
V_{10}		6				6

i.e. = isoelectric, that is, no waveform visible
N = sample number

supported by the fact that all cheetahs in this study had MEAs of between 48 and 94° with an average figure of 76°.

ACKNOWLEDGEMENTS

The authors thank Dr D.J. Brand of the National Zoological Gardens in Pretoria for the opportunity to carry out this study. Miss Ann van Dyk, warden of the De Wildt Research and Breeding Station of the National Zoological Gardens is thanked for her enthusiastic support. The loan of one of the electrocardiographic recorders by Dr J. van Heerden is gratefully acknowledged.

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BOOK REVIEW BOEKRESENSIE

AN INTRODUCTION TO PRACTICAL ANIMAL BREEDING

C. DALTON
Granada Publishing Limited, Frogmore, St. Albans, Herts AL2 2NF
ISBN 0 246 11194 1 hardback; 0246 11351 0 paperback; 162 pages, 26 Figures, Price R12,00

The subject of genetics and animal breeding has progressed enormously in recent years. The full implications of these advances have yet to be realised on farms throughout the world – especially for sheep and cattle – in spite of ever increasing economic pressures on farmers to improve the performance of their livestock.

Genetics is rather difficult for students of Veterinary Science and Agriculture to understand and the successful application of genetics to animal breeding is even more difficult in practice. The book, by an expert geneticist and breeder who fully understands the difficulties of both students and stockmen, explains the theoretical basis of Mendelism, population genetics, selection and breeding, and their applications on the farm.

Part I is an introduction to the traits or characteristics that concern breeders of farm animals. Part II covers the fundamentals of genetics and Part III carries this through into population genetics and selection. Part IV discusses breeding in practice.

A very handy "Glossary" explains the most important genetical terms, another very useful asset of the book!

Dr Dalton was a lecturer in animal production at the University of Leeds for eight years before joining the New Zealand Ministry of Agriculture and Fisheries as a scientist at the Whatawhata Hill Country Research Station, Hamilton.

D.R. Osterhoff

BOOK REVIEW BOEKRESENSIE

ANIMAL NUTRITION

J.W. GROENEWALD and P.A. BOYAZOGLU
J.L. VAN SCHAIK (Pty) Ltd., Libri Building, Church Street, Pretoria
ISBN 0 627 01108 X; 398 pages, 148 tables, 12 figures, 6 curves, Price R15,00

Both authors have been attached to the Department of Zootechnology, Faculty of Veterinary Science and lectured for many years; the senior author (J.W.G.) from 1932 to 1958 and the junior author (P.A.B.) from 1965 to 1974. This is the reason for the inclusion of many veterinary aspects in their book.

The book brings together data and concepts on animal nutrition which are peculiar to the South African situation. An effort is made to record the experience gained in the field of animal nutrition and management over a period of years, as local conditions and circumstances differ basically from those of the Northern Hemisphere.

Feeding comprises by far the largest expenditure in the production of animal products for human consumption. The aim should naturally be to obtain optimum levels of production within economical limits. This can be achieved only with a knowledge of the value of feeds available and the best way of combining them into mixtures that will afford maximum contribution to satisfy the nutrient requirements of the animal.

Many basic facts are given like "a maizeland yielding 40 bags of mielies per ha will supply 40 tons of silage per ha" and "a ton of silage requires 4 m^3 of storage space", which are very useful to all involved in animal nutrition.

The basic aspects of nutrition are subdivided into chapters dealing with composition of feeds, physiological function of animals, minerals and trace elements, vitamins and feed additives, roughage, pasture and fodder crops, and concentrates. In the second part dealing with the nutrition of different species emphasis in placed on the energy and protein requirements, examples of rations for growth, maintenance, pregnancy and lactation, nutritional deviations and deficiencies, their recognition and correction. Besides the species dealt with – horses, dairy cattle, beef cattle, sheep and goats, pigs, dogs and cats – a special chapter is set aside for sub-maintenance feeding during droughts.

A subject index helps to find your way to the different feedstuffs. In all, a very useful book to veterinarians, to animal husbandry men, to veterinary students and all students in animal nutrition and to animal breeders and producers. The book is clearly written and a great bargain for the price mentioned.

D.R. Osterhoff

SHORT COMMUNICATION KORT BERIG

SAFFAN INDUCED POIKILOTHERMIA IN CHEETAH *(ACINONYX JUBATUS)*

C. BUTTON*, D.G.A. MELTZER* and MARIA S.G. MÜLDERS*

ABSTRACT: Button C., Meltzer D.G.A., Mülders M.S.G. ***Saffan induced poikilothermia in cheetah (Acinonyx jubatus).*** *Journal of the South African Veterinary Association* (1981) 52 No. 3 237–238 (En) Department of Physiology, Pharmacology and Toxicology, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

The steroidal anaesthetic agent Saffan (a 1,2% m/v mixture of alphaxalone and alphadolone) induced a state of poikilothermia in cheetahs. On a warm day (maximum temperature 29° C) rectal temperatures rose in 7 of 8 male cheetahs given Saffan. The highest rectal temperature recorded was 41° C. On a cool day (minimum temperature 19,5° C) rectal temperatures fell in 6 of 6 male cheetahs. The lowest rectal temperatures recorded was 36,2° C. Saffan at 3 mg/kg intravenously in cheetahs is an excellent and safe hypnotic but should be used with caution on both hot and cold days

INTRODUCTION

Saffan (CT 1341, Althesin, Glaxo Labs) is an injectable steroid sedative, hypnotic or anaesthetic drug recommended for use in domestic cats and monkeys[1-3]. The injectable saline solution comprizes a 1,2% m/v mixture of 2 steroids, alphaxalone or steroid I (0,9% m/v) and alphadolone or steroid II (0,3% m/v). Polyoxyethylated castor oil (20% m/v), included in the solution as a solubilizer, is a potent histamine releasing agent in dogs and, occasionally, in the domestic cat.

One of us (DGAM) has been using Saffan for immobilizing cheetahs *(Acinonyx jubatus)* for 4 years. More than 250 hypnotic administrations of Saffan have been made with no associated deaths.

Recently we decided for general interest, to monitor rectal temperatures and pulse and respiratory rates (TPR) in Saffan hypnotised cheetahs. The results indicate that Saffan has a poikilothermic effect in this species.

MATERIALS AND METHODS

Two groups of male cheetahs, comprising 8 and 6 animals respectively, were given hypnotic doses of Saffan on 2 days, one week apart. On the first occasion the weather was warm and sunny (26° C at 10h15 rising to 29° C at 12h21) and on the second it was cool and overcast (19,5° C at 09h05 rising to 20° at 10h05).

Individual cheetahs were herded into mesh covered chutes where they were held to the ground by passing narrow poles through the chute mesh. A fore or rear leg was pulled through the mesh for an injection of Saffan into the cephalic or recurrent tarsal vein. Between 8 and 10 ml were injected over approximately 15 seconds. Retrospective calculations showed that between 2,2 and 3,3 mg/kg combined steroids had been injected into the 14 male cheetahs which averaged 43,3 ± 4,1 kg body mass.

After induction, they were moved to a table where initial TPR were recorded before anatomical measurements were made and semen was collected by electroejaculation. The animals were then carried under the shade of nearby trees, laid in lateral recumbency and an electrocardiogram was recorded. TPRs were noted as often as possible, but practical difficulties prevented recordings being made at fixed and regular time intervals.

RESULTS

On the warm day rectal temperatures (RT) rose in 7 of 8 cheetahs. In one animal RT reached a high of 41° (105,8° F) 42 minutes post induction. RTs peaked at between 30 and 80 minutes post induction, and then gradually declined (Fig. 1). On the cool day, RTs fell in all 6 cheetahs. The lowest RT recorded was 36,2° C (97,2° F) 161 minutes post induction. On both days, animals which had to be chased had higher RTs than those which entered the chute more calmly.

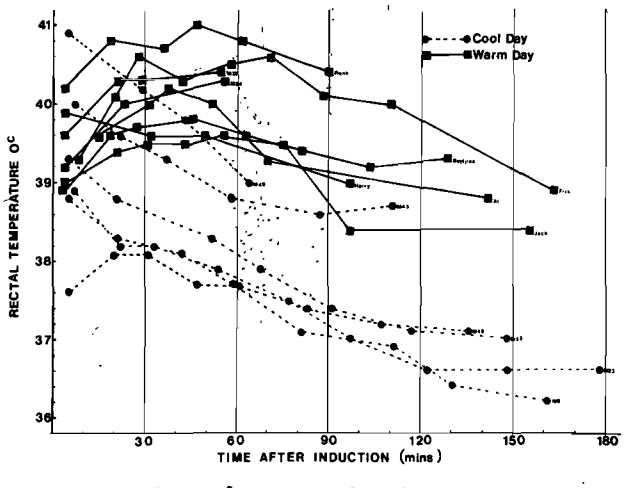

Fig. 1 Rectal temperatures in cheetah immobilized with Saffan on a warm and on a cool day

Pulse rates (PR) were between 120 and 200 per minute at the first recording after induction in both groups. There was a gradual decline in PRs in both groups with time but there was no distinct difference between the groups (Fig. 2).

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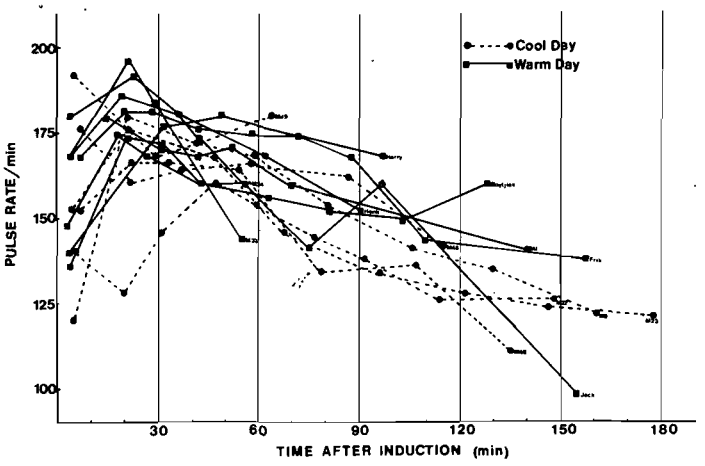

Fig. 2 Pulse rates in cheetah immobilized with Saffan on a warm and on a cool day

Respiratory rates (RR) (Fig. 3), not surprizingly followed RT closely. Animals with RTs greater than 39,5° C with few exceptions had RRs of more than 30 per minute. A maximum RR of 152 per minute was recorded on the warm day in a cheetah at 62 minutes post induction with a RT of 40,8° C. On the cool day, only 2 of 6 cheetahs had RRs of more than 30 per minute. Both of these had been very excited before induction, and both had high RTs immediately after induction (40,9 and 40° C).

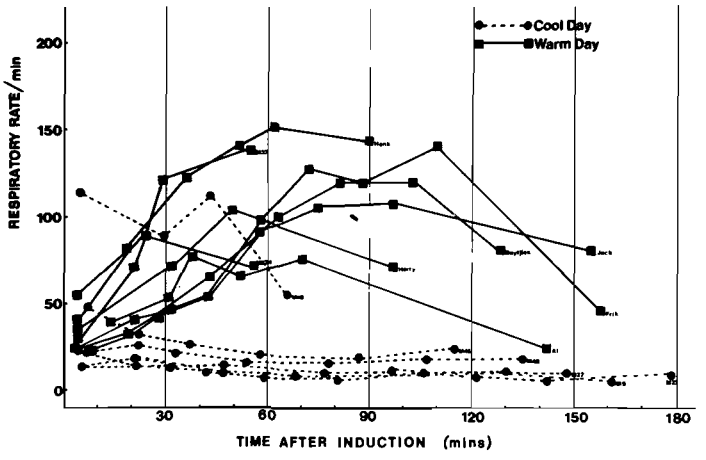

Fig. 3 Respiratory rates in cheetah immobilized with Saffan on a warm and on a cool day

DISCUSSION

The poikilothermic effects of Saffan on cheetah are presumed to be the result of supression of hypothalamic thermoregulatory areas. This effect of Saffan has not, to our knowledge, been responsible for the death of any cheetahs but obviously it has that potential. The environmental temperatures (19,5–20° C and 26–29° C) in this report are mild in comparison to the 37 to 43° experienced in some parts of the country during summer months. It would be advisable to anaesthetize cheetahs with Saffan during cooler parts of the day and to monitor RTs when environmental temperatures are above 25° C. Likewise it would be advisable to avoid anaesthetizing them in cold weather or, at least, to take steps to minimize heat loss.

The dose of Saffan in cheetahs which has been found safe and effective for minor procedures is approximately 3 mg/kg by intravenous injection. At this dosage they show hypnosis (deep sleep) but can be partly roused by noxious stimuli, e.g. electroejaculation. When left alone they remain recumbent for between 1 and 3 hours. In contrast the recommended intravenous dose for a healthy domestic cat is 9 mg/kg which gives approximately 10 minutes of surgical anaesthesia.

We conclude that Saffan is a safe and effective hypnotic when administered intravenously to cheetahs at approximately 3 mg/kg, but caution that rectal temperature should be monitored when environmental temperatures are extreme. We have never observed the histamine-release phenomenon in cheetahs at the above dose range. Intramuscular administration of Saffan is less satisfactory because larger doses have to be given to produce adequate hypnosis and the larger volume is less easily administered.

ACKNOWLEDGEMENTS

The authors thank Dr D.J. Brand of the National Zoological Gardens in Pretoria for the opportunity to carry out this study. Miss Ann van Dyk, warden of the De Wildt Cheetah Research and Breeding Station of the National Zoological Gardens is thanked for her enthusiastic support.

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SHORT COMMUNICATION **KORT BERIG**

INFECTION OF THE CENTRAL NERVOUS SYSTEM OF HORSES WITH EQUINE HERPESVIRUS SEROTYPE 1*

P. THEIN**

ABSTRACT: Thein P. **Infection of the central nervous system of horses with equine herpesvirus serotype 1.** *Journal of the South African Veterinary Association* (1981) **52** No. 3, 239–241 (En) Institute for Medical Microbiology, Infectious and Epidemic Diseases, Veterinary Faculty, Ludwig – Maximilians University, Konigingstrasse 49, 8000 Munich 22, Federal Republic of Germany.

During the last 2 years different equine herpesviruses serotype 1 strains have been isolated from cases of paretic or paralytic disease among horses in the Federal Republic of Germany. In this paper the available information is collated and briefly reviewed. A short description of the symptoms and the possible mechanism of the pathogenesis are given.

INTRODUCTION

Various research workers have confirmed the ability of equine herpesvirus serotype 1 (EHV_1) to be associated with infection of the central nervous system (CNS) of horses. This association has been based mainly on morphological and serological studies. However, in a few instances virological studies have been undertaken[1-3 6 9-11]. In most of these cases pregnant mares which had aborted as a result of the virus infection were affected. An EHV_1-infection during pregnancy therefore has been considered as a precondition for the pathogenesis of the CNS form of the infection[2 3 5 10].

From February 1977 to August 1979 we observed a number of cases of paresis and/or paralysis amongst male and female horses of different breeds in the Federal Republic of Germany. In 2 of these cases we were able to isolate EHV_1 from the CNS of sick geldings, while in another outbreak we confirmed by means of serological investigations that the aetiology was EHV_1 infection.

The clinical observations and the results of our laboratory work are presented.

DESCRIPTION OF CASES AND INVESTIGATIONAL STUDIES

Case No 1

In February 1977 an 8-year-old gelding became acutely ill with severe neurologic signs. Rabies-, Borna- or Aujesky-virus infection was suspected. The main symptoms were ataxia with continuous movement of the right hindleg which was accompanied by a "changed behaviour". There were no signs of respiratory disease. The animal had not been vaccinated against rhinopneumonitis.

This horse arrived at our clinic on the day following the appearance of the first clinical signs. At that time it could not stand and showed continuous paddling movements of the limbs. Because the prognosis seemed hopeless the animal was euthanased.

At autopsy apart from a dilated and full urinary bladder no other changes or lesions of significance were seen. Neurohistological investigation of the brain showed status spongiosus of the cerebrum and rhombencephalon. We could thus exclude infections with Rabies-, Aujesky- and Borna-virus.

In the first passage of brain material (left hemisphere) in equine foetal kidney cells (EFK) EHV_1 (strain T 473) was isolated. The cerebrospinal fluid was negative.

The isolated virus only replicated in EFK-cells. There was no cytopathic effect (CPE). It did not grow in RK_{13}- or C1-cells. In EFK-cells the virus reached an infectivity titre of $10^{6,25}$ $TC1D_{50}/m\ell$.

Intraperitoneal injection (0,05 $m\ell$ virus and 10 fold dilutions up to 10^{-4}) had no effect on one-day-old mice. This is similar to infection with the vaccine strain RAC-H and a respiratory EHV_1-strain (T252). In DTT-marker test[7 8] T 473 proved to be sensitive (DTT^+). Its serum virus neutralizing antibodies reached titres up to a dilution of 1:112. There were no EHV_1 antibodies in the cerebrospinal fluid.

The virological and serological results in conjunction with the clinical anamnesis are suggestive of EHV_1-infection of the CNS in this horse. The properties of the isolated strain are those of the so-called respiratory strains of the rhinopneumonitis virus.

Case No 2

Gelding No 2 became ill in August 1979. It showed symptoms of a generalized CNS-disorder with frenzy, ataxia, paresis, anorexia, circling and lastly paralysis.

The horse was euthanased on the 6th day of the disease. Specimens of spinal cord and blood were sent to us for virological, serological and morphological investigations.

At the second passage of lumbar spinal material in EFK-cells EHV_1 was isolated. The virus shows the same tissue culture spectrum as that of strain T 473. Further characterization of the strain is under progress – at the moment it seems to be a strain with the typical properties of the respiratory EHV_1 representatives (strain T 946).

Histopathological investigation of the spinal cord showed a myelitis which was characterized by demyelination, round cell infiltration, perivascular cuffing and haemorrhage into the nervous tissue.

*Paper delivered at the South African National and International Veterinary Congress in Johannesburg on 3rd to 7th September 1979.

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Case No 3

On a stud farm a mare (No 11) became ill. She showed paresis of both hind legs and paralysis of the urinary bladder. This occurred 6 weeks after service in March 1978 and normal foaling. Six days later she was completely paralytic and died. A few days later – that is six weeks after service by the same stallion – another mare (No 2) developed the same clinical signs. This horse survived after treatment with preparations containing vitamin B complex, antibiotics and cortisone. Ten days later a third mare (No 7) showed paresis of the hind legs. She was in the 10th month of gestation and shortly after the onset of the disease she aborted due to EHV_1 infection. She recovered after treatment.

Between April 20th and May 3rd 3 more mares (No. 1, 4 and 9) of the same stud aborted due to EHV_1 infection. The results of virological and serological investigations of these horses are shown in Table 1. Unfortunately material for virological and morphological studies was not obtained from Mare No 11.

Table 1

Horse	Statement	Virus proof	EHV_1-antibodies April	May	June
Mare no. 1	abortion 10.m.	n.d.	160	n.t.	n.t.
Mare no. 2	barren – paresis	n.d.	112	n.t.	n.t.
Mare no. 3	n.st.		n.t.	>192	>192
Mare no. 4	abortion 10.m.	n.d.		>192	160
Mare no. 5	n.st.			160	96
Mare no. 6	n.st.			96	>192
Mare no. 7	abortion 10.m. paresis	n.d.		160	160
Mare no. 8	n.st.			>192	>192
Mare no. 9	abortion 11.m.	foetus positive		>192	160
Mare no. 10	n.st.		n.t.	80	80
Mare no. 11	paralysis	n.d.			
Stallion	resp.dis.	n.d.	>192	>192	192

None of the horses had been vaccinated against EHV_1 infection and none of the mares had shown any evidence of respiratory disease. It is important to note that the stallion had manifested a chronic disease of the respiratory tract accompanied by coughing and discharges.

During the period from April 1978 to April 1979 – particularly in the spring – we were notified of 6 more outbreaks of a paresis-paralysis syndrome in horses from different stables and different regions of the Federal Republic of Germany. We unsuccessfully examined specimens of the CNS for the presence of virus from 2 horses which had been euthanased and from several which had died naturally.

DISCUSSION

The cases described here were the first EHV_1-induced CNS disorders in horses in the FRG in which the diagnosis was confirmed by virus isolation. All the previous cases which were described by Petzoldt et al.[11] were seen in pregnant mares in association with virus abortion and were diagnosed serologically. The only record of EHV_1 isolation from a male horse showing signs of paralysis is that of Saxegaard[12]. In contrast to this case both geldings that we investigated did not have contact with virus-infected horses.

Morphological changes after EHV_1-infection of the CNS in the horse consist of disseminated meningo-encephalitis with a necrotizing component[2, 10]. Similar changes were seen in Case No 2 6 days after the first clinical signs. The histological findings in the CNS in Case No 1 were characterized by status spongiosus of the cerebrum and rhombencephalon which were present on the second day after the onset of the disease. These findings are probably the first morphological changes to be manifested. The paralysis of the urinary bladder in this horse is probably due to morphological changes in the spinal cord. Unfortunately we did not obtain material from this region for investigation.

All sick horses showed high serum levels of EHV_1-antibodies. On the grounds of marked seroconversion following EHV_1-infection of the CNS in horses with pre-existing humoral antibodies one assumes a reinfection or recurring infection resulting in an extreme stimulation of humoral antibodies and immune cells[1,4,5,8]. Sensitized immune cells can be responsible as circulating immune complexes for the production of a necrotizing vasculitis. Experimental infection with EHV_1 in horses has resulted in similar histological changes in the endometrium as well as in the CNS. On the other hand there are results of pathological investigations of the CNS of naturally EHV_1-infected adult horses as well as EHV_1-aborted foals which can be explained as only being the consequence of a direct virus-induced damage of the nervous tissue. The pathogenesis of the EHV_1-infection of the CNS in the horse is therefore not clear.

I believe that the biological properties of the infecting EHV_1-strains play an important role in the pathogenesis of the disease especially as far as their ability to produce infection of the CNS is concerned. Our results show that pregnancy is no precondition for infection of the CNS – pregnancy may, however, be one of a number of different predisposing factors – and that the so-called respiratory EHV_1-strains are also of importance in this disease. An essential step in determining the pathogenesis of EHV_1-induced paresis/paralysis in the horse must involve an international comparison of the different virus strains isolated from sick horses.

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ABSTRACT: Cameron C.M.; Pienaar Lorraine & Vermeulen Aletta S.M. 1980. **Lack of cross-immunity among *Pasteurella multocida* Type A strains.** *Onderstepoort Journal of Veterinary Research,* **47,** 213–219 (1980).

Active and passive protection studies in mice using sheep antisera revealed that the immunological relationship among *Pasteurella multocida* Type A strains could not be correlated with their serological relationship as determined by a haemagglutination or an agglutination test. Furthermore, strains possessing similar phenol extractable antigens or heat stable antigens did not provide complete cross-protection.

The conclusion was reached that immunity to *P. multocida* Type A strains is induced by an antigen which is strain specific and not detectable by existing serological typing systems. The immunological relationship of strains can therefore not be predicted on the basis of their serological characteristics.

ABSTRACT: Verwoerd D.W. Williamson Anna-Lise & De Villiers Ethel Michele, 1980. **Aetiology of jaagsiekte: Transmission by means of subcellular fractions and evidence for the involvement of a retrovirus.** *Onderstepoort Journal of Veterinary Research,* **47,** 275–280 (1980).

Jaagsiekte (ovine pulmonary adenomatosis) was transmitted to new-born lambs by inoculation of the microsomal fraction of a cytoplasmic extract of cultured tumour cells or tumour tissue. Various treatments of the biologically active fraction were carried out to differentiate between various classes of possible aetiological agents. The results obtained suggested the involvement of a membrane-associated RNA containing virus. Reverse transcriptase activity dependent on Mg^{++} was subsequently demonstrated in these extracts and in lung exudate, and was shown to be associated with particles banding at a density of 1,175 in sucrose gradients. These characteristics, as well as the appearance of the particles in the electron microscope, are similar to those reported for Type B and Type D retroviruses. Serial transmissions of jaagsiekte over a number of years, using cytoplasmic extracts and purified virus, strongly suggest that this virus is the aetiologic agent of jaagsiekte.

ABSTRACT: Cameron C.M., 1980. **Effective immunization of lambs against enterotoxaemia.** *Onderstepoort Journal of Veterinary Research,* **47,** 287–289 (1980).

In contrast to adult sheep, 2- to 3-month-old lambs do not respond well to a single injection of *Clostridium perfringens* Type D oil adjuvant epsilon toxoid. This unresponsiveness can be overcome, however, by administering 2 injections of oil adjuvant vaccine or one injection of oil adjuvant followed 4 weeks later by an injection of alum-precipitated toxoid. The latter procedure evokes protective antitoxin levels which persist for 8 months, and a booster injection of alum-precipitated toxoid given at this stage results in an immunity which lasts for at least 1 year.

ABSTRACT: Potgieter F.T. & van Rensburg L., 1980. **Isolation of *Anaplasma marginale* from *Rhipicephalus simus* males.** *Onderstepoort Journal of Veterinary Research,* **47** 285–286 (1980).

Approximately 100 adult *Rhipicephalus simus* from a batch known to be infected with *Anaplasma marginale* were used to infest an ox. Fifty male ticks were manually removed from the animal's ears 9 days after infestation. These ticks were triturated and a stabilate was prepared which was injected intravenously into 2 susceptible oxen. Both these animals became infected with *A marginale.* The prepatent periods following inoculation of the tick suspensions before and after freezing in liquid nitrogen were 16 and 17 days respectively.

ABSTRACT: Jansen B.C. 1980. **A surgical technique for the experimental reproduction of epididymitis in rams.** *Onderstepoort Journal of Veterinary Research,* **47** 281–283 (1980).

A surgical technique is described for introducing a bacterial culture into the vas deferens of a ram close to the epididymis in such a manner that the infective material spreads to the lumen of the ductus epididymis.

ABSTRACT: Littlejohn A. & Bowles Felicity, 1980. **Studies on the physiopathology of chronic obstructive pulmonary disease in the horse. III. The intrathoracic pressure.** *Onderstepoort Journal of Veterinary Research* **47** 193–196 (1980).

The intrathoracic pressure was determined by direct intrapleural cannulation in 17 clinically normal horses and 14 horses with chronic obstructive pulmonary disease (COPD). There were significant differences between the normal and COPD horses with regard to max. Ppl and max. ΔPpl. The mean values for minimum Ppl of the 2 groups of subjects were not significantly different. The results were discussed in relation to those of other workers.

ABSTRACT: Jansen B.C. 1980. **The pathology of bacterial infection of the genitalia in rams.** *Onderstepoort Journal of Veterinary Research,* **47** 263–267 (1980).

Details are given of the macroscopic and histopathological changes brought about by infection of the genitalia of rams by bacteria other than *Brucella ovis.* Lesions of the vesiculae seminales and ampullae are described which, in addition to the clinically evident lesions of the testes and epididymices, could be an important reason for impaired fertility.

The name "bacterial infection of the genitalia", abbreviated to BIG, is suggested as a more appropriate designation for this condition than "ram epididymitis".

CASE REPORT **GEVALVERSLAG**

SPASTIC PARESIS IN TWO LITTERMATE PUPS CAUSED BY *TOXOPLASMA GONDII*

J.W. NESBIT*, D.C. LOURENS** and M.C. WILLIAMS*

ABSTRACT: Nesbit J.W.; Lourens D.C.; Williams M.C. **Spastic paresis in two littermate pups caused by *Toxoplasma gondii*,** *Journal of the South African Veterinary Association* (1981) **52** No. 3, 243–246 (En) Department of Pathology, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

The clinical and pathological findings in 2 sibling Bloodhound pups with spastic paresis of the pelvic limbs due to toxoplasmosis are described. Macropathology consisted of bilateral atrophy of the musculature of the affected limbs. Histopathology revealed meningo-encephalitis involving the cerebellum and medulla oblongata, diffuse meningomyelitis, radiculoneuritis of the lumbar spinal nerves and polymyositis and atrophy of skeletal muscle. Epizootological investigations failed to determine the source of the infection. Dissemination of the infection by a route other than the haematogenous pathway is considered and discussed.

INTRODUCTION

Toxoplasmosis is a disease of world-wide incidence caused by the coccidian parasite *Toxoplasma gondii*. The organism possesses a dual heteroxenous life cycle[3 7]. The definitive hosts include certain members of the Felidae, the most important of which is the domestic cat[3]. Asexual and sexual reproduction of the organism occurs in the epithelium of the intestinal tract (entero-epithelial cycle) of these species. The intermediate hosts comprise a wide range of warm-blooded animals. An asexual extra-intestinal or tissue cycle may take place in these as well as in feline hosts. It is during this stage in the development of the parasite that pathological manifestations of an infection most frequently occur[3 4 7 8]. Notwithstanding its relative rarity, overt disease has been reported in many domestic species including cattle, sheep, horses, swine, dogs and cats[3 7].

Commensurate with most susceptible species, the disease in dogs tends to greater severity in the young, in which clinical and pathological manifestations are commonly referable to the alimentary, respiratory and nervous systems[3 4 11]. However, because toxoplasmosis may mimic other disease conditions in pups, a definitive diagnosis is precluded on clinical grounds alone. Confirmation of a tentative diagnosis is dependent upon isolation of the parasite, positive serological evidence and/or histological demonstration of the organism in lesions[3 4 7 10].

Several cases of toxoplasmosis in dogs with involvement of the neuromuscular system have been reported in the literature[1 2 4-6 8 12]. This paper deals with 2 cases of toxoplasmosis characterised by spastic paresis of the pelvic limbs in littermate Bloodhound pups.

ANAMNESIS AND CLINICAL FINDINGS

The subjects of this report were 2 purebred Bloodhound pups 16 weeks of age. The animals were referred to the Department of Medicine, Faculty of Veterinary Science, University of Pretoria with a history of hindquarter weakness. Each puppy was presented by his respective owner on 2 separate occasions: initially when 10 weeks old and subsequently at 16 weeks of age.

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The history, clinical signs, radiological and clinical pathological findings, were similar in both cases. The owners had observed signs of posterior paresis shortly after acquiring the animals at 6 weeks of age. Both pups were dewormed and inoculated with measles virus vaccine at 8 weeks of age. The initial clinical examination showed them to be alert, friendly and in good physical condition. There was no evidence of mental aberration. Locomotion, however, was achieved with a peculiar synchronous hopping gait which was ascribed to a bilateral rigidity of the extensor muscles present in the pelvic limbs. The extensor muscle spasticity was most apparent on assumption of the sitting position (Fig. 1). Neurological examination revealed absence of the proprioceptive positioning (Fig. 2) and hopping postural reactions in both pelvic limbs. The patellar reflexes were weak or absent. Although pain perception was intact, no pain was evinced on palpation or manipulation. Micturition and defaecation were accomplished without difficulty. Radiological examination of the lumbosacral region of the vertebral column, pelvis and femurs revealed no abnormality in these structures. The values obtained on haematological and blood chemistry examination were considered to be within the accepted norms.

Fig. 1 Spasticity of the pelvic limbs in the sitting position

0038-2809/81/03/0243–0246

Fig. 2 Absence of the proprioceptive positioning response with spasticity of the pelvic limbs

The history and results of the physical examination suggested an upper motor neuron lesion situated most probably in the cerebellar region of the central nervous system. No definitive diagnosis was made and, owing to reluctance on the part of the owners to hospitalise the animals for further observation, the puppies were discharged.

During the period between the initial and subsequent examinations both pups were presented to a number of private veterinary practitioners. In view of the extent of the neurological involvement the prognosis was considered by every veterinarian as either poor or hopeless. This did not, however, preclude inoculation of the animals against distemper, infectious canine hepatitis and leptospirosis. Although not marked, a steady deterioration of the condition necessitated their subsequent presentation.

The clinical findings at the second examination substantiated the progressive decline in the pups' condition. In addition to the rigidity of the extensor muscles of the pelvic limbs (unchanged from the previous examination), a bilateral atrophy of the musculature of these limbs was present. This seemed to indicate both upper and lower motor neuron involvement; thus, lesions in the cerebellum and spinal cord. Based on all the available evidence the differential diagnoses considered were infectious diseases (distemper, toxoplasmosis and encephalitozoonosis) and congenital spinal anomalies (syringomyelia and Stockard's paralysis). Since the neurological involvement was considered to be irreversible the pups were euthanased and submitted for post mortem examination.

PATHOLOGICAL FINDINGS

Other than the lesions commensurate with barbiturate euthanasia, the only significant macroscopic findings were bilateral atrophy of the pelvic limb musculature and a variable degree of tibial rotation. The lesions were similar in both animals.

Specimens of brain, spinal cord, sciatic nerve, skeletal muscle, kidney and popliteal, iliac and renal lymph nodes were collected and preserved in 10% formalin for histopathological examination. Sections were prepared and stained with haematoxylin and eosin (HE). Following examination of these sections, selected sections were stained by the Periodic Acid-Schiff (PAS), Gram (Brown-Hopps modification)[9] and Giemsa methods.

Microscopical lesions were evident in sections of the cerebellum, medulla oblongata, spinal cord, radicles of the lumbar spinal nerves, skeletal muscle and, although of little contribution to the diagnosis, in the kidney and lymph node sections as well. No lesions were encountered in cerebral, thalamic, hippocampal and pontal sections of the brain, nor in sections of the sciatic nerves.

The most outspoken lesions were present in the cerebellum. These comprised numerous focal areas of encephalitis and an associated meningitis (Fig. 3 and 4). The majority of the encephalitic lesions were limited to the cortex. The outstanding features were: encephalomalacia with degeneration and necrosis of the molecular layer, Purkinje cells and neighbouring cells of the granular layer; leukostasis; proliferation of vascular endothelial and perithelial cells; perivascular cuffing of predominantly plasma cells and lymphocytes; and, gliosis with proliferation of predominantly microglial but also some astrocytic and oligodendroglial elements. In addition, some of the more severe lesions were characterised by a moderate infiltration of neutrophils and a few eosinophils; the former centrally and the latter peripherally distributed. Numerous toxoplasmal tissue cysts were present, usually in the immediate vicinity of the lesions (Fig. 4 and 6). These cysts were demonstrated to advantage in sections stained with PAS and Giemsa. The associated cerebellar meningitis was diffuse with a marked infiltration of lymphocytes and plasma cells, particularly perivascularly, and an accumulation of macrophages. The overall impression gained was that the lesions consisted of a predominantly acute and subacute inflammatory reaction.

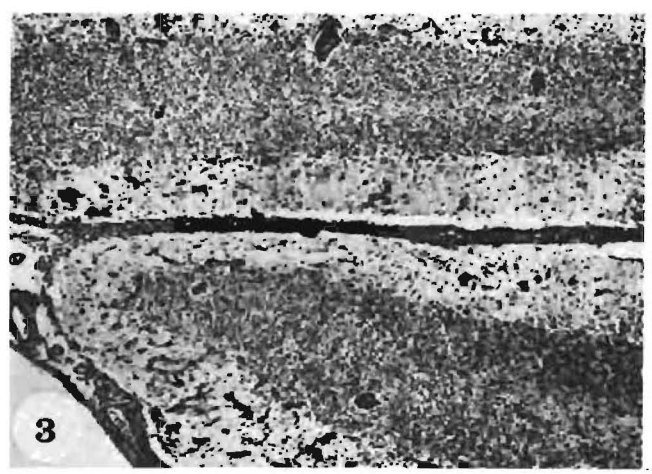

Fig. 3 Extensive meningo-encephalitis of the cerebellum. HE. Original magnification × 40

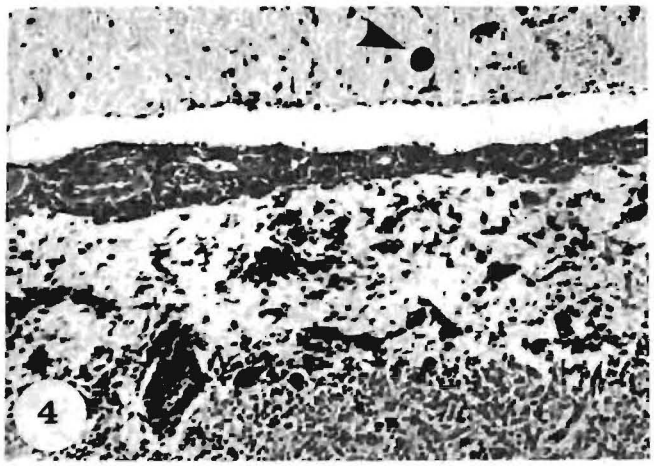

Fig. 4 Meningo-encephalitis of the cerebellum. A toxoplasmal tissue cyst (arrowed) is present in the molecular layer. Note the perivascular cuffing in the meninges and cerebellar tissue, and the lytic reaction involving the Purkinje cells and molecular and granular layers. HE. Original magnification × 100

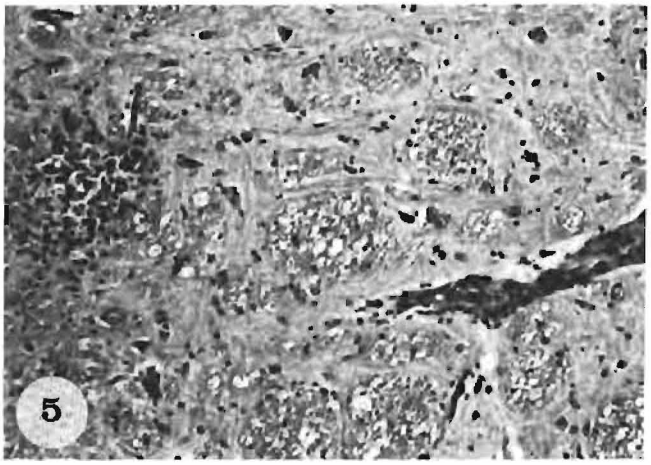

Fig. 5 Perivascular cuffing, glial nodule and status spongiosus in the medulla oblongata. HE. Original magnification × 100

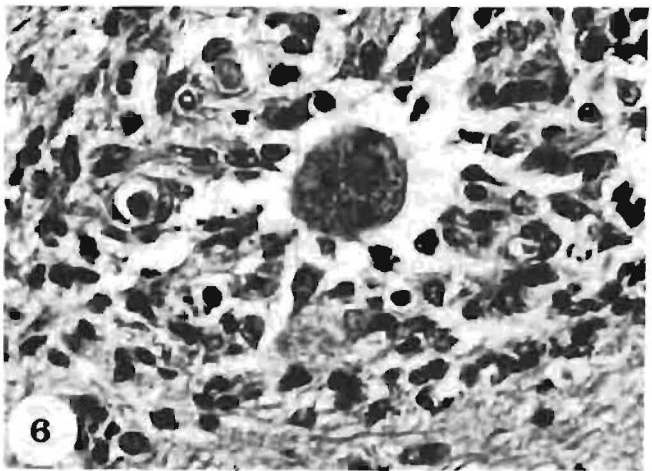

Fig. 6 Toxoplasmal tissue cyst in a glial nodule in the medulla oblongata. HE. Original magnification × 400

The lesions in the medulla oblongata and spinal cord were similar in nature but varied in extent. The lesions in the spinal cord became progressively more extensive in the caudal segments. Glial nodules and perivascular plasmacytic and lymphocytic cuffing occurred throughout the grey and white matter. Status spongiosus and swollen axis cylinders accompanied the lesions in the white matter of both brain and spinal cord. These latter changes tended to be focal in the medulla oblongata (Fig. 5) but were more extensive in the spinal cord where they involved the majority of the spinal tracts. Occasional tissue cysts were identified. An unusual feature, in our experience, was the presence of a tissue cyst in the centre of a glial nodule (Fig. 6). Spinal meningitis similar to that seen in the cerebellum was also present.

Focal lymphocytic radiculoneuritis accompanied the chronic meningomyelitis. This lesion was only encountered in sections of the lumbar spinal cord. Furthermore, the ventral nerve roots were predilectively affected. Demyelination of the nerve fibres and axonal swelling were conspicuous accompaniments of the lymphocytic infiltration. Extension of this lesion into the sciatic nerves was marked by a mild and inconspicuous demyelination of individual nerve fibres.

The lesions in skeletal muscle comprised atrophy and myositis. Atrophy was characterised by attenuation of individual muscle fibres of groups of fibres and, in a large percentage of cases, was accompanied by a marked increase of interstitial adipose tissue. The myositic lesions were focal in nature and varied somewhat in intensity. Severe reactions were characterised by Zenker's hyaline degeneration and necrosis with fragmentation of the affected muscle fibres. A notable feature was the absence of any calcification. Cloudy swelling attended the mild reactions. In all instances, the reactions were accompanied by a predominantly macrophage accumulation. In the early lesions this occurred in company with neutrophils, eosinophils and plasma cells, while in the lesions of longer standing there was a concomitant replacement fibrosis. Coccidian tissue cysts were present both within and between the muscle fibres in the affected areas.

The renal and lymph node lesions were not in any way remarkable. A mild focal periglomerular infiltration of plasma cells marked the kidney lesion. Although the architecture remained unchanged there was a diffuse accumulation of plasma cells in the medullary cords of the lymph nodes.

EPIZOOTOLOGICAL STUDY

Once a firm diagnosis of toxoplasmosis had been established, an attempt was made to determine the source of infection. The occurrence of the disease in siblings suggested congenital infection. Consequently, the Sabin-Feldman dye test was applied to serum samples acquired from the dam on 2 separate (interval of 2 weeks) occasions; both with negative results.

Although considered unlikely, the possibility of acquired infection was brought into contention. The owner of the dam was emphatic that the possibility of pup: cat contact was minimal, if not impossible. The owner of one of the pups had no other household animals. The owner of the other had 2 cats and a dog. The results of the Sabin-Feldman dye test carried out on serum from these animals also proved negative.

DISCUSSION

The infectious modality in these 2 cases is unknown. Three known natural modes of transmission are recognised: transplacental, ingestion of raw (or under-

cooked) meat from infected animals, and, contact with feline faeces containing sporulated oocysts[3 7 10]. Despite the lack of firm evidence, the limited nature of the outbreak, the fact that littermate pups were involved, the distribution of the lesions[2 4] and the absence of direct or indirect contact with cats (or their faeces) before commencement of the clinical signs, all lend support to a congenitally acquired infection. The negative results obtained on application of the Sabin-Feldman dye test on the dam's serum precludes substantiation of this contention.

The diversity of clinical and pathological manifestations of canine toxoplasmosis is legion[1-6 8 11 12]. Congenital and chronic infections are frequently associated with nervous and muscle tissue involvement. In this respect our findings concur with those of other investigators[1-6 8 12]. The clinical signs were referable to the nervous system. The lesions in the nervous system, with the notable exception of those in the cerebellum, all tended to be chronic with an essentially granulomatous response. The lesion of skeletal muscle atrophy concurs with that reported by Holliday et al.[6] while the associated focal myositis finds common ground with the muscle lesions reported by others[1 2 5 12] but possibly not to the same extent.

The exact pathogenesis of toxoplasmosis is speculative at best[3 8]. The predilection of *T. gondii* for the neuromuscular system is beyond dispute[1-6 8 11 12]. This exclusivity is, however, difficult to explain. On the assumption that dissemination of the infection occurs predominantly via the haematogenous route[3 8], the neurotropism of the parasite can be attributed to persistence of the infection in nervous tissue on subsidence of the visceral reaction in generalised (congenital and acquired) infections[8]. Reference to the anatomy of the foetal circulation suggests a further reason for the organism's neurotropism in congenital infections[3]. The myotropism exhibited by *T. gondii* in congenital and chronic infections remains enigmatic. Perhaps dissemination of the infection takes place by other routes, neural pathways being a possibility. The limited distribution of the lesions in these 2 cases suggests the possibility of an ascending infection (extending only as far as the cerebellum) and a descending infection (with involvement of skeletal muscle) from a primary focus of infection in the lumbar spinal cord and/or spinal nerve roots. Alternatively, the primary focus of infection could have been in skeletal muscle and proceeded from there, via neural pathways, to the spinal nerve roots, spinal cord, medulla oblongata and cerebellum. The graded chronicity of the lesions in the same progression lends credence to the latter hypothesis. Presumably, the occasional reactions which displayed intense severity in skeletal muscle were either acute exacerbations or a reflection of reactivation (cause unknown) of a chronic infection. Although not discussed by them, this entire concept is not at variance with the 3 syndromes of canine toxoplasmosis recognised by Ehrensperger & Suter[4]. Their findings were a radiculoneuritic form in pups younger than 3 months, central nervous system involvement in pups older than 4 months and generalised infection in dogs 7–12 months of age. It would appear that the subjects of the present paper represent a transitional stage between the radiculoneuritic and central nervous system forms of the disease.

ACKNOWLEDGEMENTS

The authors would like to thank Drs. C.M.E. Mc Crindle and M.M.T. Kruse for referring the cases to one of us (D.C.L.); Mr. B. Schoeman for conducting the Sabin-Feldman dye tests; Prof. R.C. Tustin for reviewing the original manuscript; Mrs. J.F. Ueckermann for preparation of the photographs and Mrs. V. Schurmann for typing the final draft.

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CASE REPORT **GEVALVERSLAG**

CEREBELLAR CORTICAL ATROPHY IN A PUPPY

J.W. NESBIT* and JOHANNA F. UECKERMANN*

ABSTRACT: Nesbit J.W.; Ueckermann J.F. **Cerebellar cortical atrophy in a puppy.** *Journal of the South African Veterinary Association* (1981) **52** No. 3, 247–250 (En) Department of Pathology, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

A description is given of the history and neuropathology of a mongrel puppy which had suffered from cerebellar cortical atrophy. The condition was attended by intractable cerebellar ataxia and characterised by selective degeneration of the Purkinje cells of the cerebellar cortex. Cerebellar dysfunction is briefly reviewed. The lesion and possible aetiology are briefly discussed.

INTRODUCTION

Neurologic dysfunctions in the neonatal animal are being recognised with increasing frequency. Not least amongst these are those of cerebellar origin. Diverse anatomic cerebellar defects have been documented as a cause of ataxia in the young of various domestic species[3,6-8]. There may be partial or complete agenesis of the cerebellum, or the cerebellum may be uniformly reduced in size. In many instances the cerebellum is without gross abnormality and the lesion is only detectable on microscopic examination. Hypoplasia of the cerebellar cortex is characterised by depletion of Purkinje cells and/or small neurons of the granular layer and attenuation of the molecular layer and foliate white matter[3,8]. Selective degeneration of the Purkinje cells is pathognomonic of cerebellar cortical atrophy[1]. These lesions tend to be static which correlates with the non-progressive nature of the associated clinical signs. Late onset cerebellar cortical degeneration (or onset following a period of normal development) as a cause of progressive cerebellar ataxia is indicative of neuronal abiotrophy[2-4]. The term abiotrophy implies (an inherited) degeneration or atrophy of cells that are formed normally but are unable to survive because of an intrinsic metabolic defect. Except in cases in which the lesions are outspoken, morphologic distinction of these entities is often difficult. Hence, the frequent use of the all embracing term of cerebellar degeneration.

Although the aetiology of many sporadic cases occurring in nature remain to be determined, viral infections and mutant genes are considered the major culprits. A granuloprival cerebellar hypoplasia following prenatal or early neonatal infection with feline panleukopaenia virus is well documented in the kitten[3,9]. In utero infection with the bovine viral diarrhoea virus and the attenuated hog cholera virus may also induce cerebellar degeneration in the foetuses of cattle and swine, respectively[3]. No similar intra-uterine viral infection has been observed in the dog, although perinatal infection with canine herpesvirus may underlie cerebellar lesions in surviving puppies[11]. Heritable cerebellar degeneration as a cause of neonatal ataxia has been reported in man and various breeds of cattle[1,6] and dogs[2-5,8,9] and is believed to be a cause in certain breeds of sheep, horses and swine[3,6]. Substantive evidence exists for a genetically determined form of cerebellar hypoplasia in the Chow Chow breed of dog[9]. The evidence is more conclusive for an inherited form of cerebellar degeneration in the Rough Coated Collie[5] and an inherited form of cerebellar abiotrophy in the Kerry Blue Terrier[2,3] and Gordon Setter[4] breeds. Congenital cerebellar degeneration is not confined to these breeds. The condition has been documented in Labrador Retrievers, Golden Retrievers, Cocker Spaniels, Cairn Terriers, Great Danes, Beagles, Airedales, Finnish Harriers, Swedish Lapland dogs, Bern Sennenhunde, Samoyeds, Wire Haired Fox Terriers and Irish Setters[3,4]. The involvement of purebreds is noteworthy. In most cases an autosomal recessive mode of inheritance has been proposed.

The present paper records the history and histopathologic features of a case of cerebellar cortical atrophy in a mongrel puppy.

CASE HISTORY

The animal was presented to the Outpatients Clinic at the Faculty of Veterinary Science, University of Pretoria with the request that euthanasia be performed because of an intractable ataxia.

The subject was an 8-week-old female puppy of non-descript breed. Her dam was a Dachshund crossbreed but the breed of the sire is not known. It was the only affected animal amongst the 8 siblings of the litter. (At the time of drafting this report, the 7 remaining littermates – 15 months old – are normal dogs without neurologic deficit). Although the affected pup showed no diminution of growth and was alert, playful and sought and responded to affection, an abnormality in gait and a head tremor was first noted when it became actively ambulatory at 3 weeks of age. This progressed to rigidity of the extensor muscles of the pectoral and pelvic limbs at rest and an extreme basewide ataxia with dysmetria and intention tremor when attempting to play or eat and drink. The ataxia involved all 4 limbs. Ambulation was interrupted by frequent falling to either side. An inability to maintain balance when attempting to eat or drink was evident. Head tremor occurred in both the transverse and vertical planes. The tremor was augmented in both frequency and extent and spread to involve the trunk with any attempted

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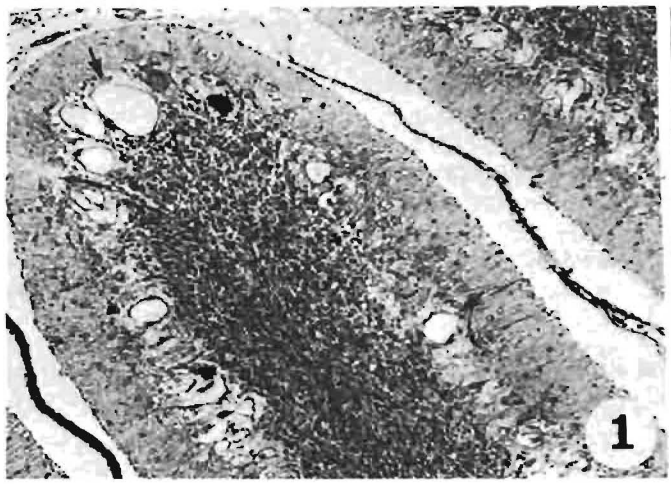

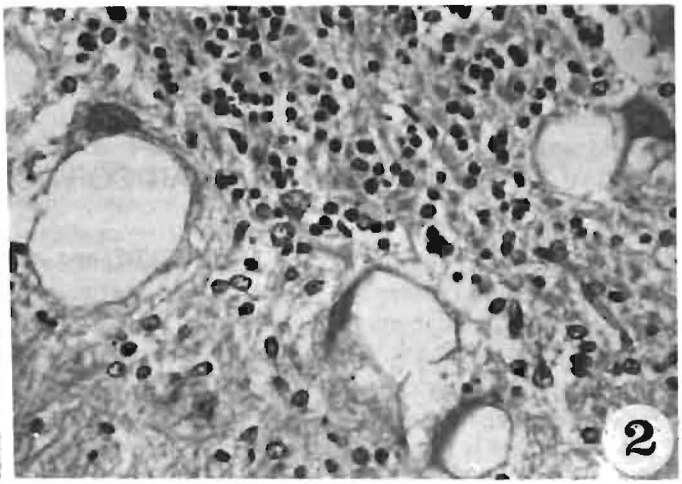

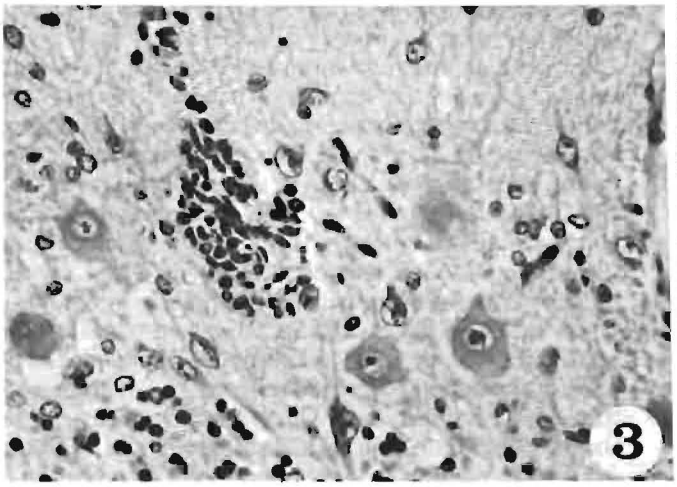

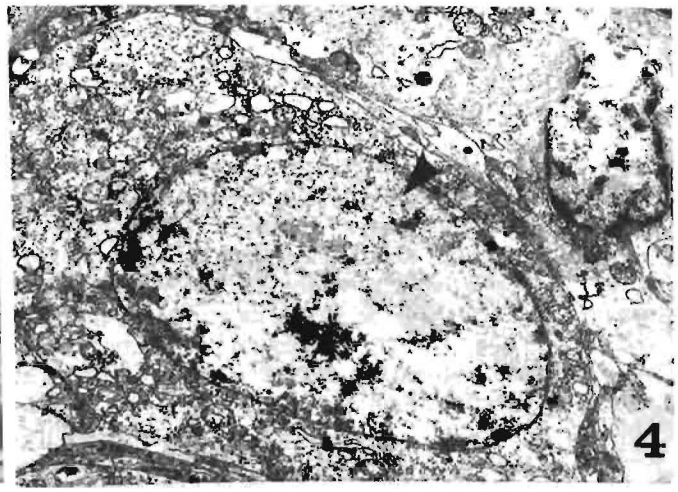

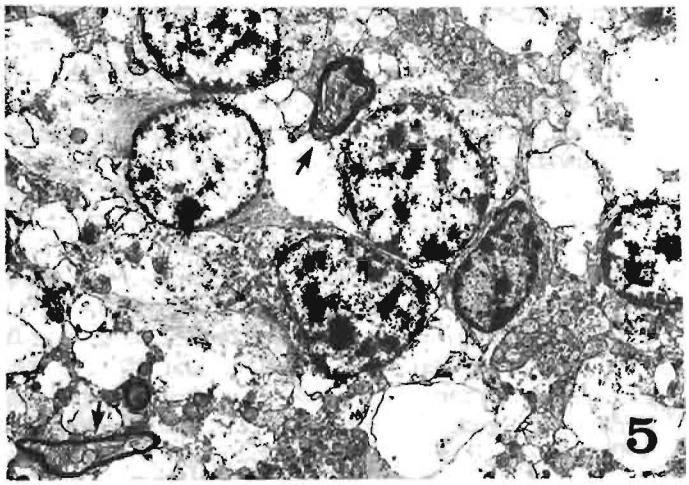

Fig. 1 Cerebellar folia exhibiting vacuolar degeneration of the Purkinje cells and attenuation of the molecular layer. Large empty baskets (arrowed) indicate remnants of degenerated Purkinje cells. Luxol fast blue – Holme's silver nitrate stain. Original magnification × 40

Fig. 2 Selective vacuolar degeneration of Purkinje cells. HE. Original magnification × 100

Fig. 3 Glial nodule at the junction of the molecular and Purkinje cell layers. HE. Original magnification × 100

Fig. 4 Purkinje cell (arrowed) degeneration with cytoplasmic vacuolation and early nuclear degeneration. Electron photomicrograph. Original magnification × 2 200

Fig. 5 Cytoplasmic vacuolation of the small neurons of the granular layer. Degenerated myelinated nerve fibres (arrowed) are evident. Electron photomicrograph. Original magnification × 1 300

motor activity. As the condition was considered to be incurable, euthanasia by the intravenous administration of an overdosage of a preparation containing a barbiturate, was performed.

PATHOLOGY

Other than a patent ductus arteriosus and those attributable to barbiturate euthanasia, no other gross lesions were evident at post mortem. The ductal patency had no other associated morphologic defect.

In view of the history, the whole brain and spinal cord, together with specimens of lung, liver, spleen, kidney and lymph node were collected and fixed in 10% formalin for histopathological examination. Sections were routinely prepared and stained with haematoxylin and eosin (HE). After the initial examination, formalin fixed cerebellar material was further processed. Frozen sections were stained with oil-red-O, Sudan IV, Sudan Black and periodic acid-Schiff methods. Thick sections (8–15 micron) were stained by the Luxol fast blue – Holme's silver nitrate and the Marchi methods. Selected portions of the cerebellum were postfixed in 4% gluteraldehyde in Millonig's phosphate buffer (pH 7,2 – 7,4) at 4° C for 24 hours and then in 2% osmium tetroxide for 1 hour following an intervening wash in the same buffer. After 2 more washes in buffer the material was dehydrated in ethanol and propylene oxide and embedded in Epon 812 in gelatin capsules at 60° C for 48 hours. Thin and ultrathin

sections were cut with a diamond knife on a Reichert OMU 4 Ultracut ultramicrotome. Thin sections were stained with toluidine blue for light microscopy. Ultrathin sections were mounted and stained with 1% uranyl acetate for 10 minutes and 0,2% lead citrate for 30 seconds and examined in a Philips EM 301 electron microscope.

Significant microscopic lesions were limited to the cerebellar cortex. This was characterised as cerebellar cortical atrophy (Fig. 1 & 2). The extent and selectivity of the lesion was remarkable. Virtually every Purkinje cell was affected although to a variable degree. The degenerative changes varied from central to peripheral chromatolysis, shrinkage and hyperchromasia of the nucleus and cytoplasm and eventual cytoplasmic vacuolation. Although the latter was the outstanding feature of the disease, it varied in extent. Some Purkinje cells had small vacuoles predominantly at the origin of the nerve processes, while others were grossly distended by 1,2 or 3 large vacuoles. Large empty baskets marked the remnants of degenerated Purkinje cells which had disappeared (Fig. 1). The vacuolar contents could not be identified by any of the staining methods applied. The granular layer appeared attenuated in isolated areas. Swollen axonal torpedoes of Purkinje cells were encountered with some frequency in this layer. Focal gliosis, of an isolated nature, was evident at the junction of the molecular and Purkinje cell layers (Fig. 3). Only in a very few areas did it extend some distance into the molecular layer but never as far as the leptomeninges. The location and conformation of the glial proliferation was suggestive of neuronophagia and replacement of degenerated Purkinje cells. Neither the foliate and central white matter nor the elements comprising the fastigial, interposital and lateral nuclei of the cerebellum were affected.

The ultrastructural study of the cerebellar lesion was disappointing. The questions which demanded answers – a possible aetiology and the nature of the vacuolar contents – remained inviolate. No viral or viral-like inclusions were observed in the nucleus or cytoplasm of Purkinje, Golgi or granule cells. The vacuoles comprised large empty spaces that contained degenerated organellar material (Fig. 4). Vacuolar degeneration, not obvious on light microscopic examination, was perceived to have involved the Golgi cells and small neurons of the granular layer (Fig. 5) and the associated myelinated and unmyelinated fibres.

DISCUSSION

Although the cerebellum is without primary motor nuclei or direct neural projections to the lower motor neurons of the cerebrospinal nerves, it nevertheless plays an essential modulatory role over equilibrium, the maintenance of muscle tone and the synergy of motor activity[7]. This regulatory function of the cerebellum is achieved primarily through the inhibitory activity of the Purkinje cells[3]. Furthermore, this occurs at the subconcious level[7]. An anatomic defect is therefore frequently reflected in functional deficit[3,6-8]. Moreover, the type of neurologic disturbance may be correlated with the site of the lesion[7]. A lesion involving the caudal cerebellar vermis and flocculus (vestibulocerebellum) results in disturbances of equilibrium, a spinocerebellar (chiefly the anterior lobe) lesion induces a deficit in muscle tone and synergy while a pontocerebellar (hemispheres of the neocerebellum) lesion is accompanied by disordered synergy and related signs. A diffuse cerebellar lesion, as with the present case, is associated with manifold signs of neurologic dysfunction. The outstanding clinical feature is ataxia. This may be accompanied by one or more of the following: an inability to maintain balance, a loss of position sense, nystagmus, a form of extensor rigidity including opisthotonus, dysmetria (the inability to judge distances), dyskinesia (the alteration in the performance of voluntary movements) and intention tremor (the uncontrolled involuntary muscular movements that either arise or are intensified when coordinated voluntary activity is attempted).

It should be appreciated, however, that the cerebellum is not fully developed in the neonatal animal[3,6,7]. The lack of development is limited to the small neurons of the granular layer, up to 85% of which only form after the animal is born (especially in carnivores). The Purkinje cells on the other hand, which arise by proliferation of germinal cells of the metencephalic plate that line the fourth ventricle, are fully formed at birth and function for the life of the animal. Although mature in the anatomic context, these cells do not reach full functional maturity in the dog until some weeks postpartum[3,6]. Maturity of this nature occurs coincidentally with the disappearance of the external granular layer; the cells of which migrate to take up their ultimate position comprising the internal granular layer. This functional immaturity of the canine cerebellum is reflected in a natural neonatal ataxia. Signs of cerebellar dysfunction can therefore only be fairly judged on attainment of maturity. Furthermore, in the presence of a nonprogressive cerebellar lesion, the clinical presentation may appear progressive during the maturation phase.

In the case reported here, the neurologic deficit was referable to a cerebellar lesion. Although the histopathological evidence suggested a static lesion, the progressive nature of the cerebellar ataxia can be ascribed to the functional maturation of the cerebellum; the signs appearing worse as progressively more defective Purkinje cells became functional. The lesion of cerebellar cortical atrophy resembled most closely that described in "daft" lambs by Innes et al., according to Innes & Saunders[6] and, more recently, in a Charolais calf by Cho & Leipold[1]. The selectivity and extent of the Purkinje cell degeneration led to the diagnosis.

The aetiology of this case can only be speculated upon. The possibilities include a basis in heredity, infectious (especially viral) disease, toxic affliction, metabolic (lysosomal storage) disease and hypoxia[3,6]. Only a single pup from a litter of 8 was affected. The dam showed no signs of illness during the entire period of gestation. There was no solid evidence of prior or ongoing infection. Identification of the cytoplasmic vacuoles in the degenerated Purkinje cells could not be determined. All these facts tend to place considerable doubt on an infectious, toxic or metabolic aetiology. Similarly, the possibility of the condition being of genetic origin is minimal particularly in view of the mixed nature of the animal's ancestory. Despite the lack of any supportive historical evidence, perinatal hypoxia has a certain attraction. The reasons for this are twofold. Firstly, the Purkinje cells of the cerebellar cortex are particularly susceptible to hypoxic insult[6]. Secondly, functional closure of the ductus arteriosus in the neona-

tal animal is attributable, in part, to a relatively high oxygen level in the blood postpartum[10]. Functional closure precedes anatomic closure of this duct. The macroscopic finding of a patent ductus arteriosus coupled with the microscopic and ultrastructural evidence of a selective Purkinje cell lesion lends credence to the hypothesis.

ACKNOWLEDGEMENTS

The authors wish to thank Prof. R.C. Tustin for reviewing the manuscript and Mrs. V. Käber for typing the final draft.

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CASE REPORT GEVALVERSLAG

BOVINE CRYPTOSPORIDIOSIS

ELIZABETH W. HOWERTH*

ABSTRACT: Howerth E.W. **Bovine Cryptosporidiosis.** *Journal of the South African Veterinary Association,* (1981) **52** No. 3, 251–253 (En) Section of Pathology, Veterinary Research Institute, 0110 Onderstepoort, Republic of South Africa.

Intestinal cryptosporidiosis was detected at necropsy in a 2-week-old calf that had diarrhoea. Cryptosporidial organisms were embedded in the microvillous border of the epithelium of the distal small intestine. The most significant histological change was a mild enteritis characterized by decreased villus length and hypercellularity of the lamina propria.

INTRODUCTION

Cryptosporidia are small protozoan parasites which inhabit the microvillous border of the host cell. They are coccidia of the suborder Eimeriorina, family Cryptosporidiidae, and the genus *Cryptosporidium*[7].

Several species of *Cryptosporidium* have been reported in various mammals including guinea pigs[4 20], calves[1 9–12 14–17], lambs [1 2], rabbits[3], pigs[5], mice[19], horses[18], monkeys[6], and humans[8]. Although species are morphologically similar, these parasites are considered to be host specific[20].

Bovine intestinal cryptosporidiosis was first described in 1971 in the United States[12]. Subsequent reports from Great Britain[14], Canada[11], and Australia[1] indicate a wide geographical distribution for this organism. Although the pathogenicity of cryptosporidia is not known in calves they are commonly associated with diarrhoea. This report is to verify the presence of bovine cryptosporidiosis in the Republic of South Africa.

CASE HISTORY

A 2-week-old Friesian bull calf was submitted to the Veterinary Research Institute, Onderstepoort for postmortem examination. It had diarrhoea and had been treated with antibiotics. The calf originated from a herd in Nigel, Transvaal where many 4 to 6-week-old calves were exhibiting diarrhoea.

It was euthanased and necropsied.

PATHOLOGICAL FINDINGS

Macroscopic Pathology

The calf was moderately dehydrated and the perineum was covered with watery yellow faeces. Loops of small intestine were distended by yellowish fluid. The colon contained yellow watery faeces.

Histopathology

Microscopic lesions were limited to the intestines and were most prominent in the distal half of the small intestine. Villi of the distal small intestine were shorter than normal and the crypt epithelium exhibited a high mitotic index. The lamina propria of the congested villous tips was mildly infiltrated by lymphoreticular cells and eosinophils. Normal to low columnar epithelial cells covered the villi.

Numerous small circular structures were embedded in the microvillous border of the epithelial cells; they were most numerous towards the tips of the villi and absent in the crypts. These structures varied in greater diameter from 1.4 – 3.0 μm; their location, size and morphological features were consistent with those of *Cryptosporidium* spp. (Fig. 1 & 2)[9 12].

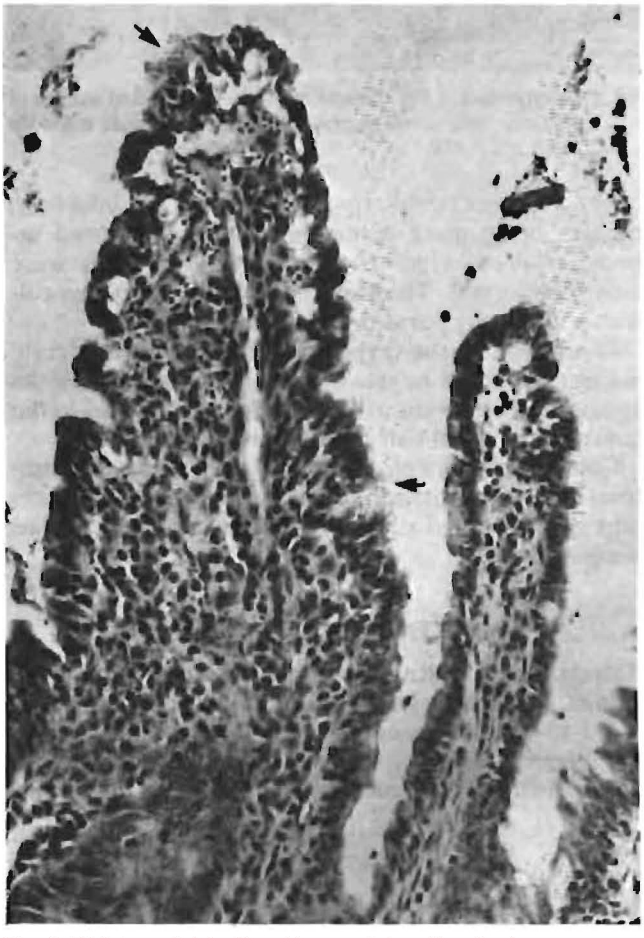

Fig. 1 Distal small intestine. Hypercellular villus having numerous cryptosporidia (arrows) in the microvillous border of the epithelial cells. HE × 160

Cryptosporidia were limited to the small intestine and increased in number from the jejunum to the ileum but were absent in the duodenum. Tissue changes were

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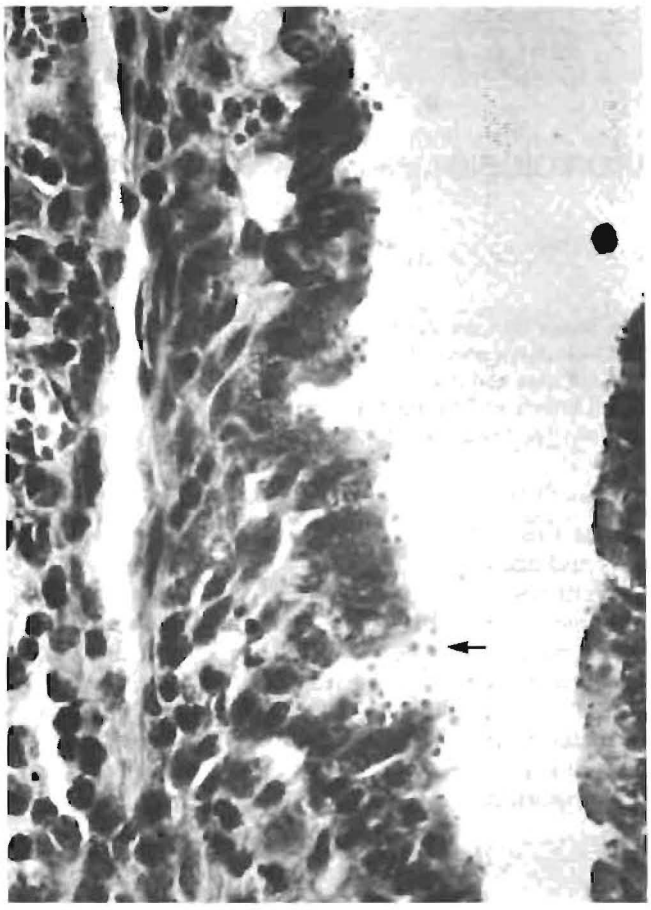

Fig. 2 Enlargement of Fig. 1. Note the various sizes and shapes of cryptosporidia (arrow) representing different stages in the life cycle. HE × 400

roughly proportional to the degree of infection, changes being more severe in heavily parasitized regions, whereas areas containing few parasites were relatively normal. The surface epithelium was low columnar in heavily parasitized areas.

In addition to the cryptosporidia small to moderate numbers of Gram negative bacilli were present on the luminal surface of the villous epithelial cells and in the lumen of the distal half of the small intestine.

Colonic lesions were characterized by irregular mucosal height and dilation of scattered crypts. No organisms were observed attached to the colonic microvillous border.

MICROBIOLOGICAL FINDINGS

Bacteriological cultivation of the spleen, liver, lung, kidney, mesenteric lymph node and intestinal contents failed to reveal organisms. Viral isolation techniques and electron microscopic examination failed to demonstrate a rotavirus or coronavirus infection.

DISCUSSION

Reports of cryptosporidiosis in calves are becoming more frequent indicating that the infection is more common than once believed[1 9–12 14–17]. In the past, the infection probably was not diagnosed in most cases because the organisms are small and easily overlooked and autolysis may prevent histological detection. Although the significance of cryptosporidia as a cause of disease is unknown, it has been suggested that they should be considered a common enteric pathogen of calves[16]. Final proof of its pathogenicity awaits the fulfilment of Koch's postulates.

Whether cryptosporidia caused or contributed to the diarrhoea and histopathological lesions in this calf is uncertain but it is difficult to ignore the association of organisms with lesions. Similar changes are known to be produced by enteropathogenic *Escherichia coli* alone[13]. In this case, a diagnosis of enteric colibacillosis could not be excluded because, although microbiological findings were negative, the calf had been treated with antibiotics. Moreover, histopathological examination of the small intestine revealed the presence of Gram negative bacilli which possibly suggests infection with *E. coli*. Mixed infections of cryptosporidia and *E. coli*[9 14 17] or cryptosporidia and rotavirus and/or coronavirus are reported to occur[10 11 16 17].

Enteric infection with cryptosporidia can be diagnosed by finding the organisms on Giemsa stained smears of faeces or smears of ileal scrapings. On smears the organisms appear as 2–4 μm diameter structures which stain various shades of blue to blue-green and frequently contain 2–5 dense granules or occasionally appear vacuolated. When possible, the diagnosis should be confirmed by histological examination of distal small intestine fixed in formalin immediately after death[16].

Basic information on the treatment and control of bovine cryptosporidiosis is lacking. Thus, current recommendations are that cryptosporidiosis be managed in a similar manner to those which are instituted in coccidiosis (*Eimeria zurnii* and *Eimeria bovis* infections) in calves[16].

ACKNOWLEDGEMENT

Major J.M. Pletcher is gratefully acknowledged for his assistance in preparing this manuscript.

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ABSTRACT: Van der Made H.N.; Van Staden J.J.; du Toit J. de V.; Jordaan Eileen; Barrett E.L. & Coetzee J.D. 1980. **Determination of the physicochemical and microbiological quality of carcass, bone and blood meal.** *Onderstepoort Journal of Veterinary Research* **47** 197–201 (1980).

The pH value and the moisture, fat and protein content of abattoir by-products which are commercially available in the Republic of South Africa were examined, and the total bacterial count and the extent of *Salmonella, Escherichia coli, Bacillus,* yeast and fungus contamination were determined. The extremes and reasonably attainable quality standards were deduced from the highest frequency and mean values of these figures. The total bacterial count was not statistically predictable from variables such as pH, moisture, protein and fat, but was found to be related to the combined effect of all 4 independent variables.

ABSTRACT: Theodoridis, A. & Coetzer J.A.W. 1980. **Wesselsbron disease: virological and serological studies in experimentally infected sheep and goats.** *Onderstepoort Journal of Veterinary Research* **47**, 221–229 (1980).

Adult sheep and goats and new-born lambs and kids were experimentally infected with a Wesselsbron disease virus. The viraemia in lambs commenced approximately 27 h after infection and lasted on the average for 50 h. A febrile reaction, which was mostly biphasic, commenced several hours after the viraemia and outlasted it by 50 h. The viraemia in adult animals began about 50 h after infection and lasted for 30 h. The fever usually commenced several hours after the viraemia and, as in 3 cases out of 4 in lambs, it outlasted the viraemia by at least 30 h. The virus could be reisolated in mice from every tissue examined in lambs, although it has previously been shown that pathological lesions are restricted to the liver and lymphatic tissues.

ABSTRACT: Begemann G.J. 1980. **Laboratory studies on the biology of *Simulium nigritarse* Coquillet and *Simulium adersi* Pomeroy (Diptera: Simuliidae).** *Onderstepoort Journal of Veterinary Research* **47,** 203–211 (1980).

The eggs of both *Simulium nigritarse* and *S adersi* took up to 13 days to hatch in water at a temperature of 25° C. The larvae of *S. nigritarse* required a minimum of 20 days and those of *S. adersi* a minimum of 17 days to pupate when reared in water at 20 ± 1° C. No difference between the sexes was observed in the time taken by the larvae of either species to complete their life cycle. The duration of the pupal stage of *S. nigritarse* ranged from a minimum of 47 hours at 25° C to a maximum of 569 hours (23,7 days) at 6° C. An ambient temperature of 30 ± 1° C was lethal for both the larvae and the pupae of *S. nigritarse.* Eclosion of *S. nigritarse* reaches a peak after sunrise, then the rate declines towards sunset. A mean of 76% of the flies were found to hatch during the day. The time of eclosion of both males and females was similar. Pupation of *S. nigritarse* could take place at a water-depth of 2 m and was common at a depth of 1,1 m. In still water no negative geotropism could be detected in the behaviour of *S. nigritarse* larvae and they were positively phototropic. In agitated water larvae did not respond to a light gradient ranging from 5 to 1100 lux. Adult larvae became negatively phototropic before the onset of pupation, which took place in dark, fast-flowing water. *S. nigritarse* can overwinter in both the larval and the pupal stages.

ABSTRACT: Prozesky L; Thomson G.R.; Gainaru M.D.; Herr S. & Kritzinger L.J. 1980. **Lesions resulting from inoculation of porcine foetuses with porcine parvovirus.** *Onderstepoort Journal of Veterinary Research,* 269–274 (1980).

In utero inoculation of 15 sows at various stages of gestation with a local strain of porcine parvovirus (PPV) resulted in resorption, abortion or the birth of weak, dead, or mummified foetuses. Histopathological lesions observed in foetuses of sows slaughtered at various post-inoculation intervals consisted of a perivascular inflammatory reaction primarily observed in the brain and kidneys. The presence and extent of the inflammatory reaction were dependent upon the age of the foetus at the time of infection. In the sow a perivascular inflammatory reaction was found in the endometrium, while the larger blood-vessel walls were infiltrated by lymphocytes, and it is suggested that these vascular lesions may contribute to the reproductive failures associated with PPV.

ABSTRACTS: Kellerman T.S.; van der Westhuizen G.C.A.; Coetzer J.A.W.; Roux Cecilia; Marasas W.F.O.; Minne J.A.; Bath G.F. & Basson P.A. 1980. **Photosensitivity in South Africa II. The experimental production of the ovine hepatogenous photosensitivity disease geeldikkop (*Tribulosis ovis*) by the simultaneous ingestion of *Tribulus terrestris* plants and cultures of *Pithomyces chartarum* containing the mycotoxin sporidesmin.** *Onderstepoort Journal of Veterinary Research,* **47,** 231–261 (1980).

The mycoflora of toxic pastures were surveyed during a number of outbreaks of ovine hepatogenous photosensitivity in South Africa. Pure cultures of several isolates were dosed to sheep, but only those of *Pithomyces chartarum* and *Myrothecium verrucaria* proved to be toxic.

Photosensitization was induced in sheep by dosing them with cultures of a *P. chartarum* isolate (GA10) obtained from *Tribulus terrestris* plants collected during an outbreak of geeldikkop in the Karoo. Thus for the first time a merchanism whereby *T. terrestris* plants can contribute to the causation of ovine hepatogenous photosensitivity was demonstrated.

When cultures of GA10 equivalent to approximately 0,75–4,0 mg/kg sporidesmin were dosed at Onderstepoort Veterinary Research Institute to Highveld and Karoo sheep on a diet of lucerne, facial eczema was produced. Dosing the same cultures at levels equivalent to *c.* 1,0 mg/kg of sporidesmin in the Karoo resulted in lesions characteristic of both facial eczema and geeldikkop. Typical hepatic lesions of geeldikkop could be elicted by dosing GA10 at levels equivalent to *c.* 0,25–0,7 mg/kg of sporidesmin to Karoo sheep grazing on predominantly *T. terrestris* pastures in the Karoo. In the latter experiment geeldikkop was induced in the sheep on *T. terrestris* pastures, while those receiving identical doses on veld with little *T. terrestris* developed facial aczema.

Geeldikkop, therefore, can be brought about by the ingestion of *T. terrestris* plants together with toxic cultures of *P. chartarum.* The plant appears not only to act as a vehicle for ingestion of spores, but also to interact with sporidesmin to induce lesions typical of geeldikkop, whereas sporidesmin alone results in facial exzema. Indications are that it can enhance the ability of sporidesmin to cause photosensivity or, possibly, vice versa.

The histopathological findings of these experiments are described in detail.

CASE REPORT GEVALVERSLAG

AKUTE SUURSPYSLAS IN 'N BEES

S. VAN AMSTEL*

ABSTRACT: Van Amstel S.R. **Acute acidosis in a bovine.** *Journal of the South African Veterinary Association* (1981) **52** No. 3, 255–258 (Afr) Department of Medicine, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

A case of acute acidosis due to over-ingestion of maizemeal is reported. The cow was in sternal recumbuncy, unable to rise and showed signs of severe dehydration, metabolic acidosis and rumen stasis. Examination of rumen contents revealed changes consistent with those of lactic acidosis. Treatment included correction of the metabolic acidosis, restoration of intravascular volume, manipulation of rumen contents including rumen lavage and other supportive treatment. Some pathophysiological aspects and the need for a systematic and vigorous treatment regime are discussed.

INLEIDING

Akute suurspyslas in die bees kan beskou word as 'n werklike geneeskundige noodgeval. Suksesvolle hantering berus op die akkurate beoordeling van die geval sowel as onmiddellike en kragdadige behandeling.

GESKIEDENIS

Die gevalsverslag het betrekking op 'n ± 400 kg, vyfjaar our Frieskoei in melk. Die eienaar het opgemerk dat die koei ernstig siek is, verdere ondersoek het aan die liggebring dat die bees oorvreet het aan mieliemeel die vorige dag. Die hulp van die Fakulteit Veeartsenykunde, Onderstepoort is toe onmiddellik ingeroep.

KLINIESE ONDERSOEK

Die uitstaande kliniese tekens was die volgende:

1. Die koei het op haar sternum gelê en kon nie opstaan nie. Steungeluide was teenwoordig.
2. Haar temperatuur was 37,4° C, hartspoed 106 per minuut en asemhaling vinnig en diep. Die vulva slymvlies was redelik kongestief.
3. Spiertrillings was teenwoordig op die laterale flank gebied.
4. Kliniese dehidrasie en 'n verminderde effektiewe sirkulasie was getoon deur vermindering in vel elastisiteit; koue ekstremiteite, droë slymvliese en 'n verhoogde kapillêre hervultyd. Bloed verkry uit 'n naaldsteek in die Vena jugularis was donker rooi, taai en dik.
5. Die rumen was vol met 'n pap konsistens en daar was totale afwesigheid van bewegings. Na versameling van 'n rumenmonster deur middel van 'n naaldsteek, is 'n ondersoek daarop uitgevoer. Die resultate van hierdie ondersoek word gegee in Tabel 1.
6. Die voorkoms van die feses met 'n rektale ondersoek was baie pap, het 'n grys kleur getoon met 'n suur reuk. 'n Oormaat vloeistof was rektaal in die rumen palbeerpaar. Die blaas kon nie gevoel word nie.

Tabel 1: RESULTAAT VAN UITSLAG VAN RUMENINHOUD ONDERSOEK

Kleur:	Melkerig grys
Reuk:	Erg suur
pH:	4,0
Protosoa motiliteit:	Afwesig

DIAGNOSE

'n Diagnose van erge akute suurspyslas is gemaak gebaseer op die geskiedenis, kliniese tekens en ondersoek van die rumeninhoud.

PROGNOSE

Vanuit 'n ekonomiese oogpunt is dit belangrik dat 'n akkurate prognose gestel word voordat behandeling begin. Die prognose word gebaseer op die tydsverloop na inname, kliniese tekens, ondersoek van rumeninhoud en die inagneming van moontlike komplikasies. In hierdie geval is 'n swak prognose gestel en wel vir die volgende redes:

1. Die tydsverloop na inname was ongeveer 24 uur en melksuurvorming bereik 'n hoogtepunt in die rumen gedurende hierdie stadium[3]. Dit word onderskraag deur die uitslag van die rumeninhoud ondersoek. Die melksuur is verantwoordelik vir 'n erge rumenitis wat met grootskaalse afsterwe van die slymvlies gepaard kan gaan[2,4]. 'n Hooggradige metaboliese asidose is 'n verdere gevolg wat lei tot die onderdrukking en uiteindelike ineenstorting van vitale funksies[4]. Die swak algehele toestand en vinnige asemhaling in hierdie geval dui klinies op die gevorderde stadium van die metaboliese asidose.

2. Daar was duidelike tekens van dehidrasie, m.a.w. van baie swak weefselperfusie (hemokonsentrasie; verhoogde kapillêre hervultyd; verminderde vel elastisiteit; koue ekstremiteite, 'n verhoogde hartspoed en 'n groot vloeistofgevulde rumen).

Hierdie dehidrasie word veroorsaak deur 'n osmotiese onttrekking van vloeistof uit die vaskulêre poel deur die rumen. Een van die meer ernstige gevolge hiervan is 'n anoksiese degenerasie van die parengiemateuse organe, veral die hart, lewer en niere[2]. In

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laasgenoemde orgaan kan dit lei tot tubulêre nekrose met feitlik totale anurie[5]. Die graad van hierdie veranderinge is ook tot 'n groot mate afhanklik van die tydsverloop na inname.

BEHANDELING EN VERLOOP

Die behandelingsprosedure vir die akute geval van suurspyslas was soos volg:

1. Regstelling van die metaboliese asidose. Hiervoor is kommersiële natriumbikarbonaatpoeier gebruik. 'n Dosis van 120 gram is gebruik wat voldoende is vir 'n volwasse bees (400–500 kg) en gelykstaande is aan 3 milli-ekwivalente per kg liggaamsgewig. Hierdie hoeveelheid is in drie liters normale soutoplossing opgelos en vinnig binneaars toegedien. 'n Opsigtelike verbetering in die dier se habitus was te bespeur na toediening hiervan.

2. Behandeling van die dehidrasie. In akute gevalle van suurspyslas soos die met uitgesproke kliniese tekens van ontwatering kan die hoeveelheid vloeistof benodig vir rehidrasie bepaal word as 10% van die liggaamgewig. Hierdie volume vloeistof is oor 24 uur gegee terwyl rehidrasie beoordeel is volgens kliniese tekens, urinevorming en veranderings in die resultate van laboratorium toetse. Die bees het 'n totaal van 45 liter binneaarse vloeistof oor 'n tydperk van 24 uur ontvang waarvan 30 liter binne die eerste 9 uur toegedien is. Gedurende die eerste 9 uur is ± 1 200 ml uriene geproduseer met 'n SG van 1 007. Die lae volume uriene (normale produksie is 1 ml per kg per uur) is aanvaarbaar as gevolg van die dehidrasie, maar die lae S.G. dui op 'n onvermoë van die nefrone om die uriene normaalweg te konsentreer. Laasgenoemde word beskou as 'n swak prognostiese teken. Uriene sediment ondersoek was egter negatief vir gietsels of nierbuisepiteel.

Die vloeistof wat toegedien is, is as volg aangemaak: 'n Vooraf afgemete hoeveelheid poliioniese poeier is by 10 liters steriele water gevoeg om 'n isotoniese oplossing te maak. Die samestelling van die poeier is die volgende:

	gm/ℓ
Natriumkloried	4,870
Kaliumkloried	0,370
Kalsiumkloried	0,220
Magnesiumkloried	0,303
Natriumasetaat	3,672
Natriumpropionaat	2,208
Natriumfosfaat	0,213

Hierdie formule is afkomstig van dr Williams J Donawick, Fakulteit Veeartsenykunde, Universiteit van Pennsyllvania.

Vir rehidrasie doeleindes moet dekstrose oplossings vermy word, aangesien 'n hiperglisemie[2,3] reeds bestaan en dit dus kan aanleiding gee tot 'n osmotiese diurese. Hierdie hiperglisemie ontstaan a.g.v. die verwerking van groot hoeveelhede melksuur in die lewer[2,4].

Die gunstige effek van die vloeistof terapie op die geval se vaskulêre volume kan gesien word in die laboratorium resultate (Tabel 2).

3. Rumeninhoud verwydering. Die indikasie hiervor is gebaseer op die graad van veranderings verkry gedurende die ondersoek van die rumeninhoud. Die graad van kombinasie van uitslae wat geneem is as 'n definitiewe indikasie vir verwydering van rumeninhoud is geïllustreer in Tabel 3.

Tabel 2: LABORATORIUMUITSLAE

	Voor behandeling	24 uur na behandeling
Hemoglobien	177	137
Hematokrit	0,49	0,37
Bloedurea stikstof	13,8	8,6

Tabel 3: VERANDERING VAN PARAMETERS AS INDIKASIE VIR RUMENINHOUD VERWYDERING IN VERGELYKING MET NORMAAL EN DIE GEVAL ONDER BESPREKING

Parameter	Normaal	Indikasie vir verwydering	Geval
Kleur	Geelgroen	Melkerig grys	Melkerig grys
Reuk	Geurig	Erg suur	Erg suur
pH	6,5–6,8	Onder 5,0	4,0
Protosoa Motiliteit	5+	0–1+	0
Tipes teenwoordig	Alle tipes	Geen of slegs klein	Geen
Sedimentasie aktiwiteit	3–6 min	Geen flotasie	Geen flotasie
Metileen blou reduksie	3 min	Meer as 6 min	Afwesig

Verandering soos geïllustreer in die tweede kolom van tabel 3 dui op 'n uiterste ongunstige rumenomgewing, tot so 'n mate dat na regstelling van die pH 'n nuwe populasie van normale rumenorganismes nie in hierdie omgewing gehuisves kon word nie. Die metode van verwydering is grootliks afhanklik van die waarde van die dier, die algemene kliniese toestand en die konsistens van die rumeninhoud. In hierdie geval is spoeling deur die linker paralumbale fossa uitgevoer a.g.v. die dier se swak toestand en die vloeibaarheid van die rumeninhoud. Spoeling is uitgevoer deur die gebruik van 'n polietileen fistel of 'n dik rubberbuis wat deur middel van 'n tabaksaknaat aan die rumenwand geheg is om sodoende lekkasie te voorkom[5]. Louwater is in die rumen ingelaat totdat die druk hoog genoeg was om die water weer vryelik te laat uitloop. Hierdie prosedure is 'n paar keer herhaal totdat meeste van die onverteerde meel en melskuur uitgespoel was. Die fistel kan in posisie gelaat word of 'n kunsmatige fistel kan geskep word deur hegting van die rumenwand aan die vel vir daaropeenvolgende behandelings[5]. Die manipulasie van die geval se rumeninhoud word geïllustreer in Tabel 4.

Vanuit bogenoemde kan gesien word dat daaglikse ondersoek van rumeninhoud belangrik is en behandeling hierby aangepas moet word. Na 'n verbetering in die parameters een dag na opname was dit gevolg deur 'n verswakking die volgende dag. Hierdie was waarskynlik veroorsaak deurdat 'n hoeveelheid mieliemeel in die rumen agterbly het na die eerste spoeling wat dan afgebreek is na melksuur deur Lactobacilli. In die lig hiervan mag dit dus voordelig wees om penicillin intrarumenaal toe te doen vir onderdrukking van die Lactobacilli. In hierdie geval moes dit na die eerste rumenspoeling toegedien gewees het. 'n Tweede spoel-

Tabel 4: BEHANDELING VAN RUMENINHOUD

Dag na opname	Rumeninhoud ondersoek	Behandeling	Eetlus en habitus
Dag 0 (80.08.24)	Soos in Tabel 3	Rumenspoeling 500 mℓ aluminium hidroksie jel	Geen Swak
Dag 1	Reuk: Effens suur Kleur: Meer groen pH: 6 Motiliteit: 0	15 liters vars rumeninhoud (Motiliteit 3^+) 200 gram gis	1 + Lusernhooi Beter
Dag 2	Reuk: Suur Kleur: Melkerig grys pH: 5 Motiliteit: 0	Rumenspoeling 15 liters vars rumeninhoud (Motiliteit $2–3^+$) 200 gram gis 500 mℓ aluminium hidroksie jel	Geen Swak
Dag 3	Reuk: Effens suur Kleur: Meer groen pH: 5,7 Motiliteit: 1^+ Klein tipes	15 liters vars rumeninhoud (Motiliteit 3^+) 500 mℓ aluminium hidroksie jel 200 gram gis	1^+ Lusernhooi Verbeter
Dag 4	Soos Dag 3	Geen	2^+ Lusernhooi Herkou Helder
Dag 5	Reuk: Normaal Kleur: Groen pH: 7 Motiliteit 2^+ Klein tipes	Geen	2^+ Lusernhooi Herkou Helder
Dag 6	Soos Dag 6 pH: 6,5	Geen	2^+ Lusernhooi Herkou Helder
Dag 8	Soos Dag 6 pH: 7,0	Geen	4^+ Lusernhooi Herkou Helder

ing was dus nodig. Verder kan uit Tabel 4 afgelei word dat kleur, reuk en pH van die inhoud redelik nou gekoppel is aan eetlus en algemene kliniese voorkoms terwyl protosoa motiliteit 'n stadiger herstellende parameter is.

4. Ander ondersteunende behandeling per os: (Tabel 4).

(i) Teensuurmiddels. Daar bestaan 'n hele aantal wat effektief gebruik kan word. Gasvorming en koste is moontlike nadele waarop gelet moet word. Aluminium-hidroksiejel is in hierdie geval gebruik a.g.v. beskikbaarheid, effektiwiteit en afwesigheid van gasvorming.

(ii) Gis is in poeiervorm gebruik teen 'n dosis van 200 gram per volwasse bees. Dit dien as substraat vir mikroflora en verskaf tiamien.

(iii) Voeding. Toe die dier weer begin vreet is slegs 'n goeie kwaliteit hooi gevoer vir 10 dae.

Parenteraal:

Die gebruik van parenterale ondersteunende behandeling in hierdie geval word geïllustreer in Tabel 5.

Antibiotika is gebruik om sekondêre bakteriese verspreiding te voorkom. Dit is iets wat maklik kan plaasvind a.g.v. die bestaande rumenitis en degeneratiewe toestande in die parengiemateuse organe.

Antihistaminika is toegedien ter voorkoming van laminitis. Laasgenoemde is 'n bekende komplikasie moontlik a.g.v. histamien- en endoteksienvorming in die rumen[1].

Tiamien is nodig vir die metaboliese verwerking van melksuur[4]. 'n Tekort mag ontwikkel soos reeds genoem.

Tabel 5: GEBRUIK VAN PARENTERALE ONDERSTEUNENDE BEHANDELING VAN DIE GEVAL

Dag na opname	Middel, dosis en roete
Dag 0	Vetibenzamine* 12 mℓ i.m. 8 uurliks Penbritin† 3 mg/kg i.m. 24 uurliks Vit B_1 2 gram i.m. 24 uurliks
Dag 1	Dag 0
Dag 2	Dag 0
Dag 3	Slegs Penbritin
Dag 4	Slegs Penbritin

*Vetibenzamine V, Ciba-Geigy.
†Penbritin inspuit. opl., Beecham.

Vanaf Dag 5 is geen verdere behandeling toegepas nie soos gesien kan word uit Tabelle 4 en 5. Die dier was egter nog gehospitaliseer vir 8 dae vir observasie. Kliniese beoordeling van die geval het berus op waarneming van habitus, eetlus en die ondersoek van rumeninhoud.

BESPREKING

Sukses in die behandeling van suurspyslas berus op korrekte beoordeling en kragdadige behandeling van die geval. Tydsduur na inname speel 'n belangrike rol aangesien die graad van metaboliese en patologiese veranderinge baie nou hiermee gekoppel is. Manipula-

sie van rumeninhoud insluitende verwydering daarvan berus op die korrekte ondersoek en beoordeling van die intrarumenale parameters soos beskryf. Daaglikse herhaling van hierdie ondersoek is noodsaaklik. Die prosedure vir behandeling moet sistematies wees en in die volgorde uitgevoer word.

(i) Regstelling van metaboliese asidose
(ii) Behandeling van die dehidrasie
(iii) Verwydering van rumeninhoud
(iv) Per os en parenterale ondersteunde behandeling.

Urienevorming moet gemonitor word aangesien dit 'n goeie aanduiding is van die graad van anoksiese veranderinge in die parengiemateuse organe. Dit kan dus as 'n goeie prognostatiese indikator dien.

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FELINE LEUKAEMIA VIRUS INFECTION*

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All aspects, including aetiology, incidence, transmission, immunity, clinical signs, pathogenesis, pathology and diagnosis of feline leukaemia virus infection in domestic cats are considered with a bias towards the more clinical aspects for the benefit of private practitioners. Non-neoplastic disease and possible methods of control are also discussed.

INTRODUCTION

The Feline leukaemia virus (FeLV) was discovered in 1964 by Jarrett and his co-workers in his laboratory in Glasgow. It has been shown that the FeLV is responsible for a variety of diseases, both neoplastic (leukaemia and lymphosarcoma) and non-neoplastic, and that it is horizontally transmitted by contact between unrelated cats.

Although the incidence of infection and its manifestation in the overall cat population is relatively low, it becomes a matter of importance in high density households, catteries or breeding establishments where there are large numbers of cats in close contact with one another. If an infected cat is introduced into such an establishment, the virus can spread rapidly with disastrous results.

Concern arose when it was discovered that FeLV could be grown in human tissue culture cells, but to date no evidence has been found that FeLV produces or is associated with any disease in man. The FeLV occurs throughout the world.

AETIOLOGY

The FeLV is a member of the oncogenic RNA (Oncorna) virus group and replicates in the cell cytoplasm. The new virus particles are released from the cell by a process of budding, but the cell is not destroyed by the virus[10 11 14]. The FeLV grows in many different types of cells in the body, not all of which may later become malignant. It can replicate in the epithelial cells of the buccal and nasal cavities, trachea, urinary bladder, intestinal tract, the salivary and mammary glands and the pancreas, as well as in the precursor cells of the lymphoid, erythroid and myeloid series in the bone marrow or lymphoid tissues of the body[11].

INCIDENCE

Incidence (as indicated by the presence of serum antibodies to the virus) depends largely on the density of the cat population in any one area and varies from about 50% in large cities where contact is high, to about 5% in rural areas. Incidence is much higher in infected catteries, breeding colonies or high density households. The actual incidence of feline leukaemia, lymphosarcoma or other FeLV-associated diseases is much lower, possibly 0,05% or less of the total cat population, but leukaemia or lymphosarcoma accounts for approximately 20% of all neoplasms in cats, whereas in man they account for only 5% of all neoplastic conditions[9 14].

TRANSMISSION

FeLV has been found in the urine, blood, saliva, nasal secretions and milk of infected cats[15]. Initially it was thought that FeLV was transmitted vertically from one generation to the next. It has since become apparent that the FeLV is readily transmissible between unrelated cats coming into contact with one another. It is thought, however, that there is little danger of transmission of FeLV infection between cats where contact is brief. It appears that contact must be relatively close and of some duration before infection can be established[14 15 22].

a) Natural Transmission

(i) The virus may be transmitted by licking, grooming, fighting, contamination of food or water bowls with saliva or litter trays or sand boxes with urine. The virus may be inhaled or ingested. Aerosol transmission is possible[14 15].

(ii) Intra-uterine (transplacental) infection seems possible as the virus has been found in newborn kittens where the queen was viraemic[15].

(iii) Transmammary infection of nursing kittens has not yet been demonstrated although the virus is excreted in the milk of infected queens[15].

(iv) There appears to be little danger of horizontal transmission of FeLV to dogs or man[22].

b) Artificial Transmission

(i) This has been achieved using cell-free isolates from lymphosarcoma cats or gradient purified virus, and has resulted in FeLV infection in previously healthy, uninfected cats[3 15].

(ii) FeLV infected blood, transfused into a non-viraemic cat, has resulted in a persistent viraemia in the recipient[15].

(iii) The virus has been experimentally transmitted by intra-nasal inoculation[15].

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SOURCE OF INFECTION

Any FeLV positive cat (viraemic) is a potential source of infection to any uninfected cat with which it may come into contact[15]. Fortunately the environment is not important as a direct source of infection because the virus will survive only a few days in moist conditions and only a few hours in a dry environment. It is also readily susceptible to common household detergents[15].

IMMUNITY

Factors which determine the response of a cat exposed to FeLV infection are degree of exposure (the amount of virus and the time period involved) and the immunological competence of the cat, which in turn is influenced by age, nutritional status, general health and individual variation[15]. Kittens are not yet fully immunocompetent and are therefore fully susceptible to FeLV infection and possible ultimate development of lymphosarcoma and other FeLV-associated disease, although it appears that kittens born to immune queens are afforded a degree of protection by transplacental or colostral antibodies derived from the queen [6 23]. The immune response to FeLV infection in the cat can result in the production of neutralising antibodies to the type-specific viral antigens and/or feline oncornavirus associated cell membrane antigen (FOCMA) antibodies[15]. Neutralising antibodies inactivate the virus. Most cats in the general population, when infected with FeLV, respond by the production of neutralising antibodies and are only transiently viraemic and do not develop leukaemia or lymphosarcoma[3]. Anti-FOCMA antibodies act against the membrane antigens of transformed cells. If they are present at sufficiently high levels, the cat will not develop leukaemia or lymphosarcoma althoughit may still be viraemic[1 3]. These cats may remain asymptomatic carriers and are as much a source of infection to the healthy cat population as are clinically affected viraemic cats[15].

SUSCEPTIBLE HOSTS

All cats previously unexposed to FeLV infection are fully susceptible. Younger cats are more susceptible to FeLV infection than older cats, there being a higher incidence of lymphosarcoma in cats under 5 years of age[8 15 22]. It seems that there is also a breed susceptibility in that there is a higher incidence of this disease in Siamese and Burmese cats. This is probably a reflection of the fact that these are exotic breeds which are often housed in relatively high density breeding establishments where the infection can readily spread once introduced[22]. Males (entire) are apparently more susceptible than females but this may be due to their greater tendency to roam[6 8 22]. Stud males are also subjected to a higher degree of exposure to possible sources of infection and are therefore more likely to become infected[6].

PATHOGENESIS

The latent period from the time of initial infection until the ultimate development of overt disease is very variable and may be as long as 4 years in some instances or as short as 1 month in others. The average length of time between detection of FeLV infection and the manifestation of disease would appear to be somewhere between 6 and 12 months[3 6 23].

Initial viral infection is followed shortly (after about 10 to 21 days) by a viraemia and a generalised immunosuppression which may persist in susceptible cats until the development of leukaemia, lymphosarcoma or some other FeLV-associated disease. It is thought that the reduction in immunocompetence is brought about by an immunosuppresive protein derived from the FeLV[19]. It is thought that the virus multiplies first in the cells of the bone marrow and then spreads via the blood stream to other tissues of the body, including epithelial cells. The role of epithelial cells in the pathogenesis of this disease is not altogether clear, although it seems that they may be important as a source of infection for other cats[11]. Ultimately a chronic viraemia results in the development of leukaemia, lymphosarcoma or some other FeLV-associated disease, depending on the target cell[5 11].

PATHOLOGY

FeLV-associated diseases are defined as those caused by or associated with the FeLV. They are not necessarily neoplastic (FeLV induces neoplasia only in the cells of the haemopoietic or lymphoid organs) and may be classified as follows[15 18]:

1. Lymphosarcoma (LSA)
   - (i) Alimentary
   - (ii) Thymic/cranial mediastinum
   - (iii) Multicentric
   - (iv) Other
2. Leukaemia
   - (i) Lymphoid/Lymphocytic leukaemia
   - (ii) Myeloid/Granulocytic leukaemia
3. Non-neoplastic diseases
   - (i) Non-regenerative anaemia
   - (ii) Glomerulonephritis
   - (iii) Thymic atrophy
   - (iv) Abortion and foetal resorption
   - (v) Panleukopaenia-like syndrome
   - (vi) Immunosuppression and secondary infection

1. Lymphosarcoma

Lymphosarcomas are solid tissue tumours involving the cells of the lymphoid series, including the histiocytic or reticulum-cells lining the sinuses and are usually aleukaemic, although tumour cells may appear in the circulation intermittently or terminally, in which case the term "leukaemic" or "sub-leukaemic" may be used to describe the condition[8]. It is characteristic of the cat that LSA may occur in organs not primarily of the lymphoid system, such as the kidneys or the intestine[8].

In the intestinal form of LSA it is usually the terminal portion of the ileum which is involved over a distance of several centimeters but occasionally the stomach, duodenum, caecum, colon or rectum may be the main sites of involvement[11 14]. Occasionally the tumour takes the form of a diffuse thickening of a large portion of the intestine, or there may be numerous small nodules in

the intestinal wall[8 13 14]. The affected portion of the bowel is distended and the wall thickened by white tumour tissue. This may result in obstruction of the lumen and dilatation of the proximal gut[8 14]. The regional mesenteric lymph nodes are frequently involved simultaneously but may be the site of the predominant lesion, with little or no involvement of the gut or other organs. They may become so massively enlarged as to impair intestinal function. Other organs such as the liver and spleen and especially the kidneys may also be involved[11 14]. The peripheral lymph nodes are not enlarged[14].

The kidneys are often the site of the predominant lesion or may be involved together with the intestine. Occasionally there may be only one or two nodules with more significant lesions elsewhere. When there is any major involvement of the kidneys, it is almost invairably bilateral and the kidneys are usually markedly enlarged[8].

Tumours of the cranial mediastinum may develop in the mediastinal lymph nodes or the thymus. A firm, pale, pear-shaped mass fills the cranial and ventral portions of the thoracic cavity and may even bulge forward through the thoracic inlet. The trachea and oesophagus may be displaced upwards and are sometimes surrounded. The lungs and heart are displaced caudally and dorsally. Occasionally the wall of the aorta may be invaded. The chest wall and diaphragm may be involved, with infiltration of the intercostal muscles and ribs[8]. There is often a hydrothorax and the fluid is usually clear and straw-coloured. Occasionally there is an obstruction of the lymphatic drainage, resulting in a milky appearance of the fluid due to the presence of chyle[8].

Thymic or cranial mediastinal LSA must be differentiated from a thymoma which is usually a benign tumour, involving both the epithelial and the lymphoid elements of the normal thymus. A diagnosis can be made by histopathological examination[8].

There is seldom massive involvement of all the lymph nodes throughout the body in the cat, as is common in dogs and cattle. In the cat it is the mesenteric lymph nodes which are most commonly involved, whether grossly or microscopically, and occasionally this is the predominant lesion. Other lymph nodes are often involved but not necessarily with any apparent relationship to lesions elsewhere. Affected lymph nodes are enlarged[8].

The spleen is frequently involved to a variable degree in all the lymphoid malignancies of the cat[8]. There may be slight to moderate splenomegaly with increased prominence of lymphoid follicles, especially on cut surface. Occasionally splenomegaly is severe.

The liver, like the spleen, is involved to a varying degree in many cats with lymphoid malignancies. The liver may be slightly or moderately enlarged, with foci of round cells or round cell infiltration in the portal and perilobular areas. Pale, discrete nodules and masses of any size are seen occasionally[18].

Lymphosarcomas do not occur as commonly in other organs but have been described in the nasopharynx, pharyngeal tonsils, larynx, lungs, tongue, oesophagus, uterus, eyes, brain and spinal cord, salivary gland, pancreas, adrenals and thyroids[8].

2. Leukaemias

True leukaemias are generally regarded as having their origin in the bone marrow and are also called myeloproliferative disorders. They are thought to arise from uncontrolled proliferation and defective maturation of the bone marrow cells[17 21]. These leukaemic cells are found in the bone marrow and in the blood. They metastasize via the blood rather than the lymphatic system and invade other organs of the body such as the liver, spleen or lymph nodes.

The leukaemias are classified according to the cell series involved. The different cell types are thought to arise from a multipotential stem-cell in the bone marrow and may be of the granulocytic, monocytic, erythroid or megakaryocytic series, either singly, sequentially or in various combinations. Unlike LSA, there is often considerable overlap between the different forms of leukaemia, both in individual animals and in the course of the disease in a particular animal[11 20].

Leukaemias may also be described as leukaemic, subleukaemic or aleukaemic. Leukaemic leukaemia is characterised by a leukocytosis, and subleukaemic leukaemia by a normal or low white cell count. In both instances there are sufficient numbers of malignant cells present in the blood to allow a diagnosis to be made by examination of a blood smear. An aleukaemic leukaemia cannot be diagnosed by blood smear examination, but leukaemic cells can be found in the bone marrow, lymph nodes or other tissue samples. A LSA could thus be termed an aleukaemic lymphocytic leukaemia but the term lymphosarcoma is generally preferred[21].

Lymphoid or lymphocytic leukaemia is the most common form seen but is not usually regarded as a true leukaemia as it does not have its origin in the bone marrow. It is thought to be a leukaemic form of LSA[5 14].

Myeloid leukaemia involves neoplastic proliferation of cells of the granulocyte series, usually neutrophils, and is therefore a true leukaemia. Differential staining is essential for accurate diagnosis[9 11]. Myeloid leukaemia involving cells of the eosinophil or basophil series is rare Basophilic leukaemia must be differentiated from mast cell leukaemia or mastocytosis[9 11].

Anaemia is always severe[9]. The spleen is massively enlarged and paler than normal due to infiltration of the red pulp by leukaemic cells. The Malpighian bodies are not visible[9 11 14]. The liver is usually pale and enlarged due to diffuse infiltration of the portal areas and sinusoids by leukaemic cells[9 11 14]. The bone marrow is always involved and is greatly expanded, filling the medullary cavities of the long bones. It is pale pink in colour and highly cellular in consistency[9 11 14]. The lymph nodes are usually moderately enlarged and are less cellular on cut surface than with LSA[9 11 14].

CLINICAL FINDINGS

The clinical signs seen with FeLV-associated diseases tend to be rather variable, depending on the organs or systems affected. General symptoms frequently associated with these conditions are anorexia, emaciation, dehydration, listlessness and depression, intermittent fever and anaemia[9 10]. Some or all the lymph nodes may be enlarged to a variable extent. Hepatomegaly and splenomegaly are common findings[9 10]. The blood picture is very variable. It may be completely normal or there may be indications of a non-regenerative anaemia, leukopaenia or leukocytosis and thrombocytopae-

nia[9 10]. Primitive or abnormal neoplastic cells may be present in blood smears[11]. Tumourous enlargements may be palpable in certain predilection sites such as the cranial mediastimum, intestine or kidneys[9 10]. The course of the disease may be peracute with death of the cat within a day or two of the first clinical signs developing, or more chronic, lasting weeks or even months[9].

1. Lymphosarcoma

LSA in the cat may be alimentary, multicentric, thymic (cranial mediastinum) or may involve other organs such as the skin, the eye or the nervous system[8 14].

(i) Alimentary lymphosarcoma

This, and LSA involving the kidney, are the most common forms of LSA in the cat[8]. If the lesion is in the upper small intestine, the main clinical signs are usually vomiting, anorexia and depression, while if the lower bowel is affected, there is usually diarrhoea and emaciation. The faeces are sometimes blood-tinged and there is loss of condition, anaemia and dehydration[8 14]. These tumours are usually easily felt on abdominal palpation but should not be confused with faecal masses, foreign bodies or intussusception[8]. A radiograph will facilitate diagnosis; areas of increased density and alterations in lumen diameter will be revealed. Barium radiographs may show a constriction or obstruction of the lumen at the site of the tumour with dilatation of the intestinal lumen proximally. Anaemia may be severe and leukaemia occurs in a few cases. Splenomegaly and hepatomegaly may be present[14 15]. If the kidneys are involved there may be a nephrotic syndrome with proteinuria, hypoproteinaemia and oedema, or uraemia with stomatitis, halitosis, anorexia, vomiting, polydipsia, polyuria and an elevated blood urea nitrogen (BUN) and creatinine. The kidneys may be markedly enlarged and, in an emaciated cat, may even be visible as bulges in the flanks[8 15].

(ii) Multicentric lymphosarcoma

This is a less common form of LSA than the alimentary form and is characterised by a bilateral and more or less symmetrical involvement of the lymph nodes. Certain groups of lymph nodes may be more markedly involved than others[11 14 15]. The enlarged superficial lymph nodes should be readily felt on palpation[14]. Splenomegaly and hepatomegaly are common and may be felt on abdominal palpation. Other organs or systems commonly affected are the kidneys, lungs, heart, gastro-intestinal tract and bone marrow. Anaemia may be present. Lukaemia may be present in some cases and occasionally there is a neutrophilia[14].

Affected cats show few specific clinical signs when suffering from this form of LSA. Generally all that is reported is anorexia, progressive depression and emaciation[14]. The diagnosis may be confirmed by a lymph node biopsy and histopathology[14].

(iii) Thymic (Cranial mediastinum) lymphosarcoma

This is again a less common form of LSA than the previous one and is usually seen in cats less than 3 years old. The tumour is thought to arise in the thymus and/or cranial mediastinal lymph nodes[11 14 16 18]. Other organs in the body such as the liver or spleen are always involved to a greater or lesser extent. The prescapular and axillary lymph nodes are sometimes also involved[11 14 16 18]. A hydrothorax usually develops, resulting in partial collapse of the lungs. This, together with physical obstruction by the tumour, causes respiratory embarrassment, dyspnoea with slow abdominal respiration, cyanosis, exercise intolerance and possibly mouth-breathing. Coughing and vomiting shortly after swallowing solid food may also be noted[11 14 16 18]. The heart sounds are muffled or inaudible. The apical impulse may be absent and lung sounds are only audible in the upper caudal portion of the chest. The chest may be barrel-shaped and abnormally firm on palpation[11 14 16 18]. Although the liver and spleen are usually involved, they are seldom sufficiently enlarged for this to be determined by abdominal palpation[11 14 16 18]. If anaemia is present in this form of the disease it is usually mild[16].

Differential diagnoses are pneumothorax, empyaemia, hydrothorax as a result of cardiac or hepatic disease, chylothorax and diaphragmatic hernia with the presence of abdominal viscera in the thoracic cavity. All these can result in respiratory distress[8]. The diagnosis may be confirmed radiographically and by thoracocentesis. The tumour is usually visible in radiographs and results in displacement of the oesophagus, trachea and heart[8]. Thoracocentesis usually yields a clear, straw-coloured fluid. If this is centrifuged and the sediment examined microscopically, malignant lymphoblasts are usually found. If the tumour is necrotic or if a blood vessel is punctured during the procedure, cell debris or red blood cells may be found in the sediment. If the fluid is milky, this may be due to obstruction of lymphatic drainage[11].

(iv) Unclassified forms of lymphosarcoma

These forms of LSA are relatively rare and the clinical signs vary depending on the organs involved[15].

(a) Skin

Lymphoid tumours of the skin are very varied in their appearance and may take the form of single or multiple, non-pruritic, nodular lesions or irregular areas of thickened skin. They may also involve the subcutis and underlying muscle and are usually present elsewhere in the body as well[8 15]. The diagnosis can be made on a skin biopsy[8].

(b) Eye

Primary intra-ocular LSA is unlikely and any involvement of the eye is usually secondary[17]. Hyphema, hypopyon and panopthalmitis are also seen in association with intraocular LSA[14 15]. Orbital infiltration and retrobulbar tumours resulting in exopthalmia have also been reported[8].

(c) Nervous system

There may be involvement of the brain, spinal cord or peripheral nerves, resulting in motor and/or sensory deficits or seizures[8 15].

(d) Nasal passages

LSA of the nasopharynx may result in a constant nasal discharge and asymmetry of the external nares. On radiographical examination, there will be increased

density in the affected areas[15]. Involvement of the pharyngeal tonsils, larynx and the lungs has also been reported[8,15].

(e) Other
Involvement of the tongue, salivary glands; uterus, heart muscle and valves, pancreas, adrenal and thyroid glands has been reported[8].

2. Leukaemia

Cats suffering from leukaemia are usually ill for a number of months, but an animal may only be presented for examination subterminally. There is usually a history of intermittent fever, anorexia and depression[14]. There is almost invariably a severe myelopthisic anaemia due to progressive destruction of the normal bone marrow constituents. The megakaryocytes are also destroyed, resulting in a thrombocytopaenia and petechial haemorrhages may be present in the skin and mucous membranes[14]. Because leukaemic cells are present in the blood stream, the liver and spleen are heavily infiltrated and there is always a marked splenomegaly and often a hepatomegaly. The lymph nodes are never involved to the same extent as they are with LSA but may be slightly to moderately enlarged. Enlargement of the superficial lymph nodes may be noticed on palpation[11,14]. A blood smear must always be carefully examined for other possible causes of anaemia such as *Haemobartonella felis* infection. In a leukaemic cat, the white cell count may be normal or decreased but is usually raised, and abnormal or immature cells of the myeloid series are seen in greater numbers than normally expected[9,14].

3. Non-neoplastic diseases

Unlike the other oncogenic viruses, FeLV is the cause of several non-neoplastic conditions in the cat[15]:

(i) Anaemia
Anaemia is commonly associated with FeLV infection and may occur as a primary clinical entity on its own in the absence of neoplasia or as part of the feline leukaemia/lymphosarcoma complex[18]. Two distincly different types of anaemia are known to occur. One is a macrocytic, normochromic anaemia of haemolytic origin, while the other is a normocytic, normochromic aplastic (non-regenerative) anaemia in which there is no indication of bone marrow response[11,14]. The clinical signs are typical of anaemia (pale mucous membranes, tachypnoea, water-hammer pulse and tachycardia, lethargy and low exercise tolerance) and affected cats usually die of heart failure due to the severe anaemia. The packed cell volume is very low and may even fall below 10%[18].

(ii) Glomerulonephritis
The incidence of glomerulonephritis in FeLV positive cats is much higher than expected. It has been reported to occur in association with LSA in cats and has also been experimentally induced. There has also been evidence of FeLV infection in cats with glomerulonephritis but which did not have neoplasia[14]. Trapping of circulating antigen-antibody complexes in glomerular basement membranes may result in a membranous or proliferative glomerulonephritis. This interferes with the glomerular filtration process and results in a uraemic syndrome in the former instance or a nephrotic syndrome in the latter[11,14]. In the uraemic form, there may be initial polydipsia and polyuria, which eventually transform into an oliguria or anuria and are followed by a typical uraemic crisis. There may also be halitosis, mouth ulcers and vomiting as well as raised BUN and creatinine levels[14]. In the nephrotic form there is a marked proteinuria, hypoproteinaemia and generalised oedema. The BUN remains normal until late in the disease[14,18].

(iii) Thymic atrophy
Thymic atrophy has been seen in young kittens experimentally inoculated with FeLV as neonates. This results in immunodepression, particularly of cell-mediated immunity, and a "fading kitten" syndrome, due to any of several secondary bacterial or viral infections. Bronchopneumonia, upper respiratory tract infections and various forms of enteritis are commonly seen and ultimately result in the death of the kitten before there is any indication of leukaemia or LSA[11,14,15].

As there are other virus infections which may result in thymic atrophy (feline panleukopaenia virus and calicivirus) and because the secondary infections can mask the primary cause, it is advisable, if possible, to excluded FeLV infection in the kittens and the queen. This could be of particular importance in a breeding establishment if there are problems in raising healthy kittens[14,15].

(iv) Abortion and foetal resorption
FeLV infection has been implicated as a possible cause of infertility, foetal resorption and abortion where no other cause can be found. Bacteriological cultures were negative and those cats tested for toxoplasmosis were also negative[3,11,14,18].

(v) Panleukopaenia-like syndrome
Panleukopaenia may occur concurrently with FeLV-associated disease but occasionally a severe form of enterocolitis with lesions similar to those of panleukopaenia is seen in association with FeLV infection. This condition if often associated with stress and is characterised by vomiting, haemorrhagic diarrhoea, dehydration, fever and anorexia[3,18].

(vi) Immunosuppression
Apart from thymic atrophy, FeLV infection is known to result in immunodepression in older animals, with suppression of the humoral as well as the cell-mediated response. This may result in secondary bacterial or viral infection with manifestations such as non-healing wounds, stomatitis, respiratory infections, enteritis and recurrent fever. There is often a leukopaenia instead of the expected leukocytosis. FeLV infection should be considered when conditions such as these do not respond to treatment. Other conditions predisposed to by the immunodepressive effect of the FeLV are feline infectious peritonitis, feline infectious anaemia, granulomatous disease and possibly toxoplasmosis[3,11,18].

DIAGNOSIS

A diagnosis is generally suggested on history and clinical signs and should be confirmed by microscopic study of the blood, bone marrow and other body fluids or

tissues[2]. Commercially available diagnostic tests include the Feleuk (Pitman Moore) test for FeLV which is a sensitive fixed cell immunofluorescence test for the detection of FeLV antigens in the white blood cells and platelets of peripheral blood. This correlates with the presence and active production of infective FeLV particles in the blood and is reputedly accurate even in blood smears which are some months old[1 13]. There is also the Leukassay-F (Ethnor Laboratories)test which is an enzyme-linked immunosorbent assay (ELISA) test which is reputedly highly sensitive, specific, quick and simple to perform[4]. The Leukassay-F test is able to detect FeLV antigens at an earlier stage of infection than the Feleuk test. A cat which is Feleuk negative but Leukassay-F positive will almost certainly be Feleuk positive if retested 7–14 days later. The Leukassy-F test can readily be carried out in a private practitioner's laboratory, whereas for the Feleuk test blood smears must be sent to a specialist laboratory[12].

It is important that these tests should be correctly interpreted. If a test is positive, it indicates that the cat is infected with FeLV, but it does not necessarily mean that the cat has the disease or even that it will ultimately develop the disease, nor does it indicate immunity or the likelihood of immunity developing[15]. A clinical diagnosis should not be based on the results of a test alone. The latter should supplement the clinical and laboratory findings and should be used to confirm and not make a diagnosis[15]. A negative FeLV test indicates that the cat is not viraemic at the time of the test. It does not mean that the cat is immune to the virus or the disease, or that it does not have the disease. Cats with LSA may not necessarily be viraemic. The virus may be present in the cells of a LSA and later be reactivated, resulting in a viraemia[15]. In certain cases a cat may not be viraemic but the virus may be present in other body fluids, such as the urine. A cat occasionally reverts from FeLV positive to negative but this is rare[15].

TREATMENT

There are 3 alternatives available to the veterinarian who is prepared to undertake treatment of a cat suffering from leukaemia or LSA. These are surgery, irradiation or chemotherapy, which may be used individually or in combination[2]. No more than about 10% of cats with leukaemia or LSA are likely candidates for treatment, and it should be born in mind that these animals may still shed virus and be a source of infection to other cats[1]. The condition of the cat and its blood picture must be carefully monitored in any treatment involving the use of cytotoxic drugs[2]. A complete physical examination and blood test should be done before commencing treatment and every 5–7 days thereafter for at least 2 months. The veterinarian should check for anorexia, lethargy, dehydration and possible secondary infection during treatment. A complete blood count, packed cell volume and platelet and reticulocyte count as well as urinalysis should be carried out on each visit[2].

(i) Chemotherapy

Drugs which are used in the treatment of leukaemia or LSA are corticosteroids, Cyclophosphamide, Vinca alkaloids, L-Asparaginase and 6-Mercaptopurine[2 14].

Corticosteroids (Prednisolone, Betamethazone) in general have few side effects in cats and are therefore good drugs to use in this species. A high dose (Prednisolone 5 mg twice daily) should be given to start with. This can then be reduced according to effect[2].

Cyclophosphamide can be used if corticosteroids are or become ineffective or can be used together with, alternately with or instead of corticosteroids. It has an advantage in that it can be administered orally. It should not be used if there is any renal involvement, and its effect must be carefully monitored as it causes a marked and sudden drop in the number of circulating leukocytes, the red blood cells and platelets[2].

The Vinca alkaloids have been used with relative success but have the disadvantage of having to be given intravenously. They are highly irritant and extravasation causes severe sloughing[2].

L-Asparaginase has not been used to any extent in treatment of leukaemia or LSA in cats but seems promising nonetheless. It is administered intraperitoneally at an average daily dose of 400 IU/kg for 10 days followed by a weekly maintenance dose. No adverse effects in cats have been reported[2].

6-Mercaptopurine causes drastic bone marrow depression as well as reducing the number of circulating malignant cells. Doses should therefore be minimal and the blood carefully monitored[2].

(ii) Surgery

Surgery is seldom successful unless the LSA is confined to a single circumscribed lesion, which is rare in the cat. Surgery should not be undertaken if there is any involvement of the blood or bone marrow. Removal of a lymphomatous spleen is seldom successful, nor is removal of a single kidney as involvement is almost always bilateral[2].

(iii) Irradiation

Use of irradiation for the treatment of leukaemia or LSA has been of limited and transient value in cats. As far as it is known, total inactivation of the bone marrow by irradiation, followed by a bone marrow transplant, has not been attempted in cats[2].

CONTROL

Two possibilities may be considered here. One is the identification of FeLV posive cats and their possible elimination by isolation or euthanasia. This is applicable in breeding establishments and catteries where large numbers of cats are in close contact with one another, rather than to the individual cat owner. The other possibility is vaccination. It is not recommended that all cats should be tested for FeLV as a matter of routine but any cat suspected of having FeLV infection as well as those suffering from chronic undiagnosed diseases which do not respond to treatment or which have been exposed to another FeLV positive cat, should perhaps be tested. In the latter instance 2 tests should be done, 3 months apart, to allow for the long incubation period[15 23]. Any cats which are due to be imported or used as blood donors should also be tested[15 28].

Testing of all cats and the removal of positive cases from catteries and breeding establishments have been advocated[1 23 24]. FeLV positive animals are strictly isolated or euthanased, while the remainder are quarantined and retested 3 months later in case any were in the incubation stage. This procedure should continue until all uninfected cats remain negative on 2 con-

secutive tests 3 months apart[1 23]. Thereafter, all stud cats brought into a cattery should be quarantined and tested before being introduced[24].

Various FeLV vaccines have been developed and tested for the prevention of FeLV viraemia and FeLV disease, but as yet none of these are commercially available[19].

CONCLUSION

A final important aspect of this disease is informing and advising the owner, always bearing in mind that the final decision as to what course of action to take must lie with the owner. In attempting to give a prognosis, it should be remembered that if a cat is FeLV-positive but does not have a FeLV disease (i.e. is an asymptomatic carrier), then, apart from being a potential source of infection to other cats, it may develop leukaemia or LSA within 6 months to 2 years, although until tests for anti-FOCMA antibodies become commercially available, it will not, in fact, be possible to predict definitely which cats will develop FeLV-associated disease and which not[15]. Isolation of such cats is a consideration, but a cat used to roaming freely may not adapt well to living indoors, and it is not always possible to isolate it effectively from other cats in the household[15]. If an owner chooses to risk infection of other cats in his household, there should be no contact with neighbours' cats. His cats will have to be kept indoors and neighbours' cats should have no access to them[15]. Euthanasia may be advised, depending on the circumstances of the cat's environment and its degree of contact with other cats. Cats suffering from FeLV-associated diseases may respond temporarily to chemotherapy, and a remission lasting some months may result. Treatment is, however, prolonged and expensive and extensive follow up care on the part of the owner and the veterinarian is required[14]. Few cats are in fact suitable candidates for chemotherapy in terms of their general condition and ability to withstand the side effects of the drugs[15].

Chemotherapy does not destroy the virus. The cat therefore remains a potential source of infection and the disease may even become aggravated or manifest in other forms[15].

Prognosis, with or without treatment, is poor and the quality of life of the animal can deteriorate rapidly[15]. Euthanasia is probably the best course to suggest in cases manifesting overt disease, but the emotions and ultimate decision of the owner must always be respected.

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OUR PRESIDENT

COLIN McKENZIE CAMERON

Colin McKenzie Cameron is a man of many parts. His quiet unassuming manner belies a dynamo which turns inside and generates a multitude of talents which are reflected in his wide spheres of involvement.

Born in Pretoria in 1937, Colin matriculated from the Afrikaanse Hoër Seunskool in Pretoria in 1954. He obtained his BVSc in 1959, and DVSc in 1973 with a thesis entitled *"The antigenicity of Corynebacterium pseudotuberculosis."*

In 1966 he was awarded a BP Postgraduate Scholarship which took him to the United States where he spent 6 months at the Rocky Mountain Laboratory, and a further 18 months at the Medical School of the University of Minnesota. Shortly after his return to the Republic, Colin became Head of the Section of Bacteriology at the Veterinary Research Institute, Onderstepoort.

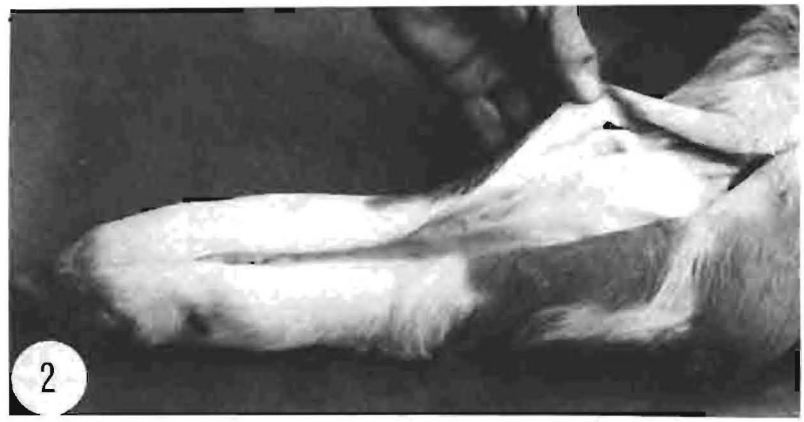
Apart from his research responsibilities, Colin became active in teaching and from 1969 to 1973 served as part-time Senior Lecturer in the Department of Infectious Diseases of the Faculty of Veterinary Science, University of Pretoria.

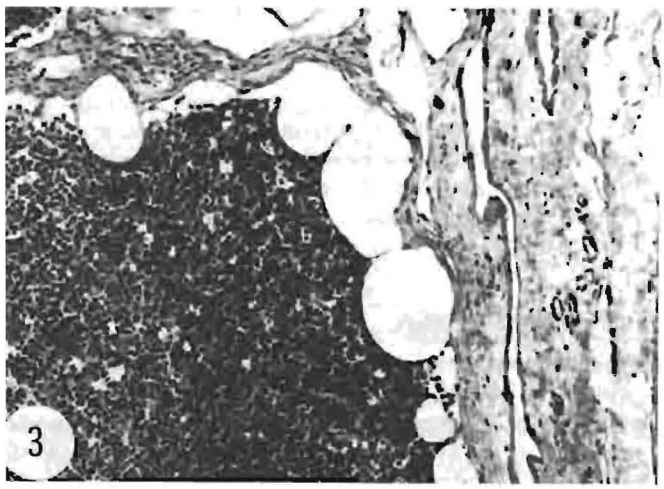
During 1974 he was promoted to an Assistant-Director of the Veterinary Research Institute in charge of the Sections of Bacteriology, Reproduction, Food Hygiene and Vaccine Production, a position he still holds. To add to these many responsibilities, Colin was elected President of the Public Servants' Association in 1979, a singular honour not only for himself but also for his profession.

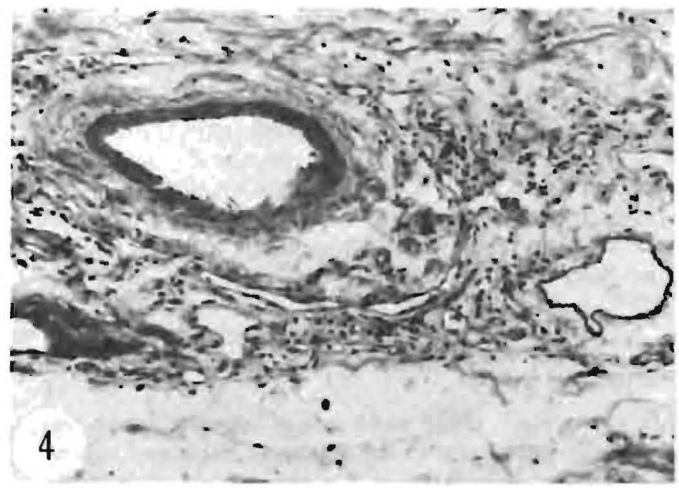
Within the S.A. Veterinary Association, Colin has taken an active and leading part, serving on Council, on many special committees, several of which were under his chairmanship. For the past 2 years he has served as Vice-President.

His courteous and sincere manner establishes the goodwill necessary to create the correct milieu for meaningful deliberations, which in turn contribute markedly to the progress of our profession. His deep insight, vision and administrative experience will serve the needs of our diversified Association to the full. His thorough, well thought-out approach to any problem has placed a high value on his opinion. A man of principle and integrity, a man prepared to listen to all sides before formulating a directive, his leadership in these changing times will be invaluable to the affairs of our Association.

Married to Wina (neè Rudolph), they have 3 children.







CONGENITAL HYPOPLASIA OF THE LYMPHATIC SYSTEM IN AN AYRSHIRE CALF*

History and Clinical Signs

A one-month-old Ayrshire bull calf was presented with a history of progressive swelling of legs and head regions. Clinical examination revealed severe diffuse anasarca of the legs and submandibular region (Fig. 1). These were the only abnormal findings on clinical examination. A tentative diagnosis of lymphatic hypoplasia was made.

Clinical pathology

Haematology and clinical chemistry revealed the following:

Submitted by Drs I.B.J. van Rensburg, Dept. of Pathology and D.C. Lourens, Dept. of Medicine, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort.

KONGENITALE HIPOPLASIE VAN DIE LIMFVATIESE STELSEL IN 'n AYRSHIRE KALF*

Geskiedenis en Kliniese Tekens

'n Eenmaand oue Ayrshire bulkalf is ingebring met 'n geskiedenis van 'n progressiewe swelling van die bene en kopgebied. Kliniese ondersoek het 'n erge diffuse anasarka van die bene en submandibulêre area aan die lig gebring (Fig. 1). Hierdie was die enigste abnormale klinies waarneembare bevindings. 'n Tentatiewe diagnose van hipoplasie van die limfvatiese stelsel is gemaak.

Kliniese patologie

Hematologie en kliniese chemie het die volgende resultate opgelewer:

*Ingedien deur dr. I.B.J. van Rensburg, Dept. Patologie en dr. D.C. Lourens, Dept. Geneeskunde, Fakulteit Veeartsenykunde, Universiteit van Pretoria.

Haematology/Hematologie	Patient Pasiënt	Normal** Normaal**
Haemaglobin/Hemoglobien	105	80–140 g/ℓ
Red cell count/Rooiseltelling	7,88	5,0–9,0 × 10^{12}/ℓ
Haematocrit/Hematokrit	0,34	0,24–0,4 ℓ/ℓ
Mean cell volume/Gemiddelde sel volume	41	40–60 fl/ℓ
White cell count/Witseltelling	11,1	4,0–10,0 × 10^{9}/ℓ
Neutrophils (mature)/Neutrofiele (volwasse)	0,58	0,15–0,45
Neutrophils (immature)/Neutrofiele (onvolwasse)	0,02	—
Lymphocytes/Limfosiete	0,36	0,45–0,75
Monocytes/Monosiete	0,04	0,02–0,07
Eosinophils/Eosinofiele	0	0,02–0,20
Basophils/Basofiele	0	—

Serumproteins/Serumproteïene	Patient Pasiënt	Normal** Normaal**
Total serum protein/Totale serum proteïene	72	70–78 g/ℓ
Albumin/Albumien	26,3	31–37 g/ℓ
Globulins/Globuliene	45,7	31–44 g/ℓ
Albumin: Globulin/Albumien: Globulien	0,58	0,9–1

**Normal values as used by clinical pathology laboratory of Dept. of Medicine, Faculty of Veterinary Science.

A moderate neutrophilia was present (stress induced?). The serum proteins showed a marginally decreased albumin value, but it was felt that such a slight decrease was unlikely to cause such a severe anasarca, and was probably the result of protein leakage into the anasarcous fluid.

Pathological findings

Macroscopically there was a severe anasarca which was especially prominent in the submandibular and ventral neck regions (Fig. 1) as well as the ventral parts of the extremities (Fig. 2). A clear light straw-coloured fluid oozed from cut surfaces into these areas. All superficial lymph nodes were present but were rather small in size. The liver showed abnormal lobation.

Microscopically the subcutaneous tissues were very oedematous which was manifested by a separated and teased apart appearance of the collagen fibres. No coagulable protein was observed in the intercellular areas while a mild round cell infiltration occurred in the vicinity of some of the blood vesels (Fig. 4). The peripheral lymph nodes showed a marked dilatation of the hilar lymphatics as well as of the subcapsular sinuses (Fig. 3). The spleen had a washed-out appearance while the thymus was morphologically normal.

'n Matige neutrofilie was teenwoordig (spanning veroorsaakte?) Die serum proteïene toon 'n geringe daling in albumienvlak, maar die gevoel was dat dit nie tot so erge anasarka sou lei nie en dat dit eerder die gevolg is van proteïen-lekkasie in die interstisiële vloeistof.

Patologiese bevindings

Makroskopies was daar 'n erge anasarka wat veral prominent was in die submandibulêre en ventrale nekgebied (Fig. 1) asook in die ventrale gedeeltes van die ledemate (Fig. 2). 'n Helder ligte-strooikleurige vloeistof het uit snitvlakke in die gebied gesypel. Al die oppervlakkige limfknope was aanwesig, maar was kleiner as die normale grootte. Die lewer het abnormale lobasie getoon.

Mikroskopies was die onderhuidse weefsels geweldig edemateus. Dit het opgewys as 'n uitmekaar getrekte voorkoms van die kollageen vesels. Geen koaguleerbare proteïen is in die intersellulêre spasies waargeneem nie terwyl 'n ligte rondesel infiltrasie teenwoordig was in die omgewing van sommige bloedvate (Fig. 4). Die periferele limfknope het 'n uitgesproke dilatasie van die limfvate in die hilus asook van die subkapselêre sinusse getoon (Fig. 3). Die milt het 'n uitgewaste voorkoms gehad terwyl die timus morfologies normaal vertoon het.