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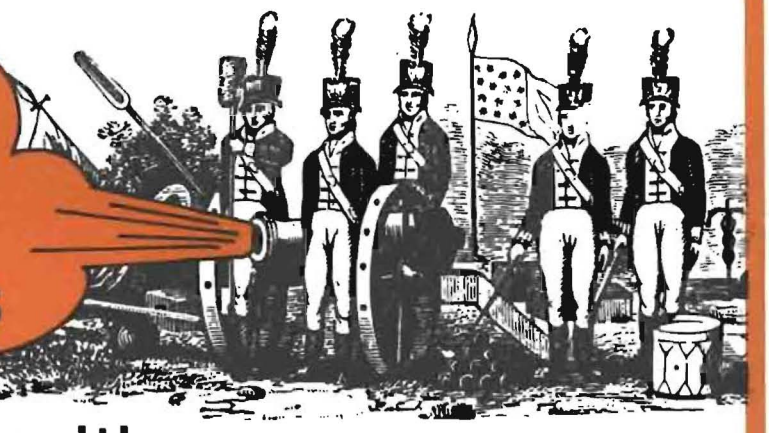

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THE USE OF HALOPERIDOL AS A LONG-ACTING NEUROLEPTIC IN GAME CAPTURE OPERATIONS*

J.M. HOFMEYR**

ABSTRACT: Hofmeyr J.M. **The use of haloperidol as a long-acting neuroleptic in game capture operations.** *Journal of the South African Veterinary Association* (1981) 52 No. 4 273-282 (En) Etosha Ecological Institute, P.O. Okaukuejo 9000, South West Africa/Namibia.

Haloperidol (R1625, Serenace) a potent, long-acting butyrophenone neuroleptic, was shown to be very effective in game capture operations for the neuroleptization of several species of African wild herbivores, especially the medium and small antelopes. With a rapid onset of action following intravenous injection and a duration of action of 10-12 h in the majority of cases, haloperidol produced profound psychomotor effects and remarkable tractability in red hartebeest, blesbok, springbok, duiker, steenbok and dik dik. Haloperidol suppressed the alarm reaction and facilitated the large-scale handling and translocation of captured animals. It also produced favourable sedation in Hartmann's zebra, Burchell's zebra, tsessebe and Black-faced impala. Extrapyramidal effects were observed in some species.

Key words: antelopes, Equidae, game capture, haloperidol, Serenace, transportation, tranquillizer, wild animals.

INTRODUCTION

One of the major problems in the capture and transport of wild herbivores is animal losses caused by an alarm reaction which results in stress, exertion, hyperthermia and injuries. Moreover, in aggressive species and amongst male animals of many species, fighting is a major drawback during translocation operations. In view of these problems, there has long been a need for a suitable long-acting neuroleptic that would effectively suppress the alarm reaction, reduce the effects of psychological, somatic and heat stress and facilitate the handling and transport of captured wild herbivores.

Haloperidol (R1625, Haldol, Halopidol, Serenace***) is a potent and specific neuroleptic drug or major tranquillizer which was developed by Janssen Pharmaceutica, Beerse, Belgium[13 14]. It belongs to the butyrophenone group of compounds, and the chemical designation and empirical formula for haloperidol are, respectively 4'-fluoro-4-[4-hydroxy-4 (4-chloro-phenyl)-piperidino]-butyrophenone and C21 H23 Cl FNO_2[14]. The butyrophenones also include such well-known neuroleptics as fluanisone (Janssen Pharmaceutica, Beerse, Belgium), azaperone (Stresnil, Janssen Pharmaceutica, Beerse Belgium) and droperidol (Inapsine, Janssen Pharmaceutica, Beerse, Belgium)[21]. Of these drugs, haloperidol has the longest action.

Janssen[13 14] gives a comprehensive description of the mode of action and pharmacology of haloperidol and other potent neuroleptics and states that these drugs are powerful and effective central nervous system dopamine blocking agents which have a high affinity for the membranes surrounding the synaptic cleft of dopaminergic neurones in the midbrain. At lowest effective doses, the nigrostriatum, or A9-system is specifically depressed. At significantly higher doses these drugs exert a blocking effect on the noradrenergic A10-group of neurones, i.e. on the median forebrain bundle system for self-stimulation. The autonomic noradrenergic system in the mid-brain and the rest of the sympathetic system are only significantly interfered with at much higher doses[14]. Janssen[14] put forward the hypothesis that the true antipsychotic activity of neuroleptic drugs is associated with their inhibitory effects on the dopaminergic nigrostriatum system of the midbrain and that the psychomotor sedative effects are associated with their inhibitory effects on the noradrenergic median forebrain bundle system.

In contrast, the low potency so-called sedative neuroleptic drugs such as promazine, are active only at much higher dose levels and are relatively aspecific in their neuroleptic action. Their first effect is to block noradrenergic neurotransmission in the midbrain, including the autonomic sympathetic centre. They are also active as peripheral alpha-adrenolytic compounds at low dosage levels, while the dopaminergic neurones in the midbrain are interfered with at very high doses only[14].

It is therefore not surprising that in man haloperidol is extensively used in psychiatry and is the drug of choice in the emergency treatment of psychomotor agitation, irrespective of its origin[15]. Crane, according to Thomas[23], states that in man, the most important side effects of haloperidol are extrapyramidal symptoms and dystonia, closely followed by restlessness, including akathisia.

According to Pienaar[21] the butyrophenones are not active hypotensive and hypothermic substances and consequently have little effect on the heat regulatory mechanism, blood pressure or heart rhythm of animals. In contrast these side effects are pronounced for some of the commonly used phenothiazine derivatives. Gerle[6] reports that although mild arterial hypotension is regularly seen in haloperidol treatment, it is considered insignificant and that the drug is remarkably well tolerated in patients with grave heart complaints. He concludes that haloperidol has a remarkably low toxicity and possesses powerful neuroleptic properties.

Reports on the use of haloperidol in wild animals are limited to a few studies only. Pienaar[21] found it to be a useful drug for acclimatising newly captured impala (*Aepyceros melampus melampus*) lambs to their holding pens. Hofmeyr et al.[12] found that springbok (*Antidorcas marsupialis*) are one of the more excitable ungulates and are easily alarmed during capture operations. They report on the successful tranquillization of this species with haloperidol at dosage rates of approx-

* Includes the papers presented at (1) The Second International Symposium on African Wildlife Research and Management, Pretoria, 5-8 July 1977. (2) The South African National and International Veterinary Congress, Johannesburg, 3-7 September 1979.

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imately 0,25 mg/kg. Tranquillized springbok were exceptionally calm and tractable and showed marked catalepsy when they were placed in the back of an enclosed truck. In addition, they were not alarmed when clinical examinations were performed and blood samples taken. Therapeutic effects were maintained for 10-12 h. Extrapyramidal effects were absent even when springbok received as much as 30 mg haloperidol. However, restlessness, possibly due to over-dosage was occasionally observed. Because Hofmeyr et al.[12] only gave dosage rates, the recommended dosages for the different age groups and sexes in springbok are given in Table 1.

During the same study, Gericke et al.[5] investigated the effects of haloperidol on various blood parameters in captured springbok. They found that although the animals were considerably over-exerted as a result of the capture operation, clinical observations and blood chemistry studies showed that haloperidol was effective in reducing the effects of stress and suppressing the alarm reaction. This resulted in a marked reduction in capture mortalities[12].

Dr D.G.A. Meltzer of the Department of Physiology, Pharmacology and Toxicology, Faculty of Veterinary Science, University of Pretoria (personal communication), used haloperidol for the transportation of bontebok (*Damaliscus dorcas dorcas*). He found that initial doses of 10 mg haloperidol for ewes and 15 mg for rams appeared to be too high following immobilization with etorphine hydrochloride (M99, Reckitt & Colman, Hull, England) and that the animals were only calm when the transport vehicle was stationary. Consequently Meltzer suggests a combination of 5 mg haloperidol and 5 mg xylazine (Rompun, Bayer, Leverkusen, Germany).

Mr P. Norton, Department of Nature and Environmental Conservation, Cape Province, (personal communication), reported suitable psychomotor sedation in a single klipspringer (*Oreotragus oreotragus*) injected with 4,0 mg (0,3 mg/kg) haloperidol.

Because of its long-acting properties which maintain therapeutic levels for 8-12 h, haloperidol was evaluated in several other species of wild ungulates, including eland (*Taurotragus oryx*), kudus (*Tragelaphus strepsiceros*), gemsbok (*Oryx gazella*), roan antelope (*Hippotragus equinus*), sable antelope (*Hippotragus niger*), Burchell's zebra (*Equus burchelli*), Hartmann's zebra (*Equus zebra hartmannae*), red hartebeest (*Alcelaphus buselaphus caama*), blesbok (*Damaliscus dorcas phillipsi*), tsessebe (*Damaliscus lunatus lunatus*), Black-faced impala (*Aepyceros melampus petersi*), reedbuck (*Redunca arundinum*), common duiker (*Sylvicapra grimmia*), steenbok (*Raphicerus campestris*), and Kirk's dik dik (*Madoqua kirki*).

GENERAL PROCEDURE

Pharmaceutical solutions of haloperidol at concentrations of 10 mg/ml, 20 mg/ml and 40 mg/ml were used (see addendum). The animals under consideration were captured in South West Africa/Namibia during the period 1972-1980. Dosages and routes of administration, drug action and duration of therapeutic effects were noted. In several cases, clinical observations on rectal temperature, cardiac rate and respiration rate were monitored. Wherever possible the mass of a sample of animals was determined in order to ascertain the dosage rate, otherwise it was calculated from body mass obtained from other sources (Tables 1 & 2).

Eland, kudus, gemsbok, plains zebra, mountain zebra and hartebeest were captured with the boma method described by Oelofse[19] and Pienaar[22]. These animals were loaded via a ramp into communal crates on trucks. Animals were injected with haloperidol by darting them either in the holding pen or following immobilization. The holding bomas were about 25-40 m long and not wider than 20 m to accommodate the darting of animals using a pneumatic projector (Palmer Chemical & Equipment Co. Inc, Palmer Village, Georgia, USA), which has a range up to 15-20 m. The darting was done through appropriate slits made in the hessian or plastic lining, care being taken to prevent human shadows from falling against the lining and frightening the game. Zebra were usually injected while moving up the loading ramp.

The drop net technique[10 22] was used to capture sable antelope, red hartebeest, tsessebe, blesbok, reedbuck, duiker and steenbok. Black-faced impala were either lured into a capture boma or caught in drop nets. Roan antelope were lured into a boma and then immobilized before haloperidol was administered. Dik dik were caught with a netting method. Netted animals were injected intramuscularly or, preferably, intravenously with haloperidol, using disposable syringes fitted with 22 or 25 gauge needles. The veins of the ear pinna were considered the most suitable sites for injection. Animals which were darted from a helicopter or in a holding pen with etorphine hydrochloride (M99) and azaperone were injected with haloperidol before the administration of the narcotic antidote. Because haloperidol precipitates when mixed with etorphine or fentanyl (Janssen Pharmaceutica, Beerse, Belgium), it could not be incorporated in the narcotic-neuroleptic mixture.

In the majority of cases, animals were transported in communal crates and were observed to determine the effects of haloperidol during transport and release as well as the duration of therapeutic effects. Observations also included the reactions of animals to humans and other animals. In the case of red hartebeest, blesbok, Black-faced impala, duiker and steenbok, attendants usually travelled with the animals which were kept under constant surveillance in transit.

INDIVIDUAL ANIMAL SPECIES: PROCEDURE, RESULTS AND DISCUSSION

Although obvious species differences exist, the neuroleptic effects of haloperidol were to a considerable degree influenced by the capture and transport methods used for each species, while other extraneous factors and variables also played a role. It is, therefore, necessary to give a brief description of the procedure used for each species, followed by the results obtained and a discussion where necessary.

Burchell's zebra and Hartmann's zebra

When captured with the boma method, both species invariably commenced biting and kicking one another in the holding pen. Furthermore, considerable fighting and restlessness were displayed by untranquillized zebra transported in communal crates. This led to mortalities and injuries caused by exertion, particularly amongst foals.

Owing to the traumatic effect of dart needles on zebra, and frequent haemorrhage from the dart wound, the injection of haloperidol by remote means was not successful in these species. More consistent results were obtained when adult zebra were injected intramuscularly with haloperidol using an automatic syringe and floating needle, as they walked onto the ramp during loading. Twelve Burchell's zebra and 11 Hartmann's zebra which each received 100 mg haloperidol in this manner, at dosage rates of approximately 0,30 mg/kg and approximately 0,35 mg/kg respectively, were much calmer than controls or zebra darted with haloperidol. Soporific and cataleptic effects were evident in several of the Hartmann's zebra. Although the drug took effect within 10 min, it was necessary for the transporting vehicle to remain stationary for at least 15 min for haloperidol to exert its desired effect.

In a comparative study and following the same procedure, similar sedative effects were observed when 7 adult Burchell's zebra were each injected with 25 mg propionyl-promazine (Combelen, Bayer, Leverkusen, Germany). However, Combelen produced preputial prolapse in stallions. Duration of sedation was not determined with either drug, although haloperidol should have a longer action.

Recommended haloperidol doses for free-ranging Burchell's and Hartmann's zebra are given in Table 1. Following preliminary investigations, the indications are that captive zebras, particularly stressed animals, require significantly lower haloperidol doses.

Red hartebeest

A total of 355 hartebeest were captured, 292 with the

Table 1: RECOMMENDED HALOPERIDOL DOSAGES FOR FREE RANGING BURCHELL'S ZEBRA, HARTMANN'S ZEBRA, BLESBOK, TSESSEBE, BLACK-FACED IMPALA, SPRINGBOK, DUIKER AND STEENBOK

SPECIES	EXERCISE	AGE AND SEX	RECOMMENDED DOSAGES		*BODY MASS (kg)			DRUG EFFECTS AND DURATION
			Total dose (mg)	Dosage rate (mg/kg)	Range	$\bar{x}$	n	
Burchell's zebra+	Automatic syringe and floating needle on ramp	Adult	100	± 0,3	290-371	334	23	Calm but not tractable
Hartmann's zebra+	ditto above	Adult	80-100	0,28-0,35	—	287	45	Calm but not tractable. Soporific effects at 100 mg
Blesbok	Intravenous injection in nets	Adult M Adult F Young	15 up to 20 10 5-7,5	± 0,21 up to 0,28 ± 0,14 0,11-0,16	65-78 70 45-47	72 — 46	11 1 2	Good, tractability lasting 12-14 h. Occasional aggression
Tsessebe+	Intravenous injection in drop nets	Adult M Adult F Young	40-45 40-45 20	0,25-0,30 0,25-0,30 ± 0,25	148 148 81	— — —	1 1 1	Good psychomotor effects and tractability, lasts > 6 h
Black-faced impala++	Intravenous injection in drop nets and boma	Adult M Adult F Subadult Young 8 mths Young 6 mths	7,0-7,5 (10-12) 5,0-6,0 5,0-5,5 3,5-4,0 2,5-3,0	± 0,10 0,88-0,10 0,09-0,10 0,09-0,10 0,09-0,11	— — — — —	73,1 60,0 51,8 38,0 26,3	7 9 6 7 9	Good psychomotor effects and tractability ± 7 h. Extrapyramidal effects
Springbok+++	Boma and drop nets	Adult M very large Adult M large Adult F Subadult Young	10-15 7,5-10 7,5 5,0-7,5 2,0-5,0	0,2-0,3 $\bar{x}$ 0,25	45-55 35-45 25-35 25-35 15-25	47 40 30 ? 19	— — — — —	Excellent effect and tractability. 10-12 h
Duiker (Semi-tame)	Intravenous injections in drop nets	Adults	7,5	± 0,45	15-18	16,5	2	Excellent effect and tractability > 12 h
Steenbok+ (Semi-tame)	Intravenous Injection in drop nets	Adults	5,0	± 0,48	—	10,5	5	Excellent effect and tractability > 12 h

+ Optimum doses need confirmation.
++ Recommended dosage rate = 0,1 mg/kg. May be increased to 0,16 mg/kg, especially in troublesome rams, but antiparkinson's drugs advocated to counteract extrapyramidal symptoms.
+++ Kalahari springbok which are generally considered to be larger than springbok found elsewhere in southern Africa.

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Burchell's zebra – from personal routine immobilization data.
Mountain zebra – Joubert[17].
Blesbok and duiker – P. Brand, Chief Professional Officer, Department of Agriculture and Nature Conservation, SWA/Namibia, personal communication.
Impala, blesbok and tsessebe – Sample of haloperidol tranquillized game.
Steenbok – Hofmeyr & Skinner[9].
Springbok – H.G. Luchtenstein, Lochkolk, Keetmanshoop, SWA/Namibia, personal communication.

boma method and 63 in drop nets. Eleven animals died (3,8% of boma captured hartebeest) as a result of injuries sustained in the boma. Bulls were also responsible for inflicting stab wounds in the inguinal region of other animals.

A total of 281 boma captured hartebeest were tranquillized with haloperidol soon after capture. Physical restraint was avoided by darting the hartebeest in the holding/darting pen with haloperidol at doses given in Table 1. Palmer darts fitted with NC2 barbed needles were generally fired into the gluteal or thigh muscles of the buttock (Fig. 1). Groups of up to 20 animals were handled at a time. Adults were always darted first to reduce injuries inflicted by their horns. Before they were herded into the crates via a ramp, they were left undisturbed for 20-30 min for the drug to take adequate effect. The disposition of the animals before and especially after darting was most important. The most desirable effects were achieved when the animals were alarmed as little as possible before and after darting.

Although the hartebeest were unapproachable in the darting pen, they showed remarkable tractability and cataleptic immobility inside the crates (Table 2). They were easy to handle and attendants were able to move amongst the animals without causing alarm (Fig. 2). Darts were removed, animals examined, stab wounds treated and a long-acting antibiotic (Penimycin, Panvet) administered. Animals were sexed, aged and sorted without the need for physical restraint. Polythene piping was pushed over the horns of adults and secured with Pattex contact adhesive. Only occasionally did bulls engage in combat. Effective psychomotor sedation and tractability were maintained for 9-12 h and sometimes up to 15 h. Cataleptic immobility was maintained for several hours. While under the influence of haloperidol animals were able to urinate and defaecate normally. Upon arrival at their destinations the majority of hartebeest were still affected and were often reluctant to leave the crate.

The 63 hartebeest captured in drop nets were suitably tranquillized within 5-10 min of the intravenous injection of haloperidol. This facilitated removal from the nets and loading. No losses were sustained among netted hartebeest. Although the recommended doses (Table 2) are somewhat lower than for boma captured hartebeest, the results were more favourable and consistent, presumably due to a shorter alarm reaction and the rapid effects which followed the intravenous injection of haloperidol.

The majority of boma captured and netted hartebeest were transported directly to their final destinations soon after capture. It was safe and advisable for attendants to travel with the animals. However, 86 hartebeest were transported to holding pens where they stood in quarantine for a month with the result that 8 animals died of fighting and exposure to cold. No obvious macroscopic lesions of capture myopathy were found during all the post mortems conducted.

After quarantine, the hartebeest were again darted with haloperidol. In this instance, dosage rates were considerably lower and accuracy was more critical in captive than in free ranging hartebeest (Table 2). Side effects such as hypertonia and allotrophagia, which were only occasionally seen in captured free ranging hartebeest, were commonly observed in captive animals. In one case, abnormal feeding behaviour and the inges-

Table 2: HALOPERIDOL THERAPY IN RED HARTEBEEST

Exercise	Age, Class and Sex	Recommended Dosages		*Body Mass (kg)			Effects
		Total Dose (mg)	Dosage Rate (mg/kg)	Range	$\bar{x}$	n	
Boma captured hartebeest	Adult bulls	20-25 up to 30	0,13-0,16 up to 0,2				Excellent psychomotor sedation, tractibility and catalepsy inside crates. Severe alarm reaction before neuroleptization produced inconsistent results
	Adult cows	15	0,09-0,13 $\bar{x}$ 0,1				
	Young 8-11 months	7,5	0,8-0,1				
Netted hartebeest	Adult bulls	15-20	$\bar{x}$ 0,1	145-160	152	3	Excellent psychomotor effects, tractability and catalepsy. Consistent results
	Adult cows	12,5	$\bar{x}$ 0,85	118-170	146	7	
	Young 8-11 months	7,5	0,8-0,1	77-100	88	7	
Captive hartebeest	Adult bulls	12,5	0,7-0,8				Favourable psychomotor effects, tractability and catalepsy, but dosages more critical; dystonia and allotrophagia more common
	Adult cows	10	$\bar{x}$ 0,7				
	Young 8-11 months	5	$\bar{x}$ 0,6				

*Body mass determined in netted hartebeest tranquillized with haloperidol.

tion of a piece of wire resulted in death due to traumatic reticulo-pericarditis, peritonitis and necrotic foci in the liver.

Fig. 1: Red hartebeest darted with haloperidol. To avoid the accidental redarting of animals, they were all darted on the right side

Fig. 2: Fully tractable red hartebeest under the influence of haloperidol in a transport vehicle

Observations were also conducted when maintenance therapy was given to 4 free ranging netted hartebeest. Three animals were observed for 26 h and one animal for 75 h. Optimum effects were evident in the first 12 h, although suitable sedation and tractability were obtained when maintenance doses, injected at 11-12 h intervals, were equivalent to or 20 % more than the initial doses. Some restlessness was noted, when maintenance doses were 40-47 % lower than initial doses. An 88 kg yearling which was observed for 75 h, was still tractable 36 h after the last injection of 7,5 mg (0,085 mg/kg) haloperidol given at Hour 36. This may be the result of the prolonged elimination half-life of haloperidol[2], which had a "taming" effect on the animal. Extrapyramidal effects were absent, but may present problems during maintenance therapy.

In conclusion, the best neuroleptic effects and overall results were undoubtedly obtained in netted hartebeest transported directly to their destinations. Haloperidol had a significant anxiolytic effect and proved to be a most useful and valuable neuroleptic to control exertion and psychological stress during handling and transport. These favourable effects are well illustrated by a cow that gave normal birth when she was transported with several other animals. No harm came to the calf inside the crate and at the destination it was off-loaded with the rest of the group.

In another instance, a large calf that had been gored by a bull, remained completely calm and tractable under haloperidol therapy while the reticulum, abdominal muscles and skin were sutured without local anaesthetic. The calf made a full recovery. There is some support from the literature that haloperidol possesses analgesic properties. Using the writhing test and hot plate method, Christensen et al.[1] demonstrated analgesic activity of haloperidol in mice, but at dosages affecting spontaneous activity and motor coordination, the analgesic effect may be unspecific. For instance, in the tail withdrawal test in rats, which is a much more sensitive measure for analgesic properties, haloperidol was found to be virtually inactive[16]. Therefore in the event of surgery, the additional use of a local anaesthetic is considered necessary.

Blesbok

Of 92 blesbok captured, 9 were caught in a boma, 5 were darted from a helicopter and the balance were netted. Haloperidol was administered intravenously at recommended dosage rates which are given in Table 1. Some aggressive rams received as much as 20 mg (0,28 mg/kg) haloperidol. Neuroleptic effects were evident within 5 min and effective psychomotor sedation was maintained for 12 h (in certain cases for up to 14 h). Dosage rates were somewhat higher than for hartebeest. Although the effects were similar to those seen in hartebeest, some rams showed aggression towards attendants in the crates. Rams also fought occasionally. The use of protective piping over the horns of rams in particular, was therefore necessary to safeguard both animals and attendants from injury. Side effects of an extrapyramidal nature were rare and transient. While under sedation, micturition and defaecation occurred and several animals ruminated.

The majority of blesbok were transported directly to their final destinations, remaining completely tranquil in transit. A few animals were kept in holding pens before they were distributed to farmers 3-10 d later. There were 2 deaths in the drop nets and 2 in the holding pens, but farmers had no losses either during transport or after the animals were released.

Clinical observations made every hour for 8 hours on 9 blesbok captured in a boma, handled and tranquillized with haloperidol, showed a notable decrease in cardiac rate, respiration rate and rectal temperature after one hour, followed by almost constant values for the following 7 hours (Fig. 3, 4 & 5).

Tsessebe

Ten tsessebe captured in drop nets were injected with haloperidol intravenously at dosage rates that ranged from 0,14-0,40 mg/kg. Favourable psychomotor sedation was obtained within 5 min at dosage rates of 0,24-0,40 mg/kg, which are considerably higher dosage rates than for hartebeest and blesbok. Neuroleptic effects were maintained throughout a 6 h observation period. Although some tsessebe were not completely tractable even at high dosage rates, it was possible to

travel with a group of 5 animals and conduct clinical observations over a period of 5 h. In general the animals were calm, but transient agitation was evident when they were transported on exceedingly bumpy roads. The use of polythene piping over the horns was necessary.

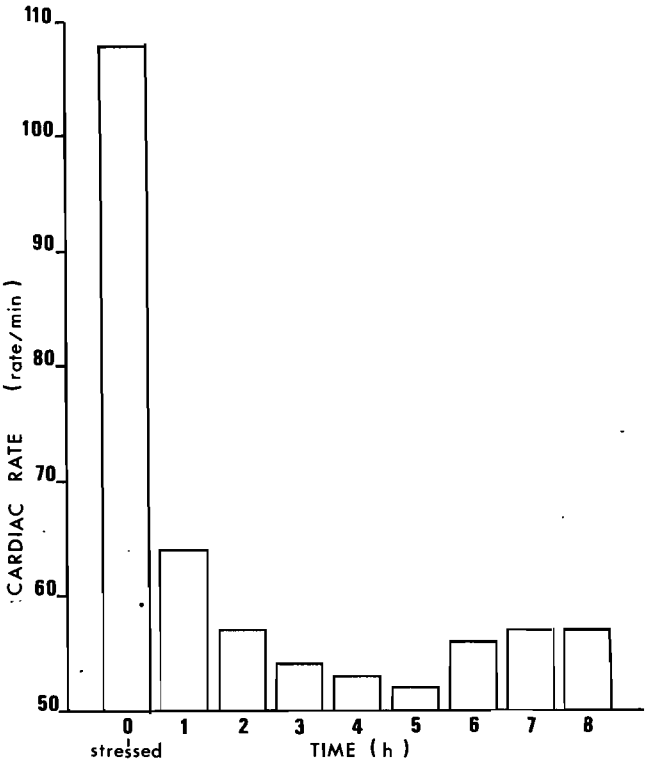

Fig. 3: The effect of capture and haloperidol therapy on the cardiac rate of blesbok (n = 9)

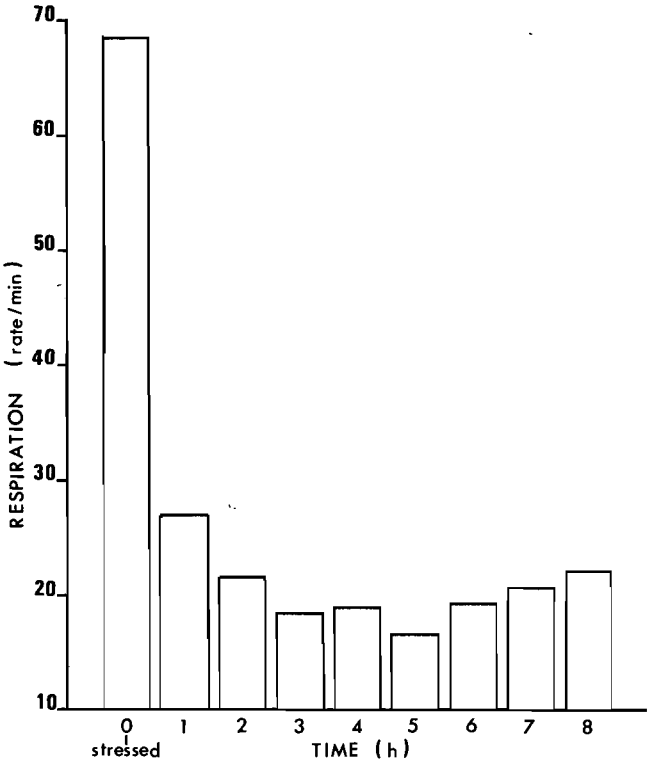

Fig. 4: The effect of capture and haloperidol therapy on the respiration rate of blesbok (n = 9)

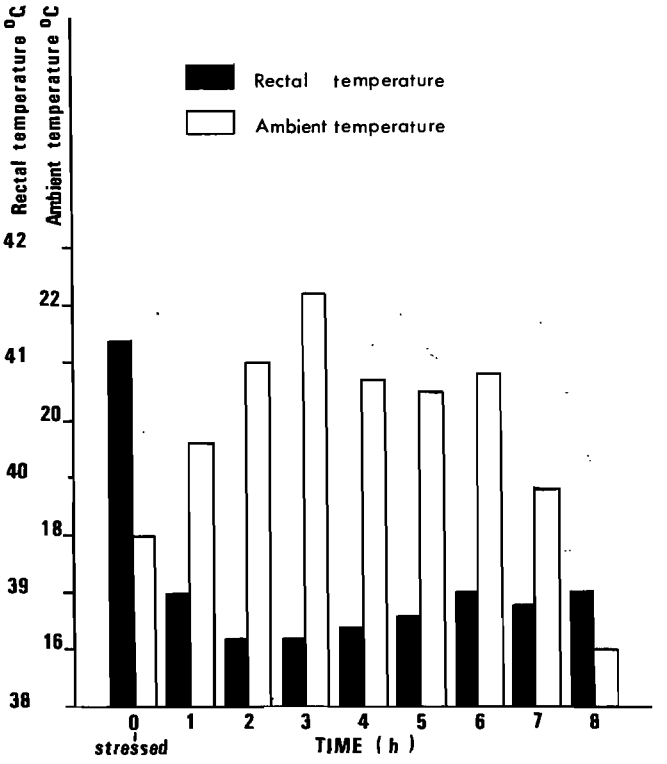

Fig. 5: The effect of capture and haloperidol therapy on body temperature of blesbok (n = 9)

There were no side effects or losses, and haloperidol successfully suppressed the alarm reaction. These results are promising in view of the fact that tsessebe are susceptible to capture myopathy and that mortalities of 64% have been reported when tsessebe were immobilized from a helicopter[24].

It should be mentioned that tsessebe can be extremely pugnacious when confined to small pens. It is therefore advisable to place bulls in individual pens, and cows and calves in a large enclosure. Recommended doses (Table 1) are 40-45 mg (0,25-0,30 mg/kg) haloperidol for adults and 20 mg (approximately 0,25 mg/kg) for large calves of approximately 80 kg mass.

Black-faced impala

Of a total of 234 Black-faced impala captured, 70 were lured into a boma and 164 were caught in drop nets. All the impala were injected intravenously with haloperidol. A favourable neuroleptic response was observed within 5-10 min, although full tranquillization sometimes developed after 20-30 min. The use of blindfolds facilitated the handling of animals until the drug had a desirable effect and the impala were inside the crates.

Dosages are more critical and extrapyramidal symptoms, which ranged from allotrophagia in mild cases to hypertonia, torticollis and excitement in severe cases, were more frequently observed in this than in other species. Although there may be an individual predisposition, extrapyramidal effects appeared to be precipitated and enhanced by exertion, hyperthermia and excessive noise caused by the rattling of the crate during transportation. The margin, therefore, between an effective dose and one resulting in side effects is much narrower in impala and in this species haloperidol also tends to produce mild soporific effects (Fig. 6).

Fig. 6: Attendance of haloperidol tranquillized Black-faced impala during transport. Note the mild soporific effect

Fig. 7: Fully tractable duiker under haloperidol therapy

At the recommended optimum dosage rate of 0,10 mg/kg (Table 1) the animals were suitably tractable inside the crates (Fig. 6) and effective sedation lasted for approximately 7 h. At a dosage rate of 0,16 mg/kg, therapeutic levels were maintained for at least 12 h, probably longer. Extrapyramidal symptoms were controlled by the injection of 5 mg biperiden (Akineton, Knoll A G Ludwigschafen, Germany) an antiparkinson's drug. However, its effect was of rather short duration and side effects sometimes recurred. A longer acting and potent antiparkinson's drug such as dexetimide (R16470, Tremblex, Janssen Pharmaceutica, Beerse, Belgium) which has a duration of action of 48-72 h, is therefore suggested[4 25]. Although 5-10 mg xylazine controlled extrapyramidal symptoms, a pronounced soporific effect developed.

Impala are rather susceptible to injuries and exertion when caught in nets and losses as high as 10 % were encountered. They were also prone to injuries when handled in a capture boma or in pens. The injection therefore of haloperidol, without causing injuries, is still a problem which needs to be overcome.

Duiker and steenbok

Thirty-four semi-tame common or grey duiker captured in drop nets, showed remarkable tractability and psychomotor sedation, following the intravenous injection of 7,5 mg (approximately 0,45 mg/kg) haloperidol. Similar results were obtained in 2 steenbok which received 5 mg (approximately 0,48 mg/kg) haloperidol intravenously (Table 1).

The effect was rapid and animals could be removed from the nets and loaded after 5 min. Once released in the truck they were exceptionally calm. In both species, haloperidol had a marked anxiolytic effect and there was a pronounced change in disposition of the animals, with complete loss of fear for people (Fig. 7). Duiker ewes at full term pregnancy responded well to haloperidol therapy. They were not distressed and there was no evidence of abortions.

During tranquillization, the animals either lay or stood and urination and defaecation were normal. In 3 duiker the haloperidol dose was increased to 12,5 mg. They appeared more drowsy and were inclined to sternal recumbancy, but no pronounced soporific effect was evident.

Twenty-seven duiker were transported 275 km inside a steel crate in a 15-ton truck. The animals were in the truck for 11 h and were completely at rest in the stationary vehicle, but during transportation the noise of the rattling steel crate and bumpiness of the truck caused restlessness amongst certain animals. Apparent extrapyramidal effects of a transient nature, noticeably chewing and licking of objects, occurred but these effects completely disappeared when the vehicle stopped.

The other 7 duiker and 2 steenbok were transported 420 km in a 1,25-ton truck fitted with a canopy and canvas flaps. They were in the vehicle for 12 h. In this vehicle the animals became restless when the truck commenced travelling with the flaps raised, but they immediately calmed down once the canvas was lowered. However, as soon as the animals became conditioned to the moving vehicle, the flaps could be rolled up again without causing alarm. Transportation with raised flaps was necessary to ensure adequate ventilation and cooling by convection at that time of year. These observations are important and clearly show that desirable psychomotor effects of haloperidol will be influenced by the immediate surroundings of the animal and that certain occular and auditory stimuli influence the degree of neuroleptic effect produced.

Therepeutic levels were maintained for at least 12 h, possibly longer and the animals were still calm when they were released. Observations continued for 48 h after transportation; no losses occurred and all animals fed and drank water.

Dik dik

Five dik dik were captured at night in a net and placed in an enclosed truck. They showed profound tractability soon after the injection of 2,5 mg (0,42-0,64 mg/kg) haloperidol. However, one animal required an additional 2,5 mg haloperidol after 3 h. Maintenance doses (2,5-5,0 mg) were necessary in all the dik dik approximately 10 h later. During a separate investigation a single dik dik required 27,5 mg (5,5 mg/kg) haloperidol over a 12 h period. Apart from a mild soporific effect, no other side effects developed. In dik dik, haloperidol dosage rates are somewhat higher than in the other species investigated.

Other species

Eland

Adult eland bulls may be particularly pugnacious and can fatally injure other eland when captured in a boma or transported in a communal crate[11].

Although 3 adult bulls which were captive for 3 months were successfully transported together following haloperidol therapy at 0,1-0,125 mg/kg[11], communal transportation was not possible with 3 free ranging bulls which were immobilized, injected with 150 mg haloperidol (approximately 0,22-0,3 mg/kg) and then revived. In view of these findings, the communal transportation of free ranging adult bulls tranquillized with haloperidol is not recommended and problems may also be experienced with the communal transportation of captive bulls.

The effects of haloperidol when used alone, that is without the after effects of or interaction with immobilizing drugs, were not determined.

Kudu

Haloperidol produced a favourable response in 2 young kudus, one of approximately 150 kg and another of approximately 50 kg body mass, when injected intravenously with 30 mg (0,2 mg/kg) and 12,5 mg (0,25 mg/kg) haloperidol respectively. However, an adult bull darted with 60 mg haloperidol and which showed a neuroleptic response after 30 min, became decidedly aggressive and dangerous when attempts were made to herd it on to a ramp and charged the author.

Although untranquillized kudu cows and calves remain calm inside suitably enclosed transport crates, haloperidol may be indicated for the release of kudus into pens. Dr T. van Wyk, veterinarian of the game capture team, Department of Agriculture and Nature Conservation, South West Africa/Namibia (personal communication), found haloperidol useful for the handling of kudu calves which had been caught in drop nets.

Gemsbok

This is one of the aggressive species which present significant problems during capture operations. Ten gemsbok darted with 80 mg (approximately 0,36 mg/kg) haloperidol did not show any favourable drug effect, neither did 5 gemsbok which were each injected with 90 mg (approximately 0,40 mg/kg) haloperidol. The animals fought and remained restless.

Roan antelope

Although roan antelope have been successfully air-lifted under narcosis[8], their transportation by road in communal crates, remains a problem. Following the immobilization of 43 boma-captured roan antelope, the intravenous injection of 5-10 mg haloperidol for 21 calves and 20-30 mg for 22 adults, did not produce favourable psychomotor sedation. During the 6 h 425 km journey, hypertonia, allotrophagia, hyper-excitability and occasional, but severe, fighting were observed which resulted in 6 casualties, of which 2 were the victims of fighting and 4 died of capture myopathy.

Sable Antelope

Sable calves, 45-70 kg body mass, captured in drop nets, and transported in communal crates, showed favourable psychomotor sedation, but were not fully tractable when injected with 20-25 mg haloperidol at dosage rates of 0,29-0,42 mg/kg.

Reedbuck

Although a subadult semi-tame reedbuck ram was very tractable during an airlift operation when injected with 7,5 mg haloperidol, suitable tranquillization could not be achieved in 8 free ranging reedbuck which received as much as 90 mg haloperidol without producing soporific effects in certain individuals. In this species 30-40 mg xylazine produced suitable tractability but it was accompanied by pronounced soporific effects.

GENERAL CONCLUSIONS AND SUMMARY

Janssen[15] points out that one surprising fact about tranquillizers in veterinary practice is their marked species specificity, which generally limits the usefulness of a particular neuroleptic to a few species only. During these investigations, haloperidol was shown to be particularly effective in the majority of small and medium antelope species, especially red hartebeest, blesbok, springbok, duiker, steenbok and dik dik. In these animals it produced a pronounced psychomotor effect. It was shown to effectively control psychological stress, injuries and additional exertion after capture and to suppress the alarm reaction during handling, transportation and even initial acclimatisation. The very successful application of this drug has made it possible to overcome innumerable problems associated with the handling, treating, sorting and transportation of game.

In the author's experience, haloperidol has greatly enhanced the management and survival rate of the above species during translocation operations. In particular, farmers who received animals tranquillized with haloperidol, have been most impressed with the favourable responses produced by this drug. Haloperidol also shows considerable promise in tsessebe.

In the larger ungulates, variable results were obtained. However, haloperidol produced a favourable response in young kudus and sable calves, and in Burchell's and Hartmann's zebra. Recent studies have shown it to be a useful and effective neuroleptic for the transportation of black rhino (*Diceros bicornis*) (personal observations).

Side effects of an extrapyramidal nature were observed in roan antelope, Black-faced impala, red hartebeest and to a lesser degree in blesbok and duiker. Springbok tend to show transient restlessness. Although certain animals may show an individual predisposition to side effects, there is substantial evidence that these effects are enhanced by hyperthermia, noise, excitability and a concommitant catecholamine reaction. Care should therefore be taken not to over-excite the animals during capture and handling and not to exceed recommended dosage rates in species which are prone to extrapyramidal symptoms. It is essential to keep animals calm after injection to enable haloperidol to exert its desired effect. In addition, in view of the abnormal feeding behaviour which occasionally accompanies haloperidol therapy, special care should be taken to prevent the ingestion of foreign bodies such as syringe needles or bits of wire as this can lead to a traumatic reticulo-pericarditis. Extrapyramidal effects, particularly excitomotoric phenomena, combined with ex-

ertion and hyperthermia, may lead to irreversible capture myopathy. Severe extrapyramidal effects should therefore be controlled with biperiden or preferably with the potent longer acting dexetimide.

The fact that pronounced soporific effects and concommitant ataxia are not a feature of haloperidol, are major advantages for the mass translocation of game. Mild soporific effects were seen mainly in Hartmann's zebra and Black-faced impala. It should be noted that haloperidol therapy following immobilization was generally not entirely successful and results were inconsistent, possibly because of unfavourable drug interactions. Neuroleptics such as azaperone would tend to potentiate extrapyramidal side effects and xylazine would enhance soporific effects.

As haloperidol is almost devoid of anti-adrenergic and other autonomic effects at normal dosage rates[13 14], tractability is enhanced by placing the animals in a suitably enclosed crate and by having them in groups, particularly those species which are gregarious by nature. For instance, red hartebeest, blesbok, impala, springbok, duiker and steenbok showed pronounced tractability inside crates but not outside. In addition, it was possible and indeed advisable, for an attendant to supervise and remain with the animals during transportation. *However, it should be emphasized that large and medium-sized herbivores tranquillized with haloperidol, should be handled with caution and respect as they tend to show aggression to people and may become extremely dangerous when on their own.* When retained individually in pens or crates adult kudu bulls, adult male hartebeest and blesbok rams, may attack without provocation when under the influence of haloperidol.

Another interesting feature of these studies was that haloperidol doses and effects differed significantly in certain species between free ranging and captive animals as well as between wild and semi-tame animals. In captive animals stress and/or taming produced by captivity, may account for these differences. Hence zoo animals may not only respond differently to haloperidol but may also require different dosage regimens.

Haloperidol produced a rapid neuroleptization in the majority of species which was evident within 5 min of intravenous injection. As with any tranquillizer, a major drawback is the disturbance and handling associated with giving the injection. Therefore, the most suitable technique for injection must be sought and the advantages of haloperidol therapy need to be weighed against the disadvantage of handling or possible disturbance of the animals. In animals which are successfully captured in nets, drug administration is no problem.

As losses during transportation may be high, especially when animals are moved after a short captivity period, Harthoorn[7] recommends transportation immediately after capture, or only after a lengthy period of captivity to allow for rest, readaptation, change of diet and taming. Even a lengthy period of captivity may present problems with psychological stress and management, and result in increased losses, unless there are proper holding facilities and supervision. During these studies, the translocation of red hartebeest and blesbok immediately after capture, thus avoiding a captivity period, was most successful. Therefore, in view of the long-acting properties of haloperidol, the transportation of game direct to their destinations is recommended, if this is practicable.

The therapeutic effects of haloperidol were maintained for 10-12 h in most cases. Sedation of a longer duration, particularly when animals are transported over long distances, may be obtained by maintenance therapy, although results may not be as consistent and there is the added problem of having to reinject the animals. The use therefore, of longer acting neuroleptics such as bromperidol (R11333, Janssen Pharmaceutica, Beerse, Belgium)[18 20] and haloperidol decanoate (R13672, Janssen Pharmaceutica, Beerse, Belgium)[3] which have effects lasting for up to 24 h, and 30 d respectively, is worth considering.

In conclusion, haloperidol holds considerable promise in game capture operations especially for the small antelopes, notably the Cephalaphinae and Neotraginae, and the medium-sized species, particularly the Antilopinae and Alcelaphinae. Furthermore, haloperidol may be advocated for the members of the Tragalaphinae and Equidae. It should be emphasized that haloperidol therapy should not be a substitute for but must go hand-in-hand with sound game capture principles.

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ADDENDUM

According to the manufacturer's instructions the formulation of haloperidol at the following concentrations should be prepared as follows:

Formula	Concentration		
	10 mg/ml	20 mg/ml	40 mg/ml
Haloperidol	4,0 g	8,0 g	16,0 g
Lactic acid U.S.P. (85%)	4,40 ml	8,80 ml	17,60 ml
N/1 Sodium Hydroxide (Analar) appr.	1,20 ml	2,40 ml	4,80 ml
Water for injection	400 ml	400 ml	400 ml

1. Determine the mass of the haloperidol and place it in a glass beaker. Add the lactic acid. Mix well whilst heating on a hot water bath at 80 °C and stir until the mass is liquefied.
2. Boil about 200 ml of the water and stir in the material from stage 1 until dissolved. Cool.
3. Make almost up to volume with water, stir in thoroughly the sodium hydroxide, check pH to 3,2 ± 0,1 then adjust to final volume.
4. Stand the solution for 24 h protected from light.
5. Clarify the solution through a No. 3 sintered glass filter, or membrane filter and distribute into suitable amber multidose vials. Seal.
6. Autoclave the ampules at 115-116 °C for 30 min to sterilize. The pH of the final solution is 3,2. Care must be taken to add no more than the correct amount of sodium hydroxide, otherwise haloperidol may be precipitated.

During processing the solution should be protected from direct sunlight as far as possible, and the bulk or filled vials stored in the dark as necessary.

HAEMODYNAMIC AND NEUROLOGICAL RESPONSES OF VENTILATED AND APNOEIC CALVES TO SUCCINYLDICHOLINE

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ABSTRACT: Button C.; Bertschinger H.J.; Mülders Maria S.G. **Haemodynamic and neurological responses of ventilated and apnoeic calves to succinyldicholine.** *Journal of the South African Veterinary Association* (1981) **52** No. 4 283-288 (En) Department of Physiology, Pharmacology and Toxicology, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

Succinyldicholine-induced asphyxia in awake calves led to massive catecholamine release by the adrenal medulla. Hypertension and bradyarrhythmias resulted. Electroencephalograms recorded during periods of succinyldicholine-induced apnoea indicated that calves were probably conscious and under psychic stress for at least 4 min after the onset of apnoea. Electroencephalographic signs indicative of decreased consciousness became evident in one calf only after 4,8 min of apnoea but were absent in 3 calves subjected to maximum periods of apnoea of 4,1; 3,2 and 4,4 min. The latter 3 calves all recovered with no apparent neurological deficit after intravenous injection of plasma pseudocholinesterase.

Key words: Asphyxia, calves, game cropping, succinyldicholine.

INTRODUCTION

Succinyldicholine chloride (SDC) (Scoline, Glaxo Allenburys, Germiston) is a peripheral-acting, depolarizing skeletal muscle relaxant[1 18]. The drug molecule comprises two molecules of acetylcholine (ACH) linked at the alpha methyl position[4]. SDC binds the ACH receptor of the neuromuscular junction resulting in sustained depolarization[6]. Flaccid muscular paralysis is preceded by involuntary and uncoordinated fibrillatory muscle contraction which, in man, may be moderately painful[20]. Skeletal muscle fibres remain depolarized and paralysed for as long as SDC molecules remain attached to their sarcolemmal ACH receptors. SDC molecules have a low affinity for ACH receptors at autonomic ganglia so that direct autonomic effects of the drug are not a feature of clinically used doses but may be recorded after massive doses[8 27].

Muscle groups are not equally susceptible to the effects of SDC[20]. Smaller doses of SDC paralyse muscles of the head, neck, trunk and limbs[30]. Larger doses paralyse all skeletal muscles, including those responsible for respiration, so that without artificial ventilation, asphyxia results[1 18 20].

The duration of SDC-induced muscular paralysis depends on the rate at which SDC molecules are metabolised by the enzyme plasma pseudocholinesterase[29]. Domestic ruminants are approximately 10 times more susceptible to the paralysing effects of SDC than are, for example, human beings or horses[11-13]. The increased sensitivity of cattle compared to horses is the result of cattle having approximately one tenth the concentration of plasma pseudocholinesterase of horses[26].

SDC is a polar, water soluble molecule. The drug is given by parenteral routes because, in theory, absorption from the gastro-intestinal tract is minimal[18]. In practice, however, oral doses as low as 3 mg/kg have killed jackals approximately 20 min after administration[22]. Because it is mostly ionized at a physiological pH, SDC cannot gain access to the substance of the brain, which is protected by tight endothelial junctions of the blood-brain barrier. In man and, presumably, in animals, SDC has no central nervous depressant effects and is not an anaesthetic[6 14 20]. During early clinical trials, SDC was injected into a conscious human volunteer. During SDC-induced muscle paralysis the subject remained awake and fully conscious of his surroundings and state of respiratory paralysis[20].

SDC is used in human[18] and veterinary[1] medicine to induce profound muscular relaxation in anaesthetised, mechanically ventilated surgical patients. SDC has also been used to immobilise conscious, non-anaesthetised horses and cattle for surgical procedures, e.g. castration[11-13 19 31]. In this case, dosage rate is critical because it must be sufficient to paralyse all skeletal muscles except those of respiration. The method is no longer used in most countries as it has been condemned as inhumane (the patient is presumably conscious and aware of surgical pain) and dangerous (small overdoses result in asphyxia and death)[2 6 15 21 25].

The use of SDC as a "euthanatizing" agent has been widely condemned because animals are assumed to be fully conscious, aware of pain and terrified for the few minutes between the onset of somatic and respiratory muscle paralysis and hypoxic loss of consciousness which precedes death[2 6 15 21 25]. An extremely controversial issue in South Africa has been the use of SDC for chemical immobilization of elephant and killing of buffalo during game cropping operations[3 7 28]. The drug is, from the viewpoint of the game croppers, ideally suited for this use because:

(1) SDC acts extremely rapidly and animals are immobolized and appear dead within 4 min after injection[3]. Rapid immobilization prevents game moving far from the site of cropping and minimizes deleterious changes in meat quality associated with prolonged chasing, e.g. glycogen depletion.
(2) SDC is highly soluble in water and can be made up in concentrated solutions, allowing suitably small volumes to be injected from a helicopter using projectile darts[3 14].
(3) Residues of SDC in meat and biltong are apparently considered acceptable by public health authorities. This is presumably the case because SDC concentrations are likely to be low in the final product. According to Harthoorn[14], SDC is destroyed by cooking and digestion. Should a few molecules be absorbed after ingestion by humans, they would be degraded within a matter of minutes by plasma pseudocholinesterase to metabolites which normally occur in the body, i.e. succinic acid and choline[6].

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Concern over the use of SDC has resulted in the appointment of 2 committees of enquiry by the South African Veterinary Association[3 28]. Both committees visited the Kruger National Park and witnessed first hand the cropping of game using SDC. The first committee submitted a report in 1975 which did not favour the use of SDC for cropping of game[28]. The second committee made its report in 1979 and noted that while most elephant darted with SDC continued breathing until they were shot in the head with a rifle, buffalo were "dead" within 3-4 min of darting making "shooting before exsanguination unnecessary"[3]. The criterion for determining death was not described. The committee concluded that the culling method as used on buffalo was the best available at the time but proposed research into the "dose-related action of S-choline in buffalo, as well as the nature and duration of the post-darting response".

The present preliminary investigations on calves were undertaken on the basis of the above recommendation. SDC is still being used as an immobilising and killing agent in South African game parks and so the issue is still a live one. The purpose of the present investigation was:

(1) to determine, as far as was feasible, how long calves paralysed by SDC remain conscious;
(2) to find a measure of the level of anxiety in calves paralysed by SDC and to determine whether or not they are still aware of pain while paralysed;
(3) to determine haemodynamic (blood pressure, heart rate) changes in both ventilated and non-ventilated SDC paralysed calves in order to ascertain whether cerebral perfusion was likely to be impaired during states of SDC induced paralysis.

MATERIALS AND METHODS

Four male Friesian calves approximately 3 months old with a mean body mass of 61 ± 11 kg were used. A silastic carotid and jugular catheter and a 12 mm outside diameter disposable, cuffed, tracheostomy tube (Portex, England) were implanted surgically after calves had been given 100 µg/kg xylazine HCl (Rompun, Bayer, Isando) intramuscularly, supplemented by infiltration of surgical sites with 2 % lignocaine HCl.

Two days after surgery, calves were laid in right lateral recumbency on a table and restrained manually. The arterial catheter was connected to a calibrated pressure transducer (Statham P 50). Alligator clip electrodes were attached to electrode-paste prepared skin over the heart on the left lower thorax and half way up the left side of the neck for recording a base: apex electrocardiogram (EKG). Arterial blood pressure (BP) and EKG were monitored on a physiological recorder (Siemens-Elema Mingograf, Model 62). Four electroencephalographic needle electrodes were placed in a square pattern over the subject's forehead. A 5th needle electrode was placed in the centre of the square (Fig. 1). An 8 channel electro-encephalogram (EEG) was recorded on a multi-channel recorder (Elema Schonander Mingograf EEG Junior).

Next, the tracheostomy tube cuff was inflated and the tube was connected via a respirometrical transducer (Wright Flow Transducer) to the T piece of a circular volatile anaesthetic apparatus which allowed forced mechanical ventilation with oxygen when appropriate.

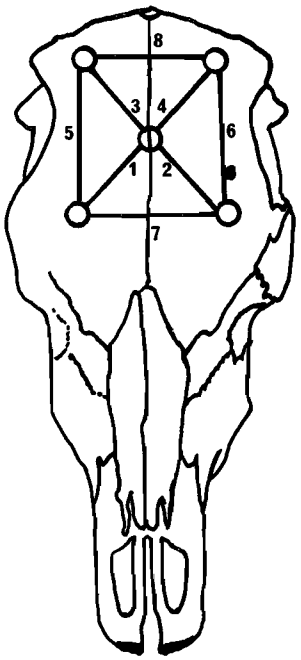

Fig. 1: Placement of electrodes for the electroencephalographic lead system used on the calves

The respirometrical transducer was connected to a second physiological recorder (Washington 400 MD 4). Calves were allowed at least 10 min to become accustomed to the recording equipment. At the end of this time, control EKG, BP, EEG and respiratory recordings were made. Control venous blood samples for catecholamine assay were collected from Calves 2 and 3 into evacuated tubes containing 1,8 mg EGTA and 1,2 mg glutathion per ml blood collected (Vacutainer, Becton Dickinson).

Table 1: Plasma Catecholamine Concentrations (µmol/l) in 2 Calves Paralysed by Succinyldicholine

	P-Dopamine	*P-Adrenaline*	*P-Noradrenaline*	*Total catecholamine*
Calf 2				
Control pre SDC	0,77	0,19	0,59	1,55
175s of first period of apnoea	14,34	22,97	10,85	48,16
180s of 4th period of apnoea	21,62	47,22	18,67	87,51
Calf 3				
Control pre SDC	1,00	0,20	1,16	2,36
180s of first period of apnoea	9,89	93,06	66,28	169,23
60s after a 300s period of apnoea	56,09	225,26	92,00	373,35

Next, doses of 0,5 mg/kg (Calf 1) and 1,0 mg/kg (Calves 2,3 and 4) of SDC were injected into the gluteal muscle mass while continuous recordings of BP, EKG, EEG and respiration were made. The time from injection to the onset of apnoea was noted. Initially calves were allowed to remain apnoeic for approximately 3 min, after which they were ventilated with oxygen for at least 2 min. Calves were then allowed to remain apnoeic

for longer periods (to a maximum of 5 min), followed in each case by a minimum of 2 min ventilation. In Calves 2 and 3 blood samples were again collected towards the end of periods of apnoea for catecholamine assay (Table 1). Calves were submitted to between 3 and 6 periods of apnoea each. The duration, frequency and number of periods of apnoea varied according to the individual response of each calf.

In 1 paralysed Calf (number 4) the tail was forcibly pinched with a haemostat during periods of ventilation and the EKG and EEG were observed for changes. During the final period of apnoea in Calves 3 and 4, 100 μg/kg atropine sulphate was injected intravenously. The purpose of the atropine injections was to determine whether apnoea associated bradycardia was vagally mediated.

When all data had been collected, experiments were terminated by injecting 45 mg of reconstituted human freeze dried plasma pseudocholinesterase (Hoechst, Isando) intravenously and stopping mechanical ventilation when spontaneous ventilation recommenced. Vascular catheters were withdrawn, the tracheostomy tube was removed, and calves were given long-acting penicillin (Compropen, Glaxo Allenburys, Germiston).

Catecholamine (dopamine, noradrenalin and adrenalin) assays were performed using a commercially available kit (Upjohn Diagnostics, Kalamazoo, USA) which makes use of a radio-enzymatic technique. This is a modification of the method originally reported by Passon and Peuler[23]. We modified the method described by the manufacturers of the kit by using an extraction and plate spotting technique as described by Hjemdahl et al.[16]. This modification resulted in a greater recovery rate of methylated derivatives.

RESULTS

All 4 calves were completely paralysed by the doses of SDC used. Onset of apnoea was 60, 76, 75 and 119 seconds after injection of SDC in Calves 1-4 respectively. Apnoea was preceded by a short period of struggling and muscular tremor. The initial period of apnoea was 40, 174, 180 and 200 s in Calves 1-4 respectively.

During the first 3 min of apnoea, systolic and diastolic BP increased and heart rate decreased markedly in all calves (Fig. 2). From normal sinus rhythm during control periods and periods of ventilation, cardiac rhythm changed during periods of apnoea to an extreme sinus bradycardia (Fig. 3) or to bradycardia with second degree atrioventricular block.

When, in Calf 3, apnoea was allowed to proceed for more than 4 min, BP began to decline, cardiac rate increased somewhat and both ST segment deviation and giant T waves were noted on the EKG. When mechanical ventilation was re-instituted, the bradyarrhythmia disappeared within less than 30 s and ST and T wave changes rapidly reverted to the control pattern (Fig. 4). In contrast to the bradycardia which was rapidly abolished by ventilation, BP remained elevated for at least 90 s after re-establishing ventilation (Fig. 2).

Atropine sulphate, given during the final periods of apnoea in Calves 3 and 4, abolished the bradycardia within 30 s of intravenous injection. After atropine injection Calf 4 developed a transient high grade 2nd degree atrioventricular block followed by sinus tachycardia (Fig. 3).

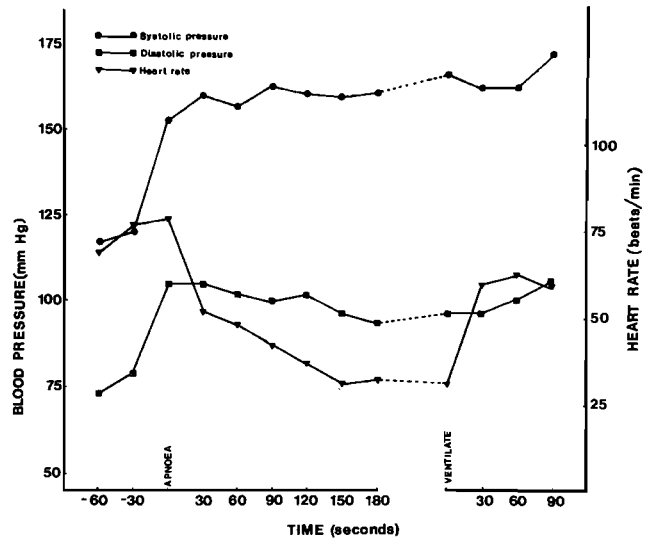

Fig. 2: Changes in arterial blood pressure and heart rate associated with apnoea and ventilation in succinyldicholine paralysed calves. Data points are the mean values for Calves 2, 3 and 4 during the first period of apnoea following succinyldicholine injection

Fig. 3: Changes in arterial blood pressure and heart rate during a period of apnoea in a succinyldicholine paralysed Calf (No. 4). The control period was 30 s pre-apnoea (−30 s); + 90 s; + 180 s; + 210 s and + 250 s indicate seconds after apnoea. Bradycardia and hypertension are obvious. Intravenous atropine during apnoea resulted in transient second grade atrioventricular heart block (+210 s) followed shortly by sinus tachycardia (+250 s)

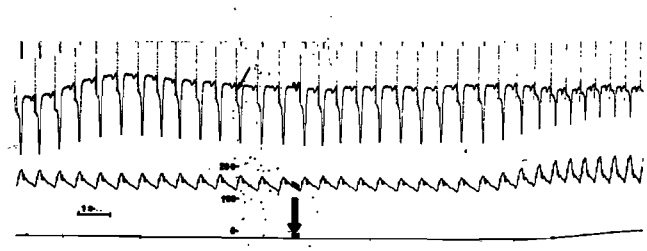

Fig. 4: Arterial blood pressure and electrocardiogram in a succinyldicholine paralysed Calf (No. 3) during prolonged apnoea. The lower heavy arrow indicates re-institution of mechanical ventilation after 295 s of apnoea. The upper arrow points to ST segment depression on the EKG, a reliable sign of myocardial hypoxia. Note the disappearance of ST and T wave changes and increased blood pressure after ventilation was initiated

The control EEG during spontaneous and mechanical ventilation was of moderate (approximately 30-40 μv) amplitude with slower frequency waveforms. Soon after the onset of periods of apnoea, waveforms changed to a more rapid frequency pattern with a lower amplitude

(approximately 10-30 μv). These changes were promptly reversed when ventilation was re-instituted (Fig. 5 & 6).

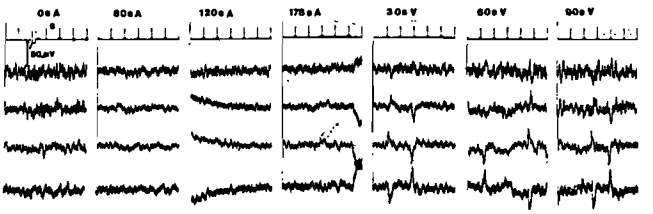

Fig. 5: Electroencephalograms (channels 1-4) of a succinyldicholine paralysed Calf (No. 2) before apnoea (0s A), during apnoea (60s A, 120s A, 178s A) and after apnoea (30s V, 60s V, 90s V). Time lines are 1s

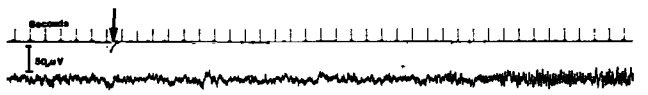

Fig. 6: Electroencephalogram (channel 1) of a succinyldicholine paralysed Calf (No. 4) towards the end of 198 s apnoea and beginning of ventilation. Note the increase in amplitude and decrease in frequency of the recording after ventilation

Bursts of high amplitude (> 200 μv), low frequency EEG waveforms were noted after some 4,75 min of apnoea in Calf 3 (Fig. 7). These bursts coincided in time with the ST and T wave changes on the EKG and declining BP referred to above. The re-institution of ventilation was accompanied by prompt reversal of the EEG pattern towards the control pattern, disappearance of ST and T wave changes on the EKG and elevation of arterial BP (Fig. 4).

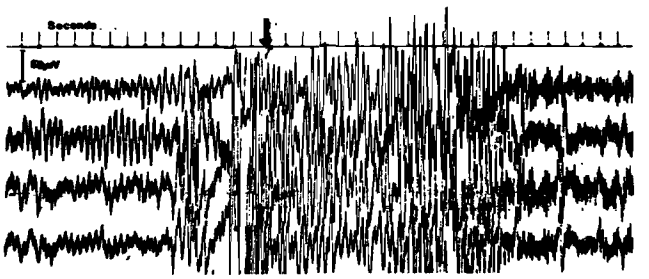

Fig. 7: Electroencephalograms (channels 1-4) of a succinyldicholine paralysed Calf (No. 3) after prolonged apnoea. The arrow marks the end of 295 s apnoea and initiation of ventilation

Tail pinching (Calf 4) during periods of ventilation consistently resulted in spike potentials on the EEG (Fig. 8).

Plasma catecholamine concentrations rose markedly during or very shortly after periods of apnoea (Table 1).

Blinking, chewing and chest movements commenced 1-2 min after intravenous injection of plasma pseudocholinesterase. Calves 1, 2 and 4 regained spontaneous ventilation 360, 240 and 448 s after injection of plasma pseudocholinesterase respectively. Calf 3, which was subjected to the longest period of apnoea (5 min) started breathing 19 min after pseudocholinesterase but soon lapsed back into apnoea and died. Calves 1, 2 and 4 made uneventful recoveries and suffered no apparent neurological sequelae from the trial.

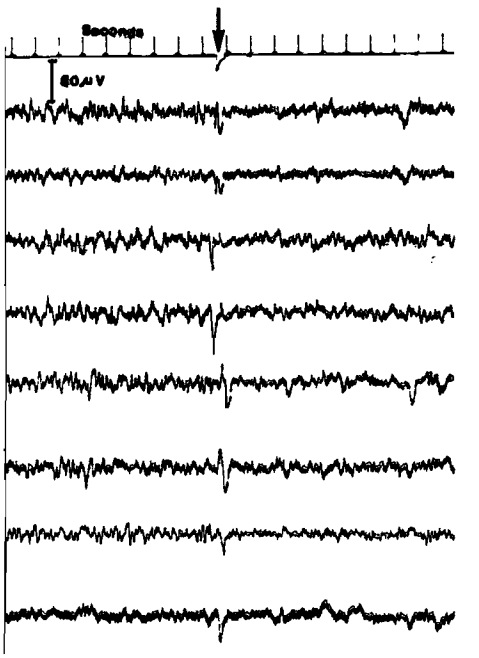

Fig. 8: Electroencephalogram (channels 1-8) of a succinyldicholine paralysed Calf (No. 4) during a period of mechanical ventilation. The arrow marks the time when the tail was pinched with a haemostat

DISCUSSION

The absorption from intramuscular sites and distribution of SDC was extremely rapid, with lag times between injection and apnoea of less than 2 min in all cases.

The arterial hypertension noted during periods of apnoea was ascribed to the release of catecholamines by the adrenal medulla and possibly other sites in the body. Total catecholamine concentrations in plasma at the end of or shortly after periods of apnoea were 56 and 158 times greater than control values obtained from Calves 2 and 3, respectively (Table 1).

The bradyarrhythmias noted during periods of apnoea in this study were, at least in part, manifestations of the baroreceptor reflex arc whereby high BP triggers baroreceptor discharge, afferent impulses to the vasomotor centre and efferent impulses by way of the vagus to slow the rate of sino-atrial (SA) nodal discharge. This supposition was supported by the injection of atropine which rapidly reversed apnoeic bradycardia by blocking muscarinic ACH receptors at the SA node. Interestingly, in Calf 4, atropine blocked SA nodal muscarinic receptors some 15 s before blocking atrioventricular nodal receptors. The result was a transient second-degree partial atrioventricular block with atrial tachycardia and ventricular bradycardia. This rhythm converted rapidly to a conducted atrial tachycardia as soon as atropine became effective at the AV node (Fig. 3).

Hypertension and arrhythmias, including bradyarrhythmias, have been recorded in non-ventilated horses and dogs paralysed with SDC[1 4 13 15 31]. These findings are in marked contrast to the situation in SDC paralysed but ventilated animals and human beings, where typical findings at moderate SDC dosage rates are no or only very minor increases in blood pressure[1 4 5 8 9 11 13 26 27 31].

A comparison of the present and other studies suggests that asphyxia triggers massive catecholamine

release, resulting in hypertension in non-ventilated animals paralysed by SDC. Massive catecholamine release apparently does not occur in SDC paralysed animals if they are ventilated because no or only minor changes in BP are found. One is led to the conclusion that a combination of asphyxial hypoxia, hypercarbia and acidosis are profoundly stressful to animals and, not surprisingly, trigger massive catecholamine release with associated secondary haemodynamic changes. Although it has been suggested that hypertension is the result of direct stimulation of autonomic ganglia by SDC, it has been shown that direct ganglionic stimulation is only significant at very high doses of SDC[27].

During periods of SDC induced paralysis with ventilation, EEG waveforms were of greater amplitude and lower frequency, typical of a less-alert or non-stressed mental state[17]. During periods of apnoea, EEG waveforms converted to an "activated" pattern with lower amplitudes and greater frequencies. The "activated" EEG patern during the first 3-4 min of apnoea suggests both the conscious state and psychic alertness[10 17 24]. The return of lower frequency, higher amplitude waveforms soon after ventilation was reinstituted indicates a reduction in the level of anxiety (Fig. 5 & 6).

When apnoea was allowed to proceed beyond 4,75 min (Calf 3), hypoxic changes were noted on the EKG, blood pressure started declining and EEG waveforms converted from an "activated" pattern to a pattern of low frequency, giant waveforms (Fig. 7). The latter were consistent with cerebral depression and may have marked the onset of declining consciousness or unconsciousness[10]. Similar giant waveforms have been seen on the EEGs of SDC paralysed, non-ventilated dogs occurring at about the time of cardiovascular collapse[15]. In the present study the giant waveforms disappeared soon after ventilation was re-instituted, strengthening the supposition that they were of hypoxic origin.

During SDC induced paralysis, tail pinching resulted in spiked potentials on all EEG leads (Calf 4). This finding proves that sensory neural pathways between the tail and brain were intact and suggests that calves were sensitive to pain while paralysed by SDC.

Apart from Calf 3, which lapsed into apnoea and died, the other 3 calves all recovered fully from their ordeal with no apparent neurological damage. The longest period of apnoea in a surviving calf (No. 4) was 264 s (4,4 min). Calves 1 and 2 had maximum periods of apnoea of 246 and 189 s, respectively.

It must be stressed that once calves had been paralysed by SDC they appeared dead. The corneal, anal and withdrawal reflexes could not be elicited. They were, however, alive and had more than adequate blood pressure for cerebral perfusion and an active EEG for at least 4 min after they would have been pronounced "dead" by a casual observer.

CONCLUSIONS

SDC induced muscle paralysis in non-ventilated calves results in massive catecholamine release by the adrenal medulla. This response is almost certainly the result of asphyxia. Circulating catecholamines induce hypertension. Elevated arterial BP activates the baroreceptor reflex which induces vagally mediated bradyarrhythmias which can be blocked by atropine.

EEGs recorded during SDC-induced paralysis with apnoea suggest that calves are probably conscious and under psychic stress for some 4 min after the onset of apnoea. Signs of cerebral depression become evident only after 4 min of apnoea.

We conclude that any animal asphyxiated by SDC almost certainly suffers extreme psychic stress between the time of onset of apnoea and hypoxic cerebral depression. A more acceptable alternative method of game cropping should be found as a matter of urgency.

ACKNOWLEDGEMENTS

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BOOK REVIEW — BOEKRESENSIE

CURRENT THERAPY IN THERIOGENOLOGY: DIAGNOSIS, TREATMENT AND PREVENTION OF REPRODUCTIVE DISEASES IN ANIMALS

DAVID A. MORROW

W.B. Saunders Company, Philadelphia 1980 pp XXIX and 1287, numerous illustrations and tables, Publ. Price £42,50 (ISBN 0-7216-6564-0)

This is one of the most comprehensive books in the field of reproduction to be published in recent years. Prof. Morrow has brought together some 168 contributors, all experts in their respective areas, to set out a most thorough presentation of the most recent information on the diagnosis, treatment, and prevention of reproductive conditions in animals.

The first 4 sections of the book deal with general topics such as the principles of hormone therapy, clinical pharmacology, embryo transfer and cytogenetics. Hereafter each species is dealt with in some detail, starting with bovine, which is extensively covered, followed by sections on canine, equine, feline, ovine, caprine, porcine and laboratory and zoo animals. The concluding section deals with diagnostic procedures. Three appendices set out a drug list, an equipment and materials list and a series of tables which contain a host of valuable information for ready and comparative reference.

As in any text of this magnitude there will always be opinions expressed which do not necessarily coincide with approaches used by all the clinicians in the diverse field of animal reproduction. This in itself is in fact good since it generates and stimulates debate.

For the teacher, the practitioner and student alike this is an excellent book, which can only be most highly recommended. It will serve as an exciting source of information. Rarely have such a highly qualified team of consultant editors blended the expert knowledge of such a wide range of workers so well and concisely. This book will undoubtedly become a standard reference work for some considerable time.

R.I. Coubrough

CHEMOTHERAPY OF *BABESIA FELIS* INFECTION: EFFICACY OF CERTAIN DRUGS*

F.T. POTGIETER**

ABSTRACT: Potgieter F.T. **Chemotherapy of *Babesia felis* infection: Efficacy of certain drugs.** *Journal of the South African Veterinary Association* (1981) 52 No. 4 289-293 (En) Veterinary Research Institute, 0110 Onderstepoort, Republic of South Africa.

The efficacy of 10 drugs was tested against *Babesia felis* infection in domestic cats. Primaquine phosphate administered per os or as an intramuscular injection was found to be highly effective and the obvious drug of choice when compared with conventional babesicides. The recommended dosage is 0,5 mg/kg body mass of primaquine base. Repeated treatments are well tolerated but single doses in excess of 1 mg/kg are known to cause mortality in cats.

Key words: Babesiosis, cats, chemotherapy.

INTRODUCTION

Babesia felis was first described by Davies[3] in a Sudanese wild cat, *Felis ocreata*. Levine[11] lists *Babesiella felis, Nuttalia felis* var. *domestica* and *Babesia cati* as synonyms of *B. felis*. As far as is known, *B. felis* appears to have a fairly wide host range amongst the cat family and it is not the only *Babesia* sp. of the Felidae.

In South Africa feline babesiosis appears to be enzootic all along the Natal Coast and in the eastern and southern coastal areas of the Cape Province where, according to local veterinarians, it is a major cause of feline mortality. The vectors and reservoirs involved are as yet unidentified. Private practitioners inland are occasionally confronted with clinical cases of *B. felis* infection. The patients are usually pets which had accompanied their owners on coastal holidays.

According to reports, many cases of feline babesiosis respond poorly to treatment with babesicides or with tetracyclines, even though the latter drugs are said to be effective against *Nuttalia*-type parasites such as *B. felis*[2 7 16]. A number of advanced, naturally infected cases of *B. felis* infection were seen at the Veterinary Research Institute, Onderstepoort and treatment with primaquine phosphate proved to be highly effective in these cases.

The purpose of this paper is to record observations made on the efficacy of primaquine and 9 other drugs against experimental infections of *B. felis*.

MATERIALS AND METHODS

Experimental animals

The cats were bred and accommodated in wire mesh cages under tick-free conditions. Their daily diet consisted of raw meat and milk supplemented with vitamin B_1 (brewer's yeast).

Source of *B. felis* infection

Three experimental cats, originally infected by Dr W.O. Neitz of the Veterinary Research Institute and known to be carriers of *B. felis*, were bled and the blood pooled to infect a susceptible cat with 4 ml subcutaneously (s.c.) The resulting *B. felis* infection had a prepatent period of 28 days. Blood collected from this cat by cannulating the radial vein, showed a parasitaemia of approximately 12 %. A blood stabilate of 1 ml aliquots was prepared[15]. For inoculation purposes the blood was thawed rapidly at 37 °C and immediately injected intravenously (i.v.) or s.c.

In certain trials cats were infected by direct subinoculation with blood collected from cats undergoing primary *B. felis* reactions.

Parameters of infection

Rectal temperatures were recorded daily. *Packed cell volumes* (PCV) were determined twice weekly, on Tuesdays and Fridays, from blood collected from a small incision on the tip of the ear into Clay-Adams heparinized microhaematocrit capillary tubes and centrifuged in a Damon model M.B. centrifuge. Normal values were determined for all the animals prior to infection. Giemsa-stained thin blood smears were prepared daily and examined at 1 000 × magnification. Five hundred erythrocytes were differentially quantitated and the *parasitaemia* expressed as a percentage.

Chemotherapy

Drug treatment was initiated when the PCV of an infected cat fell to approximately 50 % of its normal value irrespective of the level of parasitaemia. The first day of treatment was taken as Day 0.

The different drugs used in this investigation included babesicides, anti-malarials and antibiotics. Drugs were administered as single or multiple doses, depending on the efficacy as determined by the effect on the parasitaemia and PCV and also by the tolerance shown by the animals to the specific treatment. Reactions of untreated controls were observed for the purpose of comparison.

RESULTS

Artifically induced feline babesiosis

Prepatent periods

The prepatent periods of the various experimentally infected animals appeared to depend on the size, route and degree of infectivity (parasitaemia) of the inoculum. One and 2 ml inocula administered i.v. and s.c. resulted in prepatent periods varying from 3 to 28 days. Intravenous injections produced shorter prepatent periods. However, individual variations amongst cats infected from the same stabilate were observed.

*Paper presented at Biennial National Congress of the SAVA, Durban, September 1975.

**Veterinary Research Institute, 0110 Onderstepoort.

0038-2809/81/04/0289-0293

Parasitaemia

After the first parasites were detected, the parasitaemia increased relatively slowly in most cases, reaching levels of 15-28 % at the time when a 50 % reduction in PCV occurred 2-3 weeks later (Fig. 1a-d; 4 & 6). A direct correlation between rising parasitaemia and falling PCV was observed in all the cases studied.

Under controlled laboratory conditions cats were observed to remain patent carriers of the infection for at least 2 years.

Parasitic relapses occurred after treatment with certain drugs and some proved fatal when left untreated. Parasitaemia peaks of approximately 50 % were recorded during these relapses (Fig. 2).

Anaemia

From the PCV reductions, it was evident that anaemia appeared to be the most consistent symptom of *B. felis* infections. It was used as a parameter for the evaluation of response to treatment.

During this investigation only 3 deaths out of 11 cases could be attributed to untreated *B. felis* infections. One cat, which died acutely, showed a parasitaemia of 11 % and PCV of 30 %. Another died when the parasitaemia had reached 18 % and the PCV had dropped to 22 %. The 3rd death occurred during a relapse (Fig. 2) when the parasitaemia increased to 48 % and the PCV dropped to 12 %.

Body temperature

This proved to be a totally unreliable parameter of *B. felis* infections and had no practical value in the assessment of the clinical condition of infected cats. Most of the cats used in this study showed no elevation of body temperature above the normal even during the acute phase of the infection.

Chemotherapy

Positive response to treatment was indicated by a drop in parasitaemia and concomitant increase in the PCV. However, the quantitation of parasites after treatment proved to be difficult in some cases owing to the persistence for several days after treatment of degenerated parasites in the erythrocytes. The small size of the parasites made differentiation between live parasites and the degenerating ones very difficult.

Primaquine phosphate (Primaquine, I C I)

Primaquine phosphate was the drug with the highest parasiticidal effect against *B. felis*. It is a member of the 8-aminoquinoline group of anti-malarial compounds. The dosages used were 0,5 mg and 1,0 mg/kg of the primaquine base (1 part by mass of primaquine base = 1,76 parts by mass of primaquine phosphate). The primaquine phosphate powder was either placed in small gelatin capsules and dosed by mouth or dissolved in sterile water and injected parenterally in small volumes (< 1 ml).

Twenty experimentally infected cases were treated successfully with this drug when administered either orally or intramuscularly (i.m.). The effect of primaquine when given orally at 0,5 mg/kg once only or 3 times is shown in Fig. 1d & 2. In both cases treatment resulted in a drop in parasitaemia to less than 1 % within 3 days with a concomitant rise in PCV. Single i.m. injections of 0,5 or 1,0 mg/kg primaquine (Fig. 3, 4 & 5) resulted in a response equal to that following oral treatment.

Recrudescence of the parasitaemia commonly occurred about 2-3 weeks after treatment which, in at least 1 case, proved to be fatal. Three doses of 0,5 mg/kg given at 3 day intervals failed to sterilize the infection, but was well tolerated (Fig. 2). However, single dosages in excess of 1 mg/kg (2-10 mg/kg) caused mortality in 4 out of 4 cases. Oral administration frequently led to vomiting in clinical cases.

Chloroquine sulphate (Nivaquine, May & Baker)

Three cats were treated with chloroquine at 3 different dosages via the i.m. route. Cat 1 received 0,4 mg/kg 3 times at 2-day intervals, Cat 2, 5 mg/kg 4 times every 24 h and Cat 3 a single injection of 10 mg/kg. The first 2 regimens had no effect on the parasitaemia, while in Cat 3 the rise in parasitaemia was halted for a day.

Diminazene (Berenil, Hoechst)

Three cats were treated once only at the dosage recommended by the manufacturers, viz 3,5 mg/kg i.m.

In Cat 1 the parasitaemia continued to rise for 3 days after treatment, before dropping, while in Cat 2, it remained static at approximately 30 % for 6 days after treatment. In the third case, however, the parasitaemia dropped from 15 % to 1 % by Day 5, but rose again to 29 % by Day 11.

Diminazene therefore has some effect on *B. felis,* but the extreme variation in the results seems to preclude its use in cats.

Phenamidine isethionate 4,95 % (Phenamidine, Maybaker)

This drug was used in 2 cats at a dosage level of 0,3 ml/kg of a 4,95 % solution s.c. as recommended by the manufacturers for the treatment of *Babesia canis* infections.

Cat 1 was treated once only, the parasitaemia dropping from 12 % on Day 0 to as low as 4 % on Day 3. The cat died on Day 7, showing a parasitaemia of 10 % and a PCV of 30 %. The cause of death was obscure but was possibly complicated by a confirmed thiamine deficiency (the diet of this cat consisted of raw meat and milk only). This condition was diagnosed by Dr Lucia Lange of the Department of Pathology, Faculty of Veterinary Science, University of Pretoria.

Cat 2 received 2 injections 3 days apart. The first was given during a rising parasitaemia (32 %) when the haematocrit had dropped to 22 %. After treatment the parasitaemia fluctuated between 30 % and 32 % for 2 days, creating the impression that the drug prevented multiplication of the parasite. However, on Day 6, (3 days after the second treatment) the parasitaemia had increased to 41 % and reached 52 % by Day 8, while the haemotacrit dropped to 17 %. The cat died on Day 9.

Quinuronium sulphate (Babesan, I C I)

Two cats were treated at the dosage recommended for dogs, namely 0,25 mg/kg s.c. As in the case of diminazene, widely varying results were obtained. One cat showed no response to 2 injections at 2 day intervals, and died 2 days after the last treatment with a parasitaemia of 40 %. Cat 2 (Fig. 5) showed a drop in parasitaemia from 28 to 6 % in 3 days after a single treatment, and this was followed by a severe recrudescence 1 week later.

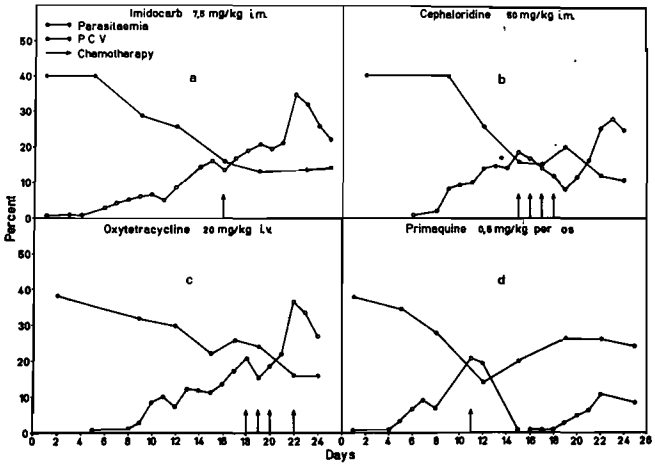

Fig. 1a-d: Parasitaemia and PCV in *Babesia felis* infection following the administration of imidocarb 7,5 mg/kg i.m.; cephaloridine 50 mg/kg i.m.; oxytetracycline 20 mg/kg i.v. and primaquine 0,5 mg/kg per os

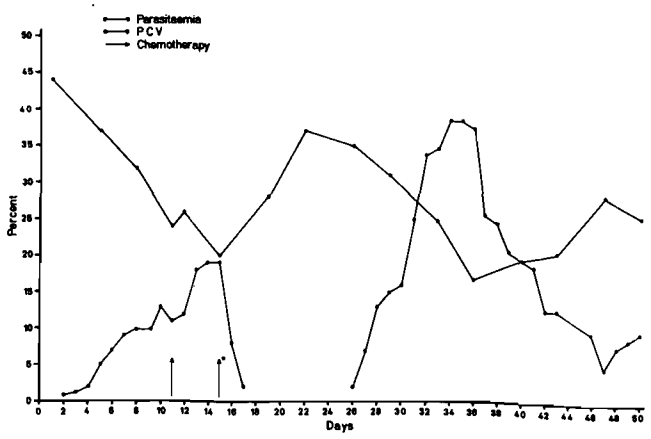

Fig. 4: Parasitaemia and PCV in *Babesia felis* infection following the administration of trypan blue 9 mg/kg i.v. and primaquine* 0,5 mg/kg i.m.

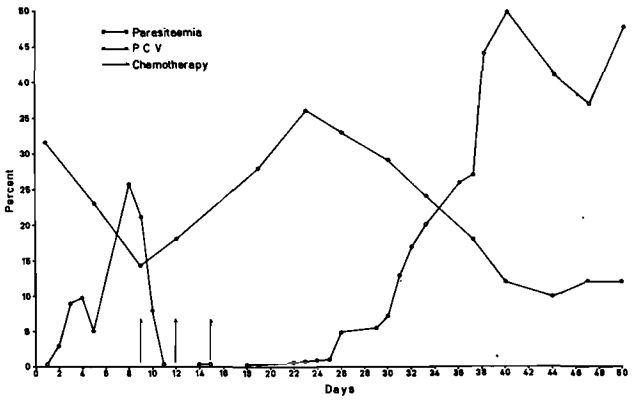

Fig. 2: Parasitaemia and PCV in *Babesia felis* infection following the administration of primaquine 0,5 mg/kg per os

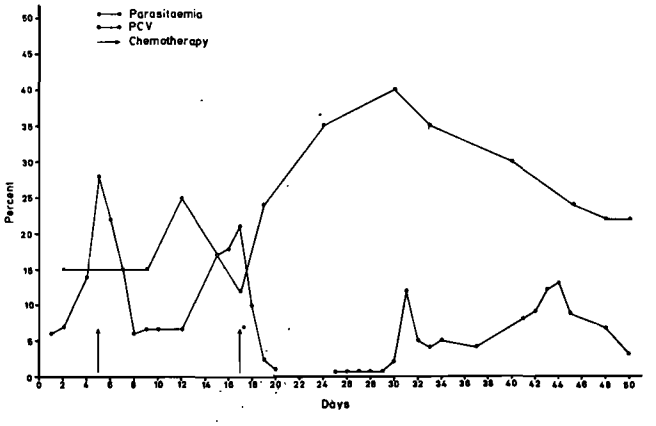

Fig. 5: Parasitaemia and PCV in *Babesia felis* infection following the administration of quinuronium sulphate 0,25 mg/kg s.c. and primaquine* 1 mg/kg i.m.

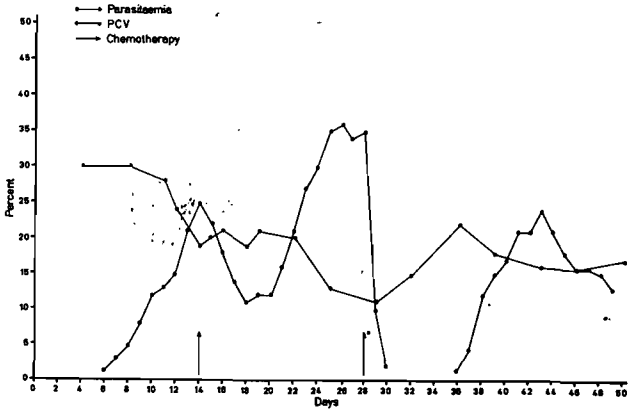

Fig. 3: Parasitaemia and PCV in *Babesia felis* infection following the administration of euflavine 2,3 mg/kg i.v. and primaquine* 0,5 mg/kg i.m.

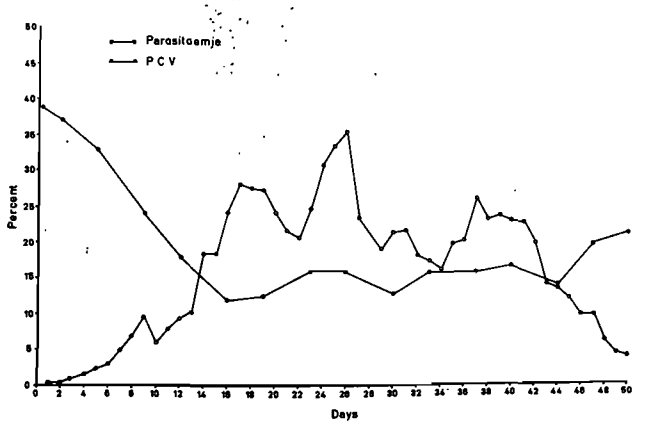

Fig. 6: Parasitaemia and PCV in *Babesia felis* infection of an untreated control

Euflavine B (Gonacrine, Maybaker)

Euflavine was administered i.v. to 3 cats at levels of 2,3 and 11 mg/kg. Cat 1 was treated twice at 2,3 mg/kg with a 1-day interval during a recrudescent parasitaemia. Cat 2 (Fig. 3) was given a single treatment of the same dosage during a primary *B. felis* reaction. The results of the experiment were comparable. The parasitaemias steadily declined for a period of 4 days after treatment with no further drop in PCV during this time. This was followed by a sharp rise in the parasitaemia accompanied by a drop in the PCV (Fig. 3).

Euflavine, given at a much higher dosage of 11 mg/kg to a cat showing a 20 % parasitaemia and a PCV of 13 %, resulted in a sharp decrease in the parasitaemia. The cat died on Day 6 after treatment, showing severe anaemia but no live parasites in the blood smears.

Unpleasant side effects in the form of spontaneous vomiting and defecation followed the injections in all 3 cases.

Imidocarb (Burroughs Wellcome)

Two cats were treated with imidocarb. Cat 1 received 7,5 mg/kg i.m. of imidocarb dihydrochloride (4A65). Cat 2 was treated at the same dosage but with imidocarb diproprionate (Imizol) (Fig. 1a). In both cases the drug had no noticeable effect on *B. felis*.

Trypan blue (I C I)

Trypan blue was administered i.v. to 3 infected cats at a dosage level of 9 mg/kg. In all 3 cases the parasitaemias continued to rise after treatment. In 2 out of the 3 animals treated a slight suppressive effect on the rising parasitaemias was noticed. However, a second injection after 2 days in one cat did not enhance the effect. No marked recovery of the PCV was noticed in any of the animals. The effect of trypan blue treatment on a rising parasitaemia of *B. felis* during a primary reaction is illustrated in Fig. 4.

Cephalordine (Ceporan, Glaxo-Allenburys)

Cephalordine was administered to one cat only which showed a parasitaemia of 20 % (Fig. 1b). Intramuscular injections of 25 mg/kg were given twice daily for 4 days. The parasitaemia showed a gradual drop during the period of treatment and a corresponding increase in the PCV. However, 2 days after the last injection an increase in parasitaemia occurred and continued until a level of 29 % was reached 3 days later. The rising parasitaemia was again accompanied by a drop in the PCV.

Oxytetracycline (Terramycin, Pfizer)

Two cats were treated using different dosage regimens. The one showing a parasitaemia of 12 % was given 10 mg/kg i.m. 5 times at different intervals over a 10-day period. The parasitaemia fluctuated greatly, reached a peak of 21 % on Day 3 and declined to 6,4 % by Day 10. However, the PCV dropped steadily from 22 % on Day 0 to 16 % on Day 10.

Cat 2 was given 20 mg/kg i.v. on Days 0, 1, 2 and 4 (Fig. 1c). During the course of the treatment the parasitaemia actually increased from 21 to 38 % and a steady drop in PCV indicated that Terramycin had no babesicidal effect at all when used in this way.

DISCUSSION

The main aim of this investigation was to find an effective drug against *B. felis* infections and not to compare the efficacy of the various drugs tested. The results given are therefore only indicative of their potential as therapeutic agents against *B. felis* infections.

Primaquine given at 0,5 mg/kg emerged from this study as obviously the drug of choice for the treatment of *B. felis* infections of domestic cats in South Africa. It had a dramatic effect on the parasites even though it failed to sterilize infections at the dosages used. The effect of treatment on the PCV was equally dramatic. In addition, it was found that this drug could safely be administered as an i.m. injection, which has obvious advantages over the oral route. Sick animals are anorexic and per os administration caused obvious epigastric distress and vomiting.

Euflavine, given as 0,5 ml of a 5 % solution i.v., reportedly results in immediate response in most cases, but prompt emesis follows injection of the drug[2]. Brownlie[2] came to the conclusion that euflavine produced no effect other than a suspended state of chronicity. The present investigation indicated that euflavine definitely suppressed the parasitaemia. However, the unpleasant side-effects, the fact that one cat died 6 days after treatment and the ever present danger of sloughing at the injection site, preclude euflavine as a drug of choice.

Brownlie[2] reported clinical control and fairly rapid improvement after the oral administration of 100 mg chlortetracycline (Aureomycin) every 8 hours for 3 days. He stated that both the colour of the mucous membranes and the blood picture improved, and parasites became infrequent. The same author found chlortetracycline given at 10 mg/kg i.v. to be less effective than euflavine treatment. In the present study oxytetracycline appeared not to have any effect at 20 mg/kg administered i.v. daily for 3 days. Higher doses given parenterally may, however, prove to have the same effect as that reported by Brownlie[2]. Robinson[16] reported oxytetracycline (Terramycin) to be effective either alone or in combination with trypan blue.

Cephaloridine, a semi-synthetic antibiotic, had a rapid curative effect after i.m. injections at 20 mg/kg daily for 3-4 days[7]. Although this drug was found to suppress *B. felis* parasitaemia, in the present study, it could hardly be rated as effective.

Trypan blue is commonly known to be effective against large *Babesia* spp. and has also been reported to be effective against *B. felis*[13 16]. Davies[3], however, found that trypan blue given i.v. had no effect on *B. felis*. Similar observations were made in the present study where it was found that even 2 treatments given 2 days apart did not affect the parasite.

Robinson[16] believed that drugs such as phenamidine and diminazene did not produce any response in the treatment of *B. felis*. This is an opinion shared by many desperate private practitioners who have relied on these drugs purely because of their efficacy against *Babesia canis* infections. Observations made in this study support the fact that neither of these drugs is suitable for the treatment of *B. felis* infections. Another *Babesia* sp. of a member of the cat family, *Babesia herpailuri*, is apparently susceptible to diminazene treatment[9].

Early workers reported on the successful treatment of *B. felis* with quinuronium sulphate (Acaprin or Aci-

ron)[10 13]. The limited observations made in this study with Babesan gave varying results, although strong suppressive action was seen in one case. Further observations are required, however, before the potential of these drugs can be rightly assessed.

Different *Babesia* spp. have been reported to parasitize various members of the family Felidae[1 4-6 12 14 17 19]. Though imidocarb had no effect on *B. felis* in the present study, it has been shown to suppress *B. herpailuri* infections in the domestic cat[8].

In a critical evaluation of these trials it would appear that the following important factors, which were not taken into account in this study, could possibly have influenced the results:

1. Age of the experimental animals.
2. Possible individual variation in resistance to infection.
3. Unknown influence of stress on reacting animals.
4. All infections, being needle passaged, disregarded possible differences in the course of reactions from natural as opposed to artificial infections.

Research should be directed at the study of the epizootiology of this disease with special reference to the transmission and identification of possible reservoir hosts in the enzootic areas. Finally, it is suggested that primaquine therapy could be tried for the treatment of feline cytauxzoonosis[18] in the United States of America since antibiotic treatment does not affect the outcome of the disease[20].

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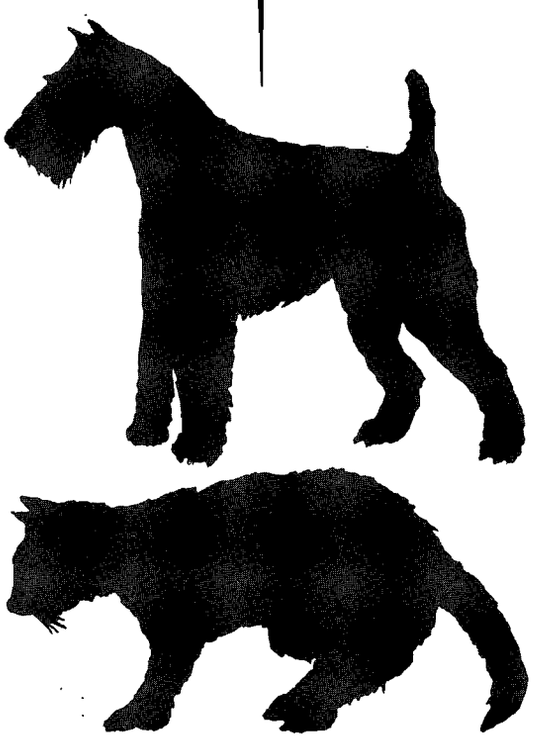

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THE CHOLERETIC ACTION OF CLANOBUTIN IN DOGS

A. IMMELMAN, C. BUTTON and GILLIAN DREYER*

ABSTRACT: Immelman A.; Button C.; Dreyer Gillian. **The choleretic action of clanobutin in dogs.** *Journal of the South African Veterinary Association* (1981) 52 No. 4 295-298 (En) Department of Physiology, Pharmacology and Toxicology, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

After cannulation of the bile duct in anaesthetised dogs, clanobutin was injected intravenously. Samples were collected for periods of 15 min. Arterial and venous blood pressures as well as the electrocardiogram were recorded during the experiment. There was a slight increase in arterial and central venous pressure during the trial. Heart rate slightly decreased with a slight increase in ventricular ectopic beats.

In the first 15 min after treatment bile flow increased by 260 %. The choleretic action lasted for 1,5 h. The concentration of sodium, potassium and magnesium in the bile followed a similar pattern to that of the volume. Bilirubin and calcium excretion showed a sharp increase within the first 15 min after administration. Thereafter there was a sharp drop and 30 min after administration the concentration was below the control value.

Key words: Choleretic, clanobutin, dogs.

INTRODUCTION

Choleretics are substances that stimulate hepatic bile secretion. Bile salts, bile acids and partially synthetic derivatives, e.g. dehydrocholic acid, are well known choleretics.

Studies with clanobutin (Bykahepar, Byk Gulden) in rats proved that this substance is a more effective choleretic than dehydrocholic acid. It was also established that clanobutin increased pancreatic secretion, had a positive inotropic effect and increased cardiac minute volume[4].

After intramuscular administration in rats clanobutin was rapidly absorbed and the maximal blood level was reached within 2 h. Eight hours after administration the drug could still be demonstrated in the blood and 48 h after administration the drug was completely excreted. Excretion took place via the urine, 85 % of the administered dosage was excreted unchanged and the rest as metabolities[1]. These authors do not mention the species in which their studies were done.

Glawischnig & Baumgartner[2] studied the effect of clanobutin in calves with fistulae in the abomasum and duodenum. After a dose of 20 mg/kg body mass they demonstrated a marked increase in the concentration of pepsin in the abomasum. In the duodenum there was an increase in pepsin, trypsin and chymotrypsin. The serum amylase concentration decreased after the administration of clanobutin. In pigs the same authors demonstrated a decrease in amylase and bilirubin in the blood after the administration of 10 mg clanobutin per kg body mass. There was also an increase in faecal trypsin and chymotrypsin for the first 6 h after administration.

In rats the intra-duodenal administration of clanobutin at a dose rate of 50 mg/kg body mass was followed by an intravenous injection of bilirubin. The conclusion of this study was that after 30 min, bile flow increased by 149 % and after 120 min the flow decreased to 94,5 %. Bilirubin excretion in comparison to control animals was not increased significantly[4].

The purpose of the present study was to determine the choleretic action of clanobutin in the dog.

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MATERIALS AND METHODS

Three healthy mongrel bitches were used for this study, varying in age from 4 to 5 years and in mass from 21 to 30 kg.

The dogs were surgically anaesthetised with pentobarbitone sodium (Sopental, Peterson Ltd). The right jugular vein and carotid artery were exposed surgically and catheterised. The catheters were connected to previously calibrated pressure transducers (Gould Statham P 50). Pulsatile and mean arterial pressures and mean venous pressure along with a base: apex electrocardiogram were recorded on a physiological recorder (Siemens Elema Mingograf 62).

A mid-ventral incision was made into the abdominal cavity, the gall bladder located and clamped off, leaving the common bile duct patent. The duodenum was opened and a polyethelene cannula was passed via the duodenal opening into the ductus choledochus. A firm ligature around the cannula prevented leaking of bile but care was taken not to restrict the flow of bile in the cannula.

Bile was collected for 2 control periods of 15 min each and the volumes were expressed as ml/15 min. Next 20 mg/kg body mass clanobutin (Bykahepar, Byk-Gulden 100 mg/ml) was injected slowly intravenously. After clanobutin administration another 7 bile samples were collected at 15 min intervals. At the end of this period the dogs were euthanised.

The volume of all the specimens was determined and then analysed for total bilirubin using a colorimetric method in kit form (Boehringer Mannheim Diagnostica). The bile sodium, magnesium, potassium and calcium were determined using atomic absorption spectrophotometry (Varian AA 275).

RESULTS

Arterial blood pressure was well maintained in all 3 dogs, rising slowly from an average control value of 152/108 mm Hg to an average of 187/130 mm Hg, 105 min after the injection of clanobutin. Mean central venous pressure rose very slightly from an average control value of 4,1 mm Hg to 7,5 mm Hg at 90 min after clanobutin administration. Heart rate decreased gradually during the experiment (control 173 beats per min), falling to 160 beats per min at 105 min.

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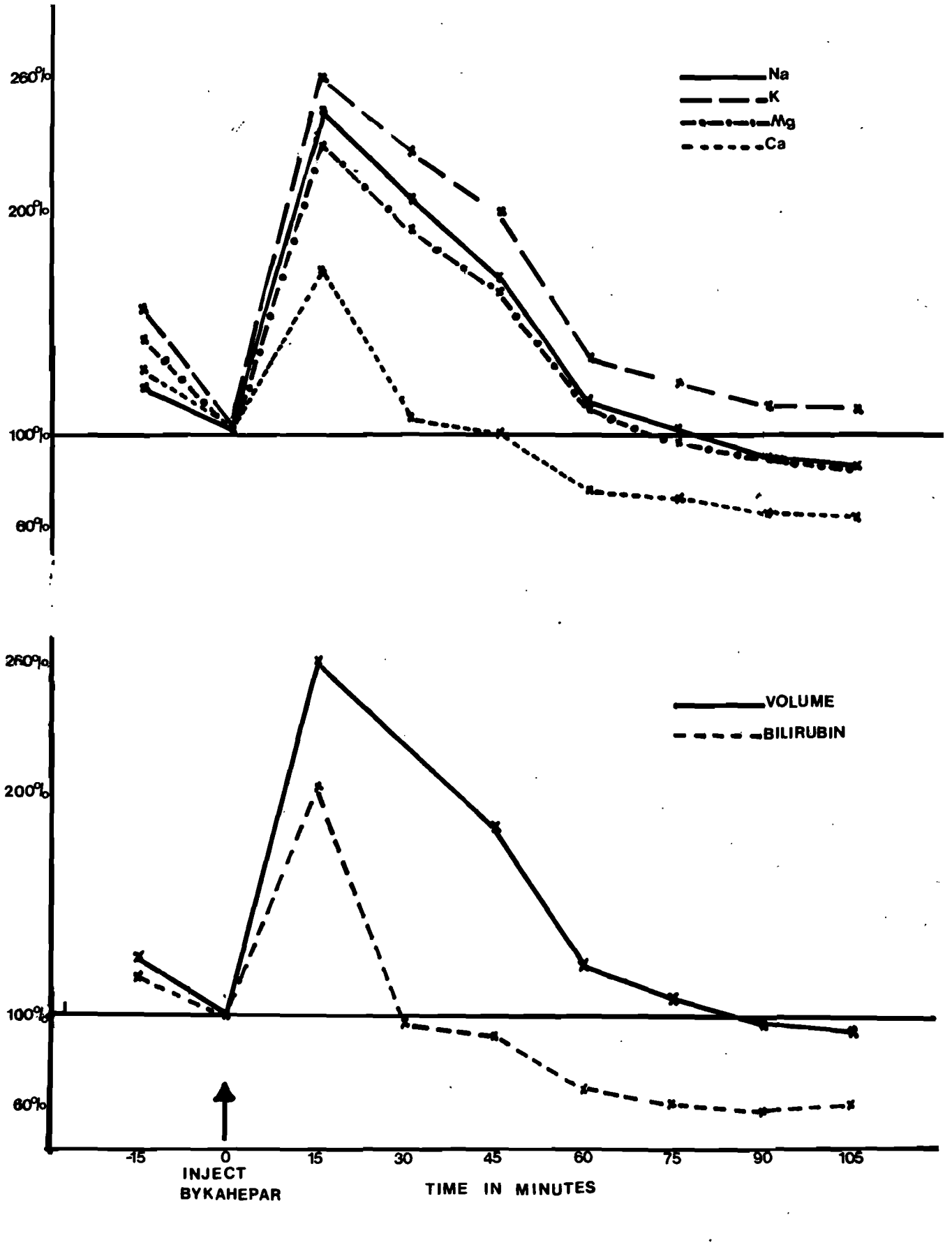

Fig. 1: The excretion of bile, bilirubin, magnesium, sodium, potassium and calcium after the intravenous administration of clanobutin in dogs. The average value of 3 dogs expressed as a percentage of the second control sample is depicted

Two of the 3 dogs had intermittent ventricular ectopic beats during the experiment. The incidence of ectopic beats increased for approximately 1 min after the intravenous injection of clanobutin in these 2 dogs.

The mean volume of bile (Fig. 1) for control sample 1 was 3,23 ml/15 min. The mean volume for control sample 2 was 20 % lower, 2,53 ml/15 min. Individual variation between the 3 experimental animals was significant, the highest flow rate was almost double that of the lowest flow rate. This difference was constant between the first and second control samples.

After injecting clanobutin there was a marked increase in bile volume during the first test period, with an average volume increase of 260 %. During the second test period bile volume decreased slightly to an average of 220 % above the control value. Forty five minutes after administration the volume was still 184 % and at 60 min 133 % of control volume. After that the volume dropped to a level below the control values, the last specimen collected 105 min after administration yielded only 80 % of the control volume.

The total amount of bilirubin excreted during each collection period was calculated and is expressed as a percentage increase or decrease in Fig. 1. The total amount of bilirubin excreted during the first control period was 15 % higher than that excreted in the second control period. After injecting the drug the bilirubin excretion rose 202 % above the second control value. From then on there was a sharp drop in the amount of bilirubin excreted, and 30 min after injection the total amount of bilirubin dropped to only 90% of the second control value. Thereafter the decline was slower reaching 60 % of the second control value after 60 min, this was maintained up to the end of the trial.

The drop in sodium excretion between the first and second control specimens was very similar to that recorded for bilirubin. After treatment there was a sharp rise of 243 % in the total amount of sodium excreted in the first 15 min test period (Fig. 1). There was no sudden drop as recorded in the case of bilirubin but a slow decline as recorded for the bile volume. The control value was reached 75 min after administration. The lst 2 specimens were 90 % and 85 % of the control amount.

The difference in total potassium excreted between the 2 control specimens was very marked, the second being only 63 % of the first. After treatment the total amount of potassium rose by 259 %. The decline was more gradual than for sodium, and even at the end of the experiment the total amount of potassium exceeded the control value (Fig. 1).

The values for magnesium also showed a drop of 30 % between the first and second control specimens. After treatment the amount excreted rose 229 % within the first collection period, and thereafter there was a slow drop going below the control value after 75 min and reaching 85 % in the last specimen.

The pattern of calcium excretion differed from that of sodium, magnesium and potassium and followed a pattern very similar to that of bilirubin. There was the initial drop between the 2 control samples. The increase after treatment was not as marked, only 173 % for the first sample. After 45 min the control value was reached and at the end of the study only 62 % of the control value was obtained.

DISCUSSION

Intravenous injection of clanobutin has no deleterious effect on arterial and central venous blood pressure or heart rate. The rapid intravenous injection did, however, result in a transient increase in ventricular ectopic beats in 2 of the 3 dogs. It would be advisable therefore to make intravenous injections of clanobutin very slowly and to take particular care when administering clanobutin to dogs with existing cardiac arrhythmias.

The decline in bile flow between control samples 1 and 2 could be due to the fact that during surgery bile flow was restricted, and bile accumulated in the bile ducts. The accumulated bile resulted in an increased flow which was recorded in the first 15 min. The second control samples should thus give a more accurate picture of the normal bile flow over that period: for this reason it was used as the 100 % value against which the other findings were compared.

As the bile volume increased, the total amount (concentration x volume) of sodium, potassium and magnesium increased. The pattern of the graphs for Na, K and Mg appear very similar (Fig. 1).

Similarly, the total amount of bilirubin excreted after treatment rose for the first 15 min only. The steep decline after 5 min might be attributed to the fact that hepatic bilirubin became depleted. The increased volume of bile was therefore not due to an increased excretion of bilirubin. The calcium profile resembles that of bilirubin so closely that it would appear as if calcium excretion is linked with bilirubin excretion. This could be due to calcium binding on the carboxyl groups of conjugated bilirubin. A similar finding was recorded in a study of another choleretic (Genebile, Willows Francis) and it was then postulated that the mode of action of the latter compound could be due to its effect on the sodium pump mechanism[3]. The investigators demonstrated a marked increase in sodium excretion with very little effect on potassium. Clanobutin increased the excretion of sodium as well as of potassium. It would therefore appear that the increased flow of bile cannot be attributed to an influence on the sodium pump mechanism.

The choleretic action of clanobutin lasted only 1 h after an intravenous injection in these dogs. In cattle and pigs the action of the drug after an intramuscular injection has its maximum effect after 2 h and the choleretic action continues for 10 h[4].

In conclusion, it can be stated that clanobutin may be given intravenously to dogs. This treatment will result in a marked increase in the flow of bile lasting for approximately 1,5 h.

ACKNOWLEDGEMENTS

We wish to express our gratitude towards Byk-Gulden Pharmaceuticals who financed this trial. The help of Dr F. Reyers during analyses of the constituents in the bile is appreciated.

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INFORMATION

INLIGTING

SCIENTISTS SEEK ALTERNATIVE MEANS OF TOXICITY TESTING*

London (LPS): A group of British scientists, which believes the use of animals for toxicity testing of consumer goods is wasteful and unreliable, hopes to produce a comprehensive report on alternatives later this year.

Dr Michael Balls, of the Department of Human Morphology at the University of Nottingham School of Medicine in the English Midlands, heads the Toxicity Committee established by FRAME – the Fund for the Replacement of Animals in Medical Experiments.

Dr Balls explains: "Current toxicity testing using animals is expensive and time-consuming and in the opinion of many experts may yield results that are often irrelevant and unreliable. The safety of the population, and of persons or groups at special risk, is of paramount importance. We believe that unless the present predictive procedures are at least partially replaced by more economic and more reliable tests, the drive towards safety in use or safe exposure will become self-limiting and self-defeating."

The committee is currently reviewing toxicity procedures through a number of working parties, consisting of pharmacologists, toxicologists, biochemists and other scientists from relevant disciplines. The working parties will review the procedures, assess their reliability and suitability, and make recommendations for their refinement.

It will also assess the prospects of developing procedures for reproducing biological processes in isolation from living organisms, and theoretical and target organ systems to replace studies on live animals, and will act as an advisory group to a projected FRAME research fund, which would support projects to develop and validate alternative systems in toxicology testing.

An alternative is defined as any technique which could replace or reduce the demand for laboratory animals. Dr Balls adds: "Our hope is that there will be progress in the field of toxicity testing as a result of our efforts, leading to scientific improvement and the replacement of massive crude animal experiments by more meaningful studies and, hopefully, by the eventual complete replacement of animal models."

*Science and Technology News, London Press Service.

THE SIMILARITY BETWEEN ARRESTED DEVELOPMENT IN PARASITIC NEMATODES AND DIAPAUSE IN INSECTS*

I.G. HORAK**

ABSTRACT: Horak I.G. **The similarity between arrested development in parasitic nematodes and diapause in insects.** *Journal of the South African Veterinary Association* (1981) **52** No. 4 299-303 (En) Department of Parasitology, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

The similarities between arrested development in parasitic nematodes and diapause in insects are discussed. Particular attention is paid to the similarity between arrested development in *Haemonchus contortus* and diapause in *Oestrus ovis* in sheep.

Factors inducing arrested development and influencing resumed development and measures to control arrested nematodes in ruminants are discussed.

Key words: Arrested development, diapause, nematodes, insects.

INTRODUCTION

Parasitic nematodes in their normal definitive hosts do not always reach adulthood within a developmental period of characteristic length. Prolonged interruption of the life cycle is a frequent alternative[25]. This interruption is known as arrested development and has been defined as the temporary cessation of development of nematodes at a precise point in early parasitic development, where such an interruption contains a facultative element, occurring only in certain hosts, in certain circumstances or at certain times of the year and often affecting only a proportion of the worms[17].

In insects a similar interruption is known as diapause and in certain species it is not facultative but obligatory[4]. Obligatory arrest may well occur also in nematodes at the extreme range of their distribution, where the external environment may barely permit the continued existence of the parasite[25].

It has been sugested that the term hypobiosis includes the terms arrested, retarded, inhibited or suppressed when applied to worms which have not completed their prepatent period within the commonly accepted time[10]. Although arrested or inhibited worms are hypobiotic, the word itself does not embody the dynamism of the term "arrested", which implies the ability to resume development, but rather the direct opposite. Consequently the word "arrested" will be used in this discussion although "hypobiotic" or "inhibited" may on occasion be used synonymously.

Although arrested development in nematodes generally occurs at the precise time that the larvae of ruminant parasites are in the early fourth stage of larval development, this is not always so and does not necessarily apply to nematodes of other host species.

Not only are there differences between species as to the stage of development at which they become arrested, but there are also differences within species as to the proneness of various strains to become arrested. Differences have been demonstrated in the degree of inhibition and in the storage of infective larvae that inhibition occurred, when 2 morphologically and geographically distinct strains of *Haemonchus contortus* were used to infest sheep[16]. It has also been shown that selection of strains prone to arrested development or free from it can be rapid so that strains of a particular parasite within a given locality may vary depending upon husbandry practices and micro-climate[19].

FACTORS INDUCING ARRESTED DEVELOPMENT

Numerous factors have been suggested as reasons for the occurrence of arrested development. These factors can be grouped into 3 major categories[25] which can be listed as:

(1) External environmental factors acting on the free-living stages, which subsequently enter a diapause-like state within the host.
(2) Host factors which determine the host's suitability for further development and which, when adverse, may lead to arrest.
(3) Parasite-related factors which are either genetic or density-dependent.

Factors from each of the groups can act singly or together with other factors from the same or other groups to induce arrest or increase the proportion of arrested larvae over that which would occur if the stimuli acted independently[25].

The external environmental factors acting on the free-living stages may be chilling[1], reduction in photoperiod[9] or ageing of the larvae[16]. It is also possible that helminths may become adapted to a particular environment and that an arrest in development is obligatory[27].

Host factors that have been suggested as possible causes of arrested development are acquired resistance[7], increasing age of the host[27], endocrine changes in the host[5] and environmental factors acting on the host[18].

Parasite-related factors which could lead to arrested development are the presence of adult worms[8] or the number of larvae dosed[21].

NON-SPECIFIC AND SEASONAL ARRESTED DEVELOPMENT

In my opinion the 3 major categories of factors which give rise to arrested development between them result in 2 types of inhibition, namely non-specific and seasonal arrested development. Non-specific arrested development may be present at any time of the year and its causes are either host-related or parasite-related factors, both of which affect the immediate environment of the

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nematode and inhibit its development. Seasonal arrested development occurs annually during the same season. It is generally dependent upon the nematodes affected being adapted to a particular environment and susceptible to 1 or several seasonal external environmental stimuli acting upon the infective larvae, and resulting in arrest in a later stage of development.

Non-specific arrested development is similar to quiescence in insects which is a state of delayed development directly referable to immediate environmental conditions. If these conditions are altered, by for instance removal of adult worms or breaking down the host's resistance with immuno-suppressant compounds, the arrested larvae can immediately resume development[8].

SEASONAL ARRESTED DEVELOPMENT AND DIAPAUSE

Seasonal arrested development can be compared with diapause in insects in which development is inhibited in response to environmental signals which prelude the coming of adverse conditions[4]. Development cannot be resumed in diapausing insects, even in the presence of apparently favourable conditions, unless diapause is broken by an appropriate environmental change or until a fixed period of diapause development has been completed[15]. Similarly a resumption of development cannot be initiated in seasonally arrested nematode larvae by altering host or parasite-related factors, and development will resume only after a fixed period of time has elapsed. It is probable that at certain times of the year most hosts simultaneously harbour non-specifically and seasonally arrested worms, but whereas the non-specifically arrested parasites can resume development at any time, provided host- or parasite-related factors alter, the seasonally arrested parasites will resume development only after a fixed period of time has elapsed. This resumed development may not necessarily by synchronous for all larvae present.

In a series of surveys conducted in sheep, cattle and impala in the Transvaal[12] seasonal arrested development of nematodes was evident in all host species and I intend discussing this phenomenon and its similarities to diapause in insects, using quotations from Chapman[4] for comparative purposes.

"Diapause is usually restricted to one stage of the life history, but commonly an earlier stage is the recipient of the environmental signals initiating the delay in development"[4]. In a large number of parasitic nematodes it is third stage infective larvae that are the recipients of environmental signals and early fourth stage larvae which are arrested in their development[1].

"Sometimes every individual in every generation enters diapause. This is obligatory diapause and as a result there is usually only one generation each year. Alternatively, in other species, some generations may be completely free of diapause while in others some or all may enter diapause. This is facultative diapause and as a rule there are two or more generations per year".[4]. The seasonal fluctuations of *Haemonchus contortus* in sheep at Armidale in Australia[26] and on the Transvaal Highveld[12] indicate that there are 2 or more generations of this nematode annually. The generation or generations acquired in spring or early summer are relatively free from larval inhibition while in infestations acquired during autumn some or all larvae may become arrested.

Obligatory arrested development may be essential for the survival of nematodes at the extreme range of their geographic distribution, as external environmental conditions may for most of the year be unfavourable for the development or survival of their free-living stages. This is probably why a single generation only of *Haemonchus contortus* occurs annually in north-east England, the major portion of the year being spent in the host as arrested fourth stage larvae[27].

"Although facultative diapause is largely controlled by environmental factors, different races of a species may become genetically differentiated with respect to diapause . . . and each of these responds differently to environmental factors"[4]. An analogous situation exists in a number of nematode species. In Scotland environmental influences acting on infective larvae of *Ostertagia ostertagi* during autumn result in arrested development of fourth stage larvae in cattle during late autumn and winter[1], while in parts of Australia it is larvae of this species ingested in spring that may be arrested in their development[13]. *Ostertagia* spp. infestations acquired by sheep either in England or on the Transvaal Highveld during winter exhibit a high degree of larval arrest[6 12] while at Armidale in Australia it is infestation acquired during spring that exhibits this tendency[26]. In semi-arid areas desiccation may be the stimulus for subsequent arrest of worms of this genus in sheep[1]. *Haemochus contortus* ingested by sheep during summer in north-east England[27], as opposed to autumn in the south of England[6], New South Wales[26] and the Transvaal Highveld[12] were subject to larval arrest. Thus parasites of the same genus or species seemingly responded differently to different stimuli at different localities.

"The most reliable and consistent indicator of seasons is day length or photoperiod and this is the most important of the sign stimuli initiating diapause. Other possible indicators are temperature, the state of the food, and the age of the parent"[4]. In nematodes chilling is probably the most important of the sign stimuli[1], although it has been shown that photoperiod does have an effect[9].

It can be assumed that species with extensive geographical distributions are differently adapted to temperature or photoperiod in different parts of their ranges and that these differences become inherited characteristics of the populations. Thus, the third stage infective larvae of *Ostertagia* spp. and *Haemonchus contortus* in their various habitats respond at different seasons of the year to seasonal environmental stimuli. However, the mean midsummer temperature in north-east England[27] is similar to the mean early winter temperature at Armidale in New South Wales[26] and at Hennops River on the Transvaal Highveld[12]. It would thus appear that if temperature is the stimulus for *H. contortus* to become arrested in its development the same mean temperature is effective, albeit in different seasons in these widely dispersed localities.

In insects a number of photoperiodic cycles are necessary to produce an effect[4]. Similarly in nematodes, in which temperature appears to play a more important role than photoperiod, the length of time infective larvae are exposed to cold is important[19]. The longer the larvae are stored at a low temperature the higher the subsequent degree of inhibition; if, however, a certain optimal time of storage is exceeded the process is reversed[20].

It is thus evident that there are considerable areas of similarity between arrested development in nematodes and diapause in insects. Even greater similarities become apparent if the seasonal occurrence of arrested development in *H. contortus*, which has an extensive geographical distribution, is compared with that of diapause in the parasitic first instar larvae of *Oestrus ovis*, the equally extensively distributed nasal bot fly of sheep.

In the cold climate of New Zealand, where survival outside the host is impossible for much of the year, *O. ovis* survives during autumn and winter as first instar larvae in the nasal passages of sheep, maturing to second and third instar larvae in spring and then developing to pupae and adults on pasture during summer[14]. This prolonged period of diapause permits the development of only one or two generations a year, as is probably the case with *Haemonchus contortus* in north-east England[27] and the south of England[6]. In the warmer climates of Kentucky and the Transvaal Highveld diapause is present only in some of those larvae of *Oestrus ovis* deposited in late autumn and winter and these larvae resume development in early spring[11 23]; other larvae complete their parasitic life cycles in approximately 30 days and numerous generations are possible annually. This type of life cycle corresponds to that of *Haemonchus contortus* in New South Wales[26] and on the Transvaal Highveld[12].

That this period of arrested development in *Oestrus ovis* is indeed diapause and not just quiescence brought about by cold winter temperatures is proven by the fact that the temperature in the nasal passages may be constant irrespective of the external temperature[24]. Thus arrested development in the first instar of *O. ovis* is true diapause as it has not been caused by the effect of the immediate environment on the larvae but rather by a stimulus received during an earlier stage of development, namely the parent larviparous fly. Similarly the abomasal temperature at which *Haemonchus contortus* find themselves is constant and does not contribute to their state of arrested development.

RESUMED DEVELOPMENT

During diapause in insects morphogenesis ceases but a gradual process of physiological development takes place before growth can be resumed. This process has been described as diapause development[15]. The duration of this period can vary considerably with temperature and photoperiod and from species to species, but under optimum conditions it is fairly constant within a particular species[4 15] and may also cease spontaneously after a fixed period of time[1].

Morphogenesis ceases early in the fourth larval stage in many of the common parasitic nematodes exhibiting seasonal arrested development[3 16]. It is quite probable that a period of diapause development is a prerequisite to further morphogenesis in these larvae, and as the temperature in the gastro-intestinal tract of the host animal is constant it can be assumed that the length of this period will also be reasonably constant for a particular species.

Armour & Bruce[1] artificially infested calves with infective larvae of *Ostertagia ostertagi* which had previously been chilled at 4 °C for 5 weeks in order to produce a large proportion of arrested larvae. After anthelmintic removal of the adult worms that might have developed they found that larvae spontaneously resumed development 16-18 weeks after infestation.

In an even more striking demonstration of the fixed period of seasonal arrested development, arrested larvae of *Haemonchus contortus* were surgically transferred from naturally infested ewes to parasite-free ewes maintained under worm-free conditions[2]. Ten to 12 weeks after this transfer the worms matured causing a marked rise in faecal worm egg count which coincided with a marked mid-April rise observed in the egg counts of sheep in other experiments.

If the duration of seasonal arrested development is predetermined then larvae acquired in early autumn should mature sooner than those acquired later, yet the time of maturation within a species appears to be reasonably synchronised. The period during which maturation occurs may be fairly short in infestations with *H. contortus* and longer in those with *Ostertagia* spp.[17]. There are a number of actual and possible factors that could bring about this synchronisation.

In many regions and with many species the greatest availability and ingestion of infective larvae occur over a relatively short period and this may coincide with the time that inhibited development of these larvae is at its height[6 12 26]. Thus if the period of arrested development is constant the greatest proportion of seasonally arrested larvae of a particular species can be expected to mature at approximately the same time.

It has been demonstrated that if larvae which have been conditioned to become arrested are not ingested, the changes that have taken place are reversible and with the passage of time these larvae, if ingested, will not become arrested[1 20]. This seems to indicate that once larvae are conditioned, the physiological processes that have to be completed before they can resume development commence irrespective of whether they are ingested or not. It has been found that conditioned larvae of *O. ostertagi* stored for 8 weeks resulted in maximum inhibition but that this declined markedly between 8 and 19 weeks of storage[1]. Maximum inhibition in calves has been recorded when they were infested with larvae of *O. ostertagi* stored at 10 °C for 12 weeks, but a marked decline in inhibition if larvae from the same batch were used but stored for longer beforehand[20].

It is thus possible that both inside the host and in conditioned free-living stages, changes associated with arrested development are reversed within the same period and although conditioned larvae are ingested at various times their development to adulthood will be reasonably synchronised.

Yearling cattle were exposed in the south of England during autumn to grazing infested with *O. ostertagi*[22]. These animals were housed at the end of December under conditions designed to preclude further infestation and their worm burdens studied after slaughter at intervals until summer. From these it was concluded that a small constant number of arrested larvae resumed development every day but that this rate was markedly increased during March so that nearly all arrested larvae had developed by the beginning of April, thus indicating synchronisaton in the development of the majority of arrested larvae.

Once diapause development is complete, morhogenesis is resumed provided environmental conditions are suitable. If they are not the insect remains in a state of quiescence until they become more favourable[4]. If

diapause in insects and seasonal arrested development in certain nematodes is analogous the completion of the period of seasonal arrested development in the host does not necessarily mean that morphogenesis will resume. Host- or parasite-related inhibiting factors may now come into play and the larvae may enter a state of non-specific arrested development, and may resume development once their immediate environment alters. This resumed development may be either gradual or sudden, depending upon the inhibiting factors and the manner of their removal.

One could conclude that the observations of Michel et al.[22] contradict the above hypotheses. They stated that large numbers of arrested larvae of *O. ostertagi* could develop to adulthood at a time earlier than usual because of a breakdown in host resistance. If, however, one examines the worm burdens of the calves in their experiments it is obvious that the south of England is a reasonably favourable region for *O. ostertagi*, as fairly large numbers of adult worms and developing fourth stage larvae were present even in the middle of winter and thus only some larvae were seasonally arrested. One can also assume that, because of the very large worm burdens present in the calves, host- and parasite-related factors would also come into play causing inhibition of development of other larvae. With the breakdown of host resistance, those larvae retarded because of host-related factors resumed development and caused disease, while the seasonally arrested larvae remained so, as can be seen from the large residual burdens of early fourth stage larvae in the diseased animals. Thus rather than contradicting my hypothesis the findings of Michel et al.[22] confirm the multitude of factors that may give rise to larval inhibition and show that arrested larvae may react differently to the removal of these inhibiting factors.

CONCLUSIONS

In conclusion it is my opinion that seasonal arrested development in nematodes is similar to diapause in insects. It is triggered by stimuli of which temperature and to a lesser extent photophase are probably the most important, acting on the free-living stages and resulting in inhibited development in a subsequent stage of the life cycle. Non-specific arrested development occasioned by host- or parasite-related factors is similar to quiescence in insects, in that the immediate environment exercises a restraining influence.

THE CONTROL OF ARRESTED LARVAE

The control measures suggested are applicable in the Highveld regions of the Transvaal.

Sheep

All animals should be treated during July with a broad-spectrum anthelmintic effective against arrested larvae. This treatment will also have an extended effect for little reinfestation will take place before November or December.

Cattle

A broad-spectrum anthelmintic should be administered during July and provided it is effective against arrested larvae, it will have an extended efect until November against the majority of species as little reinfestation will take place before then.

Antelope

If antelope are confined on farms or in small wild-life 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.

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ABSTRACT: Spickett, A.M., Keirans, J.E., Norval, R.A.I. & Clifford, C.M., 1981. ***Ixodes (Afrixodes) matopi* n. sp. (Acarina: Ixodidae): A tick found aggregating on pre-orbital gland scent marks of the klipspringer in Zimbabwe.** *Onderstepoort Journal of Veterinary Research*, 48, 23-30 (1981).

Ixodes (Afrixodes) matopi n. sp. is described from females and males collected off twigs bearing deposits of intraspecific communication marks secreted by the pre-orbital glands of the klipspringer *Oreotragus oreotragus* and from laboratory-reared immature specimens. One female was also found on a goat.

The 4 collections were all from Zimbabwe, 3 of them from Matabeleland South Province and the fourth from Inyanga District, Zimbabwe.

ABSTRACT: Spickett, A.M., Bezuidenhout, J.D. & Jacobsz, Catharina J., 1981. **Some effects of ^{60}Co irradiation on *Cowdria ruminantium* in its tick host *Amblyomma hebraeum* Koch (Acarina: Ixodidae).** *Onderstepoort Journal of Veterinary Research*, 48, 13-14 (1981).

An attempt was made to attenuate *Cowdria ruminantium* by irradiation of the nymphal stage of its tick host, *Amblyomma hebraeum*. The irradiated nymphae were homogenized and serial dilutions of the resultant suspension were injected intravenously into heartwater-susceptible sheep. No attenuation could be demonstrated but the results indicate that progressively more micro-organisms will be destroyed the higher the irradiation dosage applied, and that dosages between 20 and 30 kilorad apparently prove fatal to all the pathogenic organisms.

ABSTRACT: Van der Walt, J.G., Hunter, Gael & Procos, J., 1981. **A rapid quantitative colorimetric determination of blood acetone applied to the assessment of ketosis in fasted pregnant ewes.** *Onderstepoort Journal of Veterinary Research*, 48, 15-18 (1981).

A simple, accurate, colorimetric method for determining blood acetone as an adjunct to the enzymic method of estimating the other ketones was developed and tested on a group of fasted pregnant ewes. Acetone reacted with 2-hydroxybenzaldehyde to form a stable coloured complex that followed Beer's Law up to an acetone concentration of at least 4 mg/100 mℓ of the test solution at 490 nm. While the optimum incubation time of the reaction mixture was found to be 3 h at 40 °C, it could also be left to incubate overnight at room temperature. When tested in a blood matrix, the method gave a mean within-batch coefficient of variation of 0,7%, and a day to day variation of 0,3-1,2%, while an overall recovery of 100,6 ± 1,4% was achieved over 5 concentration ranges (2,86-19,53 mg/100 mℓ). The values obtained from this method corresponded closely to those from the diffusion technique previously employed and it considerably simplified the procedure. A direct linear relationship, $y = 2{,}594x + 2{,}917$ with a coefficient of determination $r^8 = 0{,}958$ for 49 pairs of data, was found between the acetone (= x mg/100mℓ) and total ketone (= y mg/100mℓ) concentrations in blood samples drawn from fasted pregnant sheep. This relationship can therefore be used to estimate accurately the degree of ketosis from the blood acetone concentration alone.

ABSTRACT: Herr, S. & Roux, D., 1981. **The efficacy of bacteriological procedures for the isolation of *Brucella abortus* from abattoir material.** *Onderstepoort Journal of Veterinary Research*, 48, 7-12 (1981).

A process of emulsifying and centrifuging abattoir specimens before plating out is described. *Brucella abortus* was isolated more successfully by this process than by conventional methods, especially in low grade infections. The 5 different media used were equally effective in our attempts at isolation, but growth did not necessarily occur on all 5 plates. In dairy cows, specimens from supramammary lymph nodes, udder and iliac lymph nodes accounted for a high percentage of positive isolations.

ABSTRACT: Howell, C.J., Begemann, G.J., Muir, R.W. & Louw, P., 1981. **The control of Simuliidae (Diptera, Nematocera) in South African rivers by modification of the water flow volume.** *Onderstepoort Journal of Veterinary Research*, 48, 47-49 (1981).

It was found that the build-up of simuliid numbers subsequent to the construction of dams in the Vaal and Orange Rivers could be successfully prevented by periodic, artificially controlled reduction in the water-levels in these rivers.

ABSTRACT: De Vos, A.J. & Roos, J.A., 1981. **Observations on the transmission of *Theileria mutans* in South Africa.** *Onderstepoort Journal of Veterinary Research*, 48, 1-6 (1981).

Four isolates of *Theileria mutans* obtained from geographically distant parts of South Africa by subinoculation of infected blood were found to be readily transmitted by the bont tick *Amblyomma hebraeum*. All attempts to transmit these isolates with *Rhipicephalus appendiculatus* were unsuccessful. Possible explanations for differences between these results and those reported by earlier workers in this country are discussed.

CRITERIA FOR DEWORMING BEEF CATTLE UNDER RANCH CONDITIONS*

J. SCHRÖDER**

ABSTRACT: Schröder J. **Criteria for deworming beef cattle under ranch conditions.** *Journal of the South African Veterinary Association* (1981) **52** No. 4 305-308 (En) MSD (Pty) Ltd, Private Bag 3, 1685 Halfway House, Republic of South Africa.

Anthelmintics provide the cattle farmer with a means of controlling worm infestations. Whether their use is economical, depends upon how it is integrated with climatic changes, pasture management, and the immune state of the animals. Preventive deworming based on a system which monitors worm burdens is idealistic and generally impractical. Monitoring systems which have been employed include faecal egg counts and cultures, haematological determinations, and worm recoveries post mortem. An efficient method of deworming beef cattle is the use of a strategic drenching programme, based upon seasonal variations in the incidence of the helminths. The economics of this approach can be improved by a tactical drenching programme in which the timing of drenches is dictated by factors which could lead to an outbreak of helmninthosis. The most efficient method is dosing which keeps pastures free from contamination over longer periods.

Key words: Anthelmintics, beef cattle, deworming, ranching, strategic drenching.

INTRODUCTION

The harmful effects of helminth infestations in cattle have been extensively investigated[6 18 20]. Helminths that cause clinical signs cause monetory loss but the economic loss resulting from subclinical helminthiasis can be a cause of doubt[16 27 32].

The beneficial effect of treatment has been demonstrated[6 7 9]. It must be remembered, however, that the economics of a response depend on the current value of animal products and the cost of control measures. The return on investment in a control programme will fluctuate therefore with market values[5]. The extent of the production improvement will in turn depend on factors such as the magnitude of the worm burdens, the rate of re-infestation after treatment, and the sensitivity of the variables being measured to helminth infestations[27]. Most of the harmful effects of parasitism can be diminished by a high plane of nutrition[20].

Today it is generally conceded that effective parasite control can only be achieved through an integrated system, including grazing management, the acquisition of immunity, and the judicious use of anthelmintics[6 11 19]. It is difficult to decide when these remedies should be dosed to achieve the maximum benefit. This paper will discuss the principles governing possible alternative methods of using anthelmintics.

ALTERNATIVE METHODS OF USING ANTHELMINTICS

No anthelmintics

The most effective way of saving money on worm drenches is of course not to buy them at all. This may seem a drastic attitude to adopt, but will be the most sensible one under certain circumstances. These will include arid conditions, a prolonged dry season, a very low stocking density, and a herd consisting of relatively insusceptible (usually mature) cattle. The experience of Reinecke in a semi-arid area however, is ample example that rainfall is not a prerequisite for an outbreak of helminthosis[22]. A heavy dew precipitate may provide sufficient moisture for eggs to hatch and larvae to migrate free.

In addition to the abovementioned conditions, which would all adversely affect the acquisition of nematode parasites in ranch cattle, a well-planned system of pasture management could contribute to parasite control. Such a system would include adequate spelling (no shorter than 8 weeks, although pastures can remain infective for 6 months or more[19]) and a short grazing period (no longer than 5 days)[23]; these periods being a function of time, weather, and species of helminth. A pasture management system would also alternate susceptible and non-susceptible hosts[3 4 28]. Such alternation would be between sheep and cattle, which would control the host-specific nematodes in particular[3 30], and also between young and mature stock[6]. In the latter instance it would see logical to let young follow old after a short spelling interval, and vice versa (the rationale being that the more susceptible stock are exposed to the lesser of the two potential evils).

Curative anthelmintic treatment

This represents the situation where anthelmintics are used only after helminthosis has been diagnosed clinically or post mortem. In an era when a shortage of rural veterinarians, skilled stockmen, and manpower in general, necessitates a herd health approach based on preventive stock medicine, such a fire-brigade mentality hardly deserves mentioning.

Having said this, it is nevertheless surprising to see how many people fail to realise that those animals which becme clinically ill, represent the tip of the iceberg. By the time the first animals in a herd die, or show other signs of helminth infestation, the loss in potential productivity in the rest of the subclinically infested herd is substantial[6 31].

Strategic drenching

Despite the fact that our knowledge is lacking with regard to the prevalence and seasonal incidence of cattle helminths in many parts of southern Africa, sufficient information has been gathered to enable us to establish the broad principles of epizootiology. It is upon these principles that drenching programmes are based[12 25]. Cattle are dosed strategically only when an outbreak of helminthosis is expected.

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Strategic drenching is common amongst sheep farmers, and has a lot of merit. If dilegently applied, it is a very effective means of controlling internal parasitism. It obviates the need for making a diagnosis, is convenient, and requires no deviation from traditional management systems[19].

The one drawback of strategic drenching, and probably the main reason it has not become popular with cattle farmers, is that it is often uneconomical. There are several possible reasons for this. Firstly, the acquisition of infestation due to favourable climatic conditions, on which a strategic programme is based, may never materialize. A good programme, however, is flexible in design and able to accommodate fluctuations in climate from one year to the next. Secondly, the worm burdens which are acquired, may be to small to justify the expense of treatment (in general terms, range cattle harbour fewer worms than sheep, probably because of their lower stocking density, and because they graze higher off the ground). Thirdly, worms are apparently less harmful in cattle than in sheep, simply because there are fewer parasites per unit bodymass of host, if a hypothesis that Gordon propounded for lambs versus adult sheep[12] is true, and if the observation with regard to calves versus adult cattle[13] can be extrapolated. A fourth reason for an uneconomical drench, is that the animals are exposed to such high levels of re-infestation immediately after treatment, that treatment has no effect. This is the justification for the principle of coupling deworming with a shift to a "safe" environment[5 19].

It seems more prudent to keep pastures relatively free from contamination, than to await a potential outbreak before deworming cattle. Treatment achieves this when the chances for translation (development of free-living infective larvae from eggs)[1] are lowest (so-called "offensive" drench[24]). If these treated animals are moved to a safe pasture, very little chance of re-infestation exists and the effect of the drench is prolonged[6]. Very few infestive larvae will be acquired between July and October[14], because conditions are unfavourable for the hatching of eggs or the survival of larvae[26].

Tactical programmed drenching

This type of programme will be built upon the same epizootiological princples, but ought to trim away much of the fat of the strategic approach. In other words, here there is little hard and fast long term planning, and each drench is dictated by conditions conducive to an outbreak of helminthosis. These conditions can be classified under 4 main headings[12]. There can be an increase in the infesting mass. This can come about through increased contamination, either seasonally, as when hypobiotic larvae (which can constitute > 90 % of the population from April to November) proceed to adulthood in early summer[14], or managerially, through an increased stocking density. The infesting mass can also increase due to enhanced translation, as can be expected with an increase in temperature (egg hatch), or good rain after a prolonged drought (moisture favours survival of eggs and larvae, movement of larvae from faecal pats to herbage, and disintegration of faecal pats[26]). This involves a forecast based upon meteorological data. Forecasting systems for various species have met with some success abroad[6 10].

Secondly and thirdly, susceptible stock can become exposed to infestation[1], either through being introduced to an infested area, or through the introduction of infested stock into an uninfested paddock.

Alteration of the susceptibility of existing stock[1] is a fourth possible cause of an outbreak of helminthosis. This can come about through the effect of an existing infestation after a reduction in the nutritional value of the diet (as may occur at weaning), or due to stress such as pregnancy and lactation. Alteratively, the acquisition of a new infestation can be enhanced, as for instance during the P P R R (peri-parturient relaxation of resistance, i.e. pre-or post calving), or by concurrent infection with other agents (e.g. *Salmonella dubline* and *Babesia* spp.[1]). There are no known recorded instances of P P R R in cattle, but it has been seen in sheep and swine[1].

Preventive deworming

This approach relies upon a monitoring system for worm burdens to provide effective warning of when control measures should be applied. If it were feasible it would have many advantages. The athelmintic would seldom be wasted, but would be given more accurately and purposefully. Provided the manpower and expenses the system requires is offset by the cost of the drenches which are saved, it can also be the most economical way of using anthelmintics.

This "scientifically guided opportunism" as it has been called[6], is idealistic because it assumes that an efficient economical monitoring system exists. The monitoring systems described to date, however, are unreliable and/or impractical to implement[6].

ALTERNATIVE MONITORING SYSTEMS (OR CRITERIA FOR DEWORMING CATTLE)

Faecal worm egg counts

The determination of faecal egg counts is a relatively simple procedure, and can be done on large numbers of samples at relatively low cost. It has been recommended as a basis for advice on control[6].

Its great shortcoming is that it is difficult to interpret, and is therefore unreliable as a tool for diagnosing worm burdens[17], for the following reasons:

(i) The egg production of any female worm (or population of worms) follows a standard curve, with a peak and a decline after certain time lapses[17]. The age of the infestation thus has an influence on the egg count.

(ii) Even though grazing cattle are supposedly exposed to continuous re-infestation, the peak egg-production of subsequently acquired infestation will seldom be the same as that of the initial infestations[21 25]. This can be the result of immunity, which is known to suppress egg production[33], or of population competition, where some worms are inhibited in the larval stages, and only a certain percentage reach adulthood[28 31].

(iii) There are substantial differences in the fecundity of different worm species; *Haemonchus* produces many more eggs per female than say *Trichostrongylus*[29].

(iv) It is difficult to identify gastro-intestinal nematodes by the shape of their eggs under the microscope alone.

(v) Sexually mature (i.e. potential egg laying) female worms constitute different proportions of the para-

sitic population at different times of the year[14 15]. As a result, worm egg counts are highest in summer[8 17] when a greater percentage of worms are adult[14 15], and lowest in winter[8 17], when the greatest degree of hypobiosis or arrested development occurs[14 15]. The immature and larval stages of some helminths are decidedly more pathogenic than the adults[6](*Ostertagia, Oesophagostomum, Paramphistomum).*

Faecal culture

This is an essential adjunct to the faecal egg count techniques[23]. Identification of infective larvae, which hatch after a few days incubation, will give an indication of the relative egg production by adult females of different species.

Disadvantages are that larval identification is a fairly specialised procedure which requires a considerable amount of experience. It is time-consuming in that the cultures need to stand for 5-7 d for eggs to hatch and larvae to migrate free of the faeces. It still provides no information on the number of parasites in the host, nor of the relative proportion of adults and immatures.

Haemotology

A recent article by O'Kelly indicated that haematology may provide a means of assessing the severity of parasitism in cattle[21]. Haematocrit, and plasma levels of thyroxine, albumin, glucose and cholestrol were all found to be depressed, either due to anorexia (as a result of intestinal discomfort and tick-worry), intestinal leakage, or malabsorption. These determinations can be done easily and speedily in the laboratory.

Disadvantages are those of cost, the need for rapid processing (4-6 h), and difficulty of interpretation. Good baseline data would have to be established for comparative purposes. Ideally a non-parasitised reference group should be available for every set of determinations to account for differences due to breed, age of host, age of the infection, seasonal changes in nutritional status, etc.

An additional diagnostic tool is the determination of plasma pepsinogen levels to diagnose ostertagiasis[2].

Post-mortem helminth recovery

The recovery of worm from a representative sample of animals is the best means of assessing the parasitological status of a herd. This method is however rarely practical in the field. The total intestinal helminth recovery from adult cattle is a laborious process which consumes about 1,5 man days per animal (J Schröder 1978 MSD, Private Bag 3, Halfway House, unpublished observations). It is also potentially very expensive if the animals are slaughtered solely for this purpose, and the meat cannot be used. This can be overcome if an effort is made to collect viscera from every batch of cattle a farmer sends to the abattoir. The information which can be obtained in this fashion more than justifies the effort.

CONCLUSIONS

Decisions to deworm beef cattle under extensive conditions are based on a number of criteria. Faecal worm egg counts are not reliable, for a number of reasons. The most reliable criterion is the actual number of parasites in the herd, but its evaluation may be impractical or too costly. Climatic changes conducive to an outbreak of helminthiosis can be a useful criterion, but there are other climatic circumstances when a single drench will have a longer lasting effect.

Seeing that in most instances the veterinarian will do little more than to advise the farmer when it comes to the deworming of livestock, the following quotation from Brunsdon[6] seems appropriate: "The succesful promotion of schemes for the preventive control of helminths requires that discussions with . . . farmers would encompass three primary aspects . . . Firstly, the basic principles and rationale should be explained. Secondly, a model scheme should be proposed and an outline given of the various ways and means by which the objectives . . . may be achieved. Thirdly a number of 'permissible' compromise procedures should be sugested, which would overcome foreseeable management difficulties".

Based on the foregoing, the following "basic principles", "model scheme" and "permissible compromise procedures" can be proposed:

(a) Start with a "clean" herd on "clean" pastures by deworming in early to mid-winter with an anthelmintic that is effective against inhibited fourth stage larvae.
(b) Be prepared to deworm concurrently with any managerial procedure which can affect the host-parasite relationship, e.g. calving (PPRR), weaning, introduction of new stock, movement of stock to new pasture.
(c) Be aware of climatic and/or seasonal changes which can precede an increase in the infecting mass. Sudden rises in temperature or rainfall can cause enhanced translation. Seasonal resumption of development by inhibited fourth stage larvae in summer can lead to increased contamination.
(d) Utilize every opportunity to assess a herd's parasitological status from the viscera of slaughtered stock.
(e) Any deworming drench/injection which is prompted by any of the factors mentioned in (b), (c) and (d) must be accompanied by a shift of the herd to a rested ("safe") paddock.

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ABSTRACT: Littlejohn, A. & Bowles, Felicity, 1981. **Studies on the physiopathology of chronic pulmonary disease in the horse. IV. Blood gas and acid-base values at rest.** *Onderstepoort Journal of Veterinary Research*, 48, 37-45 (1981).

Radiometer Blood Micro-system 2 was used in studies designed to, (a) compare the mean blood gas and acid-base values of 38 normal horses and 20 horses with chronic obstructive pulmonary disease (COPD), (b) determine the means and standard deviations of blood gas and acid-base values of Thoroughbred horses in training, and (c) investigate the relationships between clinical data, blood gas values, intracardiac and pulmonary arterial pressures in subjects with COPD.

There were significant differences between the mean values for partial pressure of arterial oxygen (PaO_2), arterial carbon dioxide ($PaCO_2$) and mixed venous carbon dioxide ($P\bar{v}CO_2$) in normal and COPD subjects.

The mean values and standard deviations for determinations of blood gases and acid-base status in Thoroughbred horses in training were as follows: $PaO_2 = 77{,}4 \pm 4{,}3$ mm Hg; $P\bar{v}O_2$ (mixed venous oxygen partial pressure) $= 36{,}2 \pm 4{,}1$ mm Hg; $PaCO_2 = 40{,}9 \pm 5{,}8$ mm Hg; $P\bar{v}CO_2 = 49{,}4 \pm 5{,}0$ mm Hg; pHa (arterial) $= 7{,}358 \pm 0{,}051$; pHv (venous) $= 7{,}343 \pm 0{,}027$; standard bicarbonate $= 22{,}7$ mM/ℓ.

The PaO_2, the $PaCO_2$ and the arterial pH were significantly correlated to the respiratory frequency in COPD subjects.

The correlations of pulmonary diastolic pressure to both PaO_2 and pHa were of probable significance ($P < 0{,}05$) in COPD subjects.

$PaCO_2$ was highly significantly correlated to PaO_2 and pHa in COPD subjects.

RABIES IN KUDUS (*TRAGELAPHUS STREPSICEROS*) IN SOUTH WEST AFRICA/NAMIBIA

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ABSTRACT: Barnard B.J.H.; Hassel R.H. **Rabies in kudus *(Tragelaphus strepsiceros)* in South West Africa/Namibia.** *Journal of the South African Veterinary Association* (1981) **52** No. 4 309-314 (En) Veterinary Research Institute, 0110 Onderstepoort, Republic of South Africa.

A serious outbreak of rabies amongst kudus in South West Africa/Namibia has accounted for the deaths of an estimated 10 000 of them since 1977. The disease has spread at a rate of 40-60 km per year although its progress in an easterly direction was checked for more than 2 years by a game fence. Although the fence restricted the movements of big game such as kudus, it did not prevent movement of the known vectors of rabies such as dogs and jackals.

The outbreak coincided with a few years of above average rainfall with a resultant improvement in vegetation and an increase in the population density of kudus and jackals. The incorporation of game, especially kudus into the farming industry in South West Africa/Namibia and the greater awareness of farmers of the need of protecting them contributed to the population increase of kudus.

Circumstantial evidence is supplied to suggest a horizontal spread of the disease amongst kudus. Factors involved include their grooming habits, social behaviour, the restricted spread of the disease through the game fence and the absence of a corresponding increase in the number of cases of rabies in other species. Mouth lesions caused by the browsing of thorn-bush may be a contributory factor.

Key words: Kudus, rabies, South West Africa/Namibia.

INTRODUCTION

In rabies epizootics carnivorous vectors usually play an important role. In various parts of the world different animal species have been incriminated as vectors in the perpetuation of the disease[28] but large outbreaks are rare particularly if only a single victim species is involved. One of the most serious outbreaks to date where recognized vectors played an insignificant role, occurred in the Richmond Park in Great Britain where 257 fallow deer succumbed to rabies[6]. In this case dogs played a less important part in the transmission of the disease and there was circumstantial evidence and, later, established proof of horizontal transmission.

The first confirmed case of rabies in South West Africa/Namibia (SWA/N) was reported in Ovamboland in 1926 and the first case south of Grootfontein was recorded in 1938[23]. Subsequently, rabies gradually spread until today it occurs in all the thickly populated areas of SWA/N.

North of the 23rd parallel in SWA/N the jackal (*Canis mesomelas*) and the domestic dog are the most important vectors of rabies[3]. Between 1967 and 1976, 73 % of the total number of the cases diagnosed in vectors in the area between the 23rd parallel and the Etosha Game Park were in dogs and jackals. During the same period there were 167 cases of rabies in victims as against 110 cases in vectors. Three kudus (*Tragelaphus strepsiceros*) were among the victims, but this was considered to be a normal number in an enzootic rabies area. In 1977, rabies was confirmed in 2 kudus in that area, and during 1978/1979 the increase in the number of kudus that succumbed to the disease made it clear that an outbreak of inordinate proportions was being experienced. This marked increase of rabies in kudus was quite unexpected and seemed to point to an unusual epizootic. What strengthened the surmise was that there was no concomitant increase in the number of cases of rabies in other species.

Notwithstanding the inherent threat that rabies-infected kudus are to man, they play an increasingly important role in the economy of SWA/N and there is a flourishing trade in breeding game, trophy hunting and the export of venison. Game farming, of which kudus constitute more than 60 %, has become an integral part of animal husbandry in this country[19]. The contribution made to the economy by game in 1978 exceeded R10 million. During the past 4 years an average of more than 20 000 kudus were harvested annually.

The danger rabies constitutes to the consumer of venison and the hunter cannot be underestimated, especially as most game are harvested at night, as is the practice in SWA/N, and consequently the symptoms of rabies are not easily detected.

The purpose of this article is to indicate the extent of the outbreak and to describe the symptoms of rabies in kudus and its possible epizootiology.

VIROLOGICAL OBSERVATIONS

Diagnostic procedures

Specimens: Brain specimens of suspected cases of rabies in a variety of game and domestic animals collected by veterinarians, stock inspectors and farmers, together with case reports, were submitted to the Veterinary Research Institute, Onderstepoort for examination. One half of the brain was preserved in 50 % aqueous glycerine solution for serology and virus isolation while the other half was preserved in 10 % formalin for histological examination. A positive diagnosis was made when at least one of the methods gave positive results. When the presence of rabies was confirmed on a farm the diagnosis of further cases was usually based on symptoms of affected animals.

Tests: The direct fluorescent antibody test for rabies (FATR) was used for diagnosis. Apart from this test, the identity of the virus was further confirmed by virus neutralization tests in 3-week-old mice. The reaction of guinea-pigs and mice inoculated with the virus isolated from kudus was also compared with the reactions provoked by the inoculation of rabies virus isolates from other species of animals from other parts of the country during routine diagnostic procedures.

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The diagnosis of rabies with the FATR is as simple in kudus as in other species. No difference could be observed in respect of brilliance of fluorescence, or the morphology and distribution of inclusion bodies. The results obtained with the FATR agreed with the results obtained by histopathological examination. Mice and guinea-pigs inoculated with the kudu isolate reacted in the same way as with isolates from other species. In virus neutralization tests, virus from kudus could not be distinguished from virus isolated from other animals.

Table 1: RABIES CASES IN THE PART OF SWA/N WHERE IT OCCURS IN KUDUS AND IN AN ADJACENT AREA WHERE KUDUS ARE NOT AFFECTED

Species	Rabies cases											
	Area with rabies in kudus						Area without rabies in kudus					
	1974	1975	1976	1977	1978	1979	1974	1975	1976	1977	1978	1979
Vectors												
Dog	2	1	4	3	4	5	1	0	0	0	0	2
Jackal	2	1	2	4	4	6	1	0	0	0	1	1
Other	0	0	0	0	4	5	0	0	0	3	0	4
Total:	4	2	6	7	14	16	2	0	0	3	1	7
Victims												
Cattle	4	0	10	5	18	20	7	3	4	1	6	10
Kudu	0	0	0	2	35	58	0	0	0	0	0	0
Total:	4	0	10	7	53	78	7	3	4	1	6	10
Total Number of Cases	8	2	16	14	67	94	9	3	4	4	7	17

EPIZOOTIOLOGICAL OBSERVATIONS

Rabies cases

The estimated number of rabies cases was determined by experience gained with routine examination of specimens, case reports, questionnaires and observations made by field staff including veterinarians, stock inspectors and nature conservation specialists. The incidence of rabies in different species in areas where kudus contracted rabies was compared with the incidence in the same species in areas where rabies among kudus was not encountered.

It is clear from the general trend of the disease in all species that there has been a gradual increase in rabies in jackals and dogs since 1976, while the increase in kudus was dramatic during the period 1978-1979 (Table 1).

Only 2 cases of rabies were confirmed in kudu during 1977. During the next 2 years, 161 cases were confirmed in all species of which 30 were vectors and 93 were kudus originating from the Okahandja, Karibib, Omaruru and Windhoek districts. No other game were involved during this period. According to our estimation at least 10 000 kudus succumbed to rabies since 1977.

Spread of the disease: The first case to be confirmed in kudus originated from the farm "Bergquell" on the Swakop River in February 1977. From this point the disease spread in a westerly direction along the Swakop River to the Karibib district where a case was confirmed on the farm "Uitdraai" in February 1978. After this east-west progress the disease spread both northwards and southwards in the vicinity of the Swakop River. The first case to be confirmed in the Omaruru district was on the farm "Kaliombe" in 1978, and in the Windhoek district in April 1979 from a specimen originating from the farm "Monte Christo". It is increasingly evident that rabies in kudus occurs in contiguous areas and that the spread of the disease is progressive. At first rabies in kudus did not spread eastwards beyond the game fence but, since November 1979, cases have been confirmed on the other side of the fence as well (Fig. 1). By the end of 1979, cases were also reported in Otjiwarongo. The infection spread an average of 40-60 km per year, except for a period of 2 years when it was contained by the game fence.

Social behaviour of kudus

Knowledge of the movement and behaviour of normal and sick kudus, their feeding habits, physical contact between them and other game and the vegetation in the area as well as of the population density helped to form a picture of the outbreak.

Social groups: Kudus have been observed associating for the greater part of the year in social groups, which include cows and young calves. They keep together, move together, eat together and exist in relatively close contact. During the breeding season in summer the group splits up and later comes together again. Bulls mostly wander around alone but occasionally form looser groups. Mating usually takes place in the autumn but this may vary from area to area and from year to year, influenced apparently by a number of unidentified factors. Kudus in different social groups often make contact at watering places. Bulls in particular often range over great distances. Contact with other species does take place especially at watering places.

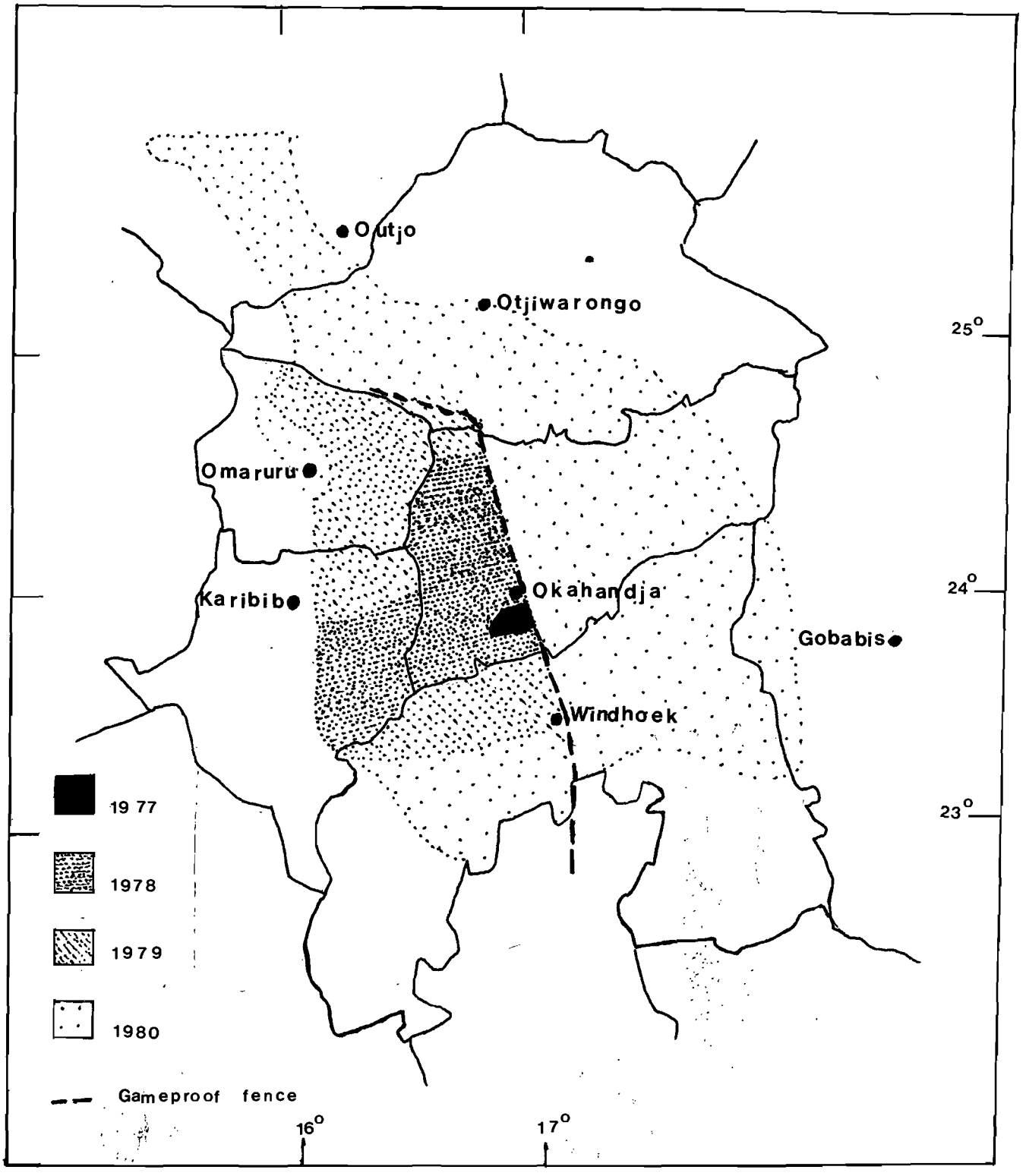

Fig. 1: Distribution of rabies cases in kudu in South West Africa/Namibia during the period 1977-1980.

Fences: Although some farms in SWA/N have boundary and inner fencing, they seldom are game-proof. The normal wire fencing, which is effective for cattle and gemsbok, does not control the movement of kudus. On one occasion a kudu bull, which was being kept in quarantine, leap over a 2,3 m fence without any difficulty and subsequently escaped over a standard game fence.

Grooming: It is a common sight to see cows licking their calves. Kudus of all ages lick themselves (self-grooming) and also each other (mutual grooming). Two kudus thus engaged usually stand head to head and lick the head, neck and shoulders of the opposite numbers.

Feeding habits: Kudus are browsers. In the area of SWA/N where rabies occurs in kudus, they are largely dependent on leaves of the *Acacia* spp. Thorn-trees are still covered with leaves until late in the winter and also bear pods which are eagerly devoured. Furthermore, the thorn-tree is the first tree to bud early in the spring. In some species leaves and/or racemes appear even before the first rains. Kudus have often been observed standing browsing at the same thorn-bushes, especially when food is scarce.

Vegetation

In large parts of the region where rabies is encountered in kudus the vegetation consists of *Acacia* spp. In some places bush encroachment by *A. mellivera* and *A. erubescens* is taking place. These 2 species are small trees or thorny shrubs which are sometimes spread over the veld forming tangled growth. The Khomas Hochland, the mountainous areas of Windhoek, is characterized by the berg thorn (*A. hereroensis*) as well as other *Acacia* spp., including *A. mellivera*, in lower lying areas. The thorns of *A. hereroensis, A. erubescens* and *A. mallivora*, which appear in small hooked pairs, are inconspicuous and innocent looking, but as a rule cause severe wounds when handled. Other species including *A. erioloba* and *A. albida* are also common in these areas.

Rainfall

Reports obtained from 11 meteorological stations in the area provided an estimate of the effective seasonal rainfall in the area. A downpour of 10 mm or less was only taken into account when it occurred within a week either before or after a shower of 5 mm or more.

It is clear (Table 2) that, ever since the good season in 1973, the rainfall has been well above average, and 39 out of the 55 readings taken at 11 points in the area registered 25 mm or more above normal. Only 9 readings were below average during this period. During the 1975 and 1976 seasons the rainfall almost doubled and luxuriant growth of vegetation resulted which benefited not only kudus but all animal life.

Table 2: EFFECTIVE RAINFALL REPORTED BY 11 METEOROLOGICAL STATIONS

Meteorological Station	Season									
	68	69	70	71	72	73	74	75	76	77
Okairu	B	B	N	N	N	A	A	A	A	A
Otjozondu	B	B	A	A	B	B	A	A	N	A
Godeis	B	B	B	N	B	A	B	A	A	A
Augeigas	B	B	B	N	B	A	A	A	A	N
Wilhelmstal	B	B	A	B	B	A	B	A	A	A
Klein Okapuka	B	B	A	A	B	A	B	A	A	N
Kaliombo	N	B	B	A	B	A	B	A	A	N
Windhoek	B	N	N	N	B	A	A	A	A	N
Karibib	N	B	A	N	B	A	B	A	B	A
Dusternhoek	B	B	A	A	B	A	B	A	B	A
Westfalenhof	B	B	A	A	B	A	B	A	B	A

B = Rainfall reported 25 mm or more below average
N = Average rainfall reported
A = Rainfall reported 25 mm or more above average

Population density

The density of the kudu population in the rabies infected area is estimated on the average at 1 kudu per 40 ha. On certain farms the ratio is much higher. Kudus are not diffusely distributed, however, and since they remain in their social groups, their effective density is much greater. Farmers are in agreement that the kudu and jackal populations have increased significantly during the past 2-3 years. The density of the jackal population could not be determined, but there is no doubt that it is very high. On one farm 70 jackals were accounted for in one night with poison bait. If this is taken as an average, the population density is 1 jackal to 80-120 ha.

Table 3: SYMPTOMS IN 80 KUDUS WITH SUSPECTED RABIES

Symptoms	53 Positive cases[1]		27 Negative cases[2]	
	No.	%[3]	No.	%[3]
Salivation	22	55	3	15
Docility	21	52	5	25
Visit buildings	20	50	4	20
Paresis-Paralysis	14	35	3	15
Associate with domestic animals	6	15	0	0
Injuries	2	5	8	40
Pain	2	5	1	5
Bellowing	2	5	3	15
Aggressiveness	2	5	1	5
Depressed	2	5	0	0
Tail twitching	1	2	0	0
In social group	0	0	6	30

[1] Including 13 specimens collected from dead kudus
[2] Including 7 specimens collected from dead kudus
[3] Expressed as a % of live kudus examined

Symptoms

Table 3 is a summary of the symptoms seen in confirmed cases of rabies in kudus and in suspected but unconfirmed cases. Salivation (55 %), docility (52 %) and varous stages of paresis to paralysis (35 %) were the most noteworthy symptoms. Docility manifested itself in a gentle appearance, a tendency to approach buildings and playful behaviour towards domestic animals and people. Some kudus shared the kraal with cattle, others entered kraals and even attempted to enter houses and, moreover, these animals could not easily be scared away. Paresis of the hind legs and a difficult gait resulting in inco-ordination were marked symptoms. The commonest lesions were abrasions, chafing and cuts. No particular parts of the body were involved. On-

ly 5 % of the animals bellowed or showed signs of aggression. Affected kudus were not found in social groups.

Kudus with rabies-like symptoms but which eventually proved negative constituted an entirely different group. Thirty per cent of such animals were encountered in their own social groups, and 40 % had serious injuries such as deep wounds, broken bones and shot wounds. These injuries were evidently the cause of the symptoms such as paresis, pain, bellowing, aggressiveness and exhaustion. The unusual docile appearance in 25 % of the kudus in this group cannot be explained.

DISCUSSION

The outbreak of rabies amongst kudus in the thornbush savanna of SWA/N coincided with a period of above average rainfall which contributed to the high population density of both kudus and jackals. The increase in the demand for venison and the incorporation of kudus into the farming eonomy also favoured the kudu population, since farmers were motivated to protect the species. The pastures in SWA/N were estimated to be 23 % overpopulated[19] in 1978 and carried an estimated kudu population of 1 kudu per 40 ha. Statistically the situation was ideal for the onset and perpetuation of a rabies epidemic. The increase in the number of cases in cattle and dogs is an indication that the prevailing conditions did in fact favour the increase of rabies cases in the area (Table 1). Nevertheless, the selective increase in the number of cases in kudu cannot be ascribed to jackals as the only vectors and indicates an uncommon epizootology.

Although the claim has not been established, it is widely accepted that rabies is a density-related disease[8]. Gier[10] has estimated that a density ratio of 2 foxes per square mile (259 ha) is sufficient to support a rabies epizootic.

The compartmentalization of rabies within a paramount species has been recognized repeatedly but remains unexplained[12 22]. Foxes accounted for 64-86 % of the reported cases throughout Europe during the 1954-1972 outbreak[26] while skunks accounted for 60 % of the cases in America[17]. Sixty-two percent of the rabies cases reported in Florida and 71 % of the cases in Georgia during the period 1960-1970 were in raccoons[14]. During the period 1967-1976 the jackal accounted for 50 % of the cases reported in the northern part of SWA/N[3] while in this outbreak in SWA/N, kudus, the most commonly involved species, accounted for 52 % of the reported cases. The jackal and dog accounted for only 28 % of the cases diagnosed during the latter outbreak.

In SWA/N and South Africa a close relationship exists between rabies cases encountered in victims and vectors[4]. However, the rabies outbreak in kudus in SWA/N is an interesting exception; the incidence of the disease in kudus in that part was not related to the incidence in vectors. Such rabies outbreaks where the majority of cases occur in game and without any apparent correlation between cases in vectors and victims are rare. The situation may, to a certain extent, be compared with that in South America where high mortality rates are encountered in cattle[7 9 29]. However, it must be remembered that the chief vector in South America is the vampire bat which preys on cattle. Vampires do not occur in SWA/N and there is no reason to suppose that vampires or other vectors of rabies have made their appearance in SWA/N.

The temporary lull (Fig. 1) in the spread of rabies in kudus brought about by the game fence which can be penetrated with ease by jackals and other vectors but not so readily by kudus, is an indication that kudus themselves possibly play an important role in spreading the disease.

The estimated rate of progress of an epizootic wave of rabies is estimated at 30-60 km per year[24 26 29]. This rate of spread of the disease is similar to that in SWA/N except that for more than 2 years spreading in an easterly direction was prevented by the game fence. However, after cases were encountered east of the fence the disease was progressive from that point at the rate of 30-60 km per year.

Shaw concluded that mechanical transmission plays an important role in kudus and that mouth lesions caused by browsing of thorn bushes is a contributory factor[20]. Since rabies virus is very unstable and cannot survive for any length of time when exposed to the environment, close contact between vector and victim is essential. The formation of close social groups by kudus followed by the breaking up of these groups during the winter months and by regrouping during summer, create ideal conditions for the spread of the disease. In SWA/N, and also in the Kruger National Park[16], individual kudus have been observed browsing at the same bush and sometimes the same branch. Grooming habits provide ideal conditions for the direct transmission of the virus. Although there is no definite information available on the excretion of rabies virus by kudus, it is generally known that in dogs rabies virus is excreted in the saliva and that it can occur even before clinical symptoms are observed[25]. The possibility of this happening in kudus is reinforced by observations made on a dog and cheetah (case reports) respectively, which developed rabies within 21 days of their having bitten affected kudus on the nose and mouth.

Since sick kudus segregate themselves from their social groups, it is difficult to explain when transmission of the disease takes place. There is a possibility that it may be transmitted through the saliva even before symptoms of the disease are apparent. This could be an indication of virus proliferation in the salivary glands and nasophyrangeal epithelium, even before the brain is affected.

The established concept that rabies is transmitted only by biting has been weakened by reports of the disease occurring after the non-bite exposure of animals and man[1]. The most important non-bite route appears to be respiratory infection. Oral transmission has also been demonstrated[5 18 21]. In most instances, abrasions in the gums caused by teething or breaks in the buccal mucosa were suspected as the ports of entry of the virus. The sensory nerve endings may also play a role in viral entry from superficial exposure[15]. Injury to the buccal epithelium of kudus is often encountered. Transmission may therefore occur whenever infected kudus, which are already excreting the virus, browse the same branch or during grooming.

All available evidence seems to make it reasonably certain that high density populations, especially involving kudus and jackals, resulted in the initial cases of this outbreak and that contact infection accounted for the

subsequent spread and high incidence of rabies in kudus. Mouth lesions are probably a contributory factor. The outbreak bears a great resemblance to that in Richmond Park[6] in Britain in which deer attempted to bite one another and, although they failed to actually penetrate the skin, they produced sores and left a certain amount of saliva on the skin of the bitten animal. On several occasions healthy bitten animals were observed licking the sores.

If transmission occurs from kudu to kudu, as circumstantial evidence would seem to suggest, it is still not clear why this has not happened previously. Almost 90 years have elapsed since the first case of rabies was reported in southern Africa[11]. Since then there has been ample time and opportunity in vast areas of the country for rabies to make its appearance in kudus, but it has never happened to any significant degree. As it has been pointed out that virus strains with different penetrating abilities exist[2], one may speculate that the kudu rabies virus has developed an unusual penetrating power in kudus.

In SWA/N kudus are used on a large scale for human consumption. The habit of harvesting kudus at night in an orderly fashion increases the risk of infected animals being handled and used for food. However, there is no known case either in South Africa or in SWA/N of anyone contracting rabies from having eaten a rabid animal.

Likewise, in South America where up to 4 % of apparently normal animals slaughtered at abattoirs are infected with rabies, there has not been a single known case of rabies in humans as a result of eating or handling meat from such sources[13]. Nevertheless, the possibility of infection, especially during the handling of meat, should always be kept in mind.

Cooked kudu meat or biltong constitutes no risk, since rabies virus is very unstable and is thus destroyed during the normal processing of meat.

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REVIEW OORSIG

RHIPICEPHALUS APPENDICULATUS: CAUSE AND VECTOR OF DISEASES IN AFRICA

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ABSTRACT: De Vos A.J. ***Rhipicephalus appendiculatus:* Cause and vector of diseases in Africa.** *Journal of the South African Veterinary Association* (1981) **52** No. 4 315-322 (En) Veterinary Research Institute, 0110 Onderstepoort, Republic of South Africa.

Rhipicephalus appendiculatus Neum. occurs mainly in the eastern and southern parts of Africa and is the principal cause and vector of some very important stock diseases in these areas. The diseases include the theilerioses, brown tick toxicosis and Nairobi sheep disease. These are briefly discussed, and emphasis is laid on the role of *R. appendiculatus* in their epidemiology. *R. appendiculatus* is a 3-host tick particularly well adapted to survive where climate and vegetation are suitable. The basic requirements and breeding potential of this tick are also discussed.

Key words: Disease vector, *Rhipicephalus appendiculatus.*

INTRODUCTION

Throughout the world approximately three-quarters of more than 1 000 million cattle are "at risk" to tick-borne diseases, with associated economic losses "almost too great to visualize"[61].

According to Henning[30], the first record of the detrimental effects of a tick-borne disease (East Coast fever) in Africa south of the Sahara is probably contained in an account of a journey made by Francisco Barreto in 1569. Theiler[77] also refers to a report in 1846 by 2 missionaries in South Africa in which they mention that "ticks torment the animals grievously".

Statistics, such as that 900 000 head of cattle in the Transkei died from East Coast fever between 1910 and 1914, led Neitz[50] to conclude that the theilerioses were a very important group of diseases responsible for severe losses in Africa. "These diseases" he said, "were materially affecting the development of extensive areas. Production of milk and beef, urgently required by the ever increasing human population, could have been much higher had it not been for this hazard". East Coast fever was eradicated from South Africa in 1954 after a campaign lasting half a century and costing the State R100 million[53].

A UNDP/FAO East African Livestock Survey report, published in 1967 and cited by Purnell[60], also concluded that: "In East Africa, the tick-borne diseases are serious killers of cattle, and control of these diseases, above all East Coast fever, deserves the highest priority for disease research".

Despite recent advances in the methods of tick control as well as in our knowedge of tick-transmitted diseases, statements such as tick-borne diseases "are the major health impediments to efficient livestock production in many countries"[12], "ticks and tick-borne diseases are undoubtedly of the most important problems facing the stock industry in South Africa"[10], and "tick-borne diseases of cattle make havoc of the most ambitious plans for importing exotic breeds into tick-infested countries"[80] are common in the literature even today.

There is, surprisingly, still a lack of authoritative estimates on the cost of tick-borne diseases and ticks to the South African[10] and African livestock industry. Even where estimates are available, the reliability of these are open to question. One official estimate made in 1977[2], gave the losses from ticks in South Africa as R70 million annually. Figures often used in the press and advertisements by pharmaceutical companies indicate that 25 % of all direct stock losses in South Africa are due to ticks and tick-borne diseases, and the losses to the cattle industry are estimated at R60 million per annum[3]. It was estimated in 1977 that, in East Africa alone, half a million cattle died from East Coast fever per annum[45].

The theilerioses, and particularly East Coast fever, are clearly the most important of the tick-borne diseases on the African continent[6 35]. *Theileria parva* can be transmitted by at least 10 different tick species[49], but of these only *Rhipicephalus appendiculatus* plays a significant role in the epidemiology[6 80]. The incidence of *Theileria lawrencei*, another important *Theileria*[60], is also closely restricted to the distribution of *R. appendiculatus*[6]. It is therefore safe to conclude that of all the tick species infesting domestic animals in Africa, *R. appendiculatus* is the single most important species.

Apart from its importance as vector of diseases, *R. appendiculatus* is also capable of inflicting considerable damage *per se*, presumably because of the action of a highly toxic secretion[78]. The exact importance of this form of tick toxicosis is unknown, but Thomas & Neitz[78] stressed that due consideration should be given to this particular condition because of resultant loss of condition, retardation of growth and even death.

ECOLOGY

R. appendiculatus, commonly known as the brown ear tick, is found in Central and East Africa, from the southern part of Sudan southwards to the Cape Province, Republic of South Africa[31], but is absent from West Africa.

This tick prefers moist conditions and is usually found in South Africa where the rainfall is evenly distributed and in excess of 400 mm per annum[76]. In Kenya, it normally requires a habitat with not less than 500 mm per annum to flourish[56], although some areas with as little as 400 mm support vigorous populations[13]. In the more arid, marginal conditions transpirational

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microclimates in vegetation may assume a critical significance[13]. In Zimbabwe (Rhodesia), Norval[57] found *R. appendiculatus* to be absent from over-grazed areas, despite these being in a part with relatively high rainfall.

A relative humidity range of 60-70 % is considered critical for the survival of eggs and larvae, but nymphae and adults are more resistant[79]. In southern Africa, *R. appendiculatus* is common in low-lying areas (below 1 500 m above sea level) which have an adequate rainfall, and is found in Northern and Eastern Transvaal, Natal and the Eastern Province[32]. In East Africa, on the other hand, it is most often found between 1 200 and 2 100 m above sea level[86].

Prevailing temperatures exercise a decisive control over the rate of development of *R. appendiculatus*[13 14]. It thrives in areas with a mean maximum temperature of 15 °-27 °C and a mean minimum of 10 °-15 °C (Lewis, cited by Hoogstraal[31]). The temperature limits for any development are 16 °C and 34 °C for eggs and 12 °C and 41 °C for larvae and nymphae[79]. This tick is generally absent in places where more than 30 days of frost occur annually[32].

R. appendiculatus is a 3-host tick and is extremely well-adapted to survive where climate and vegetation are suitable. Unfed larvae can survive for 9 months, unfed nymphae for 20 months and unfed adults for as long as 2,5 years[37]. Under adverse conditions, e.g. where suitable hosts are lacking, this tick can theoretically take 4-5 years to complete a single generation. A generation is normally completed in 1 year[44], but under ideal conditions, up to 3 generations can be completed (Wilson, cited by Hoogstraal[31]). According to Howell et al.[32], a single female can lay as many as 5 700 eggs!

The pattern of seasonal occurrence of *R. appendiculatus* varies in different localities and is largely dependent on the timing of the activity period of the adult stage. This again is regulated by the combined influences of humidity, temperatures and length of day[72]. In hot tropical areas with well-defined rainy seasons adult activity is initiated by the onset of the rains while in the cool, subtropical and temperate areas low winter temperatures prolong the development periods and are of importance in the regulation of the seasonal occurrence[72]. As reviewed by Short & Norval[72], a minimum day length of 11 h or less is necessary for adult activity.

The seasonal occurrence of larvae and nymphae is determined by the pattern set by the adults and there is no evidence that rainfall patterns directly influence the activity patterns of these stages[72].

Adult *R. appendiculatus* characteristically have a pronounced wet season (summer) peak[38 39], while larvae are active in the cool dry season (late summer to early winter) and nymphs in the hot dry season (spring)[35 87]. There is not much evidence in the literature regarding the seasonal incidence of diseases associated with this tick species. Thomas & Neitz[78] noted that brown tick toxicosis occurred in summer when adult ticks were active. Theileriosis in Rhodesia, according to Matson[42], is seasonal, and outbreaks coincide with the flush of adult ticks from December to April.

Cattle are undoubtedly the main hosts of the adults of *R. appendiculatus*[31 40 87], but virtually all the African game animals, and particularly the larger species including buffalo, can also be infested. The nymphs also occur in large numbers on cattle, although the relative importance of this host in maintaining the nymphal populations is not known precisely[40]. In Zambia MacLeod & Colbo[40] found the overall annual ratios of larvae to nymphs on 2 herds of cattle to be 1,5:1. From this they concluded that cattle-fed larvae may not be adequate to maintain the population at existing levels and that alternative hosts may play an important role. Control of *R. appendiculatus* by dipping only cattle is therefore no easy task.

According to Nuttall, cited by Hoogstraal[31], the various stages remain on the host for very short periods (larvae 4-7 d, nymphs 5-11 d, adult females 6-14 d), and thus the efforts of farmers to control this tick are further confounded. According to Baker & Ducasse[5], 69 % of adult *R. appendiculatus* attach to the ear pinna, the part of the body which may not always be reached by standard dipping procedures. *R. appendiculatus* is therefore not only well adapted to its natural environment in East and southern Africa, but it is also well equipped to survive the attempts of man to control it. This is certainly a major contributory factor to the tremendous importance of this tick both as a vector and a causal agent of disease.

The various diseases associated with *R. appendiculatus* include tick toxicosis and the transmission of the theilerioses as well as some viruses such as Nairobi sheep disease and the rickettsias, e.g. *Rickettsia conori*. The role of *R. appendiculatus* in the epidemiology of these diseases will briefly be discussed below.

DISEASES CAUSED OR TRANSMITTED BY *R. APPENDICULATUS*

Brown tick toxicosis and Tzaneen disease

These are names used for rather poorly defined, interrelated syndromes associated with the exposure of highly susceptible animals to very severe infestations of *R. appendiculatus*.

R. appendiculatus and particularly the adult tick, is known to cause or predispose to certain severe local effects when present in large enough numbers. These include bleeding from the pinna, suppuration, abscessation, myiasis, loss of ears and, in chronic cases, the formation of scar tissue in the ears resulting in the so-called "*kruloor*" (curly-ear) condition[17 78].

As early as in the 1930's the brown ear tick was also suspected of producing systemic effects if infestation was severe[22]. These authors examined severe mortalities after cattle were transferred from Vryburg, a *R. appendiculatus*-free area, to heavily infested pastures at Tzaneen. They attributed the mortalities to the effects of the massive tick infestations acquired by these animals. This, they felt, provoked an abnormal reaction of *Theileria mutans*. The nature of this disease resembled East Coast fever almost in every respect. Schizonts in all stages of development occurred as in East Coast fever, and the mortality was high. Although *T. mutans* was emphasized in their study, other tick-borne diseases were evidently also involved, and based on this study, the entire syndrome eventually became known as Tzaneen disease.

Further information was provided by Thomas & Neitz[78] from observations they made on susceptible animals introduced on to heavily infested veld at Louis Trichardt at the height of adult *R. appendiculatus* activity. Oedematous lesions of the face, eyelids and ears were common, as well as severe inflammation and fre-

quent necrosis of the lymphatic glands which drained the sites of tick infestation. These lesions must have been due to ticks, but the exact pathogenesis is unknown. It would seem that a highly toxic substance injected by the ticks was involved. Affected animals also apparently exhibited a lack of resistance to infections such as babesiosis, theileriosis and heartwater[78], and it was suggested that the reticulo-endothelial system was impaired or even paralysed by the action of a toxin. Reactions to *T. mutans* appeared to be accentuated in these animals. The course of this usually mild disease lasted longer and erythrocytic piroplasms appeared in extremely large numbers in the peripheral blood. Previous inoculation of some animals with the babesiosis vaccine of the Veterinary Research Institute, Onderstepoort also seemed to have had no effect on the susceptibility of these animals to babesiosis. In addition, therapeutic treatment of animals affected with babesiosis had little or no effect on the course of the disease. Despite this, clear-cut evidence of direct cytotoxic impairment of the reticulo-endothelial system was lacking[84].

In the outbreaks reported by Thomas & Neitz[78] and Van Rensburg[84], anaemia was one of the most prominent changes seen. There was some doubt as to whether this anaemia could be attributed to concurrent diseases only. Impairment of the reticulo-endothelial system and bone marrow by a toxin was suggested, but in none of the cases could the acute anaemia be ascribed directly to the effects of a presumed tick toxin[84].

The degree of brown ear tick infestation appeared to determine the severity of all concurrent diseases[78]. A high degree of immunity developed to this form of toxicosis[84].

Based on these observations, Neitz[52] described Tzaneen disease as "a disease syndrome caused by a leucocytotropic brown tick toxin responsible for a regional subcutaneous oedema and a dysfunction of the reticulo-endothelial system and followed by relapses of parasitic tick-borne diseases". The name of this disease is also used erroneously to indicate classical *T. mutans* infections in South Africa.

It is significant that the disease as defined here has evidently not been reported from countries other than South Africa. As far as can be ascertained only local effects of *R. appendiculatus* infestations have been described in other parts of Africa[17]. The final word on this disease has therefore certainly not been written, and the following should be considered during future research:

1. At least 2 mildly pathogenic *Theileria* spp. are present in South Africa (see below) and it is not known which was primarily involved in the outbreaks reported by De Kock et al.[22].
2. The relationship between Tzaneen disease and Rhodesian theileriosis should be examined.
3. The role of *Ehrlichia* as a primary or complicating immuno-suppressant (see below) also requires further study.

East Coast Fever

This important tick-borne disease of cattle was undoubtedly known to the inhabitants of East Africa long before the arrival of the Europeans[49], but it was not until the introduction of this disease into Zimbabwe (Rhodesia) and the Transvaal during the early part of this century that the causative organism was identified and described.

In the past, East Coast fever has been defined as a highly fatal disease of cattle in Africa caused by *T. parva* and transmitted by several tick species, chiefly *R. appendiculatus*[49]. More recent findings, however, have considerably complicated the clear-cut definitions of this and other theilerial diseases in Africa. Purnell[60], for instance, chose to define East Coast fever as a "syndrome resulting from the infection of cattle by one or several parasites of the family Theileriidae".

In South Africa during the first half of this century East Coast fever had a mortalty rate in cattle of more than 95 % regardless of age[49]. According to Uilenberg[80] the same still applies to susceptible animals, even of Zebu breeds, in the epizootic regions of East Africa. In the enzootic regions in East Africa mortality rates are variable but calfhood losses of 30 % or more have been reported[80].

East Coast fever is transmitted either by *R. appendiculatus* nymphae infected as larvae or as adults infected during the nymphal stage. Adult ticks generally have a higher infection rate than nymphae[63], but nymphae infected as larvae have more parasites per g of tick tissue. Transovarial transmission of *T. parva* from one generation of ticks to another is not known to occur in *R. appendiculatus* or, for that matter, in any other species of tick.

T. parva can be transmitted artificially by subinoculating large volumes of blood and organ suspensions, but this technique is cumbersome, unreliable and the reactions are seldom comparable with natural reactions[49]. Recent East African research was therefore aimed at harvesting the infective parasites from feeding ticks. Various methods were employed, but the most significant breakthrough came when it became possible, not only to obtain the infective parasites by grinding partly fed ticks[67] or by using artificial feeding techniques[19 62 65], but also to cryopreserve the "infective particles"[18]. Commonly known as "ground tick stabilate", the deep frozen infective material is today in standard use in research on East Coast fever in Africa, Great Britain and Europe. Recently Schreuder & Uilenberg[71] and Walker et al.[85], also succeeded in infecting fully engorged nymphs of *R. appendiculatus* by inoculating infected blood through the cuticle. After moulting, the adults transmitted the disease to a susceptible animal.

Cyclic variations in the seasonal incidence of East Coast fever do occur, but are not marked. In general, only sporadic outbreaks occur during winter, while a comparatively larger number of susceptible animals contract the disease during summer[49]. This tallies with the seasonal appearance of adult *R. appendiculatus* (see above).

After attachment, infected ticks are not immediately infective, but adult ticks are capable of transmitting the disease after 24 h[41]. Maturation of the parasites is completed in infected adults 108 h after attachment and in nymphae after 72 h[63].

Unfed adult ticks will seldom remain infective for more than 8-9 months after moulting, even though they may remain viable for 15 months or longer[41]. Recovered cattle are not as a rule carriers of East Coast fever, and infected *R. appendiculatus* ticks are therefore the main reservoirs of this disease.

Nymphae feeding on a parasitaemic animal ingest an estimated 1×10^7-1×10^8 piroplasms and of these 0-10 are likely to develop to the infective stages in the salivary glands of the adult tick[60]. The infection rate in

adult ticks varies, but there is no true correlation between the percentage of ticks infected and the parasitaemia of the host at the time of nymphal engorgement[66]. Bailey[4] considered a 1 % parasitaemia adequate for the infection of nymphae, but Purnell et al.[66] found that only 30 % became infected after taking in blood with a 1-5 % parasitaemia, while 60 % became infected on parasitaemias of 41-50 %.

Apart from cattle the African buffalo is the only other indigenous animal convincingly implicated in East Coast fever[49 60] but is only mildly affected.

Corridor disease

In the 1930's Lawrence, cited by Matson[42], investigated a disease which appeared frequently in certain areas of the southern lowveld of Rhodesia (now Zimbabwe), and was associated by farmers with the presence of buffalo. This gave rise to the name "buffalo disease". Investigations proved the disease to be caused by a *Theileria* sp. which differed strikingly from *T. parva*. In contrast with the high rate of parasitosis and parasitaemia seen in advanced cases of East Coast fever, the *Theileria* schizonts and erythrocytic forms were consistently present in small numbers in this disease[42]. It was not until more than 20 years later that Neitz et al.[55] reported a similar condition in the "Corridor" between the Umfolozi and Hluhluwe Game Reserves in Zululand and a detailed identification became possible. Neitz[47] concluded from his investigations that this "Corridor disease" was similar to Lawrence's "buffalo disease", and in honour of the earlier work by his colleague he named the protozoon *Theileria lawrencei*. Subsequent work in East Africa has also demonstrated the presence of this parasite in Kenya[8].

R. appendiculatus is the only tick species known to be capable of transmitting Corridor disease[51]. According to Barnett[6], the incidence of the disease is closely restricted to the distribution of this tick. Transmission occurs transstadially as in the case of East Coast fever[49] and, under ideal conditions, up to 6 % of the ticks can become infected after feeding on buffalo.

In South Africa, Corridor disease has only been encountered in Zululand and the Eastern Transvaal where cattle come into contact with buffalo. Cattle do not serve as reservoirs and no cattle to cattle transmission occurs. In Zimbabwe (Rhodesia) cattle to cattle transmission is considered important but, for the purpose of this discussion, the condition known as Rhodesian theileriosis, or January disease, will be regarded as a distinct entity (see below). Workers in East Africa[9] have also shown that under laboratory conditions the repeated passage of *T. lawrencei* through cattle (as opposed to the usual buffalo to cattle transmission) resulted in such changes in *T. lawrencei* that it became indistinguishable from *T. parva*. A variable degree of cross-immunity has also been shown between Corridor disease and East Coast fever[49], as well as serological cross-reactions[15 69]. Despite great epidemiological differences between the 2 diseases, these findings have resulted in the sinking of *T. lawrencei* as a species and acceptance of *T. parva* as the only valid pathogenic *Theileria* sp. transmitted by *R. appendiculatus*[6 36]. The validity of the lumping of these species has not found universal acceptance and many today are still regarding the 2 organisms as separate species or subspecies[7 60]. In a recent taxonomic review of the theilerias of southern Africa, Lawrence[34] preferred to identify the cause of classic Corridor disease as *T. parva lawrencei* as opposed to *T. p. parva*.

The importance of Corridor disease is well known when contact between cattle and buffalo is permitted. Neitz[47] described outbreaks with a morbidity rate of 15 % and a mortality rate of 90 %. In East Africa the importance of this disease has generally been masked by the presence of East Coast fever. But according to Purnell[60] its importance is becoming increasingly recognized. In buffalo, on the other hand, a well adapted host/vector/parasite relationship appears to exist with death rarely occurring in this host[49].

Despite the potential lability of *T. lawrencei* in Central and East Africa, the fact remains that this parasite has not reverted to East Coast fever in nature under South African conditions, notwithstanding ample opportunity to do so in the past[11 33]. To summarize, *T. lawrencei*, as seen in South Africa, can therefore be defined as a *Theileria* sp. of buffalo infective for cattle, characterized by a low rate of parasitosis and parasitaemia. It is transmitted by *R. appendiculatus* ticks which acquire the infection by feeding in the previous instar on infected buffalo.

Rhodesian theileriosis

At a time when buffalo-associated theileriosis was a well-known disease in Zimbabwe (Rhodesia), Lawrence (as cited by Matson[42]), reported a very similar disease in the Melsetter area where buffalo were not involved. Whereas typical buffalo disease was reported mostly from the lowveld, outbreaks of this theileriosis were seen more commonly in the higher veld such as in the Salisbury, Umtali and Sinoia districts. These outbreaks had a distinct seasonal character, commencing mostly with the summer rainfall season from which the name "January disease" came into common use[42].

As in the case of East Coast fever and Corridor disease, Rhodesian theileriosis is also transmitted transstadially, primarily by *R. appendiculatus*[42]. It appears that transmission by the adults is epidemiologically the most important as outbreaks generally coincide with the flush of adult ticks in summer. This finding has been confirmed experimentally[43].

Mortality rates may be as high as 80 %[35], but, in general, relatively low mortality is seen[42] and recoveries do occur. In 55 outbreaks studied by Matson[42], only single deaths were observed in 23 while a 35 % mortality rate was reported in one outbreak. The incidence of theileriosis in Zimbabwe (Rhodesia) has remained fairly constant since 1954. An annual average of 32 outbreaks account for approximately 290 deaths per year[35]. In experimentally produced cases[43] a mortality rate of 15 % was observed which is considerably lower than that reported by Neitz[49] in experimental cases of Corridor disease.

Rhodesian theileriosis may be complicated by concurrent rhipicephaline tick toxicosis, as outbreaks generally occur when numbers of adult *R. appendiculatus* are at their peak. Laboratory evidence has also been presented by Matson to show that ehrlichiosis may aggravate this condition[42]. The exact significance of these complicating factors still needs clarification, but it is interesting that the most severe outbreak reported by Matson (35 of 100 animals died) occurred in susceptible animals recently introduced onto an infected farm. Cattle born on this property were not affected. This finding

agrees with those of De Kock et al.[22], and Thomas & Neitz[78] on Tzaneen disease (see above).

After consideration of differences in the behaviour of the parasites causing buffalo disease and Rhodesian theileriosis, and also the marked differences between the epidemiology of these diseases, Neitz[49] proposed to describe the latter as a new species *Theileria bovis*. The creation of this species did not meet with general approval, and Neitz, in a footnote to his original description of the new species chose to make it synonymous with *T. lawrencei*. Basing his opinion on the many similarities between this parasite and *T. lawrencei*, Matson[42] also proposed to identify it as *T. lawrencei* transmissible from either cattle or buffalo to cattle. More recently, Lawrence[33] demonstrated that this *Theileria* was serologically indistinguishable from *T. parva*, a fact shown by others also to hold good for *T. lawrencei* (see above). In addition, a cross-immunity exists between Rhodesian theileriosis and East Coast fever (Lawrence as cited by Matson[42]). Uilenberg et al.[81] also found the Boleni strain of Rhodesian theileriosis to be indistinguishable in the indirect fluorescent antibody test from *T. parva*. In a recent review of the taxonomy of the theilerias, Lawrence[34] proposed to call this parasite *T. parva bovis* as opposed to *T.p. parva* (true East Coast fever) and *T. parva lawrencei* (Corridor disease). Uilenberg et al.[81] referred to it as *T. parva* (*bovis* type).

Other theilerioses

Ever since Theiler[74] reported a single successful attempt to transmit *T. mutans* with *R. appendiculatus*, this tick has been considered to be the principal vector of this parasite[49]. More recent work[16 23 82 90], however, has indicated that *Amblyomma variegatum* and *Amblyomma hebraeum*, and not *R. appendiculatus*, are the vectors of classical *T. mutans*.

From earlier work it is evident that a mild *Theileria* sp., transmitted by *R. appendiculatus* and thought to be *T. mutans* at the time, was present in South Africa[22 49 51]. This fact has been borne out by the isolation in East Africa of *Theileria* sp. (Githunguri)[16], *Theileria* sp. (Mwanza) and *Theileria* sp. (Idobogo)[83]. These isolates were serologically distinct from other known bovine *Theileria* spp. but had some antigens in common with *T. parva* and *T. lawrencei*[16].

Subsequently, it was reported that cattle could be infected with *Theileria taurotragi* of the eland, *Taurotragus oryx*[89]. It was also found that this parasite cross-reacted with the Githunguri and Idobogo isolates[28 29 89]. As a result it was concluded that the bovine and eland *Theileria* spp. may be closely related and could represent a new species of *Theileria* infective for cattle[89]. Working with the Idobogo strain, Grootenhuis et al.[28] felt that it could be called *T. taurotragi* but that further studies were needed on the biology and antigenic nature of the parasites before firm conclusions could be made. Consequently, the parasite in cattle was referred to as *T.* ? *taurotragi*[81]. Recently, *Theileria* sp. (Tzaneen) was isolated in South Africa and found to be related and probably identical with *T.* ? *taurotragi* (Idobogo)[81].

Purnell[60] reviewed some of the theilerial parasites of wild animals in East Africa. Apart from *T. taurotragi* of the eland, *Theileria gorgonis* of the blue wildebeest *Connochaetes taurinus* is known to be able to develop in the salivary glands of *R. appendiculatus*.

Nairobi sheep disease

This infectious disease of sheep and goats is characterized by acute haemorrhagic gastro-enteritis and is caused by a filtrable virus transmitted primarily by *R. appendiculatus*[21 88]. It was first noticed in sheep grazing on the Nairobi commonage, Kenya, hence its name. Subsequently, it has also been found in Uganda and the Congo[91], and there is serological evidence of its presence in South Africa (FAO/OIE cited by Zahran[81]). In addition, Ganjam virus in India has recently been shown to be identical with this virus[12].

Nairobi sheep disease was the first viral disease of animals shown to be tick-transmitted[46] and it is restricted in its distribution to those areas heavily infested with *R. appendiculatus*. Other ticks such as *Rhipicephalus simus*, *Rhipicephalus pulchellus* and *Amblyomma variegatum* have also been shown to be capable of transmitting this disease but are less efficient vectors than *R. appendiculatus*.

Transmission of Nairobi sheep disease by *R. appendiculatus* is stage to stage or transovarial. When the infection is picked up by one stage it is generally retained only to the next stage; the virus appears to be confined to the salivary glands of infected ticks and it dies out during the next moult[21]. If, however, the incubation period of the disease is so short that the temperature reaction commences before the transmitting stage has finished its feed (the incubation period may be as short as 5 d but it averages 9 d, according to Montgomery[46], the same ticks can become reinfected with transmission taking place in the next instar. Nairobi sheep disease appears to be the only filtrable virus proved to be transmissible transovarially by a tick[91].

Outbreaks of this disease are usually seen in animals introduced into infested areas and the mortality rate may be 50 % or higher. Local sheep become infected during the first 12 months of life and they either die or acquire immunity. A carrier state is unknown in sheep, but unfed adult *R. appendiculatus* can remain infective for 18-24 months, nymphae for 12 months and larvae for 9 months[37]. This tick is therefore not only the main vector of this disease but also a prime reservoir.

Neitz[48] quotes Bugyaki as describing a fatal viral disease in sheep in the Kisenyi area of the former Belgian Congo. It is transmitted by adult *R. appendiculatus* and is identical with Nairobi sheep disease, except that goats are refractory.

Louping ill

This is another tick-borne viral disease of sheep and it is infective for cattle and also man. It occurs primarily in Scotland and in the north of England and is characterized by an acute to chronic encephalomyelitis with, in some cases, a high mortality[70]. The vector is *Ixodes ricinus* and transmission occurs transstadially from larvae to nymphae or nymphae to adults. Alexander & Neitz[1] showed that this disease could also be transmitted experimentally by *R. appendiculatus*. Even though louping ill has not yet been encountered in Africa, one must nevertheless assume that there is the danger of its becoming established if it were to be introduced, even in the absence of *I. ricinus*.

Bovine ehrlichiosis

Ehrlichia bovis, also known as *Rickettsia bovis*, was first reported from the north of Africa in 1936, the vec-

tor being a *Hyalomma* sp.[24]. De Kock et al.[22] saw it first in South Africa in 1937 during their observations on Tzaneen disease. *R. appendiculatus* is an efficient vector of *E. bovis* in southern Africa and transmission takes place stage to stage from nymphae to adults[42 58]. From field observations made in South Africa it appears that adult *R. appendiculatus* are often infected (A J de Vos 1979 Veterinary Research Institute, Onderstepoort, unpublished observations).

The exact significance of the presence of *E. bovis* is unknown, but severe and even fatal cases, possibly complicated by precipitating factors, have been reported by some workers in Central and West Africa[25 27 68].

In Zimbabwe, Matson[42] observed *E. bovis* during his studies on Rhodesian theileriosis. He considered this organism as a complicating factor in the pathogenesis of this disease, but did not elaborate. Norval[58] considered it to be mildly pathogenic.

Recent observations made in South Africa indicate that the organism transmitted by *R. appendiculatus* has a degenerative effect on leukocytes and thrombocytes (A J de Vos 1979 Veterinary Research Institute, Onderstepoort, unpublished observations). During the acute stage of the infection affected animals generally show a fever and appear to be more susceptible to mild theileriosis and babesiosis. In addition one experimentally infected animal developed severe haemorrhagic tendencies which led to a depression of its packed cell volume to 6 %, and in this way closely resembled a case of bovine petechial fever (*Ehrlichia ondiri* infection), as it is seen in Kenya[20].

Tick bite fever

This disease of man is known by a variety of names of which "tick bite fever" is in common use in South Africa. The cause is *Rickettsia (Dermacentroxenus) conori* which, according to Philip[59], is "essentially a domiciliary biocoenose involving dogs and *Rhipicephalus sanguineus* plus the accidental impingement of man". In Africa the epidemiology of *R. conori* variety *pijperi* involves a number of other tick species, including *R. appendiculatus*[26] and field rodents, such as *Rhabdomys* and *Otomys*, though infected dog ticks also occur in urban areas. Here, too, man is an accidental and terminal intruder in the disease cycle.

In man, this disease is characterized by a primary sore, often having a blackish necrotic centre, by regional lymphadenitis and, in most cases, by intermittent fever lasting 10-14 d. A maculopapular rash appears on the 3rd to the 5th day of illness. When profuse, the disease involves the palms of the hands and the soles of the feet[26].

Bovine babesiosis

Theiler[73] noticed a *Babesia bigemina* infection in a bull which had been experimentally infested with adult *R. appendiculatus*. He subsequently reported 3 successful attempts to transmit this parasite with adult *R. appendiculatus*, the prepatent periods of which were given as 23, 24 and 40 d[74]. Later, at an internatinal congress in The Hague, Theiler[75] incriminated only ticks of the genus *Boophilus* as vectors of *B. bigemina*, but gave no explanation.

No further research was conducted on this subject for many years and in 2 comprehensive reviews on the transmission of piroplasms, Neitz & Du Toit[54] and Neitz[48] referred only to Theiler's original work. Even in the absence of work confirming those observations, this led to the general acceptance of *R. appendiculatus* as a vector of *B. bigemina*. Purnell et al.[64], however, were unable to repeat Theiler's work, and concluded that the lengthy and variable prepatent periods reported by him may indicate that infection was due to unobserved *Boophilus decoloratus* infestations. Until such time as more evidence is produced, it must therefore be assumed that *R. appendiculatus* is not a vector of *B. bigemina* or is, at best, a very poor one.

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ABSTRACT: Colborne, J., Norval, R.A.I. & Spickett, A.M., 1981. **Ecological studies on *Ixodes (Afrixodes) matopi* Spickett, Keirans, Norval & Clifford, 1980 (Acarina: Ixodidae).** *Onderstepoort Journal of Veterinary Research*, 48, 31-35 (1981).

Ixodes (Afrixodes) matopi occurs in association with the klipspringer (*Oreotragus oreotragus*) in rocky areas in Zimbabwe. The adult ticks are specific parasites of this antelope and the immature stages feed on klipspringers, hyraxes (*Procavia capensis* and *Heterohyrax brucei*) and red rock hares (*Pronolagus crassicaudatus*). Adults are active only in the wet season and prior to feeding are found on bushes growing adjacent to rocks. The ticks aggregate on twigs which have been marked with the secretions of the preorbital glands of klipspringers. Larvae are evident in greatest numbers in the latter part of the wet season and nymphs in the cool dry season. Unfed larvae and nymphs occur predominantly on mats of humid leaf litter in the cracks and gaps between rocks, and both show well-defined patterns of daily activity.

ABSTRACT: Van Heerden, J., 1981. **The role of integumental glands in the social and mating behaviour of the hunting dog *Lycaon pictus* (Temminck, 1820).** *Onderstepoort Journal of Veterinary Research*, 48, 19-21 (1981).

The marking and mating behaviour of captive hunting dogs, *Lycaon pictus*, is described. Urine scent-marking was the most frequent marking behaviour observed, but anal dragging, body-rolling and body-rubbing were also recorded. The mating behaviour was typical of that of Canidae but the copulatory tie in this case was of very short duration. There was a dense accumulation of sebaceous glands in the praeputium and these secretions are probably important in the urine scent-making. There is no tail gland in *L. pictus*.

SHORT COMMUNICATION

KORT BERIG

AN OUTBREAK OF AFRICAN HORSESICKNESS IN DOGS

I.B.J. VAN RENSBURG*, J. DE CLERK**, H.B. GROENEWALD*** and W.S. BOTHA*

ABSTRACT: Van Rensburg I.B.J.; De Clerk J.; Groenewald H.B.; Botha W.S. **An outbreak of African horsesickness in dogs.** *Journal of the South African Veterinary Association* (1981) **52** No. 4 323-325 (En) Department of Pathology, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

Several dogs died from African horsesickness which was contracted by the consumption of uncooked meat from the carcase of a horse that had died from the disease. Respiratory embarrassment was the main clinical sign, while marked hydrothorax and pulmonary congestion and oedema were the major post mortem findings. Serotype 6 horsesickness virus was isolated from 2 of these dogs.

Key words: African horsesickness, dog.

INTRODUCTION

The susceptibility of the dog to the virus causing African horsesickness (AHS) has been well established by the work of Bevan[1], McFadyean[4], Theiler[6] and Piercy[5]. The dog can be infected by parenteral administration of the virus or by the oral route. According to the survey done by McIntosh[3] it appears that natural insect-borne transmission is very rare in the dog, if indeed it does exist. The most common way therefore that dogs become infected with this virus is through the consumption of uncooked meat derived from the carcase of a horse that has died from AHS.

The late summer of 1981 was a period during which many horses died in the Pretoria-Witwatersrand area from AHS. In one instance bones and meat from such a carcase were fed in an uncooked state to 13 dogs in a commercial breeding kennel, while some of it was also given to a friend of the owner of the horse as dog food. This was after the owner had allegedly sought veterinary advice on the soundness of such a procedure. Thirteen out of 17 dogs died within 12 days of commencement of ingesting the infective material. Two acutely ill dogs, a German Shepherd and a Schipperke from the breeding establishment were referred to the Department of Medicine, Faculty of Veterinary Science, University of Pretoria. Formalinised specimens from one of the friend's dogs were submitted to a private diagnostic histopathology practice and were examined by one of us (W.S.B.), while lung and spleen from the same case was sent to the Veterinary Research Institute, Onderstepoort for virological examination.

Both dogs admitted to the hospital of the Department of Medicine died within 24 hours despite intensive treatment and post mortem examinations were carried out. At autopsy sterile specimens from the lungs, spleen and lymph nodes were collected for virological examination from these 2 cases.

CLINICAL FINDINGS

On physical examination both dogs showed moderate fever (39,5 and 39,3 °C respectively), hyperpnoea (120 and 130/min) and mild tachycardia (150 and 120/min)†. Both patients were very depressed. They showed dyspnoea, moist rales on auscultation and the presence of white foam around the nostrils.

CLINICAL PATHOLOGICAL FINDINGS

The results of the clinical pathological examinations are summarised in Table I.

MACROSCOPICAL POST MORTEM FINDINGS

Both dogs showed a moderate generalised congestion and cyanosis. The most conspicious and significant lesion was a severe diffuse pulmonary congestion and oedema with focal areas of emphysema. In the case of the German Shepherd, the lungs also showed focal areas of early red hepatisation. On cut surface large amounts of reddish fluid exuded from the lungs while the air passages were filled with a reddish foam in each of the subjects. A hydrothorax consisting of approximately 350 ml of clear straw-coloured transudate was present in each case. This gelled upon exposure to air. The mediastinum and thymic areas were very oedematous. Some endocardial ecchymoses were present as well as a moderate dilatation of the right ventricle in each case. The mild splenomegaly and hepatomegaly observed was mainly the result of congestion.

Sterile specimens from the lungs, spleen and superficial lymph nodes were collected from each case for virological examination.

MICROSCOPICAL FINDINGS

The most prominent and significant lesions occurred in the lungs where, in the case of the German Shepherd, there was an acute serofibrinious pneumonia present with areas showing a marked protein-rich oedema while others showed a marked exudation of leukocytes into the alveoli. The reaction consisted mostly of neutrophils and macrophages. The lungs of the Schipperke as well as those of the friend's dog were severely oedematous with infiltration of small numbers of macrophages into the alveoli. The myocardium from the German Shepherd

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†The first figure given in each case refers to the Schipperke and the last to the German Shepherd.

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Table 1: CLINICAL PATHOLOGICAL RESULTS

BLOOD	SCHIPPERKE	GERMAN SHEPHERD	NORMAL
Haemoglobin conc (b-Hb) g/ℓ	205	172	120-180
Haematocrit (B-Ht)	0,53	0,46	0,37-0,55
B-Erythrocytes (B-RBC) 1 × 10^{12}/ℓ	7,87	7,35	5,5-8,5
Mean corpuscular volume (E-MCV)	68	64	60-77
B-Leukocytes (B-WBC) 1 × 10^{9}/ℓ	26,2	14,7	6-15
Differential white cell counts			
Lkc – Neutrophils (mature) – Proportion of 1	0,57	0,74	0,6-0,8
Lkc – Neutrophils (immature) – Proportion of 1	0,36	0,10	
Lkc – Lymphocytes – Proportion of 1	0,01	0,03	0,12-0,30
Lkc – Monocytes – Proportion of 1	0,06	0,13	0,03-0,10
Lkc – Eosinophils – Proportion of 1	—	—	0,02-0,10
Total serum proteins (S-TSP) g/ℓ	51,3	50,9	53-75
S – Albumin g/ℓ	20,4	22,6	25-35
S – Globulins g/ℓ	30,9	28,3	20-37
Albumin globulin ration A/G	0,66	0,8	1
S – α – Globulins g/ℓ	14,4	11,0	12,8
S – β – Globulins g/ℓ	11,0	10,5	16,8
S – γ – Globulins g/ℓ	5,5	6,8	6,0
Alanine transaminase (ALT) iu/ℓ	21	37	< 40

showed a few lymphocytes present in the interstitium between the myocardial fibres. The lymphoid follicles in the lymph nodes and spleens from all 3 cases were small and inactive while the livers, intestines and brains were congested. No significant lesions were noticed in sections of the skeletal muscles, diaphragm, pancreas, adrenals or kidneys except in the friend's dog where the latter organ showed acute tubular necrosis which was attributed to a shock reaction.

RESULTS OF THE VIROLOGICAL EXAMINATION

In all instances virus was isolated on baby hamster kidney (BHK 21) cells as well as by the intracerebral injection of a 10 % tissue suspension in buffered lactose peptone into day old mice. The isolates from the German Shepherd and the friend's dog were typed on Verocells as African horsesickness serotype 6 virus. The isolate from the Schipperke has not yet been typed.

DISCUSSION

The susceptibility of the dog to AHS has been established beyond doubt by earlier workers[1 2 4-6]. The presence of the virus was usually confirmed by injecting tissue suspensions from the dogs into susceptible horses. The virus was isolated with relative ease from the lungs, lymph nodes and spleens of the affected dogs described in this report. After experimental infection of dogs, Dardiri & Yoshiro[2] could not isolate virus from the blood of such animals although the latter developed antibodies against AHS virus.

Despite the high incidence of AHS amongst horses in the late summer of 1980-81, no cases of natural insect borne AHS were encountered in dogs in the enzootic area that we are aware of. This is in accordance with the results of the serological survey done by McIntosh[3]. One can therefore assume that dogs are naturally infected only by the consumption of infected meat. This is possibly because a high infective dose is necessary to generate the disease in the dog (B.J. Erasmus 1981 Veterinary Research Institute, Onderstepoort, personal communication). Further it should be stressed that not all dogs fed infective meat develop clinical illness as many only show a transient fever reaction. However, when dogs do become ill they develop the "pulmonary form" of the disease and, once symptoms of respiratory embarrassment have set in, the prognosis is poor, as the mortality rate is very high amongst such patients. In our outbreaks the incidence of infection and the mortality rate was very high, i.e. 13 out of 17 dogs died.

As in equine animals the pathogenesis of the severe pulmonary oedema is unknown. According to Littlejohn (Faculty of Veterinary Science, University of Pretoria, personal communication 1981) it is not a hypertension oedema but a "permeability" oedema in the horse. In this respect the clinical pathological finding of a lowered serum albumin is an interesting one. This reduction was of a sufficient degree to have influenced the osmotic balance and thus the oncotic pressure of the blood plasma in the 2 cases where this was determined. The albumin content of the oedematous fluid was not analysed, but if there is leakage of albumin into the interstitial fluid this would have aggravated the oncotic discrepancy. One could also speculate that albumin loss into the interstitial fluid may have been responsible for the hypoalbuminaemia. From this it seems logical that the therapeutical use of plasma expanders should be considered while isotonic fluid therapy should best be avoided. Electron microscopical studies on these cases were not conducted; these might have helped elucidate the question. We are of the opinion that the acute pneumonia present in the German Shepherd was due to a bacterial infection superimposed on the basic lesion of pulmonary oedema. No bacterial isolations were attempted.

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PERSONAL ENCOUNTERS WITH RABID KUDUS

Several people have experienced anxious moments when confronted by rabid kudus during the present epizootic in South West Africa. Two encounters which were reported in the Windhoek Advertiser* of 7 and 8 April 1981 are examples:

'Mrs Else Meier, 93 years old and confined to a wheelchair, was attacked and gored by a kudu at Otjiwarongo over the weekend.

'Mrs Meier and her friends of the Evangelical Lutheran Church Home for the Aged were sitting outside in the sun on Saturday morning when a kudu jumped the fence surrounding the home.

'The kudu charged at Mrs Meier in her wheelchair and gored her in the leg with one of its horns. Attempts by her friends to beat it off with walking sticks proved futile. Eventually it jumped back over the fence and was later shot by the Police.

'The seriously-injured Mrs Meier was immediately taken to the Catholic hospital for medical treatment as well as a series of anti-rabies injections.

'Early this morning a spokesman at the hospital said that Mrs Meier's condition was good considering her age, which was a drawback with such an injury. The attack by the kudu on Saturday was "terrifying" according to one of the residents of the old age home. "We were all sitting there peacefully when the kudu appeared. Things happened so fast – there was nothing we could really do and the kudu just ignored the other people and went for Mrs Meier."

'People encountering a kudu that acts uncharacteristically have been warned to be careful and not get into contact with it at all. The same goes for any other animal that acts in a strange way.'

'An apparently rabid kudu gave the Thomas family in Klein Windhoek a few very anxious moments on Sunday morning before it was shot by the Police.

'A peaceful Sunday morning was rudely disrupted for the Thomas family at about 8.30 when the kudu, foaming at the mouth entered their property in Klein Windhoek. It had come down from the hills east of Klein Windhoek River.

'They managed to get their two small dogs into the safety of the house, before they could come to any harm and spent an awkward few minutes staring at the kudu through the glass of their front door – while the buck stood on the doorstep gazing back at them.

'Mr R. Thomas then telephoned the Police.

'In the meantime, the kudu jumped over their fence into the neighbouring property. From there it returned to the riverbed.

'When a Policeman arrived, he borrowed the Dodd's rifle and put the animal out of its misery in the riverbed.

'This morning early the Windhoek Advertiser spoke to the State Veterinary Department. A spokesman for the Department said that as long as no one had come into contact with, or handled the kudu there was no danger involved.

'He mentioned that there had been a number of incidents involving rabid kudus around Windhoek, but ascribed this fact to the recent rains experienced around the city.

'Kudus, in great numbers converged on the areas that had had rain around Windhoek and, of course, this heightened the danger of transmission of rabies from a diseased animal to a healthy one.'

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ETHOLOGY AND ANIMAL WELFARE*

D.R. OSTERHOFF**

ABSTRACT: Osterhoff D.R. **Ethology and animal welfare.** *Journal of the South African Veterinary Association* (1981) **52** No. 4 327-329 (En) Department of Zootechnology, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

Much scientific information concerning animal behaviour has become available only recently and it continues to increase rapidly. There is evidence indicating that the behavioural needs of animals have sometimes been neglected when natural life-styles are replaced by artificially contrived ones. More attention to and study of animals' social and other behavioural requirements would be mutually beneficial to both man and beast. If those needs can be met more adequately, animals will be easier to handle, stress will be reduced and productivity improved.

Animal welfare legislation in different countries is mentioned and ethological research as basis for new legislation discussed. The development in this critical field of Ethology and Animal Welfare is advancing fast and the South African Veterinarian must be aware of the new movement from Animal Science to Animal Rights.

INTRODUCTION

A better title for this paper could have been "From animal science to animal rights", since the contribution deals with those aspects of animal production which reach into the shadow area of stress and disease where measures for protection and humane treatment of livestock must be applied.

During the last 20 years it has been more common to talk about livestock production instead of animal husbandry[2 5 6 7 9]. The change from husbandry to production has meant the development of problems both ethologically and ethically. For too long the goals have been on production and not on the relationship between behavioural well-being, disease and productivity[1 2 12].

Animal science has greatly advanced in animal nutrition, genetics, physiology, disease control and artificial environmental designs and control systems, but the study of the relationships between these physical and physiological variables and the animal's behaviour suffered to a great extent. In the last decade this situation has changed and a great amount of information on normal domestic animal behaviour has been collected which will aid in the treatment and prevention of abnormal behaviour and will also enable us to plan optimal artificial environments for livestock production. The term animal welfare will be widely used in this paper: What is really meant by good farm animal welfare? No attempt will be made to define the term but it will be clear that ethology studies will help us in the collection of information on the animnal's physical needs and preferences and also help us to decide on questions relating to their mental well-being[10].

Our aim should be to promote the welfare of animals and the purpose of this paper is to serve as a means of progress towards this aim and in particular the animals' welfare legislation. There is no doubt that ethological studies are needed more than ever before to provide the basis of appropriate animal welfare legislation.

ANIMAL WELFARE LEGISLATION IN DIFFERENT COUNTRIES

A very interesting reconsideration has taken place during the last 20 years and in many countries the legislations are regarded as outdated. Prof. H.H. Sambraus of the University in Munich expresses the situation in the following way: "We have to revise our thinking, no reasonable person would want to dismiss the keeping of farm animals. We need them for our alimentation. However, this fact should not deter us to see in the animal a living creature with unrestricted rights but also with obligations for us. Farm animals in industrial agricultural establishments are sentenced to inactivity and suffer extremely under boredom. As a consequence of the suppressed urge for activity we meet with behaviour problems which have to be regarded as signs of lack of well-being"[12].

It is useful to study the animal welfare legislation in Europe and then compare this with the situation in South Africa. It can be seen that "on paper" most countries have legislation which in many respects appears comparable to that in other countries. At first it would seem that all the legislation is aimed at the same objective, namely the protection of animals, but when one talks to different people on these topics it becomes obvious that one's appreciation of "what is in the animal's best interest" varies tremendously. It must be mentioned that a "Council of Europe Expert Commitee on the Protection of Animals" exists which – of course – can only make recommendations but has no power of control[3].

Three examples of European legislation will be briefly mentioned – legislation in France, Germany and Sweden.

Legislation in *France* is very confusing because it is either part of the Criminal Code or the Rural Code of which the last Decree was published in 1970[3]. Article 453 makes it an offence for any person unnecessarily, in public or otherwise, to commit an act of cruelty on a domesticated, tamed or captive animal. (Bull fights and cock fights are allowed if "an unbroken local tradition can be established"). The rules of performing experiments on living animals are especially strict and these experiments may only be performed by a person authorized for the purpose, and only if they are of such nature to throw light on unsolved scientific problems. With regard to slaughtering, all species of animals must be stunned immediately before being bled in the slaughtering process.

The *German* Animal Protection Act of 1972 is a far reaching piece of legislation.[11] The word "well-being" of the animal comes into the vocabulary and means that nobody shall cause pain, suffering or injury to any animal. It is said, furthermore, that he shall not per-

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manently restrict the needs of an animal of that species in relation to movement and exercise so that it is exposed to avoidable pain, suffering or injury. The killing of animals is regulated as well as operations on animals. The experiments on animals are also regulated. For example, it is required that at the end of an experiment an animal shall be examined by a veterinarian and the decision taken as to whether or not it shall be destroyed.

In *Sweden* the King still has the final say in animal welfare[3]. In general, it is proclaimed in the Animals Protection Act of 1944, with amendments in 1966, that housing must be adequate as regards space and cleanliness, and authority is necessary to make regulations in the interest of animal welfare. For example, horses tails may be docked only to cure disease, injury or vices and the operation must be carried out by a veterinarian. Permission from the King is required for any exemption from the above rule. No animal over the age of 2 months may have its tail docked unless by a veterinarian. Dog's ears may not be cropped. Furthermore, provision is made for the seizure of animals which have been the subject of cruelty and regulations are laid down as to what action is to be taken by the County Council. The regulations concerned with loading and transporting of animals are interesting to South Africans. For example, water is to be given to animals for journeys exceeding 5 h, and for journeys exceeding 8 h the animals are to be fed. For journeys which last overnight, animals are to be left in a sheltered place.

Special regulations cover the rearing, sale and boarding of dogs.

To summarize the European situation, one could say that a great deal of work has been carried out in a number of countries in determining parameters to reach common standards. One tries to find an objective basis which is acceptable to all who are concerned with what is "in the best interest of animals".

It is believed that every veterinarian present should know the *South African* Animal Welfare Legislation as promulgated in the Animal Protection Bill No 71 of 1962 as amended by Bill No 7 of 1972[4]. In general, one may say that the South African legislation is very vague but it is in agreement with the essential basic European legislation. We find a few odd rules like those concerning spring-traps (slagysters), or those permitting the police to kill animals under certain conditions. The penalties mentioned in the bill are also interesting: the maximum fine is R200 for any contravention of the 19 basic rules of protection. Corporal punishment may also be ordered under certain conditions. The law is also binding in South West Africa, including the Eastern Caprivi Zipfel (which is especially mentioned).

ETHOLOGICAL RESEARCH AS BASIS FOR NEW LEGISLATION

Ethology or the study of the behaviour of domestic animals is a very young branch of the big tree of biological sciences. Nevertheless Ethology is now regarded as the discipline able to provide new and better information to the legislative bodies in the developed and possibly also in the developing countries[13]. In most countries the animal welfare legislation is regarded as outdated and research is initiated in the whole field of studies of behaviour and management of animals in order to provide exact data on minimum requirements for stables and all kinds of animal housing to ensure the new "rights" mean the best possible well-being of animals. The law-makers define well-being as being a condition by which life is in complete harmony with the environment both physiologically and ethologically[13]. Disturbed body functions, bodily harm, obvious expressions of pain and suffering as well as disturbed behaviour are signs of a diminished well-being.

The big difficulty is to decide on welfare standards. To do this we first of all need to know much more about the animal's "physiological and ethological needs". Once these are established, I believe that it will solve the second part of the problem, that is, the provision of laws and other measures for the protection and humane treatment of livestock. On the international scene harmonisation and unification of legislation for the protection of animals must, of necessity, be a slow business but it seems that at least in the European countries a considerable amount of co-operation and goodwill exist towards this aim[12]. It must be pointed out, however, that one should also permit flexibility in the legislation when this is appropriate. Mandatory and inflexible legislation enacted in advance of scientific knowledge can actually inhibit the development of livestock husbandry to the detriment of animal welfare.

In recent years appeals have been heard from all over the globe for more and better research on animal behaviour. There is no doubt that a greater knowledge of the behaviour of our domestic animals will not only enrich our lives, but also provide information which will be of benefit to the producers and consumers of animal products. Information on normal domestic animal behaviour will aid in the treatment and prevention of abnormal behaviour and information on the behaviour of commonly domesticated species in a semi-natural environment will enable us to plan optimal artificial environments for livestock production.

The veterinarian's role in all these new investigations and observations is obvious because the disease panorama in cattle, pigs and poultry during the last decades has shown considerable changes. The frequency of environmentally evoked diseases has increased while others have decreased. The increase in environmentally evoked diseases is mainly due to the changed relationships between the animals and their environments. Environmentally evoked diseases – the so called man-made diseases such as mastitis, very often due to traumatic injuries to the udders in unsuitable stables, or tail biting in pigs which is often found in barren environments, or "cannibalism" in battery-hens, or abnormal licking or playing with the tongue or abnormal biting especially in young stock – requires some new methods of combat in veterinary medicine which in turn requires new knowledge, not least of which are changes in behaviour which are symptoms of stress. The increasing possibilities for successful therapy of the already sick animal or group of animals should, of course be utilized and developed, but in order to effectively combat disease, the veterinarians must be able to utilize new preventive methods. Efforts must be made at regional or even national level in order to prevent disease effectively. In some countries the prevention of environmentally evoked disease has been rendered more effective by the fact that all plans and drawings for new constructions or alterations of animal pens must be presented to and approved by veterinarians specializing in animal hygiene or animal ethology. The assessments made so far indicate that this way of fighting disease has been successful.

SUMMARY

Several aspects of Ethology and Animal Welfare in general are mentioned.

The development in this field is advancing tremendously and the South African Veterinarian must be aware of this new movement from Animal Science to Animal Rights.

Professor George Heuse, the Founder and first President of the International League for Animal Rights found considerable claim in the animal protection movement of his Declaration of the Rights of the Animals in 1978, of which only the first and last articles will be given[8]:

Article 1

All animals are born with an equal claim on life and the same rights to existence.

Article 14

(1) Representatives of movements that defend animal rights should have an effective voice at all levels of government.
(2) The rights of animals, like human rights, should enjoy the protection of law.

Finally, it is of great interest to all South Africans – not only the animal scientists or husbandry men, what can be expected in the future in connection with the closing of the gap between the ethical imperative and the economic reality[8]. Possibly the new wind of changes is blowing too forcefully, but – if all aspirations of the well-doers are fulfilled for the animals – the year 2000 might look like this:

(1) Free-living animals – eventually to be effectively protected by a globally accepted convention;
(2) Captive wild animals – no longer suffering in outdated zoos;
(3) Farm animals – to be accommodated in facilities meeting their natural needs and to be properly stunned prior to slaughter, with the transport of carcasses preferred to that of live animals;
(4) Pets – to be well cared for by responsible owners; animal shelters to be publically supported and operated, and where euthanasia will be accomplished by humane methods; population control to be achieved by non-surgical methods in municipal spay and neuter clinics;
(5) Marine mammals – as a result of international public and governmental pressure, no longer to be massacred;
(6) Animals exploited for mere profit or amusement – the fur industry to find itself without customers after prohibition of sealing and of trapping of or farming with fur-bearing animals or subsequent to import bans on pelts; culinary delicacies at the price of cruelty to be withdrawn from markets; animals no longer to be victimized in blood sports, circuses, rodeos, dolphinaria, etc.;
(7) Laboratory animals – to be replaced by alternative, non-sentient techniques; classroom experiments and demonstrations with animals to be strictly limited; and
(8) Animal rights – to be widely recognized, with a Universal Charter globally accepted.

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AAN DIE REDAKSIE **TO THE EDITOR**

DIE VEEARTS, TROETELDIERE EN PSIGOTERAPIE

Die rol van die troeteldier-veearts in sy gemeenskap word moontlik ver onderskat. Hy staan soms onder fel kritiek alsou hy slégs daarop uit wees om 'n goeie inkomste te verdien. Ons twyfel sterk of sodanige materialisme as die oorheersende dryfveer by enige troeteldierveearts teenwoordig is. Aan die anderkant word die troeteldier-veearts se werklike bydrae tot die gemeenskap, sy ware roeping en diens aan sy medemens nie altyd na waarde geskat nie. Ons wil beweer dat die troeteldier-veearts in die moderne ontwikkelde gemeenskap selfs onontbeerlik geword het vir die mense wat hy bedien.

Daar word dikwels spottenderwys gesê dat die veearts wie se praktyk hoofsaaklik uit die behandeling van troeteldiere bestaan, 'n kwasie-sielkundige behoort te wees. Alhoewel hierdie soort stellings meestal ligtelik opgeneem word, glo ons dat daar tog waarheid in kan steek. Daar bestaan geen twyfel dat die troeteldier 'n besonder belangrike plek in veral ons stadssamelewing inneem nie.

Daar is 2 hoof faktore wat aangevoer kan word as oorsaak van hierdie toestand. Hierdie aanleidende faktore word as agtergrond gebruik om sommige van die troeteldiereienaars se besoeke aan die veearts te kategoriseer. Laastens volg 'n kort opsomming van publikasies wat handel oor die rol van troetediere in psigoterapie.

Die eerste faktor wat 'n behoefte aan troeteldiere laat ontstaan, is die intermenslike verhoudinge in die hoogs gespesialiseerde en kompeterende lewe wat veral in die gejaagde stadslewe, ten volle manifesteer. Alhoewel almal skynbaar jaag na die boonste sport in elke onderskeie lewenssfeer, is daar per slot van sake in die meeste gevalle, slegs een bestuurder in die fabriek, net een voorsitter van die direksie, net een kaptein van die span of net een voorman van 'n groep werkers. Op die pad na een man se sukses, bly daar dus 'n hele aantal verydelde pogings agter van andere wat ook probeer. Selfs die bereiking van die boonste sport is nie altyd sonder frustrasie en spanning nie aangesien dit meer verantwoordelikhede meebring. Menige mense moes al agterkom dat die voorsitterstoel hard is om op te sit. 'n Mens kan in die algemeen konstateer dat die moderne stadssamelewing, soos dit daagliks voor ons oë afspeel, noodwendig ontladings van spanning en stremminge vereis. Dit is onnodig om op hierdie oorbekende tema te veel te borduur. Die feit bly staan dat hierdie gemeenskapspanninge dikwels sy ontlading tuis vind. Ouers teenoormekaar, ouers teenoor kinders, kinders teenoor ouers en kinders onder mekaar is almal verhoudinge wat vertroebel kan word indien ontading nie ook op ander wyses kan geskied nie. Vertroebelde menseverhoudinge ontstaan nie noodwendig slegs in 'n volledige huisgesin nie. Hier word gedink aan verwaarloosde kinders sonder versorgende ouers, vereensaamde oumense wat nie meer deur familie besoek word nie, kinderlose ouerpare wat nie 'n volle huisgesin kan of wil hê nie en alleenlopendes van alle soorte. Waar menslike verhoudinge, weens watter oorsaak ookal, versteur is, kan troeteldiere 'n belangrike rol speel as ontladingsvoorwerp. Met die troeteldiere kan 'n ander tipe verhouding ontwikkel word volgens die wil en wense van die vertroebelde mens. Selfs by huisgesinne wat dikwels verhuis of ouers wat baie uithuisig is, is die troeteldier vir die kind soms die enigste lewende konstante faktor.

Die tweede faktor wat 'n behoefte aan troeteldiere laat ontstaan, is die omgewing waarin hierdie stadsgemeenskap se aktiwiteite hom afspeel. Die ontwikkeling van groot stede en die ontvolking van die platteland het 'n wêreldwye tendens geword. Alhoewel die stadsomgewing talle voordele het, bring so 'n "miershoop" van mense ook sy stremminge as omgewing na vore. Skielik word 'n groot deel van die mens se vryhede hom ontneem en moet hy talle ander mense naby hom in ag neem. 'n Hele aantal nuwe reëls en regulasies word tot die daaglikse verpligtinge van die mens bygevoeg. In die hele proses van verstedeliking met kunsmatigheid en natuursurrogate ontstaan daar dan 'n "behoeftespanning" deurdat die noue skakel met die natuur grootliks verbreek word. Dit is miskien onnodig om voorbeelde te noem maar kom ons noem net weer enkele gebroke skakels: In plaas daarvan dat ons direk met die grond in kontak kom, beweeg ons op teerpaaie en sementplaveisels; ons plant nie meer groente en vrugtebome nie, maar kry dit klaar behandel teen insekte en netjies in plastiek verpak by supermarkte; ons verloor kontak met plaasdiere deurdat ons kotelette en T-bene by die huis afgelewer kry, toegedraai in bruin papier en al, en ons melk kom in steriele bottels. Ons stadskinders weet min van speensalf, spantoue en emmerskop, ons vervoer is nie meer te perd of perdekar nie maar met haastige metaalvoertuie (miskien tog met skaapvel wat by die motorhawe gekoop is oor die sitplek); die lug is soggens ook nie meer vars nie want ons stik in die rook en brandstofgasse van die vroeë oggend; selfs die sonlig is nie meer vir almal beskore nie aangesien hoë geboue permanente donker skadus in die betonoerwoud gooi, die sterre is ook nie meer so duidelik nie omdat talle kunsliggies die oë verdof; ons let nie meer op die wolke nie, want water is 'n handdraai ver – en so kan mens aanhou en aanhou.

'n Gejaagde stadslewe wat nadelige menseverhoudinge tot gevolg kan hê en die verwydering van die natuur is dan moontlik die twee belangrikste faktore wat aanleiding gee tot die aanhou van troeteldiere.

Omdat troeteldiere as lewende wesens maklik liefde kan gee sonder om ingewikkelde verhoudinge te bewerkstellig en sonder om eise aan die eienaar te stel soos sy medemens dit sou doen, kan die eienaar baie van sy stremminge herlei deur aanraking van sy troeteldier. As voorbeeld om so 'n spanningsontlading te illustreer, was daar eenkeer 'n tekenprentjie met die volgende strekking: Die baas by die werk skree op die werknemer, die werknemer kom by die huis en skree op sy vrou, die

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vrou kry die seuntjie in die hande en skree op die kind, die seuntjie gaan na sy hond en skop die hond. Die onderskrif van die prentjie: Deurgegee.

Wat die gebroke skakel met die natuur betref is die troeteldier die ideale voorwerp om iets van hierdie verlore kontak te herstel. Baie moderne mense is so kiembewus dat hulle werklik in die waan leef dat hulle in 'n steriele omgewing beweeg en dat enige bron wat hierdie steriele omgewing kan besoedel, onmiddellik van die aardbol verwyder moet word. Vir sulke mense is van al die bedreiginge troeteldiere feitlik die nr. 1 oortreder. Die feit bly staan dat die hond alreeds tienduisend jaar intiem met die bestaan van die mens verbind is en daar is geen aanduiding dat hierdie tydlose simbiose verbreek gaan word nie. Dit is nie waar dat 'n mens die belangrikheid van higiëne onderskat nie, maar valse verwagtinge t.o.v. higiëne moet in perspektief gestel word en die klem moet op gebalanseerdheid en realisme geplaas woprd. In hierdie opsig kan troeteldiere baie help om die balans te herstel deur weer 'n noue skakel terug na die natuur te vorm. Korrekte versorging van troeteldiere kan kennis en begrip by die eienaar tuisbring oor 'n realistiese beskouing van higiëne. Die teenwoordigheid van 'n troeteldier kan selfs die handhawing en toepassing van gesonde higiëne versterk. Baie troeteldiere verskaf aan hulle eienaars ook fisiese beweging en selfs gereelde oefening, aangesien baie mense opsien om alleen te gaan stap of draf. Die troeteldier is hier die altyd-gewillige metgesel. Soos hieruit blyk, dra die troeteldier nie net by tot die mens se beter gees nie, maar kan ook fisies 'n bydrae lewer ten opsigte van 'n beter begrip van higiëne en gesondheid.

Met hierdie paar gedagtes as agtergrond wil ons nou die onvermydelike kontakpunt tussen veearts, kliënt en troeteldier bymekaar bring. Ons het reeds gesien hoe die twee hooffaktore naamlik lewensomstandighede en lewensomgewing bydra tot 'n basiese behoefte aan troeteldiere en dat die mens troeteldiere terwille van homself aanhou. As ons hierby voeg dat die veearts sy dienste primêr aan die mens aanbied, dan kan 'n mens goed begryp dat die troeteldier self, soms op die agtergrond kan raak en dat die veearts se kontak met sy kliënt, 'n "sielkundige" ontmoeting kan word. Ons sien hierdie sielkundige aspek dikwels in gewone praktyk waar antropomorfisme 'n wesenlike dee van die eienaar/troeteldier verhouding geword het. Voorbeelde is volop soos: "hy is soos 'n kind in die huis", verf van toonnaels en strikke in die hare, selfs 'n omnivore dieet vir 'n karnivoor(?); gesprekke met diere soos met 'n medemens en baie ander voorbveelde. Antropomorfisme kan by troeteldiere 'n onderwerp op sigself wees. Die eienaar se behoeftes kan op die troeteldier geprojekteer word en die vermeende menslike behoeftes kan as ware behoeftes van die troeteldiere gesien word. Hierdie tipe konsultasies kom voor as 'n deel van die eienaar se spanningsontlading waarvoor hy sy troeteldiere gebruik.

Daar is natuurlik ook die normale omsien na en versorging van die troeteldier. As diere met werklike behoefte aan veeartsenykundige hulp na die veearts gebring word, kan 'n mens hierdie tipe konsultasies in verband bring met die eienaar se skakel met die natuur, nl. die verantwoordelike versorging van sy dier wat hieruit voortspruit. Dieselfde eienaar kan in beide kategorieë met afsonderlike besoeke ingedeel word. Wat ons hiermee wil sê is dat die eienaar wat gewoonlik 'n "sielkundige besoek" aan die veearts bring, ook per geleentheid sal aanmeld as die dier werklike siektes/beserings het. Dit sluit nie uit dat die eienaar wat gewoonlik sy troeteldier vir werklike versorging na die veearts bring nie ook per geleentheid 'n "sielkundige besoek" aan die veearts kan bring nie. Die troeteldier is in elk geval altyd beskikbaar indien die eienaar sou voel dat hy die troeteldier wil gebruik as ontladingsvoorwerp en dit sluit besoeke aan die veearts in.

Die veearts behoort simpatiek teenoor beide kategorieë te staan omdat hy primêr sy dienste aan die mens lewer – hy werk vir mense maar met diere. Die veearts sal sy rol as diereklinikus sowel as "menssielkundige" behoort te kan vervul. Alhoewel die sielkundige aspek van die veearts in privaatpraktyk vir sommige veartse aanvanklik 'n skok en selfs 'n irritasie is, lei dit geen twyfel dat dit 'n wesenlike deel van die praktyk uitmaak en dat hierdie aspek deeglik in ag geneem moet word nie. 'n Veearts wat die sielikundige aspek van sy praktyk minderwaardig ag, ignoreer of nie kan identifiseer nie, lewer nie sy volle, regmatige diens aan sy gemeenskap nie. So 'n veearts het dalk nog nooit begryp dat sy kliënte vir wie hy werk ten volle mens is nie – hy het dalk slegs teen sy dierepasiënte vasgekyk. Die deel van die gemeenskap wat troeteldiere as ontladingsvoorwerp aanhou, het die simpatieke benadering van die veearts baie nodig. Sommige kliënte sal allerlei klagtetjies op sy troeteldier projekteer wat spesifiek kan lei tot 'n besoek aan die veearts. Hierdie klagtes kan die dekmantel wees om die eienaar se eie skuldgevoelens, verworpenheid, eensaamheid, gebrek aan kommunikasie of frustrasie te gelei. Indien sulke sielkundige besoeke geïdentifiseer kan word, moet die veearts nie net aan sy kliënt se menslike behoeftes dink nie maar ook aan die sg. "dierepasiënt". "Behandeling" moet nie die dier benadeel net om die eienaar tevrede te stel nie. 'n Veearts kan soms net nie aan al die versoeke en klagtes van die kliënt voldoen nie, veral as die kliniese ondersoek geen abnormaliteite toon nie. Die veearts behoort hier sy weg takties tussen fantasie en werklikheid te vind sodat beide kliënt en dier nie benadeel word nie. Troosmiddels kan dalk hier 'n belangrike rol speel.

Voor mens die gedagte van die gebruik van troosmiddels as hulpmiddel net so laat, moet hier 'n ernstige waarskuwing gerig word. Troosmiddels kan beslis nie deel uitmaak van elke dag se praktyk nie. Hulle mag nie gebruik word indien die pasiënt nie baie deeglik ondersoek is nie en mag net aangewend word indien die veearts die kliënt en pasiënt oor 'n geruime tyd in konsultasies en ondersoeke in sy spreekkamer gehad het. Etiek moet die veearts so lei dat troosmiddels nooit misbruik word nie. Dit moet as hoë uitsondering slegs tot voordeel van die pasiënt aangewend word.

Onder veeartse staan kliënte wat chronies van sielkundige besoeke gebruik maak, gewoonlik as "neurotiese kliënte" bekend. 'n Mens moet onthou dat alle mense nie ewe goed van spanning kan ontslae raak nie en dat sekere troeteldier eienaars noodwendig meer projeksies op hulle diere sal oordra en dus meer sielkundige besoeke aan die veearts sal bring. Dit kan 'n moeilik hanteerbare las op die veearts laai. 'n Veearts moet dus geduldig maar ook ferm wees. Die veearts behoort simpatiek op te tree sonder om die neuroses aan te moedig. Indien die veearts nie ook ferm optree nie, kan so 'n kliënt later die praktyksroetine versteur. So 'n toestand moet ten alle koste vermy word omdat dit weer ander kliënte kan benadeel. Die sogenaamde "neurotiese kliënt" moet as deel van normale privaatpraktyk aanvaar word en ook as deel van die gemeenskapsdiens wat

die veearts lewer. Ons meen dat kliënte ook soms besoeke aan veeartse bring om ontlading deur sy dier se probleme te verkry, op só 'n subtiele manier dat niemand hulle as neuroties sal beskryf nie. So 'n besoek kan selfs as 'n onderbewuste daad gedoen word sodat die eienaar self nie altyd bewus is dat hy sy troeteldier gebruik nie. Die veearts se rol en bydrae tot die sielkundige aspek van sy praktyk is dus beslis nie beperk tot die uitgesproke neurotiese kliënte nie.

Ons het tot dusver besin oor die rol van die veearts ten opsigte van die sielkundige aspek van privaatpraktyk maar hoe opgewasse is die veearts vir hierdie taak? Word hierdie aspek op 'n ondubelsinnige wyse tydens sy opleiding uitgewys? Word sy vermoëns en hantering van mense direk getoets? Of word daar nog steeds slegs op 'n lighartige basis onder ons na die sogenaamde neurotiese kliënt verwys of word die kliënt sélf afgejak? Hou ons nie 'n lae profiel oor hierdie belangrike aspek van ons daaglikse praktyk omdat ons dit nie altyd as deel van ons taak wil aanvaar nie? En hoekom wil ons dit nie aanvaar nie? Moontlik weens gebrekkige opleiding, moontlik omdat ons dit nog nooit as deel van ons gemeenskapsdiens ingesien het nie, moontlik omdat ons glo dat "sielkunde" totaal buite ons veld lê.

Die veearts se professionele diens word aan die mens gelewer en waar die troeteldier in ons moderne samelewing 'n al hoe belangriker spanningsontladingsvoorwerp word, sal die veearts nie van sy verantwoordelikheid in hierdie opsig kan ontsnap nie.

Om die redenasie te ondersteun kyk ons laastens na wat die professionele, toegepaste sielkunde sê oor die gebruik van troeteldiere in psigoterapie asook die rol van troeteldiere tuis. Ons het 'n beperkte literatuurstudie gedoen en hou vervolgens 'n paar direkte aanhalings uit die volgende publikasies voor:

PETS AND ENVIRONMENT – B.M. Levinson[1]

"Because change is an ever-accelerating process, the conditions of our environment have become transformed. Our children are growing up in a very different world from the one in which we matured. Consequently, our children are different from what we were at their age. They live under severe new stresses. Their needs and their drives are expressed in ways that may seem strange to us. To cope with the complex problems of the late twentieth century, many of them will need help. Although we can never train enough mental hygiene professionals to fill the increasing need, there is an alternative solution that already may have occured to this audience. We are becoming ever more aware that animal companions can perform a competent therapeutic role for our seriously alienated youth.

The Childhood Environment

Being close to nature and associating with animals is a basic human need. In the childhood of mankind, people solved many of their problems by observing and learning from nature.

Preparation for Parenthood

Learning how to take care of a pet, by tolerating inevitable messes created by the pet; learning to tolerate the hair sheddings of the dog or the clawing up of the furniture by the cat; learning to tolerate and overlook the extra work caused by the pet can help prepare the prospective parent for baby's messes. Enjoying the care of the pet can help parents enjoy the infant. Feeling confidence in one's ability to care for a pet can give a parent assurance in the handling and care of the neonate. The mother, at this point, will be prepared psychologically to welcome the infant and to provide it with the necessary sensory stimulation. The infant will feel more accepted when he is born and he will develop an unconscious feeling that the world is a worthwhile and desirable place in which to live.

Early Experience

The establishment and strengthening of body contact and sensory stimulation are important for the child's subsequent development.

If the infant at this point secures the needed contact, comfort from the mother or mother substitute, he intuitively perceives the world as secure, makes tentative groping steps to leave his shell and to see himself as an individual in his own right. He develops positive feelings toward people and is on the road to an adequate social and emotional development.

However, in homes were the child gets perfunctory care because the nurturing parent is absent, or in institutions where the child is exposed to routine indifferent regimes because of a frequently changing unconcerned staff, there is need for a soft cuddly succouring presence to enable him to meet his first developmental task. Specially trained animal companions can partly fill the void left by missing parents. These animals serve as transitional objects.

Infancy to 7 years: In testing his new found powers of locomoton, the child finds that certain territories are "taboo". In this predicament, under the protective guidance of a large pet whom the child sees as an ally, the child can safely assert himself and say "No".

The unknown is frightening. Having a pet as a protector helps the child become more independent and assertive and encourages the child to explore otherwise frightening objects. This provides experiences which will make the youngster aware and confident of himself. Toilet training is the next difficult developmental task. By observing that when the pet has a similar mishap the pet is scolded but yet accepted, the child feels that he too is loved. This will tend to restore the child's confidence in himself.

Reality and Imagination

The very young child usually plays alone. He imitates the activities of important persons in his life, mimics them and punishes or praises the pet. The child is able through this imaginative play to get rid of some of his tensions, frustrations, fears and hostilities. The pet thus plays a salutary role in the emotional development of the child.

Through the reciprocal love between a child and his pet, the child becomes reality oriented and feels that he is not isolated from the universe. He begins to trust the real world.

Shared Problems and Emotions

Since showing affection for a pet is not considered demeaning or unmanly in our society, the child can openly and freely kiss and fondle the pet without anyone thinking something is wrong. This ability to express his love

openly and freely may later be transferred to a human being.

Sibling Substitute

The child may be psychologically an only child who is over-protected and smothered with love. He may become egoistic, sensitive, unsocial and unduly dependent upon his parents (Anthony & Benedek 1970). Occasionally, a pet provides the only meaningful companionship for the "nuclear" child. Removing the pet may leave the door open to loneliness, emotional conflicts and even emotional disorder. A pet may thus become a sibling substitute.

Responsibility

A development task can be accomplished more easily when a child assumes responsibility for the care of a pet. When a child assumes responsibility for a pet, he becomes more responsible for himself. He can try himself out safely in his relationship with the pet. He learns what he can and what he cannot do.

Child Substitute

The child's ability to be on his own and to care for himself, sometimes creates a critical situation for the mother who may feel that nobody wants her any more and that life's work is done. To avoid a depression she may hold on for dear life to her child whom she sees as an extension of herself and not permit him to become self-sufficient, retarding his emotional growth and the development of a strong ego. If, at this point, the mother herself has a pet that she can baby, a pet that will continue to be small and dependent upon her when the other members of the family leave, she will be able to maintain her emotional poise.

Learning

One of the most complex areas of development and growth is learning how to learn. Accompanied by his pet, the child finds transition to school and school routines easier.

Sexual Awareness

Eventually the child must acquire a positive attitude and accept sexual identity and sex activities as normal and natural. Pets lead the child to see sex not as sinful and repugnant, but as a natural expression of life.

Fear

The child also has to learn how to overcome fears of animals and of the outdoors. An active pet will help a child acquire a host of pleasant experiences with animals and with nature.

Companionship

No matter how bright, the child, if he finds the school-appointed tasks increasingly difficult, may develop many self-doubts, think that he is stupid and become resentful of his siblings, parents, school and life itself. A priceless asset in this situation is a pet who can listen and not condemn, who can be trusted, who will not betray his confidences; a pet on whose shoulders he can cry himself to sleep.

Death

Death is an object of great concern to the child and he finds it difficult to accept the death even of a pet. If the family accepts the pet's death as a common loss or a common critical situation and the family mourns together for the loss, it will lessen the child's grief, helplessness, anger, hostility, and fear and teach him that sharing the feelings of loss with someone will tend to decrease the feelings of guilt. Some time later the pet may be replaced and the child may transfer the love he had for one pet to another. This unconsciously teaches the child the continuity of life.

Conclusion

Regardless of the differences in our points of view, I am sure that the majority of the people in this audience as well as my professional colleagues, would agree that our precious twentieth-century youngsters will probably mature in a chaotic, disturbed environment. If we have a therapeutic tool such as the use of pets as a mental hygiene adjunct, it behoves us to explore and develop fully the possibilities of this adjunct. If we do not, we as adults must take full responsibility for the consequences of our neglect."

In hierdie eerste artikel word ook na die veranderde lewensomstandighede en omgewing verwys. Die troeteldier word uitgewys as 'n belangrike psigiese geleier waardeur hierdie lewensveranderinge makliker beleef word. Die skrywer se strekking word sterk beklemtoon in die laaste twee sinne van die konklusie. Die troeteldierveearts sal hom moet vergewis van hierdie belangrike rol van troeteldiere vir sy kliënte.

PET-OWNER RELATIONS – M.W. Fox[2]

"Changing relationships and Human needs"

We do know that human relationships are now changing – young people are not having any children themselves or are delaying having children until a number of years after their marriage. We know, too, that senior citizens, retired people, widows and widowers whose offspring might now be living many miles away, also have a need for a close companion, be it cat, dog, fish or parakeet. It is not only the patterns of human social life that have changed over the past 20 to 30 years, but also human needs as well. The need for companionship, for example, is exaggerated when families are separated and when people are lonely and alienated in a depersonalizing urban environment. The more dependent the pet is for some owners, the more fulfilling it is as a companion or as a child substitute. It is this dependency, however, that opens the doors to a number of psychosomatic and psychogenic emotional disorders which, as we shall see, are analogous to those described by child psychiatrists. I believe, therefore, that the incidence of some of these disorders will increase and that the veterinarian in small animal practice will have to be on the look-out for such disorders in the near future, if not today.

Other critics say that to attribute a dog with human-like emotions and needs is to be unscientific and anthropomorphic. Research has shown, however, that the developing brain of the dog, its unfolding pattern of socialization and other critical and sensitive periods during development are very similar, and sometimes identical, to the same phenomena recognized in the human infant, although they develop on a different time base (Fox 1971b). The dog has basically the same limbic or emo-

tional structures capable of generating specific feelings or affects reflected in overt emotional reactions and also in changes in sympathetic and parasympathetic activity which are linked with psychosomatic and emotional disorders. Add to this common neural substrate between dog and human infant the important variable of attachment which is a consequence of socialization, as between dog and owner and child and parent, then we should not be surprised that both dog and child under certain conditions may develop analogous or homologous behaviour disorders. These can range (Fox 1968) from psychogenic epilepsy to asthma-like conditions, compulsive eating, sympathy lameness, hypermotility of the intestines with haemorrhagic gastro-enteritis, possibly ulcerative colitis, not to mention sibling rivalry, extreme sibling rivalry, extreme jealousy, aggression and depression and refusal to eat food (anorexia nervosa).

Types of relationships

The following is an arbitrary classification of various types of relationships which may be established between the owner and the dog. The first and most general one is simply companionship. The pet fulfils the social need in the owner for company and vice versa.

Another relationship with a dog is simply one of a working relationship where the dog is employed as a guard, as a guide, or is used for work such as herding sheep, driving cattle, or for sport, such as a gun dog or a fox hound. The use of the dog as a guard is very much on the increase today. People living in suburbia are increasingly paranoid about crime and violence and will buy a dog such as a Doberman Pinscher or German Shepherd that they will have attack-trained.

More recently dogs have been used as canine co-therapists by clinical psychologists utilizing the dog as a therapeutic bridge with the patient.

For a person living in the city, his dog or cat may be the only link that he has with something authentic. He plays a game in the corporate world, he has a role, he is part of the anonymous machine, he goes home to his family from which he may or may not be estranged, but always there is an accepting dog. For the young bachelor man or woman or lonely widow coming home to an animal can give not only a sense of identity but a sense of belonging. I know of more than one person in New York city who has 3 or 4 dogs or cats in a small apartment. A person returning home to such a social group literally has another world, another reality in which he may feel he has a more meaningful and integral role to play.

Some consequences of pet-owner relationships

Many people are unaware that having a dog entails a great deal of responsibility. It not only needs attention and affection, but it needs discipline when it is young in order to become a socially well adjusted and well integrated member of the family.

It is the close symbiotic relationship between dog and owner that can be the foundation for a number of emotional and psychosomatic disorders. For example, the dog that is over-indulged and is raised literally as a child substitute may develop a variety of behavioural abnormalities when its relationship with the owner is threatened – as by the birth of a child, by the introduction of another pet, cat or dog into the household or by the arrival of house guests. Separation from the owner due to the owner being sick or the dog being boarded when the owner goes on vacation can similarly trigger behavioural pathologies.

The overindulged dog may also be underdisciplined and when it reaches full sexual maturity it will behave like a socially maladjusted "canine delinquent". It is important for the veterinary surgeon to establish his dominance over such a dog and it might be discreetly done in the absence of the owner.

The real crux of the problem is that the close symbiotic relationship can be the genesis of a number of dependency disorders in the dog which can be expressed behaviourally or psychologically and somatically.

Fritz Perls, the founder of the human Gestalt therapy, and other clinical psychologists observe that it is dependency and the fear of rejection in man that is the cause of most emotional disorders.

I feel that many people who need a dog are dependent, they tend to be 'other-directed' and they gain considerable emotional satisfaction from having a dependent companion in their lives. However, more independent, 'inner-directed' people will keep a cat in preference to a dog simply for its aesthetic qualities and its less demanding attitude. The breed of dog that a person owns may be a projection of deeper need and identifications. An insecure or paranoid person may want a powerful guard dog. Another person who is attempting to live up to an ego image of grace and agility may keep an Afghan Hound or a Saluki. It is primarily because of these reasons that the pet often resembles the owner – it is something more than mere coincidence.

Today many breeds have been bred for show and selection is based on looks rather than upon temperament. It is important, therefore, that a potential owner be advised as to the suitability of a certain breed that he feels that he would like. Such 'adoption counselling' would be a great service to the owner.

Against a background of controlled experimental research and scattering of cilincal case histories, we are beginning to understand more completely how domestication and socialization influence the behaviour of man's closest companion, the dog. Such awareness will, I hope, not only improve future relationship between pet and owner but also the relationships between human beings in general.

Man is not dog's best friend because he has made the dog in his own image. He has projected his needs for freedom, virility strength and courage onto his dog and finds support in it for other needs, companionship, status, affection and a child substitute. But dogs have needs too. Only when man learns to see the dog for what it is and himself for what he is, can he free his dog from some of the frustrations of the modern world (Fox 1974b).

Hierdie skrywer wys weereens op die veranderde samelewingsmilieu. Hy maak interessante waarnemings ten opsigte van die troeteldier-eienaar verhouding. Fox lê ook klem, as mens dit so kan stel, op die troeteldier se kant van die saak. Die laaste paragraaf lig die behoefte van die mens aan die troeteldier uit, sonder om die behoeftes van die troeteldier te verontagsaam. Die veearts wat by uitnemendheid opgelei is om na die spesiale behoeftes van troeteldiere om te sien, behoort sy kliënte hieromtrent te kan inlig, terwyl hy terselfdertyd die behoeftes van sy kliënt probeer verstaan en respekteer.

PETS PSYCHOTHERAPY: USE OF HOUSEHOLD PETS IN THE TREATMENT OF BEHAVIOUR DISORDER IN CHILDHOOD – B.M. Levinson[3]

"Pets may be used in two ways by a therapist. In one case, the pet may be used as an aide by the clinician in his office. As a matter of fact, it was through the role played by my dog "Jingles" with some of my patients that I first became aware of his usefulness.

Another way of using a pet in therapy is the introduction of the pet into the home situation. With centrifugal social forces rampant in our society today, members of the family often become alienated. The presence of the emotionally disturbed child may be a storm warning of something amiss; he may be the exploded safety valve indication that very hot fires are burning under the seemingly quiet and placid surface of family living. A child in such a family must have constant support. He is the hostage of fortune. He cannot get up and leave an intolerable situation. He cannot divorce his parents, nor can he prevent a divorce by his parents – which he so much fears. Whether there actually is an estrangement in the family or whether the family is intact, a pet may act as a source of constant support. For the child who is afraid to go to school because his parents may leave (as each has loudly threatened to do in his presence), a pet will offer constant solace and will be there to greet the child with unconditional joy and warmth.

We at present have only the remotest awareness of the therapeutic implications. Do we possibly have in pet therapy a tool which permits us to examine at great length and under magnification the elusive something which promotes emotional healing? I believe we do. The possibilities for research are great."

In hierdie publikasie word die rol van troeteldiere uitgebrei tot psigoterapeutiese hulp. Wat hier van belang is, is dat die troeteldier nie slegs in die psigoterapeut se konsultasie kamer gebruik word nie, maar ook as voorgeskrewe hulpmiddel tuis. Die veearts wie so 'n troeteldier moet behandel en wel so 'n troeteldier se eienaar as kliënt aanvaar, vind hom midde in ons tema – die veearts, troeteldiere en psigoterapie.

SOME RECENT WORK ON THE PSYCHOTHERAPEUTIC VALUE OF CAGE BIRDS WITH OLD PEOPLE – R.A. Mugford and J.G. M'Comisky[4]

"Summary:

While the therapeutic value of pet animals has been investigated in a number of clinical psychiatric settings, little attention has been paid to the psychosocial role of pets as companions in the home environment. A pilot study was designed to investigate the effects of budgerigar or house plant companionship on the social attitudes, mental health and the happiness of old people living alone.

Quantitative experimentation in this area proved to be a feasible proposition, though careful controls are necessary and considerable loss in subject numbers can be expected. The presence of budgerigars generally had a beneficial effect on the social and psychosocial conditions of the old people in the experiment. All subjects became enthusiastic owners of their budgerigars."

Net soos in die vorige artikel word troeteldiere se psigoterapeutiese waarde tuis beoordeel, en weereens beklemtoon so 'n ondersoek ons tema.

HUMANS AND PETS AND ATTACHMENT – E.K. Rynearson[5]

"The bond between human and pet depends on their commanility as animals and their mutual need for attachment. Under abnormal circumstances of developmental frustration a human may displace an overdetermined need for attachment to the pet. The attachment relationship is pathological because of its defensive purpose, and its interruption can create enduring psychiatric reactions.

'What is man without beasts? If all the beasts were gone, men would die from great loneliness of spirit, for whatever happens to the beast also happens to man. All things are connected. Whatever befalls the earth befalls the son of earth'. (Chief Sealth of the Duwamish Tribe, State of Washington, Letter to the President of the United States, 1855.)

This paper will suggest that the bond between human and pet pivots on their commonality as animals; therefore, this interaction must be viewed as biological as well as psychiatric.

Attachment is of crucial importance in social animal species. '. . . attachment behaviour is conceived as a class of behaviour distinct from feeding behaviour and sexual behaviour and of at least an equal significance in human life. There is nothing intrinsically childish or pathologic about it.'

i. Anxious Attachment

Bowlby sugests that this condition is associated with parenting which frustrated the normal development of attachment through actual or treatened abandonment or rejection.

ii. Compulsive Care Giving

Though care giving is a natural attachment behaviour, in this condition it conveys a forced, overdetermined quality and is often directed at others who neither seek nor welcome the "caring".

I would suggest that this basic distrust of human attachments contributes to the intense displacement of attachment to the pet who is consistently receptive and unconditional as a source and object of caring.

Clinical implications

The attachment need of some patients is so intense that the inclusion of a pet may be an important adjuvant in psychotherapy. The sustaining presence of a pet may be of crucial support as the patient develops enough trust to divert attachment to therapist and other human figures. The pet has been a valid assistant in the treatment of disturbed children and schizophrenics who presumably share in intense need for pre-verbal attachment.

The significance of pets as attachment figures in less disturbed patients should not be under estimated. Their substitutive function following separation from significant human attachment figures is so common that their emotional pre-eminence is ignored. It is natural for the child who has left home or the spouse who has died to be warmly surrogated by a pet."

Die inleidende deel lê klem op die verbondenheid tussen mense en hulle troeteldiere in die algemeen – dus tuis waar die troeteldierveearts weer 'n rol te speel het. Rynearson meen ook dat troeteldiere in toegepaste psigoterapie gebruik kan word. Die laaste paragraaf on-

derstreep egter die onderskatte rol van troeteldiere in die normale samelewing.

REACHING THE SEVERELY WITHDRAWN THROUGH PET THERAPY – Arline Siegel[6]

In hierdie bydrae word daarop gewys dat daar reeds sedert 1800 in Engeland troeteldiere oorweeg is as terapeutiese hulpmiddels vir geestelike siek mense. In die Speyer Hospitaal, New York, word daar al geruime tyd gebruik gemaak van troeteldiere vir mense met fisiese en geestelike siektes, asook vir depressie en selfs selfmoordneigings. Siegel glo dat kommunikasie makliker met 'n troeteldier opgebou kan word as met 'n ouer of naasbestaande. Mense met 'n gebrek aan liefde van ander en die wat al vele teleurstellings met andere beleef het, wend hulle dikwels tot troeteldiere vir liefde. Hierdie diere kritiseer of oordeel nie, maar verskaf 'n gevoel van getrouheid en laat die eienaar belangrik voel omdat die dier afhanklik is van sy eienaar se versorging.

Siegel meen dat troeteldiere 'n rol speel op daardie vlak waar menslike kontak grootliks gefaal het, as hy sê dat dit lyk of die dier sekere psigologiese grense kan afbreek. Alhoewel dit hier eintlik gaan oor die psigiatriese pasiënt, kry 'n mens in die normale gang van die lewe ook terughoudende mense vir wie troeteldiere dieselfde betekenis kan hê. Sodra ons by die troeteldier in die gewone samelewing kom, kry die troeteldierveearts weer sy rol om te vervul.

PET-FACILITATED PSYCOTHERAPY – S.A. Corson, Elizabeth O'Leary Corson & P.H. Gwynne[7]

How Basic Research in Psychobiology led to pet-facilitated Psychotherapy

"We decided to use dogs for these studies for 2 major reasons:

(a) the availability of a variety of standard breeds; and
(b) the wide spectrum and richness of emotional reactions, comparable to those shown by humans, which are shown by dogs.

Overview

Animal pets have long played a humanizing and 'gentlizing' role in human social interactions. Of all animal pets, dogs have probably been the most favoured and the most widespread in human history.

Perhaps some of the reasons for the attachment humans develop for pet dogs may be related to two prominent qualities of many dogs; their ability to offer love and tactile reassurance without criticism and their maintenance of a sort of perpetual infantile innocent dependence which may stimulate our natural tendency to offer support and protection.

Pet dogs may help to fulfil the two basic psychologic needs of patients as stated by Glasser: "the need to love and be loved and the need to feel that we are worthwhile to ourselves and to others". The success of PFP is based on the proposition that many patients may accept the love of a dog before they can accept love from and give love to a human.

One of the aims of reality therapy involves the development in the patient of a sense of responsibility which in turn may lead to ego strengthening and a feeling of self-respect. A patient's interactions with a pet dog may help the patient to develop a sense of responsibility by gradually taking over some aspects of the care of a dog, walking the dog outdoors and thus becoming responsible for the safety of the dog.

Moreover, interaction with a dog sooner or later tends to impress on the patient that there are limits within which the patient must behave in relation to the animal. If the patient begins to abuse the dog, the dog will react either by growling and showing obvious signs of displeasure or by trying to get away. In either case, the patient obtains a valuable lesson in reality testing. He also learns that love and devotion require a give and take arrangement.

Pet-facilitated psychotherapy may help the patient develop his social interactions in a responsible, caring and compassionate way and to appreciate that:

> No man is an island, entire of itself;
> every man is a piece of the continent,
> a part of the main;
>
> John Donne: Devotions, XII

Summary

Pet-facilitated psychotherapy was introduced to 30 hospitalized psychiatric patients, most of whom had failed to respond adequately to traditional forms of therapy including psychotherapy, drug treatment, electroshock therapy, and occupational and recreational therapy. Two of the patients did not accept the particular pets at our disposal (dog and cat). All the remaining 28 patients showed some improvement with pet-facilitated psychotherapy."

Met die laaste verslag wou ons aandui dat troeteldiere selfs in die uiterste hositaalgevalle van psigiatriese pasiënte as psigoterapeutiese hulpmiddel gebruik kan word. As die troeteldier dan so 'n belangrike instrument in die behandeling van hierdie gevorderde pasiënte kan wees, dan kan dit in die gewone samelewing met al die stremminge en neuroses wat dit meebring, soveel te meer 'n besliste bydrae lewer as ontladingsvoorwerp. Alhoewel hierdie bydrae van die troeteldier soms feitlik onopsigtelik is, is dit daarom geensins van minder belang nie.

THE VETERINARIAN AND MENTAL HYGIENE – B.M. Levinson[8]

"In the course of the centuries, a quiet revolution has occurred in the relationship between man and his domestic animals.

Since the relationship between man and his pets has changed, the function of the veterinarian must also be transformed. The veterinarian can no longer limit himself solely to safeguarding the physical health of the family pet. Now he must become involved in the mental health of the family whose pet he treats. This trend is so inexorable that eventually veterinarians will become members of mental hygiene teams.

Man has neurotic as well as healthy needs. In the course of time, some pets would be exploited for both purposes. Whichever the need, highly charged emotional currents are characteristic of the relationship between a pet and his master. The veterinarian is the witness of the complex dynamics of personality interplay between pets and their human families.

He can be extremely helpful, not only to pets but to owners of pets, especially as the psychologic signifi-

cance of some of these situations becomes clearer. There is need for much scientific investigation, in which the veterinarian can be an invaluable collaborator, into the psychodynamics of the man-pet relationship.

Pets mirror and localize man's emotional illnesses. They serve as therapeutic agents and aids that bring emotional health. A pet can help prevent emotional disorders in a child.

Only a few general aspects of the role of the veterinarian as a mental hygienist have been touched upon. The specific ways in which veterinarians can exercise their mental hygiene function will have to be spelled out by members of the profession.

The mental hygienist must work not only to prevent emotional disorders among the minority, but to maintain and reinforce the emotional health of the majority. As important participating member of a mental hygiene team, the veterinarian will face an analogous situation."

Met hierdie uitsprake van Levinson is ons roerend eens. Levinson vat die hele tema mooi saam en meld dan ook dat die mens neurotiese sowel as gesonde behoeftes het, wat beide op die troeteldier oorgedra kan word.

Om saam te vat kan ons sê dat die psigoterapie toegepas met die hulp van troeteldiere, bevestig dat die veearts in die troeteldierpraktyk hom ook op hoogte sal moet hou van die sielkundige aspek van sy praktyk want dit is duidelik dat troeteldiere ook tuis 'n belangrike uitlaatklep aan die mens se spanninge kan bied. Net soos die huisdokter in die spreekkamer dikwels met menslike neuroses te doen kry, terwyl die algemene praktisyn nie 'n psiagiater is nie, netso sal die veearts ook sy kliënte se menslike probleme, al is dit deur die troeteldier, moet probeer verstaan en die nodige uitlaatklep bied. Om die waarheid te sê is dit moontlik dat sekere mense eerder 'n besoek aan die veearts sal verkies om sy klagtes te lug as die huisdokter, aangesien hy dit deur sy dier kan doen. Dit maak die besoek minder persoonlik en direk omdat die veearts nie die kliënt ondersoek nie terwyl die fokus hoofsaaklik op die tussenganger, die dier, toegespits is.

Ons hoop dat ons in die toekoms die rol van die veearts t.o.v. die troeteldiereienaar se psigiese behoeftes met groter erns sal benader en dat die veearts hierdeur ook sy gemeenskapsdiens ten volle sal benut.

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ACKNOWLEDGEMENTS

Permission to quote extensively from most of the above publications is gratefully acknowledged. The authorities concerned were the President of the British Small Animal Veterinary Association[1 2 4 7], the Editors of Psychological Reports[3] and the British Journal of Psychiatry[5] and Professor Boris M. Levinson[8].

A FIELD STRAIN OF *HAEMONCHUS CONTORTUS* SHOWING SLIGHT RESISTANCE TO RAFOXANIDE

Thank you for the opportunity to comment on the above paper by Van Wyk & Gerber which appeared in the *Onderstepoort Journal of Veterinary Research* (1980) 47: 137. In the final paragraph of that article the authors refer to a trial which we did with the same strain of *H.contortus*. We would like to present to you briefly the outline and results of that trial:

(a) The trial was not done according to the non parametric method (NPM). Fifteen sheep were infested with 3rd stage larvae of *H.contortus*, obtained from Dr J.A. van Wyk. Five were kept as untreated controls, 5 were treated orally with rafoxanide (RANIDE, MSD) at 7,5 mg/kg and 5 were treated orally with rafoxanide at 10 mg/kg when the infestation was 28 days old. The sheep were slaughtered 20 or 21 days after treatment for parasite recovery.

(b) The numbers of worms recovered at necropsy were as follows:

GROUP	ANIMAL NO.	*H.contortus* RECOVERED
Control	2	2715
	11	2268
	69	1477
	76	1795
	464	1043
	Mean	1860
Rafoxanide 7,5 mg/kg	3	18
	25	62
	81	14
	82	84
	Red 2	1050
	Mean	246
	Percentage reduction	86,8
Rafoxanide 10 mg/kg	9	1
	27	22
	84	5
	91	18
	Y 1	19
	Mean	13
	Percentage reduction	99,3

(c) At necropsy it was discovered that animal Red 2 had wide-spread multiple abscessation of the liver. It is possible that this condition could have interfered with the absorption and/or plasma-binding of the drug. It would appear that the "resistance" of this strain of *H.contortus* to rafoxanide, if it exists, is very slight. In view of the results of our trial and while the reason for the reduced efficacy seen by Van Wyk & Gerber remains unknown to us, we shall continue to recommend an oral dosage of rafoxanide of 7,5 mg/kg.

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PIGMENTATION OF PLASMA IN HEARTWATER

During an investigation on heartwater in Angora goats, I have found that in all cases an orange-yellow pigment appears in the plasma and I wish to draw the attention of colleagues to it. It also occurs in the plasma of sheep.

The pigment appears during the febrile stage and its presence may be a useful adjunct in the clinical diagnosis of heartwater.

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DIAMIDINE POISONING IN A DOG

A 6-year-old Bull Mastiff-cross dog with a body mass of 40 kg was presented with clinical signs of ataxia, hippus and nystagmus. The referring veterinarian had treated the animal 36 h prior to admittance with diminazene aceturate (Berenil, Hoechst). It had also received an injection of phenamidine isethionate (Phenamidine, Maybaker) 14 h after the Berenil injection.

Although a tentative diagnosis of diamidine poisoning was made, treatment with vitamins, antibiotics and parenteral administration of fluids was attempted. The dog's condition deteriorated rapidly despite treatment and euthanasia was performed 48 h later.

On post mortem examination no macroscopic lesions in the central nervous system were evident but histopathological examination of the brain revealed focal symmetrical encephalomalacia of the cerebellar stem as well as a vasculitis and neutrophil infiltration. This confirmed the diagnosis of diamidine poisoning.

The recommended dose of Berenil for babesiosis in the dog is 3,5 mg/kg once only. This dose should not be repeated within the course of the disease. Phenamidine is an alternative treatment for babesiosis and should also be administered once only at a dosage rate of 15 mg/kg.

0038-2809/81/04/0338-0339

The dog was apparently given an estimated total dose of between 175 and 420 mg of Berenil and it should subsequently not have been treated immediately with Phenamidine. In this case diamidine intoxication was therefore caused by an overdosage of a combination of Berenil and Phenamidine.

Naudé et al.[1] could not provoke clinical signs of diamidine poisoning by giving dogs a combination of 20 mg/kg Phenamidine and 3,5 mg/kg Berenil on 2 successive days. Berenil toxication could, however, be provoked by as little as 2 successive treatments at 10,5 mg/kg/d (i.e. 3 times the therapeutic dose).

In view of the potential neurotoxicity of the diamidines, the probality of accumulation in body tissues, the marked individual variation in susceptibility and especially the possibility of an increased susceptibility in sick dogs, treatment with any of the diamidines should not be repeated during the course of babesiosis in a dog.

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IN MEMORIAM

DR A.B. LA GRANGE
17.6.1922 – 10.8.1981

Met die heengaan van Andries Benjamin (Ben) la Grange het die veeartsenyprofessie in Suid-Afrika een van sy mees gesiene lede verloor.

Ben is te Ladismith gebore en het in 1948 die graad BVSc aan die Fakulteit Veeartsenykunde van die Universiteit van Pretoria verwerf. Daarna het hy etlike jare in Pretoria gepraktiseer. K.I. in Suid-Afrika was toe nog in sy kinderskoene. Die pasgestigte Transvaal K.I. Koöperasie het 'n veearts as bestuurder nodig gehad en vanweë sy groot belangstelling in K.I. en die veebedryf as geheel het hy in 1955 in hierdie hoedanigheid sy diens aan die vee- en veral die beesbedryf, begin; hieraan het hy dan ook sy lewe en al sy kragte gewy.

Ben la Grange was by uitstek die man wat 'n K.I.-Koöp. kon bedryf omdat hy die gawes van sakevernuf en die wetenskap en tegniek so gebalanseerd besit en gebruik het. Sy innemende, vriendelike geaardheid en ook sy gesonde menseverhoudinge het hom 'n ideale en geliefde hardwerkende leier gemaak wat by werknemers groot lojaliteit en 'n spangees geskep het ten spyte daarvan dat hy met net die beste dienslewering tevrede was. Daarom het Tvl. K.I. Koöp. dan ook gegroei tot 'n gesonde saak wat finansieel sowel as wat sy diens en die kwaliteit van sy produk betref, groot vreugde by die lede verskaf en respek by almal afgedwing het.

Ben het hom altyd vir die samesmelting van die verskillende K.I. Koöperasies in S.A. beywer. Die verwesenliking van hierdie ideaal in 1978 het dan ook vir hom veel beteken en hy het die taak as hoofbestuurder van Taurus Koöperasie met onderskeiding tot sy dood behartig.

Hy het hom onderskei deur sy breë siening van die ideale vir die veebedryf in Suid-Afrika en sy bydrae by talle besprekings oor die veebedryf was altyd weldeurdag en waardevol. Tog was hy oortuigbaar deur gesonde en gegronde redenasies. Hy kon met gesag oor die veebedryf, diere-rasse en algemene sake rakende die veebedryf redeneer en die heil van die veeboer het by hom swaar geweeg. Hy het gedien op verskeie liggame wat betrekking op die veebedryf het. Hy was lid van die Rade van die Brahman-, Charolais- en Friestelersverenigings en ook lid van die Uitvoerende Komitee van die S.A. Stamboekvereniging. Hy was 'n bekwame en gesogte beoordelaar van bg. rasse. Hy het verskeie studiereise na die V.S.A. en Europa onderneem en het die Franse Regering in so 'n mate beïndruk dat hulle in 1964 aan hom die "Ordre de Mérite Agricole" vir voortreflike diens op die gebied van Veeartseny- en Veekunde toegeken het. Plaaslik het hy o.a. gedien op die Minister van Landbou se Adviesraad vir Diereproduksie en op die Advieskomitees vir Nasionale Melkprestasie- en Nageslagstoetsskema en KI-aangeleenthede.

Dr la Grange was ook lank aktief aan die Transvaalse Landbougenootskap gekoppel en het eers as Bestuurslid, in 1980 as Onder-president en in die jaar van sy dood as President van hierdie genootskap gedien. Dit is veral aan sy ywer te danke dat die jaarlikse skou van hierdie genootskap te Pretoria, die belangrikste vertoonvenster vir die Suid-Afrikaanse stoetveebedryf geword het.

Daar was min kollgas wat so dinamies en onvermoeid soos Ben kon werk. Hy het homself nooit rus gegun nie. Dit was een van die foute in sy lewe. Die vrag hooi op sy vurk was, gemeet aan menslike standaarde, te groot maar daarvan was hy nie te oortuig nie. Selfs sy latere lewensbedreiging deur 'n hartletsel kon hom nie van onverpoosde en harde werk laat afsien nie.Menslik gesproke het hy sy dood vehaas.

Die veeartsenyprofessie moet groot bewondering hê vir die feit dat sy besige en vol lewe nie Ben sy professie laat vergeet het nie. Ook hier het hy buitengewoon waardevolle en onbaatsugtige diens gelewer. In 1973 en 1974 was hy President van die S.A. Veterinêre Vereniging. Ook as lid van die Raad het hy 'n groot bydrae tot die sake van die professie gemaak. Hy was 'n stigterslid van die Noord-Transvaal tak asook deurgaans 'n lid van die Produksie en Reproduksie groep van die SAVV.

Andries Benjamin la Grange was in talle opsigte 'n navolgenswaardige voorbeeld vir elkeen van sy kollegas en as elkeen die beeld van die veearts soos hy sou uitdra en laat skyn sou die respek en eerbied vir die professie groot wees.

Hy laat sy vrou Retseh en vier kinders na. Aan hulle word ons diepste meegevoel betuig

TOEKENNING AWARD

GOUE MEDALJE VAN DIE SAVV VIR 1981

CHRISTIAAN FREDERICK BEYERS HOFMEYR

Die gesogte Goue Medalje van die Suid-Afrikaanse Veterinêre Vereniging is vanjaar aan prof C.F.B. Hofmeyr toegeken.

Christiaan Frederick Beyers Hofmeyr is op 15 Augustus 1916 te Pietersburg gebore. Na sy skoolloopbaan begeef hy hom na die Fakulteit van Veeartsenykunde Universiteit van Pretoria te Onderstepoort waar hy in 1938 die B.V.Sc.-graad verwerf. Hy begin sy loopbaan as staatsveearts te Umtata, waar hy met die gevreesde beessiekte Ooskuskoors kennis maak, en word daarna na Rustenburg verplaas.

Reeds in 1942 openbaar hy van sy besondere kwaliteite deur die privaatpraktyk te betree en word daardeur een van die pioniers op dié gebied in Suid-Afrika. Gedurende die volgende 15 jaar bevorder hy hierdie been van die veterinêre wetenskap met onderskeiding. Hy het inderdaad waarskynlik meer as enigiemand anders daartoe bygedra om die professionele beeld van die veearts in die samelewing uit te bou. Sy onberispelike gedrag, persoonlike netheid en nougesette handhawing van die etiese kode is byna legendaries.

Hy spesialiseer as praktisyn in die chirurgie en doen hier weer baanbrekerswerk deur die vakrigting op 'n hoogs professionele wyse te be-oefen soos niemand voor hom nie. Tans volg feitlik die hele professie in sy voetspore. Hy het reeds as praktisyn van veterinêre chirurgie 'n wetenskap gemaak en was gevolglik in Suid-Afrika in hierdie opsig ook jare voor sy tyd.

Terwyl hy nog in praktyk was het hy reeds sy dienste aan die Fakulteit van Veeartsenykunde te Onderstepoort op 'n deeltydse basis aangebied en neem hy die ambulatoriese kliniek waar. In 1958 word hy as voltydse Professor en Hoof van die Departement Chirurgie van die betrokke Fakulteit aangestel. Hy benut die geleentheid om die groot aantal studente wat deur sy hande gaan deur sy voorbeeld en voorspraak ten goede te beinvloed wat die handhawing van die onbesproke gedragskode van 'n professionele persoon betref. Hy beywer hom vir die hoogste moontlike standaard van voorgraadse opleiding en bou sy departement uit tot een wat ten opsigte van die gehalte van opleiding en die fasiliteite wat beskikbaar is vir niks in die wêreld hoef terug te staan nie. Hy word in 1969 as deeltydse Dekaan van die Fakulteit aangestel en in 1976 word hy voltydse Dekaan, 'n posisie wat hy nog steeds beklee.

Gedurende hierdie tydperk is prof Hofmeyr baie aktief besig om die veeartsenykundige leerplan te bevorder. Hy beywer hom veral vir die ontwikkeling van nagraadse opleiding as gevolg waarvan die M.Med.Vet.-spesialiste grade in 1962 ingestel word. Tans bestaan daar 18 verskillende rigtings waarin veeartse kan spesialiseer. Hierbenewens was hy ook verantwoordelik vir die instelling van 'n B.V.Sc.(Hons)-graad wat spesifiek daarop gemik is om voortgesette nagraadse opleiding binne die bereik van so veel as moontlik veeartse te bring. Hierdie kwalifikasies het 'n nuwe era in nagraadse opleiding ingelui. Die geleenthede wat hierdeur gebied is, is veral deur veeartse wat as dosente en/of as navorsers werksaam was benut, maar heelwat privaatpraktisyns het ook reeds hierdie kwalifikasies verwerf. Dit het 'n onbetwisbare stimulerende invloed op veterinêre navorsing en opleiding gehad wat op hul beurt groot voordele vir die gesondheidstatus van die dierebevolking van hierdie land ingehou het.

Prof Hofmeyr het hom ook beywer vir die instelling van 'n 2-jarige diplomakursus in veterinêre verpleging. Hierdie verpleegsters staan sedert 1978 hul plek in menige praktyk vol. Tydens sy regime as Dekaan is die vak Anatomie van die B.V.Sc.-kursus na die eerste jaar verskuif en dit het plek ingeruim vir 'n kursus oor Bevorderderende Diergeneeskunde in die laaste jaar van die kursus wat na 5½ jaar verleng is. Lg. sal daarvoor sorg dat voornemende veeartse beter voorberei is vir landelike praktyk en veral vir voorkomende geneeskunde, 'n diens wat sal aanpas by Suid-Afrikaanse toestande en waarvoor daar 'n dringende behoefte bestaan.

Prof Hofmeyr was ook 'n voorstaander van inlywing van die Fakulteit van Veeartsenykunde as volwaardige Fakulteit van die Universiteit van Pretoria, 'n opspraakwekkende gebeurtenis wat in 1973 plaasgevind het en bepaalde voordele vir veterinêre opleiding ingehou het.

Tydens sy dienstermyn as Dekaan van die Fakulteit het prof Hofmeyr 'n ontsaglike bydrae tot die bevordering en vooruitgang van veeartsenykundige onderwys

gemaak, 'n prestasie wat nie maklik oortref sal word nie. Die hoë aansien wat Suid-Afrika se voor- en nagraadse kwalifikasies in die buiteland geniet getuig van die hoë gehalte van die opleiding. Hierdie kennis word daagliks in alle sfere van veeartsenykundige aktiwiteit benut en wetenskaplike prestasies vloei daagliks hieruit voort, hetsy in die kliniek, die navorsingslaboratorium of op die plaas. As leier op die gebied van veterinêre onderwys het prof. Hofmeyr inderdaad die veeartsenykundige wetenskap op ongekende wyse bevorder.

Prof Hofmeyr het ook as wetenskaplike presteer. Hy het 2 nagraadse kwalifikasies, nl. die M.Med.Vet.(Chir) en D.VSc(cum laude) grade verwerf. Hy is outeur of mede-outeur van bykans 100 wetenskalike publikasies. Hulle strek oor 'n wye veld, maar handel veral oor chirurgie en getuig van buitengewone prestasie in hierdie dissipline. Dit is veral op chirurgiese herstel van *impotentia coeundi* by die bul wat prof Hofmeyr 'n uitsonderlike wetenskaplike bydrae gelewer het. Hy het ook verskeie omvattende ongepubliseerde werke wat steeds deur sy opvolgers vir studente-opleiding gebruik word, geskryf. Hy het hom onderskei deur 'n omvattende handleiding in Afrikaans vir onderrig in veeartsenykundige chirurgie op te stel. Hy is tans besig met die opstel van 'n handboek oor *impotentia coeundi* wat waarskynlik nog in hierdie jaar sal verskyn. Prof Hofmeyr geniet besonder hoë aansien as veterinêre opvoedkundige en wetenskaplike in Suid-Afrika sowel as in die buiteland. Hy is bv. sedert 1955 Akademielid van die S.A. Akademie vir Wetenskap en Kuns, Raadslid en Lid van die Uitvoerende Komitee van Medunsa, Lid van die Uitvoerende Komitee van die Wêreldvereniging vir Beessiektes, hy was Voorsitter van die Fakulteitsraad vir Natuurwetenskap en Tegniek van die S.A. Akademie en hy was Vise-president van die SAVV van 1971-1975, om maar enkele prestasies te noem.

Prof Hofmeyr is op spesiale uitnodiging herhaaldelik na die buiteland. Enkele voorbeelde hiervan is die Peter Wilson Uitnodigingslesing wat hy by die Universiteit van Edinburgh gelewer het, sy voorsitterskap van sessies by die kongres van die Wêreld Veterinêre Vereniging te Meksikostad en die kongres van die Wêreldvereniging vir Beessiektes in Israel, asook die 3-uur seminaar oor Bees Chirurgie wat hy by die kongres van die Amerikaanse Veterinêr-Mediese Vereniging gehou het.

Hy het ook sy plek in die wetenskaplike verenigingslewe beide in Suid-Afrika en oorsee volgestaan en op die bestuur van die SAVV asook die Veeartsraad gedien. Daar word in 6 verskillende biografiese werke oor vooraanstaande mense na prof Hofmeyr verwys, inderdaad 'n bewys van erkenning vir prestasie wat deur min Suid-Afrikaanse wetenskaplikes nagedoen kan word. Dwarsdeur sy loopbaan is hy deur sy vrou Brenda met besondere entoesiasme en toewyding op uiters bekwame wyse bygestaan. Sy verdien 'n groot aandeel in hierdie uitsonderlike toekenning.

JACK BOSWELL AWARD FOR 1981

BARNETT MOSS HORWITZ

The Jack Boswell award for 1981 has been awarded to Dr Barnett Moss (Bertie) Horwitz. The award is given to Dr Horwitz in recognition of his dedicated services to the veterinary profession, particularly at the "Branch" level, and to his calling as a veterinarian in the field of Public Health.

Bertie Horwitz was born in 1906, completed his schooling at Selborne College, East London, and qualified as a veterinary surgeon at the Faculty of Veterinary Science, University of Pretoria in 1929. After having had short spells of government service and private practice, he became the first full time veterinary officer of the Port Elizabeth municipality in 1937, where he was in charge of the municipal abattoir and milk supply of the town.

On his return from 4 years of Army service during World War II, he was appointed Milk Control Officer to the municipality of Cape Town in 1944, the first veterinarian to hold such a position. Here he introduced some revolutionary and far-sighted measures such as compulsory cooling of all milk on the farms before delivery and regular veterinary inspection of all dairy herds. On his recommendation pasteurization of milk was also made compulsory in 1949. Dr Horwitz was appointed Director of the Cape Town abattoir in 1952 and once again showed his originality and drive by being responsible for the designing and building of the first modern "on the line" abattoir in South Africa.

Even after his retirement from the Cape Town municipality in 1968, Dr Horwitz continued to serve as a veterinarian and scientist to the best of his ability and as far as his health would allow him. He first joined the Division of Veterinary Services and was later appointed in the Department of Medical Microbiology of Tygerberg Hospital.

Dr Horwitz can be regarded as a parent of the Western Cape Branch of the SAVA. Together with the late Drs Cooper and Heydenrych, he founded this Branch in 1947. He served as its secretary from 1951-1956, vice-chairman from 1956-1959 and chairman from 1959-1960. He continued to serve on the committee of the branch as an elected member until 1970. In recognition of his enthusiasm for, and dedication to the Branch over so many years he was elected an honorary life member in 1970.

Bertie Horwitz has also served the general community in a quite outstanding and unique manner by being very actively involved in various types of charity work. During the depression in the early 1930's, only a few years after he qualified, he organized soup kitchens in Port Elizabeth for unemployed people. He also served as a committee member of the Port Elizabeth branch of the SPCA. He was a charter member of the Table Bay Rotary Club and became its President in 1959.

He founded the Peninsula School Feeding Association in 1958, an organization which now feeds 126 000 children in 226 schools at an estimated cost for 1980 of R400 000. He has been chairman from its inception. In order to raise funds for the feeding scheme he organized the building of the Peninsula Golf Driving Range, a facility now owned by the Feeding Association. The tremendous effort he has put into charity has been recognized by the Table Bay Rotary Club who honoured him by electing him a Paul Harris Fellow in 1976.

This most commendable charity work has elevated the image of the veterinary profession amongst the large number of people who have come into contact with this quiet distinguished gentleman.

It is perhaps fitting that on the occasion of the Annual General Meeting and Biennial Congress of the SAVA being held in the Western Cape, that the recipient of the Jack Boswell Award happens to be this very eminent life member of the Western Cape Branch, which is hosting this auspicious occasion.

AWARD TOEKENNING

CLINICAL AWARD OF THE SAVA FOR 1981

GRAHAM JOHN FUTTER

The first recipient of this new award of the SAVA is Dr Graham John Futter.

Dr Futter graduated from the Faculty of Veterinary Science, University of Pretoria as a veterinarian in 1964 and was awarded the May Baker prize in his final year. From 1965-1967 he served as state veterinarian in South Africa and as private practitioner in South Africa and Canada. The following year he lectured in Medicine at the University of Saskatchewan in Canada. In 1970, after he had returned to South Africa, he was offered a fellowship at the University of Iowa, U.S.A., which he could not accept due to circumstances.

He has been in private practice at Tokai, Cape Town, since 1979. Despite his many commitments as a private practitioner, he enrolled at the University of Stellenbosch and was awarded an MSc-degree in 1979. His thesis was entitled: Studies on the pathophysiology of feline babesiosis in the domestic cat.

The Clinical Award of the SAVA for 1981 is awarded to Dr Futter for an excellent series of publications which have appeared in the Journal of the SAVA on the subject of his thesis. The articles which were taken into consideration for this award are as follows:

Futter G J, Belonje P C 1980 Studies on feline babesiosis. 1. Historical review. Journal of the South African Veterinary Association 51: 105-106

Futter G J, Belonje P C 1980 Studies on feline babesiosis. 2. Clinical observations. Journal of the South African Veterinary Association 51: 143-146

Futter G J, Belonje P C, Van den Berg A 1980 Studies on feline babesiosis. 3. Haematological findings. Journal of the South African Veterinary Association 51: 271-280

TOEKENNING **AWARD**

NAVORSINGSTOEKENNING VAN DIE SAVV VIR 1981

JACOBUS DÜRR BEZUIDENHOUT

Die eerste ontvanger van hierdie nuwe toekenning van die SAVV is dr Jacobus Dürr Bezuidenhout.

Dr Bezuidenhout het in 1966 as veearts in die Fakulteit Veeartsenykunde, Universiteit van Pretoria te Onderstepoort, Pretoria gekwalifiseer. Hy begin met sy loopbaan as 'n staatsveearts in Ovambo in Suidwes-Afrika waar hy in 1969 na die Veterinêre Streekslaboratorium te Windhoek verplaas word om met bakteriese en parasitologiese diagnostiek behulpsaam te wees.

In 1974 kom hy na die Entomologie-seksie van die Navorsingsinstituut vir Veeartsenykunde, Onderstepoort waar hy met navorsing op verskeie onderwerpe begin. Die belangrikstes hiervan handel oor die biologiese beheer van bosluise, die etiologie van sweetsiekte en die lewensloop van *Cowdria ruminantium*.

Dr Bezuidenhout word in 1979 as hoof van die Entomologieseksie en in 1981 as Assistent Direkteur van Onderstepoort benoem.

Terwyl hy in die noorde van Suidwes-Afrika werksaam was, is dr Bezuidenhout se belangstelling gaande gemaak deur die lae bosluisbesmettings wat deur die inheemse Sanga-tipe *Bos indicus* beeste gedra word. Die teenwoordigheid van rooibekrenostervoëls op die diere stimuleer hom om hulle potensiaal om bosluise biologies te beheer, te ondersoek.

Die geleentheid hiervoor kry hy op Onderstepoort en hy onderneem saam met dr C.J. Stutterheim 'n omvattende studie van die voedingsgewoontes van die renostervoël. In hierdie ondersoek word die verbasende mate waartoe hierdie unieke voëlsoort aangepas is om op bosluise te lewe deur besonder sistematiese en doelgerigte navorsing vir die eerste keer onthul. Die resultate van hierdie indringende studies word in 'n uitgebreide artikel gepubliseer, naamlik:

Bezuidenhout JD, Stutterheim CJ 1980 A critical evaluation of the role played by the red-billed oxpecker *Buphagus erythrorhynchus* in the biological control of ticks. Onderstepoort Journal of veterinary Research 47: 51-75.

Die SAVV se Navorsingstoekenning vir 1981 word op sterkte van hierdie monumentale werk aan dr J.D. Bezuidenhout toegeken.

INTERNJAARKLAS 1981/82
FAKULTEIT VEEARTSENYKUNDE
UNIVERSITEIT VAN PRETORIA

INTERN YEAR CLASS 1981/82
FACULTY OF VETERINARY SCIENCE
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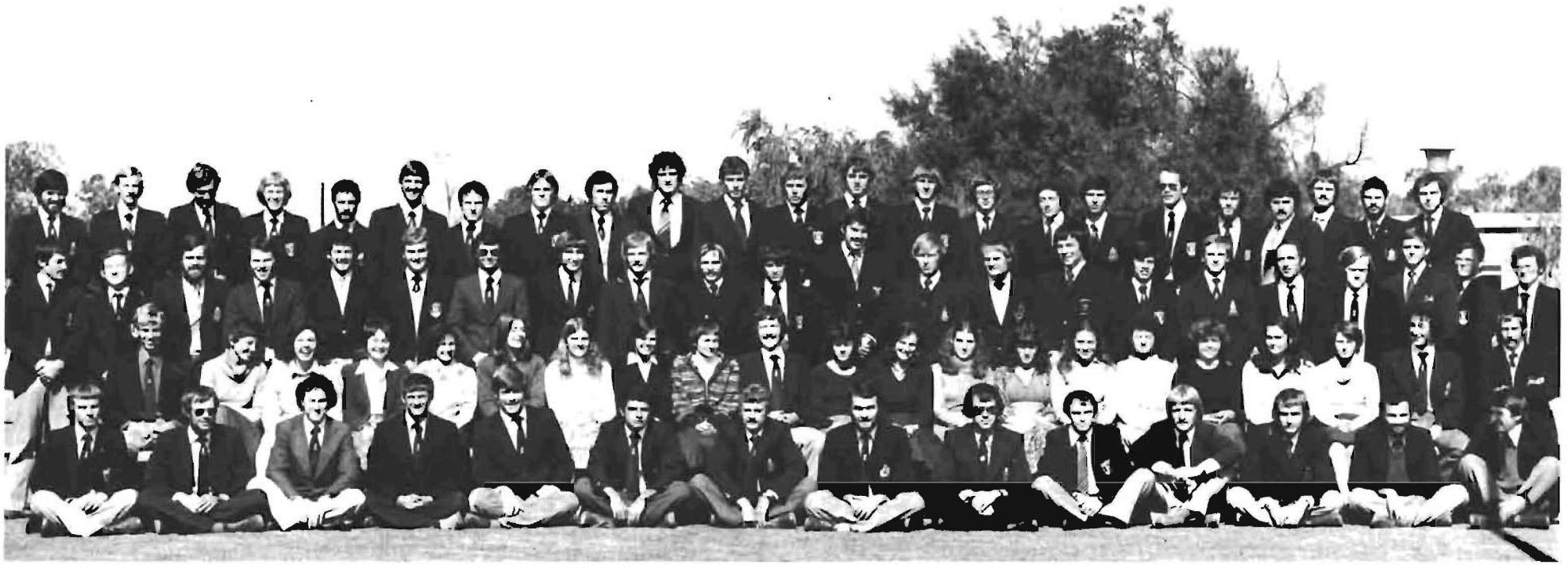

Back row (l to r): P. Nel, C. van Niekerk, A. van Halderen, C. Hambly, St. C. Hayes, H. Lategan, N. Fourie, M. Meyer, J. Walters, H. Hesse, H. Bosman, M. Rohwer, A. Hillier, D. Nischk, N. Duncan, P. Vervoort, O. Botha, C. van Dijk, M. Bigalke, P. van Zyl, P. Human, W. Cilliers, K. le Roux.
3rd row: R. Williams, P. Eisenhammer, C. Fourie, T. Shead, L. van Niekerk, K. MacWilliam, G. Fuller, N. Arkell, M. Warren, E. de Maudave Bestel, T. Makin, M. Ross, K. Pettey, T. Shakespeare, G. Stevens, C. Botha, R. Larson, J. Beck, P. Kelly, J. Kahts, J. Davies, P. Smith.
2nd row: F. Huberts, S.M. Kotzé (Mrs), J. Frean, A. Dogon, J. Slaven, V. Brain, B. Voigts, M. Vermooten, R. van Nieuwenhuizen, S. Varrie, J. Been, R. Walwyn, D. Chain, K. Levy, R. Hyde, C. Williamson, A. Olivier, S.H. Kotzé, J. Tebje, I. Sandler, T. Zagt.
1st row (sitting on ground): M. Ferreira, A. du Plessis, D. MacDonald, G. Green, H. Andrew, J. Meyer, D. Nolte, T. Marriott, P. van Dam, J. Cilliers, K. Kroon, M. Evans, S. Taylor, I. Heyns.

ABSTRACTS OF PAPERS DELIVERED AT THE PROCEEDINGS OF THE VETERINARY PATHOLOGY GROUP OF THE SOUTH AFRICAN VETERINARY ASSOCIATION ON 10 SEPTEMBER 1981

DIE AFDELING VEEARTSENYDIENS SE DIAGNOSTIESE DIENS EN DIE KUDDEGESONDHEIDSBENADERING – MET DIE KLEM OP BEESTE

P.P. BOSMAN*

'n Oorsig word verskaf oor die ontwikkeling van die Afdeling Veeartsenydiens van die Departement Landbou en Visserye se diagnostiese tak.

Die funksies van laboratoria word kortliks uiteengesit sowel as hul ligging en die Afdeling se toekomsplanne toegelig.

Dienste tot die beskikking van die beespraktisyn wat 'n kuddebenadering volg, word bespreek. Hierdie kollegas en die Afdeling streef na 'n gemeenskaplike doel, wat slegs bereik kan word deur middel van volle samewerking tussen die privaat en openbare sektore.

*Afd. Veeartsenydiens, P/Sak X138, 0001 Pretoria.

DIAGNOSTIC SERVICES AND THE HERD HEALTH APPROACH IN THE SMALL STOCK INDUSTRY: PRESENT AND FUTURE

E.M. VAN TONDER*

The small stock industry comprising 31,4 million sheep and 2,7 million goats constitutes approximately 24,6 % of the total agricultural production and 20-22 % of agricultural exports of the Republic of South Africa.

On account of its expansion through the years this industry is now practised throughout the country under a wide variety of conditions which naturally contribute towards considerable annual losses. Through lack of accurate figures, it is estimated that direct animal losses at present could be 165 million rand per year, while an additional income to the industry of 28 million rand per year could be earned, for every 5 % increase in lambing percentage. Indirect losses were not taken into account.

For various reasons until fairly recently, the diagnostic service available to the small stock industry was extremely limited. With the aim of increasing livestock production and reproduction, Regional Veterinary Laboratories and Veterinary Laboratories were also established in the small stock farming areas. These laboratories have developed and expanded gradually and are at present capable of rendering a fairly comprehensive diagnostic service. While investigations and research at the Regional Veterinary Laboratory at Middelburg, Cape are mainly directed at small stock problems, these activities are also undertaken at the Veterinary Research Institute, Onderstepoort, the Regional Veterinary Laboratory at Stellenbosch and the Veterinary Laboratory at Grahamstown, in addition to their other research programmes.

Certain deficiencies which should receive urgent attention, do however still exist in the present diagnostic service at the Regional Veterinary Laboratory at Middelburg, Cape. This mainly concerns diagnostic virology, although the diagnostic activities in certain other sections dealing with other aspects, also need to be improved and expanded so that this laboratory could become fully functional in the entire field of veterinary diagnostics for sheep and goats. Similar improvements should also be undertaken at other Regional Laboratories concerned with the small stock industry while the Veterinary Laboratories involved should be equipped to undertake a fairly wide range of basic diagnostic work. Consideration should also be given to the establishment of another one or two laboratories in the extensive small stock areas.

The herd approach in veterinary practice has as yet not taken hold in the small stock industry. The only service of this nature is at present undertaken by the state and is mostly free of charge. As such an approach on a remunerative basis appears to hold possibilities for the future, it should be encouraged to develop along certain lines.

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DIAGNOSTIC SERVICES AND THE PIG HERD HEALTH APPROACH

I. ZUMPT*

The role of the veterinarian in modern pig farming is sketched and the different approaches i.e. a fire brigade service, routine diagnosis and treatment, and the situation where the veterinarian becomes an integral part of the production and management team, are outlined. The role of the veterinary laboratory in respect of disease detection is discussed and the necesity to adapt to the ever increasing demands of specialization and intensification emphasised.

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THE PRIVATE VETERINARY PATHOLOGIST

I.B.J. VAN RENSBURG* and W.S. BOTHA*

A brief analysis of the first 1000 cases referred to a part-time, private diagnostic histopathology practice during the past twelve months is presented. The value of histopathology as a diagnostic aid is stressed while some difficulties encountered and possible means to overcome these are discussed. Some speculation on the scope for full time specialists in veterinary pathology is put forward.

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THE AVERMECTINS: A NEW FAMILY OF ANTIPARASITIC AGENTS

I.K. HOTSON*

The avermectins are macrocyclic lactones produced by fermentation of the soil micro-organism *Streptomyces avermitilis*. They show activity against a broad range of nematode and arthropod parasites of domestic animals at dose rates of 200 μg/kg or less. Unlike the macrolide or polyene antibiotics, they lack significant antibacterial or antifungal activity.

By oral or parenteral administration, avermectins are active against gastrointestinal nematodes and lungworms, and important ectoparasites such as lice, mange mites, ticks and larval stages of flies. They show excellent activity against parasites resistant to existing anthelmintics or ectoparasiticides.

The avermectins appear to cause paralysis of nematodes and arthropods by potentiating the release of the neuro-inhibitor *gamma*-aminobutyric acid (GABA).

*Merck Sharp & Dohme Research Laboratories, Ingleburn, N.S.W. Australia.

IVERMECTIN AS AN ANTIPARASITIC AGENT IN HORSES

J. SCHRÖDER* and G.E. SWAN*

Ivermectin, described as 22,23-dihydroavermectin B_1, is the compound chosen from the avermectins for development as an antiparasitic agent in horses.

Parenteral administration in horses at 200 μg/kg body mass is highly effective against the strongyles *Strongylus vulgaris*, *S. edentatus*, *Triodontophorus* spp. and *Craterostomum acuticaudatum*, and adult and immature cyathostomes, including strains resistant to benzimidazole anthelmintics. Other nematodes controlled in the horses include *Oxyuris equi*, *Parascaris equorum*, *Trichostrongylus axei*, and *Habronema* spp.

Ivermectin is also highly effective against stomach bots (*Gastrophilus* spp.).

*MSD Research Centre, Private Bag 3, 1685 Halfway House.

THE TOLERANCE OF CATTLE TO INJECTABLE RAFOXANIDE

J. SCHRÖDER*

Thirty-two weaned steer calves were injected subcutaneously with rafoxanide solution to determine the lethal dosage. The recommended therapeutic dose rate is 3 mg/kg. Eight of 12 calves treated at 45 to 60 mg/kg displayed signs of toxicity 24h to 8d after treatment. These included recumbency, polypnoea, muscle tremors and clonic spasms, opisthotonus, paddling movements of the feet, blindness with mydriasis and death. An easily detected histopathological lesion was *status spongiosus* of the central nervous system.

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SOME TOXICOLOGICAL ASPECTS OF CERTAIN SHEEP DIPPING COMPOUNDS BASED ON CHLORFENVINPHOS, FENCHLORPHOS, DIAZINON, LINDANE AND AMITRAZ

R.J. TAYLOR*

The toxicity to laboratory animal and target species of 5 sheep dipping compounds, chlorfenvinphos, fenchlorphos, diazinon, lindane and amitraz, are briefly compared. When fenchlorphos and chlorfenvinphos or amitraz and diazinon are used simultanously, a potentiation of toxicity is found.

The extent of research both in the laboratory animal and sheep in order to ensure the safety of new products, is detailed. This includes metabolic, carcinogenic, mutagenic and chronic toxicity studies to determine the no-effect levels in the laboratory animal. These data, considered in conjunction with tissue data obtained from sheep, are used to set safe withholding periods between last treatment and slaughter for human consumption. The safety of these products since their introduction for field use, vindicates this approach.

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THE TOXICITY AND CARCINOGENICITY OF SOME SOUTH AFRICAN *ENCEPHALARTOS* SPECIES (CYCADS)

R.C. TUSTIN*

The toxicity and carcinogenicity of the seeds of 5 of the 28 South African *Encephalartos* species were determined for rats: viz. *E. umbeluziensis, E. villosus, E. lebomboensis, E. laerifolius* and *E. lanatus*. The livers and kidneys of the animals showed the most severe lesions, the nature of which varied according to the concentration and part of the seed and the survival period of the animal.

Renal mesenchymal tumours were the most frequent neoplasm to be encountered. They were induced in rats that had received the whole seed of *E. umbeluziensis,* outer flesh of the seed of *E. villosus, E. lebomboensis* and *E. laevifolius,* or the kernel of the seed of *E. villosus, E. lebomboensis* and *laevifolius,* or the kernel of the seed of *E. villosus, E. lebomboensis* and *E. laevifolius,* or the kernel of the seed of *E. laevifolius* and *E. lanatus*. Renal adenocarcinomas were seen in 2 rats, the diet of one of which had contained for a limited period the whole seed of *E. umbeluziensis* and the other the kernel of *E. laevifolius*. The whole seed and the outer flesh of the seed of *E. villosus* and the kernel of *E. lanatus* produced hepatocellular carcinomas in a small number of animals, whereas the whole seed of *E. umbeluziensis* produced a cholangiocarcinoma in one rat.

The seeds of all 5 cycads tested caused severe periacinar necrosis of the liver when fed in high concentration. More chronic intoxication resulted in nodular hyperplasia of the liver which was frequently accompanied by bile duct hyperplasia, cystic bile ducts and focal hepatic telangiectasis.

* Department of Pathology, Faculty of Veterinary Science, P.O. Box 12580, 0110 Onderstepoort.

FIRST REPORT OF ANNUAL RYEGRASS TOXICITY IN THE REPUBLIC OF SOUTH AFRICA

D.J. SCHNEIDER*

The occurrence of annual ryegrass toxicity in sheep and cattle is reported for the first time in South Africa. The disease in this country is similar to that described in Australia. To date it has been diagnosed conclusively in South African Mutton Merino sheep on a farm in the Caledon district and also in cattle on 3 farms of which 2 are situated in the Bredasdorp district and 1 in the Ceres district. It is a neurological disorder, characterised by tremor, ataxia, intermittent epileptiform seizures, nystagmus, opisthotonus, abortions and a high mortality rate. The history, cilincal signs, experimental reproduction as well as the pathology of the disease in cattle and sheep are described.

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A COMPARATIVE STUDY OF RIFT VALLEY FEVER AND WESSELSBRON DISEASE IN ANIMALS AND MAN

J.A.W. COETZER

Rift Valley fever was first described in the Rift Valley in Kenya. Since then the disease has been reported in a wide range of animal species and man in a variety of ecological environments in different countries in Africa, extending from South Africa to Egypt in the north. The epidemiology, symptomatology and pathology reported in different animal species during these outbreaks will be discussed.

Rift Valley fever has long been known to cause a non-fatal influenza-like illness, which is sometimes complicated by visual disturbances in man. New insight was gained on the disease during the 1974/75 epizootic in South Africa and especially the recent outbreak along the Nile Delta and Valley in Egypt. The latter outbreak involved an estimated 200,000 people. Approximately 600 patients presented with a fatal haemorrhagic diathesis which was accompanied by marked liver necrosis. Serious ocular lesions and encephalitis were also reported. The zoonotic implications of Rift Valley fever and the danger that the virus may spread beyond the African continent will be point out.

Wesselsbron disease is a milder zoonotic disease than Rift Valley fever. Although the two diseases have many properties in common there are differences that distinguish them. These differences will be emphasized.

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SOME GASTROINTESTINAL DISORDERS IN PIGS UNDER INTENSIVE REARING CONDITIONS IN SOUTH AFRICA

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Of the numerous conditions which affect the gastrointestinal tract of the domestic pig only porcine intestinal adenomatosis complex (PIA), swine dysentery (SD) and colibacillosis, are of prime importance in intensive pig production in South Africa.

PIA complex is a group of related syndromes affecting primarily the ileum and caused by *Campylobacter sputorum* subsp. *mucosalis*. The four manifestations of infection with this bacterium are porcine intestinal adenomatosis (PIA), proliferative haemorrhagic enteropathy (PHE), necrotic enteritis (NE) and regional ileitis (RI). The underlying lesion in the PIA complex is a marked hyperplasia of immature epithelial cells leading to the formation of adenomatous thickenings of the

mucosa. Diagnosis of the condition is based on symptoms, macroscopic lesions (in the ileum), histopathology (organisms may be demostrated in the apical cytoplasm of epithelial cells in adenomatous areas using silver stains) and bacterial isolation by culture. Control of the disease is difficult due to inadequate knowledge at present. Tetracyclines in the diet suppress symptoms of the disease although in some instances only temporarily.

Swine dysentery is a disease of mainly post-weaned growing pigs in which the spirochaete *Treponema hyodysenteriae,* in association with other intestinal anaerobes, induces colitis with dysentery. Presumptive diagnosis is based on history, symptoms and pathology (demonstration of large numbers of spirochaetes associated with the lesions). A definitive diagnosis can only be made by isolating the organism and testing its pathogenicity in vivo. The demonstration of beta-haemolysis in vitro is a useful indicator of pathogenicity. The recent discovery of a closely related condition termed "spirochaetal diarrhoea" has made definitive diagnosis of SD even more difficult. Control of SD at present is based largely on the use of a number of antimicrobials.

Colibacillosis is well known as a disease of pigs. Enteropathogenic *Escherichia coli* overgrowth in the intestinal lumen is mediated by a host of environmental and genetic factors and produces either diarrhoea (exotoxins), endotoxaemia, septicaemia (rarely) or oedema disease. Presumptive diagnosis in most cases is not very difficult and involves isolation of pathogenic serotypes from the anterior small intestine (K88 – positive) or posterior small intestine (K99 – positive). In septicaemic cases the bacteria can be isolated from a number of organs and tissues. Control of colibacillosis should be aimed at eliminating or reducing those factors responsible for triggering the disease rather than relying on medication and/or immunization procedures.

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SARCOCYSTOSIS IN DOMESTIC ANIMALS

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Coccidian parasites of the genus *Sarcocystis* are familiar to the veterinarian as microscopic or macroscopic cysts which occur in the cardiac and skeletal musculature of a wide range of vertebrates.Recently it was found that there is a sexual, intestinal phase in meat-eating animals and man, the life-cycle of *Sarcocystis* having become adapted to the predator/prey relationship existing between its hosts.

Until 1975, *Sarcocystis* in the bovine host was usually called *S. hirsuta*, ovine *Sarcocystis* was known as *S. tenella* and porcine *Sarcocystis* was termed *S. miescheriana*. There are, in fact, three known species in cattle, three in sheep and three in swine (Markus 1978, Advances in Veterinary Science and Comparative Medicine 22: 159-193, Academic Press, New York; Collins *et al.* 1979, New Zealand Veterinary Journal 27: 204-205). Following this discovery, the nomenclature of *Sarcocystis* has become very confused. To add to the problem, it appears that the specificity of certain species of *Sarcocystis* for the intermediate host is not as strict as had been thought (Erber 1980, Proceedings of the 3rd European Multicolloqium on Parasitology: 142; Markus & Daly 1980, Proceedings of 3rd European Multicolloqium on Parasitology: 141).

Some species of the protozoon are particularly common. For instance, the prevalence in cattle of the microscopic bovine/dog species is virtually 100 per cent in animals slaughtered at many abattoirs in South Africa. On any given day it is difficult (and usually impossible) to find a carcase that does not contain this particular species of the parasite. Considering that the stage which gives rise to these muscle cysts comes from dog excrement, the reason for this remarkably high infection rate has hitherto remained obscure. The frequency with which sporocysts are transported from dog faeces by coprophilic flies and distributed in the vicinity of cattle needs to be studied in the field (Markus 1980, Journal of Parasitology 66: 361-362).

The infection in cattle caused by bovine/dog *Sarcocystis* was thought to be of no importance. However, we have shown experimentally that in South Africa, as elsewhere, fatal disease can result 4 weeks after the bovine host has ingested unusually large numbers of sporocysts. Clinical features prior to recumbency and death include anorexia, anaemia, weakness, muscle tremors, mild dehydration, loss of weight, excessive salivation and raised temperature. In acute sarcocystosis, schizonts are to be found in endothelial cells of capillaries throughout the body. Sarcocystosis may be a cause of cases of unexplained abortion not only in cattle in South Africa but also in sheep and swine. It is possible that *Sarcocystis* occasionally gives rise to macroscopically apparent eosinophilic myositis in chronically infected animals in South Africa, because of which many thousands of rands worth of meat are condemned annually at abattoirs in the country. However, the relation between *Sarcocystis* infection and eosinophilic myositis in cattle, sheep and other animals is still not clear.

The presence in South Africa of ovine/dog *Sarcocystis* and of a species of ovine/cat *Sarcocystis* have also been established by means of ultrastructural and life-cycle studies (Daly & Markus 1980, Proceedings of the Electron Microscopical Society of Southern Africa 10: 95-96.

Further work on various non-pathogenic and potentially pathogenic species of Sarcocystis of domestic animals is in progress.

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OUTBREAKS OF MYOCARDITIS IN SHEEP

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Outbreaks in sheep of a primary myocarditis accompanied by a mild meningoencephalitis in a percentage of cases, are decribed. Outbreaks occur suddenly, are accompanied by a high mortality rate and are characterised clinically and pathologically by an acute or chronic congestive heart failure.

Macroscopic lesions, which may be extensive, are present in the heart. The lesions are seen as a dull-white mottling of the atrial and ventricular walls extending into the myocardium and which are interspersed with haemorrhages. Attendent changes of an acute or chronic heart failure are seen elsewhere in the body.

Microscopically the myocardial changes vary from an acute lymphocytic myocarditis to extensive myocardial fibrosis in the cases of a longer duration. These changes occur throughout the myocardium of the atria and ventricles but are more extensive subepicardially and at the atrio-ventricular junction. A mild lymphocytic meningitis is a constant finding while a focal disseminated encephalitis of the cerebral gray matter, in particular, is encountered in 40 % of cases.

The aetiology of the ourbreaks could not be determined. However, based on the nature of the lesions, a virus is considered to be the most likely cause.

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