JOURNAL OF THE SOUTH AFRICAN VETERINARY MEDICAL ASSOCIATION

TYDSKRIF VAN DIE SUID-AFRIKAANSE VETERINÊR-MEDIESE VERENIGING

VOLUME 42 No. 1 MARCH/MAART 1971 JAARGANG 42 Nr. 1

CONTENTS/INHOUD

Review **Oorsig**

Papers **Referate**

THE JOURNAL OF THE S.A.V.M.A. is owned and published by the South African Veterinary Medical Association, of which it is the official organ. It appears quarterly and is devoted to matters of veterinary importance generally.

The statements made and opinions expressed by contributors to this Journal, are their responsibility only; such statements are not necessarily endorsed by the Editorial Committee, neither do their opinions reflect those of the Committee.

SUBSCRIPTION — A free copy of each issue is sent to all Members of the Association in good standing. The subscription rate for non-members is R10.00 per annum, post free surface mail

BACK NUMBERS are obtainable from 50c to R2.00 per number depending on rarity.

CONTRIBUTIONS — The Editor will consider contributions of veterinary interest. Double spaced, carefully revised, typewritten manuscripts should be submitted in triplicate (original plus first two copies). Layout and references should be in the style of this number. The number of figures and tables may be limited at the Editor's discretion unless the author contributes to the cost of reproduction.

REPRINTS can be obtained by authors and should be ordered at the time articles are submitted for publication. A limited number of "tear-outs" will be available free to authors.

ADVERTISING RATES on application.

AGENTS IN GREAT BRITAIN — Bailliere, Tindall & Cassell, 8, Henrietta Street, Covent Garden, London.

CORRESPONDENCE AND CONTRIBUTIONS should be addressed to the Editor, Jl S. Afr. vet. med. Ass., P.O. Box 2460, Pretoria (Tel. 4-4964).

Jl S. Afr. vet. med. Ass. 42 (1): 3-7 1971

REFRESHER COURSES IN PHARMACOLOGY
II. THE ABSORPTION OF DRUGS

W. L. JENKINS*

INTRODUCTION

There are a number of routes of drug administration available to a veterinarian in the treatment of the domesticated animal species. In enteral administration the drug is placed directly in the gastrointestinal tract by using the sublingual, oral or rectal routes. In parenteral administration the gastrointestinal tract is avoided. The term "parenteral" literally means "other than by the gut"; however, due to usage it often only implies "by injection." The commonest parenteral routes employed include subcutaneous, intramuscular, intravenous, intra-arterial, intramedullary, intrathecal, intra-articular, intraperitoneal and intradermal. Other routes employed include intraconjunctival, intra-uterine, intramammary, percutaneous and by inhalation.

In almost every case a drug must traverse an absorbing membrane or series of membranes prior to its distribution to the tissues and ultimately to its site of action. The principles which govern such movement of drugs across body membranes were reviewed in the first article of this series. The application of these concepts to the absorption of drugs from the more important sites of administration will be discussed here.

ABSORPTION FROM THE GASTROINTESTINAL TRACT

The absorption of drugs, in general, may take place along the whole length of the gastrointestinal tract. However, the physicochemical properties of each drug, factors related to gastrointestinal physiology, alterations of the normal structure and function of the gastrointestinal tract, and a number of pharmaceutical considerations may all play a role in determining the major site of absorption and more particularly the rate of intestinal absorption of any drug.

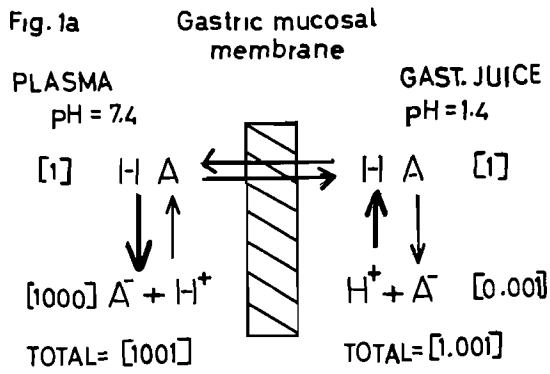
Gastrointestinal absorption of non-electrolytes

The property which governs the rate of absorption of non-electrolytes, e.g. simple alcohols, polyhydric alcohols, amides, ethers, etc., is primarily the lipid solubility of the compound. The general trend is thus for the substances with the higher lipid water partition coefficients to penetrate the gastrointestinal epithelium more rapidly. However, the size of the molecules and the nature of the groups may also exert an effect. Some compounds of high molecular weight cannot be absorbed or are only absorbed after they have been degraded enzymatically, e.g. polysaccharides and neutral fats. Generally absorption takes place by the process of simple lipid diffusion and is independent of the pH of the gastrointestinal fluid.

Absorption of weak electrolytes from the gastric lumen

The gastric epithelium has been shown to be a barrier which is also preferentially permeable to the lipid soluble nonionized form of a drug. Thus weak acids (pKa 3-10) such as acetylsalicylic acid, pentobarbitone, phenol, nalidixic acid, nitrofurantoin, sulphadimidine, etc., which are mainly undissociated in the acid gastric juice, are readily absorbed from the stomach (Fig. 1a). Weak bases (pKa 5-10), such as quinidine, pethidine, ephedrine, tolazoline, etc., which will be highly ionized at a pH of about 1.4, are hardly absorbed at all from the stomach. In fact, the marked difference in hydrogen ion concentration between gastric juice and plasma leads to an uneven distribution of both weak acids and bases between the two fluid compartments (Figs. 1a and 1b). Basic drugs like levorphanol, strychnine and many others will become more concentrated in gastric juice than in plasma (Fig 1b) because they dissociate into the ionized form within the gastric lumen and cannot be reabsorbed.

*Department of Medicine, Faculty of Veterinary Science, University of Pretoria, P.O. Onderstepoort.



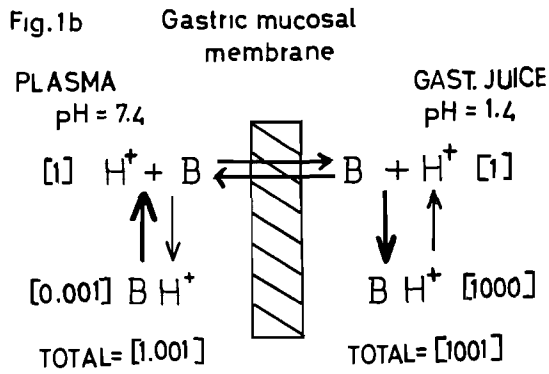


Fig. 1a. The distribution of a weak acid (pKa : 4.4) between plasma and gastric juice. Note that equilibrium favours absorption from the stomach.

Fig. 1b. The distribution of a weak base (pKa : 4.4) between plasma and gastric juice. Note that equilibrium favours diffusion from plasma into the stomach.

This penomenon is called "ion-trapping."

Absorption of weak electrolytes from the intestinal lumen

The degree of ionization and lipid solubility of a weak electrolyte will once again determine its rate of diffusion through the intestinal mucosa. Detailed studies with a great many drugs have revealed that in the normal intestine, acids with a pKa greater that 3.0 and bases with a pKa less than 7.8 are very well absorbed. Outside these limits the absorption of the stronger acids and bases occurs very slowly. These findings have lead to the conclusion that the "virtual pH" in the micro-environment of the absorbing surface in the gut is about 5.3. This is rather more acidic than the figure which is usually accepted as being the pH in the intestinal lumen. Theoretical distribution and absorption patterns for a weak acid and base are presented in Figs. 2a and 2b respectively to illustrate these concepts.

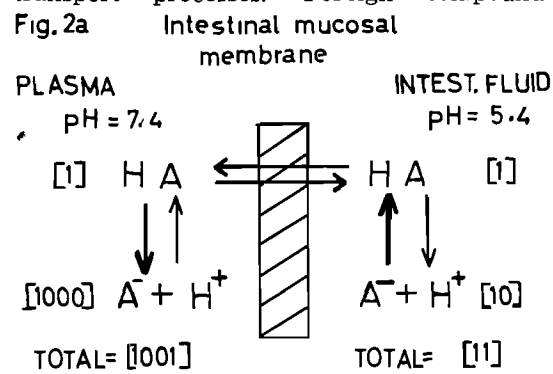
Absorption from the colon is less rapid than from the small intestine but otherwise takes place by the same mechanisms.

Absorption of organic ions from the intestinal lumen

In some cases a drug may traverse the intestinal epithelium to a significant degree as the charged species, although the rate of absorption is usually much slower than that of lipid soluble uncharged molecules. There is now evidence available which suggests that in these cases the formation of complexes within the intestine "augments" the absorption of such drugs. Examples include benzamethamine, dextromethorphan and the tetracyclines. These complexes may be formed with ions or with other compounds.

Active transport of drugs across intestinal epithelium

The absorption from the small intestine of natural substrates, e.g. L-amino acids, glucose and uracil, occurs by specific active transport processes. Foreign compounds



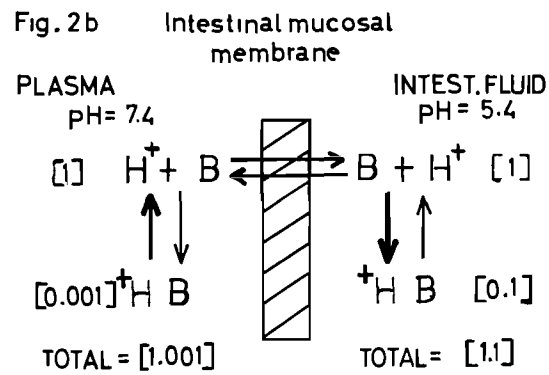


Fig. 2a. The distribution of a weak acid (pKa : 4.4) between plasma and intestinal fluid. Note that the equilibrium favours absorption from the intestine.

Fig. 2b. The distribution of a weak base (pKa : 4.4) between plasma and intestinal fluid. Note that equilibrium favours diffusion from plasma into the intestine.

which resemble natural substrates sufficiently closely may be transferred by these mechanisms. The best known examples of this phenomenon include the transport of a few unnatural sugars by the glucose mechanism and 5-fluorouracil by the uracil mechanism.

FACTORS AFFECTING THE GASTROINTESTINAL ABSORPTION OF DRUGS

Although the basic principles of drug absorption from the gastrointestinal tract have largely been clarified, many additional factors may play a role in modifying the rate of absorption. The following list will serve to summarize the most important considerations.

a) FACTORS RELATED TO PHYSICOCHEMICAL PROPERTIES OF THE DRUG

1) *Molecular size and shape*
2) *Degree of ionization*
3) *Lipid solubility*

1, 2 and 3 have been discussed previously.

4) *Interactions with other drugs or foreign compounds coadministered or present in the gastrointestinal tract*

Any interaction which produces a change in the physicochemical state of a drug will also affect its absorption. A few examples can be cited here to illustrate this problem, viz., calcium, magnesium, aluminium and iron salts may interfere with the absorption of tetracyclines, activated charcoal reduces the absorption of many compounds, lipoid cathartics may dissolve some drugs and thus affect the amount of drug that can come into contact with the intestinal epithelium, and quaternary ammonium compounds may interact with mucopolysaccharides present in intestinal mucus.

5) *Pharmaceutical factors*

The absorption rate of a drug is very often a function of its formulation and usually correlates fairly well with the *in vitro* dissolution rate (rate at which a drug dissolves in a liquid medium) but poorly with the disintegration rate (rate at which a tablet breaks up and fragments in a liquid medium). However, factors such as particle size, vehicle, coating, solubility and ageing affect physiologic availability. Once again examples will serve to illustrate these considerations. The role of particle size on the efficacy of griseofulvin and phenothiazine is well known and will not be discussed here. Surface-active agents used as solubilizing adjuncts may produce either facilitation or inhibition of drug absorption. The inhibitory effect is due to complexation — the entrapment of the drug molecules within micelles of the surfactant. An enhancing effect is evident in the accelerated absorption of paracetamol and phenacetin in the presence of sorbitol and "Tween 80." The effect of ageing is well demonstrated by the reduced absorption of chloramphenicol due to polymorphism.

b) PHYSIOLOGICAL FACTORS

1) *Rate of gastric emptying*

If a drug is absorbed from the stomach, but not the intestine, an increased rate of gastric emptying may reduce absorption, whereas faster gastric emptying could accelerate the absorption of drugs from the intestine.

2) *Intestinal motility*

Changes in intestinal motility can produce varying effects. Excessive peristaltic activity may remove a drug before absorption has occurred. This is particularly applicable to enteric-coated formulations and drugs which are usually slowly and incompletely absorbed like digitalis and the tetracyclines. However, the absorption of some compounds may be increased from the hyperactive gut and this is possibly due to better contact between drug and epithelial surface. Decreased intestinal motility may increase the time available for absorption. However, in this case the rate of drug absorption may be decreased because of lessened surface contact although the total amount absorbed may not be radically altered.

3) *Various feeds*

The presence of various foodstuffs may interfere with drug absorption by reducing the concentration of the compound, by obstructing access of the drug to the absorbing surface, by binding with the drug, or by influencing the secretion of gastrointestinal hormones which may affect gastric motility.

4) *Volume of the gastrointestinal tract*

The rate of drug absorption is proportional to the concentration in the intestinal tract and thus the higher the concentration of the drug the greater the absorption rate. Therefore dilution in the gastrointestinal fluid

will reduce a drug's absorption rate. The role of an increased fluid volume on dissolution and disintegration rates and on intestinal motility must also be borne in mind.

5) *Osmotic pressure*

Differences between the osmolality of the gastrointestinal fluid and the plasma will produce water flux through the epithelium. This in turn may lead to a solvent drag effect on sufficiently small solute molecules. Furthermore the fluid volume in the gastrointestinal tract may be altered.

6) *Intestinal blood flow*

Although there is increased splanchnic blood flow during digestion and this is the basis for the administration of drugs after meals, it does seem that the blood supply to the intestinal mucosa is rarely a rate-limiting factor in drug absorption. It is, in fact, unlikely that a decreased blood flow will produce any significant decrease in the rate of absorption of drugs absorbed by passive diffusion. This situation does not, however, apply to the gastric mucosa where changes in blood flow can radically alter the rate of drug absorption.

7) *Intestinal lymph flow*

Lymphatics do play a role in the absorption of drugs but more especially in the absorption of large molecules such as cholesterol, protein and fatty acids. If lymph flow is increased, it is possible to have a greater proportion of a particular compound carried by lymph.

c) FACTORS RELATED TO THE STRUCTURE AND FUNCTION OF THE INTESTINAL MUCOSA

1) *Disruption of the structural integrity of the epithelium*

If any process causes a breakdown in the structure of the cell membrane then the barrier to diffusion is lost. Such processes would include physical and chemical injury, a wide variety of inflammatory reactions, inhibition of the normal metabolism of the intestinal epithelial cells, etc.

2) *Malabsorption syndromes and enhanced absorption*

Some drugs may produce malabsorption states which are usually reversible. Examples of these agents include diphenylhydantoin, colchicine, para-aminosalicylate, methotrexate, cholestyramine, clofibrate and neomycin. On the other hand certain anionic or non-ionic surfactants appear to enhance the absorption of various drugs by altering the physical properties of the barrier. In addition, chelating agents increase the absorption of certain drugs by widening intercellular channels.

3) *Inhibition of epithelial metabolic functions*

Inhibition of general metabolic activities may result in nonspecific inhibition of drug absorption if this depends on a specialized process. Specific competitive inhibition of a transport mechanism may also occur, e.g. 5-fluorouracil and 5-bromouracil compete with each other.

4) *Drug biotransformation within the intestinal mucosa*

The intestinal mucosa is capable of carrying out a wide variety of drug transformation reactions, particularly glucuronidation. This means that although a drug may be readily absorbed it may be delivered to the circulation in an inactive form.

ABSORPTION THROUGH THE SKIN

The skin allows the passage of lipid soluble substances but efficiently retards the diffusion and evaporation of water except at the sweat glands. It seems that the outer cornified layer, densely packed with keratin, is responsible for preventing water loss. However, just beneath this layer is the so-called "barrier area," a clear dense region quite different from the horny layer in microscopic appearance and in chemical properties. This layer is responsible for normal skin permeability. Furthermore, absorption through appendageal structures is no greater than through an equivalent area of epidermis.

Although lipid soluble molecules are absorbed much more readily than lipid insoluble molecules, drugs penetrate skin slowly in comparison with their rates of absorption through other body membranes.

Absorption of drugs through the skin may be enhanced by inunction or more rarely by iontophoresis if the compound is ionized. However, recent studies have suggested the possibility of using pharmacologically inactive solvents to facilitate the penetration of drugs through the skin. The best known of these solvents is dimethyl sulphoxide.

ABSORPTION THROUGH THE CORNEA

Many drugs traverse the cornea at rates related to their degree of ionization and lipid solubility. Thus organic bases, like atropine, ephedrine and pilocarpine, often penetrate quite readily whereas the highly polar antibiotics generally penetrate the cornea very poorly.

INHALATION OF DRUGS

The volatile and gaseous anaesthetics are the most important group of drugs administered by inhalation. These substances enter the circulation by diffusion across the alveolar membranes. As they all have relatively high lipid water partition coefficients and are generally rather small molecules, they equilibrate practically instantaneously with the blood in the alveolar capillaries.

Drugs may also be inhaled as aerosols but this method of drug administration is still rather rare in veterinary medicine.

ABSORPTION FROM THE COMMON PARENTERAL SITES

After a drug has penetrated the skin, gastrointestinal epithelium, or other absorbing surface or has been deposited by injection into a body tissue, it comes into the immediate vicinity of the blood capillaries. Solutes then traverse the capillary wall by a combination of two processes, viz. diffusion and filtration. Diffusion is the predominant mode of transfer for lipid-soluble molecules as well as for small lipid-insoluble molecules and ions. Filtration (hydrodynamic flow) predominates for large lipid-insoluble molecules whose rates of diffusion across the capillary endothelium are, however, relatively slow. All drugs, whether lipid-soluble or not, cross the capillary wall at rates which are extremely rapid in comparison with their rates of passage across other body membranes. In fact, the movement of most drug molecules in various tissues is limited by the rate of blood flow rather than by the barrier imposed by the capillary wall.

Intramuscular administration

Ordinary aqueous solutions of drugs are usually absorbed from an intramuscular site within 10 to 30 minutes provided the blood flow is unimpaired. Faster or slower absorption is possible depending on the vascularity of the site, the lipid solubility of the drug, the volume of injection, the osmolality of the solution and other variables. It is noteworthy that substances with molecular weights above 20,000 are principally taken up into the lymphatics.

Subcutaneous administration

Absorption of drugs from subcutaneous tissues is influenced by the same factors that determine the rate of absorption from intramuscular sites. Furthermore, there now seems to be some doubt about the previously accepted fact that absorption from subcutaneous sites is always slower than from from intramuscular sites. Some drugs at least are known to be absorbed as rapidly from subcutaneous tissues as from muscle.

Facilitation of drug absorption from parenteral sites

Increasing the blood supply to the site of injection by heating, massage or exercise will hasten the rate of dissemination. However, of some importance is the problem of poor tissue perfusion present in shock. A drug injected intramuscularly will not be readily absorbed if shock is present and no response can be expected. If such injections are repeated and if the animal ultimately recovers, tissue perfusion will improve and high concentrations of the drug will then circulate with possible deleterious effects.

Spreading of an injected mass may be facilitated by including hyaluronidase in the injection solution.

Prolongation of action of injected drugs

The rate of absorption of an injected drug may be prolonged in a number of ways. These methods include immobilization of the site, local cooling, a tourniquet, incorporation of a vasoconstrictor, solutions in an oil base, implant pellets and other "depot" preparations. Amongst these depot preparations are included water-soluble drugs which are converted to less soluble salts, e.g. procaine and benzathine penicillin, or to a less soluble complex, e.g. protamine zinc insulin, and microcrystalline suspensions, e.g. methylprednisilone.

SUGGESTED READING

Binns T. B. (ed.) 1964. Absorption and Distribution of Drugs, E & S Livingstone Ltd., Edinburgh and London

Bowman W. C., Rand M. J. & West G. B. 1968. Textbook of Pharmacology. Blackwell Scientific Publications, Oxford and Edinburgh

Levine R. R. 1970. Factors Affecting Gastrointestinal Absorption of Drugs. Digestive Diseases 15: 171

Announcing a significant breakthrough in veterinary geriatrics

salupet

Extensively tested and documented, SALUPET is recommended for

* Counteracting the symptoms of old age and retarding the ageing process
* Heart conditions and dilation of heart supply vessels
* Rheumatism, Arthritis and other forms of stiffness in limbs and joints
* Listlessness, excessive panting and loss of appetite

Animals of all ages also benefit greatly from a course of SALUPET for

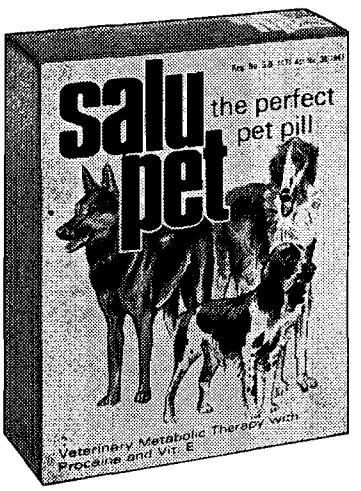
* Sturdy development of muscle and bone
* Show-condition coats
* Alertness and endurance in game dogs
* Convalescence – particularly after biliary as it increases red blood corpuscles and haemoglobin values

Each tablet contains:

Vitamin E (Alpha Tocopherol Acetate)	5.00 mg
Haematoporphyrin	0.50 mg
Procaine Hydrochloride (H_3)	12.50 mg
Vitamin A 1250 i.u.	3.25 mg
Vitamin B_1	0.50 mg
Vitamin B_2	0.25 mg
Nicotinamide	3.75 mg
Vitamin C	6.25 mg

In a food yeast base

Dosage: Up to two tablets daily according to body weight.



Readily accepted by animals whole or crushed and mixed into food.
Registered in terms of Act No. 36 of 1947, as amended. Available from all chemists. Pack of 60 tablets—1 to 4 months supply: R1.30.

More detailed technical documentation available from Salusa (Pty) Ltd., P.O. Box 17, Silverton/Pretoria.

417

Jl S. Afr. vet. med. Ass. 42 (1): 9-12 1971

PLASMA AND BLOOD VOLUME CHANGES IN SHEEP EXPERIMENTALLY INFESTED WITH *HAEMONCHUS CONTORTUS*

N. C. OWEN*

SUMMARY

Plasma and blood volume changes were studied in three German Merino sheep experimentally infested with *Haemonchus contortus* and compared with three uninfested controls. The plasma volumes were determined with Evans blue at weekly intervals. The red cell volume was initially determined with ^{51}Cr labelled red cells and the blood volumes subsequently calculated using suitable correction factors.

The plasma volumes increased significantly 2-3 weeks after infestation in the severely infested animals. However, the blood volumes of all animals remained constant throughout.

INTRODUCTION

In view of the extensive blood loss [1, 2, 3, 4] and the plasma composition changes [5, 6, 7] caused by *Haemonchus contortus* infestation, the plasma and blood volume changes were studied in artificially infested sheep.

MATERIALS AND METHODS

Six worm-free German Merino lambs, aged four months were used. Three were infested with 50,000 infective *H. contortus* larvae given by pipette *per os* in two doses of 34,000 and 14,000 four days apart. All lambs were housed individually in metabolism cages and fed milled lucerne hay *ad libitum*.

The trial was taken as commencing on the day prior to the administration of the second dose of larvae. The degree of infestation was gauged by regular faecal egg counts [8] and total worm counts at autopsy [9].

On day one, the plasma and red cell volumes of all six sheep were measured using Evans blue and ^{51}Cr respectively. Thereafter the plasma volumes were measured at weekly intervals together with venous haematocrits (1,600 g for 30 minutes in Wintrobe tubes). From these results and the mean venous to whole body haematocrit ratios (F_{cells} ratio) established on day one, the blood volumes were calculated.

Plasma volumes were determined as described by Chien and Gregerson [10], where residual dye in the syringe is rinsed into the animal's bloodstream after injection. Suitable Evans blue standards were prepared in normal sheep plasma and the peak absorption established at 625mμ.

Washed red blood cells from 16 ml of venous blood were labelled *in vitro* with 100μCi ^{51}Cr as sodium chromate [11]. Radioactivity was measured by solid scintillation counting (Phillips PW. 4111 NaI crystal), compared with suitable standards and the red cell volume calculated [10].

The procedure for initial blood volume determination was as follows: Adrenalin (20 μg/kg) was injected intravenously to contract the spleen and ensure rapid and complete mixing of labelled red cells [12]. A blood sample was withdrawn followed by injection of 6.98 mg of Evans blue in 3 ml of sterile water and ^{51}Cr labelled red cells reconstituted in sterile saline. After a mixing time of 10 minutes, three blood samples were taken at 8-10 minute intervals, alternately from the left and right jugular veins. Radioactivity of the blood and Evans blue content of the plasma were determined at zero time by extrapolation.

These values were used to calculate red cell and plasma volumes.

RESULTS

The severity of infestation can be gauged from the results presented in Table 1.

Although the haematocrit dropped as low as 12.9% in the case of sheep 189, the net decrease in haematocrit was somewhat less than that for sheep 169. Nevertheless sheep 189 voided a greater number of eggs

*Section of Physiology, Faculty of Veterinary Science, Onderstepoort.

Table 1: RESULTS FROM INFESTED SHEEP SHOWING THE RELATIVE DEGREE OF INFESTATION AND ANAEMIA

(Figures in parenthesis indicate the day on which the maximum net decrease in haematocrit occurred, and the corresponding egg count was recorded.)

Sheep No.	Net decrease in haematocrit (%)	Faecal egg count (e.p.g.)	H. contortus at autopsy
189	22.1 (39)	40,800	9,470
169	24.2 (41)	37,900	7,410
153	16.2 (26)	5.570	2,750

over the experimental period and had some 2,000 more parasites in the abomasum at autopsy.

Plasma volume changes

The plasma volumes (P.V.) of the infested animals increased more rapidly than those of the controls. This trend is illustrated in Fig. 1.

The plasma volumes for the respective sheep expressed as ml/kg body weight are recorded in Table 2.

The increase in the plasma volume of sheep 189 was significantly greater than that of the controls by the 32nd day, becoming more so by the 41st day. The plasma volume of sheep 169 had increased significantly by day 20, and the animal developed severe clinical neck and intermandibular oedema shortly thereafter.

Table 2: PLASMA VOLUMES OF EXPERIMENTAL SHEEP (ml/kg)

The increase in plasma volume of each infested sheep was tested against the experimental error within the control sheep by t-test (*$p<0.05$; **$p<0.01$)

Sheep No.	Treatment	No. of days after infestation 0	14	20	32	41
189	Infested	51.57	57.06	60.73	67.27*	73.94**
169	,,	48.93	51.53	64.63*	55.67	65.65**
153	,,	50.69	50.32	52.43	55.70	50.81
191	Control	49.41	50.07	51.42	56.28	—
171	,,	46.92	44.88	47.74	47.17	42.87
137	,,	45.05	40.92	45.39	51.13	53.27

By the 32nd day, the plasma volume had decreased considerably and the animal was passing excessive quantities of urine. The plasma volume, however, again increased significantly by day 41.

The plasma volume of the mildly infested sheep (no. 153) did not differ significantly from the controls, while the plasma volumes of the controls remained reasonably constant throughout.

Blood volume changes

The red cell volumes (R.C.V.), measured initial blood volumes (B.V.=R.C.V.+P.V.) and the venous : whole body haematocrit

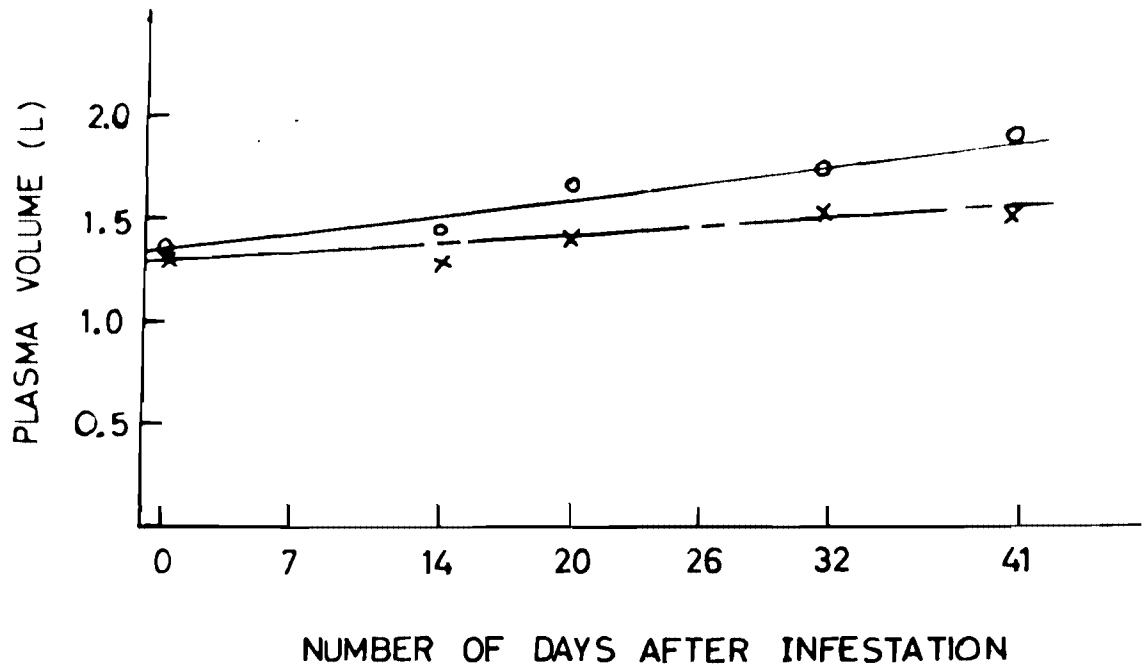


Fig. 1. Mean plasme volumes of infested (O———O) and control (X———X) animals over the experimental period.

Table 3: INITIAL RED CELL VOLUMES, BLOOD VOLUMES AND F_{cells}—RATIO DETERMINED ON FIRST DAY OF EXPERIMENT

(All sheep may be regarded as normal)

	R.C.V.		B.V.		H'%	F
	ml	ml/kg BW	ml	ml/kg BW		cells
137	553.7	19.99	1802	65.05	32.8	0.9366
153	617.9	22.63	2002	73.33	33.2	0.9298
169	614.2	24.09	1862	73.02	34.4	0.9590
171	449.2	17.62	1645	64.51	31.0	0.8807
189	573.8	22.95	1863	74.52	35.6	0.8657
191	507.1	19.58	1787	68.99	31.3	0.9076
	Means	21.4 ± 1.01		69.9 ± 1.79		0.9132 ± 0.0457

H' = haematocrit corrected for trapped plasma [14].

$$F_{cells} = \frac{100 \times R.C.V.^{10}}{\frac{(R.C.V. + P.V.)}{H'}}$$

ratios (F_{cells}) for each sheep are given in Table 3.

The blood volumes of the experimental animals were calculated from each of the measured plasma volumes using the mean F_{cells} factor of 0.91 and the corrected haematocrits presented in Table 3. These results are given in Table 4.

Table 4: CALCULATED BLOOD VOLUMES EXPRESSED AS ml/kg BODY WEIGHT

Sheep No.	Treatment	No. of days after infestation 0	14	20	32	41
189	Infested	76.40	69.18	74.27	78.00	84.67
169	,,	71.34	68.22	82.58	69.60	78.89
153	,,	72.74	69.78	71.48	75.60	68.67
191	Control	69.16	68.76	72.63	78.00	—
171	,,	65.45	64.34	67.03	68.08	62.01
137	,,	64.32	57.62	64.32	71.10	74.87

The tabulated results were analysed as for the plasma volumes (Table 2) and no statistically significant differences ($P<0.05$) were found between the blood volumes of the infested and control sheep.

DISCUSSION

The mean red cell volume obtained with the normal sheep is reasonably close to the values obtained by Hodgetts [12] and Neethling, Brown and de Wet [13] using larger numbers of sheep. However, the mean F_{cells} following adrenalin injection is somewhat higher than that recorded by Hodgetts [12] using a similar technique. The individual variation was also greater in the present investigation. This finding may be due to small differences in the time between adrenalin injection and plasma volume measurement.

The results obtained show a significant increase in the plasma volumes of fairly severely infested sheep. On the other hand the blood volumes remained reasonably constant throughout. It is clear that the infested sheep compensate for the reduction in red cell volume caused by the parasitic blood loss, by increasing the plasma volume.

The fact that one animal developed overt clinical oedema suggests that infested sheep in some way increased their extracellular fluid volumes in order to maintain the blood volume. This is supported by the finding that the plasma volumes were increased in the face of a marked hypo-proteinaemia [14] coinciding with the rapid decrease in haematocrit.

In view of these results, it is obvious that body fluid composition changes should be interpreted in relation to the plasma volume changes.

ACKNOWLEDGEMENTS

My thanks are due to the Faculty of Agriculture, University of Natal, Pietermaritzburg for supplying the facilities to conduct this work.

REFERENCES

1. Veglia F. 1915 *3rd & 4th Rep. Direct. Vet. Res.*, Union of South Africa: 349
2. Fourie P. J. J. 1931 *Direct. Vet. Serv. and Anim. Ind. Ann. Rep.* 17: 495
3. Boughton I. B. & Hardy W. T. 1935 *Texas Agric. Exp. Sta., Annual Report* 48: 236
4. Andrews J. S. 1942 *J. Agric. Res.* 65: 1
5. Nagahata S., Fugita J. & Ikegaya S. 1941 *Jap. J. vet. Sci.* 3: 155
6. Wilson G. I. & Turner J. H. 1965 *Am. J. vet. Res.* 26: 645
7. Shumard R. F., Bolin D. W. & Eveleth D. F. 1957 *Am. J. vet. Res.* 18: 330
8. Reineke R. K. 1961 *Jl S. Afr. vet. med. Ass.* 32: 167
9. Reineke R. K., Horak I. G. & Snijders A. J. 1963 *Proc. 1st Int. Conf. World Ass. for Adv. of vet. Parasit.* Aug. 22-23: 167
10. Chien S. & Gregerson M. I. 1962 Physical techniques in biological research. Vol. IV. Special Methods. Academic Press, New York and London.
11. Brambell M. R. & Charleston W. A. G. 1964 *J. Comp. Path.* 74: 338
12. Hodgetts E. 1961 *Aust. J. exp. Biol.* 39: 187
13. Neethling L. P., Brown J. M. M. & de Wet P. J. 1968 *Jl S. Afr. vet. med. Ass.* 39: 73
14. Owen N. C. 1968 The pathological physiology of haemonchosis in sheep. Dissertation submitted in partial fulfillment of the requirements for the Degree M.Med.Vet. (Physiol), University of Pretoria.

BOOK REVIEW

AN ATLAS OF PLACENTAL FINE STRUCTURE

NILS BJORKMAN V.M.D.

Bailliére, Tindall and Cassell Ltd. London. 5 October 1970. 1st Edition.

12″×8½″ 96 pp. including 30 pages of Black and White Plates. Price R9.00.

With research which has led to this atlas of placental fine structure, the author has succeeded in filling a gap which has always been felt in teaching placental morphology to veterinary students, namely the lack of knowledge concerning the exact structure of the barriers which exist between foetal and maternal capillaries or spaces in the placenta. By means of photo- and ultramicrographs orientated from low power to ever increasing powers, a clear morphological picture is presented which outlines the basis of the histological classification of the placenta types. The author found no evidence of the syndesmochorial type.

The subjectmatter entails an introductory but adequate review of the principles of classification of the widely divergent placental types. The placenta is represented as a transient organ which initially develops rapidly but is finally subject to involution. The placentae of pig, horse, cow and sheep are dealt with as examples of the epitheliochorial type, those of the dog and cat as endothelio-chorial, those of man, mouse, rabbit and guinea-pig as haemochorial and that of the vampire bat as a developmental transition between endotheliochorial and haemochorial types.

The ultramicrographs are of excellent quality. An extensive reference list as well as an index is included.

As a first edition there are bound to be some essential omissions, for example omission of ultramicrographs on the zone of erosion of maternal epithelial cells and of absorption of haemglobin in region of haematomas in the dog placenta. The author has also mostly omitted to state the gestation age, an omission which is greatly felt in considering the placenta as a transient organ. It is hoped that later editions will improve on these aspects.

This book is considered a very valuable addition to the as yet rather limited bibliography on developmental morphology, especially in the veterinary field.

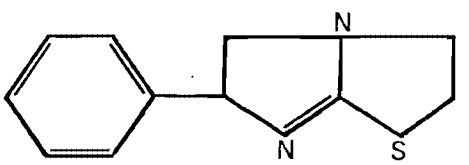
— W.H.G.

TRAMISOL WM

Die beproefde Rondewurmmiddel, beskikbaar in twee formulerings — Dis u keuse

(L-Tetramisoolhidrochloried)

‚Tramisol' WM (l-tetramisoolhidrochloried) is die linksdraaiende isomeer van rasemiese tetramisool, en is l-2, 3, 5, 6, -tetrahidro-6 fenielimidaso (2, l-b) tiasoolhidrochloried. Dit is 'n wit, reuklose poeier wat maklik in water oplosbaar is, en die chemiese struktuur daarvan is soos volg:



l HCl

Die orale formulering van ‚Tramisol' WM is beskikbaar as 'n l-tetramisoolhidrochloried-oplossing van 2.5% g/v in verpakkings van 1, 2.25, 10 en 20 liter. Dosisvoorskrifte: Een standaard-voorskrif vir alle diere — skape en bokke — 3 ml per 10 kilo; beeste — 5 ml per 50 kilo; volstruise — 8 ml per 5 kilo. Enige konvensionele veeldosis-uitrusting kan gebruik word.

Die inspuitbare formulering word aangebied as 'n steriele oplossing, bevattende 7.5% g/v l-tetramisoolhidrochloried in veeldosis-bottels van 500 ml. vir toediening by wyse van **onderhuidse** inspuiting. Dosisvoorskrifte: Een standaard-voorskrif vir alle lewende hawe — skape en bokke — 1 ml per 10 kilo; beeste — 5 ml per 50 kilo; Enige konvensionele veeldosis-toerusting kan vir die toediening van ‚Tramisol WM' gebruik word.

Ons wil u aandag ook vestig op die feit dat die aktiwiteit van ‚Tramisol' WM vir die verskillende maagdermnematodes en longwurms by beeste, skape, bokke en volstruise geregistreer is ooreenkomstig die Nie-Parametriese Evaluasiemetode (Reinecke/Groenewald).

TRAMISOL WM

ICI

Verkrygbaar by:

I.C.I. SOUTH AFRICA (PHARMACEUTICALS) LIMITED

Posbus 11270, Johannesburg.

Posbus 948, Durban.

Posbus 3451, Port Elizabeth.

Posbus 15, Observatory, K.P.

Ook by:

MILBOROW & CO.

Get the jump on mastitis... before your patient can say "Mooo"

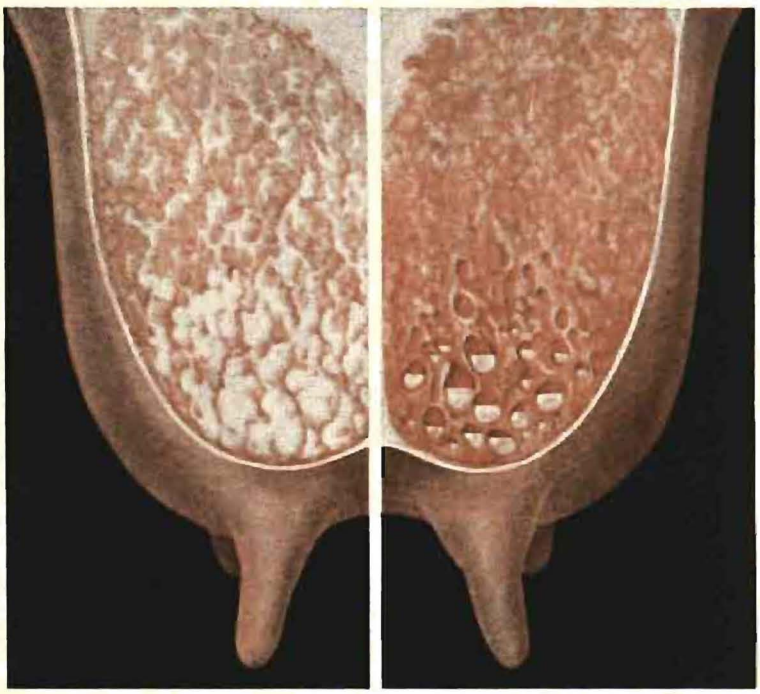


Illustration shows how new Metibiotic Mastitis Foam, when injected, completely fills the quarter of the udder.

Contrast this with the way ordinary oily remedy only fills the teat and cistern, failing to reach upper rear quarter.

New METIBIOTIC is a self-propelled foam. Only a foam can fill the whole quarter. And then hang on to do its work!

There are dozens of fine antibiotics for mastitis. But conventional methods of infusion after milking leave the agents undispersed and floating in the teat and gland cistern. Medication usually fails to reach the infected upper udder for a complete milking cycle.

New Metibiotic aerosol-powered mastitis foam reaches the top of the udder instantly. Metibiotic also contains Tween, emulsifying and dispersing agent which carries the antibiotic to conventionally hard-to-reach collecting ducts and alveoli.

No "milk-out" before treatment. In conventional treatment much of the medicating agent is frequently "milked-out" before reaching infected tissue. Metibiotic's instant dispersing action puts the entire dosage to work before "milking-out" can occur.

Tested formula, reduces tissue damage. Active ingredients include two proven antibiotics (penicillin G procaine 100,000 units, dihydrostreptomycin 300 mg.) and one corticosteroid (prednisone acetate U.S.P. 4 mg.) to control infection and soothe inflammation. Treatment is faster, tissue damage smaller. Cost is low.

NEW METIBIOTIC

Warning: Milk taken from animals during treatment and for 72 hours (6 milkings) after the latest treatment must not be used for food.

Packaging: Single dose containers, box of 12.

SCHERING CORPORATION USA. Scherag (Pty) Limited, 54 Electron Ave., Isando, Transvaal.

BKA1699

Jl S. Afr. vet. med. Ass. 42 (1): 15-17 1971

CYANOCOBALAMIN (VIT. B_{12}) ABSORPTION IN NORMAL AND *HAEMONCHUS CONTORTUS* INFESTED SHEEP

N. C. OWEN*, L. P. NEETHLING** AND H. M. TERBLANCHE***

SUMMARY

The simultaneous free and intrinsic factor bound radioactive cyanocobalamin urinary excretion test has been successfully applied to sheep, using direct intra-abomasal injection of cyanocobalamins. Normal and *Haemonchus contortus* parasitized sheep were investigated. Large individual variations were observed in the percentage absorption of the administered dose. However, the ratio of bound to unbound (^{57}Co to ^{58}Co) cyanocobalamin excreted in the urine approached unity in all cases. The results suggest that intrinsic factor is involved in the uptake of vitamin B_{12} in sheep. The absorption of vitamin B_{12} was studied during both the immature and adult stages of haemonchosis, but no changes in the intrinsic factor activity were encountered.

INTRODUCTION

Although the absorption of cyanocobalamin has been studied extensively with regard to pernicious anaemia in man [1], virtually no work appears to have been done on the role of intrinsic factor in the anaemias of sheep. It has been shown that the pyloric region of the abomasum of sheep has a binding affinity for cyanocobalamin similar to that of other species [2], which suggests that cyanocobalamin absorption is intrinsic factor dependent in the sheep. Since mucosal damage or partial gastrectomy limits the absorption of the vitamin in man, we assumed that mucosal damage due to haemonchosis could similarly affect vitamin B_{12} absorption in sheep. Such a finding would explain the macrocytic red cell changes often associated with haemonchosis [3, 4, 5].

Bell, Bridges and Nelson [6], using the simultaneous administration of free and bound radioactive cyanocobalamin, correlated urinary excretion of radioactivity with absorption of the vitamin. The absorption of vitamin B_{12} has been studied in normal and *Haemonchus contortus* infested sheep by a similar technique.

MATERIALS AND METHODS

Merino wethers were housed in metabolic cages and fed milled lucerne hay *ad libitum*. Each sheep was fitted with a standard faeces collecting bag and harness to enable the separate collection of urine without faecal contamination.

Free (^{58}Co) and human intrinsic factor bound (^{57}Co) cyanocobalamin were obtained from the Radiochemical Centre, Amersham. Before use, 0.25 μg of both free and bound vitamin B_{12} corresponding to 0.5 μCi of radioactivity, were dispersed in 5 ml physiological saline containing 0.1 equivalents of hydrochloric acid per litre.

The procedure for studying vitamin B_{12} absorption in sheep was as follows: After a 24-hour fasting period, individual sheep were restrained on an operating table and the abomasum isolated by midline incision under local anaesthesia. Both forms of radioactive vitamin B_{12} were then injected directly into the abomasum. After suturing the abdominal wall and skin in the usual manner, 1 ml of unlabelled free cyanocobalamin (1 mg) was injected intramuscularly. The sheep were then immediately returned to the metabolic cages and a 24-hour urine sample collected.

In all, ten absorption studies were carried out; four on normal sheep and six on *Haemonchus contortus* parasitized sheep.

The parasitized sheep consisted of yearling Merino lambs infested orally with 14,000 third stage larvae. Absorption studies were done on the 12th and 26th day following infestation.

In two infested sheep bound cyanocobalamin (^{57}Co) was injected intravenously (0.1 μg) on the 14th day after infestation and the urine collected after 16 hours.

The total amount of radioactivity (measured as ^{57}Co and ^{58}Co) was determined in all urine samples by counting a suitable aliquot.

*Dept. of Physiology, Faculty of Veterinary Science, University of Pretoria, Box 12580, Onderstepoort.
**Section of Radiation Biology, Veterinary Research Institute, Onderstepoort.
***Section of Reproduction, Veterinary Research Institute, Onderstepoort.

The severity of infestation was established by total worm count at autopsy 33 days after infestation. Micro-haematocrits were conducted periodically throughout the experimental period.

RESULTS

The absorption of cyanocobalamin by the normal sheep as judged by the urinary excretion of radioactive cobalt, is given in Table 1.

Table 1: URINARY EXCRETION OF LABELLED VITAMIN B_{12} BY NORMAL SHEEP

Control Sheep No.	Radioactivity in 24 hr. urine sample (%)		Ratio $^{57}/_{58}$
	^{57}Co	^{58}Co	
C_1	1.9	2.1	0.9
C_2	16.2	15.7	1.0
C_3	27.5	29.0	1.0
C_4	39.3	37.1	1.1

TABLE 1

The data presented above show a considerable variation in the amount of radioactive cobalt excreted in the urine. The ratio of ^{57}Co to ^{58}Co however, approaches unity in all cases.

The values obtained from parasitized sheep together with haematocrits and total worm burdens are set out in Table 2.

A similar variation is observed between individuals and the ratio (^{57}Co to ^{58}Co) is again approximately one irrespective of the stage or degree of infestation. The haematocrit values indicate the development of anaemia.

DISCUSSION

The method used for sheep gives a range of urinary excretion similar to that of Bell *et al*[6] used for diagnosing malabsorption of vitamin B_{12} in man.

A striking feature of all the results obtained is that the percentage of either free or human intrinsic factor (H.I.F.) bound cyanocobalamin absorbed remains the same, approximating a ratio of one in all cases. This implies that the mode of absorption is identical in both instances and supports the assumption that vitamin B_{12} absorption is intrinsic factor dependent in the sheep. On the other hand it may be reasoned that the sheep is capable of absorbing both free or bound cyanocobalamin at the same rate. However, this seems unlikely in view of the disparity in molecular size.

Species differences with regard to intrinsic factor have been clearly demonstrated e.g. H.I.F. promotes vitamin B_{12} absorption in the guinea pig but not vice versa[7]. Our results suggest that a similar situation may exist with regard to sheep and man. This would explain the lack of anti-pernicious anaemia principle in sheep stomach tissue described by Wilkinson[8].

A large variation in the amount of administered vitamin B_{12} excreted by the individuals was apparent in both normal and parasitized sheep. The finding that two sheep (I_1 and I_2) showing a tenfold difference in excretion following intra-abomasal injection of bound and free vitamin B_{12}, excreted virtually the same amount after intravenous injection of bound vitamin B_{12}, suggests a limiting mechanism at the mucosal level. The reason for this difference in absorption is unknown.

As parasitized sheep absorbed similar amounts of vitamin B_{12} compared to the normal sheep, both during the immature and adult stage of the development of the parasite, it would appear that intrinsic factor production was unimpaired. This was contrary to expectations and may merely reflect the relatively mild mucosal damage caused by *Haemonchus contortus* infestation[9].

ACKNOWLEDGEMENT

The authors wish to thank messrs. R. J. J. Briel and P. J. de Wet for technical help.

Table 2: URINARY EXCRETION OF LABELLED VITAMIN B_{12}, HAEMATOCRITS AND TOTAL WORM BURDEN IN PARASITIZED SHEEP

Infested Sheep No.	Radioactivity in 24-hr. urine sample (%)				Ratio $^{57}/_{58}$		Haematocrit %			Worms
	^{57}Co		^{58}Co							
Days after infestation	12	26	12	26	12	26	0	12	26	33
I_1	30.1	28.4	27.4	25.9	1.1	1.1	29	32	15.5	9,208
I_2	3.4	13.2	3.1	11.9	1.1	1.1	32	36.5	25	695
I_3	14.7	56.0	13.7	56.5	1.1	1.0	30	30	23	9,398

REFERENCES

1. Castle W. B. 1968 *Handbook of Physiology* Section 6: Alimentary canal Volume III. C. F Code (Editor) Washington D.C. American Physiological Society.
2. Gregory M. E. & Holdsworth E. S. 1959 *Biochem. J.* 72: 549
3. Fourie P. J. J. 1931 *Direct. Vet. Serv. and Anim. Ind. Ann. Rep.* 17: 495
4. Whitlock J. H. 1950 *Cornell Vet.* 40: 288
5. Owen N. C. 1968 *The Pathological Physiology of Haemonchosis in Sheep.* M. Med. Vet. (Phys.) Thesis, University of Pretoria.
6. Bell T. K., Bridges J. M. & Nelson M. G. 1955 *J. Clin Path.* 18: 611
7. Glass G. B. G. 1963 *Physiol. Rev.* 43: 529
8. Wilkinson J. F. 1949 *Lancet* 256: 249
9. Charleston W. A. G. 1965 *J. comp. Path.* 75: 55.

BOOK REVIEW

MICROSCOPIC ANATOMY OF THE DOG:

A Photographic Atlas

WILLIAM S. ADAM, M. LOIS CALHOUN, ESTHER M. SMITH AND AL W. STINSON

Charles C. Thomas, publisher, 301-327 East Lawrence Avenue, Springfield,

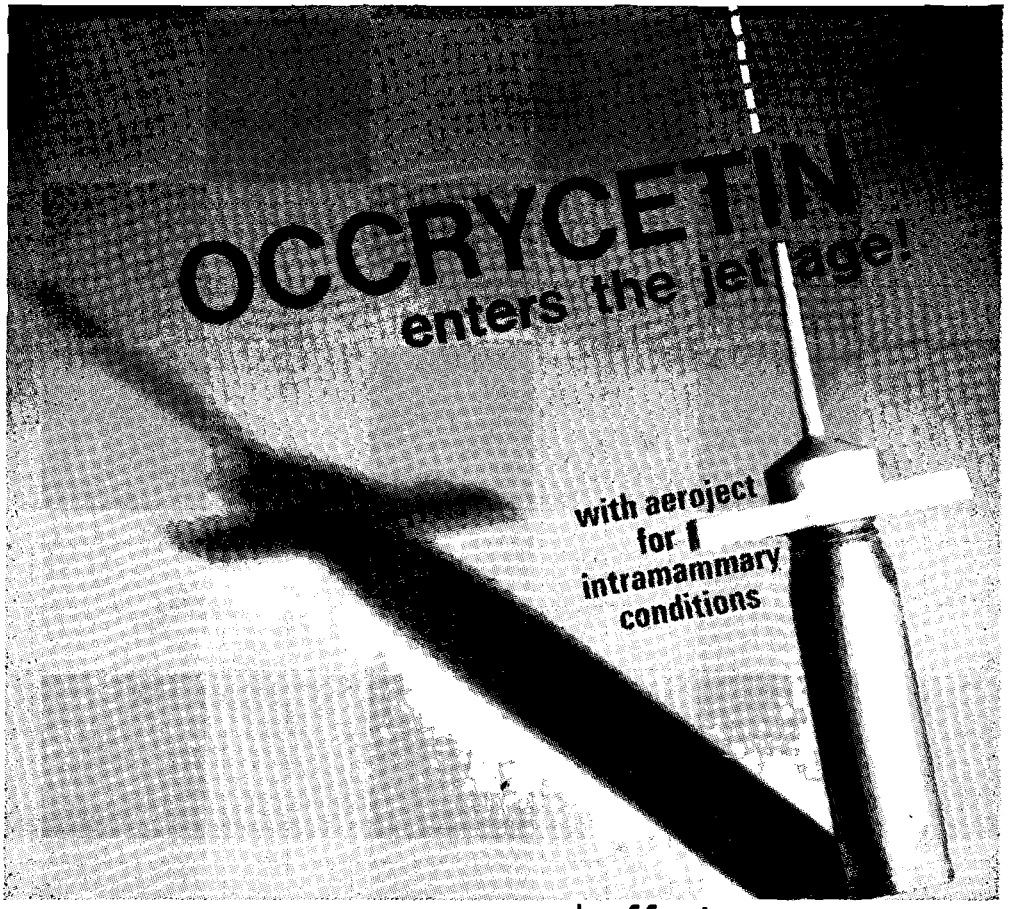
Illinois, U.S.A. July 16, 1970. Pp 292. Price: $25.50.

Since the first atlas of human histology was published in 1957 several others have appeared. These have been followed by several atlases on ultracytology. The above atlas of microscopic anatomy of the dog is however, the first on one of our domestic species and fills a much-felt gap amongst veterinary students, pathologists and research workers. Here is a book which is bound to develop the initiative and to stimulate the self-reliance of veterinary and even medical students. The systematic approach which the authors have adopted namely, that of diagrammatic line-drawings of organs or systems followed by annotated photomicrographs of ever increasing magnification is ideally suited for orientation and self-study. Introductory remarks at the beginning of each chapter stress the main histological features of the system being dealt with and mention some of the more important species differences. The integumentary, cardiovascular lymphatic, respiratory, digestive, urinary, male and female reproductive, endocrine and nervous systems are each dealt with in a separate chapter. To direct additional reading the authors have included quite an extensive bibliography, classified according to the systems.

The photomicrographs based on material obtained from six-month-old purebred beagle dogs, are all in black and white, and are of excellent quality. The four fundamental tissues of the body have not been dealt with separately, nor have any ultraphotomicrographs been included. It is intended to be used as a supplement to standard textbooks and mainly as a reference book for the experimental investigator and student.

I can wholeheartedly recommend it as a reference work of high quality.

— W,H.G.



A new system of mastitis therapy

offering

SPEED
and convenience of administration

RANGE
from broad spectrum activity

PENETRATION
in depth of the udder tissue

Pack: ten disposable aerosols with plastic applicators. Each 5 G. aerosol contains Oxytetracycline 437.5 mg., Lignocaine 35 mg.

WILLOWS FRANCIS LTD.
Pharmaceutical Manufacturers since 1751

VETERINARY DIVISION

73-75 Shacklewell Lane, London, E.8. Telegrams: Forty Hack, London. Telephone: CLIssold 6361

Sole S.A. Distributors:

GOLDFIELDS VETERINARY MEDICAL SUPPLIES

144a Hay Street, Turffontein, Jhb. Phones 32-4929, 32-4994. P.O. Box 4071, Johannesburg

Jl S. Afr. vet. med. Ass. 42 (1): 19-29 1971

ON THE THERAPEUTIC USE OF DICOUMARIN IN MERINO SHEEP

D. H. G. IRWIN AND HILDEGARD SCHUMANN*

SUMMARY

The use of dicoumarin in Merino sheep for consistent prolongation of prothrombin time over protracted periods as a means to prevent thrombosis, was found to be impracticable for two reasons. One, daily dosing of dicoumarin induced resistance to the drug after about three weeks in most sheep, even when the dietary vitamin K was reduced; and two, the effective dose appeared to be close to the fatal dose.

Normal prothrombin time, as judged on 219 blood samples from 16 sheep was found to be 12 ± 0.3 seconds.

The degree of uniformity in the biological response to dicoumarin by four fourth-generation Letelle Merino wethers was no different from that of four Merino wethers chosen at random.

INTRODUCTION

Many attempts have been made to collect venous blood samples through indwelling catheters placed in the vessels of experimental animals. This technique is of great importance to all biologists interested in metabolic studies, but its successful application over long periods has been limited by the clotting of blood with consequent thrombus formation in the vessels at the operation site. The mechanisms which lead to clotting of blood are summarized schematically in Fig. 1. In addition to these, blood from the alimentary tract carries various nutrients, including lipids, which encourage platelet aggregation and which occur in much lower concentrations, if at all, in systemic blood. This is partly why clotting and thrombosis tends to limit long-term venous catheterization of the hepatic portal system more than that of systemic vessels [1].

The clotting factors and their known antagonists are presented in Table 1. Clot-free catheterization of blood vessels could be anticipated if any clots already formed are lysed by proteolytic enzymes e.g. streptokinase and bromelain; or, alternatively, if the clotting process is prevented by the use of anticoagulants e.g. heparin and dicoumarin. This paper presents the rationale for the choice of an anticoagulant and the results of its use in sheep; experiences with the use of proteolytic enzymes are given in a second paper [11].

Anticoagulants have not attracted the attention of veterinarians from the clinical-therapeutic point of view but rather from the fact that fatal haemorrhage commonly follows ingestion of spoiled sweet-clover hay, in which coumarins have changed to dicoumarin. On the other hand, research into anticoagulant therapy in man has been active for many years, and has shown *inter alia* that the effect of heparin *in vivo* begins immediately after injection, but its duration is only a few hours. Conversely, the effect of the vitamin K antagonists (dicoumarin) is slower to begin and persists for periods measurable in days. Heparin is administered by intravenous injection four to six times daily, and because it is both tedious and difficult to monitor the effect of this drug, under- or over-dosing may occur. Dicoumarin drugs are administered by mouth once daily, and are easily monitored by a rapid and accurate test. Both types of anticoagulant can be neutralized efficiently: heparin by protamine sulphate or hexamethrine bromide, and dicoumarin by vitamin K. After surgical operations there is an increased tendency for blood to clot. This hypercoagulability persists for about 20 days after operations upon ruminants [12]. Because of the length of this period, and for other reasons mentioned above, dicoumarin was preferred to heparin. *bis*-Hydroxycoumarin was employed, and it induced a prolongation of prothrombin time in sheep when dosed

*Formerly of Unit for Digestion and Metabolism in Ruminants, Veterinary Research Institute, P.O. Onderstepoort. Present address of senior author: P.O. Box 1, Sandton, Transvaal.

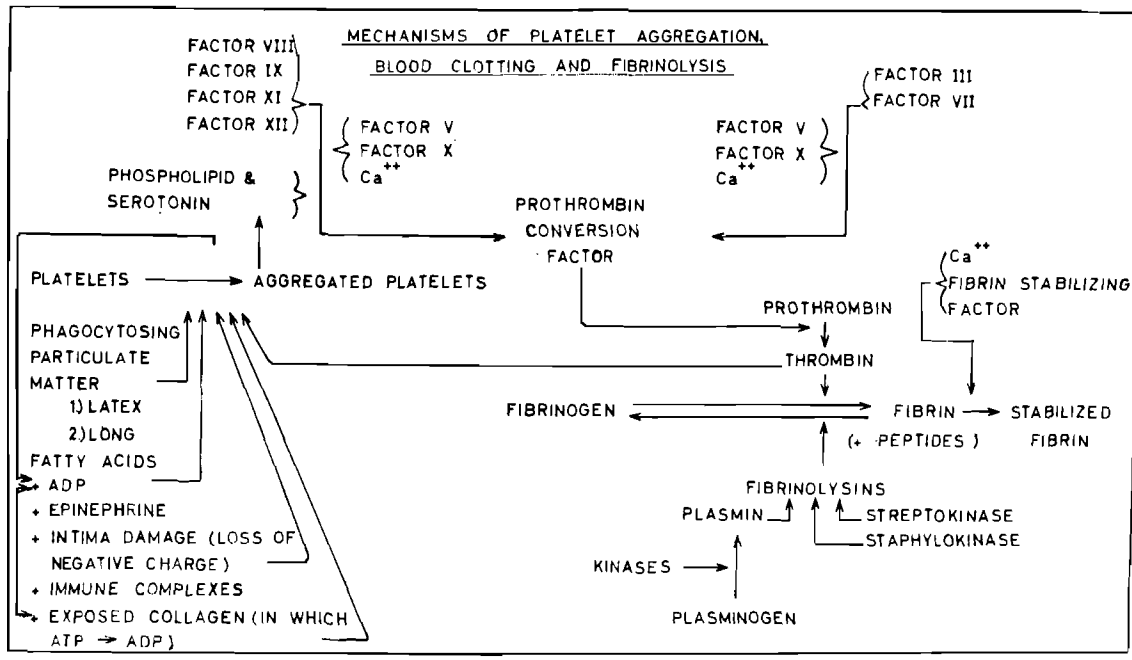


Fig. 1. Mechanisms of platelet aggregation, blood clotting and fibrinolysis.

Table 1: THE BLOOD CLOTTING FACTORS ACTING ON THROMBIN AND FIBRIN, THEIR ESTIMATION AND ANTAGONISTS

Clotting factors	Substrates	Recommended methods of estimation	Antagonists [2, 3, 4, 5]	
			Natural	Preparations
I Fibrinogen		Quick et al.[6]		
II Prothrombin		Quick et al.[6]	Heparin	Dicoumarin
III Tissue thromboplastin		—	Antithromboplastin, Heparin	
IV Calcium (Ca + +)		Ferro & Ham[7]		
V Proaccelerin (synm. labile factor		Quick et al.[6]	Heparin	
VI Accelerin		—		
VII Proconvertin (synm. stable factor)		Quick et al.[6]		Dicoumarin
VIII Antihaemophylic globulin		Tocantins[8]		
IX Plasma thromboplastin component (PTC) (symn. Christmas factor, intrinsic prothrombin activator)		Owren[9]	Heparin(?)	Dicoumarin
X Stuart-Power factor		Quick et al.[6] Roberts & Geratz[10]		Dicoumarin
XI Plasma thromboplastin antecedent (PTA)		Tocantins[8]	Heparin(?)	
XII Hageman factor	Thrombin	Tocantins[8] Whole blood clotting time	Antithrombins, Heparin	
	Fibrin	—	Plasmin	Streptokinase, Bromelain etc.

*Dicoumarin acts on clotting factors VII, IX, X, II in that sequence.

by mouth at the *pro rata* dosage levels recommended for man by Levine [13].

MATERIALS AND METHODS

Animal management

The clinically healthy adult Merino sheep used in the three experiments reported, consisted of ten ewes (D1, D4E, D14, D22, D25, D27, D28, D29, D37, D40) and four wethers (D2, D3, D4W, D5) selected at random, and also four fourth generation wethers of the Letelle strain (D41, D42, D46, D47) equal in age and from the same farm. The wethers were each provided with a perma-

nent ruminal fistula. Portal catheters were inserted into ewes D27, D28, D29 and D37 by a procedure described by Irwin [1]; and, in addition, two of these ewes (D27, D29) were provided with a rubber tube 30 cm long leading from the exterior through the bodywall to the lumen of the abomasum. The sheep were housed in individual pens covered top and back. They were fed separately once daily at 8.30 a.m. except before operations when food was withheld for 18 to 24 h. The food was weighed out to each individual and any residues were weighed back and recorded. Water was freely available. The live-weight of each animal was determined at weekly intervals. Samples of jugular blood (4 ml) for determining prothrombin time were withdrawn before feeding only from animals conditioned to their diet for at least six weeks. The blood was added to 1 ml of isotonic sodium citrate solution in a screw-cap-bottle, inverted gently three times and taken to the laboratory. After feeding, the appropriate dose of *bis*-hydroxycoumarin (Dicumarol, Abbott) was given to the wethers by ruminal fistula deep into the ingesta, and to ewes D27, D28, D29 and D37 by mouth or in the case of D27 and D29 by abomasal catheter as indicated in Figs. 2 and 3.

Diets

Two isonitrogenous and isocalorific diets were fed at approximately maintenance level. One was lucerne hay (C.P. 15% dry wt.) 1000 g. The second consisted of teff hay (C.P. 6%) 600 g with concentrates (skim-milk powder : blood meal : maize meal : 10 : 8 : 15) 300 g. Both diets were supplemented with 5 g of a lick containing minerals, trace-elements and B vitamins (RX754, Ruffel), and once weekly with 1 g of vitamin A concentrate ('Duravit A', Agricura, 20,000 i.u./g). The ewes received only the lucerne hay diet while the wethers were given both diets. The animals almost always consumed all their food except for those *in extremis* and ewes D27, D28, D29 and D37 which ate about half of their rations for approximately a week after insertion of the portal catheters. At the full level of intake the sheep on lucerne hay obtained from their feed 9 mg while those on teff hay and concentrates obtained only 2.7 mg of vitamin K daily.

Doses of dicoumarin

In Exp. 2 the doses of dicoumarin were designed to increase the prothrombin time of the animal by two to two-and-a-half times its pre-dosing value. The initial dose given to ewes D27, D28, D29 and D37 with starting weights of 34.5, 34.5, 32.8 and 37.7 kg respectively was approximately 4.5 mg/kg. The size and frequency of the subsequent doses indicated in Fig. 2, 3 and 4 for D27, D29 and D37 depended upon the effect of the previous dose(s) in lengthening the prothrombin time of these animals.

In the first period of Exp. 3 when the lucerne hay diet was fed, the daily dosage of dicoumarin given for 24 days to wethers D41, D42, D46, D47, D2, D3, D4W and D5 with predosing weights of 42.2, 43.3, 46.3, 44.5, 30.4, 36.7, 29.0 and 28.6 kg, was that which maintained the prothrombin time of the most sensitive reactor at about 50 sec. In the second period when the diet of teff hay with concentrates was given, the predosing weights of the above series of animals minus their wool-clip (43.4, 45.2, 45.8, 44.3, 30.6, 37.9, 30.2 and 30.4 kg) resembled their weights recorded in the first period. Thus for comparison, exactly the same daily dosage rate was used as on the corresponding day of the first period, regardless of its effect on prothrombin time. Thereon from the 25th to the 33rd day of dosing, the drug was increased as shown in Fig. 5, 6, 7 to a level which proved fatal for two of the sheep.

Prothrombin time

The method of Quick *et al.*[6] was used for determining the prothrombin time of the blood samples at not longer than 90 min after collection. The determinations were made by the same technician throughout.

Statistical method

Analysis of variance (weighted) was used in obtaining the value for normal prothrombin time for Merino sheep.

RESULTS

Exp. 1. Normal prothrombin time

A total of 219 determinations of prothrombin time were made for eight ewes and eight wethers when the former were fed lucerne hay and the latter either lucerne hay or teff hy with concentrates. The results, summarised in Table 2, show that the values obtained for the wethers (12.3 ± 0.4 sec) and ewes (11.6 ± 0.4 sec) on lucerne hay were similar, and also similar to those obtained when the same wethers were fed teff hay with concentrates (12.1 ± 0.5 sec). In view

Table 2: NORMAL PROTHROMBIN TIME OF MERINO SHEEP

WETHERS					EWES		
fed teff hay witht concentrates			fed lucerne hay		fed lucerne hay		
Sheep No.	No. of Samples	Time (sec)	No. of Samples	Time (sec)	Sheep No.	No. of Samples	Time (sec)
D2	9	13.3 (±1.3)	9	13.0 (±0.6)	D1	10	11.4 (±0.9)
D3	9	12.4 (±1.3)	9	12.4 (±1.3)	D4E	10	11.0 (±0.7)
D4W	9	12.0 (±1.1)	9	12.6 (±1.0)	D14	10	11.7 (±0.6)
D5	9	11.7 (±1.1)	9	12.0 (±1.2)	D22	10	12.0 (±0.8)
D41	9	12.4 (±1.0)	9	11.6 (±0.7)	D25	10	12.0 (±0.6)
D42	9	11.7 (±0.8)	9	11.6 (±0.6)	D27	8	12.5 (±1.5)
D46	9	11.4 (±1.0)	9	12.1 (±1.0)	D29	7	12.4 (±1.7)
D47	9	13.0 (±1.1)	9	13.3 (±0.8)	D40	10	11.2 (±0.7)
Group av.		12.1 (±0.5)		12.3 (±0.4)			11.6 (±0.4)

General mean for Merino sheep 12.0 (±0.3)

of this all the results were pooled in determining a general mean of 12.0±0.3 sec for the normal prothrombin time of Merino sheep.

Exp. 2. Effect of dicoumarin on prothrombin time and clot formation in ewes with portal catheters

An early indication that different sheep respond differently to a given dose of dicoumarin, was observed in the effect of the initial two doses (each 4.5 mg/kg approx.) administered to four ewes just prior to insertion of portal catheters. After the second dose the prothrombin times for D27, D29, D37 (see Fig. 2, 3, 4) and D28 increased from normal values of 12±0.3 sec to 26, 30, 32 and 43 sec. With continued dosing the most sensitive sheep (D28) died as a result of haemorrhage through the action of dicoumarin. By contrast the sensitivity of the least sensitive ewe (D27) decreased. From the 14th day of dosing its tolerance to the drug became more apparent, and this developed into frank resistance to as much as 5.9 mg/kg of dicoumarin by the 25th day. Ewe D29 also developed a tolerance despite a high initial sensitivity. On the 11th day of treatment a prothrombin time as long as 97 sec was elicited by small doses (1.7 mg/kg) of dicoumarin, then suddenly from the 13th day onward the animal became increasingly tolerant, and eventually responded with a prothormbin time of only 18 sec to a dose of 6.8 mg/kg on the 24th day. This ewe had previously received heparin (10,000 i.u.) in the operating theatre on the 3rd day. But as the action of that coagulant is short (6 h), at the most it could have influenced the prothrombin time (93 sec) reported for that day. In only one of the four ewes, D37 (Fig. 4) was a satisfactory prolongation of prothrombin time achieved over a period of 29 days.

To exclude the possibility that the ruminal flora were inactivating the dicoumarin which was administered to D27 and D29 by mouth, doses of this drug were introduced through a catheter into the abomasum of these animals from the 26th and 27th day respectively until dosing was stopped nine days later. As can be seen from Fig. 2 and 4, D27 and D29 responded to intra-abomasal doses of 5.9 and 6.8 mg/kg respectively with prothrombin times as short as 10 and 24 sec. These times were of the same order as those previously obtained for similar doses given *per os* to these animals. Thus it seemed unlikely that the drug was being inactivated by the ruminal flora. Furthermore, the continued sensitivity of D37 suggested that the resistance to the drug exhibited by D27 and D29 was due to individual peculiarity, and not to environmental, management or technical influences. In view of this the practice of dosing the drug into the rumen by mouth or ruminal fistula was continued.

When operating to place the catheters in the portal veins of any of the four treated ewes, the tardiness of blood clotting was

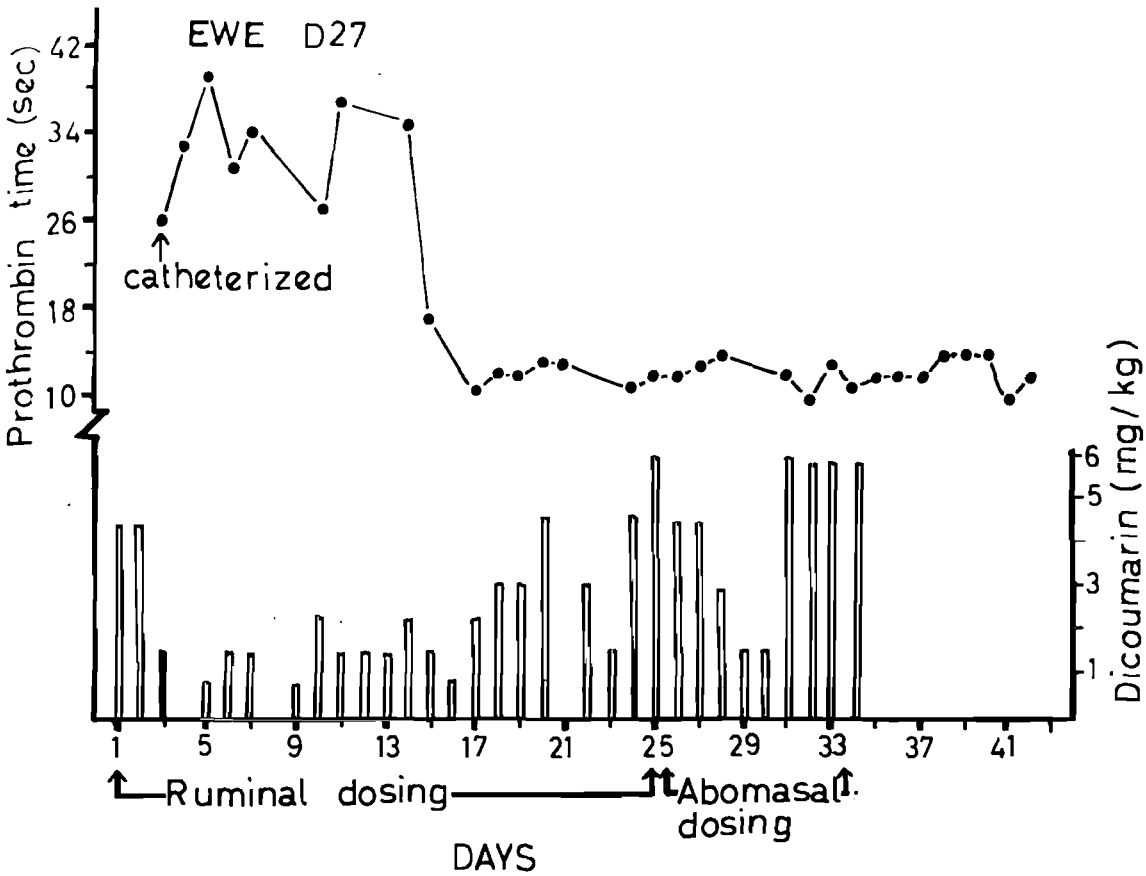


Fig. 2. The influence of intra-ruminal and of intra-abmoasal doses (histograms) of dicoumarin on the prothrombin times (●——●) of Ewe D27 over a period of 34 days.

obvious. It was necessary to twist off or to ligate even very small vessels, since the usual seven-minute forci-pressure did not stop haemorrhage. Post-operative swelling was far greater than that produced by operations on sheep not previously dosed with anticoagulants. Nevertheless, healing of the skin in ewes D27, D29 and D37 was by first intention. Despite the consistently increased prothrombin times displayed by D37 from the time of operation till the time of destruction, the degree of clot-formation around the intravascular portion of the catheter at post mortem was no less than that found in ewes D27 and D29 which had become resistant to dicoumarin, nor that commonly found in sheep without experience of anticoagulants but under otherwise similar experimental conditions. On the other hand, autopsy revealed no intravascular clot around the catheter in D28 which died from haemorrhage due to the dicouramin. In this animal there was no haemorrhage from the vessel at the catheterization site, but there were many haemorrhages into the body-wall at the site of operation and into the lungs. These facts indicated that the dose of dicoumarin capable of preventing intravascular coagulation around the catheter overlaps with that causing fatal haemorrhage.

Exp. 3. Effect of dicoumarin on prothrombin time in wethers on diets of different vitamin K content

Resistance to the action of dicoumarin was further investigated in eight wethers when they were conditioned to a diet of lucerne hay supplying 9 mg of vitamin K daily in the first dosing period, and to a diet of teff with concentrates providing 2.7 mg of this vitamin daily in the second dosing period. Despite the reduction of dietary vitamin K by two-thirds in the

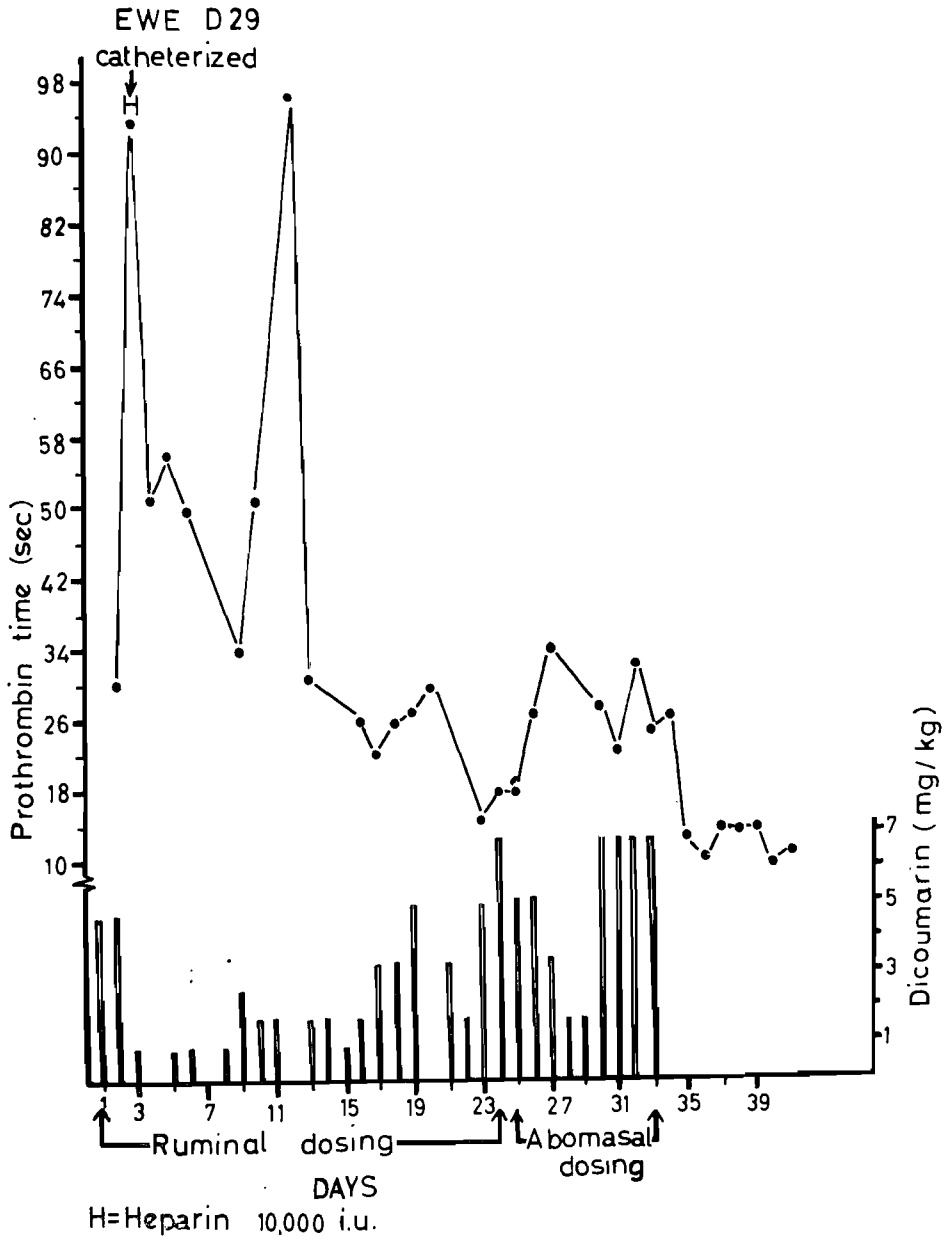


Fig. 3. The influence of intra-ruminal and of intra-abomasal doses (histograms) of dicoumarin on the prothrombin times (●——●) of Ewe 29 over a period of 34 days.

second period, the prothrombin times of seven sheep (D5, D4W, D2, D47, D46, D42, D41) were distinctly shorter than those obtained for the same animals during the first period (see Table 3). The exception was D3 which displayed a small increase. The four Letelle Merinos (D47, D46, D42, D41) showed no difference in response to the drug from the four Merinos selected at random (D5, D4W, D2, D3). As in experiment 2, three main types of response were seen. Three animals (D2, D5 and Letelle D47) tended to show resistance to the drug from the start of dosing (see Fig. 5) in the man-

ner of ewe D27. Two of the Letelle Merinos (D42 and D46) responded initially to the dicoumarin dosed, but later became increasingly resistant to it (see Fig. 6) as ewe D29 had done. Lastly, three wethers (D3, D4, Letelle D41) retained their sensitivity to the drug (see Fig. 7) similarly to ewe D37, and two of these (D3 and Letelle D41) succumbed to high doses and died of generalised haemorrhage at the end of the second dosing period.

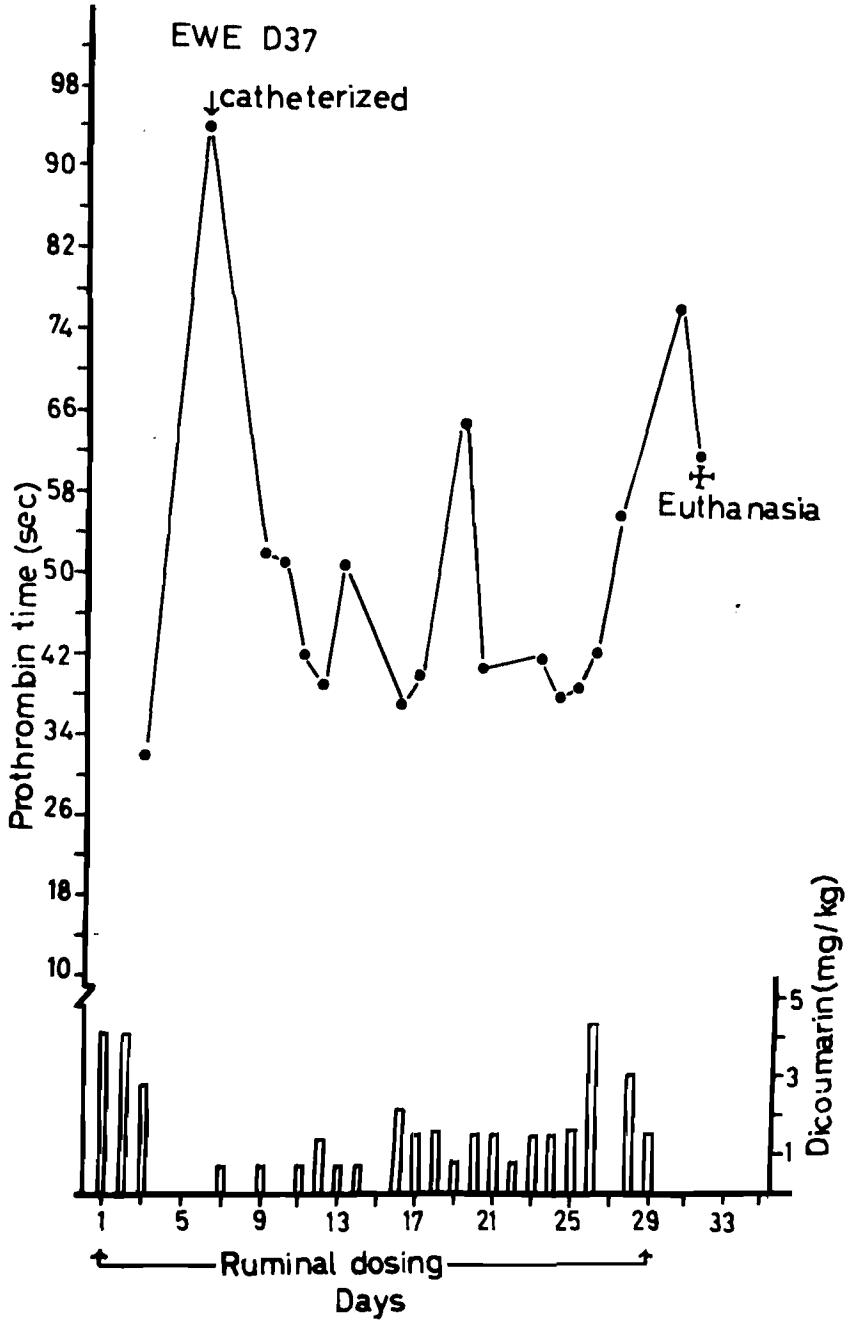


Fig. 4. The influence of intra-ruminal doses (histograms) on the prothrombin times (●——●) of Ewe D37 over a period of 29 days.

Table 3: THE RESPONSE IN PROTHROMBIN TIME TO DICOUMARIN BY TWO GROUPS OF MERINO WETHERS EACH CONDITIONED TO TWO DIETS DIFFERING IN VITAMIN K CONTENT

Sheep		Dicoumarin dosed (mg/kg, approx.)	PROTHROMBIN TIME (SEC)			
			1st dosing period (animals on diet of lucerne hay supplying 9 mg vitamin K daily		2nd dosing period (animals on diet of teff hay with concentrates supplying 2.7 mg vitamin K daily)	
Group	No.		3rd day	22nd day	3rd day	22nd day
Selected at random	D5	5.1	18	18	14	15
	DW4	5.1	17	23	14	18
	D2	4.9	18	28	17	16
	D3*	4.1	16	22	15	26
Letelle	D47	3.4	13	28	14	18
	D46	3.3	14	33	12	14
	D42	3.4	15	42	12	24
	D41*	3.6	17	47	14	23

*D3 and D41 haemorrhaged fatally when subsequently given high doses of dicoumarin.

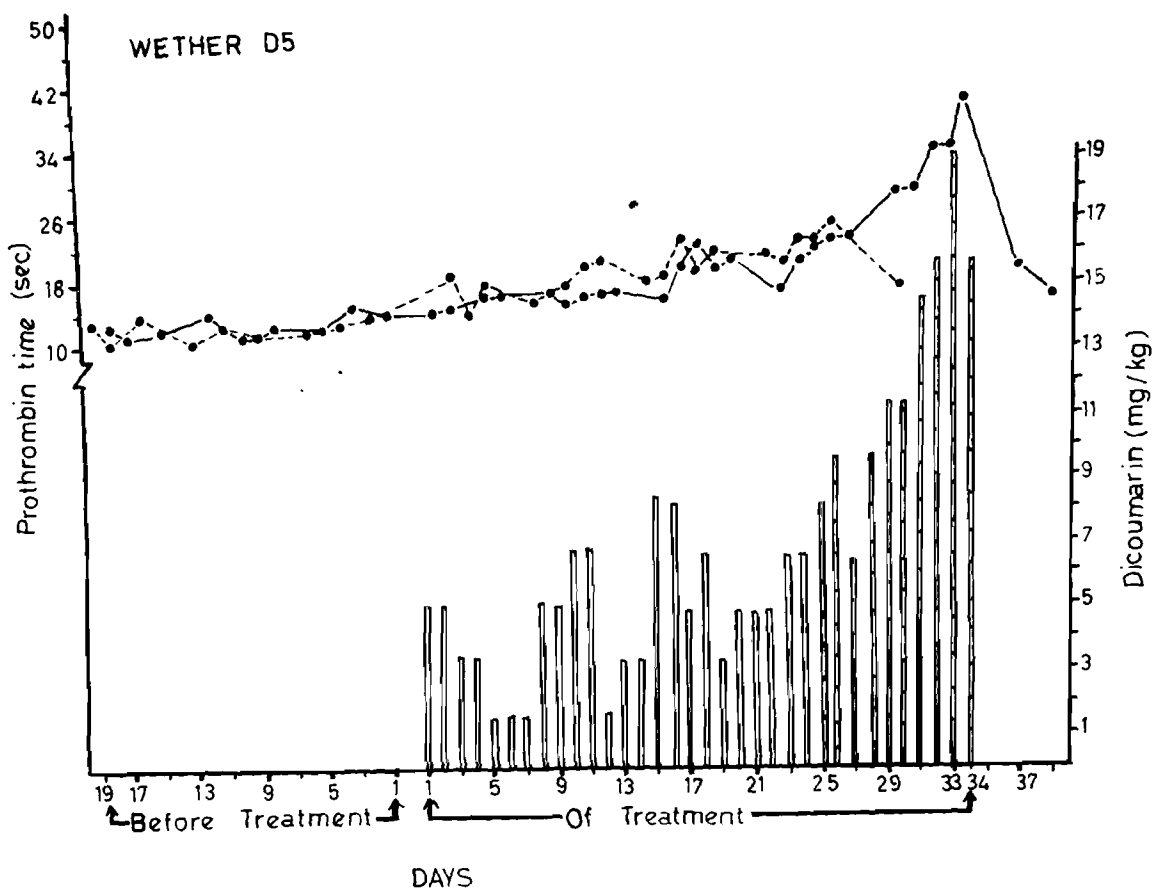


Fig. 5. Prothrombin times of Wether D5 before and during two periods in which an identical intra-ruminal dosing programme (open histograms) was followed up to the 24th day. Nine mg dietary vitamin K was porvided daily in the first period (prothrombin times (●----●) and 2.7 mg daily in the second period (prothrombin times ●——●). After the second period higher doses (stippled histograms) were administered up to the 34th day.

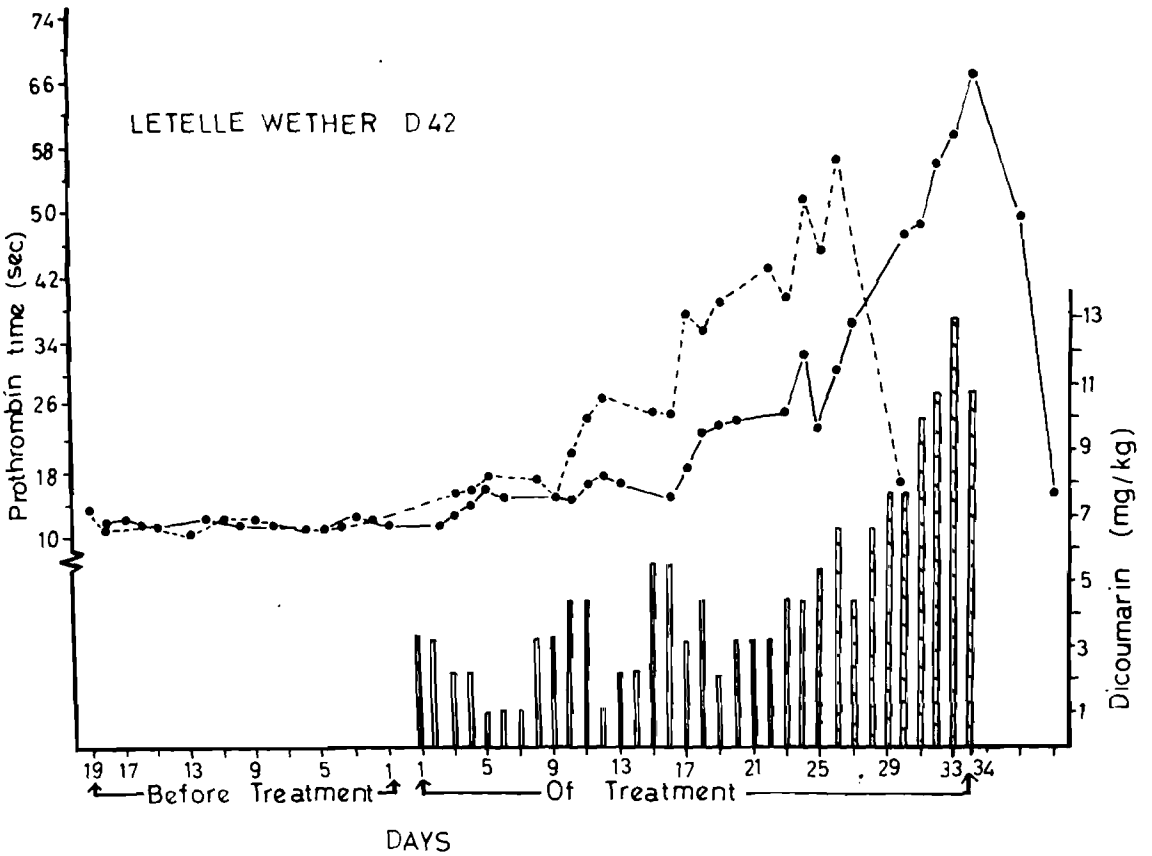


Fig. 6. Prothrombin times of Letelle Wether D42 before and during two periods in which an identical intra-ruminal dosing programme (open histograms) was followed up to the 24th day. Nine mg dietary vitamin K was provided daily in the first period (prothrombin times (●- - -●) and 2.7 mg daily in the second period: prothrombin times ●——●. After the second period higher doses (stippled histograms) were administered up to the 34th day.

DISCUSSION

The failure of dicoumarin to fulfil the requirements of a manageable anticoagulant for use in sheep prepared with indwelling venous catheters for biological experimentation, was serious disappointment. Particularly as it is difficult to know where else to turn for a drug of equal promise; and because heparin is unsuitable for use in experimental sheep over protracted period of time, owing to the need for frequent administration and the difficulties in keeping it accurately monitored.

Dicoumarin was found to be unmanageable in the 12 treated sheep because seven of these animals were either resistant or developed resistance to the drug; and, of the other five which remained sensitive, three haemorrhaged to death due to the fact that the effective dose was so close to the fatal dose. The deaths of ewe D28 and wethers D3 and D41 occurred about 60 hours after the last dose which is an occurrence recognized in humans (Dunston, T. 1966, personal communication). On the other hand, certain humans are also known to become resistant to dicoumarin and other anticoagulants (Kingsley, C. S., 1965, personal communication). Thus it would appear that the phenomena seen in the treated sheep did not stem from the fact that they were multigastric ruminants, since resistance and hypersensistivity to dicoumarin have also been associated with monogastric humans. The fact that ewes D27 and D29 responded to large intra-abomasal doses of dicoumarin (5.9 and 6.8 mg/kg respectively) with prothrombin times (10 and 24 sec respectively) of the same order as those obtained when similar doses were given by

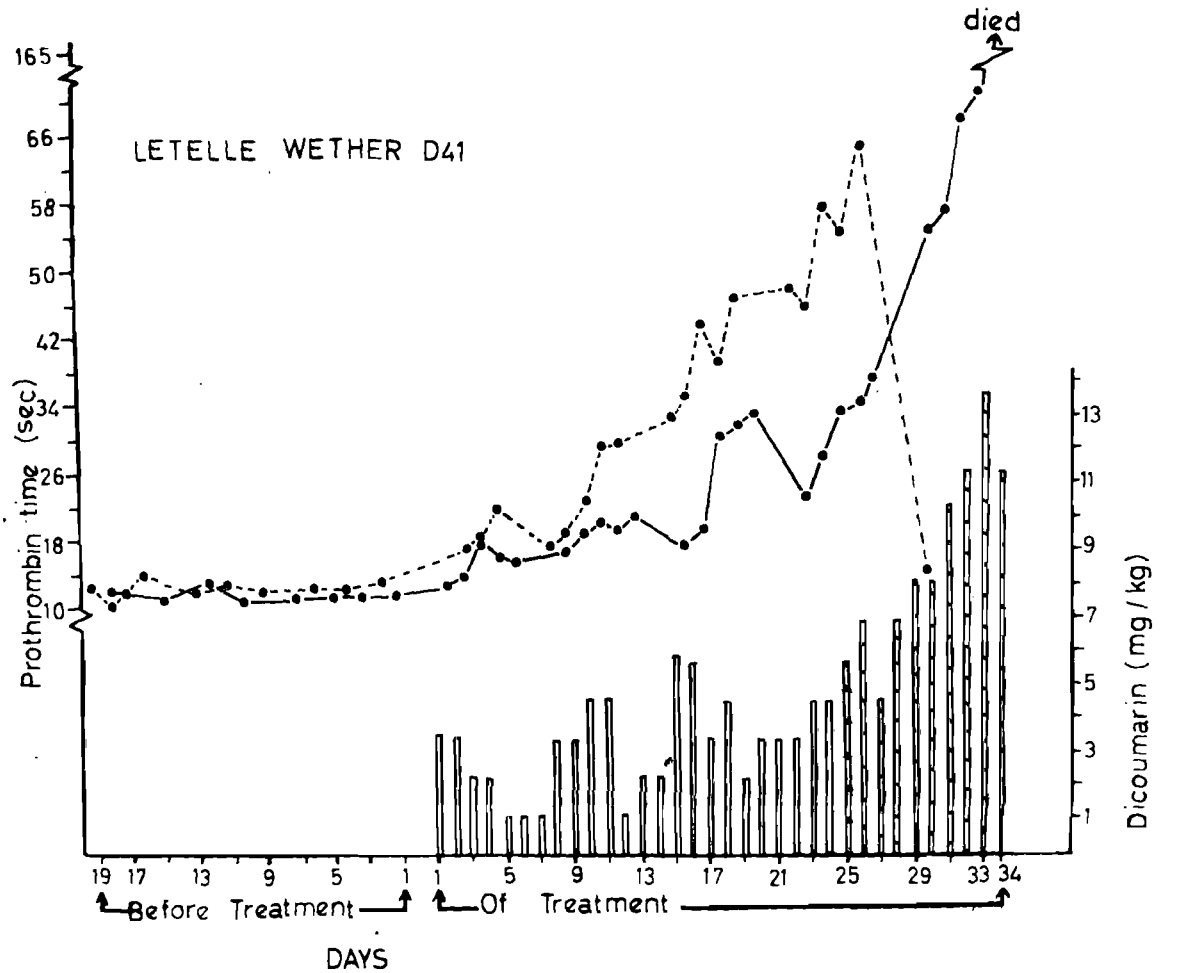


Fig. 7. Prothrombin times of Letelle Wether D41 before and during two periods in which an identical intra-ruminal dosing programme (open histograms) was followed up to the 24th day. Nine mg dietary vitamin K was provided daily in the first period (prothrombin times ●----●) and 2.7 mg daily in the second period (prothrombin times ●——●). After the second period higher doses (stippled histograms) were administered up to the 34th day.

mouth, clearly demonstrated that the drug was not inactivated by the ruminal flora of these animals, but that the animals themselves were resistant to the dicoumarin. The extent of this resistance may be gauged from the fact that the prothrombin times obtained under these conditions were either almost equal to or only twice that of the normal value of 12.0 ± 0.3 seconds. Reducing the vitamin K content of the diet to a level which provided only 2.7 mg daily in no way altered resistance to the drug. Thus it is unlikely that the resistance exhibited by more than half the animals treated, was due to the antagonistic effect of dietary vitamin K on the dicoumarin.

It was surprising that the fourth-generation Letelle Merino wethers did not respond to dicoumarin more uniformly than the other Merino wethers chosen at random. However, the degree of heterozygosity for other characteristics such as wool-type and blood-group factors, was also no less for the Letelles than for the randomly selected Merinos. This was probably because the Letelle sheep employed, were not sufficiently inbred to make uniform the many genetic factors which govern their make-up. There is a great need for a uniform strain of sheep for drug evaluations and studies of responses to various other treatments, since a uniform strain would greatly reduce

the numbers of animals and the amount of experimental work required to obtain desired information.

ACKNOWLEDGEMENTS

Our thanks are due to Professor Griminger of Rutgers University, New Jersey, for biological determinations of the vitamin K content of the diets employed in this work; to Mr B. J. Briel for collecting most of the samples of blood and for the illustrations presented; to Mr H. R. L. Fechter for determining the blood-group factors; to Dr F. M. C. Gilchrist for reading the manuscript; and to Mr. Groenewald of Statistics, Agricultural Technical Services, for statistical analyses.

REFERENCES

1. Irwin D. H. G. 1965 Studies on venous catheterization in the Merino sheep. Thesis: M. Med. Vet. (Chir.), University of Pretoria
2. Mustard J. F., Rowsell H. C. & Murphy E. A. 1964 *Amer. J. med. Sci.* 248 : 469
3. Wurzel H. A. 1964 Anticoagulant Drugs. In Pharmacological Techniques in Drug Evaluation. Ed. J. H. Nodine & P. E. Siegler, Year Bk. Med. Publishers : Chicago
4. Biggs R. & MacFarlane R. G. 1957 Human blood coagulation and its disorders. Blackwell Scientific Publications: Oxford
5. Guyton A. C. 1961 Medical Physiology. 2nd Ed. Saunders: Philadelphia
6. Quick A. J., Stanley-Brown M. & Bancroft F. W. 1935 *Amer. J. med. Sci.* 190 : 501
7. Ferro P. V. & Ham A. B. 1957 *Amer. J. clin. Path.* 28 : 689
8. Tocantins L. M. 1955 The Coagulation of Blood: methods of study. Grune & Stratton: New York
9. Owren P. A. 1969 *Lancet* 2 : 754
10. Roberts H. R. & Geratz J. D. 1960 N.I.H. Conference on Thrombolytic Agents. Univ. N. Carolina Press. Quoted by Mustard *et al.* 1964[2]
11. Irwin D. H. G. 1971 Ref. to next article in *Jl S. Afr. Vet. Med. Assoc.*
12. Heyer S. 1962 Untersuchen über den Fibrinogen-gehalt in Blutplasma bei chirurgischen Erkrankungen des Rindes. Inaug. Dissert, Hanover
13. Levine W. G. 1965 Anticoagulants. In The Pharmacological Basis of Therapeutics. 3rd Ed. L. S. Goodman & A. Gilman. MacMillan : New York, p. 1443

FORTHCOMING PUBLICATION

A Supplement to the British Veterinary Codex, 1965, will be published overseas during December, 1970. This 320-page supplement includes new monographs on anthelmintics, antibiotics, coccidiostats and ovulation controllers.

In the formulary section there are new monographs for oral pastes, premixes and pellets, all appearing for the first time in the British Veterinary Codex.

In Part II the standards for antisera, vaccines and related products have been completely revised and Part II of the Supplement replaces part II of the British Veterinary Codex, 1965. The following monographs in Part II apear for the first time:

Avian Infectious Bronchitis Vaccines
Avian Infectious Encephalomyelitis Vaccine
Brucella Abortus (Strain 45/20) Vaccine
Escherichia Coli Antiserum (for pigs)
Laryngotracheitis Vaccine
Various Salmonella Vaccines

The Supplement includes as an appendix a full list of British veterinary non-proprietary names, with graphic formulae, chemical names, trade names and uses, and all these names are included in the general index. There is also a list of "other names" of the new B.Vet.C. substances, and a Pharmacological and Therapeutic Index.

The price for the Supplement (1970) to the British Veterinary Codex, 1965, is R7.50 post free. This publication will be available in South Africa from about March/April 1971 onwards.

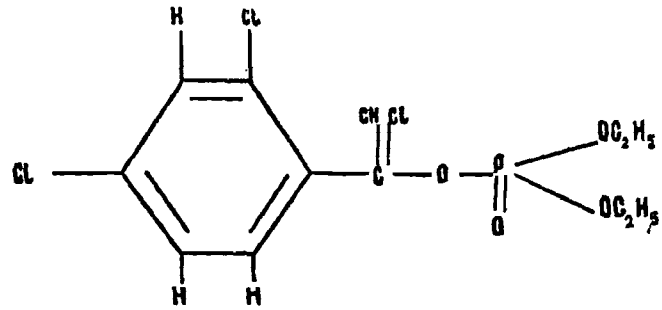
The British Veterinary Codex, 1965, currently available, sells at R12.30 post free.

Both publications are obtainable from: The A.P.S. Journal (Pty.) Ltd., P.O. Box 31360, Braamfontein. Phone: 724-3441.

CHLORFENVINPHOS

IS THE COMMON NAME FOR

2-chloro-1-(2,4-dichlorphenyl) vinyl diethyl phosphate
previously referred to as GC 4072 and SD 7859.



Shell's* Registered Trade Mark for this insecticide is —

SUPONA*

Cooper workers in Britain, Africa, Australia and America, have investigated and proved this to be a stable compound and a remarkably rapid killer of ecto-parasites of domestic stock, particularly suitable for controlling all species of ticks, blowfly, keds, fleas and lice. Cattle and sheep treated with it may safely be dosed with Haloxon.

Cooper's Supadip Sheep Dip and Blowfly Remedy
Cooper's Supajet Blowfly Remedy
Cooper's Tick and Maggot Oil
Cooper's Supabok Dip
Pulvex Liquid Dog Shampoo,
Pulvex Dog Dip and
Cooper's Supamix Cattle Dip
all contain this insecticide.

COOPER PRODUCT

Cooper & Nephews, S. Af. (Pty.) Ltd., P. O. Box 2963, Johannesburg.
Cooper, McDougall & Robertson (C. A.) (Pvt.) Ltd., P. O. Box 2699, Salisbury.

treat mastitis at drying off

In the average herd 50% of cows carry sub-clinical infections. In the untreated cow, infection increases over the dry period with each successive lactation. Orbenin Dry Cow, active in the quarter for about 28 days, is effective in controlling infection present at drying off and the incidence of new infection during the dry period.

Successful mastitis control is a system that will reduce the burden of infection and the incidence of mastitis throughout the herd. The system will employ routine hygiene procedures, good management and the selective use of antibiotics at drying off and in the treatment of clinical cases.

Orbenin Dry Cow is designed for use at drying off and will reduce residual infection and help to prevent new infections in the dry period.

Orbenin Lactating Cow is designed for the treatment of clinical mastitis during lactation and is active for long enough to produce bacteriological cures.

The Orbenin Mastitis Control Code

Available through the veterinary profession only—consult your veterinary surgeon.

Orbenin* Dry Cow and Orbenin Lactating Cow are products of Beecham *research*.
Beecham Veterinary Products, Brentford, England
Distributed in South Africa by:
Petersen Ltd., P.O. Box 5785, Johannesburg. *Regd.

Jl S. Afr. vet. med. Ass. 42 (1): 33-36 1971

SOME PHYSIOLOGICAL MECHANISMS OF THE SCALY WEAVER (*Sporopipes squamifrons*) DURING WATER DEPRIVATION

L. P. NEETHLING*, N. C. OWEN**, H. M. TERBLANCHE***, J .M. M. BROWN**, O. P. M. PROZESKY† AND P. J. DE WET**

SUMMARY

The ability to withstand severe water deprivation over periods of up to 65 days has been investigated in the case of the scaly weaver (*Sporopipes squamifrons*).

The metabolism by this bird of glucose, glycine and oleic acid has been studied using C-14 labelled substrates and monitoring exhaled $^{14}CO_2$. Plasma tri-iodothyronine activity, pulmocutaneous and faecal water loss, haematocrit, osmolality and plasma proteins were determined.

It was concluded that β-oxidation of fatty acids was of minor importance in water conservation while other physiological mechanisms involving reduced water loss were operative. The alpha-1-globulin fraction was shown to be increased in the plasma of water deprived birds and it is suggested that this fraction may be directly involved in the regulation of water homeostasis.

INTRODUCTION

The scaly weaver (*Sporopipes squamifrons*) inhabits the Kalahari desert and adjacent semi-arid savannah regions[1]. Although a small bird, it can survive for unexpectedly long periods on a dry diet[2]. It is therefore obvious that this species is physiologically adapted to resist dehydration. In view of the above, attempts were made to elucidate the possible mechanisms involved.

MATERIALS AND METHODS

A number of birds were caught at random in mist nets in the Zeerust area of the Western Transvaal. They were kept in wire mesh cages and fed on millet (*Setaria sphacelata*, Graminae) with an average moisture content of 8.8 per cent. Two groups were used, one receiving water and millet *ad libitum* (controls) and the other receiving only millet seed (water deprived) for the duration of the experiments.

Metabolic studies

The metabolism of glucose, glycine and oleic acid was studied *in vivo* with the aid of labelled substrates as follows: 25μl of an aqueous solution of D-glucose-1-C 14 (specific activity: 58.8 mCi/mM), 40 μl of an aqueous solution of glycine-C 14 (U), (specific activity: 109 mCi/mM) and 5 μl oleic acid-C 14 (U) (specific activity: 149 mCi/mM) were injected individually into the thigh muscles of the various experimental birds. The dosage of injected substrate represented 2.5 μCi in each instance.

Immediately after injection each bird was placed into a small exhalation chamber and covered with a black cloth to induce minimal activity on the part of the bird. The exhalation chamber was connected to an ionization chamber (250 ml) and a Cary 31 vibrating Reed electrometer operating in the one second mode of critical damping. Air was pumped through the system at a flow rate of 75 ml/min. The sensitivity of the ionization chamber was previously established at 6.8×10^{-3} μCi/hr/mv[3].

The radioactivity of the expired air, indicative of the metabolism of the labelled substrate, was measured for one hour at room temperature (ca. 25°C). The area under the activity versus time plot was evaluated by tracing onto uniform paper, cutting out this area and weighing it. The result was expressed as mv min/g body weight.

Tri-iodothyronine (T3) levels were determined as an index of thyroid function in water deprived and control birds using the

*Section of Radiation Biology, Veterinary Research Institute, Onderstepoort.
**Dept. of Physiology, Faculty of Veterinary Science, University of Pretoria, Box 12580, Onderstepoort.
***Section of Reproduction, Veterinary Research Institute, Onderstepoort.
†Transvaal Museum, Paul Kruger Street, Pretoria.

"Thyopac-3" kit (Radiochemical Centre, Amersham) and standard techniques.

Water loss studies

Insensitive and respiratory water loss was measured by passing dry air over the birds individually and trapping the water vapour released with anhydrous calcium chloride. Faeces were weighed directly after voiding and the moisture content thereof determined gravimetrically. At the termination of the experiments birds were autopsied and blood collected in heparinised glass capillary tubes. Micro haematocrits were determined on water deprived and control birds and the plasma collected for osmolality determination by freezing point depression (Knauer semi-micro osmometer).

Plasma proteins

Total plasma proteins (TPP) were determined by the biuret method[4] and fractionated by microzone electrophoresis on cellulose acetate strips[5].

RESULTS

The results of the substrate metabolism are outlined in Table 1.

Table 1: RATE OF METABOLISM OF LABELLED SUBSTRATES

Waterless Period days	Metabolism of substrate mv min/g			Average body weight— g
	Glucose	Glycine	Oleic ac.	
0	488 ± 106 (n=5)	106 ± 36 (n=3)	54.5 ± 17.2 (n=3)	11.3
63 ± 2	505 ± 121 (n=7)	167 ± 27 (n=3)	13.5 ± 10.9 (n=4)	9.2

All values are means ± one standard deviation.
n denotes number of determinations.

The results show a considerable weight loss due to water deprivation and a significantly lowered oleic acid metabolism. The rate of glucose and glycine metabolism was virtually the same in the case of both groups.

The plasma T3 levels of five control birds and five birds which had been deprived of water for 35 days were compared and scarcely any difference was found (controls: 95±2%; water deprived 99±8%).

Mean values for insensitive and respiratory as well as faecal water loss are presented in Table 2.

Table 2: MEAN WATER LOSS BY WATER DEPRIVED AND CONTROL BIRDS

Waterless period days	Insensitive and Respiratory water loss g H_2O/hr	Faecal water loss % H_2O
0	0.17 (n=3)	28.9 (n=6)
63 ± 2	0.08 (n=3)	21.8 (n=3)

n denotes number of determinations.

Differences were found in both the faecal water content as well as in the combined insensitive and respiratory water loss.

The average values for haematocrit and osmolality obtained are given in Table 3.

Table 3: PHYSICAL PROPERTIES OF BLOOD (MEAN VALUES)

Waterless period days	Haematocrit	Osmolality mOsmole/litre
0	44.4 (n=3)	373 (n=2)
63 ± 2	51.3 (n=4)	372 (n=4)

n denotes number of determinations.

The data presented above show haemoconcentration in the water deprived birds but no change in osmolality as compared to the controls.

The values obtained from plasma protein analysis are set out in Table 4.

Table 4: PLASMA PROTEIN CHANGES IN CONTROL AND WATER DEPRIVED BIRDS

INDIVIDUAL BIRDS	PLASMA PROTEINS %					g% T.P.P.
	ALBUMINS	GLOBULINS				
		α1	α2	β	γ	
Controls						
1	42.2	4.4	17.8	22.2	13.3	4.0
2	39.1	6.5	15.2	28.3	10.9	3.8
Water deprived						
3*	44.7	6.4	14.9	25.5	8.5	2.5
4	30.6	8.2	14.3	36.7	10.2	3.0
5	34.4	9.4	15.6	28.1	12.5	5.1
6	41.5	7.6	13.2	26.4	11.3	3.7

*In extremis.

Apart from bird No. 3 which was *in extremis* just prior to blood collection, all water deprived birds (4, 5 and 6) showed a definite increase in the alpha-1-globulin fraction. The other pasma protein fractions were similar to those of the controls.

DISCUSSION

It has been shown that in general small birds weighing less than 60g produce relatively less metabolic water than larger birds[6]. On the other hand, some desert species appear to be exceptions in this respect under certain circumstances[7]. As the way in which this is achieved is as yet unsettled, it seemed reasonable to assume that one possibility could involve an increased rate of fatty acid oxidation. However, our results have failed to confirm this as oleic acid metabolism was markedly decreased, while glucose and glycine metabolism remained unchanged. Since oleic acid does not undergo any oxidative cleavage prior to β-oxidation[8], it was considered to be indicative of the overall rate of fatty acid breakdown. Therefore, it does not seem likely that an increased utilization of fats *per se* can supplement body water under conditions of water deprivation. In addition, the basal metabolic rate appears to be unchanged as judged by the level of thyroid function in the two groups.

Thus, in view of the above, it is clear that other adaptive mechanisms must exist to preserve water homeostasis.

It has been suggested that the black-throated sparrow *(Amphispiza bilineata)* and the zebra finch *(Taeniopygia castanotis)* have a method of restricting evaporative water loss without curtailing their activity under conditions of water deprivation[7]. Since our birds were examined at a constant activity level our results suggest that the scaly weaver may invoke a similar mechanism.

The well documented fact that there is on the average a 30% decrease in moisture content of faeces in desert birds deprived of water, i.e. the zebra finch *Taeniopygia castanotis)*[9], black-throated sparrow *(Amphispiza bilineata)*[10], grey-backed finch lark *(Eremopterix verticalis)* and Stark's lark *(Spizocorys starki)*[11], is in complete agreement with our findings for the scaly weaver *(Sporopipes squamifrons)*.

The observed haemoconcentration and loss of body weight of the water deprived birds confirm the partial dehydration seen at autopsy. In spite of this the osmolality remained constant, indicating a shrinkage of fluid compartments thereby necessitating increased electrolyte excretion.

The alpha-1-globulin fraction has been shown to be osmotically more active than the other plasma protein fractions, including albumin[12]. The noticeable increase in the alpha-1-fraction of the water deprived birds suggests that this fraction may play an important role in their survival. It is possible that in the face of an overall fluid loss the increase in these proteins could be involved in maintaining an adequate plasma volume. This aspect, however, requires further investigation.

The incredible ability of these birds to endure water deprivation for up to 65 days remains to be fully explained. We assume that the overall contribution of body fat reserves towards the maintenance of body water through β-oxidation of fatty acids, plays a minor role. It is believed that sofar unexplained mehanisms exist by which the insensitive and respiratory loss of water and the excretion through faeces and urine is reduced, and in which plasma alpha-1-globulins could play a cardinal role.

REFERENCES

1. Roberts A. 1940 *The Birds of South Africa* Lond. H.F. & G. Witherby Ltd
2. Cade T.J. 1965 *Ostrich* 36 : 131
3. Neethling L.P. 1970 *'n Vergelykende fisiologies-chemiese studie van die rooisel van die skaap en die hond.* D.Sc. thesis, University of Pretoria
4. Wootton I.D.P. 1964 *Micro-analysis in Medical Biochemistry.* London. J. & A. Churchill Ltd
5. van Zyl L.C. 1967 *Onderstepoort J.vet.Res.* 34 : 633
6. Bartholomew G.A. & Dawson W.R. 1953 *Physiol.Zool.* 26 : 162

7. Brown G.W. 1968 *Desert Biology* New York and London. Academic Press
8. Anthony G.J. & Landau B.R. 1968 *J. Lipid Res.* 9 : 267
9. Calder W.A. 1964 *Physiol.Zool.* 37 : 400
10. Smyth M. & Bartholomew G.A. 1966 *Condor* 68 : 447
11. Willoughby E. as cited by reference 6
12. Ott H. 1956 *Klin.Wschr.* 34 : 1079

BOEKBESPREKING

DISEASES OF POULTRY 2nd EDITION

P. SENEVIRATNA

Bristol: John Wright & Sons Ltd. 1969

pp iii-229, Fige 20, Tabelle 22. Prys £2-6

Alhoewel Prof. Seneviratna aan ons onbekend is, het hy hierdie boek die lig laat sien na sestien jaar se ondervinding as pluimveepatoloog in Ceylon. Die eerste uitgawe van die boek het hy grootliks voltooi tydens sy werksaamheid by die Universiteit van California in 1963 - 4, en hierdie tweede hersiene uitgawe is aansienlik verbeter.

Hierdie boek is saamgestel om veral aan praktiserende en aander veeartse gemoeid met diagnostiek, maar ook aan voorgraadse veeartsenykunde studente, 'n kort geheelbeeld van 'n species-vak te gee. Hierdie vak word hedendaags moeilik in 'n neutedop saamgevat sonder om tot niksseggende oppervlakkigheid te verval.

Vyf afdelings kom in die boek voor te wete:

A. Siektes van hoenders met elf hoofstukke. Hierdie is die mees breedvoerige afdeling.
B. Algemene siektes van kalkoene met vyf hoofstukke.
C. Siektes van eende, ganse en 'n paar ander voëlsoorte met twee hoofstukke. Slegs kortliks behandeld.
D. Algemene siektes van hokvoëls — in die vorm van handige tabelle voorgestel.
E. Allerlei, met vier hoofstukke, waarin o.a. voorkom die mees algemene middels wat gebruik word, broeieryprobleme, en vergiftigings by pluimvee.

Die benadering van die skrywer val mee, omdat die leser onder die indruk kom van die belang van die wisselwerking tussen besmetlike en nie-besmetlike faktore wat die delikate en kunsmatige omgewing van moderne pluimvee kompliseer. Gevolglik word regmatige aandag aan die belang van genetiese materiaal, behuising, voeding en bestuur gegee, en nie 'n losstaande dissertasie oor siektes, hul diagnose en beheer nie.

Die boek word maklik gelees, en gee net die belangrikste trekke van die verskillende onderwerpe. Nuttige verwysings kom by van die belangrikste aspekte voor. Die uiteensitting van die verskillende afdelings is duidelik en logies. Die boek maak dit maklik om siektes te kategoriseer en om in 'n kort tyd die belangrikste feite te bekom. 'n Omvattende reeks siektes word bespreek, en tereg word beklemtoning aangepas volgens die belang van sekere toestande.

Tekortkomings kom voor bv. die inkubasietyd van Newcastlesiekte word nie gegee nie; die voor- en nadele van die verskillende soorte Newcastlesiekte-entstowwe word nie goedgenoeg beklemtoon nie; *Haemophilus gallinarum* besmetting word onderskat en te min word oor die nadele van terapie gegee; ons stem nie saam met lae-vlak (50 g per ton) antibakteriesee behandeling vir permanente voorbehoeding van infeksies soos tifus nie; die neem van monsters vir laboratoriumdiagnoses kry nie aandag nie ;'n nieaanvaarbare bewering dat enting van duiwe teen pokke nutteloos is. Die Republiek van Suid-Afrika word 'n Unie genoem.

Die literatuurverwysings is redelik vars, en die aangee van standaard leerboeke en goeie joernale word verwelkom. Aangesien daar 'n ware behoefte bestaan vir 'n minder ingewikkelde, nie-misleidende kort boek oor pluimveesiektes, word hierdie boek as 'n goeie poging beskou. Dit kan aanbeveel word vir kollegas in die veld, veral die wat nie voltyds met geveerdes werk nie.

— L.C.

large animal small animal...

both cases for Penbritin Injectable Suspension

Horse—Thoroughbred, male, 7 months. Respiratory distress over 2-month period. Temperature 103·5°F. Various antibiotics tried. Apparent recovery—then relapse. *Diagnosis*—chronic broncho-pneumonia. Nasal swab showed mixed bacterial infection with staph. and strep. predominant. *Treatment*—Penbritin Injectable Suspension, 1G intramuscularly (5 ml) for 5 days plus ACTH on 2nd day. *Response*—Temperature reduced to 101·5°F. within 24 hours. Rapid recovery. No relapse.

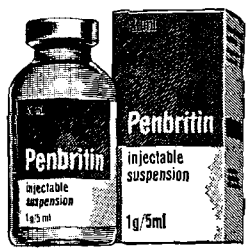
Dog—Yorkshire Terrier, male, 6 years. Sickness and diarrhoea. Protein and blood in urine. Cystic calculus had been removed in the previous year. Treated for nephritis at that time. *Diagnosis*—nephritis and enteritis. Possible permanent damage to kidneys. *Treatment*—Penbritin Injectable Suspension, 200 mg subcutaneously (1 ml) for 3 days, plus one Penbritin capsule 50 mg twice daily. Also water intake restricted. *Response*—Considerable improvement within 24 hours. Sickness and diarrhoea stopped. Urine test negative on 3rd day. Rapid response should *minimise further* kidney damage.

Two more cases where the right decision was to reach for Penbritin immediately.

In recent clinical trials 89% of bacterial infections in horses and 92% in dogs responded to therapy with Penbritin Injectable Suspension.

Penbritin is broad in spectrum. It can confidently be used before sensitivity results are known, and for all its broad spectrum power, *Penbritin is economical.*

Penbritin is presented ready for use, in multi-dose vials. It is suitable for both large and small animals.



Reach for Penbritin first

AVAILABLE THROUGH THE VETERINARY PROFESSION ONLY

Penbritin* (ampicillin) is a product of Beecham research

Beecham Veterinary Products,
Brentford, England.
Distributed in South Africa by:
Petersen Ltd., P.O. Box 5785, Johannesburg.

*Regd.

Jl S. Afr. vet. med. Ass. 42 (1): 39-43 1971

PATHOLOGICAL FINDINGS IN THE ADRENAL GLAND OF CHACMA BABOONS — 160 CONSECUTIVE CASES

P. J. PRICE, J. GREEFF, AND H. W. WEBER*

INTRODUCTION

One hundred and sixty autopsies were performed on Chacma baboons at the primate colony (Stellenbosch-Johns Hopkins Primate Project) from April, to October, 1969.

Sixty-two autopsies showed evidence of acute adreno-cortical damage, namely varying degrees of necrosis, haemorrhage and haemorrhagic necrosis. In three cases there was evidence of lesions indicating previous adrenal damage.

In view of the fact that dysentery was the commonest antemortem sign and varying degrees of histological enterocolitis the most frequent histopathological finding, the 160 consecutive cases were divided arbitrarily into two groups.

1. Those without histopathological or clinical enterocolitis — 41 cases of which 9 i.e. 22% showed adrenal damage.
2. Those with enterocolitis — 119 cases of which 54 or 46% showed sign of adrenal damage.

The predominant type of histological adrenal haemorrhage and necrosis observed was used to further subdivide the cases into four groups i.e primary vascular, ACTH overstimulation, cytotoxic necrosis and fibrin thrombi in sinusoids

A discussion follows on various factors playing a role in adreno-cortical necrosis and haemorrhage in man and the possible relationship and significance of similar observations in the Chacma baboon.

PROCEDURE

In most cases autopsies were performed on the baboons within 12 to 14 hours of death. Standard autopsy procedure as used at Karl Bremer Hospital for human autopsies was carried out apart from the cranium which was not opened. The body was entered through a single midline incision, the organs were removed and weighed and specimens obtained for histological examination. The specimens were processed in our laboratory using standard techniques. The sections were cut at 3 - 5μ and stained with Haematoxylin and Eosin. Special stains were obtained as necessary after screening the H. & E. sections.

FINDINGS

In view of the astonishing number of autopsies in which adrenal damage was found, an attempt was made to elucidate the causative factors retrospectively and thereby possibly help in preventing such drastic damage in the future.

In view of the fact that enterocolitis and dehydration were the most common signs *antemortem* and the most common finding at *postmortem*, the 160 consecutive cases were divided arbitrarily into two groups i.e. *those with* and *those without* clinical and pathological enterocolitis *with* or *without* dehydration.

Each group was further subdivided according to the predominant histological type of adrenal damage observed, i.e.:

A. Primary vascular — in which there were localised foci of haemorrhage and necrosis indicating localised vascular spasm possibly due to hypotension as described by Mack *et al.*[1] in experimental dogs (Fig. 1).

B. Haemorrhage and/or necrosis of zona fasciculata and reticularis, sparing the zona glomerulosa which is possibly due to prolonged ACTH stimulation as a result of stress[2]. Similar but less severe changes were noted by Wilbur and Rich in rats after prolonged ACTH stimulation (Fig. 2).

C. Generalised cortical necrosis and haemorrhage with cytoxic effects as noted in gram negative septicaemia[3] and DDD, a derivative of DDT poisoning[2, 4] (Fig. 3).

*Department of Pathology, Tygerberg Hospital/Karl Bremer Hospital, Bellville.
Paper read at the Symposium on Production and Use of Laboratory Animals; CSIR and Medical Research Council, Pretoria, 3 - 5 June, 1970.

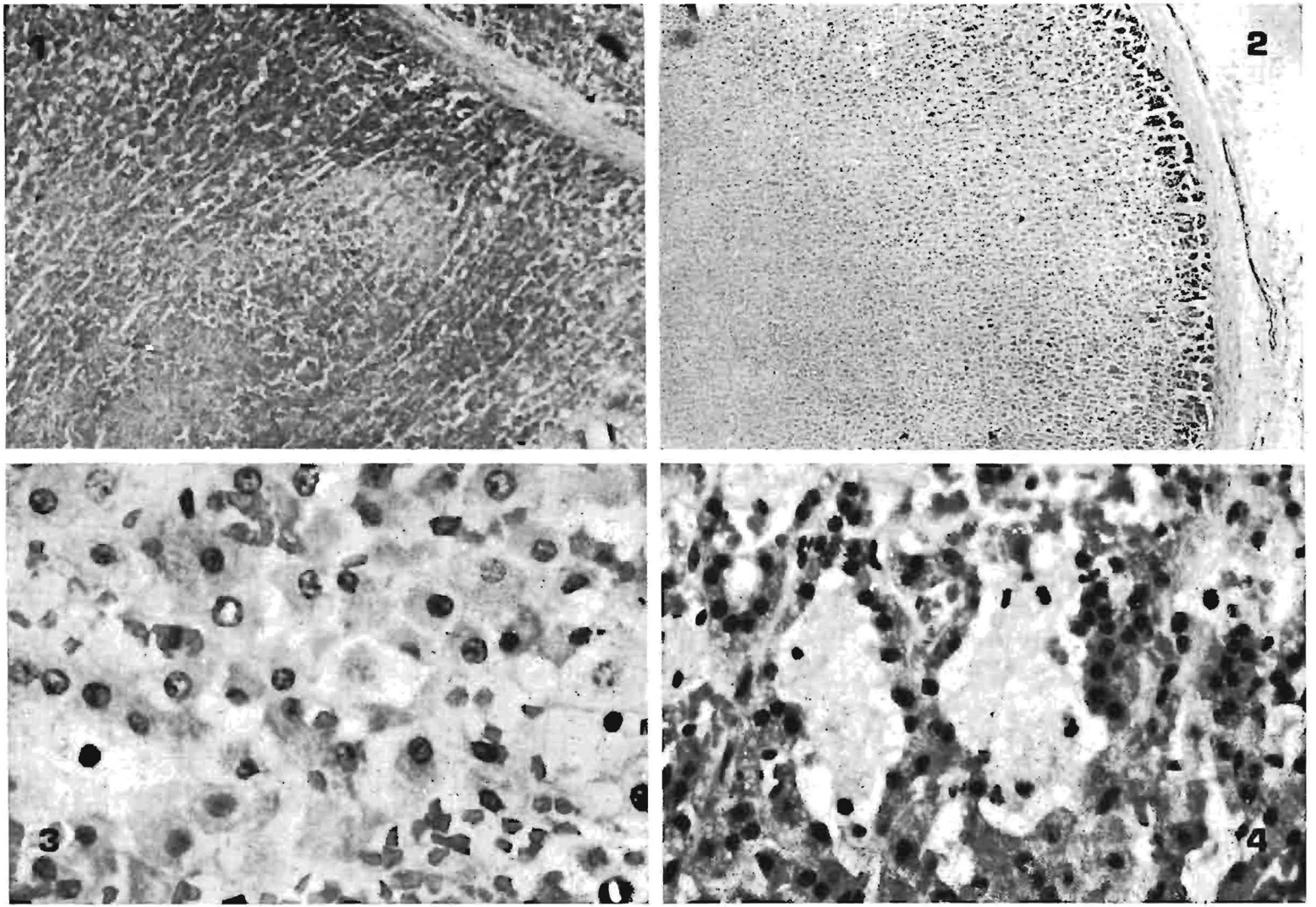
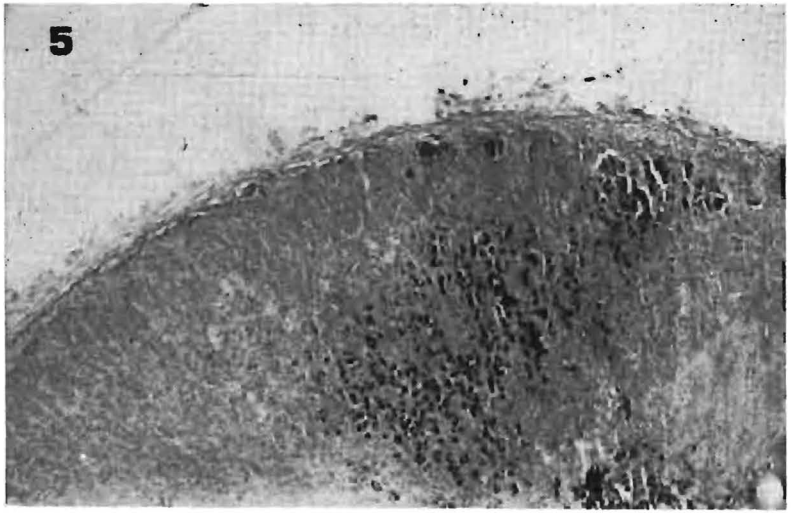
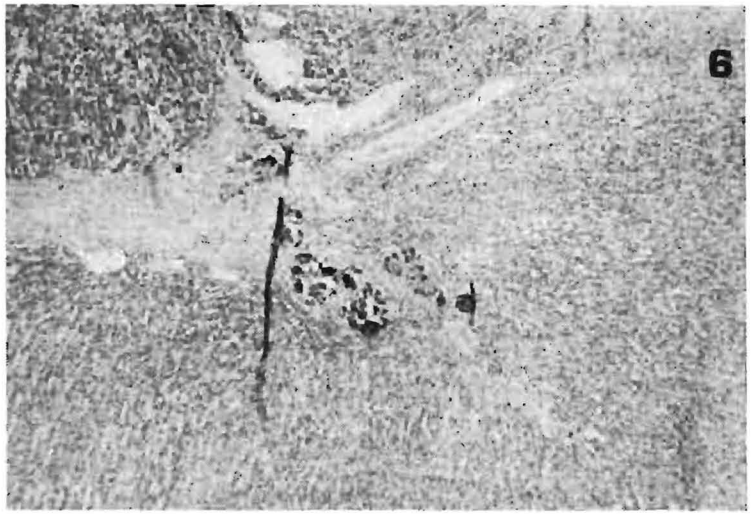
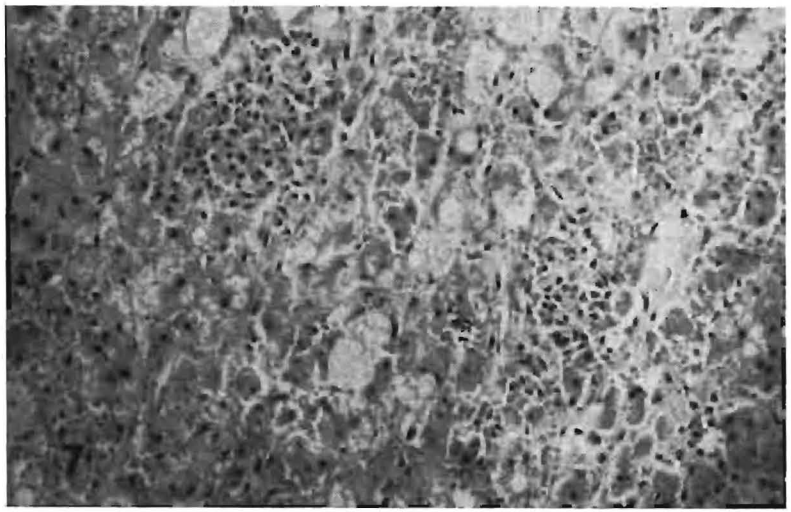


FIG. 1: H. & E. 250 × Segmental infarction from left lower corner towards right upper corner.
FIG. 2: H. & E. 100 × Necrosis of zona fasciculata and zona reticularis and retention of zona glomerulosa subcapsular area.
FIG. 3: H. & E. 600 × Toxic cytolysis.
FIG. 4: H. & E. 600 × Fibrin thrombi in sinusoids—zona glomerulosa.







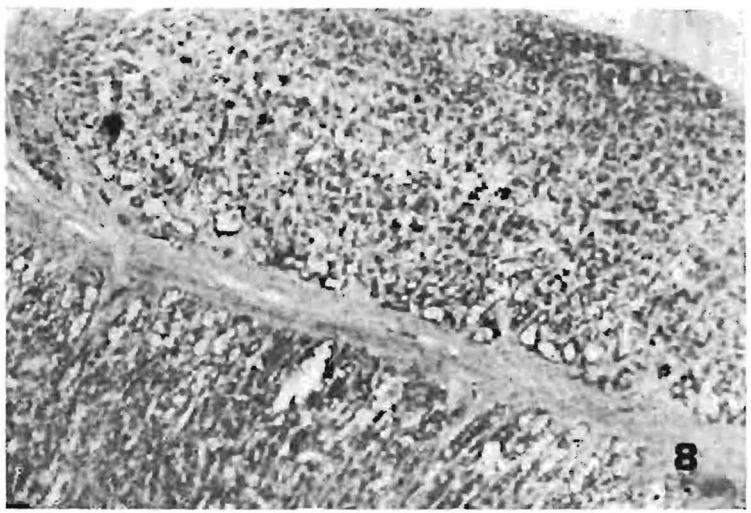


FIG. 5: Von Kossa 100 × Demonstrating calcium deposits in an area of previous segmental infarction.
FIG. 6: H. & E. 100 × Psammomatous calcific bodies at the corticomedullary junction.
FIG. 7: H. & E. 400 × Granulomatous lesions left upper and right mid-area.
FIG. 8: H. & E. 250 × Large amount of extracapsular adrenal tissue upper area.

D. Fibrin thrombi in sinusoids associated in all cases in which they were found with the histological characteristics as seen in Group D (Fig. 4)

Group I — Those without Clinical or Histopathological enterocolitis with or without dehydration.

There were 41 cases in this group of which nine showed adrenal damage, ie. 22%. Of these nine the major associated condition was as follows:

Four were rejected or non-functioning renal transplants — all Subgroup A possibly due to vascular damage at surgery. One was a necrotic lung transplant — Subgroup B. One had a confluent bronchopneumonia — Subgroup B. One had a pseudomembranous laryngitis — Subgroup D. One had a toxic anaemia — Subgroup E. One was an apparently normal baboon which had been sacrificed as a blood donor — Subgroup A.

Group II — Those with Clinical and Histopathological evidence of enterocolitis or colitis.

There were 119 cases in this group of which 54 or 46% showed signs of adrenal damage. Of the 54 cases 48 showed signs of moderate to severe dehydration i.e. 40% of the total with histopathological enterocolitis showed clinical signs of dehydration.

Of the six cases with histological mild colitis and adrenal damage but no clinical signs of dehydration *antemortem*, one was a pregnant female — pregnancy is known to predispose to adrenal haemorrhage[5]. One had bronchopneumonia. Four had histologically a mild catarrhal colitis and no other major pathology at *postmortem*, apart from adrenal haemorrhage and necrosis.

Of the 54 cases 24% were in Subgroup A.

Forty-two per cent were in Subgroup B. To these 23 the 11 cases in Subgroup D should probably be added as, apart from the fibrin thrombi in sinusoides, the features they presented histologically suggested ACTH overstimulation. Mackay[6] suggests that fibrin thrombus formation can be augmented by Cortisol. Thrombotic central veins were noted in some of these cases. The total of Subgroup B and Subgroup D is 34, or 63% which fall into the group of severe stress, ACTH overproduction, adrenal exhaustion and eventually necrosis and haemorrhage.

The remaining 13% falling in Subgroup C showed almost complete adrenal necrosis with cytolysis and nuclear damage suggesting toxic changes.

Three cases showed evidence of chronic adrenal disease One showed an area of calcification and haemosiderosis at the site of previous haemorrhage (Fig. 5). Two showed psammoma-type bodies at the cortico-medullary junction (Fig. 6). One showed a granulomatous process (Fig. 7). The significance of the last two has yet to be assessed.

Also of interest was the frequent occurrence of extra-capsular hyperplastic adrenal tissue, on occasions the only surviving viable cortical tissue (Fig. 8).

DISCUSSION

Psychological, physiological and pathological stress as represented in a recently captured animal exposed to fluctuating temperatures, a new diet and possibly new strains of bacteria leading to enterocolitis are probably the main causes of the abnormally large number of baboons showing adrenal damage.

Psychological stress in the baboon probably plays a large part in lowering their resistance during the first few weeks of captivity as we have noted in our colony. Baboons which have adapted tend to be far more resistant to physiological and pathological stress in the forms of extreme temperatures and disease, particularly enterocolitis. Further evidence of the intimate connections between the higher centres and the adrenal is demonstrated by the fact that anencephalics have either adrenal aplasia or severe hypoplasia[2]. These close connections in foetal life are maintained in the adult.

Physiological stress was represented mainly by enterocolitis of the dysbacteriotic malnutrition type. At the time of the survey a large number of diseased animals were received from our suppliers who are principally crop farmers. As we all know the baboon is no friend of the farmer and were in a few instances treated as such. However, this problem has also been largely overcome by tighter control.

Specific pathological states which have been associated with adrenal necrosis and haemorrhage in humans are pregnancies, gram negative septicaemia, abdominal operations, dichlorodiphenyldichloro-ethane poisoning and hypotension. Of these all except the DDD poisoning played some

part in the pathogenesis in the above series.

It is of interest here that the baboon may be particularly liable to the diffuse fibrin thrombotic episodes described by McKay[6] in the pathogenesis of adrenal haemorrhage and necrosis as we and other workers[7] have found that plasma fibrinogen levels in wild state baboons are 1½ to 2½ times the normal human plasma levels.

CONCLUSION

It may be concluded here that in the pathogenesis of the adrenal haemorrhage and necrosis in the above cases, certainly in the majority i.e. Subgroups B and D, multifactorial stress played a major part and that in Subgroup A possibly hypotension due to dehydration was the major factor. In Sub group C one must assume in the absence of proof that some or other toxic factor is responsible.

Further, severe adrenal damage equivalent to complete ablation can lead to precisely the same symptomatology as was observed in the present series, namely anorexia, vomiting, diarrhoea, asthenia, hypoglycaemia, hypotension, haemoconcentration, lowered blood pressure and renal failure with increased susceptibility to trauma, cold, heat, toxins and infections[8].

REFERENCES

1. Mack E., Wyler, D.J. & Egdahl, R.H. 1969 *Surg. Gynae. & Obst.* 129 : 511
2. Payling Wright G. & Symmers W. St. C. 1966 Systemic Pathology. 1st Edition, Vol II, London, Longmans, pp 1053-1093
3. Margaretten Nakai H. & Landing B.H. 1963 *Amer. J. Dis. of Childhood.* 105 : 346
4. Nelson A.A. & Woodard G. 1949 *Arch. Path.* 48 : 387
5. Crawford M.D. 1951 *J. Path. Bact.* 63 : 365
6. McKay D.G. 1965 Disseminated intravascular coagulation an intermediary mechanism of disease. New York, Harper, 80 - 88
7. De La Pena A. & Goldzeiker J.W. 1967 Clinical parameters of the normal baboon. In: *The Baboon in medical research.* Vatgborg, H. 1st Edition, Vol. II, Austin, University of Texas Press, pp 379-389
8. Ruch T.C. & Fulton J.F. 1960 Medical physiology and biophysics. 18th Edition, Philadelphia, Saunders, p 1083

LETTER TO THE EDITOR

The Editor,

re: DIETARY HYPERTROPHIC OSTEODYSTROPHY

The September Journal contains a case report by Dr. Loveday related to peculiar types of rickets cases that occur from time to time. I have a set of theories about this syndrome that satisfies me and I am curious to hear whether they are acceptable to my colleagues as well. In our practice we recognise a condition in young dogs characterised by a high fever and malaise. Clinical findings are tachycardia, sharp pulse, oedema of the lungs and in some cases severe pains in the joints. Bloodsmear shows numerous young neutrophils. Cardiac murmurs may appear during the course of the condition. Antibacterial therapy speeds up the recovery.

We know that many cases of biliary fever are diagnosed in dogs without the benefit of a bloodsmear examination, purely because of the "typical" pulse.

We also know that joint pain in a young dog is diagnosed as "rickets" without an X-ray examination.

The syndrome described above should be called acute endocarditis or something similar to rheumatic fever in humans.

If the patient is treated for biliary fever it may recover as we see plenty of old dogs with heart murmurs that have no record of an acute incident. Antibiotics given to prevent complications of biliary fever may also speed the recovery.

If the case is regarded as rickets and given high doses of minerals and vitamin D, bonelike material is deposited in all these inflamed areas, particularly collagen tissues like the endocard, aorta, heart valves and the areas adjacent to the joint capsules.

This produces the clinical picture that Dr. Loveday has described so vividly.

Trusting that this communication may contribute to an explanation of this puzzling syndrome.

P. H. LE ROUX.

Hermitage Terrace,
Richmond, Johannesburg.

30 Different animal species are being anaesthetized with Fluothane

Fluothane is the most versatile, trouble-free, safe anaesthetic known. Non-inflammable and non-explosive, Fluothane provides steady, reversible anaesthesia on any plane with complete relaxation and suppression of salivary, bronchial and gastric secretions. Smooth, rapid induction leads to rapid and uneventful recovery.
Small and large animal portable closed-circuit anaesthetic units are available direct from I.C.I.—including all accessories.

Fluothane

Twice as potent as chloroform, four times as potent as ether and twice as safe as either.

Made and guaranteed by

ICI SOUTH AFRICA (PHARMACEUTICALS) LIMITED

P.O. Box 11270, Johannesburg. P.O. Box 3451, Port Elizabeth.

P.O. Box 1088, Salisbury.

P.O. Box 15, Observatory, C.P. P.O. Box 948, Durban.

Jl S. Afr. vet. med. Ass. 42 (1): 45-48 1971

THE FEEDING OF BIURET TO DAIRY COWS

R. E. ALTONA*

SUMMARY

An experiment was conducted on a commercial herd under practical farming conditions to compare a dairy concentrate in which biuret (Prosup) contributed 30% of the total nitrogen, with a standard dairy concentrate containing no biuret.

The cows were allocated to treatments 4 weeks after calving down and the results from 70 cows were used to evaluate treatment effect. No difference in milk yield could be shown between the two treatments when the cows were fed the concentrate containing biuret from shortly after calving. Pre-feeding daily with a small quantity of biuret (28 g) was necessary if the cows were changed from the standard concentrate to the biuret containing concentrate at a later stage in the lactation.

Heavy milkers (25 litres per day) fared equally well on either concentrate.

INTRODUCTION

Experimental data on the feeding of biuret to dairy cows are scarce in published literature. Iwata[1] fed a daily dose of 40 g of crude biuret in the concentrate rations of dairy cows and reported that it had no influence on milk production. Waite *et al.*[2] reported that when all the oil cake in dairy concentrates was replaced by either biuret or urea the milk production of cows fell by 10 per cent. They found no significant difference in milk yield between the biuret and the urea treatments.

In our own work[3] we have not found any significant differences in milk production between cows fed concentrates with or without crude biuret (Prosup). These tests were carried out on two milk breeds, Friesland and Ayrshire.

Much has been said about the adaptation period required when feeding biuret[4-11]. The breakdown of biuret by bacteria in the rumen is dependent on the enzyme biuretase. The length of adaption period is governed mainly by the level of crude protein in the diet and the presence of readily available carbohydrate in the feed. On low protein roughage diets Schröder[11] found that maximum biuret breakdown was achieved within 8 days after biuret was added to the daily ration. On high protein diets, initial breakdown took place within 24 hours of feeding biuret but maximum biuretase activity resulting in 100 per cent breakdown was obtained only after 59 days. Waite *et al.*[2] found that milk production declined more rapidly during the first 5 weeks in cows fed biuret than in the control cows fed natural proteins only. However, after the initial 5 weeks the decline in milk production was slower than that of the control. They conclude that biuret can effectively replace the nitrogen usually supplied by oil cake provided the energy supply is adequate. They suggest that to overcome the 'adaptation period' in practice, biuret should be included in the cows' ration during pre-lactation feeding.

An experiment was conducted in 1968-1969 to investigate the effectiveness of crude biuret as a source of nitrogen in dairy concentrates as fed to a commercial herd under practical farming conditions. The crude biuret used was the commercial product Prosup and provided 30% of the nitrogen in the concentrate. The herd used was the Kynoch/Capex Ayrshire Stud at Modderfontein. The results of this experiment are presented in this paper.

METHODS

All cows in the herd were included in the experiment. In order to eliminate variation due to time of lactation, cows were placed in the experiment 4 weeks after calving, by which time each cow should have settled down and reached the peak of her lactation curve. All cows were fed concentrate A (without biuret) during the initial 4 weeks.

*Research Department, African Explosives and Chemical Industries, Limited, P.O. North Rand, Transvaal.

At the beginning of the 5th week each cow was allocated, at random, to one of the seven groups in the experiment. The composition of the two concentrates fed in winter and summer are given in Table 1.

Table 1: COMPOSITION OF CONCENTRATES

	Summer		Winter	
	Concentrate A %	Concentrate B %	Concentrate A %	Concentrate B %
Maize meal	71.5	83	68	80
Wheaten bran	8	8	8	8
*HPC 40%	15	1.5	18	3.75
Fishmeal	3.5	3.5	4	4
Dicalcium phosphate	1	1	1	1
Salt	1	1	1	1
**Crude biuret (Prosup)	—	2	0	2.25
	100	100	100	100
Percentage C P	15.8	15.98	16.97	16.89
Crude biuret (Prosup) as % N in concentrate	0	31	0	29

*H P C is a commercial High Protein Concentrate containing 40% crude protein.

**Crude biuret composition: 70% biuret, 8% urea, 7% triuret, 7% trihydroxytriazine (cyanuric acid), 8% moisture: 37% N.

The change in concentrates was made one, three or six weeks after the animal had been drafted into the experiment (which was done four weeks after calving). The object was to see the effect of such a change on animals in different stages of lactation as would occur if such a change were made in a commercial herd.

In order to test the effect on the 'adaptation period' of feeding small amounts of biuret before the change over, each of the above groups was subdivided. In one subgroup no biuret was fed before the change while in the other 28 g biuret per day was added to the control ration prior to the change. The final groups were therefore as follows:

Group 1 (Control)—concentrate A throughout,
Group 2 — concentrate A for one week then on to concentrate B.
Group 2A — concentrate A plus 28 g biuret (Prosup) per day for 1 week then on to concentrate B.
Group 3 — concentrate A for 3 weeks then on to concentrate B.
Group 3A — concentrate A plus 28 g biuret (Prosup) per day for 3 weeks then on to concentrate B.
Group 4 — concentrate A for 6 weeks then on to concentrate B.
Group 4A — concentrate A plus 28 g biuret (Prosup) per day for 6 weeks then on to concentrate B.

Concentrates were fed in the morning and evening at milking. In summer 0.3 kg of concentrate was fed per litre of milk produced and in winter 0.4 kg of concentrate per litre. Adjustments were made weekly, based on the average milk production over the previous 7 days. The experiment continued until a minimum of 10 cows in each group had completed 24 weeks of milking after calving. The milk records of these 70 cows were used in evaluating treatment effect.

Normal farming practices were applied to the herd. In summer the cows grazed on *Eragrostis curvula* (Weeping Lovegrass) and *Pennisetum clandestinum* (Kikuyu) pastures and during the dry winter months these pastures were supplemented with maize silage and Eragrostis hay fed *ad lib.* At no time were the cows sheltered from the weather and slept out winter and summer. This is a summer rainfall area with an average rainfall of 750 mm and heavy frosts occur during the dry winter months.

RESULTS

The daily average per cow for each successive 4 week period is presented in Table 2.

Table 2: AVERAGE DAILY MILK PRODUCTION PER COW (LITRES)

Group	Week after calving						Mean daily average (l)	Per cent drop in milk 5—24th week
	5	8	12	16	20	24		
1 (control)	21.1	20.8	20.3	18.1	16.0	13.6	18.3	35.5
2	21.6	21.7	20.3	18.3	16.0	13.9	18.6	35.7
2A	20.9	20.7	19.3	17.6	15.1	13.6	17.9	34.9
3	19.6	19.3	17.7	16.0	14.2	12.1	16.5	38.3
3A	20.9	20.7	19.1	17.5	15.2	14.4	17.9	31.1
4	18.0	18.0	16.2	13.7	11.0	9.3	14.4	48.3
4A	21.1	20.9	19.7	17.4	15.3	14.5	18.1	31.3

The total volume of milk produced in 140 days by the group was in order of magnitude.

2	26 096 litres
1	25 634 litres
4A	25 368 litres
3A	25 116 litres
2A	25 074 litres
3	23 058 litres
4	20 104 litres

As would be expected in a large commercial herd, where the ages of the cows in milk varied from 2½ to 12 years, milk production varied considerably from cow to cow. The milk yields were therefore normalised and a lactation curve for each group was drawn with the basic figure of 100 for the first week's milk yields.

Analysis of these curves showed no significant differences between the control and any other group except Group 4. Only in this case, where the change was made 10 weeks after calving without any prefeeding of biuret, was the slope of the curve significantly depressed.

Results in high production cows

The production figures of six high producing cows from Groups 1, 2 and 2A over the 20 weeks were compared.

The daily average per cow per group in the first week, the final daily average in the 20th week and the mean daily average per cow over the whole period are given in Table 3.

Table 3: PRODUCTION PER COW PER DAY IN LITRES

Group	Initial production	Final production	Average production over 20 weeks
1	24.7	16.1	20.3
2	24.7	16.1	21.0
2A	23.9	15.0	19.9

The differences between the treatments were not significant.

DISCUSSION

In most experiments the cows used are in all stages of lactation and too often the experiments are of short duration. Conditions are artificial in both the feeding and the management of the cows and seldom can the results be interpreted directly into farming practice. To overcome some of these experimental weaknesses, treatments were introduced directly into a commercial herd without changing normal farming practices. To standardise still further, all treatments were commenced at the same period of lactation. In order to keep the palatability of both concentrates as similar as possible the fishmeal and bran contents of both concentrates were the same. Part of the high protein concentrate (HPC) was replaced by biuret to give a concentrate in which 30% of the nitrogen was provided by non-protein nitrogen.

The milk yields obtained from the cows fed this concentrate did not differ significantly from the yields of the cows on the standard concentrate except where the change over to the biuret based concentrate took place 11 weeks after calving and without any pre-feeding of biuret (Group 4).

Heavy milkers consuming large quantities of concentrate did equally well on both concentrates and there was no evidence that the concentrate containing biuret was in any way inferior to the standard one.

Pre-feeding with small quantities of biuret prior to changing over to a concentrate containing biuret appears to be advisable particularly if a cow is well into her lactation. This procedure was suggested by Waite[2] and his co-workers who found that after 5 weeks on the biuret diet the milk production declined more slowly than the control, indicating that the adaptation period was of the order of 5 weeks.

Waite[2] reported a 10% reduction in milk production when biuret was fed but in our experiment no reduction was recorded when cows were changed to a concentrate containing biuret shortly after calving. However, there were important differences between the experiments. In Waite's first experiment biuret contributed 52% of the nitrogen in the concentrate and 43% in the second experiment while only 30% of the nitrogen in the concentrate came from biuret in our experiment. His cows were in periods of lactation which varied from 56 to 104 days. All our cows were at the same stage of lactation (28 days) when they were put into the experiment. In his continuous-type design experiment the experimental period was 15 weeks, compared to ours of 20 weeks. Our experiment started when all the cows were at the peak of their production and the milk yields over the following 20 weeks were recorded from each cow's most productive

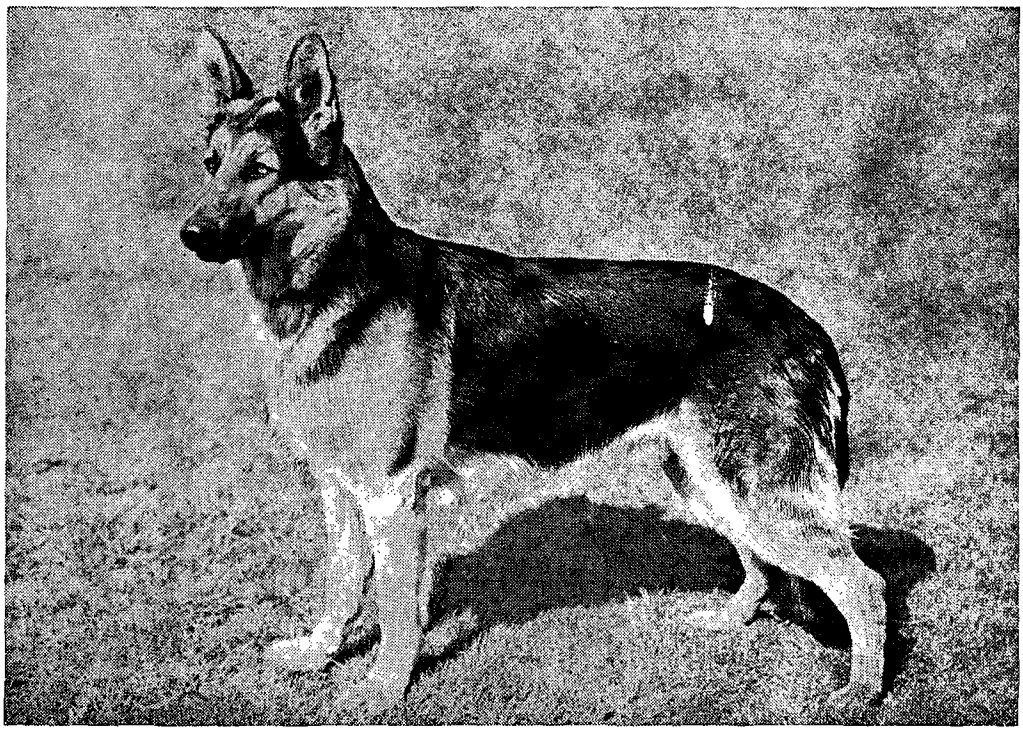
period in her lactation cycle. The experiment was not designed to study the biological value of biuret in milk production, but to assess its effect on milk production when used as a protein extender in a dairy concentrate.

It may be concluded that under normal farming conditions biuret can be safely used to supply 30% of the nitrogen in a dairy concentrate. It is advisable, however, to pre-feed biuret for a few weeks before changing the cows over from a standard concentrate to one containing biuret.

(Figures from individual cows and copies of the lactation curves will be supplied by the author on request.)

REFERENCES

1. Iwata H. 1959 *International Dairy Congress Proceedings* 54
2. Waite R., Castle M.E., Watson J.N., Drysdale A.D. 1968 *J. Dairy Res.* 35 : 191
3. African Explosives and Chemical Industries Limited 1967 *Agricultural and Biological Group* Review 33
4. Smith G.S., Anderson G.C., McLaren G.A., Campbell C.D., Welch J.A., Shelton D.C. 1957 *Proc. W. Virginia Acad-Sci.* 1957 - 58
5. Welch J.A., Anderson G.C., McLaren G.A., Campbell C.D. 1957 *J. Anim. Sci.* 16 : 1034
6. Campbell T.C. 1962 *Dissert Abs.* 22 : 4139
7. Johnson R.R., McClure K.E. 1963 *J. Anim. Sci.* 22 : 1123 (Abstract 62)
8. Johnson R.R., McClure K.E. 1964 *J. Anim. Sci.* 23 : 208
9. Pieterse P.J.S., Lesch S.F. 1964 *Proc. S.Afr. Soc. Anim. Prod.* No. 3 : 88
10. Schaadt H., Johnson R.R. McClure K.E. 1964 *J. Anim. Sci.* 23 : 891 (Abstract No. 181)
11. Schröder H.H.E. 1970 *J. Agric. Sci. Camb.* 75 : 231 - 240



The Alsatian – rugged, powerful, intelligent – is officially recognised by the Seeing Eye Institute as the dog best suited to lead the blind. The Alsatian has become a recognised symbol of strength, safety and dependability. And so has Enduracell® from Norden Laboratories. Enduracell is the thoroughbred of canine distemper vaccines. It is unique in veterinary medicine because Enduracell is produced on Norden's exclusive Stable Cell Line using proved biologically identical canine cells.
That's why Enduracell is dependable, every time. That's why Enduracell is consistently safe and consistently effective, serial after serial, year after year.

Enduracell DH Distemper/Hepatitis vaccine

Enduracell DHL Distemper/Hepatitis/Leptospirosis vaccine

Enduracell the dependable thoroughbred

ruffel A.S. Ruffel (Pty) Ltd, P.O. Box 7824, Johannesburg

EC:JA10SA

Jl S. Afr. vet. med. Ass. 42 (1): 51-55 1971

THE TECHNIQUE OF USING OESOPHAGEAL FISTULATED CATTLE FOR THE STUDY OF PASTURE UTILISATION

1. OPERATION AND REQUIRED EQUIPMENT

D. E. OSBOURN* AND R. M. BREDON**

SUMMARY

The technique of oesophageal fistulating of cattle as used by the authors is described in detail. The type of operating table and instruments required for the operation and the type of dimension of the plug used to close the fistula hole are described. Various difficulties that may occur during the operation are drawn to the attention of the readers and discussed.

INTRODUCTION

An excellent review on the development and use of the oesophageal fistula has been written by Van Dyne and Torell[1]. As this review covers rather a wide field of various aspects, it does not give details of the operation nor specifies the measurements of the equipment used.

In view of developing interest in the technique, and enquiries made, the authors decided that it would be worthwhile describing the operation and equipment used, in sufficient detail to enable a newcomer into the field to carry out the operation and reproduce the equipment without wasting time on preliminary investigations. This equipment and the operation are basically the same as used by Van Dyne and Torell, and the authors can only claim small refinements developed while following their technique.

PREPARATION OF CATTLE FOR THE OPERATION

Animals should be starved for 24 hours before the operation. The hair around the area of the neck where the fistula is to be fitted should be cut as short as possible otherwise it will be difficult to shave this area during the operation .

EQUIPMENT REQUIRED FOR OESOPHAGEAL FISTULATING OF CATTLE

1. Operating Table: The front portion of the table must be raised to a height of 50 - 75 cm above the ground and the table top should slope downwards towards the back at 35° - 40°.

2. Steel rod (preferably stainless steel): This rod should be approximately 1 m in length and finished at one end with a ball, 4 cm in diameter. The rod must be rigid as a considerable amount of pressure is required. A 1.27 cm (0.5 inch) diameter steel rod is suitable.

3. Template: This plate can be made from perspex, celluloid or even cardboard. It is used to guide the scalpel when making the skin incision during the operation. The shape of the hole in the plate and dimensions are given in Fig. 1G.

4. Spatula and plug: This equipment is made from three parts: (a) Spatula made from stiff plastic. It can be cut from 3.18 cm (1.25 inch) diameter plastic piping. (b) Plug can be made from rubber, plastic or soft wood. The authors prefer a wooden plug covered with non-toxic enamel paint or colourless laquer. This type of plug is lighter than rubber and is easier to fit without catching the oesophagus between the plug and spatula. If a rubber plug is used it is advisable to use a lubricant such as vaseline or silicone. (c) The plug is fixed to the spatula using a threaded brass rod and wing nut. The rod is permanently tied to the spatula with 36 lb strength, braided, terylene fishing line. The dimensions and full description of the spatula and plug are given in Fig. 1 A-F.

*State Veterinarian, Ixopo, Natal.
**Animal Husbandry Officer, Agricultural College, Cedara, Natal.

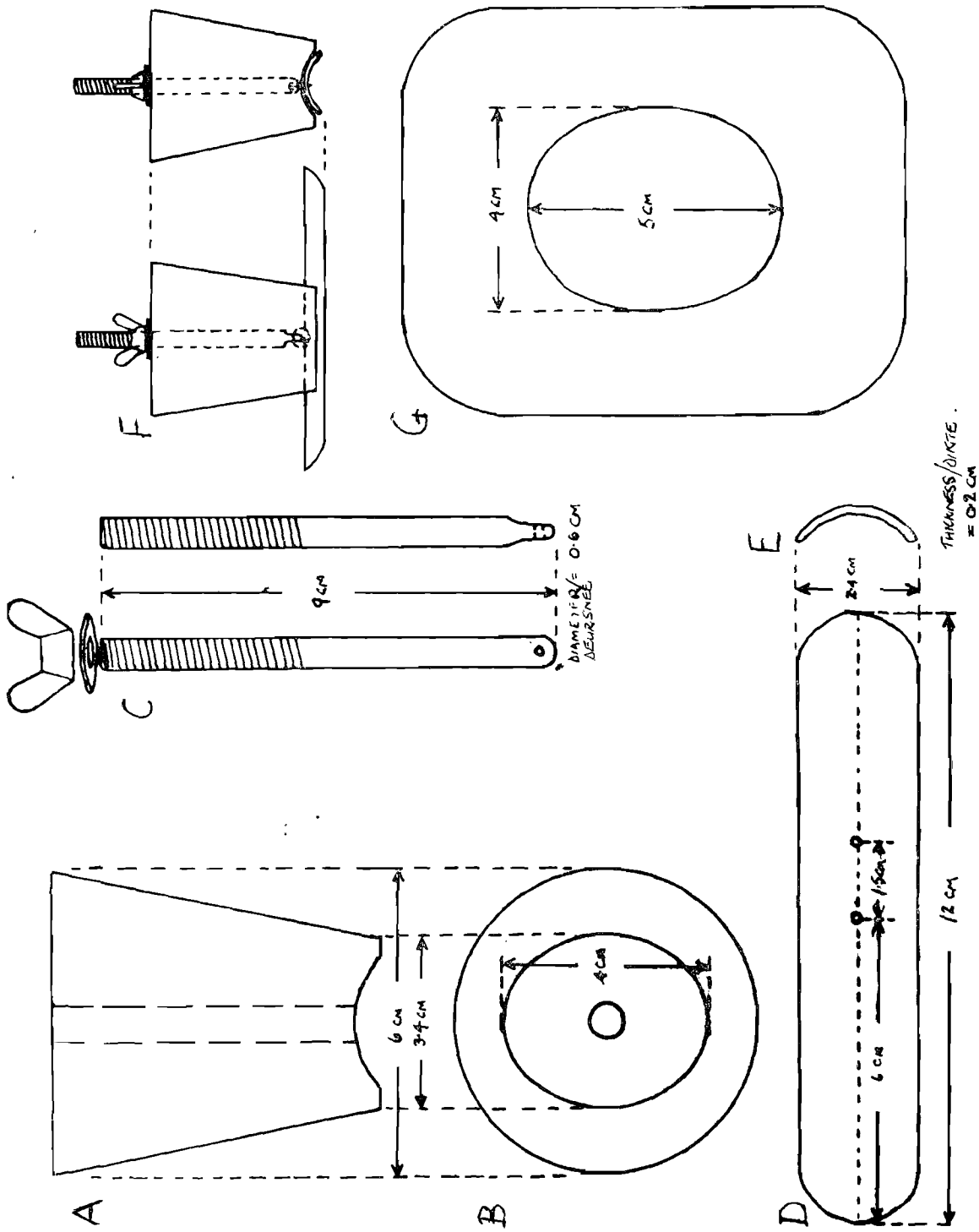


FIG. 1. Equipment for the oesophageal fistulating of cattle.

A. Plug—side view.
B. Plug—top view.
C. Connecting rod—two side views.
D. Spatula—top view.
E. Spatula—end view.
F. Assembled plug and spatula—two side views.
G. Template for use during operation.

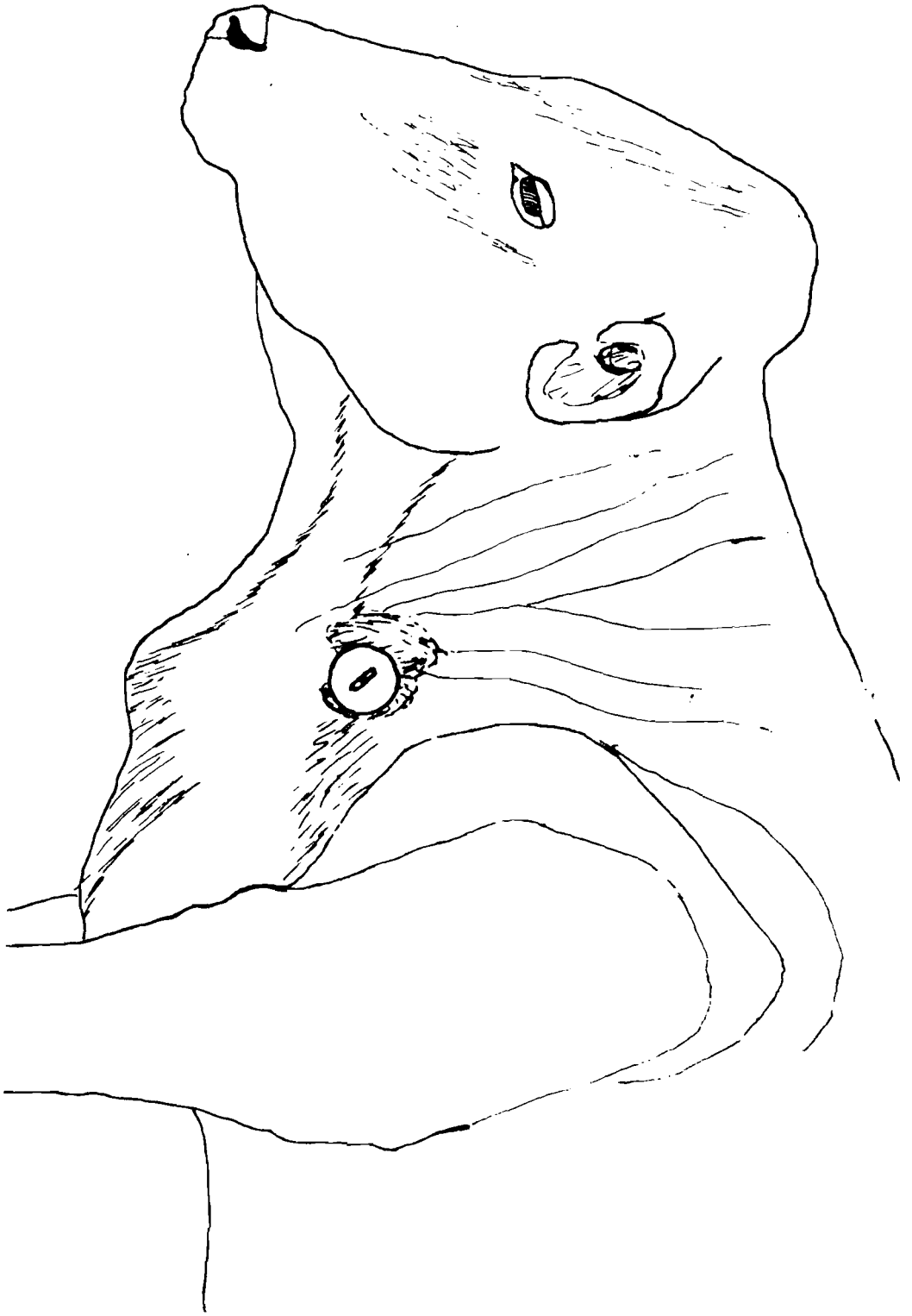


FIG. 2.
Position of oesophageal fistula on neck of animal

It should be noted that the top of the plug is circular while the bottom (narrow end) is oval. The hole in the plug is slightly larger than the diameter of the connecting rod. When the rod is tied to the spatula approximately 25 cm of line is left hanging. This line is threaded, together with rod, through the hole in the plug and is used to hold the spatula in position prior to plug fitting; otherwise the spatula could be lost inside the oesophagus. A hole made in the rod and two holes in the spatula are used for tying them together. Fig. 1F shows the complete assembled spatula and plug.

5. Operation instruments: The following instruments are needed for the operation. Scalpel with spare blades, surgical scissors (2), artery forceps (6), rat tooth head forceps (2), semicircular needles, triangular, approximately 4 cm across (6), needle holder, suture thread. This thread must be soft and therefore monofilament nylon is not suitable. Surgical silk No. 1 is suitable. In addition 2 syringes, one 20 ml and the other 50 ml capacity, for applying anaesthetics and razor blades for shaving will be required.
6. Anaesthetic: 40% chloral hydrate solution and Sagatal (Maybaker) are used for general anaesthesia and 5% procaine hydrochloride for local anaesthesia.
7. Others: Sulphonamide powder, sterile distilled water, ethanol, vaseline, cotton wool, warm water, soap, towels and ropes.
8. Antibiotics: Penicillin/streptomycin preparation in sufficient quantities to inject approximately 800 000 units daily for 6-8 days is needed.

OESOPHAGEAL FISTULA OPERATION

Forty per cent chloral hydrate solution is injected intravenously. The amount of anaesthetic used is according to the weight of cattle as prescribed (10ml/50 Kg liveweight) and in most cases is sufficient to complete the operation. Should it be necessary, Sagatal (5ml/animal) is given to complete anaesthesia. It was also found that chloral hydrate plus local anaesthetic were quite satisfactory. As individual cattle react differently to anaesthesia, it is necessary in some cases to wait and it is important not to give any extra dosage too quickly or this might cause prolonged anaesthesia or even eventual death. The animal under anaesthesia is strapped to the table with the head hanging over the raised end. The area where the fistula is to be fitted is then shaved, cleaned and disinfected. The steel rod with the ball on the end is inserted through the mouth into the oesophagus as far as the operation site and pressure is exerted resulting in a bulge on the side of the neck. This has many useful purposes. It restricts regurgitation of ruminal contents and makes it much easier to pick up the oesophagus when stitching it to the skin. The rod must be kept in position all the time during the operation. This means that someone must hold the rod and exert pressure as directed by the surgeon. Once the rod is in position the template is placed over the bulge and an incision is made into the skin following the edges of the hole in the plate. The position of the fistula is shown on the diagramatic picture Fig. 2. When an animal is lying on the operating table the distance of the hole from the shoulder joint is approximately 12-15 cm. It becomes nearer to the shoulder joint when the animal is in a standing position and care must be taken not to place the fistula so close to the joint as to affect leg movements by the animal. The next step is to remove the skin from the muscles. A longitudinal incision is made into the muscles following the direction of the oesophagus to expose the oesophagus. A small incision is then made into oesophagus and the edges are picked up and sutured to the skin, avoiding suturing the muscles. This incision of the oesophagus is extended as the suturing continues. It will be noted that the ball prevents the oesophagus from contracting and simplifies suturing. Either a continuous or an interrupted suture is used. After trying both, the authors prefer continuous suturing as it looks neater and is quicker. An oval opening big enough for the plug to fit tightly is the result. Great care must be exercised during the operation and the use of soft thread is essential as the oesophagus tears readily. Care must be taken not to remove any muscles during the operation as each small trimming of muscles tends to cause leakage from the fistula afterwards.

After completion of the operation the wound is liberally dusted with a sulphonamide powder. The spatula is inserted into the oesophagus with one hand while holding the attached rod with the other hand so as not to lose the spatula. The rod together with nylon line is then put through the plug hole. During that time holding of the nylon

line will prevent loss of the spatula. A washer is placed over the projecting end of the rod and the plug is secured by screwing a wing nut lightly onto the rod. The plug is then fitted to the fistula opening. This is done by stretching the muscles around the fistula hole and screwing the wing nut progressively as the plug gets into position. Considerable pull on the muscles must be exerted but not sufficient to tear the stitches. Once the plug is in position and there is certainty that no oesophagus is between the plug and spatula, the wing nut is screwed tightly. The area around the plug is heavily sprinkled with sulphonamide powder. The antibiotics are then injected intramuscularly and the animal removed to a place sheltered from sun and wind. The whole operation including anaesthesia can be done in less than half an hour.

CARE OF ANIMALS AFTER THE OPERATION

Very little care is required. Animals must be given approximately 800 000 units per day of a penicillin / streptomycin mixture for 6 to 8 days or until the swelling round the fistula disappears. If the site looks in bad condition for some reason, removal, cleaning and refitting of the plug might be advisable on the following day, but otherwise it is better not to remove the plug until removal of the stitches approximately 10 days after the operation. Enough workers should be available when the animal wakes up from the anaesthesia to be able to guide it to the shelter and prevent falling or running away and damaging the stitiches. During the first 24 hours after the operation it is advisable to keep the animal in a shelter and feed it there with grass which should not be too coarse and also not so low in dry matter as to cause digestive disturbances.

ACKNOWLEDGEMENTS

The authors wish to thank Mr. D. Lyle, officer in charge of the Agricultural Research Station, Kokstad, for help and facilities for the operation and Mr. A. Short, Animal Husbandry Officer, Agricultural College, Cedara for making drawings for this article.

REFERENCE

1. Van Dyne G.M. & Torell D.T. 1964 *J. Range Mangt* 17 : 7

Jl S. Afr. vet. med. Ass. 42 (1): 57-62 1971

THORACIC DUCT DRAINAGE IN THE VERVET MONKEY AND CHACMA BABOON

BRIAN C. WESSELS*

SUMMARY

When a pure suspension of lymphocytes is required in a sterile medium and free from erythrocytic contamination the thoracic duct must be drained directly. A successful technique for direct drainage of the thoracic duct is described. A short résumé states the necessary precautions to be followed in carrying out this operation which was performed successfully on five vervet monkeys and six baboons.

MATERIALS AND METHODS

Subjects

The monkeys weighed between 3.5 kg and 7.5 kg; the baboons between 10 kg and 17 kg. All were subjected to veterinary examination before the operation took place and were found to be clinically free from infectious disease. Faecal samples were negative for internal parasites and it was not thought necessary to take samples for bacteriological and virological examinations.

Pre-Operative Period

Initially the subjects were fed peanuts, *ad lib.* for 6 hours before surgery. The period of pre-operative peanut feeding was eventually extended to 24 hrs, then to 48 hrs and finally to one week.

Peanuts were fed in the belief that this would stimulate chyle flow. This in fact did take place. However, it was found that it was not necessary to feed peanuts for longer than 24 hrs pre-operatively as longer periods of feeding did not increase the quantity or quality of chyle.

The animals were housed separately from one week pre-operatively to three weeks post-operatively. Other than the addition of peanuts, *ad lib*, the subjects were maintained on their normal diet. No food, except peanuts, was given to the subjects on the day of the operation.

Premedication

All the animals were either injected (monkeys) or darted by means of capture pistol (baboons) using phencyclidine hydrochloride*. The dosage employed for all of the subjects was 1 mgm/kg body weight in a single dose.

The subjects were removed from their quarters and the left clavicular, left cervical, left thoracic and left shoulder areas were slipped and shaved. Thiopentone sodium** was then administered very slowly by the intravenous route (the standard 5% solution was first diluted to a 1¼% solution with normal saline). This was given to effect viz; when an endotracheal tube of appropriate size could be passed freely without the tracheal reflex being elicited.

A Braunule, 0.5 luer***, was then passed into a saphenous vein and a drip containing sodium chloride† at 10 drops per minute was started. Atropine sulphate†† at the usual dosage, was given at commencement of the drip.

The shaved areas of the skin were painted with the usual surface sterilizers and finally the subjects were adequately draped.

Anaesthesia

Surgical anaesthesia was maintained by one of the following drugs:

(a) Thiopentone sodium — this was given at varying intervals, always to effect.
(b) Nitrous oxide and oxygen — given continuously through a semi-closed circuit apparatus.

*Veterinary Research Officer, Natal Institute of Immunology, Durban.

* Sernylan: 100 mgm/ml: Parke Davis & Company
** Intraval Sodium: May & Baker (Pty.) Ltd.
*** Remedia (Pty.) Ltd.
† Normal Saline: Baxter Labs.
†† Atropine Sulphate,grs. 1/100: Saphar Labs. Ltd.

Fig. 1.

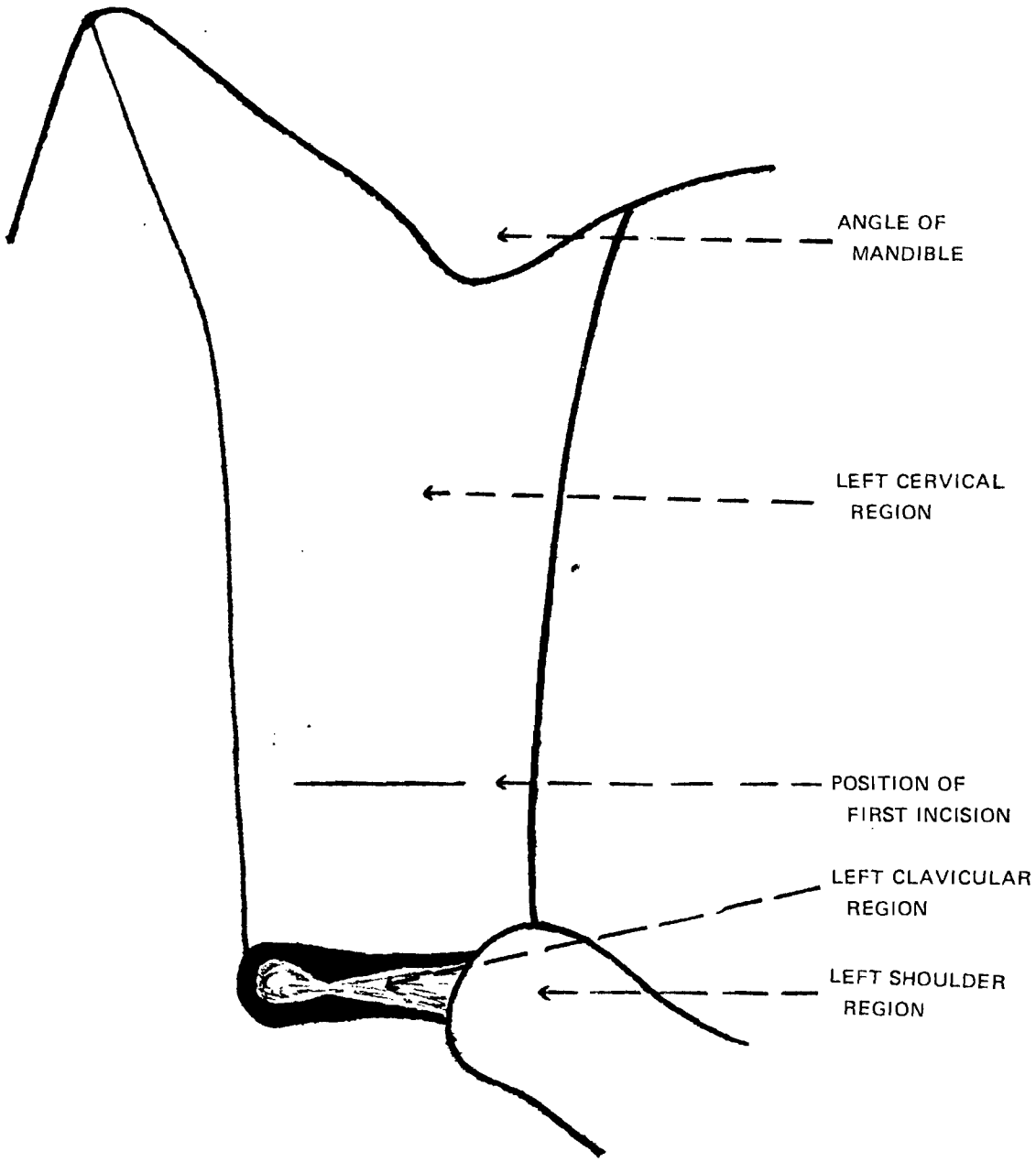


Fig. 1. SHOWING POSITION OF FIRST INCISION

(c) Fluothane††† — given continuously through a closed circuit apparatus.

In some of the baboons Diazepan‡ was given to counteract muscular spasms brought about by the phencyclidine hydrochloride.

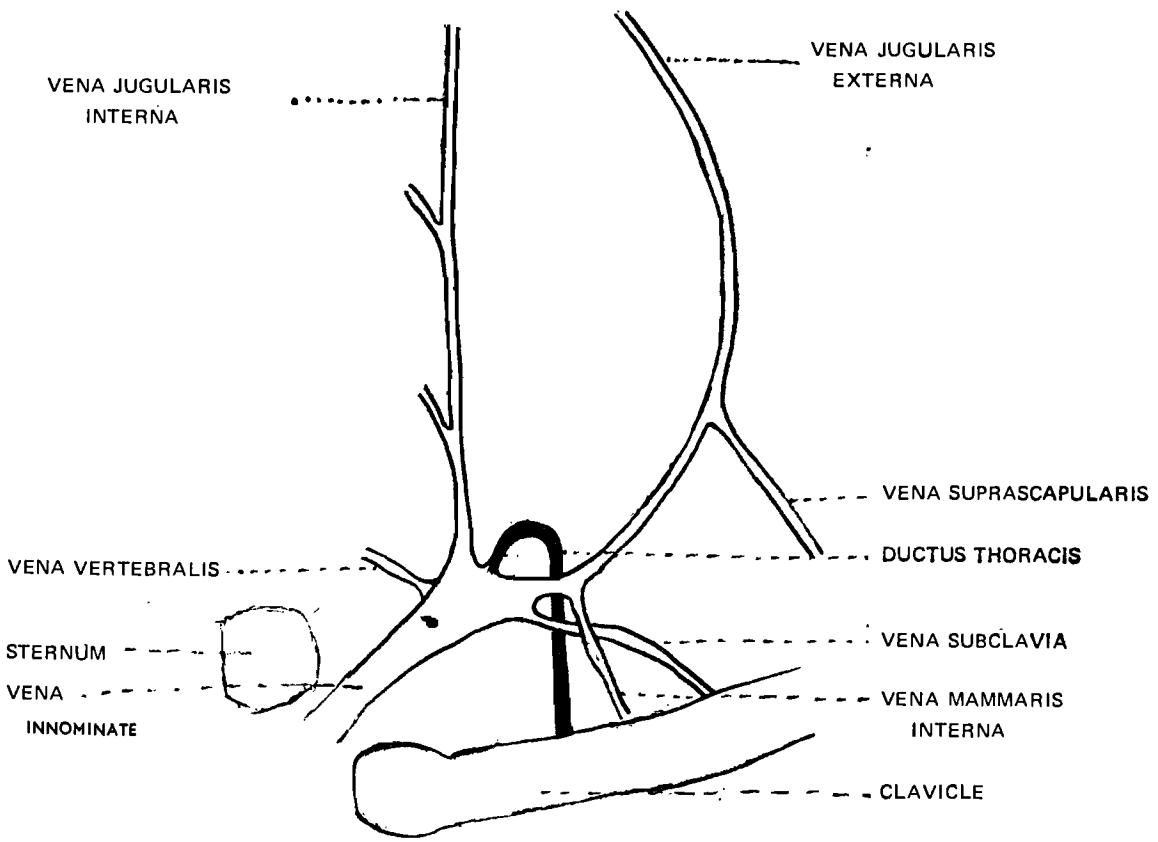
The Operation

The subjects were placed in a position of dorso-lateral recumbency with the neck well stretched. The skin incision was made about 2.5 cm cranial to upper border of the clavicle. The incision was made 1 cm lateral to the midline and continued for 5 cm laterally (see Fig. 1).

The subcutaneous fascia was dissected away and the sterno-mastoid muscle exposed. This was completely severed in the direction of the skin incision. The underlying area was exposed and the clavicle dislocated laterally at the sterno-clavicular joint. The structures shown in Fig. 2 were then identified.

Once identification was complete the internal mammary vein was ligatured and cut. This procedure was then applied to the subclavian and suprascapular veins. Great care was taken in this procedure to leave the thoracic duct intact and free-flowing.

Fig. 2



††† Fluothane V: I.C.I., S.A. (Pharm.) Ltd.
‡ Valium. 10 mgm/ml: Roche Labs. (Pty.) Ltd.

At this stage a definite "jet" of white chyle could be seen entering the internal jugular. This "jet" of chyle was greatly influenced by the respiratory movements which must be unrestricted at all times.

The internal and external jugulars, together with the innominate vein, were then isolated by blunt dissection. A loose loop of 3/0 braided silk was then passed around these structures. These loops were then pulled up to occlude the respective veins. As each vein was temporarily "cut off" the chamber thus formed became very noticably whiter due to the accumulation of chyle. Care was taken not to over distend this "chamber" as the wall might have ruptured.

If the "chamber" did not whiten completely, then blood inflow to the "chamber" was suspected. The anatomy of these structures in the monkey varies to a great extent. Lesser variations were present in the baboons. In those cases where adequate "whitening of the chamber" did not take place, a small vein — *vena vertebralis* — was found as shown in Fig. 3. Extreme care was taken in locating this vein, when present, as it lies in very close association with the thoracic duct. Once this vein is located it must be ligatured and cut.

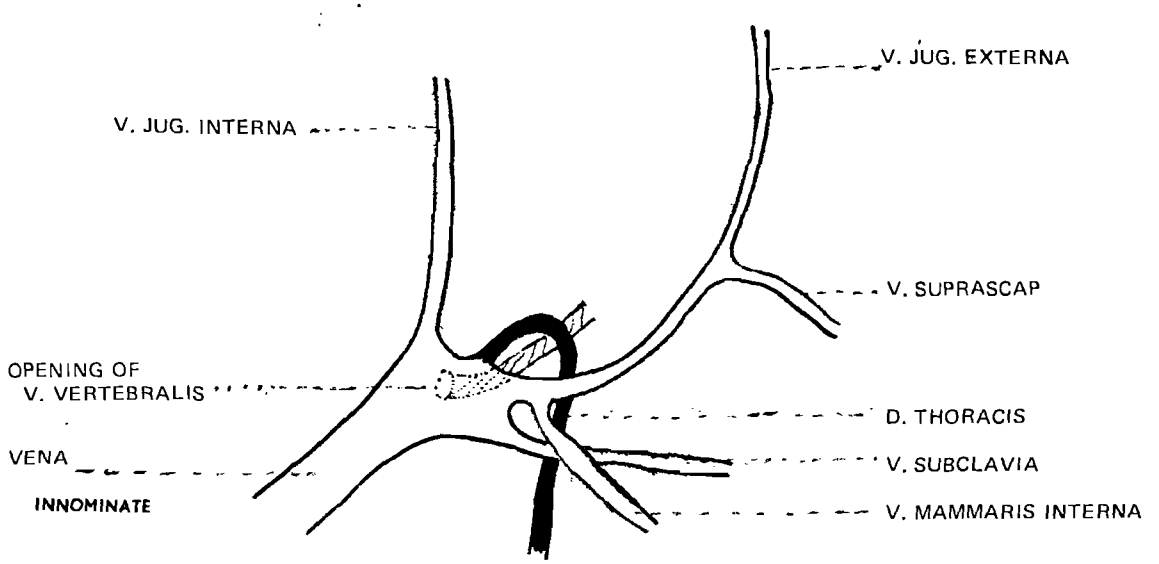
Usually the vertebral vein enters the innominate vein. Ligatures were then placed near the base of the external jugular and midway up its length. These were not yet tightened. The base ligature was pulled taut to distend the vein. An appropriate catheter (see description later) was then inserted into the distended vein and pushed down the vein so that its end was almost in the "chamber". The ligatures were only then tightened so as to anchor the catheter in the vein. The distal part of the external jugular was firmly ligatured and then cut. Approximately 7.5 cm of the external jugular was catheterised.

This procedure was then repeated on the internal jugular.

One catheter was used as the "inlet" for the sterile nutrient medium* which contained 7 500 iu heparin per 500 ml medium. The other catheter was used as the "outlet" for medium plus chyle.

Before ligaturing the innominate vein, both catheters were checked for patency. Once patency had been established, the

Fig. 3



* M. 150. — Polio Research Institute.

medium with heparin was allowed to flow in at a rate of 1 ml/min. At the same time collection of the chyle and medium was commenced. The innominate vein was then very securely ligatured but not cut.

Finally, the catheters were firmly anchored to the muscles and skin. The wound was sutured in the usual manner.

The Catheters

Epidural catheters were found to be too small and clotting took place. Silastic tubing bent too easily and thus occuded the inlet or outlet.

Sterilized nylon intraveneous cannula sets** proved most suitable. The sizes used varied from 1.34 mm to 1.6 mm external diameter.

Post-Operative Period

The subjects were maintained under light anaesthesia for a period of six hours for monkeys and eight hours for baboons. This was found to be the maximum favourable period for a high chyle and lymphocyte drainage (see Graph 1.). After this period, the quanitity of the chyle and its concentration of lymphocytes dropped dramatically, even though the number of lymphocytes remained higher than that found in the blood circulation.

The subjects were kept warm and they were maintained on a normal saline drip (10 drops/min.).

After the period of maximum drainage the catheters were withdrawn and a pressure bandage applied to the surgical area.

The subjects were then placed in recovery wards where they received the maximum daily dose of penicillin† and streptomycin†† for five days.

Precautions

For the complete success of the procedure it is very important to have:

1. Healthy subjects.
2. Adequate pre-operative peanut intake — if this is unavailable the thoracic duct can be easily overlooked and an inadequate chyle flow occurs.
3. Safe, yet light unobstructed anaesthesia.
4. Preferably free respiration — this brings about the pumping of the chyle flow which is very important post-operatively.
5. A pliable "two channel" system which can be easily washed out if necessary and one that prevents clotting of chyle.
6. Moderate distention of the veins before catheterization.
7. Complete occlusion of all veins flowing into the "chamber".
8. The subjects must be kept in the prone position post-operatively while drainage is in progress.

ACKNOWLEDGEMENTS

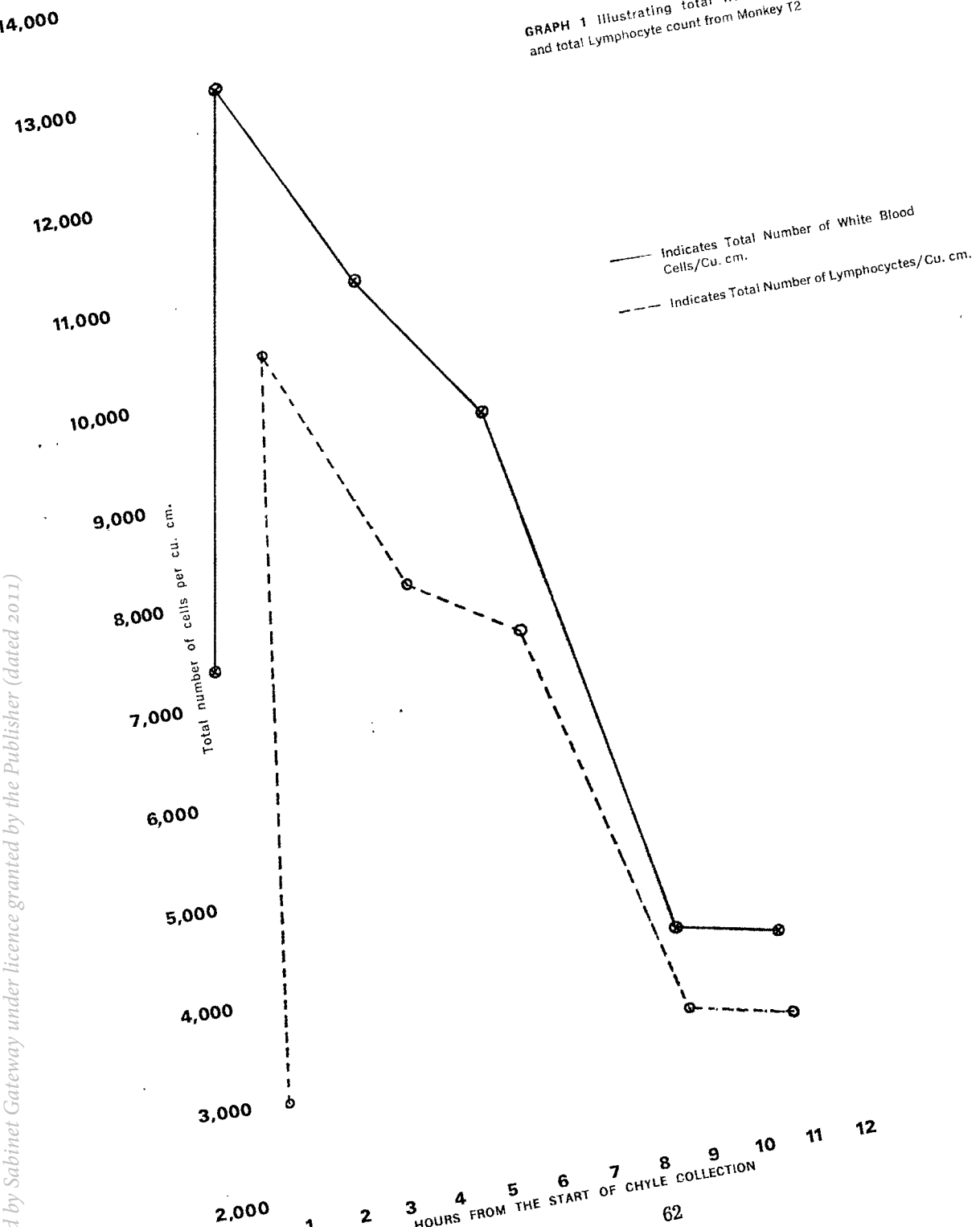
The author wishes to express his sincere thanks to Dr. B. G. Grobbelaar, Medical Director of the Natal Institute of Immunology for permission to publish this paper; to Mr. A. White, Principal Surgeon, Addington Hospital, Durban for conceiving this operation and for guidance, and to all the technical staff of the Institute especially Mr. D. Armstrong.

** Portex: Portland Plastics Ltd.

† Procaine Penicillin 300 000 iu/ml: S. A. Cyanamid (Pty.) Ltd.

†† Streptomycin Sulphate 0.25 g/ul: S.A. Cyanamid (Pty.) Ltd.

GRAPH 1 Illustrating total W.B.C.C. and total Lymphocyte count from Monkey T2



Jl S. Afr. vet. med. Ass. 42 (1): 63-65 1971

HEALTH PROBLEMS ENCOUNTERED AT THE UNIVERSITY OF STELLENBOSCH PRIMATE COLONY

J. J. GELDENHUYS, J. H. GROENEWALD, J. J. W. VAN ZYL, H. D. BREDE, H. W. WEBER,

S. A. R. STEPHAN AND T. ZUURMOND*

INTRODUCTION

The University of Stellenbosch Primate Colony receives and uses over a thousand baboons annually. This high turnover and the fact that they are received at the colony almost direct from the wild after capture, have resulted in circumstances which may contribute greatly to the occurrence of diseases which frequently prove fatal. The purpose of this paper is to discuss some of these problems, especially where these interfered with the surgical research programmes carried out at the Karl Bremer Hospital and University of Stellenbosch.

Primates referred to in this communication are classified as *Papio ursinus* commonly known as the Cape Chacma baboon and were procured mostly from the Western Cape Region but many were also received from the Eastern Province as well as South West Africa.

Diseases to be discussed are spontaneous and not the result of experimental manoeuvres. Quarantine periods at the colony vary from time to time and often have to be adjusted according to the demands of the experimental projects and the supply of animals. However, quarantine is seldom less than three weeks. Baboons procured from the farms are selected at random and only too small or injured animals are not accepted for experimental purposes. The colony personnel consists of a colony manager who is a senior technician with a B.Sc. degree, and two coloured cleaners. They are responsible for collecting baboons from farmers, conditioning and blood typing as well as routine pre- and post-operative treatment in addition to cleaning and feeding duties.

From July 1967 until December 1969 ,the colony handled over 3,100 baboons. Of these 785 died prior to being subjected to any experimental procedure. Factors contributing to this high mortality rate are discussed under the following headings:

1. TRAUMA

In their distress when newly captured, the animals tend to attack each other, so much so that they frequently sustain severe injuries; furthermore injuries are sometimes caused by incorrect means of trapping and transportation. The canine teeth of the male baboon are up to two inches long, they are dangerous weapons and even chest injuries with haemo-pneumothorax have been seen from canine penetration of the pleural cavity. Spontaneous fighting is more common between males than between males and females, although females are always attacked on the approach of humans during the early days of captivity . Despite this aggressive tendency deaths due to trauma and injuries seldom exceed 0.3% of all fatalities. Tranquilizing agents which are invariably administered during the first few days of captivity often help in getting the baboon adapted to its new environment.

2. PARASITIC INFESTATIONS

Many of the baboons received at the colony are infested with one or more parasites of which the following have been identified:

Ascaris lumbricoides, Oxyuris vermicularis and *Trichuris trichiura* were found in stools and colon as well as *Gongylonema* in the peritoneal cavity where different stages in the life cycle are usually present. Echinococcus cysts in the liver and bronchial infestations with pentastomes were found in .02% in cases operated on. *Filaroides oslerii,* which is well known in dogs, has also recently been detected in the bronchi of a baboon.

*Faculty of Medicine, University of Stellenbosch and Karl Bremer Hospital, Bellville, South Africa.

Paper read at the Symposium on Production and Use of Laboratory Animals; CSIR and Medical Research Council, Pretoria, 3 - 5 June, 1970.

Although parasitic infestations are frequently found it is unlikely that they can be held responsible for more than 0.5% of deaths. Nevertheless it is probably a contributory factor, especially in lowering the resistance against other forms of infection.

The treatment of parasitic infestations creates many problems as oral administration of anthelminthics is virtually impossible. However, a parenteral anthelminthic drug will, it is believed, be available soon.

3. INFECTIOUS DISEASES

All baboons delivered to the colony are direct from the wild and selection prior to acceptance is based solely on visual examination for physical injury and obvious signs of disease. At the final acceptance the animals are weighed and samples of blood for haematology and serology, throat and rectal swabs for culture and saliva for determination of ABO blood groups are taken.

Pulmonary infections such as bronchopneumonia are seldom encountered. Tuberculosis has been found in only one instance, the source of infection almost certainly being an attendant who was found to have active tuberculosis at the time.

Gastro-intestinal infections, however, present a much more morbid picture.

During 1969, 291 baboons out of the 875 animals received died, due to uncontrollable epidemics of diarrhoea. Within the first 48 to 72 hours after arrival at the colony these animals developed diarrhoea with foul smelling, loose stools followed by continuous diarrhoea[1] consisting almost entirely of fresh red blood and mucus. In more severe cases even pieces of mucous membrane were passed. Acute dehydration followed rapidly and death occurred within 24 to 36 hours after the onset of the diarrhoea.

At autopsy a picture similar to ulcerative colitis in man was seen in at least 5.6% of cases. Parasitic infestation of the colon was found in only 0.5% of these cases.

Bacteriological investigation of faeces and rectal swabs revealed positive cultures in only 25.6% of all cases. The following were significant:

Enteropathogenic *E. coli*	6.7%
Shigella	3.2%
Pseudomonas aeruginosa	2.2%
Proteus morgani	1.3%
Candida albicans	0.9%
Staphylococcus aureus and others	11.3%

On the other hand, however, in 30% of animals who presented with similar positive cultures no diarrhoea occurred. It thus seems possible that other factors are contributing to this high incidence of diarrhoea. These factors may include:

(i) *Composition of the diet:*

Very little is known about the nutritional requirements of *Papio ursinus* and that which is known is empirical, arising mainly from trial and error. The scientific feeding of animals centres around the following principles. Freely available foodstuffs should be used in combination to produce diets supplying adequate quantities of all the essential amino-acids and total protein to permit synthesis of the non-essential amino-acids. Energy requirements must be supplied in the form of carbohydrates and fats. Vitamins, minerals, and trace elements must be provided in standard quantities together with a free supply of clean water. The ration must be physically acceptable, palatable, hygienic, economical to produce and simple to store and distribute. The stress conditions of captivity and experimental treatments must be kept in mind insofar as they may alter the dietary requirements or interfere with normal feeding.

The food used at the University of Stellenbosch Primate Colony is supplied by Epol Feeds, a subsidiary of the Vereeniging Consolidated Milling Company. The formula has been altered several times but its present form has been satisfactorily used to feed animals for periods as long as one year. The changes in the formula resulted from observations made at the Primate Colony, for example magnesium sulphate was withdrawn as it was thought to aggravate the troublesome diarrhoea but its withdrawal had little if any effect on the diarrhoea problem. For similar reasons fibre was increased to give more bulk, extra ascorbic acid was included in the ration to obviate the need of feeding vitamin C tablets, as a few cases of scurvy, as evidenced by bleeding gums, had occurred previously.

No further symptoms of deficiency could be detected over the past one and a half years.

All ingredients are thoroughly mixed in a milled form, steam treated at 127°C and then forced through a die to produce cubes measuring 1.25 x 2.5 cm. These are immediately cooled by cold air draughts before being packed. The ingredients are breadcrumbs, wheaten bran, white exfoliated popped maize, carcase meal, fishmeal and anti-oxidant, skimmed milk powder, sun cured lucerne, bone meal, limestone powder, a vitamin premix and a mineral premix.

A ration of more or less 30g/kg bodyweight per day is given in three meals as the baboon is a monogastric animal. Pure water is freely provided through a demand valve which is described in another paper.

At the time when diarrhoea was a serious problem and the pellet diet was suspect, a number of baboons were fed on a special diet of fresh fruits and vegetables with no significant improvement. Our subsequent experience has substantiated the dietary adequacy of the pellet in its present form.

(ii) *Cross infection and re-infection:*
Cross infection must be considered as a contributory factor, but all animals are sealed off from each other by plastic coated plastered brick walls. The floors of the cage consist of metal bars so that urine and faecal recontamination is virtually impossible. Drinking water is supplied through a nipple and thus sealed as a source of contamination. A series of swabs taken from food, water, cages and the baboons showed relatively insignificant bacterial growth and cannot be blamed for harbouring infection.

(iii) *Stress as a contributory factor:*
More and more handlers of primates and other laboratory animals are becoming aware of the importance of stress which might manifest itself in many different forms[2]. It is common knowledge amongst South African farmers that a loose stool in a baboon regularly occurs if the animal is suddenly frightened in the wild state. The results described above show that only in a minority of cases a direct link was established between bacterial infection and the diarrhoea. On the other hand, at autopsies on those dying of diarrhoea, a microscopic picture similar to ulcerative colitis in man was found in 5.6% of cases. Adrenal cortex haemorrhages were seen in 6.4% and even stomach ulcerations in 0.5% of cases. In another paper to be presented the high incidence of adrenal cortex haemorrhages will be discussed in connection with stress and dehydration. Stress, as a contributory factor to colitis[3] and gastric ulcers[4], is well recognised in humans and may be of considerable importance in sub-human primates as well.

Experimental work is at the moment being done with tranquilizers to establish whether these drugs can effectively reduce the incidence of stress. On the other hand the susceptibility of the animals to human microbes has not yet been fully investigated. Handlers of baboons in our colony do not wear sterile gowns and masks which is sometimes insisted on as essential in other primate centres.

Taking into consideration the picture as a whole and bearing in mind that the mortality is largely due to the diarrhoea and that this has been greatly improved by better conditions, we would like to believe that stress caused by capture, handling and the new environment, is primarily responsible for the lowering in resistance against infections and this may be the primary cause of the diarrhoea epidemics and that dietary composition and a strange bacterial environment are secondary factors.

REFERENCES

1. Kalter S.S. 1969 *Primates in Medicine, Vol II.* p. 45 - 61 Basel New York: Karger
2. Riopelle A.J. 1969 *Ann. N.Y. Acad. Sci.* 162 : 57
3. Swinton N.W., Robert & Crozier 1969 in *Abdominal Operations* Vol. II. Edit. Rodney Maingot, Vth Edition, p. 1664, Appleton Century Crofts
4. Bouchier I.R.D. 1969 in *Abdominal Operations* Vol. I, Edit Rodney Maingot, V Edition, p. 188. Appleton Century Crofts.

Two multi-purpose drugs

Largactil*

(chlorpromazine hydrochloride)
premedicant, sedative, anti-emetic

Vallergan*

(trimeprazine tartrate)
antihistamine, antipruritic, sedative

Supplied as tablets of 10 mg. and 25 mg., and in two strengths of injection solution.
Full information is available on request

MAYBAKER (S.A.) (PTY) LTD
Port Elizabeth P.O. Box 1130 Tel. 4-5481
Branch Office
Johannesburg P.O. Box 3926 Tel. 724-2146/7

*trade mark
VA 4281

Jl S. Afr. vet. med. Ass. 42 (1): 67-71 1971

DIE VOORKOMS EN BEHEER VAN SOMMIGE UITWENDIGE PARASIETE VAN KLEIN PROEFDIERE*

P. I. M. VAN ASWEGEN**, PAULINE HESSE***, C. J. HOWELL***

Since experimental animals can only serve their purpose if they are free from diseases, their association with arthropods which provoke disease is discussed. The life cycles and habits of the commonest flies, fleas, lice, mites and ticks and suitable methods for the control of these ectoparasites, are presented. The importance of high standards of hygiene, selection and examination of food supplies and of newly introduced animals, which are all essential for the maintenance of healthy animal colonies, is discussed and emphasized.

SAMEVATTING

Aangesien proefdiere alleenlik hulle doel regverdig indien hulle totaal siektevry is, word hulle assosiasie met siekteverwekkende Arthropoda bespreek. Die lewensgewoontes van die mees algemene vlieë, vlooie, luise, myte en bosluise en metodes vir die beheer van hierdie ektoparasiete word aangebied. Die belang van 'n hoë higiëniese standaard, behoorlike keuring en ondersoek van voedselvoorrade en nuwe diere, wat die grondslag van gesonde proefdierkolonies vorm, word bespreek en beklemtoon.

INLEIDING

Klein proefdiere word in die hedendaagse wetenskap in toenemende mate gebruik vir 'n hele reeks verskillende doeleindes. Die eerste vereiste is egter dat proefdierkolonies vry moet wees van siektetoestande en dat hulle gevrywaar moet word van alle moontlike bronne van besmetting.

Uitwendige parasiete speel 'n belangrike rol as siekteverspreiders, hulle is moeilik om ten alle tye te beheer en is baie aanpasbaar, selfs onder omstandighede wat vir hulle ongunstig behoort te wees. 'n Besondere kennis i.v.m. die lewensgewoontes van die groot verskeidenheid spesies is van belang om beheermetodes doeltreffend toe te pas. Die teenwoordigheid van uitwendige parasiete veroorsaak irritasie van hulle gasheerdiere. Alhoewel dit onmoontlik is om totale uitwissing van die parasiete te bewerkstellig, is beheer daarvan 'n vereiste.

Die behuising van proefdiere speel 'n belangrike rol wat die toegang en vestiging van parasitiese Arthropoda betref. Deur geskikte boumateriale en ontwerpe te gebruik, kan hierdie aspek van siektebeheer baie vergemaklik word en kan besmettings tot 'n minimum beperk word. Wilde knaagdiere behoort geensins in staat te wees om toegang tot sulke geboue te verkry nie, aangesien hulle maklik hul parasiete so kan versprei in die proefdierkolonie.

Vlieë, vlooie, luise en myte is almal parasiete van belang in proefdierkolonies. Voorbeelde van hierdie Arthropoda en hulle beheer word bespreek.

Cordylobia anthropophaga (Blanchard, 1893)

Die orde Diptera is geweldig groot aan getalle en parasitiese vorms onder hierdie groep kan of die volwasse vlieë of die larfstadia wees. By proefdiere is daar eintlik net een myiase-veroorsakende vlieg van belang, die „tumbu-vlieg". Dit is dwarsdeur Suid-Afrika versprei en kom in toenemende getalle voor gedurende die laaste paar jaar, waarskynlik a.g.v. die vreemde lewensloop, wat meestal onbekend is vir diereversorgers.

Volwasse vlieë is groot en stewig met 'n ligbruin grondkleur. Daar is blou-grys kolletjies op die toraks en die agterste gedeelte van die abdomen vertoon donker grys.

Bevrugte wyfies deponeer omtrent 500 eiers in die slaapplekke van mense of diere, veral op klere of beddegoed wat na sweet of urine ruik. Die larwes, wat na 2 tot 11 dae uitbroei, dring die vel van die gasheer binne en vorm swelsels met 'n klein sentrale open-

*Referaat gelewer as deel van die Simposium oor die Produksie en Benutting van Laboratoriumdiere, S.A. Mediese Raad en WNNR, Pretoria, 3—6 Junie 1970.

**Voorheen Seksie Entomologie, Veeartesenykundige Navorsingsinstituut, Onderstepoort, nou by Shell Chemies Suid-Afrika (Edms.) Bpk.

***Seksie Entomologie, Veeartsenykundige Navorsingsinstituut, Onderstepoort.

ing. Binne 8 tot 15 dae word die larwes volwasse, verlaat die swelsel en verpop in die grond, waaruit die volwasse vlieë na 3 tot 4 weke tevoorskyn kom.

Benewens mense, word veral honde, konyne, wolmuise en ander kleindiere aangeval. Daar is gevind dat slegs twee of drie van die larwes in staat is om 'n wolmuis dood te maak.

Beheer:

1. Gaas voor vensters en deure om die vlieë uit te hou.
2. Meganiese verwydering van die larwes uit die letsels.
3. Skoonhou van die slaapplekke van die diere.
4. Stryk van klere en beddegoed.

Cimex lectularius (Linnaeus, 1758)

Onder die orde Hemiptera is daar ook net 'n enkele spesie van belang in die geval van proefdiere. Dit word deur die mens versprei en kry dus sodoende toegang tot proefdierkolonies. Die weeluis word oor die hele Suid-Afrika gevind. Die plat, ovaalvormige, geel tot donkerbruin insekte het prominente oë en die kop is in 'n keep in die toraks ingebed. Wyfies lê eiers in skeure en barsies van persele wat na 3 tot 14 dae uitbroei en oorsprong gee aan nimfe wat soos die volwassene lyk maar slegs in grootte verskil. Die 5 nimfstadia verskil ook slegs in grootte en die siklus kan in 8 tot 13 weke voltooi word.

Weeluise is streng nagwandelaars maar val broeihenne bedags ook aan. Naas pluimvee val die parasiet ook rotte, muise, marmotte en konyne aan en veroorsaak bloedverlies en 'n hoë mate van irritasie.

Beheer:

1. Behandel teelplekke met DDT, BHC, dieldrin, merkaptotion of een van die karbamate.
2. Indien prakties kan hulle effektief berook word met brandbare insekdoder-tablette.

Luise:

Die Mallophaga (bytende luise) en Anoplura (suigende luise) is almal klein, vlerklose, dorso-ventraal afgeplatte insekte met gereduseerde of geen oë nie. Hulle is veral bekend vir hulle gasheerspesifisiteit en die feit dat hulle permanente parasiete is. Verspreiding vind slegs plaas deur kontak, hetsy direk of indirek. Die eiers word aan hare en vere vasgeheg, waaruit die nimfe, wat presies soos die volwassenes lyk, tevoorskyn kom. Die hele siklus kan in 2 tot 3 weke voltooi word en partenogenetiese voortplanting is bekend.

Die bytende luise se monddele is aangepas vir die kou van oppervlakkige weefsels, hulle is nie bloedsuigend nie. Daar is twee spesies van belang by proefdiere. *Gyropus ovalis* (Burgmeister, 1838) en *Gliricola procelli* (Schrank, 1781) kom veral op marmotte en ander knaagdiere voor. Kenmerkend is dat hulle die haarfollikels van die gasheer binnedring en van bloedserum lewe.

Besmette proefdiere kan met gamma-BHC, merkaptotion of karbarielpreparate behandel word om hulle van luise te bevry.

Vlooie

Vlooie is klein, lateraal afgeplatte, vlerklose insekte waarvan die volwassenes ektoparasiete van warmbloedige diere, maar die onvolwassenes vrylewend is. Sommige vlooie is gasheerspesifiek maar die meeste wissel hulle gasheer geredelik.

Bevrugte wyfies lê omtrent 20 eiers per keer in stof waarin die geelwit larwes na 2 tot 16 dae uitbroei en aktief op droë bloed, uitwerpsels en ander organiese materiaal voed. Na 7 tot 10 dae word die papie in 'n kokon gevorm en dié stadium duur 10 tot 17 dae.

Die volgende vlooie mag op klein proefdiere gevind word:

Pulex irritans (Linnaeus, 1758).

Die mensvlooi is oor die Republiek versprei maar is afwesig in die droeër en warmer dele en kom op honde en muise voor. Naas die irriterende effek mag dit 'n draer van *Pasteurella pestis* wees, asook 'n tussengasheer van sekere inwendige parasiete, bv. *Dipylidium caninum* en *Hymenolepis* spp. *Nosopsyllus fasciatus* (Bosc, 1800) en *N. londiniensis* (Rothschild, 1903).

Hierdie vlooie is oor Suid-Afrika versprei, waar hulle op rotte en muise voorkom en 'n mate van irritasie veroorsaak.

Leptopsylla segnis (Schönherr, 1811).

Die vlooi is oor die Republiek versprei en kom in die Kaapprovinsie veral langs die kusdorpe, wat strek tot in die Transkei, voor. Kenmerkend van die genus is die 2 tot 3 stomp stekels op die dorsoapikale hoek van

die frons. Hierdie vlooi word op rotte aangetref, maar mag muise en honde ook parasiteer.

Listropsylla agrippinae (Rothschild, 1904).

Die verspreiding strek oor die hele Suid-Afrika. Kenmerkend is die relatiewe lang borselhaar op die tweede antennale segment by beide geslagte. Die ektoparasiet kom op muise en rotte voor en sal hoofsaaklik knaagdiere aanval wat op die oppervlakte lewe en nie in die grond tonnel nie. Hierdie vlooi veroorsaak hoofsaaklik irritasie.

Xenopsylla cheopis (Rothschild, 1903); *X. brasiliensis* (Baker, 1904) en *X. piriei* (Ingram, 1928).

Hierdie drie vlooie kom oor die hele Suid-Afrika voor. *X. piriei* is wydversprei waar die reënval onder 500 mm per jaar is terwyl *X. cheopis* geredelik in die tropiese en sub-tropiese dele voorkom. Wat proefdiere aanbetref kom *X. cheopis* op rotte en muise voor terwyl die ander twee spesies slegs op muise gevind word. Bogenoemde spesies mag draers van *P. pestis* wees.

Chiastopsylla numae form *rossi* (Rothschild, 1904).

Hierdie vlooi is versprei oor die hele Suid-Afrika, maar is beperk tot sekere temperatuurgrense. Dit kom op muise voor en mag 'n belangrike draer van *P. pestis* wees.

Dinopsyllus ellobius (Rothschild, 1905)

Hierdie vlooi is wydverspreid, maar kom in die Karoo en Kalahari slegs sporadies voor, terwyl dit veral in die vogtige graslandstreek van die Kaapse kusstrook 'n wye distribusie het. *D. ellobius* het 'n irriterende effek op muise.

Beheer:

Beide diere en persele moet behandel word.

1. Behandel diere met merkaptotion poeier
2. Trichlorfon-poeier kan op die diere sowel as in die persele gebruik word.
3. Piretrumpreparate kan gebruik word op diere.

Myte

Parasitiese myte geniet tans toenemende belangstelling weens hul rol as vektore van siektes en die veroorsaking van dermatitis by mens en dier. Die meeste parasitiese myte van ekonomiese en mediese belang is kosmopolities en hul verspreiding moet gekoppel word eerder aan dié van die gasheer as aan die habitat waar die organismes gevind word.

Die gewoontes van die parasitiese myte wat op proefdiere aangetref word is uiteenlopend. Hulle mag in die huid ingrawe (bv. *Sarcoptes),* of voorkom in die follikulêre holtes en die vetkliere (bv. *Demodex),* of korse en skubbe op die oppervlakte van die huid vorm, soos by *Psoroptes.*

Die Listrophoridae en sommige verteenwoordigers van die Trombidiidae *(Myobia)* klou aan die hare van soogdiere vas. Verteenwoordigers van die Gamasidae lewe in die neste van knaagdiere, maar word soms op die diere self aangetref.

Die lewensloop van hierdie parasitiese myte sluit normaalweg in: eier, larwe, protonimf, deutonimf en volwassene. Die larwe is voorsien van drie paar pote en die nimfe en volwassenes besit elk vier paar. Eiers word gelê nadat die wyfie 'n maaltyd geniet het. Die larwes van sommige spesies voed nie en ontwikkel tot protonimfe wat vreet, vervel en ontwikkel tot deutonimfe. Na 'n verdere maaltyd ontwikkel hulle tot die volwasse stadium.

Beheermetodes van parasitiese myte hier aangegee is gebaseer op eie praktiese kennis en literatuurbronne. Nuwe mytdoders word egter voortdurend vervaardig en persone betrokke by die beheer van myte behoort gereeld literatuur i.v.m. hierdie onderwerp te raadpleeg.

Sarcoptes scabiei (Degeer, 1778)

Skurftemyte is min of meer rond en die gegroefde kutikula word onderbreek deur stekelagtige uitsteeksels; die dorsale histerosomale setas is sterk en lansvormig; al die pote is kort en poot I en II eindig in lang flapvormige pretarsusse; poot III en IV eindig elk in 'n sweepagtige seta.

Variëteite wat fisiologies verskil, maar morfologies ooreenstem, word op proefdiere aangetref, soos *S. scabiei var. precox* op konyne en *S. scabiei var. caviae* op marmotte. Hulle geniet almal 'n kosmopolitiese verspreiding. Die siklus van eier tot eierlêende wyfie duur ongeveer 10 dae.

Die wyfie grawe in die huid in, waar sy haar eiers lê en haar op limf en jong epidermale selle voed. Die aktiwiteite van hierdie parasiete veroorsaak dat die besmette area geweldig jeuk, met die gevolg dat die dier daar krap, wat dan die toestand vererger. Die gevolglike velinflammasie gaan gepaard met 'n uitskeiding van sug, wat koaguleer en korste vorm op die oppervlakte. Daar is ook verdikking van die huid en verlies van hare.

Beheer: Insekdoders wat die gamma-isomeer van BHC bevat is doeltreffend. Twee behandelings met 'n tussenpoos van 8 tot 10 dae is gewoonlik voldoende.

Notoedres cati (Hering, 1838).

Die dorsaal gegroefde kutikula van die skurftemyt van katte is eenvoudig en opgebreek in 'n skubagtige patroon; die pote is kort en afgestomp; poot I en II eindig in flapvormige pretarsusse en poot III en IV in lang sweepagtige setas.

Hierdie myt kom voor by katte, konyne en rotte. By katte en konyne is die besmetting gewoonlik beperk tot die kopgedeelte, maar by rotte mag dit na die bene en genitaalstreke versprei.

Die lewensloop van die myt stem ook ooreen met die van *S. scabiei*. Die parasiete veroorsaak skurfte en kan 'n groot probleem word by konynkolonies.

Oorletsels veroorsaak deur **Notoedres** spp.

Beheer:

1. Besmette katte en konyne kan met dimetielftalaat behandel word. Lindaan beheer 'n soortgelyke myt, *N. muris* (Mégnin, 1877), by rotte.
2. Merkaptotion is baie doeltreffend.

Psoroptes cuniculi (Hering, 1838)

Die oorskurftemyt van konyne is relatief groot met 'n prominente gnatosoma, die wyfie besit 'n U-vormige genitaalopening; al die pote is lank, behalwe poot IV, wat klein en swak ontwikkel is; die agterste streek van die mannetjie is tweelobbig en elke lob is voorsien van twee lang en drie korter setas; adanale suiers is teenwoordig.

Myte van hierdie genus veroorsaak brandsiekte by beeste, skape, bokke en perde en verwek 'n oorekseem by konyne. Die parasiete prik die huid om te voed en word gewoonlik op die rande van die besmette area aangetref. By konyne ontstaan die besmetting gewoonlik in die ore, vanwaar dit na ander dele van die kop en selfs die bene mag versprei. Besmette diere is senuagtig, skud die kop, daar is gewigsverlies en voortplanting word beïnvloed.

Beheer:

1. Dimetielftalaat en lindaanpreparate sowel as merkaptotion of toksafeen is almal doeltreffend om die myte in die ore te beheer.
2. 'n Soortgelyke myt, *Chorioptes cuniculi* Gervais, 1859 wat ook 'n chroniese oorekseem by konyne veroorsaak, kan op dieselfde wyse beheer word.

Demodex (Owen, 1843)

Die myte is baie klein en sigaarvormig, en setas ontbreek op die liggaam en afgestompte pote; die cheliseras is naaldvormig en die genitaalopening van die wyfie is geleë tussen koksas IV.

Verteenwoordigers van hierdie genus het 'n kosmopolitiese verspreiding en word in die haarfollikels van die gasheer aangetref. Spesies van die genus *Demodex* word op honde, katte, konyne, rotte, muise en ander soogdiere aangetref.

Die hele lewensiklus word op die gasheer voltooi en oordraging van een dier na die volgende geskied blykbaar deur kontak.

Daar bestaan ook 'n teorie dat intrauterine oordraging moontlik is.

Die skurfte mag puisie- of skubagtig wees en tipiese gevalle word deur haarlose kolle op die deur gekenmerk. Die besmette huidstreek is verdik; 'n slegte reuk gaan gepaard met die toestand.

Beheer: Insekdoders soos rotenoon kan die toestand genees indien dit nie reeds baie gevorderd is nie.

Myobia musculi (Schrank, 1781)

Hierdie myte is klein en verleng, met 'n transversale, gegroefde kutikula en sonder enige liggaamsklerotisering. Die eerste paar pote is gemodifiseer om as klouorgane te dien waarmee die myt aan die hare van die gasheer vasheg.

Die myt het 'n kosmopolitiese verspreiding en word op laboratorium-muise aangetref. Eiers word aan die basis van die gasheer se hare neergelê. Daar is twee larwale stadia, elk met drie paar pote. Die tweede stadium larwe is voorsien van 'n groot, klouagtige empodium op tarsus III wat ontbreek in die eerste-stadium-larwe.

Oordraging tussen gashere geskied blykbaar deur kontak. *M. musculi* veroorsaak 'n ligte dermatitis by laboratoriummuise. *Myocoptes musculinus* (Koch, 1844) word dikwels saam met *M. musculi* op dieselfde gasheer aangetref en veroorsaak 'n soortgelyke toestand by hierdie diertjies.

Beheer:

1. Ditiosianodietieleter - mengsels word aanbeveel vir besmette muise.
2. Swawelpoeier kan ook doeltreffend gebruik word, maar veroorsaak 'n dermatitis met haarverlies wat egter binne 'n paar weke genees.

Die handhawing van 'n hoë standaard van higiëne in die proefdierkolonies, hulle behuising, beddegoed en voedsel is die mees effektiewe metode om vestiging en verspreiding van ektoparasiete te voorkom. Toevallige besmettings wat mag ontstaan kan dan ook maklik vasgestel en uitgewis word.

NASLAANWERKE

1. Baker E.W., Evans T.M., Gould D.J., Hull W.B. &Keegan H.L. 1956 *A manual of parasitic mites of medical or economic importance.* New York. National Pest Control Association, Inc.
2. Benbrook E.A. & Sloss Margaret W. 1961 *Veterinary clinical parasitology.* 3de uitg. Ames, Iowa. Iowa State University Press
3. De Meillon B., Davis D.H.S. & Hardy Felicity. 1961 *The Siphonaptera (excluding Ischnopsyllidae).* Pretoria. Die Staatsdrukker.
4. Gordon R.M. & Lavoipierre M.M.J. 1962 *Entomology for students of medicine.* Oxford. Blackwell Scientific Publications
5. Harris R.J.C. 1962 *The problem of laboratory animal disease.* London en New York. Academic Press
6. Hirst S. 1922 *Mites injurious to domesticated animals.* Ser. 13. London. Brit. Mus. Nat. Hist.
7. Imms A.D. 1957 *A general textbook of entomology.* 9de uitg. London. Methuen & Co. Ltd.: New York. E.P. Dutton & Co. Inc.
8. Short D.J. & Woodnott Dorothy P. 1963 *The A.T.A. manual of laboratory animal disease* London. Crosby, Lockwood & Son Ltd.
9. Soulsby E. 1968 *Helminths, Arthropods & Protozoa of domesticated animals.* 6de uitg. *Mönnigs Veterinary Helminthology & Entomology.* London. Bailliére, Tindall & Cassel.
10. Worden A.N. & Lane-Petter W. 1957 *The U.F.A.W. handbook on the care and management of laboratory animals.* 2de uitg. London. The Universities Federation of Animal Welfare
11. Zumpt F. 1961 *The arthropod parasites of vertebrates in Africa, south of the Sahara.* Vol. I. Johannesburg. Suid-Afrikaanse Instituut vir Mediese Navorsing
12. Zumpt F. 1966 *The arthropod parasites of vertebrates in Africa, south of the Sahara.* Vol. III. Johannesburg. Suid-Afrikaanse Instituut vir Mediese Navorsing

Jl S. Afr. vet. med. Ass. 42 (1): 73-79 1971

LOSSES CAUSED BY MASTITIS TO INDUSTRIAL AND FRESH MILK PRODUCERS IN THE REPUBLIC OF SOUTH AFRICA

W. H. GIESECKE* AND L. W. VAN DEN HEEVER**

SUMMARY

In this attempt to evaluate the losses caused by bovine mastitis in the Republic of South Africa it appears that the loss sustained by producers of fresh and industrial milk differs considerably. Estimated losses for the average dairy farmer amount to R1844 p.a. or R24.13 p.a. for the average dairy cow. Losses due to mastitis average R38.4 million p.a. or an equivalent of 25.7% of revenue from the sale of milk. The average loss of milk as such amounts to approximately R29.68 million p.a.

INTRODUCTION

The nature of the most important effects of bovine mastitis on the milk producer, milk processor and consumer is well known and may be broken down as summarized in Table 1.

The losses sustained by the milk producer as a result of the different forms of mastitis are summarized in Table 2.

Whereas the above is generally applicable to all countries where cows are the main source of milk for human consumption, as in the Republic of South Africa, assessment of the actual financial losses due to mastitis can only be established after due consideration of local conditions.

Most frequently estimates concerning losses due to mastitis are based on calculations of individual or a combination of factors such as: the loss of production of diseased cows, the amount of milk that has to be discarded due to disease and/or treatment, cost of mastitis treatment, excessive culling rates, shortening of productive life, etc. The economic losses due to mastitis in various countries have been reported, and these are summarized in Table 3.

For the R.S.A. the value of milk loss alone has been estimated as varying from R2 to R8m[12, 13].

On the basis of earlier publications[14, 15, 16] concerning the incidence of mastitis in a limited number of herds producing fresh and industrial milk, milk losses in the R.S.A. due to mastitis may be calculated as summarized in Table 4, using the conversion factors given in Table 4 (a).

Table 1: EFFECT OF THE DISEASED MAMMARY GLAND OF THE DAIRY COW ON:

A. MILK PRODUCER	B. MILK PROCESSOR	C. MILK CONSUMER
1. Decrease in milk production.	1. Inferior quality of milk and dairy products.	1. Milk and dairy products of inferior nutritional quality.
2. Cost of treatment.	2. Production failures. (Cultured dairy products).	2. Hygienically inferior or unacceptable milk and dairy products.
3. Damage to secretory tissue.	3. Bad public image and marketing difficulties.	3. Unwholesome milk and dairy products due to contamination with:
4. Uneconomic retention of diseased cows.		a. Bacterial agents
5. Decrease in productive life of dairy cows.		b. Chemical agents.
6. Expense and effort of rearing and breeding the animals concerned.		

*Veterinary Research Institute, P.O. Onderstepoort.
**Faculty of Veterinary Science, University of Pretoria, P.O. Onderstepoort.
Reproduced by kind permission of the Editor, S.A. Journal of Dairy Technology.

Table 2: ANALYSES OF LOSSES CAUSED BY MASTITIS TO THE DAIRY FARMER

	FORMS OF MASTITIS		
	X 1	X 2	X 3
1. Decreased yield			
a. Temporary	X	X	X
b. Permanent		X	X
2. Cost of treatment	X	X	X
a. Remedies	X	X	X
b. Milk unfit as food	X	X	X
ba. During treatment	X	X	X
bb. Compulsory 72h period of withholding after last antibiotic treatment	X	X	X
c. Services of veterinarian		X	X
d. Extra labour	X	X	X
3. Damage of secretory tissue without recovery	X	X	X
a. Partial		X	X
b. Complete		X	X
4. Feeding of unproductive dairy cows	X	X	X
5. Loss of dairy cows and their replacement due to—			
a. Disposal of unproductive cows		X	X
b. Disposal of chronic shedders		X	X
c. Emergency disposal or death		X	X
6. Expense and effort of breeding and rearing of the dairy cows concerned		X	X

X1 Slight mastitis with complete recovery of production.

X2 Mastitis with partial recovery of milk production.

X3 Mastitis without recovery of milk production.

The quantity of fresh milk lost annually has also been estimated to vary from 155×10^6 kg[18] to $285 - 332 \times 10^6$ kg[19]. The value of losses due to mastitis has been estimated as approximately R1033 p.a. for an average herd with 80 lactating cows[20]. Based on reports of the authors already mentioned as well as other publications[21-29] an attempt is made below to establish the total financial loss caused by mastitis to producers of fresh milk and industrial milk in the Republic of South Africa.

Table 3: LOSSES CAUSED BY MASTITIS IN VARIOUS COUNTRIES

Country	Losses due to mastitis	
	Estimated total	Estimated value of decreased milk production only
Australia [1]		R14 m
France [2]	R13 m	
Germany [3, 4]	R9—38 m	
Great Britain [5, 6, 7]	R38 m	R11 m to R30 m
Switzerland [8]	R1—1.5 m	
U.S.A. [9]	>R1 billion R70 per cow	
State of New York [10, 11]	R57 m R47 per cow R2385 per herd of 50 cows	

Table 4: MILK LOSS IN R.S.A. DUE TO MASTITIS, CACULATED ACCORDING TO INCIDENCE OF MASTITIS IN A LIMITED NUMBER OF HERDS PRODUCING FRESH AND INDUSTRIAL MILK

Reference	Fresh milk	Industrial milk
Crewe (1965)[14]	22×10^6 kg	
Herman (1965)[15]	93×10^6 kg	91×10^6 kg
Van den Heever (1965)[16]	272×10^6 kg	
Average	129×10^6 kg	91×10^6 kg

Table 4(a): CONVERSION OF CMT SCORES [10] AND LEUCOCYTE COUNTS [17] TO ESTIMATED LOSS OF MILK PRODUCTION

Diagnosis	Decrease of production
C.M.T. Score	
T	9%
1	19.5%
2	31.8%
3	43.4%
Leucocyte count ($\times 10^3$)	
500—1000	9.2%
1000—5000	24.6%
5000 and over	37.5%

MATERIAL, METHODS AND EVALUATIONS

Losses caused to producers of industrial milk (including cream producers) were calculated using basic data as listed in Table 5.

Table 5: BASIS FOR CALCULATION OF LOSSES TO PRODUCERS OF INDUSTRIAL MILK

Item	Min.	Max.
(1) average price for industrial milk per 100 kg [25]	R4.41	R4.41
(2) average annual production per cow [26, 27, 28]	940 kg	1593 kg
	average 1266 kg	
(3) average size of herd	30	30
(a) lactating cows [27]	23	23
(b) dry cows*	7	7
(4) average daily production per cow [26, 27]	2.8 kg	5.2 kg
(5) total number of cows*	1982760	1982760
(6) total number of producers [27]	66092	66092
(7) cost of rearing/heifers*	R85.00	30%
(8) slaughter value orf heifer*	R50.00	R100.00
(9) value of average cow*	R110.00	R60.00
(10) average number of lactations*	3	R180.00
		7
(11) slaugter value/cow*	R90.00	
(12) average mastitis rate (clinical/cow)*	20%	R120.00
		75%
(13) total cost of treatment per mastitis case*	R0.50	
		R1.50
(14) period of milk discarded*	3 days	
(15) rate of improvement due to mastitis control*	5%	6 days
(16) heifers culled annually due to mastitis/herd*	1	1
(17) value of milk sales (total) [25]	R76.00 m	R76.00 m
(18) extra labour required per case of mastitis	15 minutes equivalent to R0.02*	

*personal estimates

Table 6: BASIS FOR CALCULATION OF LOSSES TO PRODUCERS OF FRESH MILK

Item	Min.	Max.
(1) average price for fresh milk per 100 kg [25] (1968/69 Witwatersrand, 34 c/gall.)	R7.50	R7.50
(2) average annual production per cow [26, 27]	2362 kg	3572 kg
	average 2967 kg	
(3) average size of herd*	95 cows	95 cows
(a) Lactating [27]	76	76
(b) dry*	19	19
(4) average daily production per cow [26, 27]	5.6 kg	8.5 kg
(5) total number of cows*	328000	328000
(6) total number of producers (1969) [22]	3459	3459
(7) cost of rearing/heifers*	R85.00	R115.00
(8) slaughter value of heifer*	R60.00	R80.00
(9) value of average cow*	R180.00	R250.00
(10) average number of lactations*	3	6
(11) slaughter value/cow*	R100.00	R120.00
(12) average mastitis rate (clinical/cows)*	20%	75%
(13) total cost of treatment per mastitis case*	R1.00	R2.00
(14) period of milk discarded*	3 days	6 days
(15) potential rate of improvement due to mastitis control*	5%	20%
(16) heifers culled anuually due to mastitis/herd*	1	3
(17) value of milk sales (total) [25]	R73.00 m	R73.00 m
(18) extra labour required per case of mastitis	15 minutes equivalent to R0.02*	

*personal estimates

Losses caused to producers of fresh milk were calculated using basic data as listed in Table 6.

1. *Loss of Production*

Without considering the varying incidence of mastitis in dairy herds and/or the varying losses of production caused by mastitis of different degrees and severity, one may assume that every dairy herd in R.S.A., placed under an efficiently operated mastitis control scheme, would be able to increase its milk production by 5-30% in the case of industrial milk, and by 5-20% in the case of fresh milk. Thus one also may contend that herds not under organised intensive mastiitis control — and this applies to all herds because there is no such mastitis control in R.S.A. — experience a continuous preventable milk loss of 5-30% if producing industrial milk, and 5-20% if producing fresh milk. For cows producing an average of 1 266 kg industrial or 2 967 kg fresh milk per year the loss of production then approximates amounts and value of milk per annum as shown in Table 7.

Table 7: ESTIMATED ANNUAL LOSS OF PRODUCTION PER COW

Annual loss	Industrial Milk		Fresh Milk	
	Minimum	Maximum	Minimum	Maximum
kg of milk per cow	63	380	148	593
Value of lost production per cow	R2.79	R16.76	R11.10	R44.48

2. *Cost of Treatment*

On an average, herds producing industrial and fresh milk consist of 30 and 95 cows respectively. In both types of herds some 20 - 75% of cows will be affected by clinical mastitis in the course of the year. Based on prices of available remedies the total cost of actual treatment of each case for the producer of industrial milk is at least R0.50 - R1.50 and for the producer of fresh milk at least R1.00 - R2.00. From this it follows that the annual cost of treatment of mastitis for the entire herd of the industrial milk producer ranges between R0.24 and R0.72 per cow of the herd and for the fresh milk producer from R0.30 to R1.13 respectively.

3. *Loss of Discarded Milk*

Milk from quarters affected with mastitis must be discarded during and after treatment, a period of 3 - 6 days. If cows of industrial milk producers average 2.8 - 5.2 kg of milk per day and those of fresh milk producers average 5.6 - 8.5 kg of milk per day, losses arising from discarded milk are as shown in Table 8.

Table 8: ESTIMATED ANNUAL LOSS OF MILK DISCARDED DURING AND AFTER THERAPY OF ALL CASES OF MASTITIS OCCURRING IN AN AVERAGE INDUSTRIAL AND FRESH MILK PRODUCING HERD

Loss	Industrial Milk		Fresh Milk	
	Minimum	Maximum	Minimum	Maximum
kg of milk discarded	183	339	1147	1741
Value of milk discarded	R8.07	R14.95	R86.03	R130.58

Calculated on a herd basis, the value of discarded milk p.a. per cow in an industrial milk producing average herd ranges between R0.27 and R0.50 and in a fresh milk producing average herd between R0.91 and R1.37 respectively.

4. *Wastage of First Calf Heifers*

Considering that an average of 60% of heifers have mastitis on freshening[29], it is reasonable to assume that in each herd producing industrial milk at least one heifer freshens annually with a non-functional quarter due to mastitis. In fresh milk producing herds it is estimated that the number of these heifers ranges between 1 and 3 heifers. As these animals are uneconomic propositions from the start the heifers should be culled without delay. Hence the loss arising is the difference between the cost of rearing the heifer and her slaughter value. The loss to producers of industrial and fresh milk due to wastage of such heifers is shown in Table 9.

Table 9: ESTIMATED ANNUAL LOSS PER MASTITIC HEIFER CULLED FROM FRESH AND INDUSTRIAL MILK PRODUCING HERDS

Item	Industrial Milk		Fresh Milk	
	Minimum	Maximum	Minimum	Maximum
Rearing cost	R85.00	R100.00	R85.00	R115.00
Carcass value	R50.00	R60.00	R60.00	R80.00
Wastage per heifer	R35.00	R40.00	R25.00	R35.00

Caluculated on a herd basis, the annual loss per cow in average industrial and fresh milk herds ranges between R1.25 and R1.43 and from R.052 to R0.74 respectively.

5. *Wastage of Mature Dairy Cows*

In all dairy herds, cows are continually being culled for various reasons and new cows are acquired as replacements. The difference between market value of a new cow and the carcass value of a culled cow is the cost of replacement which decreases proportionally to the number of years a cow has been in production in a herd.

Assuming the average productive life of a cow in a herd producing industrial milk to be between 3 and 7 years and that of fresh milk producing cows between 3 and 6 years, the annual costs per cow replaced in the herds concerned are as shown in Table 10.

Table 10: ESTIMATED ANNUAL LOSS DUE TO WASTAGE OF MATURE COWS

Item	Industrial Milk		Fresh Milk	
	Minimum	Maximum	Minimum	Maximum
Market value of cow	R110.00	R180.00	R150.00	R250.00
Carcass value of cow	R90.00	R120.00	R100.00	R130.00
Years productive life	3	7	3	6
Annual replacement cost per cow	R6.70	R8.60	R17.00	R20.00
Annualreplacement cost if productive life is extended by one year	R5.00	R7.50	R12.50	R17.10
Additional replacement cost per cow	R1.70	R1.10	R4.50	R2.90

Assuming, furthermore, that in all dairy herds there is an annual replacement of 10% of the herd and that 30% of these replacements are directly due to mastitis, one may conclude that annual replacement costs due to mastitis range from R6.70 to R8 60 and R51.00 to R60.00 in herds producing industrial and fresh milk respectively.

Calculated on a herd basis, the annual cost of replacement in an average industrial milk producing herd ranges between R0.22 and R0.28 and in average fresh milk producing herds between R0.54 and R0.63.

6. *Additional Costs of Replacement*

In addition to the wastage of mature dairy cows as discussed above, one also has to consider costs resulting from the widespread premature culling of dairy cows due to the ravages of mastitis. If a herd would be placed under an efficient mastitis control program and the incidence of mastitis could be decreased to such an extent that the productive life of the dairy cows is extended by one year only, the replacement cost would decrease as shown in Table 10.

Thus mastitis causes additional replacement costs ranging in industrial herds between R1.10 and R1.70 and in fresh milk producing herds from R2.90 to R4.50.

7. *Costs of Extra Labour*

Considering that for adequate care of a mastitis case an average of 15 minutes of extra labour equivalent to R0.02 is required, annual costs resulting from extra labour due to mastitis range between R0.87 and R1.74 in herds producing industrial milk and between R2.73 and R5.46 in herds producing fresh milk.

Calculated on a herd basis, annual costs of extra labour due to mastitis amount to R0.03 - R0.06 per cow in herds producing industrial or fresh milk.

CONCLUSIONS

From the calculations summarized in Table 11 it can be concluded that the average total annual loss to producers of industrial milk and fresh milk amounts to R27.1 m and R11.3 m respectively. The estimated minimum and maximum loss caused by mastitis annually to all dairy farmers in the Republic of South Africa is R18.8 m and R58.1 m respectively, with the average loss amounting to R38.4 m. Calculated on a cow basis for herds producing industrial and fresh milk, mastitis causes an annual loss per average cow of R13.67 and R34.60 respectively, and for the average producer of industrial and fresh milk an annual loss of R409 and R3280 respectively.

In terms of the dairy farmer's revenue from milk sales it appears that in herds producing industrial milk, mastitis causes losses equivalent to 35.66% (range 16.97 - 54.34%) and in herds producing fresh milk the loss amounts to an average of 15.48% (range 8.1 - 23⅛%). The average financial loss to all dairy farmers in the Republic of South Africa amounts to 25.57% of revenue from the sale of milk.

Table 11: SUMMARY OF ANNUAL LOSSES CAUSED BY MASTITIS TO PRODUCERS OF INDUSTRIAL MILK AND FRESH MILK

Nature of losses	ANNUAL VALUE OF LOSSES IN RAND			
	Industrial milk producer		Fresh milk producer	
	Minimum	Maximum	Minimum	Maximum
Decreased production	2.79	16.76	11.10	44.48
Treatment	0.24	0.72	0.30	1.13
Discarded milk	0.27	0.50	0.91	1.37
Wastage of heifers	1.25	1.43	0.52	0.74
Wastage of cows	0.22	0.28	0.54	0.63
Additional cost of replacement	1.70	1.10	4.50	2.90
Extra labour	0.03	0.06	0.03	0.06
Total loss per animal	6.50	20.85	17.90	51.31
Average loss	13.67		34.60	
Total loss for all cows	12.9×10^6	41.3×10^6	5.9×10^6	16.8×10^6
Average loss	27.1×10^6		11.3×10^6	
Total loss per producer	195	624	1705	4856
Average loss	409		3280	

Table 12: ESTIMATED TOTAL ANNUAL MILK LOSS SUSTAINED IN THE R.S.A. DUE TO MASTITIS

Nature of loss	Industrial milk producer		Fresh milk producer	
	Minimum	Maximum	Minimum	Maximum
Decreased production				
– kg	125×10^6	753×10^6	48.5×10^6	195×10^6
– Rand	5.5×10^6	33.2×10^6	3.6×10^6	14.6×10^6
Discarded milk				
– kg	12.1×10^6	22.4×10^6	4.0×10^6	6.0×10^6
– Rand	0.53×10^6	0.99×10^6	0.30×10^6	0.54×10^6
Total loss				
– kg	137.1×10^6	775.4×10^6	52.5×10^6	201×10^6
– Rand	6.03×10^6	34.19×10^6	3.90×10^6	15.05×10^6
Average loss due to decreased production				
– kg	439×10^6		121.7×10^6	
– Rand	19.4×10^6		9.1×10^6	
Average loss due to discarded milk				
– kg	17.3×10^6		5.0×10^6	
– Rand	0.8×10^6		0.38×10^6	
Average of total loss of milk				
– kg	456.3×10^6		126.7×10^6	
– Rand	20.2×10^6		9.48×10^6	

The loss of milk due to mastitis only is summarized in Table 12.

From the above one may conclude that the estimated annual loss of milk for producers of industrial and fresh milk ranges between 137 and 775 million kg and between 52 and 201 million kg, with averages of 456 million kg and 127 million kg, respectively. The minimum and maximum losses for all dairy farmers in the Republic of South Africa are 190 million kg and 976 million kg respectively, with an average loss of milk amounting to 773 million kg or 32.56% (range 8.0 - 41.1%) of the total annual milk production (2 374 million kg) representing a value of R29.68 m.

REFERENCES

1. Francis J. 1962 *Aust. J. Dairy Tech.* 17 : 144
2. Bertrand M. 1966 *Rev. Med. Vétérin* 29 : 10
3. Lerche M. 1966 Lehrbuch der Tierärztlichen Milchüberwachung. Berlin-Hamburg: Paul Parey
4. Müssemeier F. 1957 Grundsätzliches zur Tierseuchenbekämpfung. Berlin-Hamburg: Paul Parey
5. Blackburn P.S. 1958 *J. Dairy Res.* 25 : 486
6. Wilson C.D. 1961 *Vet. Rec.* 73 : 1019
7. Anonymous 1970 *Vet. Rec.* 87 : 93
8. Kästli P. 1963 Milchkunde II, Bern: Verbandsdruckerei A.G.
9. Roberts S.J. *et al.* 1969 *Jl. Am. vet.med. Ass.* 115 : 157
10. Forster T.L., Ashworth U.S. & Luedecke L.O. 1967 *J. Dairy Sci.* 50 : 675
11. Haynes N.B. 1967 The economic importance of mastitis. A Mimeographed Report. New York State Vet. College, Ithaca, N.Y.
12. Van Rensburg S.W.J. 1937 *Jl S. Afr. vet. med. Ass.* 8 : 14
13. Crewe G. 1964 Bladskrif No. 11, Departement van Landbou-tegniese Dienste
14. Crewe G. 1965 *Jl S. Afr. vet. med. Ass.* 36 : 509
15. Herman M.N. 1965 *Jl S.Afr. vet. med. Ass.* 36 : 521

16. Van den Heever L.W. 1965 *Jl S. Afr. vet. med. Ass.* 36 : 527
17. Reichmuth J. 1968 Vet. med. diss., F.U. Berlin
18. Smith A. 1970 Personal communication
19. Van den Heever L.W. 1970 Personal communication
20. Landrey J.S.A. 1965 *Jl S. Afr. vet. med. Ass.* 36 : 515
21. Van den Heever L.W. & Giesecke W.H. 1967 *The Dairy Industry Journal* 7 : 156
22. Veenstra J. 1970 *S. Afr. J. Dairy Tech.* 2 : 61
23. Milk Board 1970 Personal communication
24. Milk Board 1970 Annual Report 1968-1969
25. Division of Agricultural Economic Research, Department of Agricultural Economics and Marketing, 1970 Personal communication
26. Veeteelt- en Suiwelnavorsingsinstituut: *„Melkaantekening in Suid-Afrika"*
27. Landrey J.S.A. 1970 Personnal communication
28. Anonymous 1970 *S. Afr. J. Dairy Tech.* 2 : 87
29. Giesecke W.H. 1970 Unpublished data

BOOK REVIEW

PELZTIERKRANKHEITEN

H. C. LOELLIGER

Gustav Fischer Verlag, Jena. 1970, p.p. 399, Figs: 130.

Price in South Africa: not stated.

This very useful little book written in easily readible modern German is a "must" for the veterinarian concerned with the health of small laboratory animal colonies, and also for the veterinarian whose practice includes the care of fur-bearing animals kept for commercial purposes. The subject matter is presented in two main sections, viz. Infectious diseases and Diseases of specific organs. The first section is subdivided into virus diseases, rickettsioses, bacterial diseases, mycoses and protozoal infections. The various diseases rather than the species concerned constitute the tertiary subdivision of the material. The infectious diseases are on the whole well-described and much new material is presented. A good description of Aleutian disease of mink is one of the features which particularly caught my eye. Control measures are well described in most instances and many valuable references are given. I was rather disappointed in the discussions regarding the treatment of many of the diseases, particularly such well known conditions as canine distemper and feline panleukopaenia, but in all fairness to the author, no claims are made regarding the comprehensiveness of the subject matter.

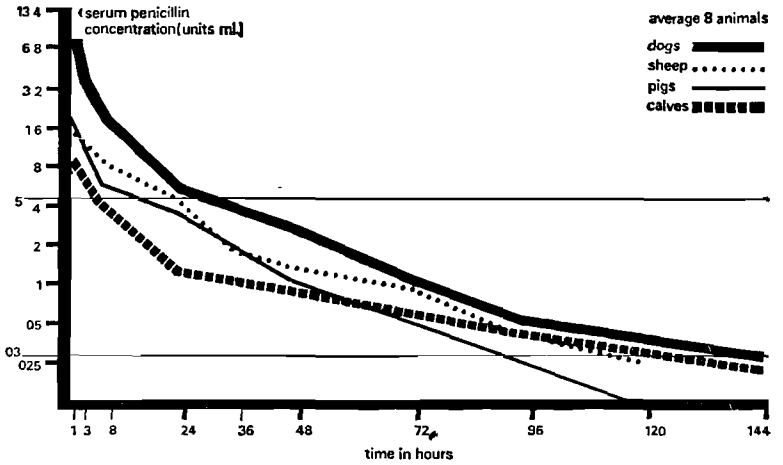
The second and major section of the book is particularly noteworthy and is one which should prove to be of tremendous value to the veterinary pathologist. Each system of the animal body receives attention. The various pathological conditions affecting each system are taken and described in so far as their aetiology, pathogenesis, course, symptomatology, autopsy findings and histopathology are concerned. References to the important literature in each case are abundant.

Another of the commendable features of this book is the excellence of its illustrations, most of which are well chosen black and white photographs illustrating the salient clinical or autopsy features of the disease concerned. The new colour plates, which are scattered throughout the book are excellent and have obviously been selected with care to illustrate particular features of the histopathology of the conditions concerned.

The author and his publishers are to be congratulated on a valuable contribution to a rather specialized but most important field in veterinary medicine.

— J.M.M.B.

6 days penicillin medication WITH ONE INJECTION!



COMPROPEN*

No mixing **No messing**

For penicillin sensitive organisms, use Compropen—a combination of Benethamine and Procaine Penicillin. Bacteriocidal level of Penicillin within 1 hour of injection. Bacteriostatic level for up to 6 days. Easy ready-to-use suspension.

Dose 1 ml. per 14 kg. (30 lb.) body weight.

40 ml. vial R1.10

*Compropen is a Glaxo-Allenbury's Trade Mark.

Glaxo-Allenbury's S.A. (Pty) Ltd.

P.O. BOX 485 GERMISTON

JA 1122

Jl S. Afr. vet. med. Ass. 42 (1): 81-84 1971

TECHNICAL NOTE

A RAPID TEST FOR THE DIAGNOSIS OF STRYCHNINE POISONING

E. E. McConnell*, I. B. J. van Rensburg** and J. A. Minne***

SUMMARY

A rapid method for the diagnosis of strychnine poisoning involves the intraperitoneal injection of a sampling of the stomach contents of the victim into a weanling mouse. The mouse shows typical signs of being poisoned by strychnine if the substance is present. Other types of poisonings may be confused with strychnine poisoning, but most of them can be differentiated on the basis of history, signs and/or results of the testing procedure described.

INTRODUCTION

Strychnine poisoning in dogs is a fairly common finding in the Republic of South Africa. This cowardly act on the part of the perpetrator can result in a stressful situation both for the client and the attending veterinarian. Because of the tetanic convulsions that are easily provoked by sudden noise and other external stimuli, the clinical picture of strychnine poisoning is recognized readily by the experienced veterinarian. In most cases, however, the veterinarian is confronted with a dead dog. Except for the history of sudden death, there may be little else upon which to make a diagnosis, although poisoning may be suspected by the owner. A post mortem examination is usually not helpful, because congestion of the central nervous system and viscera is the only constant feature[1]. The stomach with its contents and the liver of the animal are then submitted to a diagnostic laboratory for analysis, which takes 1 to 2 weeks for the results, while the legal ramifications often necessitate immediate diagnosis.

The purpose of this paper is to present a simple, rapid, inexpensive, and reliable method for the diagnosis of strychnine poisoning that can be done by the veterinarian.

MATERIAL AND METHODS

Each of 10 dogs received by the Pathology Section, Veterinary Research Institute, Onderstepoort, with a history of sudden death were tested for strychnine poisoning in the following manner. A portion of selected contents of the stomach (especially pieces of ingesta which could have been used as bait) was mixed with a proportional amount of either distilled water or tap water in a small container. The pink strychnine powder could be observed occasionally in the contents of the stomach. The mixture was agitated for approximately 30 seconds and then allowed to stand for 1 to 3 minutes, depending on the turbidity, until the heavier particles settled to the bottom. The fluid portion was removed via an 18 gauge needle attached to a syringe. One ml of this fluid was injected intraperitoneally into each of three young white laboratory mice (21 days old). These mice were observed for 1 hour, if death occurred the result of the test was considered to be positive for strychnine poisoning; if the mice were alive the result was considered negative. In several cases in which the mice died, the test fluid was diluted to 1:4, 1:8 and 1:16 and injected into mice to determine also an estimate of the concentration of the poison and confirm the reliability of the test.

The stomachs *(in toto)* from two dogs were kept at room temperature and the contents tested, in the manner described above, at 24-hour intervals for a period of 3 days to determine if gastric secretions and products of decomposition affected the results of the test.

*Major, USAF, VC, Staff Member of the Geographic Pathology Division, Armed Forces Institute of Pathology, Washington, D.C. Temporary assignment, Section of Pathology, Onderstepoort.
**Section of Pathology, Veterinary Research Institute, P.O. Onderstepoort.
***Section of Toxicology, Veterinary Research Institute, P.O. Onderstepoort.
This work was supported in part by a research grant, Project Number 3AO61102B71Q, from the Medical Research and Development Command, U.S. Army, Washington, D.C.

Contents of the stomach and approximately 500 g of liver from each dog were submitted to the Toxicology Section Laboratory, Veterinary Research Institute, Onderstepoort, for chemical analysis for strychnine. The result of the "mouse test" was not included. The test material for the chemical procedure was a hot alcoholic extract of the specimen, which was then purified by a standard method[2,3]. This extract was injected intraperitoneally into 2-week-old mice; if the extract contained strychnine, typical signs of strychnine poisoning were produced.

RESULTS

The results of the mouse injection tests were positive in 8 of the 10 cases in which strychnine was detected by the chemical procedure. One of the other two cases was labelled "suspicious". The technicians in the toxicology section found strychnine in all cases in which the mice showed typical signs. Test material from another canine case that had resulted in the death of a mouse with atypical signs in 5 minutes after injection was found to be positive for parathion.

The first significant sign observed in the mice injected with material from positive strychnine cases occurred in 2 to 3½ minutes. This was an accentuated response to noise, such as snapping the fingers or tapping the surface of the table with forceps. This hypersensitivity was progressive to a point at which even the slightest noise stimulated the mice to jump several centimeters vertically. Another constant finding was increased stiffness of the tail, often being carried erect or at a 45° angle. These signs progressed until death, which was immediately preceded by short running movements that lasted 2 to 4 seconds followed by extreme tetany with all legs rigidly extended posteriorly. Within a few seconds respiratory movements ceased.

The increased dilutions did little to alter this picture except that the response time was increased slightly. When death occurred, it was always in less than 12 minutes, usually 4½ to 5½ minutes. Even with sublethal dilutions the increased hypersensitivity to noise was still present, lasting approximately 40 minutes.

In two cases which we retested at 24 hour intervals, no decrease in the toxic effects was found after 3 days.

DISCUSSION

In the Republic of South Africa as in many other countries, it is relatively easy to buy strychnine, usually in the form of strychnine hydrocloride; therefore the malicious use of this substance will probably be a continuing problem. In Table I is presented the number of suspected cases referred to the Toxicology Laboratory over the past 10 years. Approximately 95% of these were dogs, and the remainder were cats. Positive cases have increased 42% in the past 5 years (1966 - 1970) over those of the previous five. These cases most likely represent only a fraction of the total number of poisonings by strychnine in the Republic.

Table 1: CASES OF SUSPECTED STRYCHNINE POISONING SUBMITTED TO THE ONDERSTEPOORT TOXICOLOGY LABORATORY

Year	Cases examined for Strychnine	Positive Cases	Percent Positive
1960/61	129	75	58%
1961/62	157	95	61%
1962/63	145	78	54%
1963/64	159	98	62%
1964/65	166	86	52%
1965/66	195	104	53%
1966/67	234	153	65%
1967/68	214	134	62%
1968/69	210	118	56%
1969/70	176	103	58%

The mouse inoculation test is not a new procedure, since it has been performed for a number of years as a routine procedure in diagnostic facilities in various countries throughout the world. Descriptions of the technique, however, are difficult to find and are often complicated by the need for laboratory equipment which may not be readily available to the veterinarian in private practice. It was our goal to keep the test as simple as possible.

Another diagnostic test often used is the inoculation of urine of the affected animal into mice or frogs. In our study, the bladder of the dog did not always contain urine, and in one case the test using urine was negative for strychnine, while the mouse test using the solution from the contents of the stomach was positive.

A third test — one that is highly sensitive and reliable for strychnine poisoning — involves the injection of a sampling of the stomach contents into the subcutis of the

back of frogs, but frogs may not be readily available to the veterinarian.

In an area in which several suspected strychnine poisonings have occurred each year, and white mice are not obtainable through pet shops, it may be practical for the veterinarian to keep a small cage with a pair of breeding mice to raise offspring for test purposes. They require little attention and breed prolifically.

Weanling mice are preferable because they are more sensitive to the test than adult mice. The toxicity of strychnine is dose dependant, so the younger the mouse the greater the response will be to minute doses.

A problem encountered with the test is that, at times, particulate matter tends to plug the needle. This is alleviated by allowing the mixture to stand a little longer before drawing off the fluid. A needle of larger diameter can be used, but if it is larger than 18 gauge the fluid tends to leak back through the tissue at the injection site after the needle is removed.

Other toxic substances, such as sodium fluoroacetate (1080), chlorinated hydrocarbons, and the toxins of garbage poisoning, can cause acute death when inoculated into mice[4]. After the history of the case is evaluated and the inoculated mice are carefully observed, these substances can usually be eliminated as a cause of death. In the case of sudden death of a dog, 1080 poisoning can, as a rule, be differentiated from strychnine poisoning because it produces a completely different clinical syndrome in that the victim repeatedly attempts to defaecate and runs aimlessly. These signs progress to tetanic convulsions and death, and there is no hyperirritability to external stimuli as with strychnine. The gastrointestinal tract is usually empty in contrast to that of cases of strychnine poisoning in which the stomach usually contains ingesta. In our experience, poisoning by 1080 in animals is rare in South Africa.

Poisoning of animals by chlorinated hydrocarbons (especially Dieldrin) is more common but can usually be differentiated from strychnine by its less acute course. In the mouse, it is reported to cause seizures which progress from the head caudally. In contrast, the seizures found with strychnine poisoning occur simultaneously in all parts of the body.

We encountered parathion poisoning in one case, and there was little doubt from the reaction of the mice tested that there was a different toxin present. It took longer for the signs to develop in the mice, and the hyperirritability was less intense than with strychnine. They showed, in addition, a progressive paralysis that started in the hindquarters, which is a common sign in poisoning by other organophosphorus compounds.

The rare death from garbage intoxication, (caused by the lethal toxins of *Staphylococcus* and *Clostridium* species) may be confused with strychnine poisoning[4]. Again, a careful examination of the history as to possible access to garbage could be helpful, although this may be misleading since the strychnine may have been put in the garbage. Vomition is a common sign in a case of garbage toxicity and, contrary to popular belief, is rare with strychnine. Another important differential point is that animals suffering from garbage intoxication are not sensitive to external stimuli — a cardinal sign in strychnine poisoning.

Our results indicate that a majority of cases of strychnine poisoning can be diagnosed easily by the veterinarian who uses this test, alleviating the long delay in diagnosis. The rapid diagnosis should stimulate a faster and probably a more successful investigation by local law enforcemet authorities.

It should be stressed, however, that if legal proceedings are contemplated in a given case the stomach contents and a portion of liver (minimum of 500 g) should be submitted in ethyl alcohol to a diagnostic laboratory for confirmation in accordance with the Department of Agricultural Technical Services Bulletin[5]. Also, if the mouse inoculation test results are negative, but the case history is suggestive of strychnine poisoning, the above specimens should be sent to the diagnostic laboratory for confirmation. This is especially applicable if the contents of the stomach are meagre. Both the stomach contents and the liver should be submitted for testing, because strychnine can be found in the stomach contents when it is not found in the liver, and *vice versa*[6].

Finally, a long period after death does not necessarily preclude the possibility of making a positive diagnosis of strychnine poisoning. As shown, a period of 72 hours did not significantly alter the results. In pro-

bably the most detailed study ever made on strychnine poisoning and its diagnosis, Steyn[3] showed that even after dogs had been buried for 11 months, strychnine could still be detected in 4 of 8 cases.

ACKNOWLEDGEMENTS

We wish to thank Dr. C. N. Barron, visiting scientist from the United States, for his help and advice in evaluating this procedure.

REFERENCES

1. Kamel S.H. & Ahlamy A.A. 1969 *Zentralbl. vet.* Rieke A. 16 : 543
2. Glaister J. 1938 Medical Jurisprudence and Toxicology. Livingstone: Edinburgh and London
3. Steyn D.G. 1935 *Onderstepoort J. vet. Sci. Animal Ind.* 5 : 139
4. Ramsey F.K., Buck W.B. & Duncan J.R. 1967 *Animal Hosp.* 3 : 221
5. Anon. March 1968. Directions for the Collection and Forwarding of Specimens for Laboratory Examination, revised ed. Dept. Agri. Tech. Sve., Government Printer, Pretoria
6. Hatch R.C. & Funnell H.S. 1968 *Canad. vet. J.* 9 : 161

BOOK REVIEW

VETERINARY HELMINTHOLOGY

ANGUS M. DUNN

William Heinemann Medical Books, Ltd., London 1969.

Pp XII + 302, Figs. 76, Plates 48. Price R10.80.

This is the finest book on Veterinary Helminthology to be written in English. It is lucid, well presented and frequently the canny humour of the author emphasizes certain points which may easily escape the student. It is divided into three parts and has two appendices.

Part I. *The parasites:* This is the best part of the book and deals briefly with the morphology, life cycle and importance of each parasite.

Part II. *The host-parasite relationships:* Although very brief these are soundly presented.

Part III. *The hosts:* This is divided into separate hosts and subdivided in each chapter into organ systems. This makes it very easy for the reader to follow the pathogenic effects on the hosts, epidemiology, diagnosis and control of the common helminths.

Appendix I. *Laboratory diagnostic aids:* These are sound but the techniques at autopsy should be updated.

Appendix II. *Host-parasite lists:* These are more than adequate for veterinarians.

There are a few minor criticisms and ommissions:—

Although this book is dedicated to Hugh McL. Gordon, his work is but rarely referred to. The references mentioned below have escaped the author's attention:

The studies on taxonomy of *Echinococcus* and *Taenia* by Verster; immunity studies on *Oesophagostomum columbianum* by Dobson; pathology of paramphistomiasis, trichostrongylosis and oesophagostomiasis by Horak & Clark; overwintering of immature nematodes in sheep by Muller and the ecological studies on nematodes by Donald.

In the introduction the author mentions that the development of anthelmintics is so rapid that they may be superseded by the time the book has reached the reader. This development is not as rapid as he implies and even if the better ones were merely mentioned this would be a marked improvement.

In a text book of this extent this is not surprising and does not detract from an excellent book which should form an important addition to any veterinarian's library.

— R.K.R.

BOOK REVIEW

ANIMAL PATHOLOGY

A. R. JENNINGS

First edition 1970. Bailliere, Tindall and Cassell Limited, London.

Pp. IX and 262. Price 32s.

This soft-covered book has been written primarily for the veterinary student reading the subject of animal pathology but, according to the author, may also be of interest to the veterinary surgeon in practice who desires to have essential facts marshalled for him in brief compass and thus keep himself up to date in the subject, and to the medical pathologist and people of other disciplines engaged in experimental work involving the use of animals.

The systemic approach to the subject is used and at the end of each chapter a list of selected references for further reading is given. A knowledge of general pathology is assumed. There are no illustrations.

In the preface it is stated that the purpose of the book is to provide a concise account of the pathological changes which occur in domestic animals. Each chapter starts with a brief presentation of the cardinal structural and functional characters of the organ and this is followed by an account of the disease processes which affect it. The emphasis is on the pathogenesis and on the macroscopic appearances of diseased tissue. Histological detail has been reduced to the minimum necessary for the understanding of the structural alterations which occur.

The book is intended only to assemble and review the basic knowledge of animal pathology for the student. Although, for example, the principal lesions of the common diseases are given briefly, details are lacking because it is the contention of the author that these should be filled in by reference to larger textbooks or through practical demonstration and teaching.

Certain mistakes, inconsistencies and omissions do occur and there is a lack of precision in some definitions, for example, on pages 12 and 14 the cause of pseudotuberculosis and ulcerative lymphangitis is given as *Cysticercus ovis;* on page 20 "Marrow tissue is yellow or red and consists largely of fat cells"; feline panleucopenia is given different names in different parts of the book (feline enteritis and feline agranulocytosis); on page 43 the cause of heartwater is given as *Rickettsia ruminantium* and is only mentioned under viral myocarditis; on page 81 the impression is gained that all forms of aspiration pneumonia result in a granulomatous response; on page 100 it is not mentioned on what mucosal surface ulceration frequently occurs in lamb dysentery — in this country particularly the Afrikaans name, bloedpens (blood-stomach) for lamb dysentery frequently causes confusion as to the location of the main lesions; on page 99 the cause of both piglet and bovine anthrax appears to be given as *Clostridium welchii* type C; *Actinobacillus seminis* is not mentioned as a cause of epididymitis in rams. The index is not complete and thus full use of the book cannot be made.

— R.C.T.

ABSTRACTS FROM THE ONDERSTEPOORT JOURNAL OF VETERINARY RESEARCH

Volume 36, Number 2, 1969

VAN ROOYEN, P.J., MUNZ, E.K. & WEISS, K.E. The optimal conditions for the multiplication of Neethling-type lumpy skin disease virus in embryonated eggs, pp. 165 - 174.

Maximum yields of lumpy skin disease virus were obtained in the chorio-allantoic membranes of 5- to 7-day embryonated eggs incubated at 33.5° to 35°C for 5 to 6 days. The route of inoculation did not significantly affect the growth pattern of the virus.

There was no correlation between yield of virus and the appearance of lesions in the chorio-allantoic membranes. Lesions were only produced in the membranes of 7- to 9-day embryonated eggs inoculated onto the membrane and incubated at 33.5° and 35°C.

VERWOERD, D.W. & HUISMANS, H. On the relationship between bluetongue, African horse-sickness and reoviruses: hybridization studies, pp. 175 - 180.

The double-stranded ribonucleic acid from bluetongue virus (BTV), African horse-sickness virus (AHSV) and reovirus has been tested for hybridization with messenger RNA derived from BTV and reovirus-infected cells. No relationship was found between reovirus and BTV or AHSV, but a small amount of hybridization between BTV and AHSV did occur.

HUISMANS, H. Bluetongue virus-induced interferon synthesis, pp. 181 - 186.

Blue tongue virus was found to induce interferon in mouse embryo (ME) cells and in mice. Different strains of bluetongue virus differed in their ability to induce interferon. Interferon production in ME cells commences after a 5 hour lag phase and the cells continue to produce interferon for 20 hours. Isolated double-stranded bluetongue virus RNA was found to induce maximum titres of interferon in mice approximately 4 hours earlier than was the case with whole virus.

THEODORIDIS, A. Fluorescent antibody studies on ephemeral fever virus, pp. 187 - 190.

The preparation and use of a highly specific fluorescein-conjugated antiserum against bovine ephemeral fever virus are described. The demonstration of fluorescent cytoplasmic inclusions is a dependable diagnostic test. The test also revealed cross reactions between the viruses of Japanese bovine epizootic fever and Australian ephemeral fever and that of South African ephemeral fever.

WORTHINGTON, R.W. & MULDERS, MARIA S.G. Antigenic relationship of *Brucella ovis* to *Brucella abortus* and *Brucella melitensis* using the complement fixation test, pp. 191 - 198.

The CF test was used to investigate the serological relationship of *Br. ovis* to *Br. abortus* and *Br. melitensis*. A definite antigenic relationship between *Br. ovis* and *Br. abortus* could be demonstrated. Definite results were obtained by absorbing sera with *Br. ovis*, *Br. melitensis* and *Br. abortus* before testing.

CAMERON, C.M. Antiphagocytic activity of *Staphylococcus aureus* antigens, pp. 199 - 206.

Systematic fractionation of a capsulated strain of *Staphylococcus aureus* has led to the isolation of two antigens which would specifically absorb opsonizing antibody from immune rabbit serum. One of these antigens was shown to be serologically identical to teichoic acid.

Teichoic acid is considered to be an important antigen for mediating phagocytosis and killing of staphylococci, but other antigens may also play a role in immunity depending on the strain involved, the route of infection, and possible deleterious effects of hypersensitivity reactions.

CAMERON, C.M. & MINNAAR, J.L. Immunization of mice against *Corynebacterium pseudotuberculosis* (Buchanan, 1911) infection in mice, pp. 207 - 210.

Mice were immunized with vaccines containing whole dry bacteria and adjuvant. They were challenged by the intravenous injection of living bacteria. The degree of im-

munity obtained was best expressed in terms of the difference in the Tangens values of the cumulative death rates between the immunized and control animals.

CAMERON, C.M., MINNAAR, J.L. & PURDOM, MARY R. Immunizing properties of *Corynebacterium pseudotuberculosis* (Buchanan, 1911) cell walls, pp. 211 - 216.

Mice were successfully immunized with purified cell walls. The immunizing properties were not affected by extraction with ether: ethanol or trichloracetic acid but were destroyed after treatment with formide.

BASSON, P.A. Studies on specific oculo-vascular myiasis (uitpeuloog) in sheep. V. Histopathology, pp. 217 - 232.

Specimens from 51 sheep and one goat were studied microscopically. Myiasis by *Gedoelstia* larvae occurred mainly in the organs of the head, neck and thorax, the eyes, brain, heart and blood vessels being most frequently involved. The fundamental lesion was thrombophlebitis which gave rise to glaucoma and other marked lesions in the eyes, infarction of the myocardium, lungs and kidneys and encephalomalacia in various parts of the brain. The migratory pattern of the larva appeared to be primarily intravascular, but extravascular routes such as those along the optic fasciculus and nerves of the head were also observed. The generic name, gedoelstiasis, is introduced for this specific type of myiasis.

VILJOEN, J.H. Further studies on the epizootiology of nematode parasites of sheep in the Karoo, pp. 233 - 264.

The dominant parasites in the Karoo are *Nematodirus spathiger* (Railliet, 1896) and *Trichostrongylus falculatus* Ransom, 1911. In the moister eastern regions *Haemonchus contortus* (Rudolphi, 1803) and *Oesophagostomum columbianum* (Curtice, 1890) occur but they decrease markedly as the region becomes more arid. *Ostertagia circumcincta* (Stadelmann, 1894) is of little or no significance.

The free-living stages of *N. spathiger* are highly resistant to heat and desiccation, but *T. falcalatus* cannot survive if the mean monthly mean temperatures exceed 20°C and even if the monthly rainfall exceeds 50 mm, there is but a slight increase in worm burdens. Both species reach peak worm burdens in winter. The presence of *H. contortus* or possibly *O. columbianum* has a deleterious effect on *N. spathiger*.

Strategic drenching is recommended in March and July and tactical drenching when climatic conditions are favourable.

NEVILL, E.M. The morphology of the immature stages of some South African *Culicoides* species (Diptera: Ceratopogonidae), pp. 265-284.

The morphology of the fourth larval stage of eight South African *Culicoides* species and of the pupae of seven species was studied. The value of existing taxonomic characters was tested and several useful new characters were found. Keys were constructed for the identification of both these stages. It is hoped that these studies will form a basis for future taxonomic work on the remaining South African *Culicoides* species.

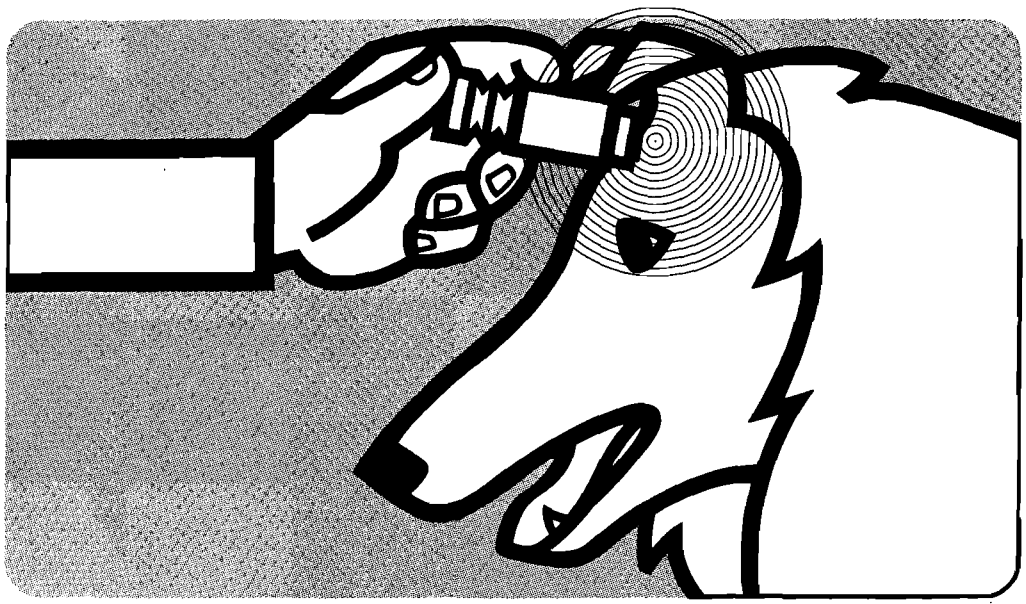
GROENEVELD, H.T. & REINECKE, R.K. A statistical method for comparing worm burdens in two groups of sheep, pp. 285-298.

In groups of experimentally infested sheep, worm distributions are markedly skew. In controlled anthelmintic tests, the worm burdens of treated and control sheep have different distributions and this invalidates the use of transformations.

Five experiments are described, of which the first three describe the evolutionary steps taken to find a suitable method for interpreting the data. A non-parametric method was evolved and the last two experiments demonstrate the use of this test to interpret the results. The entire method is explained and tables are included which simplify its use for biologists with no statistical training.

LE ROUX, J.M.W. Certain aspects of the facial and trigeminal nerves of the ox, *(Bos taurus* L.), pp. 303 - 320.

The author dissected thirty bovine heads to study the motor and sensory nerve supply to the zygomatic region. The motor and sensory branches to this region are supplied by the auriculopalpebral and auriculotemporal nerves respectively. It is suggested that these branches be named zygomatic branches. The buccal nerve constantly detaches a deep temporal branch, gives rise to glandular branches to the hard and soft palate and sends a communicating branch to the lingual nerve. Connections could be demonstrated between these branches and the otic ganglion and it is suggested that they carry visceral motor components. Observations on the otic and mandibular ganglia, the relations of the pterygoid, masticatory and buccal nerves and the variable course of the chorda tympani are recorded.



On Target with

Neo-Predef with Tetracaine

TOPICAL POWDER

effective topical treatment for eye, ear, and skin conditions in large and small animals

Four ingredients give four specific actions:

Steroid action – Predef (9-fluoroprednisolone acetate) provides greater anti-inflammatory activity than hydrocortisone.

Antibiotic action – *Neomycin offers* broad-spectrum control against Gram-positive and Gram-negative organisms.

Topical anæsthetic action – Tetracaine is more potent than either procaine or cocaine and has greater ability to penetrate mucous membranes than procaine. Its effectiveness lasts longer than that of butacaine or phenacaine.

Germicidal action – Myristyl-gamma-picolinium chloride is highly germicidal, nonirritating, and relatively nontoxic.

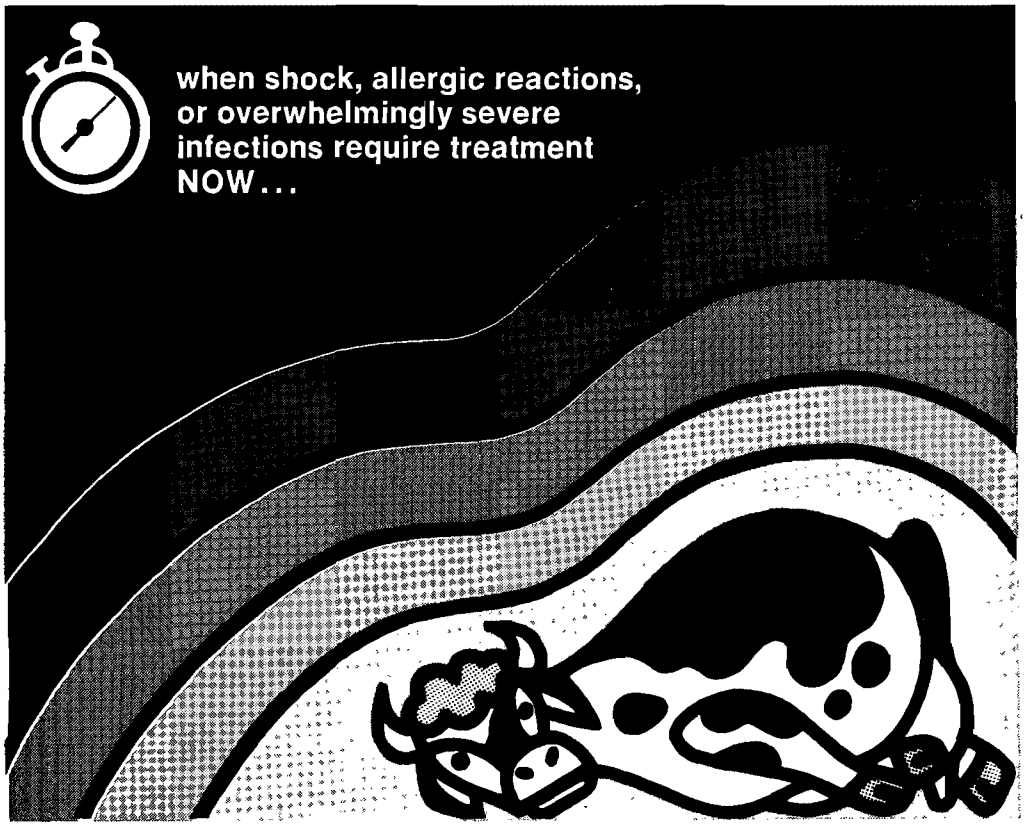
Supplied: 15 gm. plastic insufflator bottles.

TUCO

UPJOHN (PTY.) LIMITED / P.O. BOX 246 / ISANDO, TVL.

709 REGISTERED TRADEMARKS: PREDEF, UPJOHN 3AT 5998.2

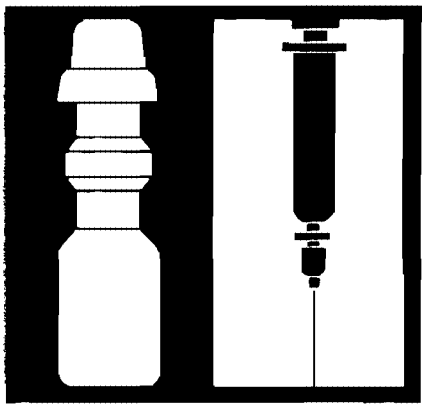
INDEX TO ADVERTISERS



Solu-Delta-Cortef

provides rapid, intense steroid action to combat situations of stress

Solu-Delta-Cortef



delivers

potent glucocorticoid activity, approximately five times that of cortisone

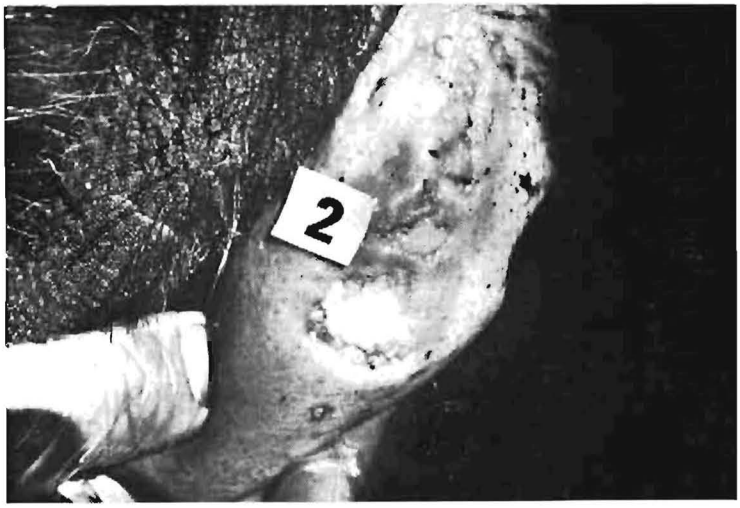
effective anti-inflammatory activity, at least three times that of hydrocortisone

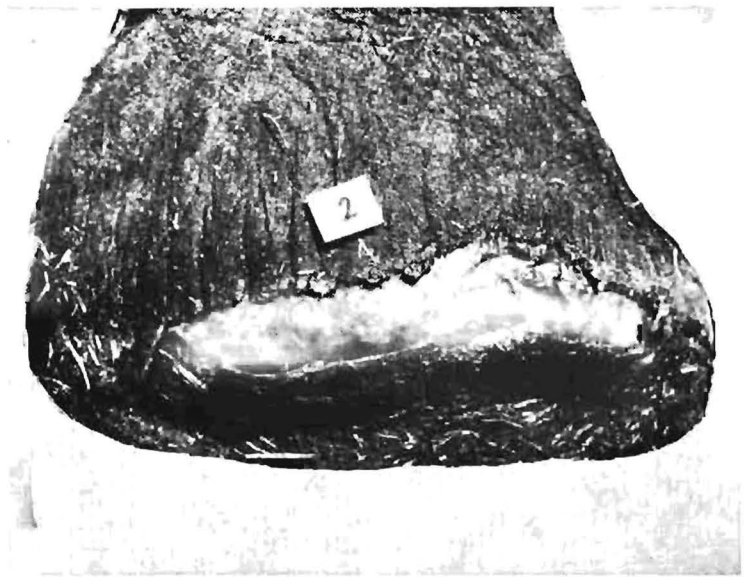
As a supportive measure to standard therapeutic procedures, Solu-Delta-Cortef provides effective, anti-inflammatory relief in large and small animals.

Supplied: Sterile, in 10 ml. Mix-O-Vials, each ml. containing 100 mg. prednisolone as prednisolone sodium succinate.

UPJOHN (PTY.) LIMITED/P.O. BOX 246/ISANDO, TVL.

TUCO





EXPERIMENTAL FOOT-AND-MOUTH DISEASE IN THE AFRICAN ELEPHANT
(Loxodonta africana africana)

During the course of a recent outbreak of foot-and-mouth disease in the Kruger National Park, an experiment was undertaken to determine the susceptibility of the African elephant to a SAT_2 strain of foot-and-mouth disease virus.

The above two photographs illustrate the lesions found 12 days after infection of one of the experimental animals. On the tongue, below the identification number of the animal, the primary site of intradermal inoculation can be clearly seen. At this stage regeneration of the epithelium was well advanced. The extension of the primary vesicle on the dorsal surface of the tongue is also clearly indicated by the irregular scar formation.

As indicated in the lower photograph, all four feet of this animal developed secondary vesicles which ruptured and gave rise to a complete separation of the soles from the underlying subcutis.

Submitted by: P. G. Howell, Veterinary Research Institute, Onderstepoort, and E. Young, State Veterinarian, Skukuza.
Photography: A. M. du Bruyn.

EKSPERIMENTELE BEK-EN-KLOUSEERLETSELS IN DIE AFRIKAANSE OLIFANT
(Loxodonta africana africana)

Gedurende 'n onlangse uitbraak van bek-en-klouseer in die Kruger Nasionale Park is 'n proef gedoen teneinde die vatbaarheid van die Afrikaanse olifant vir 'n SAT_2-stam van die bek-en-klouseervirus te bepaal.

Die bostaande twee foto's illustreer die letsels wat 12 dae na besmetting van een van die proefdiere gevind is. Op die tong, onder die identifikasienommer van die dier, is die primêre binnehuidse entingspunt duidelik sigbaar. Epiteelherstel was toe reeds goed gevorder. Die uitbreiding van die primêre blasie op die dorsale tongvlak is ook duidelik deur onreëlmatige littekenvorming te sien.

Al vier pote van hierdie dier het sekondêre blasies gevorm; laasgenoemde het gebars en die sool het geheel-en-al van die onderliggende weefsel losgelaat.

Ingestuur deur: P. G. Howell, Veeartseny-Navorsingsinstituut, Onderstepoort, en E. Young, Staatsveearts, Skukuza.
Fotografie: A. M. du Bruyn.