EXERTIONAL MYOGLOBINAEMIA IN BLACK WILDEBEEST, AND THE INFLUENCE OF GRADUATED EXERCISE*

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ABSTRACT: Harthoorn A.M. **Exertional myoglobinaemia in black wildebeest and the influence of graduated exercise** *Journal of the South African Veterinary Association* (1980) **51** No. 4 265–270 (En) Transvaal Division of Nature Conservation, Private Bag X209, 0001 Pretoria, Rep. of South Africa.

INTRODUCTION

Myoglobinaemia (and its concommitant myoglobinuria) may be regarded as one of the cardinal signs of the capture myopathy syndrome. It is readily seen in antelopes that have been subjected to unusual stress either in the form of running or after isometric exertion while roped or in a net. The serum level of myoglobin appears to be a reliable indicator of the amount of stress to which the animal has been subjected in relation to its capability to withstand such stress, but also to its survival potential. In relation to the latter it should be said that there is every indication that the animal may be fairly severely stressed with substantial levels of myoglobin in the bloodstream, but survive if released into natural or near-natural surroundings. Such an animal is likely to succumb to myoglobinaemic nephrosis if kept under conditions of close confinement with continuing adrenergic discharge, raised lactic acid levels, and possible dehydration due to unwillingness to drink out of water containers (black wildebeest on farmland during drought condition have been known to die of thirst rather than drink out of drums) and the loss of condition usually associated with holding in pens. Unlike other indicators of exertional stress such as creatine phosphokinase, the myoglobin appears to reach its highest level at the time of capture, which may be the only time that a blood sample may be drawn. For the purposes of these tests, the discolouration of the blood serum has been termed myoglobin. In fact, previous work has indicated that some haemoglobin is also present, but this is being ignored as largely irrelevant for the purpose of this experiment.

An important aspect of the capture myopathy syndrome is myoglobinuria. This is symptomatic of breakdown in muscle fibres resulting on exceptional exertion as occcurs during the capture of wild or para-wild animals. Experimentally the manual restraint of captured Sable antelope will induce a rapid rise in plasma myoglobin, and a severe hyperkalaemia rising in approximately 1 h to lethal levels. Non-acute deaths in wild animals after capture are mostly associated with myoglobinaemic nephrosis. Sublethal myoglobinaemia is a typical occurence in animals such as black wildebeest captured mechanically for experimental purposes whether capture was effected by driving into a plastic funnel, into nets or a combination of the two. When animals were subjected to regular and incremental exercise or training, however, the incidence of myoglobinaemia dropped to undetectable levels or to zero. The regime entailing semi-weekly drives at moderate speed through an open ended capture funnel also induces a reduction in the rise of potassium and of creatine phosphokinase and oxaloacetic-transaminase which under the previous capture conditions had risen to substantially high levels. It is concluded that myoglobinaemia, and its concomitants, myoglobinuria and myoglobinaemic nephrosis, may be prevented by suitable training procedures which are readily carried out in para-wild animals after restriction in suitably sized enclosures and may even be applicable to wild animals after attraction into similar or modified enclosures prior to close confinement and handling.

*Paper read at the South African Veterinary Association Congress, Rand Afrikaans University, Johannesburg, 5 September 1979

CAPTURE MYOPATHY

1. Definition of capture myopathy

Capture myopathy is the term favoured to describe a condition occuring in wild animals on or after capture[2]. Clinical symptoms are signs of pain, stiffness and disability of certain muscles and muscle groups, leading to paresis, torticollis, prostration and paralysis. Death may occur immediately after capture in hyper-acute cases, or up to 12 h later in the acute cases. The principal manifestations are dyspnoea, tachycardia, areflexia, and a disinclination to move. Discolouration of the urine is frequently seen. Characteristic signs are dullness, anorexia, and progressive lack of response to stimuli.

2. Outline of the Pathological Picture

The post-mortem picture typically shows pale areas in the muscles that are asymetrically bilateral. The lesions of exertional myopathy are apparently identical with those of nutritional myopathy due to selenium and vitamin E deficiency, and show hyaline degeneration with loss of cross striation in the muscle fibres. Ruptures in the skeletal and cardiac muscle fibres lead to haemhorrages. Where death is not acute there is necrosis and mineralisation, with sarcolemmal proliferation and fibrosis of the muscle tissue. Necrotic lesions are seen in adrenals, liver, spleen, lung and lymph nodes. The kidney usually shows signs of inflammation, necrosis and tubulorhexis.

3. Contributing factors

Contributing factors to the condition are: maximal speed of chase, prolonged exertion without rest, fear, handling, manual restraint by bonds or in a net, prolonged stress as in crating or transport, holding in crates or in pens, subjection to fear stimuli over periods of time, such as noise, renewed and even minor stresses, such as repeated moving and transport, nutritional deficiency and hyperthermia.

4. The situation on provincial reserves and on game farms

Changes in the methods and the patterns of capture in

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the Transvaal provincial reserves has greatly reduced the capture mortality over the last half dozen years. In 1973 the death rate over the 1–2 thousand animals captured and relocated a year was just under 15%, in 1974 it was under 5%. Last year (1978) total deaths from all causes during capture holding and relocation was down to 1,1%. Contributing factors to the former mortality rate was undoubtedly: the general use of nets for capture with the accompanying long periods of manual restraint, the capture of individuals rather than family groups, individual crating and transport, prolonged holding in slatted pens, further handling and transport after a resting period of a week or so[1] and a precipitative change of fodder. Favourable modifications during the latter years have undoubtedly been: the reduction of the speed of the chase, periodic rests during drives over long distances, almost total absence of handling, the capture of family or herd groups, the transport to the destination almost immediately after capture, with absence of holding or quarantine, the use of plastic sheeting or hessian funnels and corrals, and reduction of fear to the minimum in the subject animals through the elimination of shouting and other noise, and minimal contact between the animals and the capture personnel.

5. Exercise as a remedial factor

Notwithstanding this satisfactory reduction in mortality, research has continued in an attempt to formulate a system where stress is reduced to a minimum. There are two principal reasons for this objective. Firstly, mortality is not a satisfactory criterion of the success of a capture method and many animals may survive albeit significantly stressed. Such animals may die if, during a similar exercise, environmental factors are not so favourable, or if other stressing factors are added such as longer holding or quarantine. Secondly, the method of driving using a helicopter and plastic sheeting requires highly trained and knowledgeable teamwork. Consequently it has proved very much less successful in the hands of game farmers and others who have attempted to use it, so that a method more suitable for the relatively inexperienced or less well equipped is necessary. Other and relatively minor aspects are the escalating expense of a helicopter, and the pressure of time whenever such is used. Also the problems of handling and holding newly captured stock and so on, including the difficulties associated with the sudden change in food when animals are caught off the veld and then held in stockades.

Examination of newly caught animals indicates that during capture, wild animals are subjected to a degree of exercise stress that is both unusual and unnatural, and that the ability to contend with such stress has no survival value under natural conditions. Symptoms exhibited by animals after an intense chase at (their) maximal speed or pace were clearly analagous to that of azoturia in untrained or rested horses. Animals captured on game farms or on provincial reserves are even less well adapted to sudden and intense exercise than those captured in the more natural areas or in National Parks of Africa, and which also exibit capture myopathy. The hypothesis that wild and para-wild animals are basically unadapted to prolonged running and consequently suffer from stress and myopathy when stampeded over substantial distances by car or helicopter was substantiated by running eland on an exercise track. These animals exhibited spectacular drops in levels of stress indicators such as creatine phosphokinase (CPK) following exercise as compared to the first run (see Fig. 1). On the basis of these results, which were substantiated in other species of ungulates, it was felt that: on the one hand any prolonged and fast run should be avoided, and on the other the animals would be adapted to eventual capture. This was achieved by a process of mock capture.

6. Mock capture as an element in training and taming

The basis of training and taming is that of mock capture, in which the animals are subjected to runs through a double-ended capture funnel. This procedure can be carried out with a minimum of coersion while the end of the corridor or funnel remains open and the animal are induced to pass through without driving. This exercise permits familiarisation with the plastic sheeting and capture module, and also trains the animal physically through a series of incremental runs. It appears that the passage by the animals through the funnel and corridor module on a number of occasions, without actually being subjected to capture or stress, has a taming effect in that they are familiarised with the process and possibly impressed with its seemingly inocuous nature. In any case the animals subjected to this process became tamer and less inclined to panic, and are able to tolerate subsequent close confinement better than animals not so conditioned.

7. The mechanics of mock capture

(a) Enticement into enclosures

The basic module for the taming and training procedure has an area of 10 ha and measures 400 × 250 m. Where the extent of the enclosure in which the animals are to be caught or are kept is considerably larger, or in the case of animals in parks, modules of approximately this size are built and the animals are attracted into these in a number of ways. The enticement procedure is most easily carried out by means of water if other watering points in the area can be rendered unavailable. Otherwise the animals may be attracted by means of salt, lucern or other hay, or by standing crops such as sunflower. Under ideal circumstances the animals are permitted to enter the enclosure freely and remain undisturbed for weeks or even for months, or possibly on a permanent basis throughout the year until capture is required. When the correct group or composition of animals has entered and capture is desired, the gate(s) is closed.

(b) Dimensions and construction of capture corrals

Depending on the species of animals to be captured, the sides of the corral is constructed of game fencing with or without wire mesh. The fence may or may not have to be lined with plastic material. The type of construction depends not only on the species of animal, but its familiarity or otherwise with fencing. It is difficult to lay down hard and fast rules. Recently newly captured impalas were released into a 40 ha enclosure

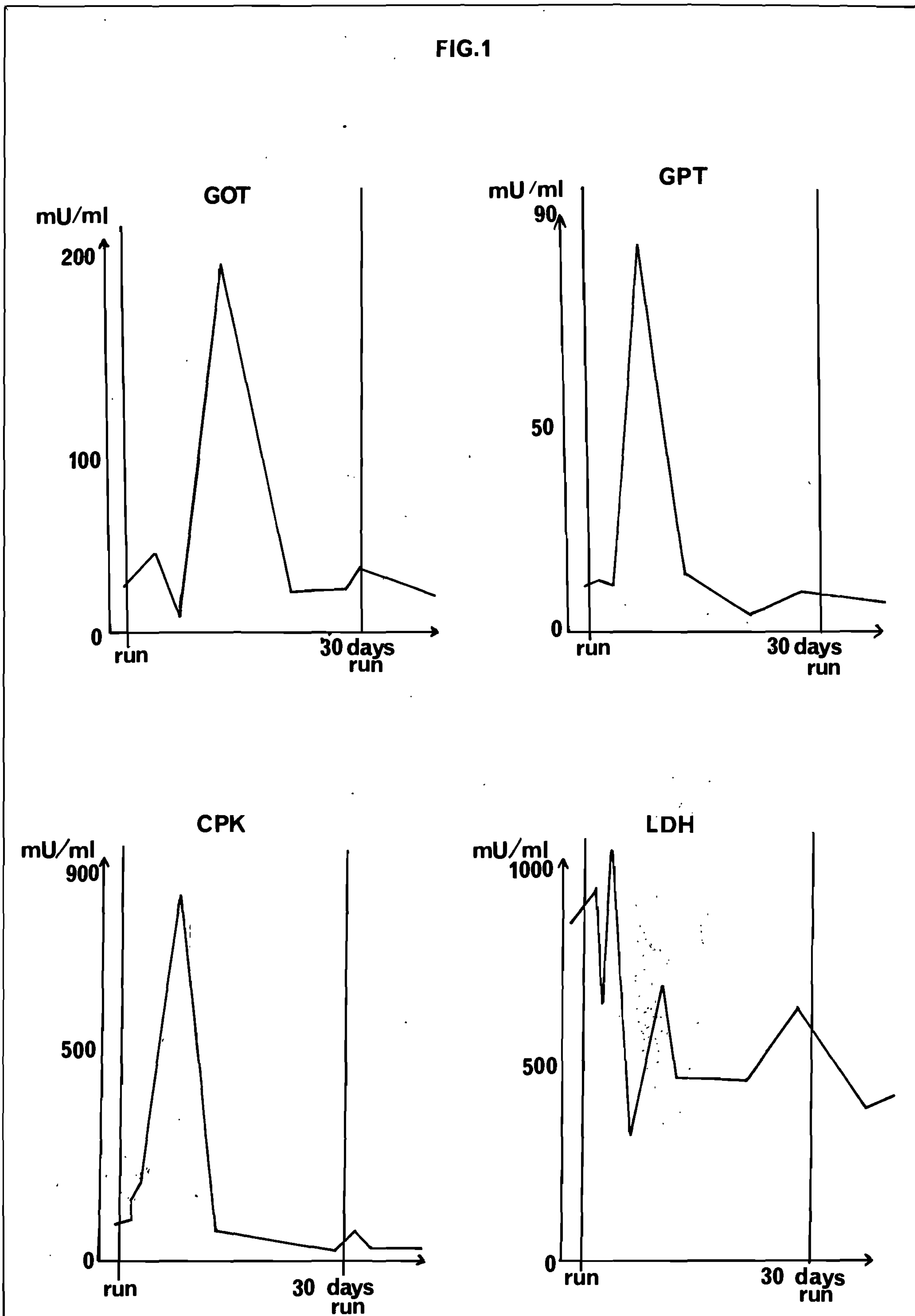

Fig. 1. Levels of GOT, GPT, CPK, and LDH before and after exercise training

composed of wire mesh, and surprisingly none came to harm or tried to jump through the fence, while blesbok, generally regarded as a much more tractable animal, broke through fencing of a capture corral. It may be mentioned that whereas the cost of such a structure as described may be substantial, it is a capital asset, and should be useable for a decade or more without additional expense apart from minor maintenance. The ideal structure is composed of 4 paddocks or corrals each of 10 ha, but two such modules placed end to end will suffice. With two modules the animals are enclosed in

FIG.2

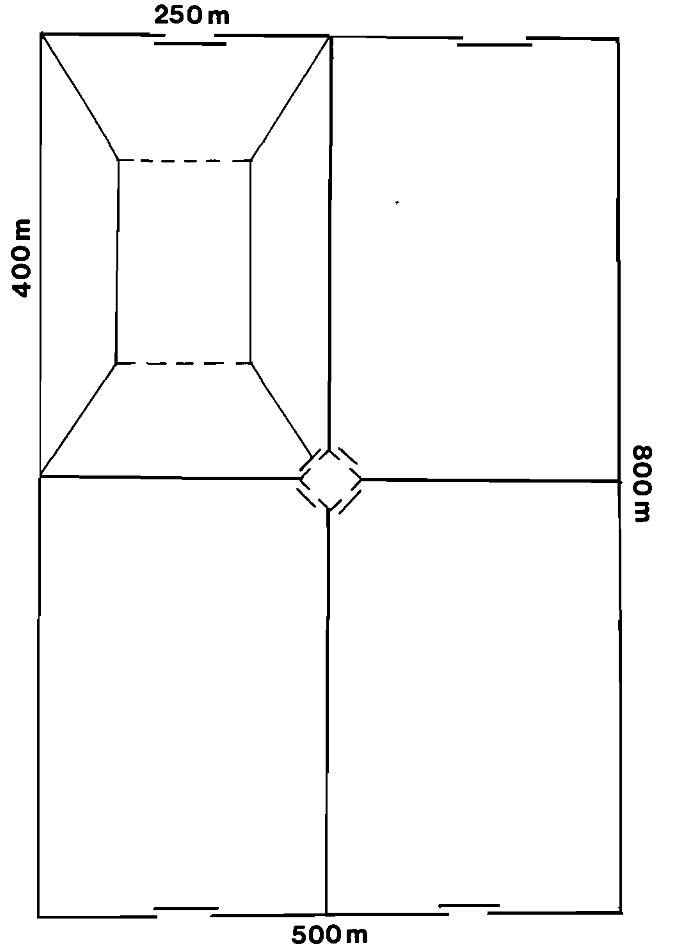

Fig. 2. The corral system used for the capture and subsequent taming and training of antelope.

one and the structure for taming and training is built in the other. Where four modules are built as in Fig. 2, the central system of gates gives scope for segregation of groups of animals, or continuation of the capture exercise without disturbance to animals already enclosed.

(c) Plastic sheeting training structure

The training structure is usually composed of polypropylene woven fibre plastic sheeting of a neutral colour. This may be 1 or 2 m high depending on the species to be driven through, for instance 1 m for black wildebeest *(Connochaetes gnu)* and 2 m for Sable antelopes *(Hippotragus equinus)*. The plastic sheeting is fixed by short lengths of wire to horizontal strands of fencing wire connecting poles placed about 10 m apart. The double funnel and corridor system is depicted in Fig. 2. Each of the two funnels should connect with the long sides of the corral fence so that the animals are forced to travel through the funnel and corridor each time they are disturbed. In such a structure it is very easy to induce the animals to move or run through the funnels and corridor with the minimum of coersion. The period of training during both experimental and practical tests has been 1 month or slightly longer, with runs being effected twice a week.

(d) Capture techniques

The connecting corridor is equiped at each end with a plastic curtain on runners (top and bottom) that may be rapidly closed. When actual capture is required, the animals are induced to run through as usual, and one curtain is closed just before their arrival at the one end. As they turn the other curtain is also closed. A truck may then be backed to one end of the corridor for loading.

By the end of the month, the animals are thoroughly adapted to most of the procedure. A normal group of animals will have been caught which have had further opportunity to react to each other on a herd basis. The strangeness of the plastic material or hessian will now have minimal impact, the animals will be in a good nutritive state, and used to the type of fodder that is being fed in addition to the natural grazing. The truck may be dug down to facilitate loading, and the ramp and floor covered with earth, litter, and preferably also the animals' dung. The tempo of the final chase need now be no more than that of any practice run, so that the animals should suffer from no exertional stress.

8. Results

The effect of one monthly capture and a period of biweekly exercise on black wildebeest was determined on the basis of the presence of intravascular myoglobin, to obviate the need of repeated capture and bleeding which is necessary when determining the rise in indicators such as CPK. The results are depicted in Fig. 3. When capture was carried out monthly there was little taming effect, and the serum myoglobin levels fell only gradually. When the animals were subjected to biweekly runs through the plastic funnel module, the myoglobin fell rapidly to zero or to undectable levels.

It is clear from the levels of myoglobin, that the effect of the taming and training programme is not permanent, and when a month was subsequently allowed to elapse without the bi-weekly runs the myoglobin levels rose again as the animals ran faster and were less easy to handle, for sampling.

9. Advantages

The obvious advantages of this capture method is the reduction in stress as indicated by levels of CPK, etc. but more particularly by the reduced levels of myoglobin in the blood serum. There are, however, a number of concurrent advantages which may be especially valuable to the game farmer, or to the staffs of animal parks which have a smaller routine in animal capture than do the provincial reserves. These are the following:

(a) Most or even all the capture work may be carried out by the personnel immediately concerned with the day to day care of the animals.

FIG. 3

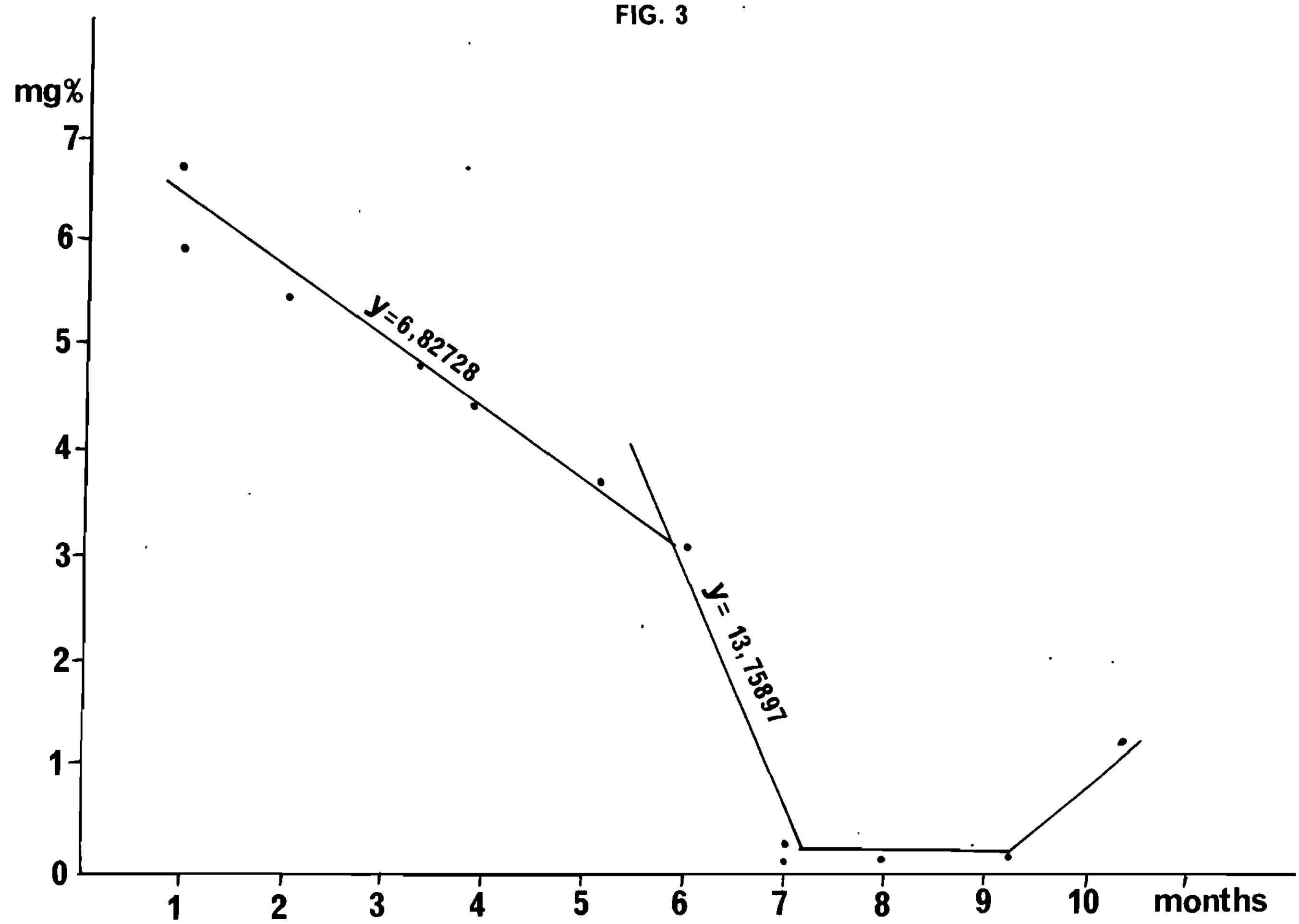

Fig. 3. Levels of free myoglobin in black wildebeest firstly during monthly capture and secondly after semi-weekly training runs.

(b) The enclosure of the animals can be carried out both without specialised teams but also with the minimum use of vehicles or the use of a helicopter.

(c) The timing or urgency of the capture operation becomes far less than is the case if a helicopter and a specialised team is hired, and also the animals can now be enclosed well before a critical day such as an auction, as the holding for relatively long periods becomes not only less of a problem, but even an advantage.

(d) The animals do not deteriorate on holding as is the case where they are driven and then placed in pens, in fact the holding in 10 ha enclosures tends to improve the nutritional status of the animals. Also the animals are accustomed over a period of a month or so to other types of food, lucerne hay or concentrates thus obviating a sudden change of diet. As in this system there is usually no period during which animals refuse food and/or water as is frequently the case of animals which are driven and held in pens.

(e) The capture preparation may now be spread over a much longer part of the year, as hyperthermia is less likely to occur. It thus no longer becomes necessary to drive animals during the latter part of winter when they are in poor condition, a factor responsible for a proportion of the mortalities in the past. Animals may in fact be induced to use the enclosures all the year round and be enclosed virtually at any time.

(f) The cost factor should be reduced over several years of capture operations, and become very much more predictable as the recurrent expenses are very small.

(g) The losses in stock (which have been well over 50%) and have been a heavy burden for game farmers, should now be much reduced whether the animals are captured for sale or relocation, or for the meat market. This method of capture has already proved a valuable asset for cropping both in wild areas and on game farms, and the enclosed animals are easily killed at an optimum time during the hours of darkness using a light and a light calibre rifle.

(h) The facilitation of capture should be an encouragement to putative game farmers and encourage the acquisition of game animals on farms.

DISCUSSION

Myoglobinaemic nephrosis was recorded as a constant symptom in almost all animals that died in pens from 1–6 weeks after capture. The wildebeest in this experiment did not show symptoms of nephrosis suggesting that certain levels of myoglobin in the bloodstream may be tolerated if the animals are released in natural or near-natural surroundings, and may be associated with the degree of sympathetic tonus, lactate levels in the blood, normal exercise and so forth. The apparent tolerance to myoglobin of animals that are not confined suggests that a much lower mortality can be expected when animals are released soon after capture instead of being confined to stalls for periods of time before being moved to new surroundings, and this tallies with the more recent routine of the capture unit whereby animals are moved within 24 h whenever possible and the sharp reduction in the death rate that has been achieved.

The increasing popularity of game farming or the stocking of sections of farmland with game animals such as blesbok *(Damaliscus dorcas)* brings such animals more closely within the province of the veterinarian. Both from the game farmers' as well as the veterinarians' viewpoints, it appears advantageous to evolve a system of capture that can be described in detail, is fairly simple to operate, is of a clearly defined cost structure, and which can be operated without specialist expertise. Such a system also becomes necessary for the veterinary treatment of such animals, and this is likely to become increasingly necessary as these animals are kept in confined surroundings and on farm land.

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2. Harthoorn A M, Young E 1974 A relationship between acid-base balance and Capture Myopathy in zebra *(Equus burchelli)* and apparent therapy. Veterinary Record 95: 337–342

BOOK REVIEW — BOEKRESENSIE

PARASITOLOGY FOR VETERINARIANS

J.R. GEORGI with a chapter on antiparasitic drugs by V.J. THEODORIDES
W.B. Saunders Co, Philadelphia, USA 1980 pp VI + 460, Fig. 270, Tab. 5, Publ. price £18=50

There are 3 parts:

Part 1 Fundamentals of Parasitology (Chapters 1–9)

The arthropods are introduced in Chapter 1 and the arthropods and helminths Chapters 2–8 are well-described. The sure hand of Ron Fayer is present in Chapter 9 on the Class Sporazoa but the other protozoa are superficially dealt with.

Part 2 Diagnosis of Parasitism (Chapters 10–15)

I might well give the author a few tips on an examination post mortem (Chapter 14) but the rest of this part is excellent, particularly Chapter 15 which contains the host parasite list which the author has illustrated.

Part 3 Clinical Parasitism of Domestic Animals (Chapters 16–19) In Chapter 16 I merely mention in passing that Tom Miller (1966a, b, 1971) spent many years of his life working on *Ancylostoma caninum* and *A. braziliense* and developed a vaccine which was commercially available in the USA. Anna Verster (1965) published a monograph on *Echinococcus granulosus* and in Africa at least, hydatid cysts in cattle are fertile not sterile. I doubt whether the treatment of cats for cestodes with arecoline hydrobomide or nitroscanate is ever used with safety nor are any chlorinated hydrocarbons (e.g. lindane) or organic phosphate insecticides used in cats.

The reviewer does not agree with many of the statements and hypotheses propounded by Prof. Georgi in Chapter 17, particularly those concerning immunity and hypobiosis in nematodes.

In Chapter 18 p 386 it should be noted that thiabendazole paste (1 g thiabendazole 5 g petroleum jelly) kills *Habronema* larvae and Ivamectin 0,2 mg/kg or Nitroxynil 20mg/kg are effective against *Parafilaria bovicola*. Taffs (1959, 1964a, b, c) who has done classic studies on *Ascaris suum* should have been mentioned in Chapter 19.

In Chapter 20 by V.J. Theodorides there is a comprehensive list of antiparasitic drugs particularly anthelmintics. Like all out colleagues in the USA he has my deepest sympathy. The Food and Drug Administration (FDA) and the Environmental Protection Agency have done their best to smother any initiative our colleagues may show even forcing Theodorides (no doubt for his own protection) to state on p 399:

> "If there is any disparity between the information presented in this chapter and that printed on the label or package insert, *always* follow the manufacturers recommendations"

Many of the excellent compounds in this chapter are synthesized in the USA and the benzimidazoles particularly have very limited use or are not approved by the FDA. Oddly enough arsenic which you cannot destroy and the most toxic of all anthelmintics, nicotine sulphate are registered as cestocides but the best drug for cestodes praziquantel is not approved. For *Fasciola* hexachlorathane is acceptable, but less toxic compounds such as nitroxynil, rafoxanide and oxyclozanide are not registered.

I think the author might warn his readers that albendazole at 25mg/kg 3 times a day for 5 days for horses can be toxic.

In my opinion this book is well worth buying and a useful addition to any veterinarian's library.

R.K. Reinecke